

Global Change and the Pacific: Problems for the Coming Half-Century

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Since 1986, scientific concern over inadvertent human modifications of global climate, and their consequences, has rapidly become public concern. It is now recognized that global mean temperatures have increased by almost 1°C since the middle of last century, though trends in different regions exhibit great variation, and that the period since 1970 has been marked by an accelerating trend. The 1980s contain the warmest years in the record (Jones, Wigley, and Wright 1986).¹ Moreover a whole series of regional temperature extremes over periods such as a year, a season, or a month has been exceeded during this decade. With atmospheric carbon dioxide now almost 40 percent above preindustrial levels—a figure likely to rise to 50 percent by the year 2040—and with the additional recognition that there has been an almost equal new input of methane, nitrous oxides, and chlorofluorocarbons, it is generally expected that a significant further increase in global mean temperature is highly probable. Model computations suggest that by the time the total “greenhouse gas” content of the atmosphere has doubled, which could be as soon as between 2030 and 2050, zonal mean annual temperatures may be 1° – 3°C warmer in low latitudes, and up to 5° – 8°C warmer in the polar regions. While the lag effects may delay this result, even for some time, the *commitment* to such an increase in atmospheric temperatures will have been created, making such a rise above “natural” temperatures inevitable. Added to these quite rational estimates has been the 1986 discovery of thinning of stratospheric ozone. Together, these concerns led in 1986 to the formation of an International Geosphere-Biosphere Programme, specifically to study the problems of global environmental change and their regional impact. This was followed in 1988 by the formation of a parallel international Human Dimensions of Global Change Programme, concerned with human causes,

consequences, and adaptations, and with the problem of achieving "sustainable development" under changing conditions.

A NEW SET OF PROBLEMS

Climatic warming has captured both public and scientific attention, but it is by no means the only element in global environmental change. Widespread degradation of land and ecosystems, deforestation, marine pollution, and the pollution of poverty are also matters for concern, and, in the view of some, for primary concern. These matters occupy a strong place in the Human Dimensions of Global Change Programme. Together, all are responses to the underlying human forces of population growth, commercialization, and industrialization, and indeed of development. While the major pollutants are derived from fossil-fuel combustion from industrial processes, and from mining, with sources at present heavily concentrated in the populous industrialized countries of the northern hemisphere, significant though lesser pollutants are derived from agricultural development, from the clearance of tropical forests, and from mining in the developing world. Growth in the numbers of livestock and the expansion of wet-rice fields are, for example, principal contributors to an increase in the amount of methane in the atmosphere, which has doubled in the last fifty years. The environmental consequences of green revolution technology are substantial. World development has been accompanied by and in large measure achieved through a massive onslaught on the biosphere, the land, the rivers, the oceans, and the atmosphere.

While some of the causes of global environmental change are responsive to "techno-fix" solutions, given the political will to apply them, others are far more difficult, and solutions for those that originate in the developing world are particularly elusive. While energy-related greenhouse-gas inputs into the atmosphere may become better controlled in the developed countries and will diminish there, they will probably increase substantially in the developing world—especially in Asia; moreover, the problems of resource degradation in the developing world are almost certain to multiply.

The Impact in the Pacific

The islands of Melanesia, Polynesia, and Micronesia are minute contributors to pollution at global scale, though land and ecosystem degradation

are significant problems in many parts of the Pacific, and deforestation is no new phenomenon in this region. However, the consequences of global warming in terms of climate, and above all the anticipated rise in the level of the sea, are problems of a major order in the Pacific region. The impact of global change on the Pacific, even at the lowest estimates of present prediction, will be as severe as in any other part of the world. For low-lying islands, and for almost the whole countries of Kiribati, Tuvalu, and the Marshall Islands, like the Maldives in the Indian Ocean, even a half-meter rise in sea level would spell disaster, and the prediction is of a greater rise than this over the span of the next century. The consequences of climatic change are potentially much more widespread, but until the possible outlines can be modeled in some detail their shape is quite unknown, and so far there are no forecasts from either modeling or deduction that are worthy of serious attention at regional scale. These statements are expanded in what follows.

