The rise and fall of the greenhouse sea-level hoax

Australian geographer Ted Bryant explains why the greenhouse gang's scenario for rising sea levels doesn't hold much water in the real world.

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The popular media and scientific literature have been bombarded in the last five years by dire warnings about catastrophic rises in sea level due to greenhouse warming. The 1985 Villach Conference in Austria fueled these predictions by proposing a rise of 20-140 centimeters in the next century attributable mainly to thermal expansion of oceans. Higher sea levels than this would be generated by dramatic melting of the Greenland and Antarctic icecaps. Sea-level rises of this magnitude would have destructive implications for the world's coastline. Beach erosion would be accelerated, low-lying areas would be permanently flooded or subject to more frequent inundation during storms, and the base line for water tables would be raised. None of these prophecies is likely. Most greenhouse advocates simply do not have the faintest idea how sea level behaves.

Sea level along any coastline consists of two components. The first is some long-term trend that may reflect the global hydrological cycle or regional movement of the Earth's crust, a process labeled "tectonics." The second is a more substantial, chaotic variation that reflects local climatic fluctuations. **Figure 1** illustrates these two components. The curves represent annual sea levels between 1930 and the mid-1970s for five major cities—London, New York, Venice, Tokyo, and Sydney—which greenhouse proponents view as evidencing rising sea levels. Hardly anyone would dispute the fact that all five cities show a trend toward rising sea level. If the increases in Figure 1 represent the global perspective, then the actual volume of water in the oceans would have to increase, because more water was physically added to it, or because a substantial amount of surface water had warmed and hence expanded. The simplest way to raise sea level would be to add more water to the oceans. This can be achieved by melting alpine glaciers, which we know have been retreating and possibly contributing to an annual sea-level rise of 1-1.5 millimeters per year. It could also be achieved by melting polar icecaps; however, we have no evidence that the icecaps are melting. Furthermore, they are extremely unlikely to melt in the near future. They won't melt because, unlike alpine glaciers, they are much colder. The Antarctic icecap has a mean temperature of −40°C. Even if polar air temperatures rose by 10°C, the temperature of the Antarctic would still be −30°C and ice doesn't melt at that temperature. Not even the melting of ice floating in the ocean would make much difference, because this ice has already displaced its weight in water. Even if the edge of the Antarctic icecap or the most susceptible West Antarctic portion melted, the process would take more than 500 years. There is no easy way to melt polar icecaps. In fact, warming the air and waters around the Antarctic would decrease global sea levels. Cold air holds very little moisture. Warming that air by even 1°C would dramatically increase the amount of moisture that could be held in the atmosphere. If this air even approached the icecap, it would be rapidly cooled, whereupon the moisture would fall as snow and slowly form part of the icecap. This process would remove water from the oceans and eventually lower sea level.

