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KIRIBATI: "SOME ASPECTS OF HUMAN ECOLOGY," FORTY YEARS LATER

BY

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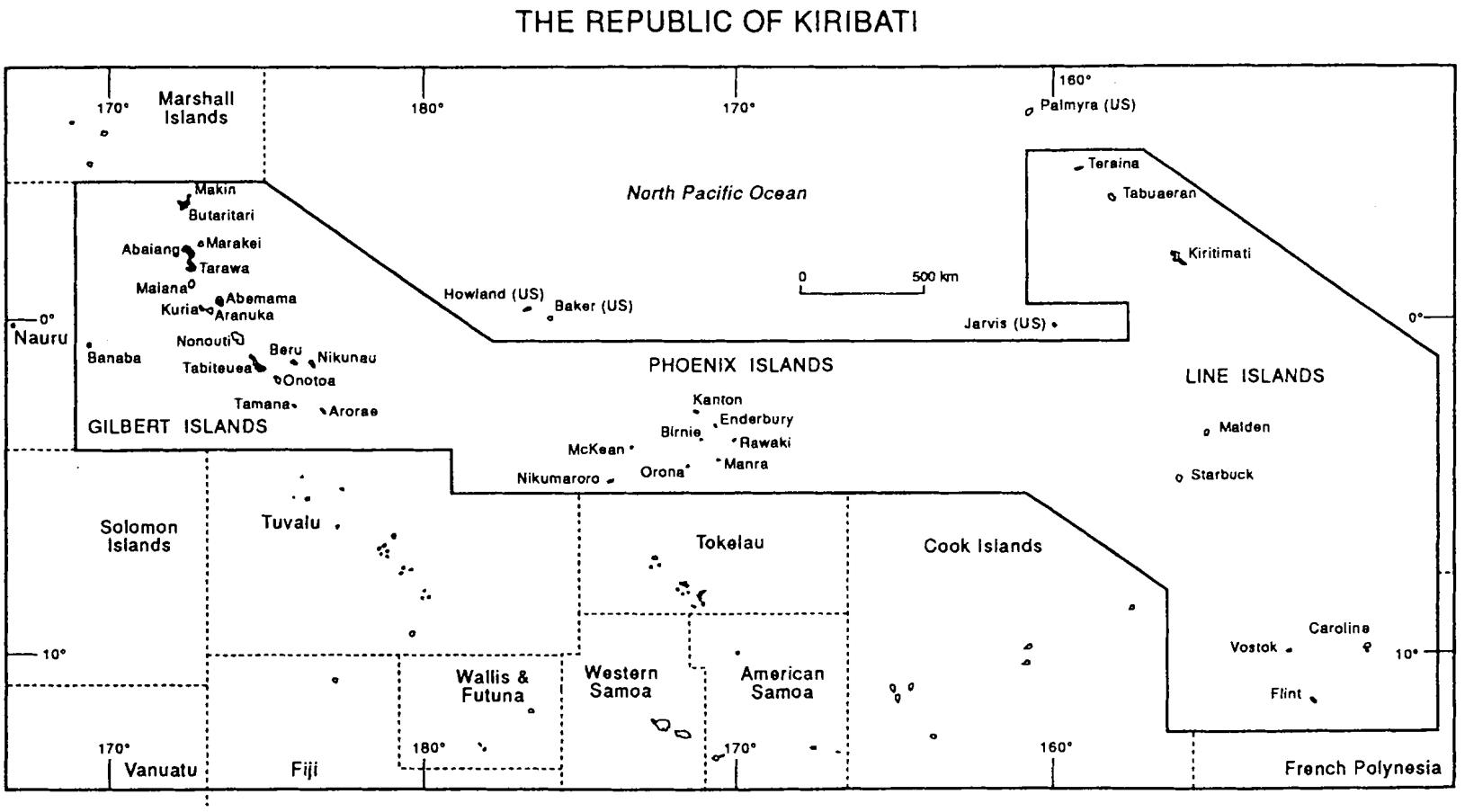

Figure 1. Index map of the Republic of Kiribati (courtesy of Macmillan Brown Centre for Pacific Studies, University of Canterbury, Christchurch, and Institute of Pacific Studies, University of the South Pacific, Suva).

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ABSTRACT

The Republic of Kiribati, comprising 33 atolls and reef islands, is unique in having the largest Pacific atoll population and the largest concentration of urban dwellers in the Pacific atoll groups. Because of uneven distribution, this population is severely taxing the environment, particularly on Tarawa Atoll. The island nation is attempting to strike a balance between modern aspirations and the need to develop limited resources in a sustainable way. The challenges of small size, remoteness, geographical dispersion, vulnerability to drought, and a highly limited internal market are of significance to the human ecology. While Kiribati benefits from aid and remittances and from other rent opportunities, including fishing licenses and income derived from the Revenue Equalization Fund (a legacy of phosphate mining on Banaba), it is also aiming to further develop its fisheries and, to a lesser degree, diversify local agricultural production in the hope of achieving greater economic independence and improve local nutrition. Future development of the primary sector cannot be divorced from wider concerns such as improvements in transport and storage infrastructure, resource management, pollution, coastal erosion, water quality control, renewable energy production, family planning, and global warming.

INTRODUCTION

It has been more than 40 years since R. L. A. Catala published his seminal work on the human ecology of the Gilbert Islands (now Kiribati) (Catala, 1957). A number of reports on these atolls and reef islands have subsequently appeared in *Atoll Research Bulletin* mainly focusing on physical geography and natural history but also including important human/environment studies such as Thaman's (1990) description of agroforestry and several reports on the state of marine resources (Beets, 2001; Johannes and Yeeting, 2001; Paulay, 2001; Tebano and Paulay, 2001). The Tarawa Lagoon Project, a major interdisciplinary environmental assessment survey (Abbott and Garcia, 1995)

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has contributed to our understanding of human/environment relationships on the main atoll. There are also case studies on social change of individual communities (Geddes, 1983; Geddes et al., 1982; Lawrence, 1983; Lundsgaarde, 1966; Sewell, 1983; Watters and Banibati, 1984) and an analysis and synthesis of socio-economic issues (Van Trease, 1993).

Although still regarded by some observers as one of the most traditional areas of Micronesia, the Republic of Kiribati has witnessed accelerated environmental and social change during the last decade. These changes would probably have gone unnoticed to the rest of the world were it not for media attention on the effects of climate and sea-level variability and the publicity surrounding the millennium celebrations on remote Caroline Island, renamed Millennium Island.

Fieldwork conducted by the author between 1993 and 2001 on several atolls focused primarily on marine resources exploitation but also covered issues on tenure systems and, more recently, agricultural production. It was realized, however, that new data needed to be integrated to wider themes, perhaps because on small, resource-poor islands with a burgeoning population the human ecological linkages are more narrowly defined than in other settings. Thus, this report attempts to cover a range of interrelated topics on past and more recent human experiences on these far-flung coral islands of the central Pacific.

PHYSICAL SETTING

Geography and Geology

Kiribati consists of 33 atolls and reef islands spread over an area exceeding 5 million km^2 of ocean straddling the equator between 04°43' N and 11°25' S latitude and between 169°32' E and 150°14' W longitude. The total land area, however, only slightly exceeds 800 km^2 (Fig. 1).

The Gilbert Islands are a group of 16 atolls and slightly raised limestone islands without lagoons. Banaba (Ocean Island), which lies some 400 km west and attains a maximum elevation of 81 m, is often considered to be part of the archipelago as a result of intensive social and political interaction with the Gilberts in recent history. The Gilbert Islands are spread over 640 km on both sides of the equator at the southeastern edge of Micronesia between 03°30' N and 02°45' S latitude and between 172°30' E and 177°00' E longitude. The total land area for the group is 279 km^2. Three subgroups within the Gilberts can be distinguished on the basis of rainfall: (i) north (Makin and Butaritari); (ii) center (from Marakei to Aranuka); and (iii) south (from Nonouti to Arorae) (Catala, 1957). Tarawa is the seat of government and main commercial center; the southern portion of the atoll includes a mixture of rural and urbanized sections. About 1,480 km east of the Gilberts lies the Phoenix Group, a cluster of eight largely uninhabited atolls and reef islands. Further east are the Line Islands including Kiritimati (Christmas Island) situated some 3,330 km from Tarawa and 2,100km southeast of Honolulu. Kiritimati is the world's largest atoll in terms of contiguous landmass (388 km^2) accounting for almost half of Kiribati's dry surface but only about 4% of the population, which is concentrated in the Gilbert Group and especially on South Tarawa.

Lagoons range from almost total enclosure, as at Marakei, to the wide-open atolls of Nonouti and Tabiteuea. In comparison to the Marshalls and Tuvalu, lagoons in the Gilberts are relatively shallow (Richmond, 1993).

Climate

Most of the Gilbert Islands and several of the Line and Phoenix Islands are located in the dry belt of the equatorial oceanic climatic zone. Islands located within 5° of the equator normally experience two wet seasons as the Intertropical Convergence Zone (ITCZ) crosses the region twice a year (Sturman and McGowan, 1999). However, rainfall is extremely variable, both annually and between islands being strongly influenced by El Niño Southern Oscillation (ENSO) events. Precipitation ranges from about 3,000 mm in the north (Butaritari) to 1,110 mm in the south (Tamana) in the Gilbert Group and from about 4,000 mm (Teraina) in the Line Islands to less than 800 mm in Kanton (Phoenix Group) (Burgess, 1987; Hoare, 1996-98). Prolonged droughts are common, notably in the central and southern Gilberts, many of the Phoenix Islands, and Kiritimati. Hurricanes are rare. Temperatures show little seasonal differences. Daytime maxima are high, averaging between 31° and 33° C., although humidity is more variable among the various islands.

Soils and Hydrology

The highly alkaline and coarse-textured, coral-derived soils of Kiribati are among the poorest in the world. They are typically shallow with very low water-holding capacity, little organic matter, and low available macro- and micronutrients apart from calcium, sodium, and magnesium (Thaman, 1992). Because the soils are alkaline, fertility is dependent on organic matter for the concentration and recycling of plant nutrients and for soil water retention in excessively well drained soils. Organic carbon values for subsoils are always low (< 0.5%) unless there has been considerable disturbance such as that associated with the digging of *babai* or swamp taro (*Cyrtosperma chamissonis*) pits. Phosphate soils, which were once extensive on Banaba, are found in scattered locations throughout Kiribati. These brown-red soils are also slightly more acidic than the surrounding areas and originated from guano deposits accumulated over long periods of time under groves of *buka* (*Pisonia grandis*), a favored seabird rookery tree.

Because of their small size, low elevation, and the porosity of the coral bedrock, there are no surface streams. Instead, rainfall soaks through the porous surface soil creating a lens (Ghyben-Herzberg lens) of often slightly brackish freshwater floating on higher density saltwater beneath it and accessible by digging wells. Apart from small amounts of water that may be collected from coconut palm fronds and trunks during precipitation, the lens is the only source of freshwater. More recently, concrete cisterns have ensured the storage of rainwater. Generally, salinity decreases from both lagoon and ocean beaches towards the center of islets. The location and degree of groundwater development influences the nature of the vegetation, as well as the location of the village wells and cultivation pits. Unchecked urbanization and population growth on South Tarawa have resulted in sewage seeping into the groundwater at several locations.

Of concern for the future of human settlement, including access to drinking water and agricultural production, is the threat of global warming and associated rise in sea level (Nunn, 1993). Sea-level rise leads to contamination of soil and water tables with salt, severely limiting yields of sensitive crops, as evidenced by abandoned *babai* pits (Sullivan and Gibson, 1991: 26-27).

