Trois objectifs ont été assignés au programme transversal Études prospectives:
mettre en relief les faits porteurs d’avenir dans les domaines de compétence
de l’UNESCO;
renforcer la fonction de centre d’échange d’information de l’UNESCO
dans le domaine des études prospectives;
promouvoir des activités de formation en matière de recherche et d’études
prospectives.

The three objectives of the transverse programme Future-oriented studies are
as follows:
- to highlight the future developments in UNESCO’s fields of competence;
- to strengthen UNESCO’s clearing-house function in the field of future-oriented studies;
- to promote training activities in future-oriented research and studies.
The designation employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of the UNESCO Secretariat concerning the legal status of any country or territory, or of its authorities, or concerning the delimitations of the frontiers of any country or territory.

Malgré l'effort notable consenti en faveur des pays insulaires aux titres de l'aide au développement, l'autosuffisance de ces pays a décru au cours de la dernière décennie. Cela a conduit à aborder la situation particulière de ces pays insulaires et aux handicaps spécifiques qu'ils doivent affronter (problèmes de transport et de communication, taille de marché, limitation des ressources, croissance démographique), mais ceci s'explique aussi par l'inadaptation des stratégies de développement mises en œuvre.


À l'instar des institutions du système des Nations Unies, ainsi que d'autres organisations internationales gouvernementales et non gouvernementales, l'UNESCO, en collaboration avec la Fondation pour la coopération culturelle ACP-CEE et avec l'assistance du Centre d'études géographiques tropicales (CEGET) de Bordeaux (France), a contribué, dans ses domaines de compétence, à cette réflexion en organisant, du 31 juillet au 4 août 1989, à l'Institut Mahatma Gandhi de Pile Maurice, un séminaire international sur le thème « Culture des îles et développement ».

Ces séminaires avaient pour premier objectif de rassembler des experts et...
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The greenhouse effect: a new challenge to island estates

J. Connell

'If the greenhouse effect raises sea levels by one metre it will virtually do away with Kiribati...if what the scientists say now is going to be true. In 50 or 60 years my country will not be there'
(Alan I. Tabai, Kiribati, September 1988)

'The environmental change caused by industrial progress in the developed world may slowly drown this unique paradise in its entirety'
(President M. Gayoom, Maldives Islands, 1987)

No environmental issue has captured public and private imaginations throughout the world more than the 'greenhouse effect'. Indeed, perhaps no environmental issue has ever stimulated such global interest and spawned such a variety of popular and academic accounts of future scenarios. Scientific studies have increasingly begun to draw important and consistent conclusions about future trends, and point to the regions where the greenhouse effect will cause the most severe problems. This chapter examines some of these trends in the context of five atoll states where the impact is likely to cause and emphasise substantial social, economic and political problems, and where such problems may begin to emerge around the start of the next century. The most extreme situation will be faced by small ocean island states occupying low coral islands on atolls. Here there is no high land to escape to, and whole populations may one day be displaced and left country-less. This chapter focuses on the five entirely atoll states, Kiribati, Marshall Islands, Tokelau and Tuvalu in the Pacific, and the Maldives in the Indian Ocean, each of which are entirely composed of low-relief atolls. Indeed the word atoll is derived from the Maldivian word 'atolu'. It has recently been stated that these states 'will be devastated if projected rises occur and consequently such states may cease to contain habitable land' (Pernetta, 1988-89).
The five atoll states considered here are quite different in language, culture, history and in their physical environment. Tuvalu and Tokelau are part of Polynesia; the Marshall Islands and Kiribati are in Micronesia. The Maldives is part of the South Asian cultural region. The state of Tuvalu consists of nine coral atolls and reef islands with a total land area of no more than 24 square kilometres, yet spread over 590 kilometres. Kiribati has twenty populated atolls (including Banaba) and a land area of 700 square kilometres but more than half of this (363 square kilometres) is on Christmas Island (Kiritimati) some 3500 kilometres away from Tarawa, the national capital. The Marshall Islands have 24 populated atolls, but the majority of the population live in the capital, Majuro, or on Ebeye, close to the American missile range on Kwajalein atoll. The Maldives has a similar number of populated atolls but, because of the exceptionally large size of many of these, the population is spread over a much larger number of islands than in the other atoll states. The population density in Tokelau (Table 1) is significantly less than in the other three states partly because of substantial migration to New Zealand where a majority of Tokelauans now live.

The greenhouse effect and coral atoll ecology

The build-up of industrial gases in the earth's atmosphere over the past 30 to 40 years is now well documented (eg. Pearman, 1988). The resulting “Greenhouse effect” is expected to raise temperatures over much of the earth's surface and lead to a rise in the levels of the world's oceans. Initially the latter will come about through expansion of surface ocean water and the melting of mountain glaciers. Very much later the melting of the polar ice sheets may significantly increase ocean volumes. Tide gauge records from around the world show a small rise in relative sea level (1.0-1.5 mm per year) over the past few decades; however the extent to which apparent sea level changes are due to the global greenhouse phenomenon or to local climatic variability or other factors (Roy and Connell, 1989) remains inconclusive. Both in Kiribati and the Maldives (Woodroffe, 1989) there is also some evidence that sea levels are not currently rising. Because of uncertainty concerning the pattern and extent of future heating of the earth's surface, and the rate at which heat will be absorbed by the oceans, rates of expansion of the oceans cannot be determined with any accuracy. Extreme scenarios for the next 50 years range from virtually no change in mean sea level to an elevation many metres higher. There is however near universal agreement that sea levels will rise.

