THE NOURISHMENT OF MOUNT LAVINIA BEACH

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Coastal areas have attracted people throughout history, developing into major population centres and for trade and economic development through development of ports and associated infrastructure. Due to a variety of competing interests, coasts are complex regions subject to a diverse range of land use, stakeholders and investments that can create adverse physical, ecological and socioeconomic interactions (Brown et al., 2014). Coastline changes have broad consequences for the sustainability of coastal communities, structures and ecosystems (Mentaschi et al., 2018). Beaches are considered as both an economic and a natural resource. As a natural resource, they add beauty to the coast and provide habitats for many creatures including birds and sea turtles and for human recreation. As an economic resource, they provide services to people, businesses and property. The coastline also forms the energetic interface between land and the ocean, absorbing and dissipating ocean energy such that the action of ocean waves, tides and currents constantly changes the shape and form of the beaches. The dynamic nature of the beach is expressed in terms of coastal erosion and accretion which are mainly due to human interference through the construction of a variety of structures and other activity such as sand extraction (both from the beach and in rivers) that alters the sediment balance. Due to these conflicting activities, the management of the beach has to include different perceptions, values, and interests and therefore is a challenge.

Solutions to mitigate beach erosion include “hard” and “soft” engineering approaches. Soft erosion control solutions are natural and may include, for example, geotextiles, beach nourishment, beach dewatering systems and sand bags. Hard solutions such as rock revetments, sea walls and groynes represent the traditional approach to shoreline and coastal protection. Globally, there is growing concern that hard measures may be accelerating erosion due to changes to the local wave and current conditions that alter the natural shoreline processes not only locally but also in downstream locations. The impact of coastal intervention is such that for the system to reach a new equilibrium, it may take decades and affect a significant area of the coast. It is also generally accepted that once a protection scheme is implemented which may be either ‘hard’ or ‘soft’ solutions, it is a continuous process to maintain it (PIANC, 2014).

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This paper relates to the recently concluded beach nourishment project undertaken at Mt. Lavinia beach in April 2020. Under the auspices of the Coast Conservation Department (CCD) of Sri Lanka, 150,000 m3 of sand extracted from two-six kilometers offshore from Ratmalana station was placed on a 500- meter length of Mt. Lavinia beach. The objective of the project has been defined as forming a 15-meter wide beach at Wellawatte through northward sand transport from Mount Lavinia (Daily Mirror, 2020).

In this paper, we undertake an analysis of the current situation through personal experience, numerical modelling together with Google Earth and Sentinel satellite imagery. The Google Earth imagery was obtained on 5 April 2020 – just prior to the commencement of the beach nourishment project, reflecting the existing state of the beach. We use these imagery for illustrative purposes. The area under consideration is a five kilometer stretch of beach between the Mount Lavinia headland to the Wellawatte canal outlet.

The stability of a beach depends on sand transport along shore (parallel to the beach) and cross-shore (perpendicular to the beach). Along the west coast of Sri Lanka, the net transport of sand is from south to north in response to the south-west monsoon waves and swell waves originating from the southern ocean. It is estimated that the transport capacity in the region is ~ 255,000 m3 per year with the net movement from south to north (Jayathilaka and Fernando, 2019). This is in response to the south-west monsoon. During the north east monsoon period, this section of the coast is sheltered by the monsoon generated waves but is influenced by the local sea breeze that transports sand from north to south. However, the volumes are small compared to that during the south-west monsoon (Pattiaratchi et al., 1999). As is the case with beaches globally, there is a seasonal variation in the beach width. In the event of energetic waves with long wave periods, there is onshore transport of sand along the sea bottom resulting in an increase in beach width. In contrast, during energetic breaking waves with small wave periods, such as those experienced during the south-west monsoon season, strong offshore transport occurs, the beach is eroded and beach width decreases. Therefore, along this coastal stretch, beaches are narrow during the south-west monsoon and wider during the north-east monsoon. This is not erosion/accretion but the natural variability.

