Chapter 27: Coastal Monitoring Programme

1. Introduction

The coastline of the city is a harsh and highly dynamic environment, where the biophysical attributes of the coastline are in a constant state of flux. Some of this change is cyclical and predictable, taking place over relatively short (seasonal) temporal scales, whilst other change is unseasonable and less predictable. Less predictable change may still be cyclic, but may take place over longer and less defined periods of time. Such change may also be a result of climate variation as opposed to human induced climate change. Reflecting seasonal dynamics at a broad scale is the accretion of beaches within False Bay (on the eastern side of the city) in winter and the erosion of these beaches in summer. The opposite pattern occurs on the west coast where beaches generally erode in winter and accrete in summer. Examples of less predictable coastal dynamics include migrating estuary mouths, localised beach regression and accretion events as well as storm surge induced coastal erosion. These unpredictable examples often result in abrupt changes in coastal geomorphology. Both abrupt changes, and to a lesser extent, the known trends in seasonal dynamics, impact on coastal infrastructure and ultimately the City's ability to maintain effective service delivery.

The dynamic and at times unpredictable nature of the coastline is a source of risk to the City. Exposure to this risk is set to be compounded considering the warming of the earth's atmosphere. Global warming is expected to have a significant impact on coastal dynamics, where fluctuations in environmental systems are set to become more pronounced. This is a key concern to the City considering the value of the coastline from an EGS perspective, but also due to the amount of critical infrastructure located along the coastline. The City's Sea-Level Rise Risk Assessment (SLRRA) identified an area totalling 25km² that is highly vulnerable to the expected impacts of sea-level rise, storm surges and subsequent coastal erosion. Within this area, it is estimated that there is approximately R5 billion worth of City infrastructure that is at risk.

2. Strategic intent of the Coastal Monitoring Programme

Considering the value invested along Cape Town's coastline and considering the potential impacts of coastal processes on city infrastructure and property, it is imperative that the City takes active measures to enhance our understanding of coastal dynamics. With this knowledge of coastal processes, how they function and what influences them, the City will be capacitated to make more informed and risk-averse decisions relating to the general management of the coast.

The development of a Coastal Monitoring Programme (CMP) will be used to improve our knowledge of coastal processes. The CMP is a GIS based programme that collects information about the coast and stores this information in a systematic manner. Information primarily linked to time series indicating coastal changes across a spectrum of coastal processes can be extracted. This information will not only be used to inform and guide day to day operational decision making that impacts on (or is impacted by) the coast but will also, through the identification of trends, be used to inform higher level strategic policy intents on how the City needs to respond to and manage the coast i.e. adopting the precautionary principle when planning for coastal development at the city-wide scale. The value and importance of the CMP increases over time – the more data that is collected over time, the greater our understanding of how the coast functions as a complex system will be enhanced.

3. Constituents of the Coastal Monitoring Programme

The CMP will monitor a range of aspects along the city's coastline. These include the following:

3.1. Coastal change through aerial imagery time series analysis

The City takes aerial imagery for the entire metropolitan area every year. The times series analysis of aerial imagery offers a powerful tool to determine not only trends in coastal processes, but to determine the impact on city decision making on coastal processes. The CMP has identified numerous locations along the coastline which will be the focus of aerial imagery analysis.

Figure 1: Time series analysis of aerial imagery depicting a migrating dune between 2009 (left) and 2011 (right) in Table Bay, Cape Town.

3.2. Coastal change through fixed point photography time series analysis

Fixed point photography is used within the CMP to determine trends in coastal change from an alternative perspective to that of aerial imagery. The CMP has identified a number of locations along the Cape Town coastline where images have been taken to capture specific areas of interest and importance. Images from the same locations, with the same photographic settings, are taken once a year during the same tidal period (i.e. low tide) and these images are then systematically incorporated into the CMP (Figure 2).

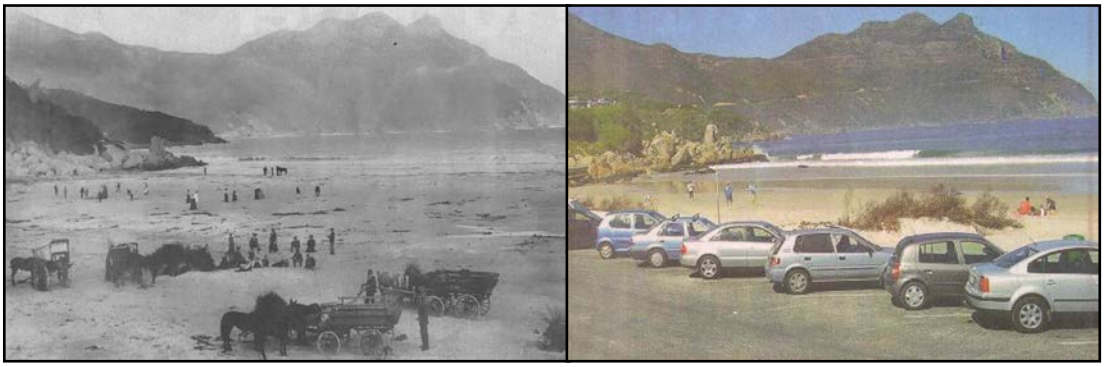

Figure 2: Coastal change over time from 1895 (left) to 2012 (right). Source: Weekend Argus

