An economic assessment of destructive fishing methods in Kiribati: A case study of *te ororo* fishing in Tarawa

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Introduction

This paper is part of a study that was undertaken for the Secretariat of the Pacific Regional Environment Programme (SPREP) to review the fishing methods and practices used by the people of North and South Tarawa (see Ram-Bidesi and Petaia 2010).

The overall aim of the project was to assess the impact of destructive fishing methods and practices on coastal fisheries and community livelihoods, and to provide recommendations on possible courses of action. The study analysed economic and social impacts by evaluating the current situation in Tarawa's coastal communities.

Kiribati's rapidly growing population is placing increasing pressure on scarce land resources. Fishing activities are seen as the mainstay of the local and national economy as well as the main source of food and protein. Fish consumption is relatively high in Kiribati. The average domestic food fishery supply has been estimated to be around 45–50 kg of fresh and frozen reef and ocean fish per household per month (ADB 2009: 9). This includes fish caught by family members or bought at roadside markets. In the outer islands, the per capita consumption of fresh fish is much higher at 88 kg/person/year in Abaiang and 110 kg/person/year on Kiritimati Island (Awira et al. 2008).

The majority of households in Kiribati fish either on a full-time or part-time basis. This underscores the importance of coastal fisheries for sustaining the livelihoods of local communities. On the other hand, although most of I-Kiribati households fish within nearshore coastal areas close to home, there is increasing reliance on fish caught from fishing grounds farther away from home and in deeper waters. Increased population pressure and demand for resources have led to areas of overexploitation in southern Tarawa where fishers now venture farther afield in search of fish, sometimes using unsustainable fishing practices. In 2006, 78% of households in North and South Tarawa were considered to be engaged in subsistence fishing (Kiribati Fisheries Division 2006:53). Direct employment in the fisheries sector is varied, ranging from domestic commercial fishers, fish sellers, crew working on foreign fishing vessels, and employment at the government-owned marketing and distribution centre known as Central Pacific Producers.

Methodology

Assessing the value of coral reefs is becoming an important policy tool to help determine use and management of reefs and fisheries. The widespread use of destructive fishing methods — such as blast fishing using bombs and dynamite — was brought under control, and marine protected areas were established in Indonesia after a series of studies that assessed the value of coral reefs in exchange for a significant debt reduction (Cesar 1996; Cesar et al.1997; Cesar et al. 2003; David et al. 2007: 2). Although the number of studies on valuing coral reef-associated fisheries has been increasing, the results show a huge disparity in the values derived. David et al. (2007) provide a list of references for variations in value. Their study, however, states that there are two approaches to understanding the value of coral reef environments. One approach involves the use of sophisticated tools and analyses through modeling in order to capture the complexity of the environment into conceptual and methodological patterns of neoclassical analysis, and the other involves a multidisciplinary approach that extends beyond the principles of neoclassical economics (David et al. 2007). This study used the latter approach to allow for a more practical and flexible effort to gather data from various sources given the limited availability of research data on coastal fisheries in Kiribati.

This study used a combination of methods to obtain primary and secondary data, including a literature review, observation of fishing gear and fishing practices, and interviews. Three villages in North Tarawa and three villages in South Tarawa were used as case studies to gather more detailed data through household socioeconomic surveys. An analysis of fisheries management regimes was made by considering the institutional structure, and an economic assessment of fishing practices was made by examining destructive *te ororo* fishing, and by analysing opportunity costs of other uses, and alternative livelihoods.

Fishing methods and practices

While most common gear owned by the majority of households include hooks and fishing line (for handlining for reef and lagoon fish), gill nets have become the most popular gear type in recent times. Splashing the water using metal rods, sticks or crow bars is commonly done to scare schooling fish into gill nets (Government of Kiribati 2004). Other traditional methods include reef gleaning during low tide in the intertidal zone, and

trolling for schooling fish such as tuna. Gill nets and encircling nets are also used largely for catching bonefish, mullet and milkfish. Other methods use underwater spear guns and scoop nets (for flyingfish and other reef fish) in conjunction with pressure lamps at night.

The type of gill net used (in terms of net length and mesh size) and the frequency and/or intensity of fishing effort depend on the fisher and the fishing method. For example, subsistence fishers use shorter gill nets (1–3 nets joined together) with a smaller mesh size (1–2 inches), fish two to three times a week, fish in nearby areas, and use either set netting or drive netting as a fishing method. Artisanal and commercial fishers use longer gill nets (5–15 nets joined together) with a bigger mesh size (3–5 inches), fish three to six days a week, and operate far away from the main village or settlement, including nearby islands. The standard dimension of a single gill net ranges from 30 to 50 meters in length and a depth of two 2 meters.