ARCHAEOLOGY

Compared to research carried out elsewhere on the Pacific, prehistoric archaeology in Kiribati with an emphasis on excavations and the use of radiometric dating techniques is a recent endeavor. Much of this work has focused on culture history and the typological approach, expanding on earlier surveys in the 1930s (Carson, 1998; Di Piazza, 1999; Emory, 1934; Lampert, 1968; Sinoto, 1973; Takayama, 1988; Takayama and Takasugi, 1987, 1988; Takayama et al., 1989, 1990; Throssell and Specht, 1989), suggesting an initial settlement of the Gilbert group from eastern Melanesia early in the first millennium AD (see also Irwin, 1992: 121-123; Pawley and Ross, 1993). This time frame appears consistent with dates obtained from the neighboring Marshall Islands (Weisler, 1999b). While earlier presence of human occupation is plausible, it might have been constrained prior to about 2,000 years ago by the absence of stable islets as suggested by dated beach rock in the Marshalls although McLean (1989: 16) argues for a period of reef- islet formation beginning around 3,500 years ago.

Data for mid- to late-Holocene higher sea level stands have been presented for a number of Pacific islands (for a review see Nunn, 1998: 243). For the Gilberts, Schofield (1977) proposed a high sea-level stand of +2.3 m as late as 1040 BP. However, most of the dated material appears to derive from cemented storm deposits having an uncertain exact relationship to a mean sea-level position (Marshall and Jacobson, 1985).

All of the Phoenix and Line Islands were uninhabited when first discovered by Europeans and have subsequently been referred to as "mystery" islands, joining other similar entities such as Pitcairn, Henderson, Nihoa and Necker, and Norfolk (Cleghorn, 1988; Diamond, 1985; Weisler, 1995). Several of these islands have yielded evidence of past human occupation. This has prompted researchers to investigate the reasons for abandonment by adopting a more ecologically oriented perspective to study the past (Di Piazza and Pearthree, 2001a; see also Thomas, 2002a for a behavioral ecological analysis of subsistence activities in the Gilberts).

Using a regional approach to understand island settlement and abandonment, Di Piazza and Pearthree (2001a) proposed the concepts of "mother communities", "satellites", and "isolates", and concluded that resource scarcity and/or isolation resulting in abandonment were explanations limited to those islands that were relatively inaccessible, small, and/or dry. Some islands appeared never to have been inhabited, perhaps because they were too marginal in terms of water availability or because their fringing reefs prevented effective fishing. Mother communities with high rainfall, such as Tabuaeran, once supported relatively large resident populations supported by a rich agricultural base. These communities periodically exploited nearby satellites (e.g., Kiritimati) which, despite their drier appearance, were located within an overnight

voyage of a richer land and offered attractive faunal resources, especially seabirds and turtles. While the demise of mother communities remains problematic, it is becoming increasingly obvious that settlement extinction need not be explained solely in terms of environmental crunches. The occurrence of exotic basalt, together with the abundance of timber on certain islands for canoe building, should serve as a reminder that populations were capable at any time of migrating to other archipelagos.

Evidence shows that present coastal sediments on Kiritimati were exposed by 3000 BP, and that the atoll might have been suitable for human settlement throughout the period of human colonization in Remote Oceania (Anderson et al., 2000). However, C14 dates from several sites cluster between AD 1200-1600 with most radiocarbon determinations centered in the early 15th century. Di Piazza and Pearthree (2001b; 2001c) have identified basalt on Manra (Sydney) in the Phoenix Islands and on Tabuaeran (Fanning) in the Line Group derived from the Tataga Matau quarry on Tutuila in American Samoa and from Eiao (Marquesas). These materials were transported over distances of 1,075 and 2,425 km, respectively.

DEMOGRAPHY

I-Kiribati (indigenous Gilbertese Micronesians) population numbers in the early period of Western contact are difficult to estimate. There is some evidence that people were aware of the problem of overpopulation and consequently devised various strategies to limit growth so as not to outstrip resources (Bedford and Macdonald, 1982).

As with all other Pacific countries, contact with the outside world brought about important demographic and social changes. In the first instance, local populations declined as a result of introduced diseases, blackbirding, and civil unrest spurred by political, economic, and religious rivalries (Bedford et al, 1980; Maude and Maude, 1981). Since the end of World War II, however, populations have increased dramatically (Table 1), while mortality has declined because of improvements in health care and access to food imports to counter the effects of drought, the most significant environmental hazard in Kiribati. However, dependency on these same imports, particularly in urban areas, has led to a rise in noncommunicable, nutritionally related diseases.

The population, having reached close to 84,500 in 2000, is unevenly distributed with about 93% living in the Gilbert Group. More than one-third of the total population lives on the islets of urbanized South Tarawa on some 16 km² of land. Averaged over the entire nation, the population density is 116 per km²; however, South Tarawa has a density of over 2,330 per km², with more than 6,000 per km² on Betio Islet. The average annual rate of natural population increase is 2.5%. At this rate, the population is expected to double in less than 30 years. The population is young, with 40% under 15 years and a median age of 20 years (CIA, 2001; Ministry of Finance 2001; South Pacific Commission, 2001).

Protestant groups tend to be smaller than Catholic families, the rate of growth poses a serious threat to living standards (Pollard, 1987). To partly alleviate population pressure,

Coastal erosion resulting from the construction of causeways and bacterial contamination of groundwater and lagoon shellfish beds linked to overcrowding are acutely felt in the fragile atoll environment (Connell, 2000; Connell and Lea, 1999; Doumenge, 1999; SOPAC, 2000). A large urban population also contributes to depletion of water reserves. Since the 1998 drought, desalinization units have been used to supplement the drinking water supply.

HEALTH

In a twist of irony, modernization, which has contributed to improving people's lives by fighting certain infectious diseases and increasing life expectancy, has also created new health hazards. Participation in the world economy has been accompanied by a rise in "lifestyle" diseases, particularly those associated with nutritionally inferior food imports, such as low-fiber bread and rice, refined sugar, tinned meats, and soft drinks. These food imports have decreased the healthy former diet, including the coconut sap-derived *kamaimai* drink rich in vitamins and nutrients, not many years ago a staple family drink. With more people living longer and birth rates remaining high, small island nations such as Kiribati must deal with overcrowding, particularly on South Tarawa. One direct consequence of this phenomenon is increasing groundwater contamination and a higher incidence of diarrheal diseases. Another hallmark of globalization is the spread of HIV/AIDS infection. According to statistics, acute respiratory infections, wounds and sores, and diarrheal diseases are the top three causes of morbidity in Kiribati. Cardiovascular conditions, originating in the perinatal period, and liver disease are the leading causes of death (WHO, 1999). Contamination of the freshwater lens and lagoon nearshore and seagrass areas by human and animal waste products led to the 1977 cholera outbreak on Tarawa (Danielson et al., 1995; Naidu et al., 1991: 77). To this day, diarrhea and related health issues continue to plague residents and certainly account for the high infant mortality rate (62/1,000 live births) – the second highest in the Pacific after Papua New Guinea (WHO, 1999; South Pacific Commission, 2001). Phillips (1995) noted that the consumption of raw or partially cooked shellfish contributes to illness and was of the opinion that, since people apparently find diarrhea so common, they do not associate it with sickness. Safe water and adequate sanitary facilities usage is a pressing problem with only about half of Kiribati's residents currently having access to both (WHO, 1999).

In addition to ciguatera poisoning (Tebano and MacCarthy, 1991), which directly affects the export of live reef-food fish as well as domestic sales, it was determined that the handling of fish after capture caused serious health risks. For example, the sale of ungutted fish is ubiquitous on Tarawa. There is a belief that ungutted fish are preferable for reasons of aesthetics and flavor, but there is little awareness of the relationship of gut and gill bacteria to spoilage. The problem is compounded by improper use of the extremely limited ice supplies. Novaczech and Chamberlain (2001) report that up to 1.5% of the population are sent to hospitals with fish poisoning every year and rates may be as high as 7% on individual islands although it is not clear how many cases can be attributed to ciguatera versus illness by spoilage.

Tobacco smoking is prevalent. Nearly three-quarters of adults are regular smokers, of which 95% are young males between 20 and 24 years old (Corrao et al., 2000). Thirty-three HIV positive cases have been confirmed so far (WHO, 1999).

Overview of Dietary Situation

As in many other Pacific Island nations, overall nutritional standards in Kiribati have been steadily declining. The root of the problem lies with changing lifestyles associated with urbanization and in food dependency fostered by foreign aid and private remittances, threatening local food-producing activities and general health standards in the region. (Dahl, 1996; Parkinson, 1982; Thaman, 1982). Food remains the prominent import item in Kiribati, totaling 17 million Australian dollars (Ministry of Finance, 1998).

Investment in a limited range of cash crops, together with urbanization, has contributed to a decline of traditional crops and thus a balanced diet. There is clear evidence that westernization and urbanization of Pacific Island populations have resulted in an increased incidence of several noncommunicable diseases, including diabetes, obesity, gout, hypertension, coronary heart disease, stroke, and certain cancers (Coyne, 2000: 14; Thaman, 1988). Dependence on nutritionally inferior food imports among growing segments of island populations is largely responsible for declining health standards. In Kiribati, between 1992 and 1998, there has been a steady increase in the number of reported hypertension and diabetes cases, which appear clearly related to rapid urbanization (Ministry of Health and Family Planning, 1998; Pargeter et al., 1984: 18). For a number of years, there has been a trend towards vitamin and mineral deficiency, especially on South Tarawa. Iron-deficiency anemia, vitamin A-deficiency-induced eye problems, and deficiencies in B-group vitamins are now regarded as serious in both urban and rural areas (Christensen, 1995; Schaumberg et al., 1996).

Inshore fishing provides the bulk of protein for the vast majority of *I-Kiribati*, even on South Tarawa. The proportion of fresh fisheries resources caught and locally consumed ranks among the highest in the Pacific region. Coastal fish catch/capita is close to 160 kg annually, surpassed only by New Zealand (Adams et al., 1999: 367). Although most households go out fishing and some sell part of their catch, they occasionally buy fresh fish as well. Tinned fish and tinned meat are readily available but most *I-Kiribati* prefer the taste of fresh fish, which are relatively cheap. Despite the wide availability of local marine products, undernutrition related to protein deficiency was found in 7% of preschool children and 69% of pregnant women (WHO, 1998).

South Tarawa faces the additional problem of land shortage which has discouraged local food production resulting in poor diets due to a switch from generally more nutritious local foods to imports high in fat, sodium, and sugar (Kienene, 1993; Lewis, 1988).

ECONOMY

The Asian Development Bank (ADB) (2000: 1) provides the following assessment of Kiribati's economic performance:

Except for a period of accelerating growth from 1994 to 1998, primarily due to expansionary government spending, economic growth in Kiribati has been relatively poor since independence. In 1999, real gross domestic product (GDP) is estimated to have increased only by 1.7 percent. The public sector continues to dominate the economy, accounting for about three-quarters of monetary GDP at factor cost. The combination of sluggish economic growth with an inability to provide adequate services to a growing population concentrated in South Tarawa has left Kiribati eighth amongst ADB's 12 Pacific developing member countries in terms of the Human Development Index.

As a "micro state", Kiribati presents unique challenges to development planners. The country is not only constrained by limited size but also by a host of other environmental and geographical factors including remoteness, geographical dispersion, vulnerability to natural disasters, and a highly limited internal market (Baaro, 1993; Briguglio, 1995; Liew, 1990; Shand, 1980).

With few opportunities for economic expansion in view of their restricted size and natural resource availability, small labor force, and low GDP, and thus restricted market size, small island nations have had the option to look outward by embracing the *MIRAB* approach to economic development by relying on Migration (of factors of production), Remittances/Aid (financial transfers), and Bureaucracy (non-tradable production) (Bertram and Watters, 1985). The *MIRAB* model of economic development highlights the importance and, some would argue, the necessity of such an approach to ensure the levels of expenditure are sustained. As Bertram (1999: 345) succinctly put it: "In a MIRAB economy, the indigenous population maximize their material well-being by means of globalization".

Despite current indications that the *MIRAB* model runs consistently, and apparently sustainably, ahead of local productive activity as measured by GDP, there is cause for concern regarding an over-reliance on such a model in light of fluctuations in the global economy, the reduced strategic importance of the Pacific Islands with the end of the Cold War, and the options that are available to "micro states" having different political status (Brown, 1992; Cameron, 1997; Gibson, 1993; Laplagne et al., 2001; Schoeffel, 1996: 23; Wartho and Overton, 1999).