3.3. Coastal change through coastal profile monitoring

Tracking change of the profile of the coastal littoral active zone is a critical component of the CMP. The CMP extracts a Digital Elevation Model (DEM) (Figure x) from digital aerial imagery to determine the shape of coastal topography and more importantly to determine how the surface of the coast changes over time. In practical terms the analysis of beach profiles enable the City to determine rates of erosion (whether caused by storm surges or migrating estuary mouths) and accretion (whether caused by migrating dune systems or linked to seasonal trends) along the coast. Importantly, quantities of loss or gain in coastal sub straight may be determined through the analysis of the DEM.

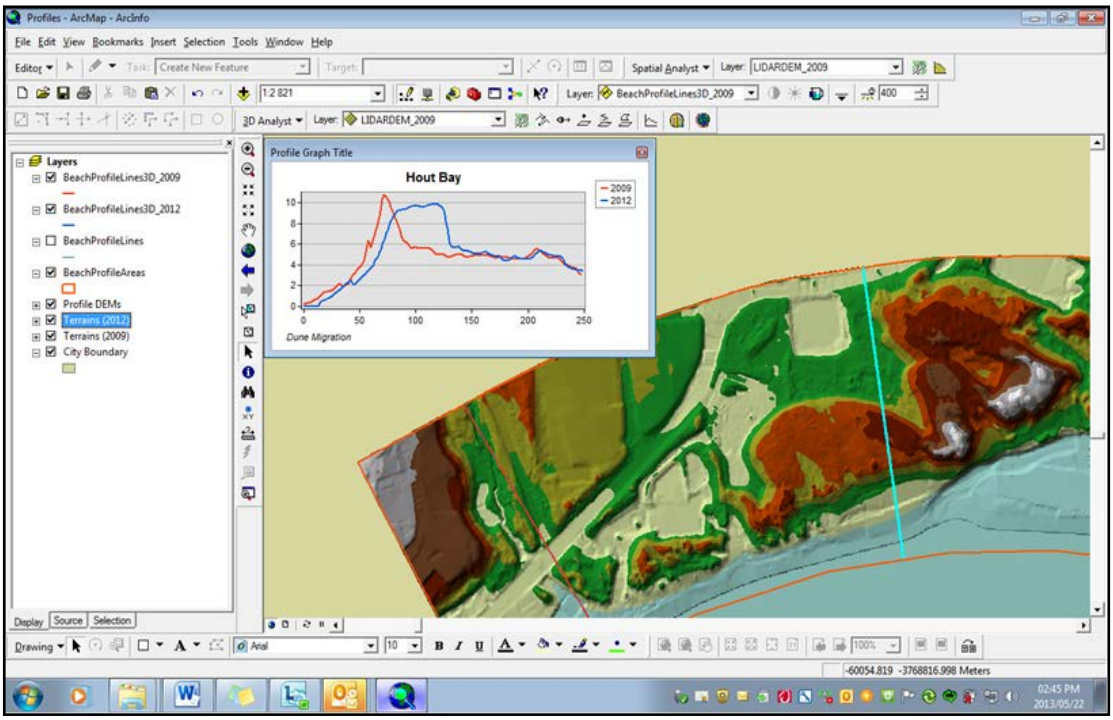

Figure 3: Screenshot of the CMP DEM used to extract profile data of a migrating dune system in Hout Bay.

3.4. Storm surge run-up monitoring

The City undertook a Sea-level Rise Risk Assessment in 2008. As part of this assessment a GIS based model was developed to determine vulnerable areas of the coastline to storm surges over the next 25 years. Spatial data from actual storm surge events, in particular wave run-up, is collected and plugged into the CMP. The comparison between actual events and the modelled predictions is useful in determining which infrastructure is at risk and to what degree for the entire length of the City's coastline. In addition to capturing wave run-up, the CMP captures characteristics associated with the storm event. These characteristics include peak wind strength and direction, maximum wave height in relation to peak tide, swell direction etc. Through associating this information with wave run-up positions, the CMP will enable the City to disaggregate risk per location and forecast which location will be at higher risk to storm damage.

Figure 4: Wave run-up measurements taken from an actual storm event with a differential GPS and overlaid with the GIS inundation model

4. Developing a collective picture of our coastal system

The CMP has applied, as far as possible, these monitoring informants to specific regions of the coast. Thus, through the use of fixed point photography, coastal profile monitoring, wave run-up measurements and the use of aerial imagery per location over time, a more holistic understanding of coastal processes and what the influences are, is generated. Further to this, the CMP is a flexible and robust programme that is designed to withstand staff turn-over and which can be adjusted according to the City's requirements and data needs over time.

5. Future development of the Coastal Monitoring Programme

The CMP will be further developed to monitor additional aspects, including, but not limited to:

- Marine animal strandings
- Pollution events
- Recreational use trends
- Disasters