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978-0-521-69671-5 - An Introduction to Coastal Processes and Geomorphology

Robin Davidson-Arnott

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## Introduction to Coastal Processes and Geomorphology

Written for undergraduate students studying coastal geomorphology, this is the complete guide to the processes at work on our coastlines and the features that we see in coastal systems across the world. Accessible to students from a range of disciplines, the quantitative approach helps to build a solid understanding of wave and current processes that shape coastlines globally. The resulting processes of erosion, transport and deposition and the features they create are clearly explained, with a strong illustration and photo programme. From sandy beaches to coral reefs, the major coastal features are related to contemporary processes and to sea-level changes over the past 25 000 years. Key equations that describe or predict measurements from the instruments used to map these processes are all presented in this wide-ranging overview. Robin Davidson-Arnott completes the teaching package with online material that brings the subject to life, including videos of coastal processes and virtual field trips.

ROBIN DAVIDSON-ARNOTT completed his Ph.D. in 1975 from the Department of Geography at the University of Toronto. He was appointed Assistant Professor at the University of Guelph in 1976, Associate Professor in 1980, and has served as

Professor from 1988 onwards. He has been a member of the Task Force of the International Joint Commission (Canada/USA) Great Lakes Water Levels Reference Study Phase 1 (1987–89), and has seconded as a Scientist to the Ontario Ministry of Natural Resources Development of Ontario Shoreline Management Policy and Technical Guideline (1992–95), and to the International Joint Commission (Canada/USA) Upper Great Lakes Water Level Regulation Study (2007–11). He has worked as a consultant for a number of studies for Ontario Conservation Authorities and Parks, Canada, and been awarded the R.J. Russell Award from the Coastal and Marine Specialty Group of the Association of American Geographers in 2000. His research interests are in coastal geomorphology – on beach and nearshore processes on sandy coasts, nearshore erosion of cohesive coasts, coastal saltmarshes, aeolian sediment transport and coastal dunes – and he has received continuous support in this from the Natural Sciences and Engineering Research Council of Canada for over 30 years. He has authored and co-authored many books and papers on the subject, including a contribution to *Geomorphology and Global Environmental Change* (Cambridge University Press, 2009).

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## Preface

This book is designed primarily as a textbook for an upper-level undergraduate course in coastal processes and geomorphology and it stems from a fourth-year course that I have taught for twenty-five years at the University of Guelph. Its primary objective is to provide students with a description of processes acting to erode, transport and deposit sediments in the coastal zone, and of the factors that act in concert with these to produce the infinite variety of features that characterise marine and freshwater coasts around the world. The intent is to provide sufficient information for the reader to be able to then tackle more detailed material available in primary sources such as refereed journal articles, monographs and the World Wide Web.

The students in the course I teach are primarily in the BSc programme in Physical Geography or Earth Surface Science, with a focus on geomorphology and hydrology, but students from a number of other disciplines, including Engineering, Marine Biology and the BA programme in Geography also take the course. In writing this book I have assumed some background in geomorphology or earth sciences and some level of comfort with mathematical equations and basic physics. However, it should still be readable for those who do not have these. It is my hope that the book will also provide a useful reference source for coastal managers and for other scientists and social scientists interested in the coastal zone.

While I have tried to be broad in my coverage and in the examples used, the book invariably reflects my own experiences and approach. This is biased somewhat towards field studies rather than numerical modelling, and to research carried out in Canada, the USA, the Caribbean and Western Europe, as well as travels to Australia and New Zealand. As much as possible I have drawn on the literature in peer-reviewed journals and some monographs, while acknowledging that there is now a wealth of information available on the web. The expectation is that material presented here will make it easier to find and interpret these sources.

Following the introductory two chapters, the book is divided into two roughly equal parts, the first intended to provide an understanding of coastal processes operating on all oceans and large lakes. The second deals with the geomorphology and morphodynamics of a number of coastal environments including beaches, barrier systems, cliffs, coral coasts and saltmarsh and mangrove coasts. A more comprehensive coverage might also include estuaries and deltas, but to treat them in the same level of detail as the other environments would have made the book too long and I was easily persuaded that these could equally be covered in a book dealing with fluvial geomorphology.

The intense media coverage of natural disasters in the coastal zone such as the December 2004 tsunami in the Pacific and Indian oceans, and Hurricane Katrina in the USA have served to focus attention on vulnerability and adaptation to these and other coastal hazards. This is reinforced by the ongoing debate over human-induced climate change and particularly the predicted increase in the rate of sea level rise and the threat this may pose to populations living in the coastal zone. At the same time there is growing acknowledgement of the need for some comprehensive system of coastal zone management to facilitate adaptation to natural hazards and to reduce human impact on natural coastal systems. This book does deal explicitly with future sea level scenarios in the chapter on sea level and in Part III there is consideration of the potential impact of increasing rates of sea level rise in each of the coastal environments treated there. There are a multitude of good texts and monographs dealing with coastal management so, rather than treating it cursorily in a separate chapter, I have chosen to give some examples of application to specific problems for each coastal environment. It is hoped that the material presented here can be used to provide coastal managers with background on the physical processes and features of the coastal zone which need to be considered in developing management strategies and plans.

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A variety of material is available online to supplement the material presented in the book. This includes colour versions of all photographs and diagrams and a consolidated list of references. Virtual field trips providing examples of the coastal environments described in Part III include supplementary photographs,

maps diagrams and short videos. A number of key coastal processes are also illustrated with short videos. Finally, data from field experiments that can be used in laboratory exercises for students are included in separate spreadsheets. It is my intention to try to add to this list over the next two years.

## Acknowledgements

This book is the outcome of my experience of many years of research and teaching on coasts. I have been fortunate in that time to have the support of many colleagues and friends who have contributed to this. Numbered among these are more than thirty graduate students who have cheerfully shared long days (and some nights) on beaches, in the water, and underwater. They have endured without complaint the tribulations of weather, equipment malfunctions and the sheer physical labour required to carry out a successful field experiment. Their contributions are evident throughout this book in references to published papers. I have also benefited over the years from working with colleagues on field experiments and sharing ideas and experiences, many of which have found their way into this book. Included among them are: Brian Greenwood, Doug Sherman, Bernie Bauer, Karl Nordstrom, Patrick Hesp, Jeff Ollerhead, Troels Aagaard, Ian Walker, Danika van Proosdij, and the late Brian McCann and Bill Carter.

I have been fortunate to have been able to teach a fourth year course in coastal processes, which ultimately spawned this book, and the students who have taken that course have continuously renewed my interest in finding new ways to stimulate their interest in all things coastal. I am indebted to my colleagues in the Geography Department at the University of Guelph who have provided such a great environment to work and teach in. I would like to thank especially Bill Nickling, Ray Kostaschuk and Mike Moss for sharing ideas over many years and Mario Finoro for building and maintaining much of the research equipment. Special thanks go to Marie Puddister who has worked cheerfully for more than a year to produce all the figures for this book and for the web resources and who has been able to turn some of my illegible scratchings into recognisable diagrams.

Thanks to Anne Lamb for pushing me to do this. Thanks also to Frances who was there at the beginning and to my daughters Julia and Alison who have of necessity spent more time on beaches than they might otherwise have cared to do.

Finally, I could not have written this without the support of my wife Sharon who has cheerfully put up with all the trials of putting this book together over the past 18 months. Her reward will likely be a bit more time together on a beach in the Caribbean.

A number of colleagues have kindly let me use photographs from their own collection and these are acknowledged within the text. I would like to thank the following for permission to reproduce figures used in the text:

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