Kiribati was granted independence in 1979 shortly after the British exhausted phosphate mining deposits on Banaba. This industry contributed about 85% of export earnings, 45% of GDP, and 50% of government revenue (Thistlethwait and Votaw, 1992: 30). Since then, copra and fish remained the main source of foreign exchange earnings but earnings from the former have fluctuated widely in recent years (Lawrence, 1985). Since independence, however, Kiribati has moved towards the *MIRAB* model of economic development by relying heavily on foreign aid and remittances by migrant workers, accounting for more than US$7 million (Bertram, 1999: 341). As mentioned earlier, remittances will likely diminish while migration options remain limited. Foreign aid is likely to continue, albeit with diminishing resources, as donors seek greater

accountability. The public sector remains a significant employer but is unable to absorb a growing number of young people, many of whom lack the appropriate training, education, or experience. The agriculture, and especially the fisheries sectors, could provide alternative sources of livelihood for migrants. However, to cater for an increased population, new forms of sustainable land- and marine-use systems need to be worked out for production of both traditional and exotic crops as well as fisheries products.

Although Kiribati falls squarely within the *MIRAB* approach, some 80% of the people are engaged in subsistence production and the sale of primary products (AusAid, 2001). This apparent contradiction can be explained by the position of households along a continuum ranging from those that are almost exclusively cash-based to those where there is only minimal cash to alleviate subsistence. Moreover, households are not consistently located at the same point in the spectrum as a result of changes in their composition and individual circumstances. Even on South Tarawa, the traditional domain remains strong among households with one or more wage earners. These households often include several extended family members who share domestic duties and subsistence cropping or fishing but also make a cash contribution through commercial fishing or the manufacture of handicrafts (Macdonald, 1998).

While recognizing the challenges posed by "smallness" to further economic expansion, successive governments have perceived marine resources development, particularly living resources, as a means of attaining greater economic independence or self-reliance. With its vast exclusive economic zone (EEZ), Kiribati has thus relied heavily on rent derived from fishing royalties, notably from East Asian countries, because of inadequate local infrastructure to exploit the fisheries sector efficiently. Consequently, the *MIRAB* economy is being perpetuated although fishing royalties, together with income from the Revenue Equalization Reserve Fund (RERF), a legacy of phosphate mining, and payments made by the Japanese Space Agency on Kiritimati, illustrate the positive side of a strategy which seeks to diversify rent opportunities. Assets from the RERF amount to US$370 million, equal to 33% of GDP. The RERF, together with fishing license revenue and remittances, make up almost half of Kiribati's national income (Asian Development Bank, 2000).

The two sectors of primary production – agriculture and fisheries – differ in their outputs with fisheries exceeding local agriculture, with the exception of copra for export, because of environmental constraints affecting the latter. However, there are good prospects to increase and improve agricultural production. Together with the development of nearshore fisheries exports and mariculture, agriculture could provide more opportunities for employment while reducing dependency on food imports.

AGRICULTURE

As a result of restricted landmass, distance from continents, the relatively young geological age of the atolls and reef islands, and harsh environmental conditions, there are estimated to be only 83 indigenous plant species in Kiribati (Gilbert group), none of which are endemic. Eight plants are presumably aboriginally introduced and the total sum

of vascular plants ever reported is believed to be approximately 306 species including exotics and weeds (Fosberg and Sachet, 1987; Thaman, 1987).

Aboriginal introductions include the giant swamp taro (*Cyrtosperma chamissonis*), taro (*Colocasia esculenta*), giant taro (*Alocasia macrorrhiza*), yam (*Dioscorea* spp.) two breadfruit species (*Artocarpus altilis* and *A. mariannensis)* in addition to a hybrid of the two) and Polynesian arrowroot (*Tacca leontopetaloides*) (Thaman, 1990). Screw pine (*Pandanus tectorius*) is considered both indigenous and of aboriginal introduction given the diversity of local cultivars. The coconut (*Cocos nucifera*) may also have a dual origin. Four of these cultivars (coconut, screw pine, breadfruit, and swamp taro) played a major role in the precontact diet and in many ways continue to do so (Fig. 2). The Pacific fig (*Ficus tinctoria*) was also relied upon as a staple, together with screw pine, on the drier islands in the south (Parkinson, 1955). Despite constraints to agriculture in an atoll environment (Small, 1972), traditional cultivation techniques in Kiribati (and other atoll locations) showed a high degree of sophistication (Baiteke, 1994; Tofiga, 1985). Thaman (1990; 1993a) stressed the importance of a tree-crop-based multistory farming system. Arboriculture – the culture of trees – is a distinguishing characteristic of the earliest agriculture in the Pacific Islands and is still a prominent feature of the Kiribati landscape, even in urbanized settings. Agroforestry is described as a sustainable system of food production by virtue of the relative permanence of land use providing a wide range of subsistence needs, with crops receiving little direct cultivation beyond occasional mulching and replanting (Vergara and Nair, 1985). However, since the end of World War II, the Pacific has witnessed accelerated removal of trees. This process began during the colonial period with the establishment of monoculture, resulting in a simplification of forest cover to make room for cash crops (e.g., coconut plantations). Other factors that have contributed to agrodeforestation include rapid population growth, increased demand for fuel, continued urbanization, and development projects affecting the environment in negative ways (Thaman, 1994). Some countries have reacted to these threats by planting and protecting trees and forests. Multi-species agroforestry development provides hope for the sustainable use of local resources while lessening dependency on expensive imports and reverses the trend leading to a further deterioration of nutritional health throughout the region. The preservation of agroforestry is in turn linked to biodiversity conservation, including ecosystem diversity, species and taxonomic diversity, genetic diversity, and ethnobiological diversity (Thaman, 1993b). In regard to the latter, there is a wide range of ecological and cultural functions and uses of trees besides food, such as provision of shade, soil improvement, construction material, fuelwood, and medicines, to name a few.

Figure 2. Toddy cutting, North Tarawa (photo F. Thomas).

Another important traditional food-crop system now generally in decline is the pit cultivation of the giant swamp taro (Luomala, 1974; Fig. 3). Like arboriculture, aroid pit agriculture has a long sequence in the history of atoll settlements (Weisler, 1999a). Up to 24 cultivars have been identified in Kiribati (Ali and Asghar, 1987). Swamp taro is capable of producing sustained yields of staple, starchy food. Some varieties, grown mainly for prestige and ceremonies, may be cultivated for 10 to 15 years. With the widespread use of rice and flour, together with salinization of the water table, consumption of swamp taro has decreased. On South Tarawa and parts of North Tarawa, the taro beetle (*Papuana huebneri*) has also contributed to the abandonment of the majority of pits.

Figure 3. Swamp taro pit, North Tarawa (photo F. Thomas).

Despite limited land and poor soils, agriculture has a significant role to play in the economy of Kiribati in the achievement of increased copra production. In 1998, 7,577 metric tons were exported worth A$4.5 million, compared to fish exports with a value of A$1 million (Ministry of Finance, 1998). With its restrictive environment, the possible avenues for development of commercial agriculture are few. However, the agricultural sector could place more emphasis on local food production as a strategy for reducing imports as well as search for specialist foods or products that might contribute as minor exports. Examples of the latter include coconut cream and the Indian mulberry fruit (*Morinda citrifolia)*. To help attain these goals, the Agricultural Division within the Ministry of Natural Resources Development (MNRD), in cooperation with the Foundation of the Peoples of the South Pacific (FSP), began to focus in the mid-1980s on exotic food plants capable of growing well under harsh atoll conditions. On South Tarawa, 'mixed gardens' (Peduzzi, 1999) have essentially taken root at Bonriki Village where about 40 smallholder farmers work. In addition to fruits and vegetables (Table 2), sampled households at Bonriki revealed that the following tree crops were being planted and/or maintained: coconut, screw pine, Indian mulberry - mainly for medicinal purposes -, breadfruit, papaya (*Carica papaya*), and Pacific fig (Thomas, 2002b).

Although mixed subsistence-cash cropping of exotic fruits and vegetables on South Tarawa is mainly confined to Bonriki (in large part because of the relatively extensive tract of land and low population density on the ocean side next to the airport runway), it shows that, with some effort and organization, atolls need not depend solely on food imports. In addition to contributing to the rise of noncommunicable diseases, food imports result in the loss of foreign exchange earnings which could be spent more wisely on improved health care, education, and other development projects (cf. Thaman, 1983: 3). It is obvious that local food production alone, including the intensification of

Table 2. Crops planted by 20 sampled farmers and frequency occurrence of the crops (from Thomas, 2002b).

Crops (English Name)	**Scientific Name**	**Frequency Occurrence (# of households)**
Chinese cabbage	*Brassica chinensis*	20
Pumpkin	*Cucurbita pepo*	20
Tomato	*Lycopersicon esculentum*	17
Watermelon	*Citrullus vulgaris*	15
Cucumber	*Cucumis sativus*	13
Rockmelon/cantaloupe	*Cucumis melo cantalupensis*	9
Chilli	*Capsicum frutescens*	8
Eggplant	*Solanum melongena*	4
Bell pepper	*Capsicum annuum*	4
English cabbage	*Brassica oleracea capitata*	3
Swamp taro	*Cyrtosperma chamissonis*	2
Chinese broccoli	*Brassica alboglabra*	1
Hibiscus spinach	*Hibiscus manihot*	1

traditional agroforestry, will never be capable of supporting current population numbers. Agricultural production could increase significantly if unemployed and underemployed individuals were encouraged to take up farming in their home gardens (Thaman, 1995), adding exotic fruits and vegetables to the existing agroforestry system as evidenced by a few existing gardens scattered throughout densely settled urban areas. However, there is little doubt that increasing salinization of the water table will severely curtail plans for agricultural development. There are also important cultural barriers to be aware of such as the widespread perception among *I-Kiribati* that green leaves, papayas, and other introduced foods rich in vitamin A should be reserved as pig or famine food while pumpkins and vegetables are commonly not valued as food (Schoeffel, 1992: 233-234). On the other hand, local-level mariculture and lagoon restocking with giant clams (Tridacnidae) may offer one possible solution to this type of problem. This is because of the presence of zooxanthellae in the clam's mantle, accounting for higher vitamin A content than that in other shellfish. As giant clams are widely esteemed in Kiribati,

As several nonfarming respondents indicated, agriculture requires a degree of constant care and thus does not appear attractive to many people. Limited cash is therefore spent on rice, flour, and a few other commodities that can be easily prepared and stored. Pollard (1987) identified the maintenance of an exchange rate determined by the value of the Australian dollar as a factor undermining local food production, thus permitting high and increasing levels of food imports. Outer island food production destined to the South Tarawa market is faced with the additional problem of unreliable transportation links. Despite these challenges, the Agriculture Division remains committed to improving transport, disease/pest control, and marketing skills for those farmers intent on supplying the domestic market (National Development Strategies, 2000). It is also important to balance off the needs for maximizing and protecting groundwater resources and maximizing overlying crop production.

FISHERIES

Fishing continues to occupy a prominent place in the lives of most *I-Kiribati.* Lagoon fishing involves both net- and line-capturing methods. Ocean fishing commonly focuses on Scombridae, notably skipjack tuna (*Katosowonus pelamis*) and yellowfin tuna (*Thunnus albacares*) as well as flying fish (*Cypselurus spp.*). Spearing is also practiced on a number of species. Fish traps, made from coral blocks, are impressive architectural features at low tides, located on ocean-side reef flats and in passages. They may extend up to 100 m in length and stand about 1 m high. Some families and villages raise milkfish (*Chanos chanos*) in specially designed enclosures located near the lagoon or in small inland pits excavated down to the water table. A number of invertebrates can also be found. While there are still gaps in our knowledge of species diversity in Kiribati, the total number of shellfish is undoubtedly comparable to the approximately 1,000 species recorded in the Marshall islands (Kay and Johnson, 1987).

Exclusive Economic Zone

With an EEZ covering more than 3.5 million km^2 – the second largest in the world – it is not surprising that the fisheries sector in Kiribati is seen as both a source of essential livelihood at the subsistence level and as a means of generating revenue by promoting the country's seemingly vast store of marine resources (Thistlethwait and Votaw, 1992: 28-29).