This paper is concerned only with the coming half-century, to about 2040. Most of the "global change" literature looks further forward than this, to conditions that might eventuate *after* the greenhouse-gas content of the atmosphere has doubled. Most predictions therefore relate to the second half of the twenty-first century, or beyond. However, such conditions would not arise in one jump at that time. It is important to examine the evidence to see what might happen sooner. During the years when the Pacific Islands, like other parts of the world, are coming to terms with these new conditions we might, globally, find means of abating them before the full consequences develop. However, we cannot prevent what is already in train. The shape of the coming fifty years is in some measure already determined by what has been done in the past, is now being done, and will be done in the next two decades. The causal forces, at least, are established, with little short-term room for maneuver.

Within the coming half-century it is possible that the sea-level problem will remain principally a growing threat, though toward the end of this quite short period it may already be a very serious threat in all low-lying coastal areas, including islands. Though variability may increase, sustained climatic changes are not likely within this time, except perhaps at high altitudes in Papua New Guinea and Irian Jaya, since climatic response to shifts in the forcing conditions of weather tends to occur in jumps after a period during which the system is able to absorb these new forces. Much greater variability is, however, quite likely, and effects on

the incidence and behavior of the El Niño–Southern Oscillation (ENSO) phenomenon—presently entirely beyond the range of acceptable long-term prediction—may become marked. During this half-century, therefore, while the world as a whole is coming to terms with what it has been doing to its environment, and may begin to change its ways, the Pacific Island region will have its own opportunity to prepare. In the course of the same half-century, the transforming forces of development and change will have radically modified the nature of the region and its ability to respond. By the year 2040, when atmospheric carbon dioxide is expected to reach 150 percent of its levels in the 1700s, the Pacific region will already be a very different place for reasons quite other than those of changing environment.

My purpose here is to analyze what can reasonably be predicted, and to relate anticipated environmental changes to other changes that have an effect on the ability of the region to manage future environmental crises. For the latter I rely on presently visible trends. Inevitably this involves some crystal-ball gazing and exposes me to the certainty of error. It is said that crystal-ball gazers mostly die of a surfeit of ground glass. At least I can say with total confidence that I shall not still be around in 2040 to see how wrong I shall have been proved.

The Threat from the Sea

Contemporary media hype notwithstanding, the major threat of rapid sea-level rise capable of making low-lying regions wholly uninhabitable belongs to the longer-term future well into the twenty-first century, rather than to the immediate future of the coming fifty years. The most imminent source of rising sea levels is expansion of the upper levels of the oceans, most rapidly in the top 100-m layer, which adjusts quickly to atmospheric temperature, then in the waters between this more saline surface layer and the thermocline, which are the main locus of transfer between high and low latitudes (Robin 1986). Over a century the rise from expansion might be at least 30 cm and very possibly much more, but it will certainly be increasing rapidly by 2040 if global temperatures continue to rise at rates exhibited since 1970. Whatever this rise, however, it is likely to be offset in part by abstraction of more water vapor into a warmer atmosphere and by the temporary storage of frozen moisture in Antarctica because of higher precipitation. Atmospheric warming will increase ablation around both the Greenland and Antarctic ice sheets and add meltwater to raise the

ocean level higher; in the long term this is the major threat, exceeding that from thermal expansion of the oceans. Accumulation of ice at higher altitudes in Antarctica, and to a lesser degree in Greenland, is in the short to medium term likely to offset this addition of meltwater with a *negative* effect of perhaps 10 cm on global sea level (Robin 1986, 343). This in turn may be partly negated by the meltwater of smaller glaciers in lower latitudes, but the collective message is that the full effect of global warming on sea level is likely to be delayed. Rightly or wrongly, most of the following discussion assumes that such a delay will take place, and that only a limited rise may be expected within the coming half-century.

The trend is nonetheless upward and likely to remain so. Gornitz, Lebedeff, and Hansen (1982) obtained a global mean rise of about 12 cm between 1880 and 1980 that was due to the combined effects of expansion and melt. The data show considerable regional variation. A net rise of this order lies well within the normal interannual sea-level variation due to global circulation changes, particularly during ENSO events. The variation from mean sea level then attains as much as 30 cm and sometimes more in the Pacific. Even during a "normal" period in mid-1988 sea level across the northern tropical Pacific ranged from +16 cm to -19 cm in relation to the mean (Climate Analysis Center 1988). These variations were persistent over several months. Present beach systems are adapted to this amount of variation in sea level. Tsunamis and sea surges under hurricanes exceed this range, sometimes substantially.

