

Beaches and Dunes of Developed Coasts

This volume discusses the role of humans in transforming the coastal landscape. The book details the many ways beaches and dunes are eliminated, altered and replaced and the differences between natural landforms and the human artifacts that replace them. A distinguishing feature of the book is the emphasis on the importance of retaining naturally functioning beaches and dunes in ways that achieve natural values while accommodating development and use.

The issues dealt with in this monograph are important in coastal management. It will therefore be of interest to practicing coastal engineers and scientists working on applied research topics, as well as to planners and managers of coastal resources at all levels of government. The book will be of particular value to investigators planning for the future of coastal development under accelerated sea level rise. It will also be useful as a supplementary reference text for graduate and advanced undergraduate courses in geography, geology, ecology and other disciplines dealing with issues in environmental management, environmental ethics and the interaction between science, technology and society.

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Preface

A considerable proportion of the coastline of many countries is now developed with buildings and transportation routes or protected against flooding and erosion, and many shorefront communities that are only partially developed or stabilized are well on the way to total transformation. Some coastal areas have been designed and built as human artifacts and bear little resemblance to the coast that formerly existed. Strip development dominates the land conversion process in many coastal communities, placing the location of much of the development where it is readily affected by wave and wind processes. Shore protection structures emplaced to protect these developments are often placed where they have the greatest impact on shoreline processes and the most dynamic landforms. Shorefront property owners alter the coastal landforms to suit their needs, and beach users alter the vegetation and landforms without even knowing it.

There is no indication that the trend toward increasing development will be reversed. Economic evaluations indicate that many locations could justify even greater expenditures for construction of new buildings and protection projects, and these expenditures will be forthcoming despite an increase in the rate of sea level rise and potential for storm damage. Major storms cause considerable property damage but little lasting effect on the landscape compared to human activities. Communities that have been severely damaged by coastal storms are often rebuilt to larger proportions. Increasing population pressure, combined with the value of shorelines for human use, makes the occupation of the coast widespread and inevitable under present management practice.

Our understanding of the relationship between human activities and coastal evolution is inadequate, despite the growing body of literature on human-induced changes in coastal environments. Geomorphologists, who are specialists in the study of landforms, have been reluctant to study

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developed coastal systems. Those who study developed systems often examine them in the context of what is happening in the present without considering how the developed landform arrived at the present stage of evolution. Scientists may examine landform evolution through time by showing how erosion rates or vegetation patterns change but do not explain this change in the the context of social processes. Some investigators are deterred by the magnitude of the problem of isolating cause and effect in complex developed systems, or they are trained to look at landscape evolution at vastly greater time scales than occur under developed conditions. The net result of the lack of focus on developed coastal systems is that human alterations most often are viewed as an aberration, rather than an integral component of landscape evolution. Use of the terms interference and intervention (rather than alteration) to describe human action underscores the lack of appreciation of the role of humans as landscape agents or a lack of objectivity in assessing their effects.

This book identifies the way coastal landforms are transformed by human action and the reasons why this transformation occurs. The context is geomorphology, and ecological and human factors (such as economic or social constraints) are presented in terms of how they affect landform size, shape, location and mobility. The focus is on beaches and dunes because human alteration of these features and the natural processes that shape them is so prevalent in the coastal zone. The book is not an examination of issues related to fields outside geomorphology, but it will have value to practitioners in those fields as a reference document. The conflict between natural and human functions and values and static and dynamic approaches to management are principal threads throughout the book, as is the issue of whether humans should be considered intrinsic or extrinsic agents of landscape evolution. My intention is to minimize discussion of purely natural processes, except to illustrate some of the basic differences in the way natural and human-altered landforms are created and evolve. Basic information on natural processes is available in several excellent texts (e.g., Carter 1988; Komar 1998), and there is no reason to repeat that information here.

