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Application and evaluation of shoreline segmentation mapping approaches to assessing response to climate change on the Illawarra Coast, South East Australia

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APPLICATION AND EVALUATION OF SHORELINE SEGMENTATION MAPPING APPROACHES TO ASSESSING RESPONSE TO CLIMATE CHANGE ON THE ILLAWARRA COAST, SOUTH EAST AUSTRALIA

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By

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Dedication

This PhD thesis is dedicated to my late mother Mama Priscah Adhiambo Aluoch for her death wish, to my late father Mzee Joshua Wandere Odame for educating a girl child and to my late husband Dr. Joseph Odhiambo Zedekia Abuodha who died during the course of my PhD studies.

And to all my “fathers”, “mothers”, “brothers” and “sisters” who I have met and will still meet for the rest of my walking life.

Certification

I, Pamela Atieno Odhiambo Abuodha, declare that this thesis, submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the School of Earth and Environmental Sciences, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. This document has not been submitted for qualifications at any other academic institution.

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Abstract

Climate change, particularly sea-level rise, threatens many coastal systems around the world. Coastal managers and decision-makers require information that enables them to assess the vulnerability of the coastlines to the range of impacts and to develop cheap, simple, generic tools, prompting the need to develop tools that can be used to study the impacts of climate change and sea-level rise on the coastal zones. This thesis examines tools that are available to assist in determining sensitivity of the coast, and then describes strengths and weaknesses of three different coastal assessment tools that adopt a GIS (Geographical Information System) approach to assess sensitivity of the shoreline, segmenting it on the basis of different variables. Each tool is applied to one case study section of the coast, the Illawarra region in southern New South Wales, Southeast Australia. The three tools are Dynamic Interactive Vulnerability Assessment (DIVA) tool, Geomorphic Stability Mapping (GSM) approach and the Coastal Sensitivity Index (CSI).

The DIVA tool uses a global shoreline database (DINAS-Coast) and can be run using sea-level rise and the socio-economic scenarios in timesteps to the year 2100. The DIVA tool incorporates, socio-economic variables, and provides a vulnerability assessment. The Illawarra coast is represented by a single segment (segment 11105), and the tool is not designed for use at such a fine segment scale. The GSM approach, based on vulnerability mapping of the Tasmanian coast, segments the coast on the basis of form and fabric. It involves a user-defined set of segments that are divided where any of the variables change alongshore. In applying GSM approach to the Illawarra coast, several fields have been redefined and new classes of shoreline landforms identified, of which open ocean sandy shores backed by plains and dunes were scored with the highest sensitivity. After mapping the relative sensitivity of the Illawarra coast on the basis of the GSM approach, a time-series of aerial photographs was used to assess the pattern of historical shoreline change. The Digital Shoreline Analysis System (DSAS) tool was employed to describe rates of shoreline change of the high water line (HWL) and the vegetation line indicators for 11 beaches, and MIKE Marine DHI was used to calculate the subaerial beach and dune sediment volumes from 1938 to 2001 for 3 beaches, in order to determine to what extent modelled sensitivity corresponded with observed patterns of change.

This historical reconstruction provided further data from which to derive the CSI, modifying the CVI method that has been used in many developed countries. Where previous assessments have used six or seven variables, this analysis of the Illawarra coast used nine variables, of which six were structural variables (rock type, geomorphology, barrier type, shoreline change, segment exposure, coastal slope), and three were process variables (relative sea-level rise, mean wave height and tidal range).

The patterns of change on the Illawarra coast are highly variable, many beaches were found to have accreted when the vegetation line was mapped over time, but different trends and different rates are observed from one beach to another and in some cases within the same beach. Each of the tools involves a level of generalisation, and their application is intended only as a first stage in assessment of shoreline vulnerability. Applying the three tools to the one case study enabled an evaluation of their relative strengths and weaknesses on the basis of several different criteria. The results from this study are useful to decision-makers and local councils in undertaking a more detailed, site-specific assessment for the Illawarra coast in the near future.

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