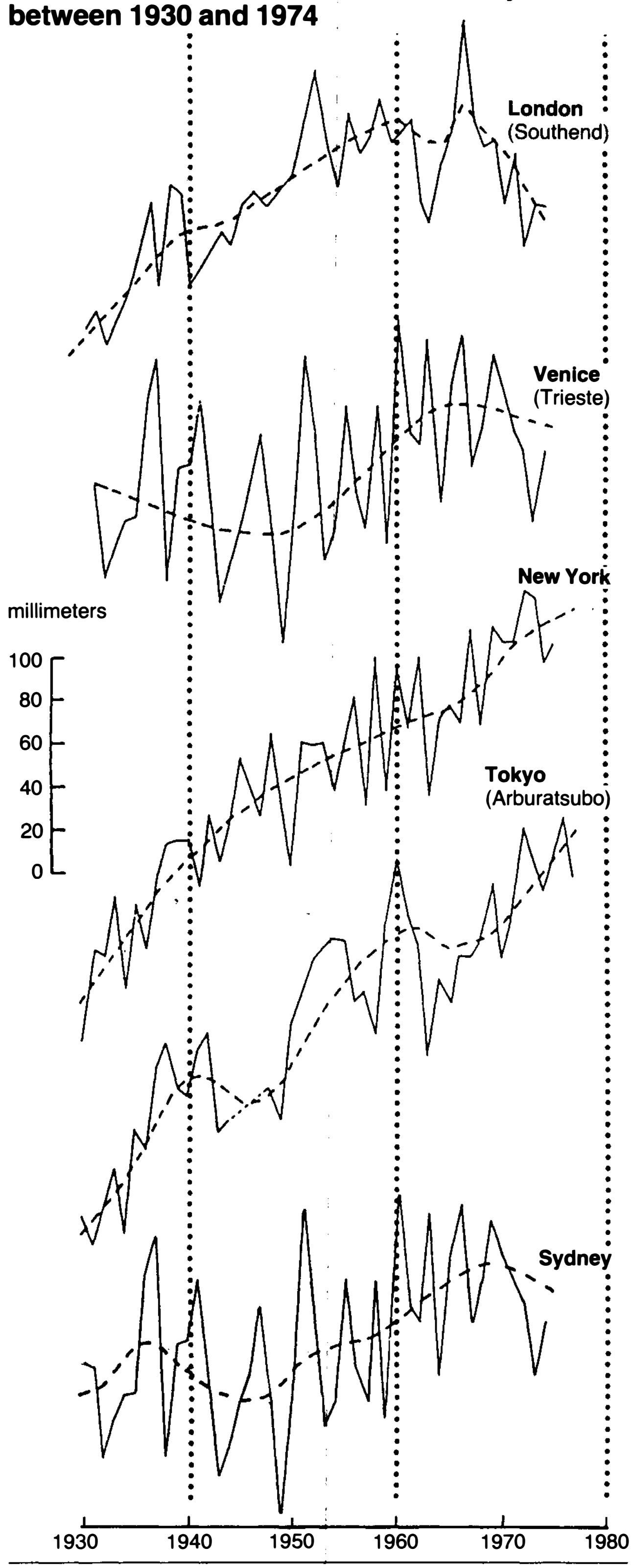
There is a third, more important mechanism for changing the volume of water in the oceans, and that is for mankind to pump it in or out. For instance, ground water withdrawals in the United States in 1980 amounted to 123 cubic kilometers. For the world, this is equivalent to 481 cubic kilometers, which would raise sea level 1.3 millimeters per year. In contrast, man also replenishes the water table through leakage from reservoirs or by direct irrigation. This leakage may amount to 550 cubic kilometers per year, but the figure is uncertain. The rise in sea level supposedly measured over the past century could simply be due to man adding to the ocean volume through ground water extraction. On the other hand, the extension of reservoirs and irrigation may be lowering sea levels or balancing the amount of water being extracted from the ground. Either way, man has a significant impact on sea levels through interference with the hydrological cycle. This is not necessarily deleterious, because it is within man's capability to deliberately withdraw water from the hydrological cycle to balance any rise in global sea level. This could be done by filling depressions such as the Qattar Basin in Egypt, Lake Eyre in Australia and the Caspian Sea in the U.S.S.R. (in total these basins could hold 15,160 cubic kilometers), building more dams on rivers or pumping freshwater in aquifers.

But is sea level really rising? A careful examination of the curves in Figure 1 indicates that sea level is not rising consistently. In fact, it decreased noticeably in London and Venice after the mid-1960s. In reality, the sea-level curves in Figure 1 are not necessarily due to a global rise in sea level, because local Earth movements dominate some areas. For instance, London is in an area where the North Sea Basin is tectonically sinking, Venice suffers from subsidence due to ground water extraction and Tokyo has tectonic subsidence caused by earthquakes. Many of the trends we witness in sea-level curves are not due to a global change in sea level but to this regional tectonic behavior.