This book is an attempt to provide an objective, scholarly scientific treatise of human-induced landscape conversion that can serve as a basis for environmental debate, a starting-point for an approach to restoration of endangered living and non-living resources, and a reference volume for those wishing to conduct more extensive research on these topics. The discussion is intended to be of interest to coastal engineers and scientists as well as to planners and managers of coastal resources at all levels of government, students, shorefront managers and users of the beaches and dunes of the coast. The book is

intended to help provide the basis for a management program for beaches and dunes, but it is not intended to discuss basic principles of management and policy. Guidelines for scientists, outlines for future studies and research methods and opportunities are presented, but the book is not designed as a handbook.

The proportion of publications devoted explicitly to human-altered coastal landforms is relatively small compared to so-called natural landforms, considering the scale of human impact. Articles on the geomorphology or sedimentology of developed coasts are rare in basic research journals, with some important exceptions, notably the *Journal of Coastal Research*. Articles in environmentally oriented journals and publications with emphasis on planning, management or societal aspects of coastal change are plentiful and contain valuable insight to the human processes operative in developed coastal systems and the way shorelines have been modified from natural conditions. The literature in engineering forums on the relationship between structures, coastal processes and beach change is truly vast. The proceedings of conferences sponsored by the American Society of Civil Engineers are particularly valuable, although much of the research is concerned with design of structures rather than the effects of structures after they are emplaced. Books oriented toward planning, management or societal aspects of coastal change often do not provide detailed assessments of mechanisms of landform evolution in developed physical systems. Proceedings of multidisciplinary conferences dealing with management issues contain valuable case studies of developed systems, but synthesis of these studies is not possible in those forums. There are numerous books and reports with a regional orientation that discuss developed portions of coastlines and collections of case studies that include developed coasts, but these volumes do not provide a synthesis of data on landforms or vegetation of developed systems or models of shoreline change specifically for developed coasts. Books that have addressed the nature of human alterations to beaches and dunes in some detail include Carter (1988), Viles and Spencer (1995) and Bird (1996). I have attempted to make this book complementary to Carter (1988) by focussing almost exclusively on the vast literature that has been produced since his publication and complementary to Bird (1996) by presenting human alterations in a basic research context with implications for modeling landform evolution rather than managing landforms. The book is complementary to Viles and Spencer (1995) in its concentration on human activities in beaches and dunes.

The focus of this book is on landforms of exposed ocean coasts. Space constraints preclude inclusion of the vast literature on estuarine environments, although human alterations of the coasts of estuaries have been profound.

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Modifications in streams and estuaries and human actions outside the portions of the coastal zone occupied by beaches and dunes, such as ocean dumping, pollution of air, water and sediments and alterations to flora and fauna, are not addressed unless the changes directly affect sediment budgets and landforms on open-coasts. The emphasis is on results of field investigations and observations rather than physical (scaled down) models or theoretical/mathematical models, although results of those types of studies are used where they provide the only meaningful assessment of human alterations of the coastal landscape.

There is no tradition of research on the geomorphology of developed coasts, and the structure and emphasis of this book could be handled in a number of ways. I have elected to lead off with a historical perspective of the economic and social forces leading to coastal development. The ways that humans alter coastal landforms to achieve specific needs other than shore protection are presented in chapter 2. Alterations resulting from projects designed to replenish sediments in beaches and dunes are presented in chapter 3. Chapter 4 focuses on interaction of waves and winds with coastal structures that have been designed for a variety of purposes, including shore protection, habitation, recreation and transportation. The ways that human alterations are compatible or incompatible with natural processes and the ways their physical characteristics and temporal scales of evolution differ are then discussed in chapters 5 and 6. The reasons why natural values do not fare well when pitted against traditional human values are identified in chapter 7, where management programs are examined in the specific context of beaches and dunes. Restoration and nature development is discussed principally in chapter 8, along with guidelines for restoring or maintaining natural landform characteristics in developed areas. The book concludes with a discussion of future research programs that will provide a basis for understanding the role of beaches and dunes in developed landscapes and serve as the basis for programs for their planning and management.

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