Remote Sensing Monitoring of Recent Morphodynamics in Kalido Beach - Kalutara, Sri Lanka

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Abstract
Kalutara is the major city in Kalutara District, Western Province, Sri Lanka. Kalido Beach is a strip of beach that runs between Kalu Ganga and the Indian Ocean. It is known for its unique ecosystem. Nonetheless, in recent years it facing challenges such as natural erosion from the sea, tourist visits, and pollutions. In addition to that recently it washed out from its original location due to the heavy flood in May 2017. Southwest monsoon weather condition brought heavy rainfall to the southeastern parts of Sri Lanka and cause so many damages to people and nature. After the flood level has risen people excavated channel across the Kalido sand dune just for control flood and discharge extra water to the sea. As a subsidiary effect of that, the Kalido sand dune washed out and a new beach developed near to the country. In this study, it investigates the incident in Remote Sensing and GIS perspective. Finally, it reveals that there were approximately 690 m of movement of the center of the new sand dune to the southeast direction respect to the previous Kalido sand dune.

Keywords: Flood, GIS, Landsat, Remote Sensing

1 Introduction

Coastal morphdynamics refers to the study of the interaction and adjustment of the seafloor topography and fluid hydrodynamic processes, seafloor morphologies and sequences of change dynamics involving the motion of sediment. Floods are the most common of natural hazards that can affect people, infrastructure, and the natural environment. They can occur in many ways and in many environments. Heavy rainfall occurring over a short period in relatively flat terrain which may cause for floods like in the situation of Sri Lanka in 2017.

Most remote sensing studies concerned with natural hazards have been about an area's vulnerability to a disaster, the monitoring of events which could precipitate a disaster, and the magnitude, extent and duration of a disaster. Digital image processing involves manipulation and interpretation of the digital images so as to extract maximum information from the image. Image enhancement is used to enhance the image display such that different features can be

easily differentiated. Density slicing is the process in which the pixel values are sliced into different ranges and for each range a single value or color is assigned in the output image. It is also known as level slicing. Density slicing may be thus used to introduce color to a single band image. Density slicing is useful in enhancing images, particularly if the pixel values are within a narrow range. It enhances the contrast between different ranges of the pixel values.

2 Study Area

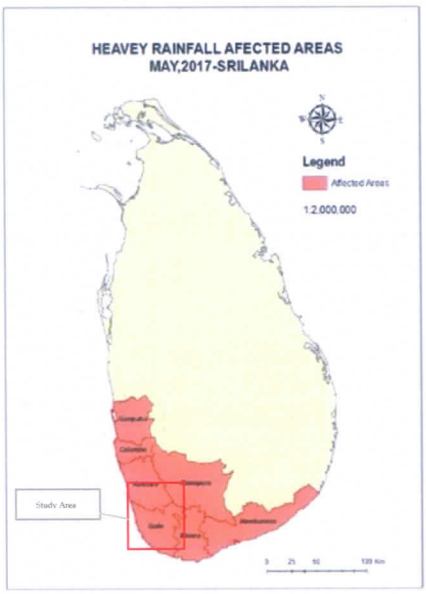

Figure 1: Rainfall Affected Areas in 2017.

Kalutara is the major city in Kalutara District, Western Province, Sri Lanka. It is also the administrative capital of Kalutara District. It is located approximately 40 km south of the capital Colombo. Kalido Beach in Kalutara, is the strip of beach that runs between Kalu Ganga and the Indian Ocean. It is enriched with natural beauty which combine river and sea at once. It is noteworthy that Kalu Ganga cannot make a beeline to the Indian Ocean in the final stages of its journey due to Kalido Beach. The river makes a ninety degree turn once it flows past the Kalutara Bridge and then flows towards Vettumankada due to this strip of land. The wide stretch of beach at the side of the Kalu Ganga, is called Kalido Beach and is a favorite of locals and visitors alike. When walking towards the Katukurunda direction through the strip of land the Kalu Ganga on east side and the Indian Ocean in the west side makes the best scenery of the nature while making a lagoon-like appearance.

Research Problem

Southwest monsoon weather condition brought heavy rainfall from 25th May 2017 in the southeastern parts of Sri Lanka, killing 100 people according to the Disaster Management Center (DMC) report on 27 May 2017, and remarkably Kalutara had the highest damage due to the flood and landslides took place at this time.

After the flood level has risen, people dug across the Kalido sand dune just to control the flood and discharged extra water to the sea.

As a result of that, the Kalido sand dune washed out from its original location, and was able to identify a new sand dune development near the country (Figure 2).

Figure 2: Google Earth Images of the Study Area in 2017 and 2019.

3 Methodology

One of the most important tools available to the regional planner is the remote sensing of the environment. Not only it is very useful in the planning process in general, but it is also valuable in detecting and mapping many types of natural hazards when, as is often the case, detailed descriptions of their effects do not exist. If susceptibility to natural hazards can be identified in the early stages of an integrated development planning study, measures can be introduced to reduce the social and economic impacts of potential disasters.

All natural hazards are amenable in some degree to study by remote sensing because nearly all geologic, hydrologic, and atmospheric phenomena that create hazardous situations are recurring events or processes that leave evidence of their previous occurrence. This evidence can be recorded, analyzed, and integrated into the planning process.