Figure 2 illustrates the complexity that can arise from tectonic variation. The diagram plots the best sea-level data available for the world for the period 1960-79. Areas with annual changes in sea level greater than 3 millimeters per year have been differentiated from those with changes of 0-3 millimeters per year in this figure. Contrary to the general belief that sea level is presently rising worldwide, sea level has fallen along significant stretches of coastline mainly in western Europe, western North America, and eastern Asia since 1960. Some of the areas of falling sea level are outside zones affected by any glaciation. Increasing sea levels are restricted mainly to the Gulf of Mexico and the eastern coastlines of North America and Japan. Noteworthy is the fact that it is difficult to delineate large areas of consistent sea-level change because sea-level behavior can change sign over distances of a few hundred kilometers or less. This is even apparent where rates of change are greater than ±3 millimeters per year as evidenced by the patterns in northern Europe and eastern Asia. Additionally, Figure 2 indicates that there is too little information to state emphatically whether or not sea levels are rising worldwide. More data are required from the centers of oceans and at regularly spaced intervals along all coastlines to account for the speeding up or slowing down of ocean gyres that could affect sea level in the short term.

FIGURE 1

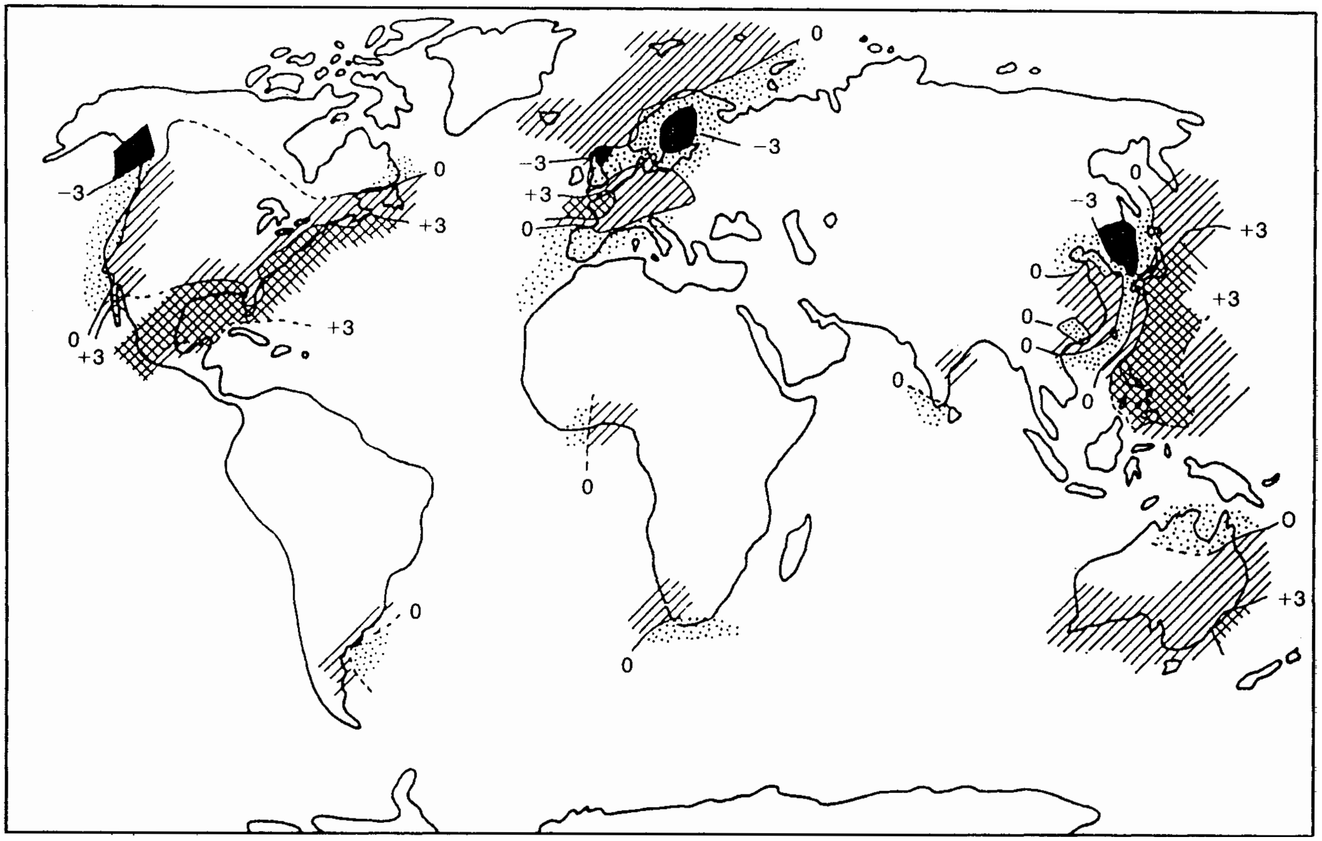
Annual sea-level curves for five major cities between 1930 and 1974



Source: Ted Bryant.