Embayed beaches bounded by headlands ('headland bay beaches') are a common feature globally and along the coast of Sri Lanka. Coastal headlands and their associated beaches are considered the most natural beach landforms. This is because waves diffracting (diffraction refers to the wave phenomenon that occurs when a wave encounters an obstacle or a slit. It is defined as the bending of waves around the corners of an obstacle) at the headland approach the beach at right angles, minimising the longshore transport (longshore transport refers to the transport of sand parallel to the shore by the combined action of waves, tides and the shore-parallel currents produced by them). The major geological formation at Mount Lavinia is the prominent headland where Mount Lavinia hotel is located (Figure 1). To the south, the headland traps sand resulting in a wide beach providing a great amenity to hotel residents (Figure 1). The sand extends offshore to the end of the headland indicating that sand can move from south to north around the headland. The beach to the north of the hotel is controlled by the headland. This is evident in the image, which shows the wave crests approaching parallel to the beach as represented in Figure 1. The presence of many rocks

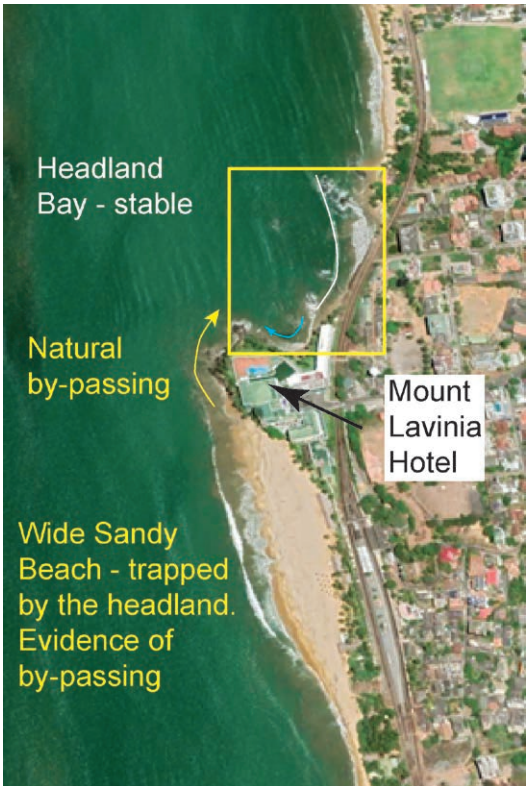

Figure 1: *Mount Lavinia hotel and headland.*

and boulders in this region will also act to break the energy of the waves. Therefore, this part of the beach is stable.

The stretch of beach between Mount Lavinia and Aponso Avenue is shown in Figure 2. The rock formation on the beach at the end of Aponso Avenue acts as a barrier to the northward sand transport. This results in a wider beach to the south for almost one kilometre. To the north of the rock at Aponso Avenue the shoreline indents but there is no erosion as evidenced by the presence of healthy vegetation (Figure 3).

The 1.6 kilometer stretch of beach between the rock at Aponso Avenue and Dehiwala canal outlet is protected by a shallow reef parallel to the coast as evidenced by the breaking waves (Figure 4). The presence of the reef dissipates the wave energy and provides protection for the beach. Nevertheless, there is still sand transport with the training groynes at the canal entrance acting as a barrier for northward sand transport. There is accumulation of

sand to the south of the Dehiwala canal outlet (Figure 4). Again, there is no evidence of erosion along this stretch of the coastline. This is highlighted by examining the shoreline change maps created using the Sentinel satellite over the period of March 2016 to November 2019 (Figure 5). The seasonal changes as mentioned above are reflected in the maps but there is no systematic erosion.

The pattern of sand accretion/deposition repeats at the canal outlets at Dehiwala and Wellawatte (Figure 4). Here, coastal structures have been built to prevent sand deposition at the outlet to keep it open. The accumulation of sand to the south of the outlets results in wider beaches while those to the north of these structures are narrow due to the trapping effect of the training groynes.

This coastal stretch has significant biological and ecological importance (Fernando, 2009) that also impact local livelihoods. Not only is it abundant with sandstone reefs and rocky habitats (Uni-Consultancy Services, 2019), but it is also reported to be a part of one of the most productive lobster fishing sites (Bruin, 1970). In addition, the environment offshore from Mt. Lavinia is significant for its various dive sites including shipwrecks which are high in biodiversity but also hold great archaeological value and have become increasingly important to our tourism industry (Jayatillake, 2020). Furthermore, Mount Lavinia beach is considered one of the best beaches in Sri Lanka to observe seashells and molluscs, some of which are only found in these areas (Fernando, 2009). The easily accessible rocks at the southern end have been used by students to observe marine flora and fauna and has been the focus of much research.

