

2009

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

Pamela A.O. Abuodha

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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**

A thesis submitted in fulfilment of the requirements for the award of
the degree of

DOCTOR OF PHILOSOPHY

From

THE UNIVERSITY OF WOLLONGONG



By

**PAMELA ATIENO ODHIAMBO ABUODHA
BSc (Hons), MSc University of Nairobi, Kenya**

SCHOOL OF EARTH AND ENVIRONMENTAL SCIENCES

September 2009

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.

Acknowledgements

I am greatly indebted to Professor Colin Woodroffe of the School of Earth and Environmental Sciences (SEES) of the University of Wollongong (UOW) for his proficient supervision of my PhD study and of this thesis; and for his continued and unwavering support during my studentship at the UOW. Thank you Prof. Woodroffe and “How are our beaches?” The Head of School, Professor Lesley Head and the School Secretary Wendy Weeks are acknowledged for administrative and logistic support. Work on Geographical Information Systems (GIS) would not have been possible without the guidance of Dr. Ava Simms, Former Associate Research Fellow of the SEES, UOW and to John Marthick and Heidi Brown of the School’s Spatial Teaching Laboratory. I also owe my heartfelt gratitude to Richard Miller for his assistance in Cartographic techniques. Field work for this PhD research was successful because of the involvement of Javier Leon, Paolo Abbale, Pat Macquarie, Dr. Ava Simms, Mrs. Olive Cotter, Marty Hazelwood, Gareth Davies, Terry Lachlan and my daughters Nora Abuodha, Magdaline Abuodha and Monica Betty Abuodha. Thank you and I very much appreciate your support.

Professor Athanasios Vafeidis of the Institute of Geography at the Christian-Albrechts University, Kiel, Germany is acknowledged for useful discussions and for providing updated SRTM data for Segment 11105 Australia that was utilised in the application of the DIVA tool for the assessment of the Illawarra coast. Chris Sharples of the University of Tasmania held several useful discussions with me on the Geomorphic Stability Mapping (GSM) approach, or ‘Smartline’, as it is nationally known, that was key to the mapping of the geomorphic landforms along the Illawarra coast. Thank you, Sharples. Professors Elizabeth Pendleton and Emily Himmelstoss of the Coastal and Marine Geology Program of the U.S. Geological Survey (USGS) at Woods Hole kindly provided assistance with application of the CSI and DSAS tools, respectively. Photogrammetry data for the delineation of historical rates of shoreline change was provided by David Hanslow and Robert Clout of the Department of Environment and Climate Change (DECC) at Newcastle, to whom I am highly appreciative.

The Australian Greenhouse Office (AGO) in Canberra is acknowledged for its support for this PhD study and for publishing our initial work on “International assessments of the vulnerability of the coastal zone to climate change, including an Australian perspective” that was key to this PhD study. I am especially grateful to Dr. Gina Newton in this regard. Mrs Virginie Schmelitschek of the UOW, Dr. Ava Simms, Harry Cotter (My Australian dad) and Dr. Thomas Dzeha (formerly of Macquarie University) had the onus of reading drafts of this PhD thesis and are therefore acknowledged for their helpful suggestions.

I appreciate the kind support of Professor Colin Murray-Wallace, formerly Head of the SEES at the UOW for making the domiciling of my children to Australia possible after the death of my husband in Kenya. Professor Salwa Woodroffe of the UOW is acknowledged for moral support and for being the sister that I never had. Former Principal of St. Mary’s Star of the Sea College, Mrs. Fay Gurr and the entire staff of the college are acknowledged for embracing my girls into the St. Mary’s family, which has been a stabilising factor for my PhD candidature. My Kenyan parents of Australian origin Mr. Harry Cotter and Mrs. Olive Cotter have been a source of moral and spiritual inspiration for me at Wollongong. I am equally thankful to my sweet daughters Nora, Lina and Betty without whose love and support this PhD would have been a nullity.

This study has taken place with a study leave from employment at the Kenya Marine and Fisheries Research Institute (KMFRI), Mombasa, Kenya and the support of the director Dr. Johnson Kazungu is highly acknowledged. David Price and Jose Abrantés ensured my regular biscuit at tea time in the school, David, having taught me how to brew tea in a cup!! Last but not least I would like to acknowledge all those people that may have directly or indirectly assisted me in making good of my stay in Australia and in finalising my PhD candidature at the UOW.

Funding of this PhD was from the Australian Government Endeavour Award International Postgraduate Research Scholarship (IPRS). The SEES is acknowledged for its support, tuition waiver and award of Bursary especially after the expiration of the IPRS scholarship and to God for giving me the good health during this period.