Figure 1. A typical gill net commonly used by fishers in Tarawa.

Fishers can either leave the nets out overnight and periodically check and remove fish from the net, or fishers can drive the fish into the net, remove them from the net, and then move on to another fishing ground. Driving the fish into the net can be carried out in several ways. Some of these methods can be destructive to corals and other marine organisms, and marine habitats in general. For example, splashing the water surface using wooden poles or metal bars to disturb the bottom of the sea and scare the fish out from under coral heads and into nets (which is commonly done in Tarawa) can break coral (Ram-Bidesi and Petaia 2010).

The main fish species targeted by gill netting and handlining include bonefish (*Albula glossodonta)*, paddletail snapper (*Lutjanus gibbus*), goatfish (*Upeneus taenogutatus*), spangled emperor (*Lethrinus nebulosus*), mullet (various species), silver biddy (*Gerres* sp.), flametail snapper (*Lutjanus fulvus*), longnose emperor (*Lethrinus olivaceus*), orange-striped emperor (*Lethrinus obsoletus*) and many other species. Bonefish, paddletail, and emperor make up a large percentage (60–70%) of the landed catch (Ram-Bidesi and Petaia 2010). Figure 2 shows a typical catch of bonefish being sold along the roadside.

Overfishing and destructive fishing methods

The term "destructive fishing" has often been used for a wide range of activities, from classical overfishing (non-sustainable use) to outright destruction of the resource and the environment (e.g. use of explosives or other methods) with significant and definitive impacts. Destructive fishing practices or the destructive use of gear in the wrong habitat should be prohibited or strictly regulated so that it affects only a relatively small part of the given habitat. On the other hand, the impact of destructive methods can be so indiscriminate and/or irreversible that they are universally considered "destructive" no matter what circumstance they are used in. Non-selective or destructive methods tend to catch many different species at all life stages, or they can be potentially dangerous to people who use them (e.g. dynamite, cyanide, traditional and modern poisons). Veitayaki et al. (1995) provide an overview of destructive fishing practices in the Pacific Islands. There has been little research done on the above practices, mainly because the people who use these methods are generally not willing to talk about these practices as they know they are either illegal or harmful.

*Figure 2. Bonefish (*Albula glossodonta*) being sold along the roadside.*

Gill nets used in combination with sticks, metal rods and crow bars to scare or drive fish into nets is a destructive practice because of the large surface area covered by using more than two nets. This study shows that gill net fishers who mainly target bonefish and other bottomfish species in Tarawa's lagoon, rely mainly on "splash fishing" — locally known as *te ororo* — which is a destructive method. In some cases, fishers use snorkeling gear and spears to assist not only with herding the fish into nets, but also to break corals in order to scare the fish out from under corals heads and into nets.

Fisheries management regime

In Kiribati, all marine resources are owned by the state or the national government, although in pre-contact days each island had its own fishing rules that regulated who could fish and where. Traditional regulations were abolished in 1967 when Local Government Councils were set up (Hunt 1996). The transition from traditional resource management to open access fishing in Kiribati has been described by Teiwaki (1988). Councils are given the responsibility to control fishing activities in their local areas but council fishery bylaws must be approved by the central government (Hunt 1996).

The Fisheries Ordinance has a provision that allows for preferential access to customary fishing grounds by the rights holders. These rights, however, are not exclusive because anyone who has obtained a license can also fish within customary fishing grounds. Although the provision recognises the access rights of customary rights holders, it does not define the rights and responsibilities with regard to management and conservation (Ram-Bidesi and Manoa 2007).

South Tarawa's increasing population and subsequent economic pressure has exacerbated the problems associated with open access fishing. As resources closer to settlements become overexploited, people venture farther out to other fishing areas. This has been observed with fishers from South Tarawa. Figures 3 and 4 show the typical fishing grounds of fishers from North and South Tarawa. From these maps of fishing areas, it is apparent that fishers from South Tarawa travel farther from their villages than fishers from North Tarawa.

Kiribati's Fisheries Division is poorly resourced with regard to carrying out routine monitoring and surveillance of coastal fisheries. Fisheries extension officers posted in the outer islands are mostly involved in facilitating the marketing of marine products under the Rural Fisheries Development Project.

