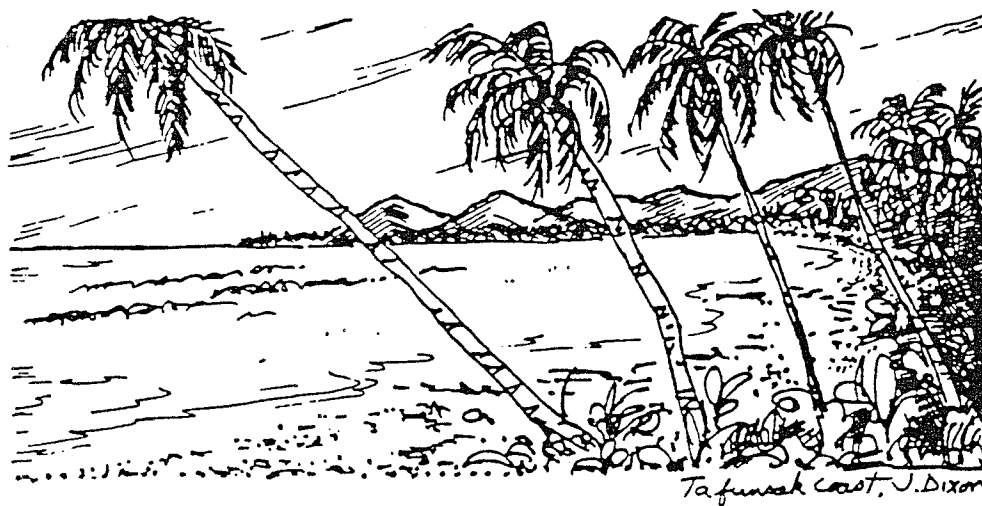


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Kosrae Island Resource Management Plan

(Volume II)



Collected Papers by:

Jan Auyong
Shannon Cripe
Kim Des Rochers
John Dixon
Michael Ham
Padma Lal

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Moliron Okat to Foko Finaumpes
Maps 16, 17, 18, and 1

Section 1
Foko Finaumpes to Foko Put
Maps 18, 1, 2, 3, and 4

Section 2
Foko Put to Foko Fukunrsal
Maps 5, 6, 7, and 8

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Coastal and Marine Tourism and Recreation Opportunities in Kosrae State, Federated States of Micronesia

by

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November 1990

INTRODUCTION

One of the greatest impacts on the economies, communities and environments of numerous tropical and subtropical communities has been the unprecedented growth of the resort/hotel and commercial recreation industry (Figure 1). Since 1960, tourism has shown the fastest growth in the Pacific Basin as compared to all other tourism regions (Table 1), although Pacific tourism is distinguished by vast stretches of ocean between destinations and tourism has grown only in certain Pacific islands (Table 2). Tourism is an attractive potential generator of employment and foreign exchange earner being second only to oil in world trade (Bosselman, 1978; deKadt, 1979; Dwyer, 1986; Mathieson and Wall, 1982; Wilkerson, 1989; World Tourism Organization, 1982). Yet, growth can often proceed at an alarming rate, without coordination, and raising questions about the possible impacts on reef, mangrove and shoreline areas as well as resident communities adjacent to or downcurrent of coastal developments (deKadt, 1979; Thomas, et al., 1989; Wilkerson, 1989).

Kosrae's potential as a small coastal tourism destination stems from its physical features as a high island, its relatively rural setting and the friendliness of its people. Kosrae offers varied topography, lush tropical vegetation, and reef and marine supported activities such as diving and fishing. Sandy beaches and calm embayments can provide the basis for numerous other marine tourist and recreational activities and enterprises by Kosrae's people. These opportunities meet some of the long-term development plans for the state including: opportunity for

households to earn cash income; increase standard of living and quality of life within the framework of the existing culture (Kosrae State Government, 1985). Basic to Kosrae's development are that activities should ensure the renewability of resources, and that development should be balanced with resource protection.

Tourism and recreation can and should be symbiotic with conservation (Gunn, 1988). Most tourism and recreation today depends upon clean physical environments and protected resources, the very foundations of conservation (Gunn, 1988; Mathieson and Wall, 1982; White, 1987; Wilkerson, 1989). A large segment of tourism depends upon the attractiveness of destinations enhanced by parks that are natural or cultural/historical, resource-oriented (parks that can accommodate a certain level of people-use) or user-oriented (development-intensive areas such as marinas, beaches, picnic areas, and playgrounds). Recreational use outside of parks also relies upon quality resources. The point to remember is that conservation and tourists can mix - where properly planned and managed.

