Island, at the northeastern margin of the Laurentide Ice Sheet. R.J.N. Devoy has synthesized paleo-sea-level data for northwestern Europe to deduce regional patterns of glacial isostatic uplift and subsidence. O. van de Plasche has produced more reliable and accurate relative sea-level curves based on new field studies at several localities on both sides of the Atlantic.

The collection of papers in this book represents a fairly thorough, up-to-date summary of the relation between the response of the earth's lithosphere to the deglaciation history, and Holocene sea-level changes, as seen from the perspectives of several disciplines. However, there are a few shortcomings. Some of the papers (*e.g.* those by Peltier, Pirazzoli, Trupin and Wahr) have basically been published elsewhere. Also, many of the figures have been reduced to such an extent that a magnifying glass is needed to read the numbers and labels on some of the graphs. Some of the papers could have undergone more careful proofreading (*e.g.* Visconti's paper on global warming). In spite of these limitations, the book, as a whole, is recommended as a good review of the latest developments in the glacial rebound problem that has challenged geophysicists, glaciologists, and coastal geomorphologists for over a century.

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Submerging Coasts: The Effects of a Rising Sea Level on Coastal Environments, by Eric C.F. Bird, 1993. John Wiley & Sons, Ltd., Chichester, U.K., 184p. ISBN 0-471-93807-6.

A number of recent books have been written on the subject of sea-level rise due to the expected global climate warming. This book, a sequel of E.C.F. Bird's 1985 book *Coastline Changes: A Global Review,* documents the nature of shoreline changes presently occurring on the world's subsiding coasts, as a preview of changes that can be expected elsewhere in the future, as global sea-level rise accelerates. It also examines three likely human response strategies.

The Introduction outlines regions where the world's coastlines are presently subsiding, and points out that these sectors will become more extensive, while emergent coasts will become rarer, as sea-level rises. Chapter Two presents an overview of the many processes that affect sea-level, of which global warming is only one. Other important factors include tectonic movements, glacial-isostatic adjustments in formerly glaciated regions and along their margins, hydro-isostatic loading of continental shelves, sediment loading at major deltas, and artificially-induced subsidence due to groundwater and/or hydrocarbon extraction. Shifts also occur in ocean surface topography due to tides, the earth's rotation, and changing patterns of ocean circulation. Given the wide variety of contributing causes, and divergence in sea-level trends deduced from tide-gauges, a certain degree of caution is recommended in interpreting the apparent rise in global sea-level of around 1.2 mm/yr.

Chapter Three examines the effects of rising sea-level in different geomorphological settings, such as steep coasts, beaches and barrier coasts, estuaries and lagoons, deltas, intertidal zones, also heavily developed coasts. Coastline responses are difficult to predict quantitatively and will depend on the interaction of many local variables. In general, however, low-lying and intertidal areas will become progressively submerged, and cliff and beach erosion will increase. The actual recession will depend on the relative rates of sea-level rise vs. offsetting trends such as rates of sediment supply, organic accretion, and in the case of coral reefs, growth rates. Critical coastal ecosystems, such as saltmarshes, mangroves, and coral reefs will be under increasing stress, not only from sea-level rise, but even more so because of pollution and over-development. Mangroves, in particular, have been cleared extensively in recent decades for agriculture and urban or industrial development. Coral reefs have been decimated by pollution, increased siltation due to inland deforestation, use of explosives for fishing, quarrying, and collecting, and also a mysterious "bleaching" believed to be caused by higher sea surface temperatures, possibly associated with El Niño events. These practices are especially unfortunate, because mangroves and coral reefs act as buffer zones to protect the inner coast and islands from flooding and erosion by cyclones or typhoons, and ultimately, to mitigate the effects of sea-level rise.