The licensing of fishing vessels belonging to Distant Water Fishing Nations (DWFNs), through multilateral treaty arrangementS, contributes highly variable returns which are largely affected by weather conditions, notably El Niño and its reverse, La Niña. For example, license revenues fell from A $40.3 million in 1998, as the impact of El Niño was felt, to A$31.8 million in 1999 during La Niña to A$17.2 million in 2000 (National Development Strategies, 2000). The main species taken are the pelagic, migratory skipjack and yellowfin tuna. Up to 40% of the world's annual tuna harvest currently originates in the central and western Pacific region — in part due to the fact that

other areas have been over-fished — (Kawaley, 1999:350). Kiribati also lacks adequate onshore facilities to attract higher levels of tuna transshipment by foreign vessels. The EEZ is believed to contain potentially significant resources of manganese nodules and cobalt crusts on the seabed but, for the moment, an economically viable operation has yet to emerge (Teiwaki, 1988: 119-140). Kiribati is also seeking to develop its local fishing industry. To achieve this goal, however, important obstacles need to be surmounted such as the cost and availability of fuel, distance to markets, and competition against efficient, capital intensive DWFNs (Kearney, 1980).

Inshore Exports and Mariculture

The exploitation of Kiribati's EEZ for accrued benefit to the people of this island nation highlights the need for improved technology skills, information, and financial resources. Dolman (1990) argued that for small-island developing countries, 12 nautical miles are generally preferable to 200 nautical miles of biologically unproductive waters and highly migratory species. He further stated that the goal should be in terms of saving foreign exchange rather than generating it and to reduce dependency rather than seeking a place in a highly competitive market. The Government of Kiribati has acknowledged that inshore and mariculture development and the promotion of artisanal fishing could bring about economic improvement while lessening dependency on foreign aid. The government has reported increases in marine product exports (Table 3). In addition to fish, the specialized aquarium-fish market fetched almost A$1 million in 1998. Other important fisheries products include seaweed (with earnings exceeding half a million dollars in 1998) and bêche-de-mer (close to A$500,000 during the same period) (Ministry of Finance, 1998).

Table 3. Fisheries export value by commodity: 1987-1998 (A$'000). Courtesy Ministry of Finance, Tarawa.

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Fish	823	1606	2600	964	277	363	513	263	266	211	110	1058
Aquarium fish	0	0	0	0	336	258	533	551	817	639	698	932
Shark fins	16	18	42	32	24	118	123	175	659	194	94	129
Seaweed	62	15	85	723	676	286	217	297	176	382	373	626
Bêche-de-mer	0	0	0	0	0	0	685	764	379	769	268	483

Plans are underway to produce and market black pearls by smallholders on some of the outer islands and to develop a sustainable baitfish industry based on milkfish on South Tarawa.

The trade in aquarium fish was initiated on South Tarawa during the 1980s but was subsequently moved to Kiritimati because of its proximity to market centers in Honolulu. There has been a growing interest by the private sector in this lucrative trade since its establishment on Kiritimati (Kiribati Fisheries Division, 1999).

Seaweed is another high-value niche product inevitably subjected to world price fluctuations and destruction due to weather. Seaweed farming provides the major raw material for carrageenan which has widespread applications such as in processed foods, textiles, air fresheners, and pharmaceuticals. As a mariculture project, seaweed farming has already proven its worth in the Pacific (South, 1993).

Two species of seaweed, *Eucheuma alcarezii* and *Eucheuma spinosium*, were introduced to Kiribati in 1977 from the Philippines. The former species was found to thrive better under local conditions (Kiribati Fisheries Division, 1999). Tabuaeran and Abaiang have emerged as the major producers subsequent to failures of pilot projects on Tarawa. These failures were attributed to competition from other uses of the lagoon, particularly shellfish collecting by a growing number of urban migrants (Schoeffel, 1996: 80). In the early 1990s, some 2,000 smallholders, or nearly half the population of Abaiang, were growing seaweed (Tikai, 1993: 171). Seaweed production for the Gilberts in general has declined significantly, however, from a high of 1,019 metric tons in 1991 to a mere 12.2 metric tons in 2001 (Atoll Seaweed Co., 2001). The increasing frequency of westerly winds associated with El Niño has in effect discouraged many households to further invest in an activity considered high risk in an essentially risk-averse subsistence environment (Neemia-Mackenzie, 1998). Additional research into more weather-resistant varieties of seaweed, together with better monitoring of suitable growing sites, are being considered.

Despite the above difficulties, seaweed farming can contribute substantially more income to smallholders than copra production. A farmer can produce several crops per year yielding close to 25 tons of dry seaweed per hectare with minimal capital. While seaweed is still regarded as an export crop, there is potential to include it in the local diet particularly in efforts at reversing the effects of vitamin A and other vitamin and micronutrient intake problems. However, as with green vegetables, marine plants are still generally avoided for cultural reasons.

Trade in bêches-de-mer (holothurians), which is one of the first export products from Kiribati after Western contact, reached a peak of 125 tons in 1996 dipping to less than 15 tons in 1997. This drop is due to over-exploitation (Kiribati Fisheries Division, 1999). Of the 13 species that have been identified, four are considered to be of high value for the Asian market.

The production of black pearls derived from the black-lipped pearl oyster (*Pinctada margaritifera*) is one of the most recent mariculture projects in Kiribati. Cultured black pearls have become the most important export commodity among marine products in French Polynesia and the Cook Islands. This has led to concerns over possible declining profitability, perturbation of lagoon ecosystems, and growing tenure disputes (Rapaport, 1995).

The feasibility of producing and marketing black pearls in Kiribati has been the focus of considerable research and development. Research trials and pilot operations have been successfully carried out. Within the next few years, MNRD is expected to complete a feasibility and business plan for privately operated enterprises and then begin implementing a strategy for transferring the technology and business approach to the private sector (National Development Strategies, 2000). Given the level of pearl-farming development in French Polynesia and the Northern Cook Islands, it is hoped that Kiribati will learn from these experiences (Macpherson, 2000).

The need for mariculture of baitfish based on milkfish has been recognized in view of low wild-bait stocks. Cultured baitfish are to be exported primarily to support the licensed foreign long-line tuna fleet. Part of the output would also be sold on the Tarawa market. One problem faced in this connection is the infestation of fishponds with a predator, the introduced Malayan mosquito fish or tilapia (*Oreochromis* spp.) (National Development Strategies, 2000). When a visiting consultant to assist the local population in its protein requirements introduced tilapia, it resulted in the destruction of the milkfish in most of the ponds. As tilapia is not eaten, nor appreciated, due to its nonsalty taste, it is considered a serious pest.

Artisanal Fishing

In the Pacific, it is difficult to separate artisanal fisheries into commercial and subsistence operations because most communities sell part of their catch (Adams et al, 1999). However, the FAO (1998) reports that the nearshore commercial fish catch in Kiribati is principally made up of reef- and deep-slope fish (54%), shellfish (25%), and pelagic species (21%).

In contrast to agricultural production, nearshore fisheries throughout Kiribati are vigorously pursued. The Outer Island Fisheries Project (OIFP) was initially established with the goal of developing commercial fisheries on the outer islands and to provide a steady supply of fish to Tarawa. With the integration of OIFP and te Mautari Ltd (TML) – the government-owned company set up in 1981 for pole-and-line tuna fishing – to more cost- effectively supply both the export and the South Tarawa markets, the project, now called the Foundation for Integration of Fisheries, is currently targeting reef fish together with tuna (Kiribati Fisheries Division, 1999; National Development Strategies, 2000). Storage facilities and transport between the outer islands and Tarawa need improvement to create incentives for artisanal fishers to sell greater volumes (Neemia and Thaman, 1993).

Shellfish harvesting

Increased fertilization by sewage-driven nutrients appears to be responsible for the expansion of seagrass beds which are good shellfish habitats. Filter feeders exposed to contaminated water are agents of gastrointestinal diseases. With expanding urbanization, there has been a growing demand for cheap, easily gathered resources such as shellfish. While bacterial pollution from overcrowding has ensured for a time the proliferation of filter feeders such as Anadara cockles (*Anadara uropigimelana*), yearly harvest of these bivalves has been estimated at close to 1,400 tons causing concerns about resource

sustainability (Paulay, 2001). Between 1993 and 1994, the roadside sale of Anadara was putting pressure on Tarawa stocks that were once relatively well-protected. Divers possessing any floating device, from a small canoe to a rubber inner tube, and goggles could collect large quantities of bivalves on a daily basis and sell their catch in rice sacks holding up to 34 kg of shellfish. The move by shellfish gatherers from the intertidal sand flats and seagrass beds to deeper sections of the lagoon was itself triggered by declining abundance and size of existing stocks closer to shore (Thomas, 2001a).

The strombid gastropod, *Strombus luhuanus*, is fast becoming the dominant shellfish taxon in Tarawa Lagoon because of gathering pressure on the preferred Anadara. The annual harvest is estimated at 400 tons (Paulay, 2001). The high variability of population density may reflect increased gathering pressure but could also be attributed to patchy distribution, perhaps linked to the snail's high mobility.

Stocks of giant clams have been greatly affected throughout the Pacific as a result of commercial exploitation by foreign vessels (Dawson, 1988). In addition, heavy exploitation to satisfy domestic consumption has led to the virtual demise of the largest taxon (*Tridacna gigas*) around Tarawa while stocks on the outer islands are low (Munro, 1986). There had been plans to culture giant clams for seeding on the outer islands and for restocking some areas of Tarawa Lagoon adjacent to reefs and away from dense human settlements (Kiribati Fisheries Division, 1994) but these were discontinued because of lack of funding.

In Kiribati, as in various other Pacific localities, small specimens (< 40 cm) of *Tridacna gigas* and *Hippopus hippopus* are occasionally carried to shallow lagoon reef flats or deposited in passes adjacent to settlements. In place, they are allowed to grow until ready for consumption (Figure 4).

Figure 4. Giant clam "garden", Abemama (photo F. Thomas).

A smaller, and more abundant species, *Tridacna maxima*, is taken from some outer islands and is the target for supporting a domestic commercial fishery. Fisheries statistics are incomplete, as many of the exploited shellfish (preserved by salting) are carried as personal consignment by boat from Abaiang to be sold on Tarawa.

Fishing on South Tarawa

Concern over the condition of Tarawa Lagoon is not limited to slow-moving animals such as bêches-de-mer and shellfish. Some reef fish are also threatened. The government continues to worry about the lack of an effective management plan for inshore marine resources. Lagoon and reef areas are witnessing increasing levels of

pollution, primarily from human and animal waste, as well as a decline of a host of organisms as a result of over-fishing. A steady growth in the population of South Tarawa and in the availability of outboard motor boats and gill nets has contributed significantly to increased effort and total catch. Catching efficiency has also increased substantially with the introduction of gill nets that are more than 1 km long. The splash-fishing method (*ororo*), whereby fishermen drive fish into long gill nets by splashing the surface of the water with iron bars, may be particularly efficient. During the past two decades, however, several lagoon fish, such as bonefish (*Albula glossodonta*) and spangled emperor (*Lethrinus nebulosus*), have been greatly reduced in number (Beets, 2001; Tikai, 1993: 170). Fish-stock declines can also be attributed to the obstruction of spawning migration routes by causeways, notably in the case of bonefish (Abbott and Yeeting, 1995). While many fishermen were keenly aware of the changes affecting inshore resources, though not necessarily the underlying causes, they were for the most part unwilling to take action -- an example of the 'tragedy of the commons' (Hardin, 1968) whereby fishers fear that if one were to reduce his/her catch others would take that catch instead (Phillips, 1995).

Fishing can be highly lucrative for families with sufficient capital and labor. Households equipped with boats, several nets and fishing lines, as well as insulated cooler boxes, can fetch anywhere between A$200 to A$700/week which is considerably more than what farmers can earn selling their produce, estimated between A$30 and A$100/ week (Thomas, 2002b).