The basic effect of a rise in sea level is for low-lying lands to be inundated and for coasts to erode. Erosion, as opposed to inundation, is most severe on shorelines composed of unconsolidated sediment exposed to storm wave attack on high-energy coasts. A gradual rise of mean sea-level will progressively lift the zone of flooding, storm wave set-up and surge effects to new levels, thus eroding areas hitherto considered safe. Human responses will vary depending on the value of the coastal land under attack and the resources available to provide protective measures. In atoll states where resources are very limited, and populations thinly spread, the provision of expensive engineering works will not be a commonly available option.

While the spectre of a rising sea level in the future seems to follow inevitably from a greenhouse-induced warming of the atmosphere, the impact will not be the same everywhere. Past sea-level changes have been influenced by local climatic and oceanographic factors, whose variability may increase with the greenhouse effect. Moreover while coastal erosion is closely linked to raised sea levels, quantitative relationships have yet to be established for coral islands. The amount of erosion will depend on the composition and height of a particular island, its exposure to wave attack and current erosion and the frequency and intensity of storms. Conceivably, in the next 50 years or so, GE shoreline erosion rates in the order of 1-2 metres per year could reduce the dimensions of some presently inhabited islands to the point where their ground water supplies would no longer support viable ecology or permanent habitation.

The general impression of the terrestrial flora (and fauna) of atolls is of a rather limited species diversity with only a few plant types predominating. However, species numbers vary considerably between islands and there seems to be a direct relationship between floral diversity and island size and rainfall (Wiens, 1962). Because of the relatively small size and the low elevation of atoll islands, virtually all plants have some tolerance to salt spray and brackish ground water conditions. Species such as the coconut and pandanus can withstand quite high levels of salt and even occasional inundation by storm waves. They survive (albeit unproductively) on downward percolating rain water in relatively exposed sites and quickly colonise even small rubble mounds that rise above high tide level. In contrast, swamp taro and Cyrtosperma are much more sensitive to salinity changes and grow in low areas, sometimes manually excavated (taro pits), in the central parts of islands; on occasion, notably after storms, salinity causes a substantial reduction in taro productivity.

Island ecology, in terms of the capacity to support human habitation, is closely tied to the existence of a permanent ground water system.
Islands above a certain size, about 1.5 hectares, contain a permanent lens of fresh water surrounded by salt water. The volume of the lens is roughly proportional to the surface area of the atoll, thus a decline in the surface area of an atoll would have a disproportionate impact on the volume of the lens (Roy and Connell, 1989). During droughts, water table levels fall and the ground water may become brackish. Environmental stress is manifested by trees losing leaves, not fruiting and even dying. In Kiribati, where ground water is the main source of drinking water on most islands, populations have been forced to migrate temporarily to areas with higher rainfall. The most severe threat to permanent water supplies is not from climatic factors directly, but rather from marine processes that cause coastal erosion and increase the frequency of storm overwash.

Atoll states

Atolls vary enormously in size, both of land and lagoon areas, and in rainfall, and hence so do their flora and fauna, their ability to support human populations and, most recently, in their ability to provide some form of diversified development. Some atolls are small, arid, drought-prone and overpopulated, as in the central Gilbert Islands chain, but where such conditions do not occur the potential for development is often quite different. Recurrent hazards of droughts, hurricanes and tsunamis have had an important demographic and cultural role in atoll states (Vayda, 1959). The basic constraints were such that, in past times, many atolls have been depopulated and repopulated, following hazards and migration movements of various kinds. Atoll populations often developed cultural ties with other atolls so that, during periods of population-resource imbalance, their proximity to each other enabled economic exchange, personnel mobility and, on the negative side, warfare and raiding (Alkire, 1978). Thus atolls were usually part of coral clusters or complexes.

The modern era has increasingly demonstrated the tyrannies of distance that have restricted contemporary development. Atolls are tiny, resource-poor, often distant from each other and remote from more substantial land masses. Atoll states consequently face a host of development problems, often in a more accentuated form than in other island microstates (Connell, 1988), which include limited skills, small domestic market size, high cost of imports and exports, restricted diversity of exports and substantial administrative costs. These have usually led to large trade deficits, balance of payments problems and considerable dependence on foreign aid and technical assistance. Only in the Maldives has there been any real industrialization, with Hong Kong-financed textile factories now providing some employment in a special Free Enterprise Zone on Gan, or effective tourist development. Atoll states have moved rapidly into situations of extreme dependence on the outside world, primarily for aid, concessional trade and, in the Pacific, for migration opportunities.

