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BOOK REVIEWS

Impacts of Sea-Level Rise on European Coastal Lowlands, edited by Michael J. Tooley and Saskia Jelgersma, 1992. Blackwell Publishers, Oxford, U.K.; and Cambridge, Mass., 167p. (Inst. British Geographers, Sp. Publ. 27), ISBN 0-631-1813-0.

This is a collective volume with introduction and conclusions by the two editors, and nine regional reports ranging from the North Sea to the eastern Mediterranean, mainly studies of deltas, inasmuch as these areas are mostly undergoing compaction and tectonic subsidence, and thus experiencing the worst effects of recent rising sea levels, and may still worsen in the next century.

The book evolved from a meeting at Nordwijkerhout (the Netherlands) in 1987 which considered the coastal zone management problems that had been designated for special concern by the 1985 Villach conference of ICSU-UNEP-WHO on the governmental policies that should be considered as a consequence of the potential global warming that has been widely anticipated in the light of the increasing atmospheric liberation of greenhouse gases. Although the amplitudes of the effects and the severity of the resultant hazards are still highly controversial, it is universally agreed that, for whatever reasons, the coastal zone deserves our closest attention. Relative sea-level rise may equally well result from dewatering compaction, from persistent tectonic subsidence or from increased storminess (the latter mentioned on p. 5, but referenced in more detail on p. 10). The amplitude of recently measured tidal surges (5–7 m above MSL) makes some of the greenhouse warming estimates pale into insignificance. Storm surges tend to be cyclical, e.g. on the Baltic coast about 15 per century.

Recommendations were made at the Nordwijkerhout conference for both scientific research and governmental policy. Possibly most interesting for our readers was the decision that an inventory of shorelines should be undertaken that would specify two fundamental categories: (a) those shores where cost-benefit studies showed that protective engineering works would be worthwhile, and (b) those which should simply be "sacrificed". No hint was provided as to how the property owners in the latter category would be compensated for their sacrifice, but perhaps that is a tricky question best ignored by scientists (in the interests of self-preservation), but some possible coastal strategies are discussed (p. 26).

In the introduction, the editors, for figure 1.1 employ the generalized graph of Houghton *et al.* (1990) which gives a "best estimate" of MSL rise by A.D. 2100 at 56 cm; they also cite the Clark and Primus models for changes in the dynamic topography of the sea surface (in the 1987 volume edited by M.J. Tooley and I. Shennan, *Sea-Level Changes*). It so happens that a weakening of the geostrophic currents would result from global warming and this would cause a rise of sea level along the major continental shorelines that would be independent of any postulated glacier melting. (In mid-Pacific situations, very little geostrophic tilting would be expected, and very little sea-level rise is observed today.) What tends to make the N.W. European coasts particularly susceptible to sea-level rise is the long-continued dike-building, which appears to have begun well over 1,000 years ago.

Chapter 2 is a fascinating review of the Dutch recordings of mean sea level, the oldest beginning in A.D. 1683, but "floodmarks" were recorded earlier. Interestingly the "All Saints" surge of 1570 was 10–25 cm higher than that of Feb. 1, 1983. The records show very significant "undulations" both positive and negative (long before the Industrial Revolution), for which a climatic forcing must be assumed. The most regular of these is the approximately 10–20-cm sine wave of the 18.6-yr lunar nodal (and planetary nutation) cycle, a component already noticed in the Baltic by Lisitzin and globally by R.G. Currie. Other cycles of

8.85, 6.3 and 4.42 yr are noted (first and last are the lunar apsides periods), while the 6.3 yr, originally cited as "unknown" in origin, is probably the Chandler Wobble axial spin beat frequency. The 11-yr sunspot cycle is only sporadically represented. Something that can be seen only on the Amsterdam 1682–1930 record is the pronounced dip from 1770 to 1820, a unique MSL indicator of the low sunspot level (that has been called the "Sabine Minimum"), and its notable climate deterioration, a last fluctuation of the "Little Ice Age".

