Effect of Bluff Erosion and Shoreline Change in Great Lake Michigan

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1.Introduction:

Bluff erosion is a result of natural causes or human disturbance? Or both?

"Coastal erosion is a common phrase referring to the loss of subaerial landmass into a sea or lake due to natural processes such as waves, winds, and tides, or even due to human interference." (Science Daily, 2019)

Shorelines are some of the most ecologically productive places on Earth. A healthy shoreline is essential to maintaining the overall health of lakes. They support microorganisms, plants, fish, insects, birds, and mammals. The first 10-15 meters of land that surrounds the water bodies are responsible for 90% of life which are born and raised in these areas. These are up to 500% more diverse than the upfront lake and rivers.

A healthy shoreline will help in maintaining water quality, prevents soil erosion, reduces the impact of flooding and can provide wildlife with food and habitat.

Shoreline erosion is a natural process where the breakdown of rocks and sediments happens not only along the shoreline, but also under the water surface. This occurs when the sand in the shore is removed. This causes the shoreline to become narrower and reduces the elevation. This can happen through various factors.

Natural Cause:

- **Waves:** This particularly depends on wind climate, bottom bathymetry and the shoreline itself. The height of the wave depends on the month. Waves are minimal in summer and reach maximum height in late fall.
- **Gravity:** This loosens soil and pull this material towards the slope.
- **Wind:** This can loosen soil or blow soil away which affects the vegetation.
- **Storms:** This study area is prone to low-pressure storms which usually blow from west to east. One of the most significant storms occurred on 18 March 1973. (Birkemeier 1980) The wind speed reached almost 72 km per hour which measured the highest recession rate. As a result of this kind of storm, water surges over the watermark causing a flood. This affects the natural shoreline.
- **Surface Water:** Ponds, lakes, and streams can supply water to shoreline, which brings down the sediments into the sea. This will cause the bluff region more slope, which can lead to erosion or bluff slide.
- **Drainage:** This includes both human wastage and excess water during floods. This can cause bluff instability.

Human Disturbances:

- **Shoreline Vegetation:** Removal of the shoreline vegetation will end in loosening of soil which was held the roots of the plants and becomes prone to wind, waves, and storms.
- **Motorized Watercrafts:** These create artificial waves that result in wiping out of the soil.
- **Foot Traffic:** Walking along the shoreline in the same route will eventually end up in damaging the vegetation along the area.
- **Construction:** Construction of buildings along the shoreline will end up with affecting the natural shoreline along the area.
- **Motorized Recreation:** The use of off-road vehicles in the dune area will affect the vegetation.
- **Shoreline Alteration:** This is a practice of replacing the shoreline with patio stones for walking and hard structures for blocking the waves, which results in the removal of shoreline vegetation and deflecting of wave energy to the neighboring shoreline.

"A Highly Unstable Bluff is near vertical or very steep with little vegetation and lots of exposed, loose sediment. Fallen trees and displaced chunks of sediment are common on the bluff face and at the base of the bluff." (Maine Sea Grant n.d.)

There are some of the signs of bluff erosion:

- **Exposed Soil:** Large areas of soil without any vegetation, especially on slopes are vulnerable to rill and sheet erosion.
- **Cloudy Water:** Turbid water is an indicator of an excess amount of sediments entering into water bodies.
- **Fading Shoreline:** This happens in the case of the construction of buildings. This can be seen by the owners of the buildings where the shoreline will be receding past the usual milestone.
- **Leaning of Trees:** The trees along the shoreline will be downed as a result of storms and winds. This is because the roots of the trees could not hold to the ground, because of the lack of soil due to erosion.

2.Methods:

The study area is located at the northwest corner of Michigan's Lower Peninsula, called as Little Traverse Bay. The primary data used for this study were aerial photos taken over in the years 1938, 1952, 1965, 1992, 1998, 2005, 2009, 2010.

These photos were taken monetarize the changes over the years. Using these images, this project can help in understanding the changes in shoreline over the years due to the effects of bluff erosion.

The primary tool used for analyzing is ArcGIS. Initially using this tool, these series of images were georeferenced, and alignment was done. For every image (based on the year) a polyline feature class was created and a line has been drawn on the shoreline. Then these shapefiles are used to analyze the change of shoreline over the years.

3.Results:

Shoreline where human intervention is high:

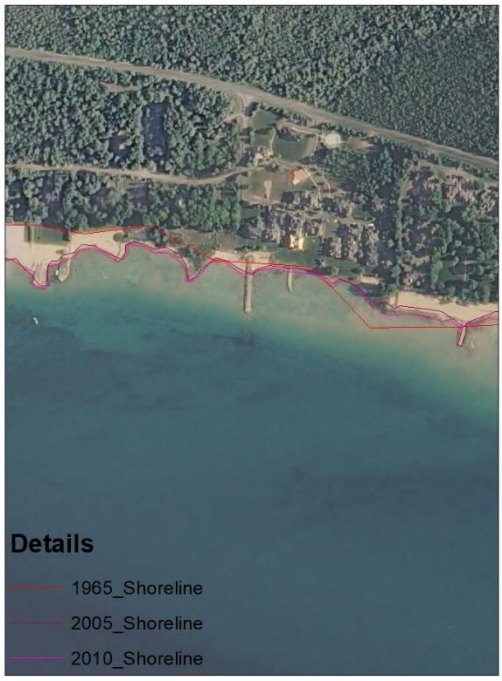

Figure 3.1 Ariel View of Northern part of Little Traverse Bay in 2010

Figure 3.2 Ariel View of South Eastern part of Little Traverse Bay in 2010

Figure 3.3 Ariel View of South part of Little Traverse Bay in 2010

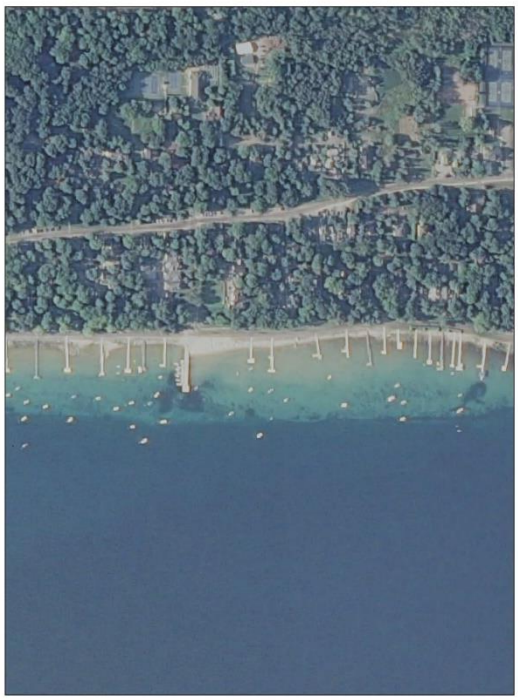

Figure 3.4 Ariel View of the North part of Little Traverse Bay in 2010

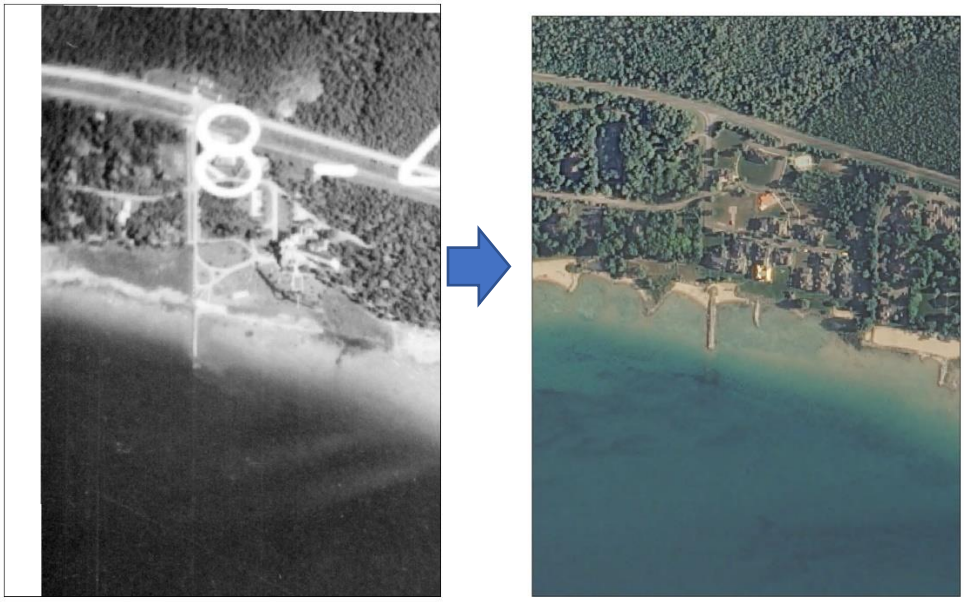

Figure 3.5 Ariel View of the North part of Little Traverse Bay in 1938 and 2010

Natural Shoreline: (No much human intervention over the years)