Atoll populations are usually small. Only the few urban centres have substantial populations and the Pacific atoll states are some of the smallest island micro-states in the world. At a very early stage in colonial history these resource-poor islands became quite significantly dependent on the outside world for consumer goods, including foodstuffs. By the 1890's for both Kiribati and Tuvalu, pacification, population growth and changing aspirations had resulted in overseas labour migration being described as 'the only alternative to starvation' (Macdonald, 1982) in the sense that population and domestic resources were already recognised to be in some degree of imbalance. Indeed in Kiribati and Tuvalu the Malthusian spectre has been sighted most frequently in the South Pacific; mid-nineteenth century Tuvaluans 'were genuine Malthusians. They feared that unless the population was kept down they would not have sufficient food' (cited by Bedford and Munro, 1980). A century later 'few countries of the South Pacific serve to remind one so well of the so-called 'Malthusian dilemma' as the two countries under consideration, with their rapidly expanding population pressing against a limited and non-expanding stock of natural resources' (Fairbairn, 1976). The situation was and is marginally better in the less densely populated Marshall Islands and Tokelau, but in the Maldives much higher population densities are unrelieved by international migration. In every case modern health facilities and medicines have resulted in a more rapid natural increase of population in most atoll situations; infants are more likely to survive, and diseases are less likely to be fatal while modern family planning is largely absent in the atoll states. The Marshall Islands now has one of the fastest growing populations of any state in the world; widespread adoption has reduced the perceived need for family planning. Kiribati and Tuvalu are not far behind and the population of the Maldives is currently growing at the very high rate of 3.3 per cent per annum. As atoll populations increase, the problem of satisfying basic needs (e.g. housing, water and food) from local resources also increases. Although there has been little research on the human carrying capacities of atolls (and it is invariably true that there are possibilities of agricultural intensification, varietal improvement, and fishing develop-
ment), in a number of cases population densities have reached extremely high levels (Table 1) and development prospects are limited.

Throughout the atoll states, the limited agricultural base of the traditional economy has further declined in colonial and post-colonial times. Artisanal fisheries have experienced a similar but less dramatic transition, which has followed the depletion of inshore and lagoon species, indirectly contributing to the necessity for more labour-intensive fishing practices. In every case there appears to have been a decline in local production per capita, paralleled by a transition to imported food, especially rice, which has followed changing tastes, preferences, convenience and so on. Limited subsistence agricultural production has been dramatically emphasized since the nineteenth century by the 'coconut overlay' (Bedford and Munro, 1980) that has transformed the economy of atolls by enabling participation, however limited, in the international economy through copra production and sales. This sole historic domestic source of income, copra production, has continued into the present, although in recent years production has not grown significantly. Nonetheless, even on the more urbanized islands, including Majuro (but not Male), copra is still produced because of its capacity for directly generating some cash income. Necessary activities, however, such as coconut replanting, are often postponed indefinitely and copra production offers an increasingly fragile basis for the construction of a modern economy.

Though fish and other marine resources have often been domestically marketed, albeit on a very small scale, marine resources have rarely been exported from the atoll states. The Maldives, however, is a prominent exception and the economy is based on the fishing industry. Not only do fisheries constitute 27 per cent of the GDP (1985) but this is one of the faster growing sectors of the economy, despite depressed prices. In the Pacific states, fisheries leases now represent a major source of domestic income for the atoll states, though substantially less than the value of those fisheries. Even the combination of fisheries and copra incomes, however, does not provide high incomes for the atoll states, most of whose national incomes are now externally generated in a non-trade manner, primarily through aid and migrant remittances.

The migration option

The combination of higher post-war rates of population increase, the growing desire for consumer goods, the location of higher education facilities and hospitals either on one central atoll or on a high island, and the concentration of formal sector employment has, in many cases, resulted in outmigration from atolls, especially where there is a central high island (Connell 1986; p.45). On small atolls especially, there are very few prospects of formal sector employment; as population and education levels increase, and demand for employment also increases, this is further emphasized. The extent of emigration in younger age groups especially is often substantial (Connell, 1986) as little local wage employment is available and almost all of this is in the public sector. In these states the private sector, apart from stores, is conspicuous by its absence. In every case public sector employment rapidly extended in the 1970s but not in the 1980s. Since many atolls are remote from capitals, the transportation costs (either of commodities or medical services) have rapidly increased with rising oil prices, and transport services have declined substantially in some areas. Migration becomes a cheaper alternative than remaining. When both population and needs have grown together in environments where local production possibilities are limited, the export of labour has become an important means of meeting some basic subsistence requirements, especially food. Migration has increasingly become a quest for essentials rather than luxuries.