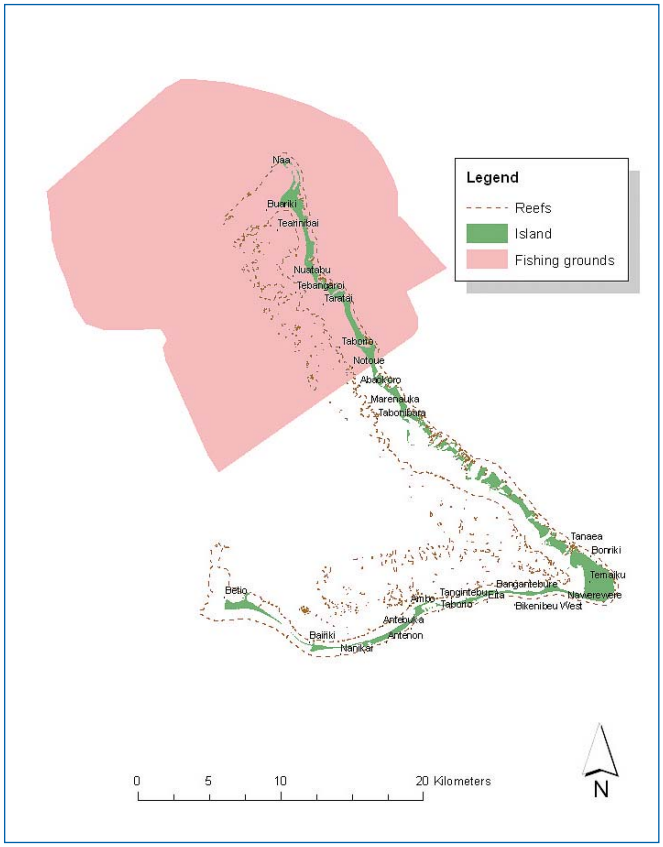

Figure 3. Fishing grounds of North Tarawa fishers.

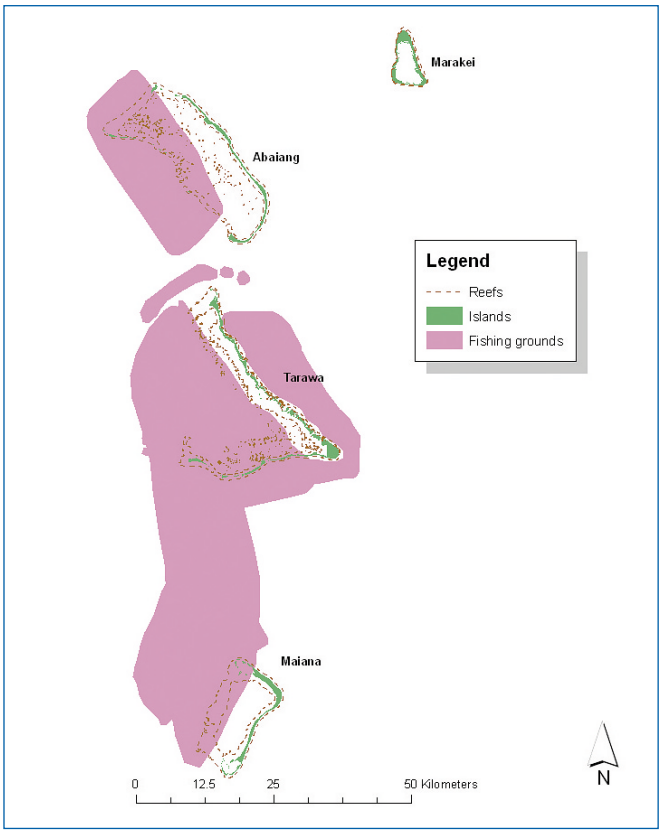

Figure 4. Fishing grounds of South Tarawa fishers.

Many fishers also operate on a part-time basis or fish for subsistence needs. Monitoring and enforcement of fisheries regulations can be an exhaustive task because it requires considerable resources in terms of staff and the capacity of the fisheries management authority. In addition, there is little recourse to punish fishers who are often unemployed or poor.

Therefore, monitoring, control and surveillance of coastal fisheries are weak and local government officials expect fisheries officers to carry out enforcement tasks while fisheries officers rely on local government officers.

The use of the destructive fishing method *te ororo* is regulated under bylaw by the Betio Town Council as well as the Teaoraereke (Teinainao) Urban Council, by designating prohibited zones. However, monitoring and enforcement remains an issue.