This should not be a reason to relax concern, for these short-term variations will still occur around a rising mean level of the sea. Because it does not seem very probable that we shall experience a mean rise of more than half a meter at most during the coming half-century, the main hazard is likely to arise from short-term events, especially where these drive higher seas over shallowing water. Moreover, even a rise of less than half a meter can lead to saline invasion of fresh-water lenses in coastal areas and can lift the very shallow fresh-water lenses in atolls. Although it is quite probable that upward growth of coral will widely be able to keep pace with sea-level rise of this order and rate, increased erosion of unprotected beaches—already a widespread problem—is very likely. In parts of Southeast Asia where tidal systems of irrigation are practiced, relying on the incoming tide to pond back fresh rivers and lift water into the fields, an extension of salt-water invasion is very probable unless rivers are able to raise their beds in response. While this is not a problem for the Pacific

Islands, it is a reminder that other areas with larger populations are just as vulnerable as Pacific atolls and cays.

It follows that the more marginal present human occupation is in relation to the level of the sea, and the more vulnerable this occupation is to present hazards from tsunami, sea surge, and exceptional sea levels experienced during global circulation anomalies, the more likely are such areas to fall early victims to a rise in the sea of no more than 20 or 30 cm, and this could happen as soon as the early decades of the coming century. Some low-lying atolls and cays, especially in dry areas, could lose their fresh water; the tidal margins of large islands could suffer significant salt-water invasion; sand cays may be eroded and moved too fast for tall vegetation to keep pace; low-lying villages and coastal lands will become much more vulnerable to surges of the sea. The sea will also build new and higher beaches, but there is likely to be net loss, not large in total quantity during this first short period, but serious enough for the people concerned.

The Unknown of Climatic Change

Much uncertainty still surrounds the threat from the sea, yet this is an area of clarity and firm prediction by comparison with the effect of global warming on global climate. About a dozen "general circulation models" around the world are being used to try to determine the nature of change, but without adequate incorporation of the effects of global warming on cloud and the effects of cloud on climate, and without adequate means to model the variables of ocean-atmosphere coupling, including ocean currents, the role of ice, and topographic effects, climatologists are still unable to move far toward firm predictions at regional scale. There is still heavy reliance on historical analogy, including the experience of warm years and decades in the record, as well as geo-archaeological data on long-past warm conditions millennia ago.

Even one totally basic element is still shrouded in obscurity. Ostensibly an increase in temperature should uplift more moisture into the atmosphere by convection and lead to an increase in global rainfall, although redistributed. As noted, some of this will fall as snow on the ice caps of Antarctica and Greenland, and it will remain there as ice until a much greater increase in temperature extends ablation to higher altitudes close to the poles. It may be significant that the glaciers in Iceland have been extending in recent years whereas those in the middle latitudes and the

tropics have been retreating, often quite rapidly. I have noted the possible slowing of sea-level rise. Despite the increased uptake of moisture into the atmosphere, it is not beyond likelihood that the net effect for climate of greater convection on the one hand and locking-up of moisture as ice on the other, could be a temporary but durable reduction in total atmospheric moisture. This would probably increase the tendency to drought in drought-prone areas, one of which is the central Pacific. Then there is the largely unknown effect, on total rainfall as distinct from its pattern, of changes in "albedo"—the reflectiveness of the earth's surface—influenced by widespread desertification and deforestation. For almost twenty years there has been a declining trend in the rainfall of some tropical areas, notably in the African Sahel and extending across the Atlantic into central America. This could be merely cyclical; there have been prolonged periods of low rainfall in the Sahel before, even early in this century.

With by far the largest area of uninterrupted ocean-atmosphere interaction, the Pacific Ocean is a key area in the world's weather, and great efforts have been made to understand its dynamics in the last twenty years. Since the basic interconnections were first established in the 1950s and 1960s, and especially since the major ENSO disturbance of 1972 and the greater one of 1982–1983, an immense amount of research and modeling has been undertaken, with a considerable measure of success in improving understanding. Not only are the tropical interconnections now better understood, but so increasingly is the interrelation with climate in middle and even high latitudes. The root causes of much of the variability in the world's weather as a whole may be found in the Pacific and southern oceans, with the western tropical Pacific a region of particular global significance.