While outmigration may solve the immediate population and welfare problems of some small, densely populated atolls, it may also increase the problems of destination areas in the atoll states. Some of the most difficult and intractable development problems are experienced in the urban centres of the atoll states. The most extreme examples of this are the Marshall Islands and Kiribati. In every case urbanization has been both recent and rapid. The reasons for these urban concentrations are many and, until quite recently, have followed growing economic and social differentials between one central atoll and the remaining atolls. A centralized administration has spawned the centralization of the service sector and hence of most formal sector employment. This centralization may be compounded by 'urban bias', where financial and technical resources are overwhelmingly concentrated in the urban areas.

This urban concentration has inevitably created problems. Many of these problems are no different from those of much larger urban centres elsewhere in the Third World: overcrowding in poor housing conditions with attendant health risks, pollution (to the extent that the lagoon in South Tarawa is a potential health risk and was one cause of a cholera outbreak in 1977), unemployment (even if disguised by sharing in extended families), the growth of squatter settlements, worsened nutrition (as cash incomes are often inadequate to purchase diets based on imported foods), and sometimes higher crime rates and social disorganization. Since migrants are not always successful in towns they may be unable, or unwilling, to contribute significantly to the needs of their
rural kin. These urban problems are not unique to atolls, but the small size of the land and lagoon areas and the problems of achieving economic growth accentuate the basic difficulties.

In the atoll states of the Marshall Islands, Maldives, Kiribati, and Tuvalu there are therefore two related problems: the relative depopulation and/or economic decline of the smaller, remote atolls and overurbanization on the principal atoll. In the absence of overseas migration from atoll states, development prospects are even more difficult. For Tokelau, migration to New Zealand is a right, since Tokelau islanders are New Zealand citizens. Hence, in terms of ethnicity, a slight majority of Tokelau islanders now live in New Zealand.

The idea of permanent emigration, involving a severance of many ties with the home island and of seeking one’s fortune elsewhere, is well established in Tokelau life and thought. For the past 70 years or so it appears to have been accepted...that some of nearly every group of siblings must take ('emigrate') simply because the local resources are seen as insufficient (Hooper and Huntsman, 1973).

Migration from the Marshall Islands (and from the Federated States of Micronesia) to the USA is possible under the terms of the Compact of Free Association; indeed the island states were anxious to ensure that such a clause be in the Compact (Connell, 1991). For Kiribati and Tuvalu opportunities are currently declining; the Maldives too have no established tradition of international migration and few Maldivians are overseas.

Both Kiribati and Tuvalu specifically train a proportion of the national population for overseas migration through their Marine Training Schools whilst Marshallese are trained in the Philippines. Apart from overseas seamen (representing 3 per cent and 1 per cent respectively of the de facto population of Tuvalu and Kiribati), there were almost 722 (8.2 per cent) Tuvaluans and 1,278 (2 per cent) I-Kiribati employed on Nauru at the time of the last censuses. The number of I-Kiribati employed on Nauru declined between 1979 and 1985 and will subsequently decline further as employment opportunities contract. Movement overseas both reduces the pressure on local resources and provides a substantial cash flow from remittances. When phosphate mining on Nauru ends, in the absence of alternative overseas opportunities, the development problems of Kiribati and Tuvalu will be considerably worsened, because of the loss of remittance income, the increased population pressure on resources as these workers (some with their families) return, and the influence of these return migrants, hitherto employed in

the urban-industrial sector, on the values and attitudes of the national population. Rates of extraction of phosphate are influenced by changing technology and prices, but there seems little doubt that commercial phosphate production will have finished before the end of the century.

The significance of international migration for Kiribati and Tuvalu is apparent not only in the flow of remittances but also in changing local attitudes to international migration. In pre-war years the colonial administration decentralized part of the population of the more densely populated Gilbert Islands to the Phoenix Islands group to the east. At much the same time groups of villagers from Vaitupu in Tuvalu purchased land in Fiji for their own private resettlement. Local and colonial perceptions of population density and domestic development prospects were both quite similar. For various reasons settlement of the Phoenix Islands was unsuccessful and the settlers were again transplanted, this time to the then British colony of the Solomon Islands, where they and their descendants remain. In Kiribati these settlers are now viewed quite differently from in the past.

In earlier days they were the unfortunate ones who did not have sufficient land. Now our values have changed. Settling overseas beyond the oceans of our islands is something to be sought after. Why? Because our population is still growing. So now, many consider them, the resettled ones, the fortunate ones and they consider us to be the unfortunate ones (Schutz and Tenen, 1979).

Permanent international migration is increasingly viewed by many, though certainly not all, as a key solution to many development problems.

The growing perception of the benefit to households of migration has led to increasing fertility rates, at least as documented in the case of Nanumea atoll in Tuvalu, where parents actively hope to produce remittance earners and most feel that this necessitates having more than one son. As one woman said of her only son “One is not enough. If he goes away to work, there is no one to look after me here. If he stays and cares for me, no one earns any money overseas”. Another woman recognized that her husband had been right to insist that they needed more children... “He said that if we had many children we might have a smart one who could go on to school and get good work. He will be our road to money and imported goods” (Chambers, 1986).

This phenomenon has also been observed in other small islands that have become dependent on remittances from migrants (Connell, 1988, p.29) and indicates that family planning is unlikely to be chosen as a
solution to development but that population pressure on resources may worsen in the absence of international migration opportunities.