FIGURE 2

Sea-level trends for the globe between 1960-1979



Rising

▨ 0-3 mm/yr ▩ >3 mm/yr

Falling

⬚ 0-3 mm/yr ■ >3 mm/yr

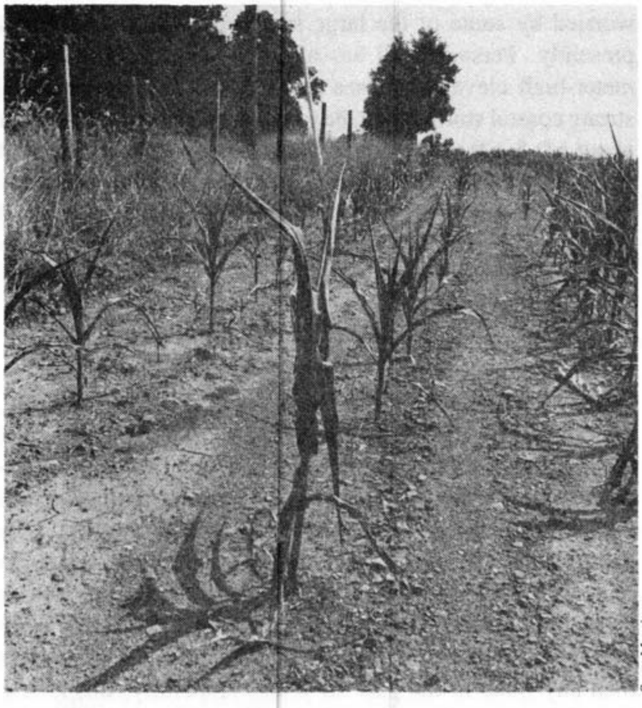
Unshaded areas do not have sufficient data to allow trends to be plotted for these two decades.

Source: Ted Bryant.

The issue of 'chaos'

The general reaction of most people to Figure 2 is that the patterns are chaotic. Mathematically these comments could not be closer to the truth. Over the years, I have tried to characterize and define the reasons for large-scale fluctuations appearing in the curves in Figure 1. The fluctuations are the superimposition of a range of patterns, consisting of a change in the rate of sea-level rise or fall over time, rapid changes in the direction of a trend, large amounts of "noise" or variation, sudden jumps in sea level over a timespan of a few years, cyclicity especially around a periodicity of three years, dramatic differences to adjacent stations, and a randomness for the prediction of any aspect of the curves. All of these characteristics fall under the umbrella of chaos theory. The significant aspect about this theory which characterizes the sea-level curves in Figure 1, and probably all other sea-level curves in the world, is the fact that one has about as much chance of predicting a specific sea-level elevation to a tide gauge 50 years from now in the year 2039, as one does in specifying the value of the American dollar, interest rates for housing, or the annual rainfall of New York City in the same year.

