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**Village life in Tarawa, Kiribati - what does the future hold? (JB Blake, AODRO)**

**REPRESENTING** the Australian community **SERVING** the victims of disaster

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# UNDERSTANDING SEA-LEVEL RISE - Predictions For Pacific Atolls

*Barry Blake, Executive Director, AODRO*

## The Greenhouse Effect and Climate Change

**The "greenhouse effect" is not new. Scientists have known for centuries that a layer of gasses surrounds the earth like an insulating blanket. Much of the sun's visible radiation penetrates this gas layer and warms the earth's surface. The earth then radiates this heat (infrared waves) back out towards space. Not all of this radiated heat penetrates the gas layer which is made up principally of carbon dioxide, methane, nitrous oxide, chlorofluorocarbons (CFCs) and tropospheric ozone. If this insulating blanket of gasses was not there, the earth would lose its absorbed heat very quickly and become extremely cold at night. The greenhouse gasses, particularly carbon dioxide, trap the reflected radiation and re-radiate some of it back to earth. This is the greenhouse effect which keeps the earth warm enough for people, plants and animals to flourish.**

Our climate has never been static however. Over the past 15,000 years global temperatures have been slowly rising as we moved out of the last 'ice age'. What is happening now though is that there has been a relatively sudden increase in the production of greenhouse gasses by the people of this and recent generations. Consequently, there is a growing concern that as the blanket of greenhouse gasses thickens, more radiation will be trapped and the earth's atmosphere will get warmer more quickly than has been occurring over recent millennia.

Carbon dioxide is currently the main greenhouse gas. It is released by burning fossil fuels (coal, oil and gas) and from clearing and burning forests. The concentration of carbon dioxide in our atmosphere has increased from 275 ppm before the industrial revolution to 348 ppm today. That is by 25 % in a period of 200 years. Scientists are concerned that the concentration of this gas could double its pre-industrial level within the next 50 years if present rates of fossil fuel burning and deforestation continue.

While carbon dioxide is currently the most prominent greenhouse gas, the others cannot be ignored. Their concentration in the atmosphere is increasing and their contribution to the greenhouse effect is expected eventually to surpass the contribution of carbon dioxide. Additionally, the CFCs pose a threat to the ozone layer in the atmosphere which filters harmful ultraviolet rays from the sun's radiation.

It is a scientific certainty that the concentration of greenhouse gasses in our atmosphere has been increasing over the past 200 years and is likely to increase more and more rapidly as we clear forests, urbanise and industrialise. What is uncertain are the effects of this. Global warming is another scientific fact. In the last 100 years the earth has warmed by about 0.5°C. This may not seem a lot but it is significant in the context

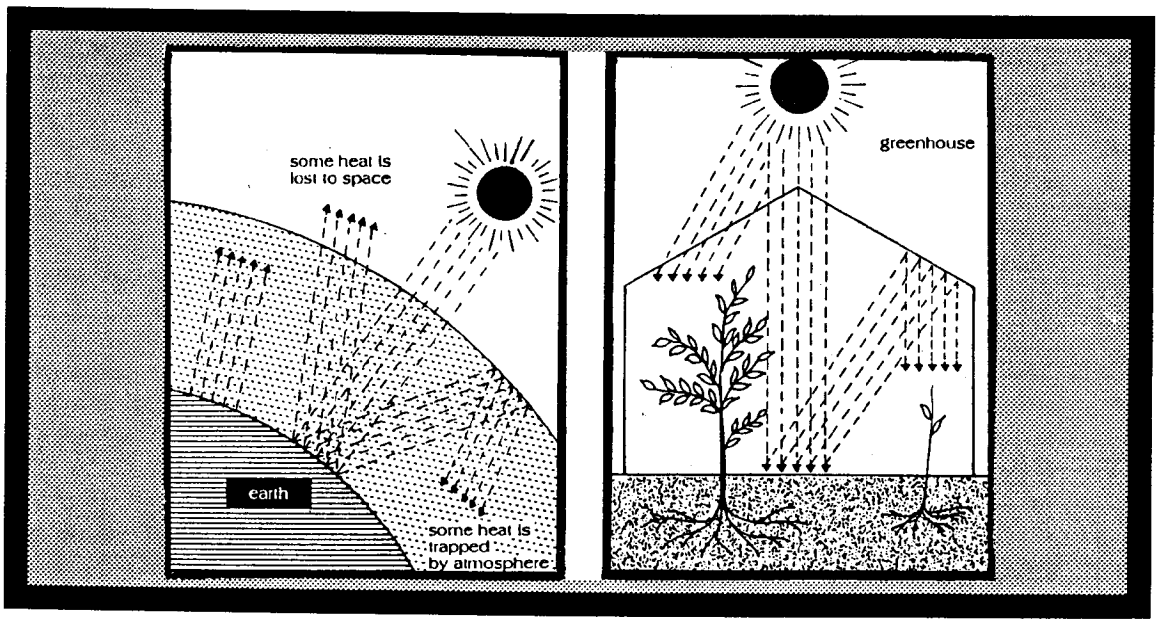


*Fig 1. The Greenhouse Effect[1] The atmosphere acts like the glass of a greenhouse, trapping some of the sun's warmth.*