It is scarcely surprising, then, that individual migrants and households and also many observers have viewed the future of the atoll states in terms of increased levels of international migration. Recent views of the possibilities for economic growth in Kiribati and other larger, less remote and better endowed countries in the South Pacific concluded that sustained increases in incomes would only be possible through greater dependence on migration (Castle, 1980; Committee to Review the Australian Aid Program, 1984). Such perceptions are indicative of the growing perception of severe development problems in Kiribati and Tuvalu and the role that international migration might play in resolving them. Nonetheless a former government economist and planning officer in Kiribati has simply stated, ‘Emigration, as proposed by the ‘Jackson Report’ is not an answer. This would result only in the removal of the best of one of the country’s few resources i.e. its skilled labour, to serve other countries and further frustrate Kiribati development’ (Pollard, 1987). Though there is some truth in this view, migration from Kiribati already occurs and there is no obvious shortage of skilled labour that would be solved by reducing migration. The Maldives, without a history of migration, is in a similar situation to Kiribati and Tuvalu. Rural-urban migration has put considerable pressure on the very limited land resources of Male, where freshwater supplies are regularly exhausted, rational and contaminated through both excessive use and the discharge of waste. Though there is some evidence of decentralisation of activity from Male to the nearest growth centre of Thulusdhoo (Republic of the Maldives, 1987) the prospects for economic growth occurring in outer islands at a rate greater than that of population growth are exceptionally poor. Moreover there is a minimalist population policy, hence little prospect of any reduction in population growth in the near future, so that international migration may come to be seen as desirable.

Alongside the contribution of remittances, further substantial financial supports for national incomes of atoll states are overseas aid, welfare payments, subsidies and compensation payments of different kinds. So substantial are aid funds that the atoll states of Kiribati, Tuvalu and Tokelau, alongside Niue and the Cook Islands, have been conceptualized as MIRAB states, where migrant remittances and aid are the most important bases of the economy and, through these flows, a government bureaucracy has become the principal source of wage and salary employment (Bertram and Watters, 1985). In the Marshall Islands direct external (US) support for the economy is even more substantial. The Maldives alone has a degree of balance between aid and exports, a result of its relatively successful fisheries and tourism sectors. Only a very small proportion of the national income of atoll states is generated within those countries, through commodity, mainly copra, fish and also postage stamp, exports but is dependent on concessionary external support. However the concessionary trade agreements of SPARTECA have proved of no use to countries that manufacture little (Tabai, 1987) and none of the states, other than the Maldives, has any manufactured exports, and the Maldives have no access to special European Community preferential arrangements. Atolls and atoll states have moved a very long way from any semblance of self-reliance. Moreover, they have gone beyond the traditional support of local coral clusters to dependence on much more distant nations.

Impact of the greenhouse effect

Previous sections have examined the difficulties of development in atolls and atoll states and noted how, over time, there has been increasing recourse to the option of migration as the preferred individual and household solution to the challenge of development, whilst the states themselves have tended to become more dependent on overseas aid. Rising sea-levels can only worsen in a number of ways the problems of achieving development in atoll states, though the extent of the changes will vary over time and from place to place in ways that are not yet possible to predict. Slowly but inexorably there will be critical environmental changes at an unknown rate and of an unknown dimension.

In some areas it will be extremely difficult to assess what the impact of the greenhouse effect will be. The intertropical convergence zone is likely to shift northwards, changing the distribution of zones of upwelling, and hence altering the distribution of fish stocks and fisheries. At local level future changes are even more difficult to assess, though the relatively simple ecosystems of atolls enable some conclusions to be made with a greater degree of certainty and the timing and impact of the greenhouse effect is uncertain. A number of specific changes that affect atolls can be separately distinguished and examined in four principal areas. These are, firstly, the drowning of barrier reefs, secondly, the intrusion of saltwater into coastal groundwater supplies; thirdly, the erosion of areas of flat land, and fourthly, storm damage to coastal installations, such as port facilities. Tourism is a significant source of income only in the Maldives, hence the disruption of coastal tourist facilities will not be significant, though it will certainly discourage any developments in that area.
The greenhouse effect is likely therefore to lead to a substantial decline in agricultural production, a possible decline in fisheries production, and a loss of vital water, timber and firewood resources, thus reducing the potential of the few areas in which the atolls and atoll states currently demonstrate a degree of self-reliance. These effects will occur alongside continued rapid population growth, and a substantial increase in population pressure on resources is therefore likely. Unless the greenhouse effect contributes to increased self-reliance in some other area (and it is remotely possible that deep sea fisheries potential might increase) this will lead to an acceleration of the present process of dependence on metropolitan states. Within countries it is likely to further encourage rural-urban migration in search of the 'fast money' of wages and salaries rather than the increasing unpredictability of agricultural and fisheries incomes. However, much current knowledge of the impact of the greenhouse effect is derived from conjecture and speculation, since the order of magnitude of future physical events cannot be determined and there is no precedent for what is likely to follow. It is nonetheless apparent that the greenhouse effect offers nothing positive to atoll states and, because all their land is low-lying, the problems will certainly be considerable and more apparent than on high islands and most continental areas.

