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CLIMATE CHANGE AND SEA LEVEL RISE FACT,

FICTION, AND CONTROVERSY

by

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The recent wave of doomsday articles concerning climate change due to increasing CO_2 levels in the atmosphere and a resulting rise in sea level has created an air of fear in the South Pacific. Many scientists agree that a rise in sea level of at least 1.5 m is possible by the year 2100. Nations which would suffer most from the supposed catastrophe are those which can do the least to prevent it. In order to better understand what is actually fact about sea level rise and what is hypothesized, the following information is presented. The only hard evidence that presently exists is the documented increase in CO_2 levels. It's relation to atmospheric temperatures, ocean temperatures, and sea level rise is speculative and the catastrophic consequences predicted from models of the interaction of these and other influencing factors may actually bear no resemblance to the course that nature will take in the future.

FACTUAL DATA AND ESTIMATIONS BASED ON DATA

CO_2 levels in the atmosphere have increased by 25% over the last century. The levels of other trace gases (such as methane, oxides of nitrogen, and chlorofluorocarbons) have also increased in the atmosphere over this time period. Deforestation by "slash and burn" for agricultural gain or lumber production is reducing an important CO_2 user and O_2 producer.

It is estimated that there has been a 0.5^0 C rise in mean annual atmospheric temperature during the last century. However, atmospheric temperature has fluctuated over the last 50 years, having fallen between 1938 to 1976 and risen slightly since the mid 1970s. CO_2 levels were increasing over the period of time when temperatures were falling. Most meteorological stations in North America (97.5%) registering temperature rise are situated in or near large cities where large populations exist and large amounts of energy are consumed. These stations show an increase in mean annual temperature, whereas the stations in rural areas (2.5%) actually show a decrease in mean annual temperature). The highest mean annual temperatures during recorded history have been measured during the 1980s. These high temperatures have coincided with EI Nino/Southern Oscillation (ENSO) cycles. However, the winter of 1988-89 was the coldest on record in Alaska. Since the beginning of 1989 the mean sea temperature has dropped as much as 2^0 C below normal and may signify the onset of a La Nina event (an opposite and cooling trend to an EI Nino). A majority of the 625 alpine glaciers checked regularly by the World Glacier Monitoring Service have been advancing since 1960 indicating a cooling trend in mountainous areas and possibly an increase in albedo of the earths surface.

Some scientists have estimated from the data available (gauged to be unreliable) that sea level has risen at a rate of about 1.3 mm/yr over the last century and 2.3 mm/yr over the last 50 years. Tide gauges that record these rises are generally in areas that are tectonically unstable due to rebound from glacial

loading (east coast North America), active tectonics (west coast U.S.A.), and coastal subsidence (gulfcoast U.S.A.). Recent rates for sea level rise of approximately the same magnitude have been suggested for New Zealand (also tectonically unstable).

Short period sea-level fluctuations of 1-3 m are normal occurrences. Evidence from several regions including the U.S.A and South Pacific suggests that average sea level at 6600 yrs BP was as much as 2.2 m (or more) higher than today. Some evidence suggests that sea level can vary 5 to 10 m over the course of a few centuries. Sea level reached its present position about 4000 yrs BP and has remained relatively stable since then.

In the South Pacific, where sea level rise would cause dramatic changes, most atolls at the present time are protected from the sea by coral reefs. Some studies of the vertical growth rates of coral reefs suggest that rates are variable between coral communities but that the range is between 3 mm and 10 mm per year. Other studies indicate that reefs have grown vertically at rates of 9-12 mm/yr over the past 200 + years. As far as is known, the upward growth of coral reefs has kept pace with sea level rise during the Holocene. Some corals actually grow at much higher rates than those noted above.

PREDICTIONS AND SEA LEVEL RISE

Many scientists predict that, by extrapolation of the rate at which CO_2 is now entering the earths atmosphere, an increase in CO_2 by 30% over the amount currently present in the atmosphere will occur by the year 2030. They suggest that the amount of other trace gases will also increase by 30% of their present volume. The production of certain food plants may actually increase due to the extra CO_2 available for consumption by the plants. However, if the climates change, the area available for agriculture may decrease and cause an overall reduction in agricultural production.

Mean annual atmospheric temperature is predicted to rise between 1.5^0 C and 4.5^0 C by the year 2030. The increase in temperature of both the atmosphere and the seas will generate more frequent and severe storms causing widespread damage to coastal zones already threatened by inundation. Weather patterns will change with temperate zone summers becoming longer and hotter and the winters becoming shorter and wetter. Areas of northern Canada and Siberia may benefit from a temperature rise and become more productive agricultural areas while desertification may increase in the sub-tropical zones. The tropics will become hotter and wetter and probably experience a higher incidence of cyclones.

The sea level rise predicted by different researchers ranges from 20 cm to as much as 4.5 m by the year 2100, however many scientists agree that a rise of at least 1.5 m could occur. For sea level to rise 1.5 m by the year 2100 it must rise at a rate of about 13.5 mm/yr, whereas if sea level were to rise the maximum predicted level of 4.5 m this would be equal to a rate of about 38 mm/yr. This means that sea level would rise at a rate which would outpace the productivity of coral reefs thereby overtopping low-lying atolls and making them uninhabitable. Any rise would lessen fresh water supplies due to the decrease in the fresh-water lens by the incursion of salt water. The productivity of low lands would also decrease as agricultural lands become saturated with brackish water. Coastal erosion will occur at high rates as the sea overtops the reefs and habitable land will quickly disappear. Most coastal towns in other areas of the world will face

similar problems. Deltaic areas will face the problem of increased flooding and river bank overtopping as sea level rises.