Economic assessment of fishing practices

Assessing the economic effects of destructive *te ororo* has required following a series of steps, together with making a number of assumptions. These steps have been carefully stated in order to ensure that the analysis is carefully understood.

- Step 1: The potential productivity of Tarawa Lagoon was estimated in order to assess the optimal level of output.
- Step 2: The impact of destructive *te ororo* on the lagoon area and fishing activities of both part-time and full-time fishers from South Tarawa were determined. (This excluded all oceanic and subsistence fishers.)
- Step 3: The revenues derived from of *te ororo* fishing were determined.
- Step 4: Costs were assessed by taking into account the apparent environmental damage caused by using a crow bar or metal rod. The methodology for assessment was adapted from a study by McManus and Reyes (1997), which looked at anchor damage to coral reefs.
- Step 5: The cost–benefit assessment was done by considering the revenue from destructive *te ororo* against the loss of revenue from non-destructive fishing practices, and change in revenue from tourism and coastal protection.

Assessing the impact of destructive fishing methods in Tarawa's lagoon is complicated because several studies show that lagoon productivity has been affected by increased population pressure, resulting in increased anthropogenic factors such as pollution due to sewage and other wastes, the construction of a causeway, and the mining of coastal beaches. Under such circumstances, any decline in reef and lagoon fisheries production is, therefore, compounded by non-fishery related factors in addition to the increased fishing pressure by different methods and intensity of fishing effort.

Given the structure of Tarawa's lagoon, which consists of several patch reefs and a shallow bottom dominated by reef fish species, the lagoon was considered as a total reef area for the purposes of determining the potential productivity of the lagoon and reef.

Assessing the impact of using destructive *te ororo*

The use of gill nets was found to be the most widespread fishing method in Tarawa, used by all fishers interviewed (in both North and South Tarawa). Fishers from North Tarawa, however, stated that they only occasionally use splash method *te ororo* while using gill nets, and no one indicated that they use encircling nets on reef patches in combination with iron bars, sticks or crow bars. Therefore, the use of destructive *te ororo* was considered to be largely practiced by fishers from South Tarawa. Fishers from South Tarawa did not out rightly admit using coral damaging *te ororo* but reported the widespread use by fishers "in their neighbourhood". Therefore, households from South Tarawa that fished using several gill nets during one fishing trip were assumed to be using coral damaging *te ororo* (in combination with crow bars and metal rods on reef patches).

Summary of results

Assessing the level of damage that *te ororo* may have on coral reefs is complicated because not there is not only an immediate impact but also an accumulated impact on habitat and species composition and, hence, productivity long after initial use. Therefore, the only major indicator of damage that could be assessed was the impact of crow bars and metal rods on coral heads to determine the amount of damage to the reef each year. This study estimates that approximately 3% of coral patches or reef area per square kilometer is damaged each year.

In conducting this economic assessment, both direct and indirect costs and benefits were considered. However, reef functions, such as social and cultural functions and biodiversity, cannot be easily monetised. The study, therefore, considered three uses of reefs: fisheries, coastal protection and tourism.

The methodology used by Pet-Soede et al. (1999) to analyse the impact of blast fishing on Indonesian coral reefs was adapted because the principles of analysis are similar even though the fishing methods used are different. The economic analysis is based on the difference between "with *te ororo*" and "without *te ororo*" scenarios. The without scenario included the commercial fishing practices of North Tarawa

$$NB_{k,t} = NR_{o,t} - (VN + \Delta VT_t + \Delta VC_t) \qquad \text{(equation 1)}$$

Where:

$NB_{k,t}$ = net quantifiable benefits to Kiribati in year t,

$NR_{o,t}$ = net revenue from *te ororo* fishing in year t,

VN = value (foregone revenues of non-destructive fishing in a situation without *te ororo* and at an exploitation level near maximum sustainable yield (constant over time),

ΔVT_t = loss in value of tourism for year t,

ΔVC_t = loss in value of coastal protection for year t (Pet-Soede et al. 1999:85).