of only a 5°C warming over the 15,000 years following the last ice age. What scientists are now predicting is an even faster rate of global warming as the concentration of greenhouse gasses increases. The prediction of some prominent scientists is that as carbon dioxide levels double there will be a consequential increase in global mean temperature of between 1.5 and 4.5°C.

What a rise in global mean temperature means to overall climate patterns is very uncertain. Temperature changes will not be uniform between the Poles and the Equator and their effects on rainfall are unpredictable. For example, increasing temperatures over the Pacific Ocean could result in increased evaporation rates and cloud formation. Could this increased cloud coverage have a cooling effect that will balance the greenhouse temperature rise?

It must be kept in mind that climate change is a very complex phenomenon. It will be driven not only by the greenhouse effect but by other changing factors such as ocean and atmospheric circulation patterns. Our scientists need more time to reach an understanding of the interaction between all the relevant factors before they are able to predict future climate change with any accuracy. This is particularly the case with predicting regional changes as opposed to mean global changes.

# Why Sea-levels Will Rise

Mean sea-levels in our oceans have been constantly changing. The major current trend is for sea-levels to be rising, though in some locations they appear to be falling.

One of the difficulties we experience in measuring sea-level is finding a datum from which to take the measurement. For hundreds of years we have been measuring tides using tide gauges that relate sea-level to some datum point on the land at the place of measurement. The difficulty with this style of measurement is that natural tectonic movements of the earth's crust causes the datum to move slowly over time. In the Pacific we know that some islands are rising while others are sinking. These movements are very slow in the mid-Pacific but can be of significance towards the edges of tectonic plates; that is, in locations such as the Solomon Islands, Vanuatu, the Tonga Trench and New Zealand.

The Australian continent is relatively stable tectonically and provides a useful datum from which to measure sea-levels. Records over the last 100 years indicate that the average rate of sea-level rise around the Australian coast-line is 1.2mm per year[2].

There are various potential causes of sea-level rise and various mathematical models used by scientists to explain and predict it[3]. The most obvious of these relates to the thermal expansion of the surface ocean layer as global warming brings about rising temperatures in these waters. Some such models predict that a 3°C mean global temperature rise could cause an average 200mm sea-level rise due to thermal expansion. This rise would not be uniform across all the oceans and could be as high as 300mm in some Pacific regions. Other possible causes of sea-level rise include the melting of mountain glaciers and polar ice sheets.

# Expert Predictions

The UN established an International Panel (of experts) on Climate Change (IPCC) in 1988 with three working groups. A recent assessment of IPCC Working Group 1, which had responsibility for scientific analysis, was that if there was no change in the trend of greenhouse gas production (what they referred to as "business-as-usual") global mean temperatures would increase by about 1°C by 2030 and sea-levels would rise by about 200mm over the same period. They also predicted a 3°C mean temperature rise under this scenario before the end of the next century together with a 650mm sea-level rise above its current level[4].

What needs to be kept in mind is that there is a great deal of uncertainty about these predictions. The scenario of "business-as-usual" might be too pessimistic in that international pressure might bring about a reduction in the emission of greenhouse gasses over time. Also, there could be time lags between greenhouse emissions and doubling of gas concentrations, or between doubling of greenhouse gas concentration and changes in climate, or between changes in climate and resultant sea-level rise. All predictions are therefore open to much uncertainty and should be looked at as a basis for policy formulation and long-term planning while we await more scientific research and greater certainty in our knowledge of the workings of our global climate.

# Sea-level Rise Trends

As already mentioned, the average trend in sea-level rise around the Australian coastline is 1.2 mm per year. Similar measurements across North America and Europe lie between 1 and 1.5 mm per year. Consequently, oceanographers believe that they know what has been happening to sea level over recent decades and consider that a good planning guideline for the current trend is a rate of sea-level rise of 1.5 ± 0.5 mm per year.

What this tells us is that if this rate of sea-level rise continues, it will take more than 300 years for the sea-level to rise a half metre. Clearly then, the predictions of scientist that this order of sea-level rise will occur before the end of the next century means that they expect the rate of sea-level rise to increase.

It is interesting to look at a graph of historical sea-level data and future predictions of sea level, to see how existing trends will have to change for the predictions to come true. Such a graph has been provided by Professor G.W. Lennon, Professor of Oceanography at the Flinders University of South Australia, and is reproduced at Figure 2.

