Short-Medium Term Assessments of Coastal Land Loss in Katat-tauk Area, Thanbyuzayat Township, Mon State

Moe Zat[1], Kyi Kyi Maw[2], Zaw Lin Phyo[3] and Yazar Phyo[4]

Abstract

In state bordering the Gulf of Martaban and the Andaman Sea, most of the research areas of coastal land have been destroyed as a result of natural processes and human activities. The physical factors that have the greatest influence on coastal land loss are reductions in sediment supply, relative sea level rise, and the intensity of storms, whereas the most important human activities are sediment excavation, stream modification, and coastal construction. As a result of these agents and activities, coastal land loss is manifested most commonly as beach/bluff erosion and coastal submergence. Wetlands are also subjected to the same physical process and activities as other coastal lands, but they are also susceptible to deterioration as a result of biogeochemical processes. Failed reclamation projects and induced subsidence also contribute locally to wetland losses in the research area which retreat ranges from nearly zero values to a few several meters.

Keywords: Coastal land loss, Coastline retreat

Introduction

Coastal land loss includes beach erosion, but it is a much broader term because it also includes land losses along bluffs and losses of wetlands around interior bays and estuaries. Coastal land loss is a global problem. It is the result of a combination of factors that develop at different scales.

The most important causes of coastal land loss are natural processes of erosion, inadequate sediment supply to beaches and wetlands, and coastal submergence (relative rise in sea level) and human activities (Table 1). Any one of these causes may be responsible for most of the land loss at a particular site, or the land loss may be the result of several factors acting in concert (Figure 1).

Table 1. Common physical and anthropogenic causes of coastal land loss

Primary Causes of Land Loss			
Natural Processes		**Human Activities**	
Erosion	Waves and currents Storms Landslides	Coastal Construction	Sediment deprivation (bluff retention)
Sediment Reduction	Climate change Stream avulsion Source depletion	Climate Alteration	Global warming and ocean expansion Increase frequency and intensity of storms
Submergence	Sea-level rise	Excavation	Mineral extraction (sand, heavy minerals)
Wetland Deterioration	Saltwater intrusion	Wetland Destruction	Pollutant discharge Failed reclamation

[1] Associate Professor, Department of Geology, Dagon University
[2] Professor and Head, Department of Geology, Dagon University
[3] Assistant lecturer, Department of Geology, Dagon University
[4] Assistant lecturer, Department of Geology, Dagon University

Study Area

The research area Katat-tauk is situated about 16.4 km (10.2 mi) northwest of Thanbyuzayat Township, Mon State, lying between 16º00'26.15"N to 16º03'09.6"N and 97º34'43.85"E to 97º35'09.19"E; about 10.7 km (6.66 mi) long (Figure.2).

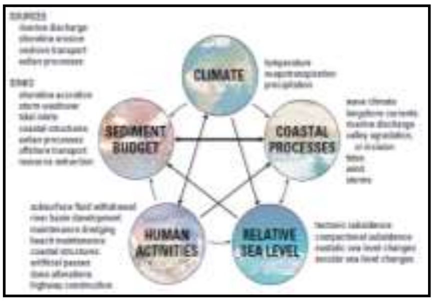

Figure 1. Interaction of factors that influence land loss (Modified from Morton, 1977)

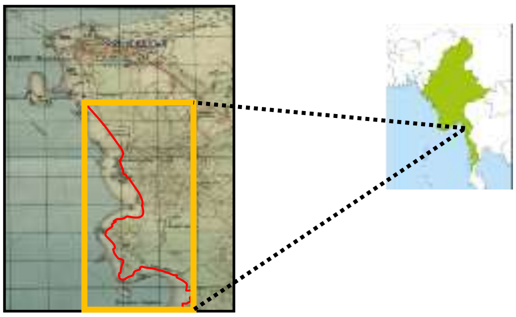

Figure 2. Map showing the location of Katat-tauk coastal area

Method of Study

The research was conducted by considering different issues related to the shoreline retreat. All the data were georeferenced in a GIS-environment. The difficulty in matching of the satellite image on the UTM (Universal Transverse Mercator) map and topographic map that constitute very different kinds of landscape representations, was overcome by selecting and georeferencing a series of “stable” points or features (e.g. Green Island).