Figure 3.6 Ariel View of Easter part of Little Traverse Bay in 2010

Figure 3.7 Ariel View of Eastern part of Little Traverse Bay in 2010

Figure 3.8 Ariel View of Eastern part of Little Traverse Bay in 2010

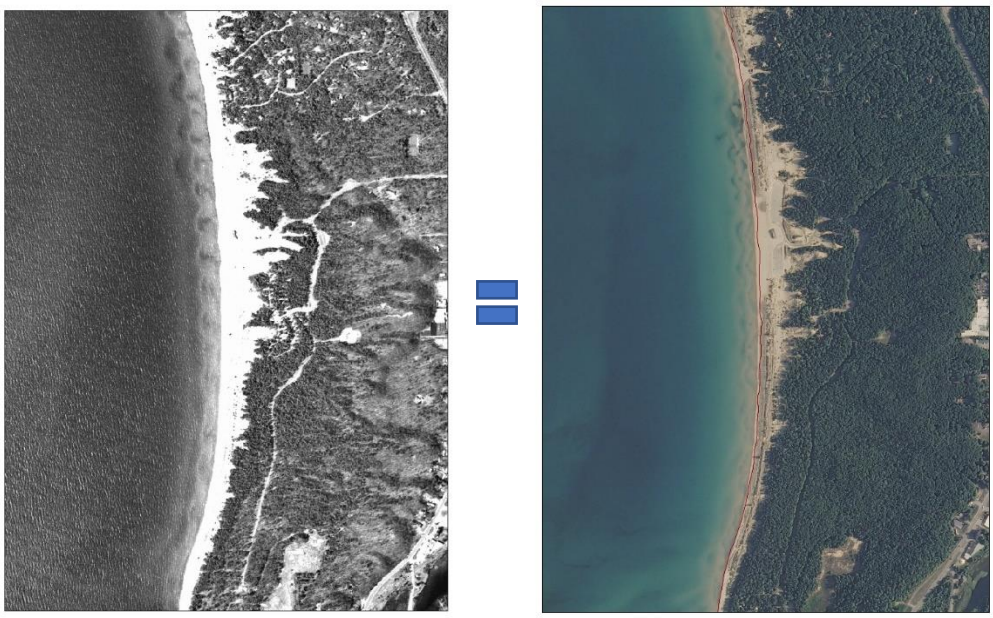

Figure 3.9 Ariel view of Eastern part of Little Traverse Bay in 1965 and 2010

4.Discussion:

The figures 3.1 - 3.3 shows the changes in shoreline over the years especially in the parts where human intervention is high. Throughout the years the normal shoreline has been persistently recreated for the human purpose. This has totally changed the regular shoreline which ought to be safeguarded. . It is probably not years of drainage that accounts for this shoreline erosion; rather the shoreline has been changed dependent on human needs.

Figure 3.4 clearly shows that the construction of docks over the shoreline for the purpose of fishing. This has a larger impact on the shoreline and the living creatures which depend on the first 10 – 15 meters.

Figure 3.5 shows the change in shoreline from 1938 to 2010. Over a period of years, the urbanization on that area is developed and people started using the nearest shoreline as a seashore for leisure purposes.

The average shift of shoreline over the years is around 30 meters. The maximum shift is around 70 meters in some parts of the shoreline (calculated using measure tool).

Figure 3.6 – 3.8 images shows the shoreline where human intervention is very less over the years. As a result, there is no much change in Shoreline. The dune vegetation remains the same over the years. Urbanization on those areas is nearly zero. The natural shoreline is preserved over the years.

Figure 3.9 shows the shoreline in that area in 1965 and 2010. There is no change in the vegetation along the shore. The average shift is around 10 – 15 meters over the years.

The pictures which are taken in 1938, 1952, 1965 come up short on the details in it. Since these pictures are in black and white, the distinction in dune vegetation and the shoreline is very hard to figure. This leads to assuming the wrong shoreline in indicated years. This distinction in mistakes result in miscount of progress in shoreline throughout the years. These blunders are the aftereffect of the inaccessibility of innovation at that timeframe.

In some of the images, the dune vegetation is over the shoreline, which makes finding the shoreline hard. There is an overlap of dune vegetation and shoreline.

From the above analysis,

- When the shoreline is undisturbed by humans, the rate of bluff erosion is very less which means the damage done by natural causes is very less.
- The parts where the natural shoreline is interrupted by humans, the shoreline is changed, and bluff erosion is high.

So, the greater part of bluff erosion is caused as a result of human disturbances.

Bluff erosion which is caused as a result of human disturbances can be controlled by:

- Minimum setback distance can be formulated along the shoreline for the construction of buildings along the shoreline. This can avoid the structural encroachment on natural waters, improves the quality of water and the sediments along the shorelines and preserves the wildlife habitat. It is suggested that the minimum setback distance should be 35 feet from the shoreline.
- Buffer strips along the shoreline – planting diverse crops along the shoreline to maintain the soil erosion.
- Beach grooming should be minimized – it is a practice of using heavy equipment to rake and sieve the sand. This affects the vegetation along the dune area which is needed to prevent soil erosion.
- Motorized recreation should be controlled.
- The sewage system should be maintained properly. These septic systems should be located at least 100 feet from the water bodies.

5.Future Work:

The mistakes can be minimized by consolidating Ariel photographs with lidar information. Thus, the bluff erosion can be controlled by figuring the profundity at each stage. This will give a concise thought of the rate of bluff erosion throughout the years.

The information can be gathered in the next years and the bluff erosion can be tracked. This additionally relies upon the urbanization around the shoreline which has a crucial impact. In this way, later, the development of urbanization can be pursued and the effect of urbanization on the shoreline can be resolved.

REFERENCES

Birkemeier, W. A. (1980). The Effect of Structures and Lake Level on Bluff and Shore Erosion in Berrien County, *Journal Name,* volume #, 1970-1974.

Maine Sea Grant. (n.d.) Retrieved from https://www.seagrant.umaine.edu/coastal-hazards-guide/bluffs-and-rocky-shores/learn-more/bluff-erosion-and-stability

Science Daily. (2019). Retrieved from https://www.sciencedaily.com/terms/coastal_erosion.htm