This latter region, the archipelago extending from Sumatra to New Guinea, is sometimes described as the "maritime continent" following Ramage (1968), who established that almost 30 percent of the surface-to-upper-atmosphere convection in the whole tropical belt around the world takes place over this archipelago of large tropical islands among warm seas. This ascending system is linked by high-altitude airflow along the equator to regions of persistently descending air to east and west, but particularly in the eastern tropical Pacific. This pattern of equatorial circulation is not stable, but in the Pacific is subject to periodic change during which convection over the "maritime continent" weakens and moves east, while descending air in the eastern Pacific is replaced by normal tropical

convection. These abnormal periods are the ENSO events which sometimes, as in 1972 and in 1982–1983, assume major proportions and have worldwide ramifications. They are accompanied by heavy rain in the eastern Pacific and over the normally dry equatorial islands in the central Pacific, and by tropical cyclones in the normally cyclone-free central and eastern Pacific; there is less rain than usual in the western Pacific and over the “maritime continent,” and sometimes periods of quite severe drought.²

These events are not new, but have happened over at least several thousand years. The regularity of the pattern may not have remained constant, however, and a major question for the Pacific Islands concerns the future behavior of the system under global warming. We know that ENSO events have occurred with much the same frequency throughout the last hundred years and more, and that an ENSO as severe and widespread as that of 1982–1983 took place in 1877–1878 (Kiladis and Diaz 1986), with several others not much less severe in between. There is at present absolutely no agreement on the important question whether severe ENSO events will become more frequent or less frequent with global warming. Moreover, there is also the question of the opposite phase of the system, in which exceptionally heavy rains occur in the western Pacific and exceptional droughts in the equatorial islands of the central Pacific, south of Hawai‘i, and in the eastern Pacific. The future frequency and distribution of tropical cyclones is notably affected by the future of ENSO phenomena.

The Limits of the Possible

The best outcome that might be expected is that global warming will be slower than predicted, that sea-level rise will also be slower, and that there will be no major change in the boundary conditions of Pacific climate well into the coming century. This is not to say that major disturbances would become any less frequent. The worst outcome is that the present represents a sort of “hinge” between slow warming during the past hundred years and a much more rapid warming in the near future; in this case the rather steep rise in global mean temperatures that has taken place since 1980 would be continued, rather than being followed by a new period of leveling off such as that of the 1950s and 1960s. Under a continuation of rising mean temperatures, the level of the sea could be expected to start rising more rapidly one or two decades from now, and major changes in global weather patterns of a nature still unpredicted would begin to become evident. It could then be that the unusual features of the 1980s,

with record floods and droughts in several parts of the world, provide an indicator of what might become normal conditions by early in the twenty-first century.

Much of the media hype would have us believe the latter scenario, and this hype serves a useful purpose in sensitizing governments and people worldwide to the dangers inherent in the present interference with global atmospheric chemistry. But while the worst-case scenario is possible it is not established, and we may have more time. Any "remission" in global warming, such as that which took place before 1970, could lull us all into believing that nothing serious, after all, is going to happen. And this, regrettably but unquestionably, would be wrong.

The range of possibilities to be considered for the coming half-century extends from a small and imperceptibly slow rise in sea level to an accelerating increase in the height of tides and waves, upward displacement of fresh-water lenses, and saline intrusion. Each or all of these could become devastating for the habitability of very low islands even within the coming half-century. In terms of weather, we may experience no strongly felt changes within this period, or we may experience much more heavy rain and much more serious droughts, or both, in different parts of the Pacific region. Cyclones could become less frequent, but alternatively they could not only become more frequent but extend further into the subtropics and into regions presently affected only rarely. It would be as well to be prepared for the worst; at best, such preparation would ease the problems arising from major disasters such as those that have already arisen in modern times and will continue to occur.

HOW CAN THE ISLAND COUNTRIES COPE?

For the whole of the independent countries of Kiribati, Tuvalu, and the Republic of the Marshall Islands, and for all the low islands of Micronesia and Polynesia, the sea-level problem is dominant, while the future of rainfall is also of major concern. For other countries, with large islands and high land, the sea level presents subregional but not national problems, though the scale varies according to the proportion of high to low land. For these countries, the future course of climate is the concern of most widespread importance. Wherever there is high ground, the coming half-century presents a need to be prepared to move low-lying coastal settlements inland and to be ready for some losses of agricultural land, while at

the same time having policies in place to cope with both drought and the consequences—in terms of road maintenance, increased erosion, and possible landslides—of heavy and frequent rain. For coastal towns, protection rather than movement is required, and sewerage and drainage systems will need to be redesigned to cope with higher outfall levels. Throughout, agricultural systems must be buffered against the consequences of both drought and excess rain by conservation measures that can have only beneficial effect in limiting and managing present degradation.