The cause of this chaos in sea-level records can be generally attributed to local climatic variations. For instance, in the Yellow and East China Seas between China and Japan, sea-level trends simply reflect long-term tectonic behavior. Land is rising by as much as 5 millimeters per year in the Korea-north China region, and subsiding by as much as 9 millimeters per year in the foldbelts of east China. However, fluctuations in the short term relate to the shifting behavior of the Kuroshio Current that dominates oceanographic effects in eastern Asia, and to the large volume of freshwater runoff mainly from China (greater than 12,000 cubic kilometers per year). Sea-level trends around Japan can also be ascribed to tectonic factors. Rates range from 24 millimeters per year of submergence along the southeast coast to 6.8 millimeters



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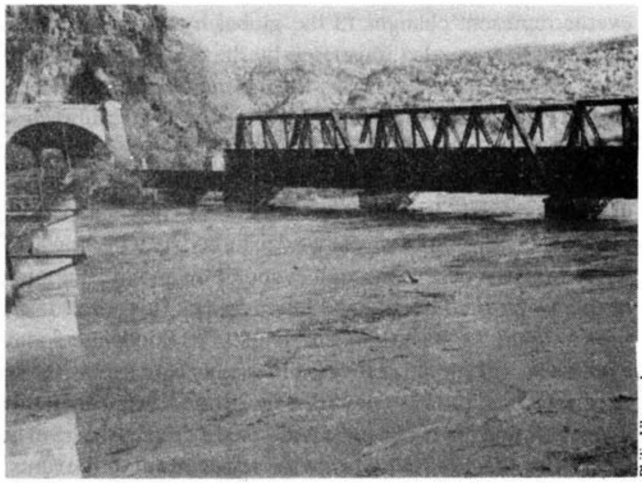
per year of emergence along the northwest coast. However, again, shorter-term fluctuations correlate well with the behavior of the Kuroshio Current. Along the east coast of North America, three independent coastal segments can be delineated for the period 1940-80 with differing trends in sea-level behavior that do not parallel depths in the shelf break or any other obvious topographic or structural feature. There is substantial evidence that much of the rise in sea level along the east coast is simply due to ground subsidence as ground waters have been extracted around major cities to supply domestic water. However, there is an equal amount of evidence to suggest that mean sea level is increasing here at a steady rate (1.7 millimeters per year) because of intensification of the Gulf Stream. In Australia, sea-level behavior correlates strongly to meteorological and oceanographic factors such as the tropical easterly trade winds, storminess, rainfall, and sea surface temperature.

The fact that sea level has such great temporal and spatial variability reflects the chaotic dynamics of the Earth's climate. These dynamics can fluctuate over timespans of days to years and greatly complicate delineation of sea-level trends. Seasonally, mean sea level fluctuates between 15-54 centimeters in such diverse locations as the Bay of Bengal, west coast of Mexico, northeastern Siberia and Australia. Over periods of days or months, sea level can fluctuate several tens of centimeters because of changes in atmospheric pressure, sea temperature, salinity, onshore wind stress components, current impingement on the coastline (as with the Kuroshio and Gulf Stream currents mentioned above), and mixing of surface and deep ocean waters. Over timespans of days, storm surge represents a major climatically induced enhance-



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River discharge along the U.S. East Coast can account for 7-21% of annual sea-level variance. Above, November 1985 flooding of the Shenandoah River at Harper's Ferry, West Virginia.

Left: Major drought can raise sea-level while heavy rainfalls can lower it because such events represent changes to the global hydrological cycle. Loudoun County, Virginia suffering the Great Drought of 1988.

ment of regional sea levels. The main concern in Bangladesh is not with a 1.0 meter rise in sea level that may occur in 50 years time, but with the next 7 meter high storm surge that could accompany a tropical cyclone. In November 1970, over 500,000 people were killed by such a surge. The largest death toll in the United States from a hurricane occurred at Galveston in 1900 when 6,000 people drowned under a storm surge that swept over that city.

The changes in sea level presented in Figure 2 spatially evidence low latitude asymmetry in the Atlantic and Pacific Oceans with a western boundary rise and an eastern boundary decline. Such a pattern is consistent with either a change in intensity of westerly winds or a shift in the fixing of pressure cells in the northern hemisphere due to the location of major mountain ranges or the degree of heating of oceans. Sea levels can also fluctuate over short distances because of shelf waves which cause water level to oscillate parallel to a coastline. For instance shelf waves, with a periodicity of one to seven days and amplitudes exceeding 50 centimeters have been found traveling counterclockwise around the south Australian coastline.