Sea-level rise is only one of 20 listed causes of beach erosion; most of the rest are attributed to various sources of reduced sediment supply. On sandy beaches, the widely-used Bruun Rule pre-

dicts an upward and landward translation of the beach profile, such that erosion of the upper beach provides an equivalent volume of sand to the lower, nearshore zone. A "rule-of-thumb" suggests that a 1 m sea-level rise would result in beach retreat of 50–100 m. While fairly good agreement between the Bruun Rule and actual shoreline retreat has been observed in Chesapeake Bay, elsewhere the erosion rates are either under- or over-predicted. Limitations include precise definition of the seaward extent of offshore sand deposition, assumption of equilibrium conditions, and neglect of sand washover, which can be a significant process on barrier islands.

Saltmarshes and mangroves show an ecological zonation that is highly sensitive to topographic and salinity gradients. Where the hinterland is low-lying, and unobstructed, the zonations can be expected to migrate landward. If sediment supplies are adequate, the seaward margin may persist in spite of higher sea-level or increased wave attack. However, reduction of these habitats can be expected where sedimentation or accretion rates are lower than sea-level rise, or where artificial barriers impede landward migration.

The response of coral reefs ranges from "keep-up", "catch-up", to "give-up", depending on the species and rate of sea-level rise. Upward reef growth of many corals can be expected, provided that rates of sea-level rise do not exceed 10–12 mm/yr. However, the renewed coral growth may be more fragile than older, more solid, filled-in reefs.

Chapter Four describes the human reactions to rising sea-level, giving examples from presently subsiding coasts. Three main response strategies are outlined: 1) abandonment or adaptation, 2) maintainance of the status quo, and 3) counter-attack. Where erosion rates are high, and damage, especially to individual houses extensive, the most viable option has been to retreat further inland. Adaptation strategies include conversion of rice fields to brackish-water fish ponds, building villages on stilts or floating platforms, or raising threshold steps to keep out floods (as in several English fishing villages). Defending the existing coastline by seawalls or dikes, etc. (the "Dutch solution") is an option for highly populated, developed, urbanized areas. "Softer" defenses, such as beach nourishment, are also viable for major beach resorts or other urban areas. Because of the high costs, economic trade-offs will determine the extent to which this option is applied. In selected areas, it may be feasible to "counter-attack", that is, to reclaim shallow areas by enclosure, such as diking the Zuider Zee in Holland. Bird sketches several sites, such as Bangkok, or Port Phillip Bay and Cairns Bay, Australia, where such an approach may be technically feasible (although probably economically and politically unpopular).

Submerging Coasts gives a good general overview of the potential consequences of sea-level rise on coastal regions, with ample illustrations and many examples derived from the author's extensive first-hand experience. The discussion is largely qualitative, and based on analog studies from the Holocene post-glacial transgression; also a comparison is made of recent changes on more rapidly subsiding coasts. More quantitative models of shoreline retreat, such as sediment budget analysis, or dynamic equilibrium methods are only mentioned in passing. Also neglected is any reference to mantle rheological models that have been used to filter out glacial and hydro-isostatic movements from tide-gauge data (*e.g.* Peltier, Lambeck, and others; see review of *Glacial Isostasy, Sea Level and Mantle Rheology*, edited by R. Sabadini et al., this issue), and the Fairbanks (A 17,000-year glacio-eustatic sea level record: influence of glacial melting rates on the younger Dryas event and deep-ocean circulation. *Nature*, v. 342, p. 637–642 [1989]) Holocene sea-level curve. The map of subsiding coasts (Figure 2) omits several other likely areas, such as the Maritime Provinces, Canada, the Yukon Delta, and the North Slope Alaska, the Mackenzie Delta, Canada, and possibly the coastal lowlands of the East Siberian Sea. (There is also an error on Figure 2. Site 2 at the head of the Gulf of California should be the *Colorado River*, not the Columbia River). Aside from these shortcomings, the book provides a useful, easy-to-read background for discussion and evaluation of coastal problems likely to arise from future higher sea-level, and also which occurs on presently subsiding shorelines. Thus, coastal planners, developers, managers, conservationists, and people living near the sea should find this book informative.

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