For the larger Pacific countries these problems are potentially manageable within the coming half-century. A prerequisite would seem to be participatory democracy in which the cooperation of the people can be secured, given open provision of information in a manner that will inspire trust. Coastal settlements have been moved inland in the past after cyclonic sea surges washed over and destroyed their sites; they can be moved inland again, progressively over time, if governments and their people are made aware of the need and cease to erect new buildings very close to high-tide level. Only under the very worst scenario is it yet necessary to be prepared for replacement of vulnerable capital investments such as jetties and low-lying airfields. It would otherwise be adequate within the coming half-century to build no more airfields in threatened locations, to protect those that exist, and to ensure that jetties can be strengthened and raised. Unnecessary “disaster” measures and costs can be avoided, or at least greatly reduced.

This last statement is important because there is no doubt that, when smitten, many Pacific Island governments will proclaim unforeseen natural disaster and will seek international aid. Certainly, international assistance will be necessary, but it cannot be unlimited, and should be directed to those regions in which preventive measures are not feasible, especially the most vulnerable countries and regions which are discussed later. While it will be unpopular to say so, there is already more than a tendency in the Pacific Island countries to seek disaster relief in preference to taking or encouraging adequate adaptive and preventive measures, and in preference to adopting development policies that could embrace such precautions. Indeed, policies continue to be followed that discourage the fragmentary remains of self-help and adaptive strategies that existed in the past. An examination of the record of “disaster relief,” following both severe and mild events in the eastern islands of Fiji since the 1970s (Bayliss-

Smith et al 1988), provides one rather clear instance of the manner in which such relief has become in reality a part of the support system for an economically declining region, an archipelago whose people were once able to cope with all but the most extreme events on their own.

The consequences of climatic change for agriculture ought to be a matter for major concern. In most Pacific Island countries the farming sector is in an unhealthy condition, dependent on cash crops very vulnerable to price fluctuation, with static or near-static production of food crops, and with growing labor-input problems as the young leave the land and the farm population ages. Conservation measures, being labor intensive, are among the first casualties. Moreover, major cash-crop expansions have been achieved at high cost in land degradation—and with official encouragement. There is no doubt that by intensification using conservationist measures, the productivity of agriculture could be greatly increased, and increased on less land than is used at present. But there is almost no official move in this direction, and private initiatives—which are not uncommon—do not receive much official support. Higher temperatures entailing greater evaporation, with or without either greater drought or more intense rainfall, will increase stresses. Even without global change there is a pressing need for new initiatives in agriculture; the climatic unknown makes such initiatives imperative. For most Pacific countries the necessary improvements are entirely feasible, but they require new approaches to agriculture. An antifarm bias has characterized both macroeconomic policy and the allocation of resources in the postcolonial Pacific. A future in which there will be much greater claims on international support than those of the small countries of the Pacific ought now to be envisaged, and ought to lead to policies designed to generate greater self-reliance in the provision of food and other inputs produced on the land.

The Problems of the Most Vulnerable

Some countries, and large regions of other countries, face much more severe problems even on a modest scenario of global change. I have already mentioned the effect of rising sea level in atoll and coastal regions. Even under the worst scenario atolls will probably not become wholly submerged within the next half-century and perhaps over a much longer period. Given a probable delay in sea-level rise, it is not likely that many islands will have been rendered wholly uninhabitable by 2040, and more likely that only a few will suffer this fate so soon. Even over a longer

period the low islands will not necessarily be simply submerged. Coral growth should be invigorated, and where this happens the seas will throw up new land-forming material. But storm-driven seas will wash over the land, and fresh water will become more scarce. If or where greater desiccation is added to the threat from the sea, the situation will deteriorate more rapidly, both from plant stress under drought and from accelerated diminution of fresh water. Conversely, if or where there is an increase in rainfall it will very probably be accompanied by greater storminess, increasing the rate of physical damage.