Effective utilization of remote sensing data depends on the ability of the user to be accurate and consistent when interpreting photographs, images, graphs, or statistics derived from remote sensing sources. Since the Landsat series of satellites have been operational for a long period of time, there is a very large data base available, both in arial coverage and in repetitive coverage, through different seasons and during periods of natural disasters. Landsat MSS coverage exists from 1972 to the present in four spectral bands at 80m resolution. The Thematic Mapper (TM) was introduced on Landsat 4 in 1982, with seven spectral bands, six of them with 30m resolution and one in the thermal IR range with 120m resolution.

The human vision is more adept at discerning colors than distinguishing shades of gray. A density slicing of the single band was used in the study. Density slicing is the process in which the pixel values are sliced into different ranges and for each range a single value or color is assigned in the output image. A digital image processing system allows for assigning a different color to each Digital Number (DN) or a range of DNs in an image. This makes it possible to assign different colors to different groups of pixels in a single-band image even though normally such an image would be displayed in shades of gray. Therefore, a density sliced image is more readable when it comes to distinguishing between different land cover types. Density slicing is useful in enhancing images, particularly if the pixel values are within a narrow range.

The resulted density sliced maps of morphodynamic movement in the study area can represent as illustrated in Figure 3.

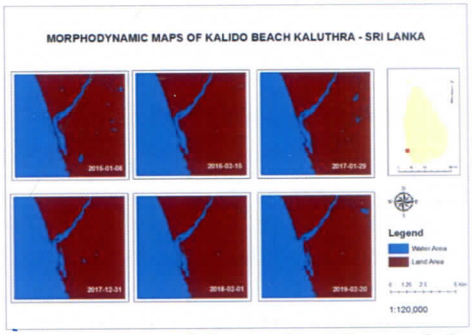

Figure 3: Morphdynamics Maps of the Kalido Beach and Kalutara Area, Sri Lanka which Derived from Landsat Satellite Images (2015-2019).

The number of slices and the range of DNs to be assigned to each slice are determined interactively, and depends on the particular scene and the kind of information that is required to be extracted. It depends on the range of DN values a particular feature may have.

Google Earth (GE) has the time series representation with high spatial resolution which plays important role in generating land use land cover maps with the use of Georeferencing and digitizing. The map in Figure 5 which generated using from Google earth images describe the spatial pattern of the dynamic changes that occurred in Kalido Sand Dune.

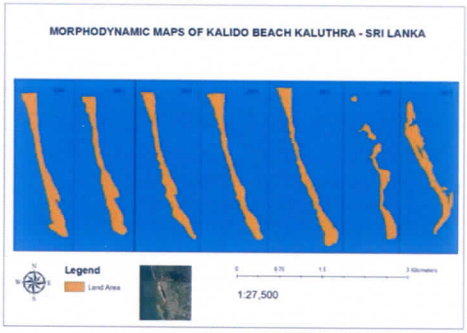

Figure 4: Morphdynamics Maps of the Kalido Sand Dune, Kalutara, Sri Lanka which Derived from Google Earth Images (2004-2019).

4 Results and Discussion

Rendering to the study, it reveals that there are identical land washed out, land Development, shape deformation and landcover change with the time.

Conferring to the graph which shows in Figure 5, could be able to identify the extent of the land cover change, means that the sand dune area gets enlarged and spread with the time due to the deformation with respect to the previous sand dune.

Figure 5: Change of the Area Coverage of the Sand Dune from 2015 to 2019.

By considering the total morphodynamic change of the sand dune, could be able to define the direction and the mean distance of the geographical center (Figure 5), and conferring to that it has approximately 690m movement to the southeast direction with respect to the previous location.

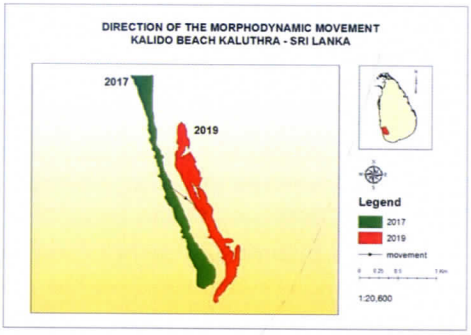

Figure 6: Direction of the Morphdynamics Movement - Kalido Beach Kalutara, Sri Lanka.

5 Conclusions

In this study, it investigates the incident in the remote sensing perspective. It includes monitoring the morphodynamics of the sand dune, calculates the extent and land cover changes of the sand dune.

The combined investigation of Remote Sensing and GIS makes the best platform to study the phenomena.

Rendering to the study, it reveals that the original sand dune washed out by the heavy rain, and also river sediment started to deposit in the south of the river mouth, and the new sand dune started to form.
In addition , it reveals that there were approximately 690 m of movement of the center of the sand dune with respect to the previous sand dune to the southeast direction.

Ultimately, there is no longer protective layer to Kalutara Beach and it could be a threat to Kalutara in a case like Tsunami because in Tsunami this Kalido sand dune functioned as a barrier for the control of seawater, and protected Kalutara town area.

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