Chapter 3, the Belgian sector (Baeteman *et al.*), covers a transition from the subsidence area of the Rhine–Scheldt delta to the Cretaceous bedrock in the southwest. The oldest tide gauge is Ostend beginning 1820, but early records were lost or interrupted. Nevertheless a mean rise of 1 mm/yr is detected, though without any recent acceleration. What is most clearly brought out is the extreme vulnerability of the larger Holocene sediments of the coastal plain, being almost entirely unconsolidated, while at the same time being subject to intense human use.

For a British example, the Wash is the subject of Chapter 4, chosen by Shennan. A region of intertidal mudflats and salt marsh, partially diked, this region (the "Fens") has a fairly detailed history spanning the last 6,000 yr. Using Möther's eustatic curve, a subsidence factor of 0.9 mm/yr is suggested; he labels it "crustal", but in such a region sediment dewatering and peat compaction should be important, shouldn't they? He makes the interesting observation that every region should prepare local plans because international cooperation is not to be expected.

On the theme of vulnerability, the editors go back to the Netherlands for Chapter 5 (Jelgersma), which at first sight might appear to be most at risk, of all countries, but in view of their sophisticated dike system, skilled engineers and national willingness to face up to the problems, the Dutch are rather well off. In the Middle Ages, the drownings from dike breaks along the southern North were often in excess of 100,000 people, but as recently as 1953 a storm-surge break took about 2,000 lives. For a given dike, the present-day planning level is 15.75 m above mean sea level. It is highly significant for planners in general to note that of this value storm surge is 5 m, wave run-up is 9.9 m, and only 0.25 m is allowed for sea-level rise. The message for greenhouse effect planners is that storm surge characteristics and storminess frequency should receive maximum attention in future coastal studies.

The next five chapters deal with Mediterranean latitudes, where potential problems are dramatically different from northern Europe. Storminess frequency and surges are in general less significant whereas local tectonic factors (positive and negative) receive greater attention. With astronomical tidal components low, the importance of wind intensities and direction become relatively high. Future climate change will then deserve close monitoring. Merino (ch. 6) considers the "hot spots" of the western Mediterranean: the deltas, lagoons, sebhkas (salt flats), and a few narrow coastal plains. The Ebro delta gets special attention, in view of its lobe switching, 4th, 10th, 14th, 16th and 20th century, and its economic development. Unfortunately, there is no historical analysis which would be invaluable in anticipating possible effects of future sea level change.

A rather comparable delta, the Rhone, is treated in chapter 7 (L'Homer). Maximum submergence since Roman times is of the order of 4–5 m, but the eustatic-tectonic ratios have not been worked out. Farther west, along the Gulf of Lions, chapter 8 (Corre) considers a lagoon and barrier coast, but details of its late Holocene history have not been worked out. On a less than decadal scale interesting patterns of shoreline advance and retreat have been mapped. The eastern Mediterranean (ch. 9) is reviewed by Sestini, who points to the deltas (notably the Po, the Meander and the Nile), small coastal plains and the salt marsh sectors as particularly vulnerable. Past climate changes over the last 6,000 yr—this region shows that temperature fluctuations (1–2 °C) are insignificant but precipitation variations have been profound, having led to catastrophic draughts and social upheavals. Future MSL fluctuations of the order of 30 cm can be considered normal in the historical framework, but if rises occur in excess of 50 cm, difficult economic decisions will be involved. The highest sea level of about 6,000 BP lay 5–20 km inland in the Po, Nile and other deltas, but a low level was reached in early Roman times. Lobe switching seems to have marked the eustatic/climatic fluctuations. For the Nile a "twenty-year" oscillation of MSL has been noted, but the writers appear to be unaware of the 18.6-yr lunar nodal cycle, widely publicized by E. Lisitzin, and by R.G. Currie. Because of its equatorial source areas the Nile constitutes a special case, so that its discharge, until the present century,

has reflected monsoonal climate factors rather than local ones. Dam construction has now inhibited the usual sediment transport to the delta and coast retreat has already become serious. The city of Rosetta is already preparing a coastal defense system.