Summary

Summarising the above description of the beach processes and variability along the five kilometer stretch of beach between the Mount Lavinia headland to the Wellawatte canal outlet, it is clear that no erosion is occurring over this stretch of the coastline – it has been stable for many decades. Instead what we see is the natural variability of the beach resulting from seasonal changes in the incident wave climate in the area as a result of our monsoonal climate.

Our analysis identified several natural and man-made barriers for northward sand transport between Mount Lavinia and Wellawatte. These include the rock structure at Aponso Avenue and the canal outlets at Dehiwala and Wellawatte. There is no indication of how much sand will bypass these obstructions and whether the siltation as a result of increased sand supply will impact these outlets. It is possible that additional dredging may be required to keep the canal outlets open.

The sand nourishment of Mount Lavinia beach appears to have no tangible outcomes with respect to the aims of the project. The exercise appears to be undertaken without adequate planning and ignoring even basic coastal engineering principles. However, a considerable amount of money has been spent. It is expected, through design or otherwise, that the majority of the sand will be washed away from Mount Lavinia beach after the south-west monsoon season. Some sand has already been removed by higher waves associated with Tropical Cyclone Amphan. The percentage of sand deposited at Mount Lavinia beach making it as far as Wellawatte is likely to be small and certainly not sufficient to create the anticipated 15-m beach. The existing seasonal change in the beach is larger than 15 m per annum.

We believe that as we move into the future a thorough review of the decision-making process should be undertaken to prevent another costly exercise similar to this recurring in Sri Lanka. Over the next few months, monitoring of critical areas where the additional sand may have an impact should be monitored and should include the coastal reef systems and canal outlets.

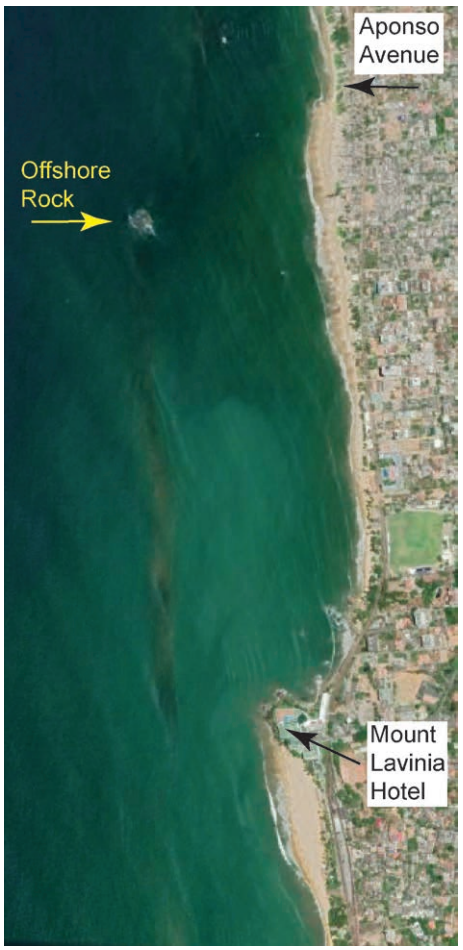

Figure 2 : Mount Lavinia hotel to Aponso Avenue.

Figure 3 : Aponso Avenue to Station Road.

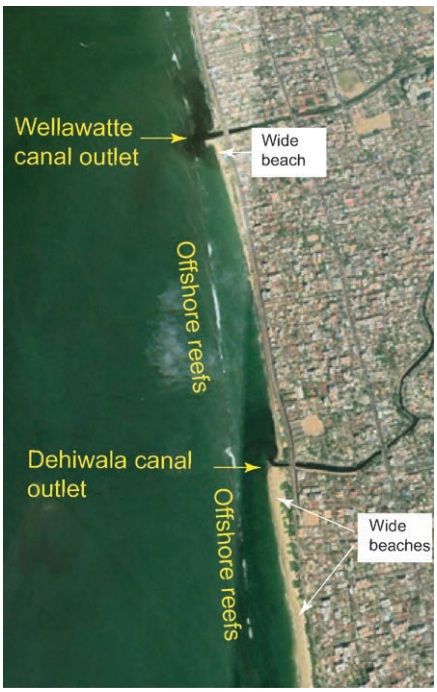

Figure 4 : Dehiwela and Wellawatte canal outlets.

Figure 5 : shoreline changes (March 2016 to November 2019) in the study region from Sentinel satellite imagery (analysis undertaken by Dr. Pushpa Dissanayake, Kiel University, Germany).

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