The input values for the model parameters were derived from the present quality of Tarawa's coral reef. The losses with change in value of tourism and change in value of coastal protection represent the difference between the values in the "with" and "without" scenarios at time t. The analysis is based through time from when the reef was intact to when 75% of the reef was destroyed (McAllister 1998; Pet-Soede et al. 1999). The analysis is carried out for the total time period needed to destroy 75% of the coral and using a 10% discount rate per year. With a rate of coral destruction, the net present value (NPV) of the individual parameters to the general model was calculated by summation of the annual totals over 75/α year with a 10% discount rate per year using the formula:

$$NPV = \sum_{i=1}^{75/\alpha} \frac{\text{value}_i}{(1+\text{discount rate})^i} \qquad \text{(equation 2)}$$

α = area destroyed by the use of crow bars and iron rods per km^2 per year over an area covered with coral per km^2 of reef. In this instance α = 2.87% or 3%.

$$NR_{o,t} = GR_{o,t} - (C_{o,t} + C_{lt}) \qquad \text{(equation 3)}$$

The yield from *te ororo* fishing was assumed to decrease linearly with destruction of the coral reef. The annual net value of non-destructive fishing, VN, was derived by subtracting the operational costs (Cn) and opportunity costs (Cl) of labour from the total gross revenue for non-destructive fishing, GRn. The VN scenario remained constant through time.

$$VN = GR_n - (C_n + C_l) \qquad \text{(equation 4)}$$

This was derived by considering the operations of part-time and full-time fishers of North Tarawa who were using nets and hook and line but not practicing destructive *te ororo*. The cost structure of fishers from Taratai, Buariki and Nooto in North Tarawa was derived from interviews.

The annual net value of coral reefs for tourism VT_t depends on the level of coral destruction, and decreases linearly at a rate of α from the initial value VT_0, reaching zero when no corals remained (Pet-Soede et al. 1999:87).

$$VT_t = VT_0 (1-t\alpha) \qquad \text{(equation 5)}$$

Tourism has been limited in Tarawa, although foreign and local visitors often visit the sandy beaches of Abatao, Biketawa and Naa islets of North Tarawa. The travel cost approach was used to value tourism-related activities of the lagoon. VT_t depends on the level of coral destruction, and decreases linearly with the rate from the initial value of VT_0, reaching zero when all corals are destroyed (Pet-Soede et al. 1999).

The study estimated the annual net returns from tourism to be AUD 4,500 at a 10% discount rate, which gave a tourism value at the end of year 1 of AUD 3,974. At the end of year 26 (assuming 75% of corals to be damaged), the tourism value declines linearly to AUD 96.00.

$$VT_t = VT_0 (1-t\alpha)$$

$\alpha = 2.87\%$, $t = 26$ years, $VT_0 =$ AUD 4,500

The annual value of a coral reef for coastal protection, VC_t, also depends on the level of coral destruction and decreases linearly with α from an initial value VC_0, reaching zero when no corals remain (Pet-Soede et al 1999:87).

$$VC_t = VC_0 (1-t\alpha) \qquad \text{(equation 6)}$$

It is often costly to carry out studies to determine the precise total economic value of coral reefs. In light of this, Cesar (2000) states that it is possible to use a meta-analysis of studies carried out in other comparable areas. The study by McKenzie et al. (2005) for the Marshall Islands estimated the value of coastal protection to be USD 11,153.30 per meter.[1] For Tarawa Lagoon, the the reefs acting as a protective barrier against strong wave damage were estimated to be worth AUD 38,478,885. The value of coastal protection when 75% of the reefs are damaged in 26 years would be reduced to AUD 819,416. Therefore, the coastal protection afforded by the reefs is seen to decline in value by approximately AUD 33,157,439.

The net benefit of using destructive *te ororo* is, therefore, the net revenue from using destructive *te ororo* minus the foregone revenue from the use of non-destructive fishing methods and the change in the value of tourism and coastal protection.

$NB_{te\ ororo}$ = – AUD 1,879,806 – (AUD 41,297,516 + (–AUD 3,878) + (–AUD 33,157,439)) = – AUD 76,338,634

[1] USD 1.00 = AUD 1.01 (October 2011).

Therefore, the annual loss can be conservatively estimated to be about AUD 3 million from the use of destructive *te ororo*. In fact, the annual loss is likely to be much higher given the rapid growth in population, which places additional pressure on the resources. Other costs, such as options or bequest values and indirect benefits, have not been calculated. In comparison, given the government revenue of AUD 59.5 million (excluding grants) in 2007, this amounts to 5% of annual government revenue and equivalent to 3.5% of the gross domestic product.

Alternative livelihoods – substitution costs

Fishers were asked to consider the most likely alternative income source to support their livelihood in the event of loss of fishing opportunities. Responses of fishers from North Tarawa were slightly different from those from South Tarawa. The four options for fishers included working as a wage earner, agriculture, running one's own business, and seafaring.