Chapter 10 (Zazo *et al.*) deals with the Mediterranean climate belt of S.W. Spain, but facing the open Atlantic and tides of over 2 m. Highest Holocene sea level is placed at 7,500 BP creating wide estuaries which were reported by Himilco, a Carthaginian sailor, around 2,500 BP. Low sea level in early Roman times generated cliffing and offshore barriers which have subsequently merged into continuous barrier beaches. Widespread deforestation of Spain since the Bronze Age played a major role in the rising supply of fluvial sediments which have largely blocked the old estuaries. The consequences of a rapid sea-level rise would involve inundation of lowlands and villages, salt pans and rice farms, coastal roads, transport system, saline incursion of aquifers, and freshwater ecology.

The volume winds up (chapter 11) with the editors' examination of future prospects. The consensus indicated the recognition of present-day hazards and cites the Fairbridge (1989) warming of "crescendo events in sea-level changes" [*Jour. Coastal Research*, v. 5(1), p. ii–vi]. They note that in the past "extreme water levels are rarely recorded accurately, because of the failure of the gauge". Nevertheless, historical evidence of major coastal catastrophes are well established, spanning the last 1,000 years. Unquestionably, since the Roman times, man-made encroachment of coastal terrain has by now built up such a precarious situation that moralists may well intone: "He who sows the wind, reaps the whirlwind". Subsidence is exacerbated by groundwater and hydrocarbon withdrawal; coastal sediments (a form of defense) are being denied by dam building; nearshore dredging is amplifying tide ranges and surge potential. On the other hand, ground levels can be raised (as shown by the "wurten" mounds of the southern North Sea, dating back to A.D. 500, see p. 224); dikes can be built, heightened and extended; coastal dunes can be encouraged by planting and isolation. An interesting point brought out is the potential use of mine tailings, that today are a polluting blot on the landscape, for coastal landfill at industrial sites.

The editors also offer some comments on the effect of sea-level rise in some developing countries (North Africa, Bangladesh, Brazil, China, the Maldives, etc.). Those countries dependent on fish ponds and paddy rice culture are most at risk.

Of the three options available—engineering, ecological or retreat—decisions are urgently needed and emphasis is placed on the need for centralized, governmental planning and action, with international cooperation to aid the less developed countries. This book is going to be invaluable, both in Europe and overseas, for scientists in general as well as administrators and engineers. The editors have done a superb job in getting it all together and deserve our gratitude for their clear and succinct reviews. The publishers likewise have done a splendid job with its production.

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Ocean Ecology of Pacific Salmonids, William G. Pearcy, 1992. Seattle: University of Washington Press, 190p. ISBN 0-295-97192-4 (cloth), 0-295-97193-2 (paper).

Salmons of the genus *Oncorhynchus* are some of the most important and best known food fishes in the world. Today environmental degradation has brought many salmon stocks to the verge of extinction and wild caught salmon are supplemented with hatchery fish which raises a new set of environmental problems. Salmons have been intensively studied both from the point of view of population dynamics and because of the physiological and evolutionary implications of the ability to thrive in fresh water at the beginning and end of their lives and in salt water during their growing period. In spite of this, many questions about the oceanic phase of salmon life history remain unanswered. This book is the third in the Washington Sea Grant monograph series, *Books in Recruitment Fishery Oceanography*. It is the result of a series of lectures on the ecology of salmon with emphasis on the author's special interest, the Oregon coho.

There is a tremendous literature on salmonid fishes, too much to master for anyone for whom salmonid biology is a peripheral interest. Still the topic is so important that the story of the salmon