TENURE

Before Western contact, settlements were dispersed, although they were usually close to the lagoon. The basic residential unit (and main social group) was the hamlet (*kainga*) composed of clustered households (*mwenga*) occupied by members of related extended families. Each *kainga* in the central and southern Gilberts owned land and designated marine areas extending in narrow strips from the ocean reef to the lagoon shore or from one ocean reef to the next on raised limestone islands (Atanraoi, 1995; Ruddle, 1994: 90-94) and engaged in economic production and in social exchanges. In the wetter, more productive northern Gilberts, chiefs held the title for an entire island or most of an island but everyone was entitled to live on the land. Swamp taro pits were divided among several *kainga* community headmen. Fishponds belonged to all those who participated in stocking and cleaning them. Fish traps were the property of individual builders and kinsmen who cooperated. Leaders of descent groups had the right to distribute flotsam, stranded porpoises, large fish, and possibly turtles, and to prohibit access to the reef (Maude, 1963). The British colonial administration, established at the end of the nineteenth century, later abolished this type of control in line with the Western concept of public rights in the sea and its resources.

Up until the late 1940s, the colonial government allowed customary marine tenure to prevail for all resources taken from the lagoon and ocean sides. The native Lands Commission subsequently recognized only certain rights, including ownership of fish traps, seawalls, accretions, reclaimed lands, and fishponds (Teiwaki, 1988: 40; Fig. 5). The registration of these rights is usually made in the name of the male head of the

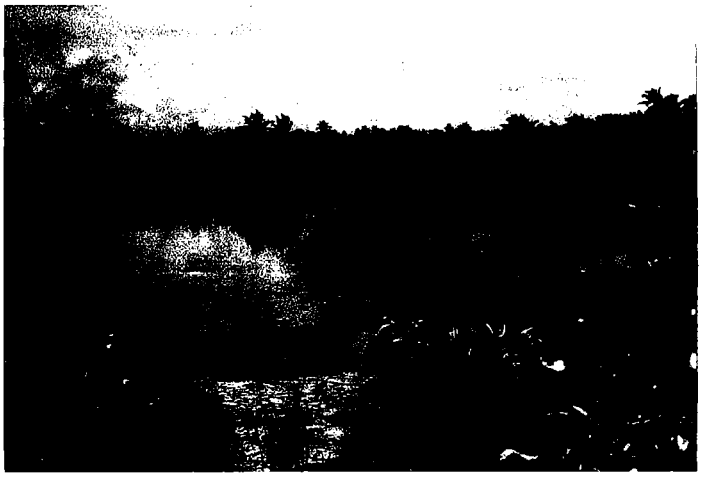

Figure 5. Fishpond, Abemama (photo F. Thomas).

kainga or descent group (*utu*) who has customary obligation towards other members. However, the law did not specify this social requirement. The negative consequences of unrestricted access, however, prompted some island councils to adopt bylaws to protect fish and invertebrates thus leading to community efforts to prohibit fishing practices in certain areas, at certain times, and in relation to types of fish and gear (Miria-Tairea, 1995: 15). For instance, island councils on Tamana and Arorae have imposed restrictions on the use of pressure lamps to catch flying fish (Onorio, 1985). On North Tarawa, some forms of customary marine tenure continue to be practiced (Johannes and Yeeting, 2001). The effectiveness of such measures remains in doubt, however, and may parallel land-court decisions (land custom has been codified in Kiribati) where judgments are often ignored because of the lack of administrative capacity to enforce decisions as a result of divided ownership, excessive fragmentation of land, and scattered rights (Crocombe, 1999; Namai, 1987).

As noted above, giant clams are sometimes brought from various sections of the leeward reef and ocean reef flat to sandy lagoon patches in proximity to residences. Both *T. gigas* and *H. hippopus* are amenable to live storage in designated "gardens" because they are sedentary, may grow large, and are generally able to survive (although not necessarily reproduce optimally) in an environment different from where they occur naturally (Hviding, 1993: 45; Johannes, 1982; Maclean, 1978). Extant giant clam "gardens" may be demarcated by the presence of a circular coral enclosure about 40 cm high, coral rubble, a fish trap, or no distinguishing feature at all (Thomas, 2001b). Concentrations range from one or two specimens to much larger aggregates, sometimes consisting of large individuals but more commonly of smaller ones. Like fish traps and areas set aside for seaweed farming, giant clam "gardens" are the property of individual households whereas the reef flats on both lagoon and ocean sides are now regarded as common property. Because of endemic pilferage in populated areas, traditional giant clam "mariculture" is currently confined to relatively isolated areas such as sparsely inhabited islets. The "gardens" are disappearing from the Kiribati seascape, however, in large part because of the erosion of customary marine tenure. Owners are now less inclined to continue to care for giant clams in designated lagoon sections or to invest in maintaining large fish traps (Fig. 6). Another factor for the neglect of fish traps (and some land plots) relates to owner absenteeism linked to internal migrations to South Tarawa (King, 1999; Latouche, 1999).

Figure 6. Fish trap, Maiana (photo F. Thomas).

The Tarawa Lagoon Project called for a remodeled form of marine tenure based on more detailed studies of traditional systems of fishing rights that can be ethnographically salvaged and the legal parameters. The contributors recognized that marine tenure would be more difficult to implement near urban centers because of the large proportion of residents who have no claims to local fishing rights. It will be interesting to see the impact of outer island black-pearl farming on claims to customary marine tenure.

BIODIVERSITY CONSERVATION

While the fauna and flora on atolls are relatively impoverished compared to other island types, a number of plant species were traditionally recognized for their utilitarian qualities, including medicinal uses, as well as for their symbolic value (Thaman, 1990). Preserving biodiversity is thus linked to the maintenance of cultural vitality.

The flora of the Gilberts has been estimated at just over 300 species (83 indigenous), while the Line and Phoenix Islands include only 283 species of which 67 are indigenous (Guinther et al., 1992). Of the indigenous species, 40 are severely restricted in their distribution, endangered, or possibly extinct due to human activities. The impact of humans on the flora, including protective mangroves, has been extensive, especially in the last 100 years, with the widespread development of coconut plantations as well as expanding populations exhibiting various degrees of changed lifestyle through the adoption of Western values (Wilson, 1994). The environmental "rape" of Banaba for phosphate beginning in the early twentieth century is a *cause célèbre* illustrating biodiversity reduction with resulting serious social consequences. Following the deportation of the indigenous population by the Japanese during World War II to Tarawa, Nauru, and the Carolines, Banabans were then resettled on Rabi in Fiji at war's end to allow further mining (Sigrah and King, 2001).

There are no indigenous land mammals in Kiribati. The Polynesian rat (*Rattus exulans*) was apparently the only terrestrial mammal noted by the United States Exploring Expedition in the first half of the nineteenth century (Wilkes, 1845: 75). Dogs may have become extinct before being reintroduced in the post-contact era (Grimble, 1933-34: 28; Takayama and Takasugi, 1988). Cats and pigs are also historic introductions. The avian fauna consists of 75 birds species with only one endemic, the Line Island reed warbler

(*Acrocephalus aequinoctialis*) (Guinther et al., 1992). The Line and Phoenix Islands, along with the Northwest Hawaiian Islands, constitute the most extensive system of tropical seabird rookeries in the world. However, these have become greatly diminished in the last few decades due to feral cats, rats, and extensive poaching, particularly on Kiritimati (Jones, 2000). Despite efforts to establish closed wildlife sanctuaries on Malden and Starbuck (Line Islands), parts of Kiritimati and, more recently, on Millennium Island, enforcement of the law remains problematic (Kepler, 2000). Because the islands in the Line and Phoenix group are widely scattered and mostly uninhabited, it is difficult to monitor activities which could have detrimental effects on the environment including illegal fishing or even the disturbance created by a single careless yachtsman (Kepler et al., 1994).

Between 600 and 800 species of inshore and pelagic finfish are believed to exist together with approximately 200 coral species (Guinther et al., 1992). However, the scarcity of certain marine organisms, such as turtles, large reef cods, and giant clams, and smaller catches and decreasing average size of species individuals indicate that atolls are seriously over-fished now. As with disturbance of vegetation, marine biodiversity is also affected by a host of human activities, including foreshore reclamation, construction of causeways, dumping of rubbish on the lagoon shore, and sewage discharge (Spalding et al., 2001; Wells, 1988: 207).

The Tarawa Lagoon Project resulted in a series of reports and a proposal to put into place a Tarawa Management Council. To date, however, no significant progress has been achieved on the implementation of the full council proposal. The Environment Act, which came into effect in 1999, gave responsibility to the Environment and Conservation Division of the Ministry of Environment and Social Development (MESD) for carrying out a community awareness and education program "on both the manner in which the Act will apply to new developments and more broadly in terms of the importance of protecting Kiribati's water, land and associated ecosystems" (National Development Strategies, 2000: 66).

There is a feeling that marine biodiversity conservation will be better served by "bottom-up" approaches tied to customary marine tenure (Tebano, 2000), but village-based control of resources and lagoon space will need to consider the potential challenge from individual fishing entrepreneurs with efficient extractive technology and even government representatives. Also, the resurrection, even in remodeled form, of marine tenure may generate or reactivate disputes concerning who has what traditional rights within bounded areas (Hunt, 1996).

CONCLUSIONS: TOWARDS SUSTAINABLE DEVELOPMENT

Literally volumes have been written on the topic of sustainable development. Yet, the concept remains elusive. As Overton (1999) remarked, sustainable development means different things to different interest groups. Referring to the Pacific Islands, he identified two noteworthy perspectives that had previously been neglected, namely the *local* and *social* perspectives. The local perspective is often regarded as subordinate

to the global, while the social perspective remains "a junior partner in the sustainable development coalition" (Overton, 1999: 1). Pacific Island "micro states" offer specific development challenges and, while they are not poor by the usual standards of world poverty, they are nonetheless vulnerable to policies largely dictated by external forces. More often than not, these policies tend to ignore social structures and needs, even though they may support ecological and economic sustainability.

It had been said that for generations traditional management of resources in Kiribati ensured a plentiful supply of marine life to the indigenous population (Zann, 1985). While the debate on the effectiveness of indigenous conservation will no doubt continue (e.g., Acheson and Wilson, 1996: 586; Anderson, 1996: 174; Burney, 1997; Grayson, 2001; Hunter-Anderson, 1991; Kirch 2000; Nunn, 1997; Thomas, 1999), the fact remains that the modern world has led to accelerated changes in the way people relate to their environment. Today, changes in Kiribati lifestyle brought about by high rates of population growth, imbalance of population distribution, and a move towards Western-oriented materialism, are placing increasing demands on the environment and natural resources.

The extent of food dependency can be related to the degree that a nation relies on a *MIRAB* economy. Kiribati, like other Pacific "micro states" will, in all probability, continue to rely on one or more aspects of *MIRAB* particularly since current agricultural production is limited in most cases. With high human population densities and high fertility rates, food imports will undoubtedly continue to play a vital role in feeding growing populations, notably in urban centers. Mobility (migration) and associated remittances will remain an option for those seeking a better future, although opportunities differ among small-island states and territories. While *MIRAB* should be viewed with some apprehension in Kiribati, it is also true that rent income can play an important *supportive* role in the economy of small-island states. Local governments should continue to explore ways to capture various rent opportunities and thus aim at diversifying their options.

Many Pacific Island nations face rapidly growing populations with changing needs, wants and aspirations, and an increasing rate of urbanization. The scope for greater reliance on the manufacturing and industrial sector is small because of the islands' remoteness from large trade and investment centers in Australasia and the limits imposed by the size of domestic markets. Most Pacific Islands have little choice but to rely on economic growth based on natural resources exploitation. Agriculture and fisheries have been, and will remain, the main economic activity in the Pacific and often the main source of export earning. Encouraging economic growth and development to meet the needs of the current generation without jeopardizing the ability of future generations to meet theirs is a major challenge facing island nations. Because *I-Kiribati* are not migrating to Western countries (except when they marry foreigners), there are few opportunities to lessen population pressure on the islands. Thus, birth control will also need to be encouraged to ensure sustainable livelihoods.