Coastal Morphology and Vegetation

The profile and plan-view-shape of the coast also determine its vulnerability to erosion and submergence. The performed field work allows subdividing the main morpho-sedimentological types of coast into four order physiographic units (Table 2). The main morpho-sedimentological characteristics are illustrated in (Figure 3).

The density and type of vegetative cover also influences land loss by (1) dissipating the wave energy reaching sheltered shores, (2) encouraging the accumulation of organic and inorganic sediment, and (3) acting as a sediment binder that resists erosion. Some common coastal vegetation habitats in the research area are maritime forests, fresh-water swamps, fresh-water marshes, mangrove swamps, salt-water marshes (Figure 4).

Table 2. Main morpho-sedimentological types of coast in Katat-tauk area

Unit	Morpho-sedimentological characteristics
1	Continuous interbedded of phyllite and quartzite (Taungnyo Formation)
2	Continuous sandy shore face
3	Silty clay coastline
4	Metasedimentary (mainly migmatite) and igneous (mainly porphyritic biotite granite) of rocky coastline with silty clayey sand

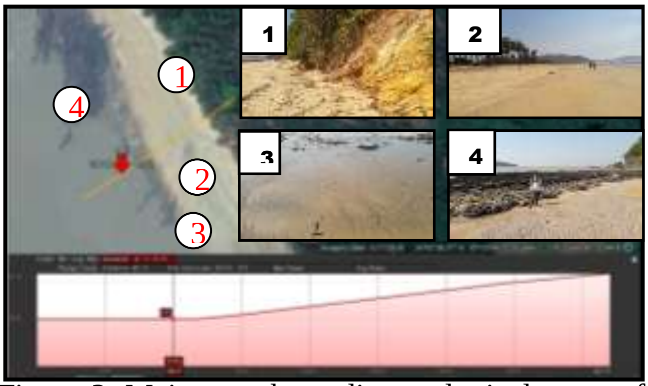

Figure 3. Main morpho-sedimentological types of coast in Katat-tauk area

Figure 4. Various natural vegetation in maritime forest Katat-tauk coast

Types of Coastal Land Loss

Mechanical erosion of waves

The mechanical action of waves is the main erosion factor in the research coastal environments, through high energy waves or storm waves. Abrasion is owed to the erosive action of currents (of wave origin) and includes the rolling of rocks and sand along slightly inclined rocky surfaces and the ejection of coarse material on steep surfaces. The erosive action of water is greatly increased when transporting sand and pebbles (Figure 5).

Weathering

Physical weathering can derive from alternating cycles of hydration-dehydration in the research area. Therefore, the rock in the intertidal zone will undergo two cycles of drying and wetting during the day. The rock is fragmented through the development and subsequent widening of capillaries and larger cracks (Figure 6). Chemical weathering is difficult to rank the susceptibility of rocks to weathering, however, igneous rocks are considered less susceptible to chemical weathering in comparison to sedimentary.

In the research area, the average temperature is about 35ºC and rainfall is 50 mm (sometimes 75mm (2.95') in 2012), so that most of the metasedimentary and igneous rocks subjected the lateritization processes and change to laterite (Figure 7). Wave action may be solely responsible for removing the weathered material.

Bio-erosion

In the research area, the crucial factor in the efficiency of bio-erosion is the spatial distribution of marine organisms along the rock surface, which is largely controlled by the available moisture and consequently the characteristics of the tide levels and wave energy (Figrue.8).