River discharge can locally increase sea levels as mentioned above in the case of sea levels in the East China Sea. The annual river discharge from the Chinese mainland adds 3.3 centimeters to the level of the ocean globally over a few months. Along the eastern United States coast, between 7-21% of the annual variance in sea level is due to this factor. Even an increase in rainfall over the coastal sector of an ocean can cause a long-term increase in sea level measured at a tide gauge. This also extends globally. Major world droughts can raise sea level while heavy rainfalls can lower it, because such events represent changes to the global hydrological cycle. These effects are also illustrated by the coincidence of sea-level increases and decreases for the major cities shown in Figure 1. For instance, sea level went up by 60-80 millimeters around 1960 in all cities shown in this figure except London. Globally 1988-89 has witnessed significant rainfall in the Sudan, Bangladesh, Thailand and Australia. Over this period, the global hydrological cycle was disturbed by withdrawal of water from the oceans through evaporation and the dumping of this water onto continental landmasses. This water takes time to return to the oceans via rivers. The floodwaters may even be stored for several years in major depressions (Lake Eyre was filled in 1989) or within the ground. Almost all tide gauges around the world have witnessed a drop in sea level as a result of the 1988-89 worldwide series of rainfall events. If rainfall accompanies a greenhouse-warmed world, and it should because warmer air holds more moisture, sea level will tend to drop because of the above process.

El Niño-Southern Oscillation events

Of particular climatic influence on sea level is the persistent inter-annual fluctuations in sea level associated with El Niño-Southern Oscillation events in the equatorial Pacific region. Generally tropical air movement in the Pacific is dominated by strong easterlies, labeled the Walker circulation. Warm surface water is blown toward the western side of the Pacific where it piles up to heights of 20 centimeters or more. The Walker circulation oscillates (the Southern Oscillation) in strength every three to five years and has relationships with climatic change worldwide. More importantly, the failure of the tropical easterlies leading to an El Niño-Southern Oscillation event causes the water in the west Pacific to surge back eastward across the Pacific in the space of two months. The 1982-83 El Niño-Southern Oscillation event raised sea levels 35 centimeters above average along the Oregon coast. The Southern Oscillation behaves as a typical chaotic system. What if El Niño-Southern Oscillation events occurred randomly with a greater frequency than the historical rate of three to five years? El Niño-Southern Oscillation events during the 1980s have tended to recur every two years. Tide gauges in the west tropical Pacific would be perceived as falling, while those in the east tropical Pacific would record higher mean sea levels, not generated by any worldwide change, but simply by this more frequent surging of water across the Pacific Ocean. For the Pacific region, sea-level increases are no indication of a global rise, but may simply reflect the regional consequences of climatic change in the south Pacific generated by more frequent, and chaotic, El Niño-Southern Oscillation events.

Greenhouse supporters' concern with a global rise in sea level is misdirected. We should not be worried by any unfounded, catastrophic sea-level predictions resulting from a climatic warming that some computer indicates may occur by the time most of us are dead; however, we should be worried by some of the large sea levels that can affect us presently. Personally, I am more concerned about the 4-meter-high elevation of sea level that can occur during a strong coastal storm along the east Australian coast than I am about a 0.5-1.0 millimeter annual rise in sea level. Even 50 years of greenhouse effect will not get sea levels up anywhere near the elevation of one of our storm surges. In the United States, short-term fluctuations in sea level are even more crucial with storm surges rising to over 7 meters along the Gulf and East coasts.

Thank goodness common sense now appears to be entering the greenhouse debate. Even some greenhouse enthusiasts are retracting their dire predictions. Over the past year, the predictions for sea-level rise due to global warming for the next 50 years have been reduced from 1.0 meter to 30-40 centimeters. In October 1989, the British Commonwealth Secretariat proposed that sea levels would rise by only 17-26 centimeters. Of course, regional tectonic trends and local climatic variations will have to be added to, or deducted from these predictions. The greenhouse debate has done more damage to scientific credibility and Western society's morale than any issue in the past 20 years. Hopefully, this article goes some way to salvaging the integrity of science and resurrecting the optimism that is the natural and just essence of our society.