The desire to achieve a higher nutritional and health status can be translated into a policy of substituting, in part, locally produced food for imported foods. In the case of South Tarawa, it should be recognized that food imports, particularly staples,

play a very important role in meeting the dietary needs of the people. However, raising local food production is desirable for improving nutritional conditions and perhaps in generating revenue based on the export of specialist produce (Ward and Proctor, 1980: 364). Recent statistics showed that, while 23% of *I-Kiribati* were employed in traditional agriculture, these statistics indicated that commercial agriculture employed 0% (Purdie, 1999: 73). However, it is suggested here that further agricultural expansion should be geared primarily to satisfy local demand rather than for export. The socioeconomic and environmental implications of overspecialization of commercial agriculture in the region are well known (Overton et al., 1999). While there is little quantitative data on productivity and the economic importance of urban food gardening throughout the Pacific, it nevertheless seems considerable in terms of encouraging import substitution, improving the balance of payments, and maximizing self-sufficiency in food, fodder, fuel, medicines, perfumes, or ornamentation, and a wide range of other subsistence and limited commercial products. Also, it must be remembered that access to food is not guaranteed by simply increasing production, and food security in a long-term view may be put at risk by overambitious short-term production increases, which also reduce soil fertility or freshwater availability (Neemia and Thaman, 1993).

"Micro states" clearly have fewer options as far as their agricultural sector is concerned compared to their fisheries, particularly regarding the range of export products. Fisheries in Kiribati highlight the opportunities and challenges facing this sector of the economy. Marine resources development, if properly managed, should lead to greater economic independence without necessarily eliminating the *MIRAB* component. In regard to its EEZ, Kiribati needs to go beyond the task of assessing the life cycles of commercially significant tuna stocks and move towards a better understanding of the ecological system where fisheries take place to protect and preserve the marine environment (Kawaley, 1999). On Tarawa, where the population density is greatest, the utilization of the reef flats and lagoonal areas will increase leading to greater pressure on existing stocks. It is hoped that with the expansion of mariculture projects on the outer islands, such as black pearl farming, Kiribati will not only benefit financially but also reverse or at least slow down the rate of in-migration to South Tarawa. For the Pacific Islands in general, and Kiribati specifically, fisheries development will remain central to attaining greater economic autonomy. According to Lawson (1980), the development of inshore resources may have greater impact on the economies of certain islands than the development of oceanic fisheries because of their accessibility, relatively low level of capital investment, technology, and organization which can be developed by local fishermen, and because they provide employment and could form the basis of development of other linkage industries as well, such as gear manufacture, boat building, and maintenance.

The uncertainty surrounding *MIRAB* economies calls for other forms of development to complement existing arrangements. Kiribati's focus on fisheries appears well-founded, but development along this line will also need to address broader environmental and social impacts with a long-term perspective (SPREP, 1998: 20). To maximize returns, Kiribati still relies on revenue by DWFNs utilizing the country's EEZ but realizes that it exercises little control over resources. For that reason, the nation has

committed itself to developing its own fishing industry and to encouraging smallholder projects focusing on mariculture. Conflicts may arise, however, as the exploitation of inshore resources for export may put pressure on artisanal fishers who have already seen declines of existing stocks caused by overfishing. Solutions will not be easy to achieve but by highlighting the complex web of environmental and social concerns, including improvements in transport and storage facilities, management of resources, pollution, coastal erosion and water quality control, approaches to renewable energy production, family planning, and responses to global warming, to name a few, it is hoped that further development of the agricultural and fisheries sector will be based on increasingly informed choices.

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REFERENCES

Abbott, R. R., and J. Garcia (eds.)
1995. *Management plan for Tarawa Lagoon, Republic of Kiribati. Volume III: management plan.* BioSystems Analysis, Inc., Santa Cruz, CA.

Abbott, R. R., and B. Yeeting
1995. The use of interisland passages by larvae and juvenile fish to enter Tarawa Lagoon. *Management plan for Tarawa Lagoon, Republic of Kiribati. Volume III: management plan.* Editors R. R. Abbott and J. Garcia. BioSystems Analysis, Inc., Santa Cruz, CA.

Acheson, J. M., And J. A. Wilson
1996. Order out of chaos: the case of parametric fisheries management. *American Anthropologist* 98:579-594.

Adams, T., P. Dalzell, and E. Ledua
1999. Ocean resources. *The Pacific Islands: environment & society.* Editor M. Rapaport, 366-381. Bess Press, Honolulu.

Ali, A., and M. Asghar
1987. The agronomy of *Cyrtosperma chamissonis* Schott in Kiribati. *Alafua Agricultural Bulletin* 12 (3):81-88.

Anderson, E. N.
1996. *Ecologies of the heart: emotion, belief, and the environment.* Oxford University Press, New York.

Anderson, A., P. Wallin, H. Martinson-Wallin, B. Fankhauser, and G. Hope
2000. Toward a first prehistory of Kiritimati (Christmas) Island, Republic of Kiribati. *Journal of the Polynesian Society* 109:273-293.

Asian Development Bank
2000. *Country assistance plan (2001-2003): Kiribati.* Asian Development Bank, Manila.

Atanraoi, P.
1995. Customary tenure and sustainability in an atoll nation. *Customary land tenure and sustainable development: complementarity or conflict?* Editor R. Crocombe, 55-73. South Pacific Commission, Noumea and Institute of Pacific Studies, University of the South Pacific, Suva.

Atoll Seaweed Co.
2001. *Seaweed production by island, 1985-2001.* Atoll Seaweed Co., Tarawa.

AusAid
2001. *Kiribati country brief.* Australian Agency for International Development, Canberra.

Baaro, B.
1993. Economic overview. *Atoll politics: the Republic of Kiribati.* Editor H. Van Trease, 161-167. Macmillan Brown Centre for Pacific Studies, University of Canterbury, Christchurch, and Institute of Pacific Studies, University of the South Pacific, Suva.

Bailey, E.
1977. *The Christmas Island story.* Stacey International, London.

Baiteke, A.
1994. Traditional agriculture in Kiribati. *Land use and agriculture.* Editors J. Morrison, P. Geraghty, and L. Crowl, 1-9. Institute of Pacific Studies, University of the South Pacific, Suva.

Bedford, R., and B. Macdonald
1982. *The population of Kiribati: a review of some myths about migration and depopulation.* Department of Geography, University of Canterbury, Christchurch.

Bedford, R., B. Macdonald, and D. Munro
1980. Population estimates for Kiribati and Tuvalu, 1850-1900: review of speculation. *Journal of the Polynesian Society* 89:199-246.

Beets, J.
2001. Declines in finfish resources in Tarawa Lagoon, Kiribati, emphasize the need for increased conservation effort. *Atoll Research Bulletin* 490:1-14.

Bertram, G.
1999. Economy. *The Pacific Islands: environment & society*. Editor M. Rapaport, 337-352. Bess Press, Honolulu.
Bertram, G., and R. F. Watters
1985. The MIRAB economy in South Pacific microstates. *Pacific Viewpoint* 26:497-519.
Briguglio, L.
1995. Small island developing states and their economic vulnerabilities. *World Development* 23:1615-1632.
Brookfield, H.
1980. The transport factor in island development. *The island states of the Pacific and Indian Oceans: anatomy of development*. Editor R. T. Shand, 201-238. Australian National University, Canberra.
Brown, R. P. C.
1992. *Sustainability, aid and remittances-dependent Pacific Island economies: lessons from Africa?* Economics Division Working Papers 92/2. Research School of Pacific Studies, Australian National University, Canberra.
Bryant-Tokalau, J. J.
1993. What future Pacific cities ? The challenge of managing urban environments. *The margin fades: geographical itineraries in a world of islands*. Editors E. Waddell and P. D. Nunn, 151-165. Institute of Pacific Studies, University of the South Pacific, Suva.
Burgess, S. M.
1987. *The climate and weather of Western Kiribati*. New Zealand Meteorological Service, Wellington.
Burney, A. A.
1997. Tropical islands as paleoecological laboratories: gauging the consequences of human arrival. *Human Ecology* 25:437-457.
Cameron, J.
1997. Sustainability and the limitations of government: a response to Halapua. *Environment and development in the Pacific Islands*. Editors B. Burt and C. Clerk, 30-33. National Centre for Development Studies, Australian National University, Canberra and University of Papua New Guinea, Port Moresby.
Carson, M. T.
1998. Cultural affinities of monumental architecture in the Phoenix Islands. *Journal of the Polynesian Society* 107:61-77.
Catala, R. L. A.
1957. Report on the Gilbert Islands: some aspects of human ecology. *Atoll Research Bulletin* 59:1-187.
Christensen, P. M.
1995. *Infant nutrition and child health on Tarawa, Kiribati: a nutrition anthropological approach*. Pacific Studies Monograph No. 15. Centre for Pacific Studies, University of New South Wales, Sydney.

CIA
2001. *The world factbook – Kiribati*. http://www.cia.gov.
Cleghorn, P. L.
1988. The settlement and abandonment of two Hawaiian outposts: Nihoa and Necker Islands. *Bishop Museum Occasional Papers* No. 28:35-49. Honolulu.
Connell, J.
1984. Islands under pressure - population growth and urbanization in the South Pacific. *Ambio* 13:306-312.
Connell, J.
2000. Urbanization and settlement in the Pacific. *Resettlement policy and practice in Southeast Asia and the Pacific*, 43-53. Asian Development Bank, Manila.
Connell, J., and J. P. Lea
1998. Urban management in Micronesia: learning from Kiribati? *Development Bulletin* 45:27-31.
Connell, J., and J. P. Lea
1999. Urban dilemmas. *The Pacific Islands: environment & society*. Editor M. Rapaport, 326-335. Bess Press, Honolulu.
Corrao, M. A., G. E. Guindon, and S. N. Shokodi (eds.)
2000. *Tobacco control country profiles*. American Cancer Society, Atlanta.
Coyne, T.
2000. *Lifestyle diseases in Pacific communities*. South Pacific Commission, Noumea.
Crocombe, R.
1999. Tenure. *The Pacific Islands: environment & society*. Editor M. Rapaport, 208-220. Bess Press, Honolulu.
Dahl, C.
1996. Different options, different paths: economic development in two atoll states. *Isla* 4:289-316.
Danielson, R. E., R. R. Abbott, W. J. Kimmerer, and K. Etauti
1995. Microbiological contamination of water and shellfish in Tarawa Lagoon, Kiribati: remediation strategies for contaminated shellfish. *Management plan for Tarawa Lagoon, Republic of Kiribati. Volume III: management plan*. Editors R. R. Abbott and J. Garcia. BioSystems Analysis, Inc., Santa Cruz, CA.
Dawson, R. F.
1988. Giant clam exploitation in the southwest Pacific. *Giant clam in Asia and the Pacific*. Editors J. W. Copland and J. J. Lucas, 254-255. ACIAR, Canberra.
Diamond, J. M.
1985. Why did the Polynesian abandon their mystery islands? *Nature* 317:764.
Di Piazza, A.
1999. Te bakoa. Two old earth ovens from Nikunau Island (Republic of Kiritimati). *Archaeology in Oceania* 34:40-42.
Di Piazza, A., and E. Pearthree
2001a. An island for gardens, and island for birds and voyaging: a settlement patterns for Kiritimati and Tabuaeran, two 'mystery islands' in the Northern Lines, Republic of Kiribati. *Journal of the Polynesian Society* 110:149-170.