Figure 5. Erosive action of wave produced transporting sand and pebbles

Figure 6. Development and subsequent widening of capillaries and larger cracks on the rock surface by weathering

Figure 7. Metaigneous rocks subjected the weathering processes and change to laterite

Figure 8. The removal of rocks by bio-erosion in the research area

Landslides and Cliff Retreat

In the research area, coastal landslides occur where unstable slopes fail and land is both displaced down slope and lost (Figure 9). Some of the fundamental causes of slope failures that lead to land loss are: (1) slope over-steepening (2) slope overloading, (3) shocks and vibrations, (4) water saturation, and (5) removal of natural vegetation.

Some coastal landslides in the research area are related to faulting and earthquakes because of Three Pagoda Fault is terminates in this coastline and enters the Andaman Sea. But most of the landslides along cliffs are intermittent and caused by combined marine and subaerial erosion. High storm waves attack and erode the base of the cliff, which causes over-steepening (Figure 10). This results in collapse of the cliff and accumulation of debris (talus) at the cliff base.

Weather patterns, sea-level fluctuations, composition of the cliff, and structural dip of the cliff strata control land loss along sea cliffs. It is noted that cliff retreat occurs frequently in the rainy in association with storms and high rainfall.

Figure 9. Landslides and rock fall causes by unstable slope fail of coastal sea-cliff

Figure 10. High storm waves undercut coastline cliffs base which causes over-steepening of cliff

Main Parameters Defining Coastal Erosion

Climate

The tropical climate condition in the research coastal zone is a significant factor for the intensity of coastal land loss. Seasonal temperatures and annual precipitation indirectly influence land loss of both rocky and sedimentary shores of this area.

In the rainy season, the southwestern monsoon wind is the most important climatic variable for coastal erosion process of this area. The wind defines the wind waves and the resulting coastal currents. The stronger the wind in the coastal zone, the larger the wave height (about 20') and therefore the erosive action is occurring (Figure 11).

Wave Regime

In the research coastal area, the wave regime is directly related to the wind conditions. It is also defining in the configuration of coastal geomorphology. The more intense the wind the more erosive is their action, as they break on the coast.

Global sea level rise and subsidence

During the last century, global temperature has increased by 0.3–0.6 ºC and the eustatic sea level has risen by about 0.2 m. Climate models have estimated that the global temperatures may rise by 2ºC by 2100, with the sea level rising by 52 cm (20 in), during the same period (Church *et al*., 2010) (Figure 12).

Releveling surveys indicate that the research area is not only sea level rising in a relative sense at many coastal sites, statistical analyses of long-term records show that the present rates of relative sea-level rise are much greater than rates of submergence for the past few ten years. This discrepancy between historical and geological rates of submergence has been interpreted as evidence that atmospheric warming since the industrial revolution has caused thermal expansion of the oceans. The ongoing and expected rise of eustatic sea level is causing coastal erosion and shore retreat.

Figure 11. Erosive action is occurring in the upper part of the coastal cliff (about 20') indicates that the wind is bluster in the coastal zone

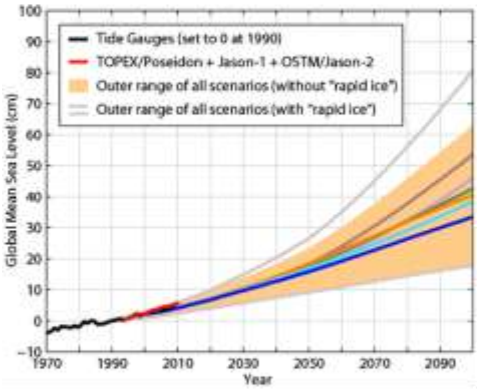

Figure 12. Calculating global sea-level curve by increasing temperature (Church, 2010)

The Role of Human Activities in Land Loss

Coastal Excavation

Extensive sand extraction has played a crucial role, in the research coastline for the construction of dam site (Winpanon Dam) and other purposes (Figure 13). This excavation causes the most rapid and direct conversion of land to open water. Depletion of sand in the coastal areas causes newly created channels intercept currents and redirect flow altering the hydrodynamics of coastal water bodies and sediment dispersal patterns (Figure 14).