Many islands may become unattractive places for human habitation, even though within the coming half-century they are not likely to vanish entirely beneath the waves or be destroyed. Both food-crop and cash-crop production will suffer, and Islanders will have to become much more dependent on the resources of the reefs and the sea. Within the time frame of this paper, the probability of economic and nutritional distress, coupled with a growing shortage of fresh water, is much greater than that of ultimate physical destruction. There is almost no set of coping strategies that can negate increasing pressures to abandon living on some islands long before they are eroded into storm-washed piles of reef-rubble, and such pressures could well be mounting long before the end of the coming half-century.

For the Islanders themselves as individuals, the problems may be less severe. The people of low-lying regions of larger countries already have communities of their kin on what will remain dry land, and the people of some Pacific countries have substantial emigrant communities in the United States and Canada, Australia and New Zealand. Many among present and future Islanders will welcome opportunities to join their migrant kin. For the remainder who lack these opportunities, within the Pacific principally the populations of Kiribati and Tuvalu, it is reasonable to expect that "environmental refugee" status will become an option, in Pacific Rim countries if less readily in other Pacific Island countries. This would not take place without some opposition from within rim countries, the nature of which was discussed for Australia in a comprehensive review of Island-Australia relations carried out in 1986 (M. Brookfield and Ward 1988). Nonetheless, there are solid grounds for hope that rim countries will be willing to offer new homes to Pacific Islanders displaced by the sea. Although it is distressing that significant parts of the Pacific Islands may be facing the prospect of early depopulation by 2040, that prospect may

be less alarming to those Islanders who are potential migrants. It is not a prospect that arises only from global change; something of an exodus from the smaller island countries and regions has already been under way for some time and has accelerated sharply within the last twenty years.

In a review that looks further forward than this paper does, and reaches a more devastating prognosis for the low-island Pacific, Ward (n.d.) has raised an important issue. Many islands bare of their land-owning inhabitants will at least for some time remain land, although reduced. As I also learned at a conference on island development (held in Malta under the auspices of the United Nations Conference on Trade and Development in May 1988), almost every Pacific Island country has received approaches, such as those lately in the news from Africa, from unscrupulous groups in developed lands who seek dumping grounds for industrial wastes unacceptable at home—even if always described as “nontoxic.” Such would-be leasers of dumping sites offer what looks like good money, though doubtless they expect to make large profits themselves. The owners of islands deserted because they have become barren, but not destroyed, must expect to be thought of as very “soft touches” for such tempting offers. Ward has added the not unlikely prospect of other would-be leasers: people who need a remote piece of land, however unattractive for permanent habitation, as a territorial base for a whole range of less-than-legal pursuits. Can the governments of island countries and regions facing a real disaster that will not go away be expected to resist such tempting offers unaided? And would they in any case be able to resist private deals made with the absentee owners of land still under their nominal jurisdiction?

Island Governments in an Unkind World

Global change will affect the Pacific Islands in ways other than through the direct physical effects. In 1988 severe droughts in the continental interiors of North America and the Soviet Union have reduced agricultural production and diminished global food reserves. By one unproven set of climatic scenarios this is precisely what is expected from global warming, though it does not follow that the 1988 events arose from this cause. Except in low islands and coastal areas the greatest impact of global change will certainly be on the pattern of world agriculture. Some regions will benefit, and in others it will be possible to change cropping patterns and adapt. Yet everywhere there will be large and expensive problems of adjustment, to which will be added the huge costs of protecting densely

populated coastal areas or resettling people from these areas. Palliative measures to reduce the input of greenhouse gases into the atmosphere will also have costs—not least those of changing systems of energy generation. The economic costs of global warming, which may include bouts of inflation due to rising food costs, to say nothing of famines in parts of the developing world, will be severe and will affect great numbers of people. How will this affect the world's willingness to give special consideration to the problems of the Pacific Islands? There are particular reasons for concern.

The developed world loves the stable Pacific it has created through its own mythology, powerfully aided by many Islanders themselves in modern times. Brilliant blue lagoons, white beaches, palm trees, and smiling, gaily dressed people twanging sugary music on imported guitars are the key elements of an image loved from Tromsø to Dunedin. When disaster strikes it is a disaster in Paradise, and the image has been a great asset to the island countries since it has helped fund a flow of aid that on a per capita basis tops the world list. Reactions to recent events, especially in Fiji and Vanuatu—Belau has received less notice—have already shown how vulnerable the island Pacific is to any dent in this image. Tourist flows, and investment more generally, reacted very sharply to the military overthrow of the legal government in Suva, and to unrest in Vila. A world that has done little more than shrug its shoulders at the steady smashing-up of Moruroa and thinks of Bikini only as a form of garment minimization is greatly upset when corrupt or power-hungry politicians and simple-minded colonels behave in the Pacific Islands much as they do elsewhere on the globe.