Di Piazza, A., and E. Pearthree
2001b. L'art d'être pirogues de voyage en Océanie insulaire. *Journal de la Société des Océanistes* 112:61-72.
Di Piazza, A., and E. Pearthree
2001c. Voyaging and basalt exchange in the Phoenix and Line archipelagoes: the viewpoint from three mystery islands. *Archaeology in Oceania* 36:146-152.
Dolman, A. J.
1990. The potential contribution of marine resources to sustainable development in small-island developing countries. *Sustainable development and environmental management of small islands*. Editors W. Beller, P. d'Ayala, and P. Hein, 87-102. UNESCO, Paris.
Doumenge, J. P.
1999. Urbanization. *The Pacific Islands: environment & society*. Editor M. Rapaport, 315-325. Bess Press, Honolulu.
Emory, K. P.
1934. *Archaeology of the Pacific equatorial islands*. B. B. Bishop Museum Bulletin 123, Honolulu.
FAO
1998. *Fishery country profile: Kiribati*. FAO, Rome.
Fleming, E., and J. B. Hardaker
1995. *Pacific 2010: strategies for Polynesian agricultural development*. National Centre for Development Studies, Australian National University, Canberra.
Fosberg, F. R., and M. H. Sachet
1987. Flora of the Gilbert Islands, Kiribati, checklist. *Atoll Research Bulletin* 295: 1-33.
Geddes, W. H.
1983. *Tabiteuea North*. Atoll Economy: Social Change in Kiribati and Tuvalu No. 2. Australian National University, Canberra.
Geddes, W. H., A. Chambers, B. Sewell, R. Lawrence, and R. Watters
1982. *Islands on the line: team report*. Atoll Economy: Social Change in Kiribati and Tuvalu No. 1. Australian National University, Canberra.
Gibson, L.
1993. International aid in the Pacific: what is in it for us? *The margin fades: geographical itineraries in a world of islands*. Editors E. Waddell and P. D. Nunn, 141-150. Institute of Pacific Studies, University of the South Pacific, Suva.
Grayson, D. K.
2001. The archaeological record of human impacts on animal populations. *Journal of World Prehistory* 15:1-68.
Grimble, A. F.
1933-34. *The migration of a pandanus people*. The Polynesian Society, Auckland.
Guinther, E. B., J. E. Maragos, and R. R. Thaman
1992. *National biodiversity overview: Republic of Kiribati*. South Pacific Biodiversity Conservation Programme, South Pacific Regional Environment Programme, Noumea.

Hardin, G.
1968. The tragedy of the commons. *Science* 162:1243-1248.
Hoare, R.
1996-98. *World climate, weather and rainfall data.* http://worldclimate.com.
Irwin, G.
1992. *The prehistoric exploration and colonization of the Pacific.* Cambridge University Press, Cambridge.
Hunt, C.
1996. Property rights and environmental management on Pacific atolls. *International Journal of Social Economics* 23:221-234.
Hunter-Anderson, R. L.
1991. A review of traditional Micronesian high island horticulture in Belau, Yap, Chuuk, Pohnpei, and Kosrae. *Micronesica* 24:1-56.
Hviding, E.
1993. *The rural context of giant clam mariculture in Solomon Islands: an anthropological study.* Technical Report No. 39. ICLARM, Manila.
Johannes, R. E.
1982. Implications of traditional marine resource use for coastal fisheries development in Papua New Guinea. *Traditional conservation in Papua New Guinea: implications for today.* Editors L. Morauta, J. Pernetta, and W. Heaney, 239-249. Institute of Applied Social and Economic Research, Boroko.
Johannes, R. E., and B. Yeeting
2001. *I-Kiribati* knowledge and management of Tarawa's Lagoon resources. *Atoll Research Bulletin* 489:1-24.
Jones, H. L.
2000. *Maiuia mannikibani Kiritimati: the birdlife of Christmas Island.* Dames & Moore Consultants, Honolulu.
Kawaley, I.
1999. Implications of Exclusive Economic Zone management and regional cooperation between South Pacific small midocean island Commonwealth territories. *Ocean Development & International Law* 30:333-377.
Kay, E. A., and S. Johnson
1987. Mollusca of Enewetak Atoll. *The natural history of Enewetak Atoll: volume II. Biogeography and systematics.* Editors D. M. Devaney, E. S. Reese, B. L. Burch, and P. Helfrich, 105-146. U. S. Dept. of Energy, Office of Energy Research, Office of Health and Environmental Research, Ecological Research Division, Oak Ridge.
Kepler, A. K.
2000. *Report: Millennium sunrise, Line & Phoenix Islands expedition.* Pan-Pacific Ecological Consulting, Athens, GA.
Kepler, C. B., A. K. Kepler, and D. H. Ellis
1994. The natural history of Caroline Atoll, Southern Line Islands: part II. Seabirds, other terrestrial animals, and conservation. *Atoll Research Bulletin* 398:1-61.

Kearney, R. E.
1980. Some problems of developing and managing fisheries in small island states. *The island states of the Pacific and Indian Oceans: anatomy of development.* Editor R. T. Shand, 41-60. Australian National University, Canberra.

Kienene, T.
1993. Health care. *Atoll politics: the Republic of Kiribati.* Editor H. Van Trease, 250-257. Macmillan Brown Centre for Pacific Studies, University of Canterbury, Christchurch and Institute of Pacific Studies, University of the South Pacific, Suva.

King, P.
1999. Land tenure and atoll society in Kiribati: the case of Kuma Village. *Strategies for sustainable development: experiences from the Pacific.* Editors J. Overton and R. Scheyvens, 80-90. Zed Books, London.

Kirch, P. V.
2000. *On the road of the winds: an archaeological history of the Pacific Islands before European contact.* University of California Press, Berkeley.

Kiribati Fisheries Division
1994. *Annual report.* Fisheries Division, Ministry of Natural Resources Development, Tarawa.

Kiribati Fisheries Division
1999. *Annual report.* Fisheries Division, Ministry of Natural Resources Development, Tarawa.

Lampert, R. J.
1968. An archaeological investigation on Ocean Island, central Pacific. *Archaeology & Physical Anthropology in Oceania* 3:1-18.

Langston, P.
1993. Northern Line Islands development. *Atoll politics: the Republic of Kiribati.* Editor H. Van Trease, 200-211. Macmillan Brown Centre for Pacific Studies, University of Canterbury, Christchurch and Institute of Pacific Studies, University of the South Pacific, Suva.

Laplagne, P., M. Treadgold, and J. Baldry
2001. A model of aid impact in some South Pacific microstates. *World Development* 29:365-383.

Latouche, J. P.
1999. Les lacs de Riki. Réflexions sur une aquaculture traditionnelle à Nikunau (Kiribati). *Les petites activités de pêches dans le Pacifique Sud.* Editor G. Blanchet, 161-174. Institut de Recherche pour le Développement, Paris.

Lawrence, R.
1983. *Tamana.* Atoll Economy: Social Change in Kiribati and Tuvalu No. 4. Australian National University, Canberra.

Lawrence, R.
1985. Views from the center and the periphery: development projects on Tamana, southern Kiribati. *Pacific Viewpoint* 26:547-562.

Lewis, D. E., Jr.
1988. Gustatory subversion and the evolution of nutritional dependency in Kiribati. *Food and Foodways* 3:79-98.
Lawson, R. M.
1980. Development and growth constraints in the artisanal fisheries sector in island states. *The island states of the Pacific and Indian Oceans: anatomy of development*. Editor R. T. Shand, 61-85. Australian National University, Canberra.
Liew, J.
1990. Sustainable development and environmental management of atolls. *Sustainable development and environmental management of small islands*. Editors W. Beller, P. d'Ayala, and P. Hein, 77-86. Unesco, Paris.
Lundsgaarde, H. P.
1966. *Cultural adaptation in the southern Gilbert Islands*. Department of Anthropology, University of Oregon, Eugene.
Luomala, K.
1974. The *Cyrtosperma* systemic pattern: aspects of production in the Gilbert Islands. *Journal of the Polynesian Society* 83:14-34.
Macdonald, B.
1998. *Pacific Islands stakeholder participation in development: Kiribati*. World Bank, Washington, D.C.
Maclean, J. L.
1978. The clam gardens of Manus. *Harvest* 4:160-163.
Macpherson, C.
2000. Oasis or mirage: the farming of black pearl in the Northern Cook Islands. *Pacific Studies* 23 (3/4):33-55.
Marshall, J. F., and G. Jacobson
1985. Holocene growth of a mid-Pacific atoll: Tarawa, Kiribati. *Coral Reefs* 4:11-17.
Maude, H. E.
1952. The colonization of the Phoenix Islands. *Journal of the Polynesian Society* 61: 62-89.
Maude, H. E.
1963. *The evolution of the Gilbertese boti : an ethnohistorical interpretation*. The Polynesian Society, Wellington.
Maude, H. C., and H. E. Maude
1981. Tioba and the Tabiteuean wars. *Journal of the Polynesian Society* 90:307-336.
McLean, R. F.
1989. *Kiribati and sea level rise*. Department of Geography and Oceanography, University of New South Wales and Australian Defense Force Academy, Canberra.
Ministry of Finance
1998. *International trade statistics 1998*. Statistics Office, Ministry of Finance, Tarawa.

Ministry of Finance
2001. *Report on the 2000 census of population.* Statistics Office, Ministry of Finance, Tarawa.
Ministry of Health and Family Planning
1998. *Health statistic report – health center and dispensary morbidity data 1992-1998.* Health Information Centre, Ministry of Health and Family Planning, Tarawa.
Miria-Tairea, M.
1995. *Fisheries legislative profile : Republic of Kiribati.* Report 95/2. FAA, Honiara.
Munro, J. L.
1986. *Status of giant clam stock and prospects for clam mariculture in the central Gilbert Islands group, Republic of Kiribati.* ICLARM South Pacific Office, Townsville.
Naidu, S., W. G. L. Aalbersberg, J. E. Brodie, V. A. Fuavao, M. Maata, M. Naqasima, P. Whippy, and R. Morrison
1991. *Water quality studies on selected South Pacific lagoons.* SPREP, Nairobi.
Namai, B.
1987. The evolution of Kiribati tenure. *Land tenure in the atolls.* Editor R. G. Crocombe, 30-39. Institute of Pacific Studies, University of the South Pacific, Suva.
National Development Strategies
2000. *National Development Strategies 2000-2003.* Tarawa.
Neemia-Mackenzie, U.
1998. *Social and cultural factors in seaweed production in Kiribati.* MacAlister Elliott & Partners, Hampshire, England.
Neemia, U., and R. R. Thaman
1993. The environment and sustainable development. *Atoll politics: the Republic of Kiribati.* Editor H. Van Trease, 285-301. Macmillan Brown Centre for Pacific Studies, University of Canterbury, Christchurch and Institute of Pacific Studies, University of the South Pacific, Suva.
Novaczech, I., and T. Chamberlain
2001. *Post harvest fisheries development project.* Marine Studies Programme, University of the South Pacific, Suva.
Nunn, P. D.
1993. Recent warming of the Pacific region. *Climate and agriculture in the Pacific Islands: future perspectives.* Editors W. Aalbersberg, P. D. Nunn, and A. D. Ravuvu, 7-20. Institute of Pacific Studies, University of the South Pacific, Suva.
Nunn, P. D.
1997. Late quaternary environmental changes on Pacific Islands: controversy, certainty and conjecture. *Journal of Quaternary Science* 12:443-450.
Nunn, P. D.
1998. *Pacific Island landscapes.* Institute of Pacific Studies, University of the South Pacific, Suva.

Onorio, B.
1985. Let's go fishing. *Kiribati: a changing atoll culture*. Editor L. Mason, 142-153. Institute of Pacific Studies, University of the South Pacific, Suva.
Overton, J.
1999. Sustainable development and the Pacific Islands. *Strategies for sustainable development: experiences from the Pacific*. Editors J. Overton and R. Scheyvens, 1-15. Zed Books, London.
Overton, J., W. Murray, and I. Ali
1999. Commodity production and unsustainable agriculture. *Strategies for sustainable development: experiences from the Pacific*. Editors J. Overton and R. Scheyvens, 168-181. Zed Books, London.
Pargeter, K. A., R. Taylor, H. King, and P. Zimmet
1984. *Kiribati: a dietary study*. South Pacific Commission, Noumea.
Parkinson, S.
1955. Food conditions in the Gilbert Islands. *Transactions and Proceedings of the Fiji Society* 6:61-73.
Parkinson, S.
1982. Nutrition in the South Pacific – past and present. *Journal of Food and Nutrition* 39:121-125.
Paulay, G.
2001. Benthic ecology and biota of Tarawa Lagoon: influence of equatorial upwelling, circulation, and human harvest. *Atoll Research Bulletin* 487:1-41.
Pawley, A., and M. Ross
1993. Austronesian historical linguistics and culture history. *Annual Review of Anthropology* 22:25-459.
Peduzzi, C.
1999. *Mixed gardens: gardening on a coral atoll*. UNICEF and FSP, Suva and Tarawa.
Phillips, G. D.
1995. A survey of Tarawa residents and their perceptions of Tarawa Lagoon. *Management plan for Tarawa Lagoon, Republic of Kiribati. Volume III: management plan*. Editors R. R. Abbott and J. Garcia. BioSystems Analysis, Inc., Santa Cruz, CA.
Pollard, S. J.
1987. *The viability and vulnerability of a small island state: the case of Kiribati*. National Centre for Development Studies, Australian National University, Canberra.
Purdie, B.
1999. Pacific Islands livelihoods. *Strategies for sustainable development: experiences from the Pacific*. Editors J. Overton and R. Scheyvens, 64-79. Zed Books, London.
Rallu, J. L., and D. A. Ahlburg
1999. Demography. *The Pacific Islands: environment & society*. Editor M. Rapaport, 258-269. Bess Press, Honolulu.