Conclusion

Atoll development options are naturally constrained by limited land (and sometimes lagoon) areas, and the simplicity of atoll environments (so that natural ecosystems may easily be disrupted). These options are broadened by the increased availability of new plant varieties, fertilizers, technology, and so on, but limited by the fact that these may be expensive (and increasingly so) and far from simple to organize and maintain. Options have however been diminished by new aspirations that have resulted in changes in attitudes to traditional agriculture (resulting in a general decline of food cultivation) and some loss of skills and knowledge (principally as modern "school" knowledge replaces inherited traditional skills) that enable survival and success in environments often threatened by natural hazards. Options will be further reduced, even removed, by the greenhouse effect.

To expect humankind’s past and contemporary massive degradation of the world’s natural environments not to induce some future change in global climate, is to be irrationally optimistic. There may be geological precedents for different world climates in the past, but there is no precedent for the speed at which contemporary changes to the environment are taking place. It is therefore unrealistic to expect present-day natural systems to compensate for, or accommodate, all these impacts without themselves changing to some extent. Inevitably, the world’s climate will change; the extent of that change depends in large part on political, social and technological behaviour in the future.

Questions as to how much the climate will change and what will be the magnitude of the associated impacts are largely unanswerable at this time – at least in detail. Increasingly, it is apparent that simplistic models, predicting environmental factors (temperature, rainfall, cloud cover, sea-level, etc.) changing progressively with time at the same rate throughout the world, are false. Changes will occur at differing rates and to a different degree from place to place. In the case of sea-level change, it is probable, as Bryant (1988) points out, that local climatic change and oceanographic factors will have a greater local impact than the transfer of heat from the atmosphere to the oceans and ice caps. Specifically, in the context of atoll islands, it is likely that degradation of present-day living conditions will come about through local factors – increased El Nino events, droughts, more storms, higher rates of coastal erosion. Impacts will vary from place to place not only because of environmental variability, but also because of inherited geological factors that have produced differences in island morphologies and compositions.

There is no evidence that present socio-political systems have the capacity or will to control global events such as the unique greenhouse 'experiment'. The majority of the various management options canvassed by Goodman and Jager (1988) recognize the improbability of governments jointly implementing the radical changes needed now to significantly modify the greenhouse effect. Meyer-Abich (1980) suggested that there are three options for response: prevention, compensation and adaptation but concluded that, from a political point of view, prevention and compensation are much less practical than adaptation. Adaptation allows the least marginal action in the present and defers expenses into the future. In addition, adaptation does not require long-term international co-operation or agreement on long-range goals. If adaptation is the most rational political option, the climate problem tends to fade ("Chalk on the White Wall") compared to the already extremely serious social and economic problems confronting developing countries. As is apparent this is particularly true in atoll states. Thus, at best, climate-oriented policies to cope with climate change would become part of development policies in general.

Judging by developments in the post-war years, the nature of technological changes in the future is hard to imagine. The best-case scenario
for a technological ‘fix’ for the greenhouse effect must entail the
development of a non-polluting form of energy production, such as solar
energy. A new energy technology, even if it was economic and available,
would still take many decades before it globally replaced the present
sources of energy and pollution. Beyond technology and economics
there are powerful vested political interests in those developed countries
that export coal and uranium. Clearly, technology cannot avert, in the
intermediate term, the inevitable consequences of a greenhouse-
induced change in global climate.

Uncertainty over the outcome of the greenhouse effect has necessa-
rily restricted ability and willingness, nationally and internationally, to
respond to the problem through policy and formation. Response is least
likely in the atoll states where information is least adequate and where
planning offices are small and fully stretched to cope with standard
recurrent activities. Planning remains in its infancy; financing and tech-
nical expertise are limited, environmental planning is almost non-exis-
tent and five-year plans (despite a history of 15-year plans in Micronesia)
are the extreme limit of long-term planning. Though ‘the decision pro-
cess will not begin until there are more conclusive findings’ (Titus, 1987)
these findings are now sufficient conclusive, despite their lack of spec-
icity, for some forms of action to be taken now. Even so it is more likely
that significant action will not be taken until there is consensus that
some local (rather than global) change, can be definitely attributed to the
greenhouse effect. Atoll states, or other microstates, cannot act individu-
ally or collectively to remove or reduce the causes of the greenhouse
effect though they can call upon international organizations to act on
these causes. An international approach is essential to tackle this global
problem though, even at an international level, climatic change is only
one element in a complex and integrated set of population, resource,
economic and environmental problems. The greenhouse effect has now
become a United Nations priority and the United Nations Environment
Programme (UNEP) is working towards an international convention for
tackling the problem.

