EDITORIAL

Whither Sea Level?

In the last few years, learned experts in coastal engineering, oceanography, geology, and climatology have been gathering in top-level committees to talk about sea level — not as an interesting intellectual exercise, but with a sense of acute national and international urgency. Meetings are being held in the United States, Canada, Mexico, Britain, Belgium, The Netherlands, Scandinavia, Brazil, Argentina, the USSR, India, Australia. . . . Scientists and national planners are seriously disturbed. Nothing disastrous is foretold for 1985 or 1990. But if you are thinking of investing billions of dollars, or pounds, or marks, or kronor, in the development of port facilities, power stations, dikes, marinas, condominiums, or luxury hotels, you must think rather in terms of a 25 to 50-year ammortization period.

And why all the fuss? The long-term historical record of sea level is that it fluctuates, year-by-year, decadally, and over the centuries. Since the first systematically recorded tide gauge was installed at Amsterdam in AD 1682, the trace of MSL has shown impressive oscillatory rises and falls: with peaks of up to 5 cm variance every 10 to 20 years, and longer-term, larger amplitude variations of the order 10 to 20 cm in the range of 50 to 100 years. The record shows that a falling trend in the late 19th century was interrupted about 1895 and a secular MSL rise initiated that has averaged 1.2 mm/yr for more than 50 years. More alarming is that it has accelerated to over 3mm/yr during the last decades (Figure 1).

What could be the cause of this acceleration? Over the same period, atmospheric scientists have been observing a secular rise in tropospheric CO_2. Invoking the "Greenhouse Effect", many scientists have jumped to the conclusion that rising CO_2 is causing a rise in temperature that, in turn, is melting glacier ice and raising sea level. In nature this gas is liberated by volcanos, by hydrothermal emanations at seafloor spreading rifts, and by the metabolic activity of animals and plants. In daylight, plants use it up once more in photosynthesis, but in the present century mankind has been busily chopping down trees, ruining savanna vegetation by desertification, and, even more importantly, by burning fossil fuels, coal, oil, and natural gas, to liberate excessive quantities of CO_2.

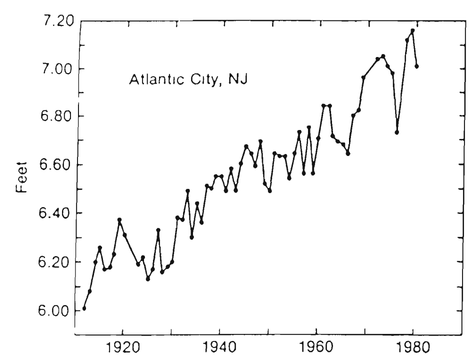

Figure 1. Yearly mean sea level at Atlantic City, New Jersey (Courtesy: NOAA). How much of this rise is: neotectonic subsidence of the mid-Atlantic coast? How much is glacioeustatic melting? And, which glaciers are melting? How much is steric expansion? How much is the Coriolis Effect?

In the geological past, large and potentially catastrophic quantities of CO_2 have been introduced into the atmosphere from time to time, at crescendos of plate-tectonic activity and during volcanic eruptions. Nature, however, can accomodate such events by some neat feedbacks. The ocean carries 40 times as much CO_2 in solution as does the troposphere. Any local disequilibrium comes back into balance within one year. If the oceanic pH is depressed by excessive quantities of CO_2 in solution, there are abundant supplies of organogenic aragonite being created all the time in the near-surface pelagic realm. The more CO_2 the better the calcium-carbonate-fixing pelagic phytoplankton will thrive, but the lowered pH will equally quickly convert the CO_2 into the soluble bicarbonate ion. A reasonable question is: how long will the present atmospheric build-up take to readjust in equilibrium with the oceans? If the adjustment is slow, some specialists calculate there will be a 2 to 4°C rise in mean atmospheric temperature. Intuitively, that would be enough to start the large-scale melting of the Antarctic and other ice sheets, which contain enough potential meltwater to raise sea level by 65 m. Several billion human beings would either be driven from their homes or drowned.

Now, it seems to me that rather a lot of intuition is being bandied around. This is just a personal impression, but your Editor-in-Chief tells me he wants this column to be a forum for personal opinions. It is not that I have anything against intuition. Most of scientific discovery is by way of intuition — to the prepared mind. So the critical question is this: do we have the necessary data, and have we carried out the appropriate experiments, for testing these worrisome deductions? And, if not, why not?

There are still numbers of questions that should be posed. Granted that the CO_2 level is rising, are we certain that an atmospheric warming is its direct consequence? Many terrestrial stations continue to show cooling trends. Sea-surface temperatures are cooler than in 1940. If we judge the long-term temperature trend from a cyclic extrapolation of the Greenland ice-core (^{18}O isotope variation), then we may just now be entering a phase of cooling due to a weakening of solar radiation (Figure 2). The principal cycle is 178 to 180 yr (corresponding apparently to the All-Planet Synod, a quasi-periodic astronomic alignment that affects solar behavior). This periodicity is further modulated by the 19.857 yr cycle caused by the Saturn/Jupiter Lap and by the torque of the inner planets as postulated by Landscheidt and by the 18.6 yr lunar nodal cycle demonstrated by R.G. Currie. Will the rising CO_2 warming effects be able to reverse the postulated cooling trend? Scientists concerned with coastal matters should be able to formulate research plans to test some of these speculations. The multifaceted problems constitute quite a challenge!

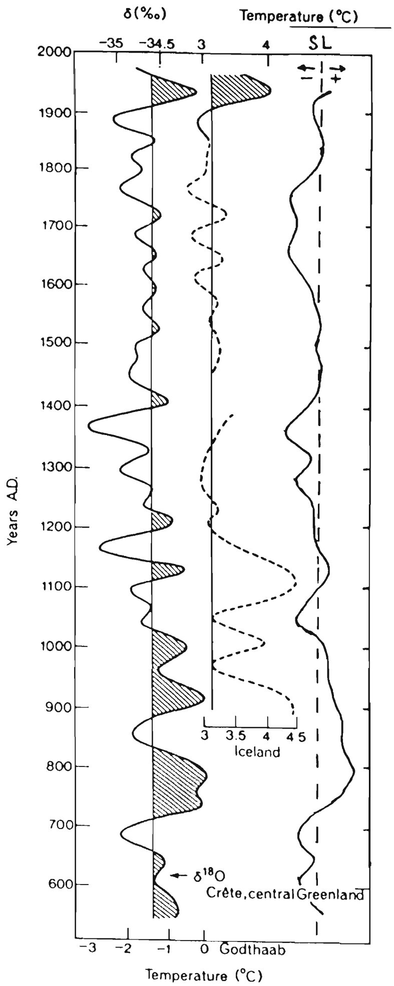

Figure 2. Historical trends from the 6th century. First column (left-hand side) shows ^{18}O values in Greenland ice core; middle curve shows Iceland's temperature variations (based on documented proxies), and right-hand column shows approximate Mean Sea Level fluctuation (from Hillaire-Marcel's work on Hudson Bay) reflecting storminess trends.

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