Rapaport, M.
1990. Population pressure on coral atolls: trends and approaching limits. *Atoll Research Bulletin* 340:1-33.
Rapaport, M.
1995. Pearl farming in the Tuamotus: atoll development and its consequences. *Pacific Studies* 18 (3):1-25.
Richmond, B.
1993. *Reconnaissance geology of the Gilbert group, Western Kiribati*. Technical Report No. 77. SOPAC, Suva.
Ruddle, K.
1994. *A guide to the literature on traditional community-based fishery management in the Asia-Pacific tropics*. Fisheries Circular No. 869. FAO, Rome.
Schaumberg, D. A., J. O'Connor, and R. D. Semba
1996. Risk factors for xerophthalmia in the Republic of Kiribati. *European Journal of Clinical Nutrition* 50:761-764.
Schoeffel, P.
1992. Food, health, and development: policy implications for Micronesia. *Isla* 1:223-250.
Schoeffel, P.
1996. *Sociocultural issues and economic development in the Pacific Islands*. Asian Development Bank, Manila.
Schoefield, J. C.
1977. Late Holocene sea level, Gilbert and Ellice Islands, west central Pacific. *New Zealand Journal of Geology and Geophysics* 20:503-529.
Sewell, B.
1983. *Butaritari*. Atoll Economy: Social Change in Kiribati and Tuvalu No. 3. Australian National University, Canberra.
Shand, R. T.
1980. Island smallness: some definitions and implications. *The island states of the Pacific and Indian Oceans: anatomy of development*. Editor R. T. Shand, 3-20. Australian National University, Canberra.
Sigrah, R., and S. M. King
2001. *Te rii ni Banaba*. Institute of Pacific Studies, University of the South Pacific, Suva.
Sinoto, A.
1973. Fanning Island: preliminary archaeological investigations of sites near the Cable Station. *Fanning Island Expedition: July and August 1972*. Editors K. E. Chave and E. A. Kay, 283-299. Hawaii Institute of Geophysics Bulletin 73-13, Honolulu.
Small, C. A.
1972. *Atoll agriculture in the Gilbert & Ellice Islands*. Department of Agriculture, Tarawa.
SOPAC
2000. *Country profile: Kiribati*. SOPAC, Suva.

South, G. R.
1993. Seaweeds. *Nearshore marine resources of the South Pacific: information for fisheries development and management*. Editors A. Wright and L. Hill, 690-696. Institute of Pacific Studies, University of the South Pacific, Suva.

South Pacific Commission
2001. *Pacific island populations data sheet*. Demography/Population Programme, South Pacific Commission, Noumea. http://www.spc.org.nc/demog/.

Spalding, M. D., C. Ravilious, and E. P. Green
2001. *World atlas of coral reefs*. Berkeley, University of California Press.

SPREP
1998. *South Pacific environment outlook*. South Pacific Regional Environment Programme, Apia.

Sturman, A. P., and H. A. McGowan
1999. Climate. *The Pacific Islands: environment & society*. Editor M. Rapaport, 3-18. Bess Press, Honolulu.

Sullivan, M., and L. Gibson
1991. *Environmental planning, climate change and potential sea level rise: report on a mission to Kiribati*. SPREP Reports and Studies No. 50. SPREP, Noumea.

Takayama, J.
1988. A pandanus fruit scraper from Makin Island, Kiribati, central Pacific. *Bulletin of the Indo-Pacific Prehistory Association* 8:162-166.

Takayama, J., and H. Takasugi
1987. The significance of lure shanks excavated in the Utiroa Site of Makin Island in the Gilberts. *Senri Ethnological Studies* 21:29-41.

Takayama, J., and H. Takasugi
1988. *Archaeology on Makin, Kiribati, central Pacific*. Department of Ethnology, Tezukayama University, Nara-shi, Japan.

Takayama, J., H. Takasugi, and K. Kaiyama
1989. The 1988 archaeological expedition to Kiribati: a preliminary report of Tamana. *Tezukayama University Review* 63:1-14.

Takayama, J., H. Takasugi, and K. Kaiyama
1990. Test excavation of the Nukantekainga Site on Tarawa, Kiribati, central Pacific. *Archaeological research on the atoll cultures of Micronesia, 1988*. Editor I. Ushijima, 1-19. Committee for Micronesian Research, 1988, University of Tsukuba, Tsukuba-shi, Japan.

Tebano, T.
2000. Case study on marine tenure systems in Kiribati: will they ever be able to sustain our inshore marine resources? *Oceans in the new millennium: challenges and opportunities for the islands*. Editors G. R. South, G. Cleave, and P. A. Skelton. International Ocean Institute, Operational Centre for the Pacific Islands, University of the South Pacific.

Tebano, T., and D. MacCarthy
1991. *Ciguatera fish poisoning and the causative organism in the Gilbert Islands, Kiribati*. Technical Report No. 9. Marine Studies Programme, University of the South Pacific, Suva.

Tebano, T., and G. Paulay
2001. Variable recruitment and changing environments create a fluctuating resource: the biology of *Anadara uropigimelana* (Bivalvia: Arcidae) on Tarawa Atoll. *Atoll Research Bulletin* 488:1-15.

Teiwaki, R.
1988. *Management of marine resources in Kiribati*. Institute of Pacific Studies, University of the South Pacific, Suva.

Thaman, R. R.
1982. Deterioration of traditional food systems, increasing malnutrition and food dependency in the Pacific Islands. *Journal of Food and Nutrition* 39:109-121.

Thaman, R. R.
1983. Food and national development in the Pacific Islands: an introduction. *Food and national development in the South Pacific: Ray Parkinson Memorial Lectures 1982*. Editors R. R. Thaman and W. C. Clarke, 1-16. University of the South Pacific, Suva.

Thaman, R. R.
1987. Plants of Kiribati: a listing and analysis of vernacular names. *Atoll Research Bulletin* 296:1-42.

Thaman, R. R.
1988. Health and nutrition in the Pacific Islands: development or underdevelopment? *Geo Journal* 16:211-227.

Thaman, R. R.
1990. Kiribati agroforestry: trees, people, and the atoll environment. *Atoll Research Bulletin* 333:1-29.

Thaman, R. R.
1992. Vegetation of Nauru and the Gilbert Islands: case studies of poverty, degradation, disturbance, and displacement. *Pacific Science* 46:128-158.

Thaman, R. R.
1993a. Atoll agroforestry on Tarawa and Abemama, Kiribati. *Agroforestry in the Pacific Islands: systems for sustainability*. Editors W. C. Clarke and R. R. Thaman, 130-144. United Nations University Press, Tokyo.

Thaman, R. R.
1993b. Pacific Island biodiversity: a basis for ecological, cultural and economic survival. *The margin fades: geographical itineraries in a world of islands*. Editors E. Waddell and P. D. Nunn, 49-65. Institute of Pacific Studies, University of the South Pacific, Suva.

Thaman, R. R.
1994. Pacific Island agroforestry: an endangered science. *Land use and agriculture*. Editors J. Morrison, P. Geraghty, and L. Crowl, 191-221. Institute of Pacific Studies, University of the South Pacific, Suva.

Thaman, R. R.
1995. Urban food gardening in the Pacific Islands: a basis for food security in rapidly urbanizing small-island states. *Habitat International* 19:209-224.

Thislethwait, R., and G. Votaw
1992. *Environment and development: a Pacific Island perspective*. Asian Development Bank, Manila.
Thomas, F. R.
1999. The precontact period. *The Pacific Islands: environment & society*. Editor M. Rapaport, 121-133. Bess Press, Honolulu.
Thomas, F. R.
2001a. Mollusk habitats and fisheries in Kiribati: an assessment from the Gilbert Islands. *Pacific Science* 55:77-97.
Thomas, F. R.
2001b. Remodeling marine tenure on the atolls: a case study from Western Kiribati, Micronesia. *Human Ecology* 29:399-423.
Thomas, F. R.
2002a. An evaluation of central-place foraging among mollusk gatherers in Western Kiribati, Micronesia: linking behavioral ecology with ethnoarchaeology. *World Archaeology* 34:182-208.
Thomas, F. R.
2002b. Self-reliance in Kiribati: contrasting views of agricultural and fisheries production. *The Geographical Journal* 168:163-177.
Throssell, B., and J. Specht
1989. Stone structures on McKean Island, Phoenix Islands, Republic of Kiribati. *Australian Archaeology* 29:17-21.
Tikai, T.
1993. Fisheries development. *Atoll politics: the Republic of Kiribati*. Editor H. Van Trease, 168-189. Macmillan Brown Centre for Pacific Studies, University of Canterbury, Christchurch and Institute of Pacific Studies, University of the South Pacific, Suva.
Tofiga, M. P.
1985. Agricultural subsistence and development. *Kiribati: a changing atoll culture*. Editor L. Mason, 156-165. Institute of Pacific Studies, University of the South Pacific, Suva.
Van Trease, H. (ed.)
1993. *Atoll politics: the Republic of Kiribati*. Macmillan Brown Centre for Pacific Studies, University of Canterbury, Christchurch and Institute of Pacific Studies, University of the South Pacific, Suva.
Vergara, N. T., and P. K. R. Nair
1985. Agroforestry in the South Pacific region – an overview. *Agroforestry Systems* 3: 363-379.
Ward, R. G.
1999. *Widening worlds, shrinking worlds? The reshaping of Oceania*. Centre for the Contemporary Pacific, Australian National University, Canberra.
Ward, R. G., and A. Proctor (eds.)
1980. *South Pacific agriculture: choices and constraints*. Asian Development Bank, Manila.

Wartho, R., and J. Overton
1999. The Pacific Islands in the world. *Strategies for sustainable development: experiences from the Pacific*. Editors J. Overton and R. Scheyvens, 33-47. Zed Books, London.
Watters, R., and K. Banibati
1984. *Abemama*. Atoll Economy: Social Change in Kiribati and Tuvalu No. 5. Australian National University, Canberra.
Weisler, M. I.
1995. Henderson Island prehistory: colonization and extinction on a remote Polynesian island. *The Pitcairn Islands: biogeography, ecology and prehistory*. Editors T. G. Benton and T. Spencer, 377-404. Academic Press, London.
Weisler, M. I.
1999a. The antiquity of aroid pit agriculture and significance of buried A horizons on Pacific atolls. *Geoarchaeology* 14:621-654.
Weisler, M. I.
1999b. Atolls as settlement landscapes: Ujae, Marshall Islands. *Atoll Research Bulletin* 460:1-51.
Wells, S. M.
1988. *Coral reefs of the world*. UNEP, Nairobi.
WHO
1998. *Country health information profile: Kiribati*. WHO, Geneva. http://www.wpro.who.int.
WHO
1999. *Country health information profile: Kiribati*. WHO, Geneva. http://www.wpro.who.int.
Wilkes, C.
1845. *The narrative of the United States Exploring Expedition during the years 1838, 1839, 1840, 1841, and 1842, vol. 5*. Lea and Blanchard, Philadelphia.
Wilson, C.
1994. *Kiribati: state of the environment report 1994*. SPREP, Apia.
Zann, L. P.
1985. Traditional management and conservation of fisheries in Kiribati and Tuvalu atolls. *The traditional knowledge and management of coastal systems in Asia and the Pacific*. Editors K. Ruddle and R. E. Johannes, 53-77. UNESCO/ Regional Office for Science and Technology for Southeast Asia, Jakarta.