REBUTTALS TO SEA LEVEL RISE

Some research indicates a cooling trend which includes the following: the area covered by snow each year is increasing, forests are shifting southward, rural weather stations show a cooling trend, arroyo floor grasses have been covering larger and larger areas.

Recent research on beach ridges dating back 5000 yrs BP suggests that there are two types of sea level rise and fall. The first is the long term glacial/interglacial type which is known to occur at intervals in the tens of thousands to hundreds of thousands of years. The second type, suggested by new research, is a short term type that occurs in intervals of hundreds to thousands of years. With the second type, low sea levels correlate to times of warmer temperature and the high stands to times of cooler temperatures. This inverse relationship may reflect the atmospheres ability to hold more evaporated water and produce more snow at high elevations during periods of relative warming. This work suggests that we are due for 1 m drop of sea level in the immediate future, rather than a rise, if the temperature increases.

Increasing temperature may lead to the "Sea-Ice Lid" or the "Faure Effect" whereby a decrease in sea-ice coverage in the northern parts of the planet leads to an increase in evaporation and an increase in snowfall in the more equatorial highlands thus increasing albedo in the more equatorial zones and cooling the planet. Increasing temperature may also lead to the "Equatorial Lid" or "Newell Effect" which maintains that a maximum surface sea temperature is reached at about 28° C to 30° C.

Although increased CO_2 in the atmosphere may be leading to a warming it may be offset by the amount of dust also entering the atmosphere. The greenhouse effect will not cause an increase in mean temperatures if the solar short-wave radiation can not enter the atmosphere in the first place. During the last glacial age dust content in the atmosphere was 30 times greater than at present.

The sea-level gauge in Suva Harbor, Fiji indicates a stable sea level over the last 20 years. Other areas of the world record rises in sea level and still others falls. Clearly, there exists no one reliable data set to determine actual sea level changes in the past. Data from the last 14 years from the tide gauges of the IOOSS Sea Level Program in the Pacific indicate no significant rise in sea level for this period. Any possible shift in sea level is small enough that it can not be separated from annual and Southern Oscillation cycles.

CONCLUSIONS

Caution is needed in the acceptance of sea level rise as fact. There is some evidence to suggest that sea level is not rising at present. If sea level does rise it will occur very slowly even at the moderate rates suggested by many scientists. There is a great need for more data on sea level rise. Most estimates existing today are speculation constructed around models that do not consider all the parameters because these parameters are either not known at present or are too complicated to include in the models. It has been suggested that other natural conditions can occur from atmospheric temperature rises that will counteract sea

level rise. Tide gauges need to be monitored for many years in order to determine whether the predicted rise of sea level is actually happening. More tide gauges in the South Pacific will insure that a more complete record is obtained.

If sea level were to rise at the moderate predicted rate of 20 cm by the year 2025 as some scientists suggest, sea level must increase at an annual rate of just less than 6 mm/yr. An increase in sea level of 1.5 m by the end of the next century would require an average rate of' about 13.5 mm/yr. Both of these rates are within a range where coral growth can keep up with the rise. There is insufficient data available on coral growth rates to predict, with confidence, maximum growth rates. However, if coral reefs were unable to keep up with rapid rises in sea level then reef building corals would have disappeared during the rapid post-glacial rise between 18000 yrs 13P and 6000 yrs BP when rates were at 1 m/100 yrs or greater (10 times greater than the rate for the last 100 years).

The method of islet growth on atolls is not fully understood. Storm surges that may cause coastal erosion may also cause the vertical and horizontal growth of islets. Coastal erosion occurs even during times of sea level stability and in itself is not a sign of sea level rise. The location of islets around a lagoon is in constant change and stability of location is not the norm over long periods of time. Their erosion and mobility are not necessarily signs of sea level rise.

Although the rain forests of the world provide an uptake of CO_2 from the atmosphere the role of algae in the worlds oceans with regard to CO_2 absorption is not understood and may have considerable effect on the amount of CO_2 in the atmosphere.

There is no need at present to build engineering structures to counter sea level rise. Because sea level rise will be caused primarily by thermal expansion of the worlds oceans the time necessary for the mixing needed to heat other than the oceans surface could be on the order of centuries. Coastal construction projects, particularly on atolls, should be developed with the thought in mind that the largest threat from the sea exists in the storms and cyclones that occur in the region every year. If sea level is rising, the resulting danger and damage experienced will be much less in the short term than that caused by storms.

It is necessary to change the energy habits of the world's nations so that there is a shift away from the burning of fossil fuels and the consequent production of CO_2 and other trace gases in quantities that are harmful to the environment. CCOP/SOPAC member countries cannot stop the large energy consuming nations from polluting the worlds atmosphere but can help by strongly voicing their opposition to atmospheric pollution and calling for reduced levels of CO_2 emissions.

CCOP/SOPAC will continue to observe and record data relevant to the potential problem of sea level rise where that data is required for other work in the CCOP/SOPAC Work Program. CCOP/SOPAC will also monitor the scientific literature, keep track of research efforts and results by communicating with scientists in the field, and keep member countries advised on new information and developments in this field.

SELECTED REFERENCES

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