Coastal Construction

Especially, the research area is blessed with some of Myanmar's bountiful fishing grounds, so most of inhabitant built the sand drying stage in the coastline for dry fish (Figure 15). As a consequence, the soil was hardened and become more difficult to be transport to the sea. As a result, coast is no longer supplied form the land, and coastal erosion is active.

In the research area of Katat-tauk Daminseik, engineering structures such as breakwaters, seawalls, and revetments are designed to control coastal land loss, but they can accelerate land loss of adjacent beaches by changing wave refraction patterns and depleting sand supply (Figure 16).

Figure 13. Sand extraction for local purposes in Katat-tauk coastline causes rapid conversion of land to open water

Figure 14. Depletion of sand in the coastal areas causes newly created channels in the research area

Figure 15. Drying stage for dry fish of the research coastline result no longer supplied form the land

Figure 16. Seawalls in Katat-tauk Daminseik which cause changing wave refraction patterns

Wetland Losses

Compared to rocky shores and sandy beaches, wetlands of the research are much more susceptible to deterioration and destruction. The interconnected network of dredged canals in the Katat-tauk wetlands account for about 10% of the land losses, but they may be responsible indirectly for additional losses of vegetation caused by intrusion of saltwater into freshwater marshes, changes in marsh hydrology, changes in sediment dispersion, and changes in nutrient distribution (Figure 17).

Figure 17. Intrusion of saltwater into freshwater marsh causes change in nutrient distribution

Findings

As observed a few years of field observations, the beach was constantly changing shape and shifting position in response to winds, waves and human interferences (dynamic equilibrium). These observations suggest a very intense coastal dynamics characterized by rapid changes in the morphology of the beach system (Figure 18).

In spite of the hardness of the metasedimentary top layers, the erodibility of the soft silty clayey sand, at the base of Katat-tauk cliff, results in a relatively rapid retreats of the coastline (in the order of 0.4 (± 0.002) m/year) (Figure 19).

Conclusion

The Katat-tauk coastline is retreating about 80% by sea level rise, the intensity of storms and human interventions. By the observation, the beach of the Katat-tauk was constantly changing shape and shifting position, which suggests a very intense coastal dynamic. The estimation retreat of Katat-tauk metasedimentary rocks coast is about 0.4 (± 0.002) m/year.

Most attempts to prevent beach erosion are defeated because the waves constantly batter and erode defenses to keep out the sea. In an effort to protect houses on eroding bluffs, constructing man-made dunes obliterates habitats and disrupts the food chain. Man-made structures, such as seawalls, sandbags, and sand fences have a plethora of drawbacks. Seawalls and sandbags actually increase beach erosion and destroy the beach, while sand fences create dunes that are temporary unless stabilized with vegetation. Erosion prevention methods temporarily halt beach erosion but do not compare to the power of the ocean.

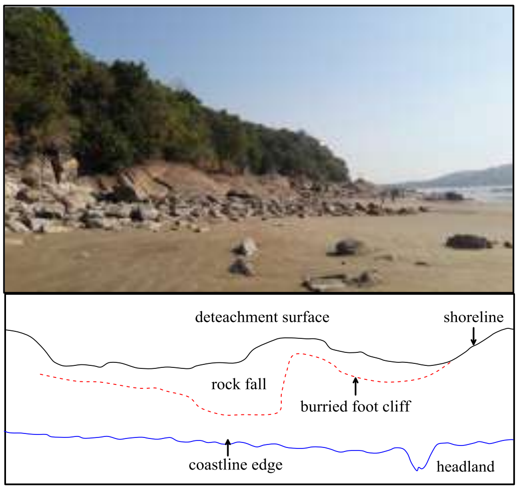

Figure 18. A very intense coastal dynamics characterized by rapid changes in the morphology of the beach system

Figure 19. Matching of the satellite image on the UTM map showing the retreat of Katat-tauk coastline

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