Clearly, some of the early predictions about sea-level rise look to be extremely pessimistic and unlikely to eventuate. They would require a dramatic and immediate change to occur in the historical trend line. The less dramatic predictions are much more likely to occur but still demand sound and purposeful policy making and planning by authorities in all countries.

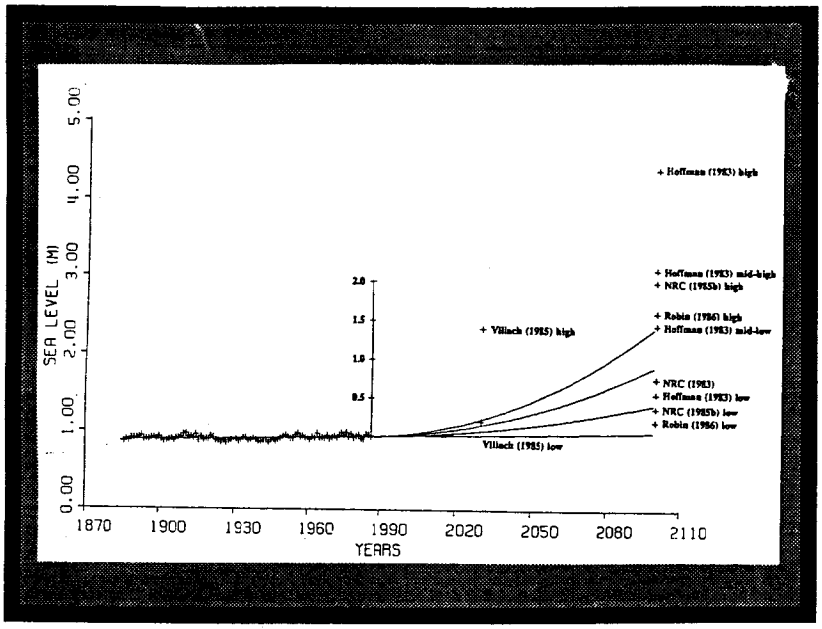


*Fig 2. Observed and projected mean sea-level in Fort Denison - Sydney Harbour*

# The Future for Pacific Atolls

The sea-level rise implications of the greenhouse effect are naturally of concern to the people who inhabit the coral atoll islands of the Pacific. The "greenhouse" is no longer open to question, it is a scientific fact. Global warming is not open to question either. Nor is the fact that sea-levels are rising. What is open to question is by how much and how soon the current rate of global warming and sea-level rise will change.

What we have at the moment is a theory as to why our global climate could get warmer more quickly than the current warming rate; and a theory about why sea-levels could begin to rise more quickly than they are at the moment. Additionally, scientists are developing mathematical models that allow us to project into the future and predict what conditions could be like.

It is human nature that our attention is drawn to the more sensational predictions. These are the staple diet of the news media and those who want to exploit sensationalism to draw attention to themselves.

It is now possible to state with certainty that the sea-levels are rising. What is uncertain is the time frame within which significant changes will occur. If the current rate of rise continues, the sea-level will rise, on average, by half a metre over the next 300 years. If the greenhouse effect accelerates this rate of rise, the IPCC prediction is that this half metre rise could occur within the next 100 years. Predictions such as a one metre rise over the next 40 years can be considered as little more than scare mongering.

The comforting thing is that recent sea-level records do not show that any acceleration in the rate of rise has commenced. It is essential, however, that scientists intensify and improve their monitoring techniques, so that we obtain the earliest possible warning of changes. At the same time it is prudent and proper for national leaders and planning authorities to act rationally in regard to these matters. There is no cause for hysteria but there is a need to recognise that changes are occurring to our environment and that communities need to adjust to these changes.

Wise leadership and good management will ensure that communities respond appropriately to change. Good and timely information is a necessary prerequisite for good management. It is therefore essential for community leaders in the atoll islands to stay informed about climate change, sea-level rise and other physical effects of the greenhouse. It is also important for them to differentiate between sound scientific information and interpretations designed to stimulate reaction and to sensationalise the issue.

Close scientific monitoring of our changing environment is essential and will provide the data from which informed predictions can be made. Present indications are that changes are happening, but at a rate that is slow enough for us to respond in a considered, controlled, appropriate and sustainable manner.

References:

1 Australian and New Zealand Environment Council 1990. **Towards a National Greenhouse Strategy for Australia - A Summary Report,** p.1

2 GW Lennon, Flinders Institute for Atmospheric and Marine Sciences. Private correspondence with JB Blake, AODRO, 1 May 1989.

3 Klaus Wyrtki Review article - Sea Leel Rise: the facts and the future **Pacific Science** vol. 44, January 1990

4 **Climate Change - The IPCC Impacts Assessment. Report** prepared for IPCC by Working Group II. WMO 1990, p.1.