For a particular state, options range from direct action to avoid or
eliminate the risk (which is clearly not possible for the greenhouse
effect), action to reduce vulnerability levels or action to move away from,
or abandon, the most risk-prone areas. The greenhouse effect will even-
tually overwhelm atolls since everything is coastal (in distance and alti-
tude). Many conventional measures to reduce vulnerability (eg. trans-
ferring populations, infrastructure and economic activities to higher
land) are impossible. Other conventional measures, such as the con-
struction of dikes, sea walls and pumping stations, are extremely expen-
sive (especially when a small population is spread over a large number of
islands) and because of the high porosity of coral and coral sand would
be unlikely to solve the problem, since the continuous inflow of water
underground would necessitate expenditure on land drainage whilst
there would be no protection for the freshwater lenses. Similarly there
would be no possibility for the transport of material to nourish island
growth on the scale that would be required. Even defending the few
urban areas, several of which are themselves spread over wide areas,
would be a complex and costly operation, and in itself would be a point-
less exercise. Moreover the finance for projects of this kind would be
wholly absent within the atoll states and no aid donor would contemplate
aid on the scale that would be necessary, even to strategically important
states. Although ‘present indications are that by far the most likely
responses to the unprecedented historical occurrence of a possible global
sea-level rise of one-metre by the year 2045 will be high-cost “technical
fix” solutions’ (Mercer and Peterson, 1988) these solutions will simply
not be available to atoll states or even other micro-states.

In the meantime it is apparent that much more research is required on
the physical, environmental and economic impacts of the greenhouse
effect at the local level, especially in the atoll states (and in other low-
laying areas). More detailed studies of the structure of atolls are required,
to describe the physical environments of individual atoll groups, to indi-
cate what proportion of the area of individual atolls, and what key instal-
lations, are particularly vulnerable to sea-level rises of different dimen-
sions; remote sensing and geographical information systems (GIS)
can play an important role here. This kind of research is most likely to be
undertaken with financial assistance from metropolitan states, though,
in the past, metropolitan states have been unenthusiastic about funding
either research programmes or development programmes that streng-
then environmental conservation because of their limited visibility and
contribution to economic growth. There is some evidence that this is
now slowly changing as the implications of the greenhouse effect
become more apparent, yet it is extremely difficult to get distant (in
space and time) problems placed on the political agenda of any country
(Mercer and Peterson, 1988). It will also be crucial to strengthen the
capacity of national planning offices, especially in relation to environ-
mental matters, to ensure that there are more restrictions on planning in
high-risk areas (a situation that will also be important for other countries,
such as Tonga, where a greater range of choice of locations is normally
possible) and to enable better monitoring of local changes. Strengthen-
ing the ability of governments to undertake conventional planning, in
areas such as population planning, becomes even more crucial than it
already is. Ultimately, however, activities in these areas may turn out to be primarily holding actions, though such actions will reduce risks and ensure greater awareness of the more long-term problem.

Increased emigration must therefore inevitably be seen as one response to the greenhouse effect, a response that builds on existing trends but that depends almost entirely on the policies of metropolitan states. Nevertheless islanders could ultimately take migration matters into their own hands. Based on the experience of existing migration from the South Pacific to Australia and New Zealand the bulk of potential migrants from Kiribati and Tuvalu would be young, with some education, and would find employment reasonably easily; moreover only a small proportion of the population would initially choose to migrate. However there is likely to be significant opposition to concessory migration at the moment though, in time, when the impact of the greenhouse effect becomes apparent this may decline. Concessory migration schemes may be granted in other potential destinations such as New Zealand or even the United States. They are unlikely within the South Pacific. They are also unlikely for the Maldives, without a history of international migration and bordered by densely-populated, impoverished South Asian states.

Resettlement poses particular problems. In pre-war times the resettlement of Gilbertese to the Phoenix Islands was eventually unsuccessful so that the resettled population was subsequently transferred to the Solomon Islands. Resettlement from atolls has otherwise moved atoll dwellers into very different environments, imposing considerable social, physiological and sometimes economic costs, as they confront a very different economic, political and biological environment. The consensus of the few studies that exist of these kinds of resettlements is that a variety of problems occur: firstly, there are racial tensions, often as a result of the denigration of the settlers; secondly, migrants have few skills and some difficulty in obtaining formal employment; thirdly, land problems often arise, especially as the resettled community grows in size; fourthly, there are agricultural (and sometimes fishing) problems from converting skills appropriate to atoll situations to those appropriate to high islands. Finally, over time, the solidarity of the community breaks down with increasing individualization, and urbanization often follows (Knudson, 1977; McKnight, 1977; Koch, 1978; O'Collins, 1988; Connell, 1990). By contrast voluntary individual and household migration in otherwise similar circumstances has been much more successful but has tended to result in selective migration of a youthful, more educated population, increasing the dependency rate in the villages and islands of out-migration. Resettlement will not therefore occur without new problems emerging, especially if resettlement to metropolitan states occurs, and it is apparent that the experience of Tokelauans in New Zealand will be of some significance for future moves.