If fisheries resources declined severely, fishers would be left with limited options and the costs of engaging in other alternatives would be high for them. For example, even if fishers turn to agriculture, there are costs associated with buying or leasing land, which is one of the scarcest resources in Kiribati. Wage employment options are limited in North Tarawa because of limited private sector activities. Fishers would have to move to South Tarawa, where the rate of unemployment is already high (ADB 2009).

Setting up a small business requires up-front capital, which many fishers do not have. In addition, too many small canteens selling similar goods results in lower incomes that are unlikely to meet the daily needs of fishers' families. The analysis underscores the importance of fisheries as a income source for fishers as opposed to other income earning options. This, therefore, demonstrates that the opportunity costs of loss of access to fishery resources would be very high for fishers who are currently relying on fisheries in and around Tarawa Lagoon. Costs associated with alternative livelihood choices must be considered as part of the economic cost of the loss of fishery income due to the use of destructive fishing practices.

Reducing fishing pressure

Controls on fishing effort and limits on catch in Tarawa will need to be imposed in order to achieve sustainability of resources. Direct and indirect strategies will need to be identified to relieve fishing pressure. A combination of policy instruments, ranging from seeking alternative livelihoods and incentive-driven measures to legislative reforms, are required. Some options include:

- Employment as seamen and crew on foreign vessels.
- Small-scale longline fishery for tuna and other pelagic fish around fish aggregation devices.
- Small-scale cottage industries that use solar energy to process tuna for local and export markets.
- Improvements in the post-harvest sector to raise the quality of fish, which can increase the value of fish sold and improve on the price.
- Cottage industries such as handicraft making, including fine mats and baskets.
- Seasonal employment in Australia and New Zealand under special arrangements.
- Nature-based tourism that capitalises on outer island locations near North Tarawa.
- Further strengthening of agricultural diversification under the Taiwan Government initiative.
- Place a higher priority on mariculture of giant clams, trochus and beche-de-mer by restocking reefs.
- Further research and feasibility studies on the deployment of artificial reefs or structures that can act as habitat for fish and areas of fish aggregation.

Fisheries management options

Community-based fishing rights in the Pacific remain a critical aspect of coastal fisheries policy. These rights are seen as more effective forms of coastal fisheries management than centrally controlled fisheries (Ruddle 1996; Johannes and Yeeting 1995; Aswani 1997), and the delegation of some management responsibilities to local people has proven to be more successful. This study also points out that community-based coastal fisheries management in Tarawa is an important option, particularly where community decision-making is still very much dependent on village elders and local councils.

In order to strengthen community-based fisheries management, a multi-pronged approach is necessary in Kiribati, and more so in Tarawa, where previously existing forms of traditional marine tenure systems have deteriorated due to centralized resource management by the government due to urbanization.

Besides the Phoenix Island Protected Area, Kiribati needs other conservation areas to effectively protect its marine biodiversity, nursery and spawning grounds, and other critical and vulnerable habitats.

An integral part of institutional reform, with respect to fisheries management and conservation in Kiribati, also includes parallel reforms with public awareness programmes through formal and informal means. The integration into school curriculum, use of media, campaigns and advocacy, involvement of youth, women, non-governmental organisations and church groups will be required to convince people why the steps taken are necessary and to gain support and legitimacy.

Conclusion

In order for fisheries in Tarawa's reef and lagoon areas to remain sustainable, there is a critical need for policy change and the modification of fishing methods

and practices at the individual fisher level. Bringing about such reforms will require adequate consultations between and among the highest levels of government, and individuals and community groups to cooperatively formulate a fisheries management plan for Tarawa. With limited alternative income sources and huge opportunity costs, it is important that fisheries are managed at sustainable levels. The economic costs are relatively high for Kiribati, particularly in light of increasing population in South Tarawa.

The economic costs of destruction from *te ororo* fishing is estimated to be 5.0% of government revenue annually and approximately 3.5% of gross domestic product. The cumulative effects of this loss over time on the economy and people of Kiribati should be underscored for immediate action.

Having an appropriate and effective fisheries management regime will not only require an appropriate institutional framework but also action to reduce fishing effort. This will in turn require further definition of fishing rights and some criteria for their allocation.

The Government of Kiribati should have a clear vision and goal for its coastal fisheries, particularly in ensuring that the lagoon remains in a healthy state. The results of this study clearly demonstrate that the use of *te ororo* is destructive and should be banned, and that regulations on the gill net use should be strengthened.

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