The affluent, developed world is not going to like the idea of its Pacific Islands dream being invaded by the sea; in the short term it might conceivably show more concern about this than about greatly increased flooding in the coastal regions of Asia. However, it is going to be distinctly more perturbed by the cost of raising Dutch dykes or helping second-home owners in Florida protect their investments. There will be very much greater complaint if climatic perturbation raises the cost of food. In a human-made disaster that creates huge adaptation costs in many parts of the world, damage done to the Pacific dream will not rank high for long. Even environmentalists are going to have bigger problems than concern over islands. The question of deforestation and reforestation will become a major issue, among many others. Moreover, "green" movements are

going to have to come to terms with the fact that the risky nuclear power they presently so strongly oppose adds no greenhouse gases to the atmosphere, whereas "safe" generation by fossil fuels is the major single contributor! With all these wider concerns to engage public attention, there will not be much patience with island governments that cannot manage their own problems and cannot help themselves. Worldwide love of the Pacific Islands is very lucrative to the present generation of Pacific Island governments—if often less so to their ordinary people—but it could melt rather quickly under the universal strains of global warming.

Pacific Island governments and people therefore need soon to contemplate a world in which the aid dollar may become a much scarcer commodity, though one would hope that it would still flow to those most truly vulnerable—both those in the Pacific and the many more elsewhere. The main job of adaptation must be done by the Islanders themselves. Given the sensitivity to global change of much of Pacific Island settlement and agriculture, it would be well to undertake the necessary re-orientation of thinking away from dependence and toward self-sufficiency rather quickly. Factional thinking and action need to give way to a sense of real peril—not, in the near future, of ultimate physical disaster so much as economic hardships augmented by cumulative minor disasters and increased stress on national resources. If the Pacific Island countries are to adapt to global change they need to develop much greater internal resilience so that real concern can flow to where it most belongs—those people and places first in peril. Whether or not this can be done remains to be seen. A very large and very basic change in thinking about the relationship of the islands and the Islanders to the world is involved, and recent political events in several countries do not encourage much belief that the fundamental issues—social, economic, or environmental—are rising to the top in national or regional consciousness.

CONCLUSION

There is no doubt that interference with global atmospheric chemistry, and the widespread degradation of resources that also reflects human attitudes to the physical base of life, will cause problems for the coming generations, beginning with the next. We are alerted to some, but not all, of the changes that can be expected to take place. We do not know how fast they will happen. For the Pacific Islands some of these untoward events,

above all the likelihood of rising sea levels, are of very serious import. This region needs to be as aware as any of the possible eventualities. Even though within the Pacific the physical impact will vary from mere troublesomeness to ultimate destruction of habitability, there will be more pervasive consequences as the global economic system is disturbed by the need for adaptation in all regions. The degree of dependency of small-country economies in the Pacific makes this region very vulnerable to the wider consequences of global change.

The best hope must lie in the still-open possibility that the major secular changes will take place more slowly than either the media hype or the more alarmist scientific predictions suggest. Well before the year 2040 we shall know; at present we do not. But it is better to prepare for the worst, and this means both major intraregional and intracountry adaptations of human settlement and resource use, as well as preparation for the possibility that some whole regions, and three whole countries, may be approaching uninhabitability within half a century. Although external aid and succor may still be available, and very necessary if large-scale migrations come to be needed, the region is going to need all the self-reliance it can regenerate after a century and a half of growing dependency. Self-reliance needs to be local, national, and international—all three at once. There is a long way to go in this respect if the Pacific Islands are going to cope with this new set of problems thrust on them by the larger world.

Notes

1 This paper is deliberately referenced very lightly. The huge literature in this area is mostly of a technical nature. Reasonably up-to-date and reliable statements are provided by Bolin et al 1986 and Pearman 1988. I am grateful to Professor R. G. Ward for helpful comments on a draft; however, I take full responsibility for all statements and opinions expressed.

2 Among many sources, a useful recent summary is provided by Allan 1988.

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