All the evidence suggests that the serious development problems experienced in the atoll states cannot adequately be met even now by internal policies or regional co-operation and that higher levels of aid will not contribute to economic growth (as opposed to improved welfare). Whilst there is much evidence of widespread social and economic disadvantages to high levels of overseas migration, in the smallest states, such as Tokelau, there are substantial gains from migration that cannot be realized by other means. Where expectations of appropriate lifestyles continue to forge further ahead of economic realities in atoll states the migration response, especially under the impact of the greenhouse effect, becomes even more probable. In historic times atoll dwellers were extremely mobile and far from insular; men and women moved readily

<table>
<thead>
<tr>
<th>Atoll State Populations</th>
<th>Marshall Islands</th>
<th>Kiribati</th>
<th>Tokelau</th>
<th>Tuvalu</th>
<th>Maldives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occupied atolls</td>
<td>24</td>
<td>16</td>
<td>3</td>
<td>9</td>
<td>22</td>
</tr>
<tr>
<td>Total population</td>
<td>43,335</td>
<td>61,186</td>
<td>1,690</td>
<td>7,349</td>
<td>181,453</td>
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<tr>
<td>Mean atoll population</td>
<td>1,805</td>
<td>3,284</td>
<td>563</td>
<td>817</td>
<td></td>
</tr>
<tr>
<td>Mean population</td>
<td>719</td>
<td>2,299</td>
<td>563</td>
<td>653</td>
<td></td>
</tr>
<tr>
<td>(excl. central atoll)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population density</td>
<td>242</td>
<td>227</td>
<td>56</td>
<td>287</td>
<td>609</td>
</tr>
<tr>
<td>(km²)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Note: Areas are land areas. Since lagoons provide maritime resources, variable lagoon areas are also important. Populations have grown significantly since the censuses to which these data refer.

a. The data refer to the Gilberts only, thus excluding Banaba and the Line Islands.
b. This figure excludes the populations of both Majuro (including Laura) and Kwajalein (including Ebeye).
c. In 1983 an informal census of Tuvalu was undertaken; this head count gave a total population of 8364 within Tuvalu, of whom 2620 were on Funafuti. A formal census is due to be held in 1989.
d. Other definitions of 'atoll' give a higher number of occupied atolls. A recent official publication records that 'out of a total of about 1200 islands only 202 are permanently inhabited' (Republic of the Maldives, 1985, p.5).
between islands in search of new land, disease-free sites, marriage partners, trade goods, and so on. In this way some islands were populated, depopulated, and later repopulated. Mobility itself was responsible for demographic survival; without mobility, adaptation and change were impossible. It is a phenomenon of contemporary times that atoll state populations are growing, and political boundaries and policies minimize long-distance migration. Without the flexibility that this kind of resettlement migration provides, the uncertainties and limitations of atoll environments are emphasized and either more permanent migration (usually to urban areas elsewhere) or an uncertain dependence replaces it. The era of great Micronesian and Polynesian voyages may be over but the future may nonetheless lie on distant shores.

Long before the contemporary implications of the greenhouse effect were recognized the choice of appropriate strategies for atoll states had caused concern. Few world states have ever had such limited prospects for development, have gained so little from contemporary technological change but have nevertheless become so dependent on the outside world. Now it is even more crucial for there to be a focus on development issues in atoll states. Without further substantial external assistance, there is little doubt that people who were once described as real and potential ‘economic refugees’ will become, in less than fifty years, a new group of ‘environmental refugees’, or, as suggested elsewhere ‘ecological refugees’ (Pernetta, 1988). It is extremely unlikely that actions taken within the atoll states alone will allay this gloomy forecast. Some of the most recently populated islands in the world may be depopulated. Some of the most recently formed islands may disappear.

References


This paper seeks to briefly explain Micronesia, a term that has become synonymous since World War II with the islands in the Western Pacific which comprise the former Trust Territory of the Pacific Islands, administered by the United States under a Trusteeship Agreement with the United Nations.

The region's colonial backgrounds, conditions of dependency, decolonization, and integration into the world economy, will all be touched upon with a view to creating some awareness of the issues which now confront the people of the islands, and which will be projected to the year 2000.

The history of Micronesia is a history of almost continuous exploitation. For more than three hundred years, and through four successive colonial administrations—Spanish, 1521 to 1898; German, 1899 to 1913; Japanese, 1914 to 1944; and American, 1944 to the present day—the many small islands of Micronesia have been induced into a cycle of dependency from which the once self-sufficient island people have been unable to extricate themselves.

Micronesia covers an area in the north Pacific of over three million square miles, and is composed of some 2,241 islands and atolls. There are three large archipelagos, the Marianas, the Carolines and the Marshall Islands. The island of Nauru and the new nation of Kiribati (formerly the Gilbert Islands) are also included geographically and culturally.

However, due to separate historical and political developments, Micronesia has been more commonly identified with the northern islands of the Marianas (excluding Guam, which has been an American territory since 1898), the Carolines and the Marshall Islands. Since World War II, these islands have been synonymous with the Trust Territory of the Pacific Islands (TTPI).