Gaining popularity among Americans and Europeans is "ecotourism" or "nature tourism" which gives developing countries economic returns for preserving nature. "Ecotourism" protects natural

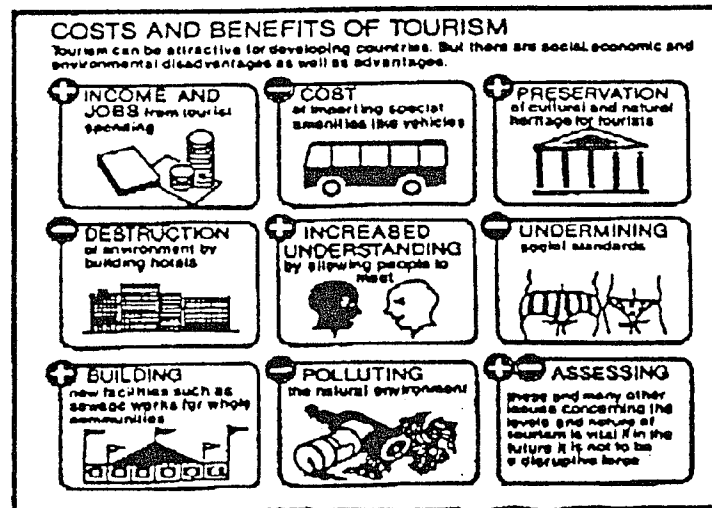


Fig. 1.1. Diagram illustrating possible costs and benefits of tourism (reproduced with permission from 'Costs and Benefits of Tourism', United Nations Environment Programme 1979).

Figure 1: Costs and Benefits of Tourism (Source: Edington and Edington, 1986)

Table 1: World Travel Trends

	Arrivals (thousands)			Annual Growth (percent)	
	1975	1980	1985	1975-85	1980-85
Africa	4,654	6,413	8,000	5.6	4.5
North America	29,360	35,376	33,491	1.3	-1.1
South and Central America	13,603	18,270	20,009	3.9	1.8
East Asia and Pacific	7,804	19,981	34,000	15.9	11.2
Europe	153,859	195,966	220,000	3.6	2.3
Middle East	3,520	5,821	7,000	7.1	1.9
South Asia	1,557	2,280	2,500	4.8	1.9
WORLD TOTAL:	214,357	284,107	325,000	4.2	2.7

Source: Lepani, C. (1988)

resources and the environment by stressing the tourism value of those resources over their exploitation or other development. Various countries have created aquatic parks along coral reefs or set aside forest parklands. New hotels are often of rustic design resembling and reflecting local architecture (Star Bulletin, 1989 a and b) and are incorporated into the local landscape rather than overwhelming it. A popular variant of "nature tourism" is "adventure tourism" which highlights sports and safari-type activities in natural settings. This sector of "nature tourism" is increasingly popular among Japanese and younger visitors. Another variation or approach is called "soft tourism." This approach emphasizes living harmoniously with tourism, striving for quality rather than quantity, stressing use of small-scale developments in tune with the surrounding landscape and community.

Many inter-related factors influence the amount, nature and distribution of tourism on small islands, but two of the main factors for locating tourism development are access and attractions. The small size and isolated nature of small islands often lead tourist accommodation to be concentrated in a small number of coastal sites in or adjacent to the major urban center and close to an international airport. The steep volcanic interiors limit the amount of land which is suitable for development and cause pressure on the narrow band of coastal plain to support transportation routes as well as tourist, commercial and residential activities. Careful and ingenious planning is essential to avoid overdevelopment and loss of those features which created tourism potential in the first place.

Sun-sand-sea tourism predominates on tropical and sub-tropical islands due to the preponderance of these types of resources over other natural resources. Coastal regions which include wetlands, such as mangroves and tidal swamps, and nearshore reefs are relatively fragile but productive habitats (Figure 2) which are extensively exposed to human influence and can be profoundly impacted by development, tourism and other human activity. These resource areas are also critical to many of the world's fisheries. The development, management and protection of these important areas can be accomplished through integrated planning to avoid or resolve conflicting priorities. Planning thoughtfully, managing natural and scenic resources, and making decisions cooperatively can lead to a number of benefits for the community through tourism development.

A useful starting point for analysis of touristic and recreational development is to consider development as a functional system with a number of interrelated elements (Gunn, 1979 and 1988; Pearce, 1981; Moisse, 1976). The basic elements should include: the tourists-users, transport networks, attractions, facilities-services, information systems, and rules and attitudes of local decision-makers and population (Figure 3). The tourist recreationist can be considered a demand element while

Table 2. Visitor arrivals (thousands) to Pacific island destinations, 1980-1984

	1980	1981	1982	1983	1984	Av. Annual Growth (%)
A Samoa	40.4	24.4	21.8	17.7	19.4	-16.8
Cook Is	21.1	18.6	17.5	19.8	25.6	5.0
Fiji	190.0	190.0	203.6	191.6	235.2	5.5
Guam	291.7	312.9	316.8	345.0	361.4	5.5
Micron	140.	137.4	127.3	124.0	131.8	-1.5
NewCal	65.5	81.6	85.8	90.4	91.5	8.7
PNewGuinea	38.8	35.2	32.5	31.6	33.6	-3.5
SolomonIs	10.5	11.2	11.1	11.1	11.1	1.4
Tahiti	94.3	96.8	113.9	111.1	101.6	1.9
Tonga	12.5	13.5	13.2	15.8	17.1	8.2
Vanuatu	22.0	22.1	32.2	32.4	31.6	9.5
W Samoa	33.1	42.6	43.0	36.7	36.7	2.6

Source: University of Hawaii, 1987

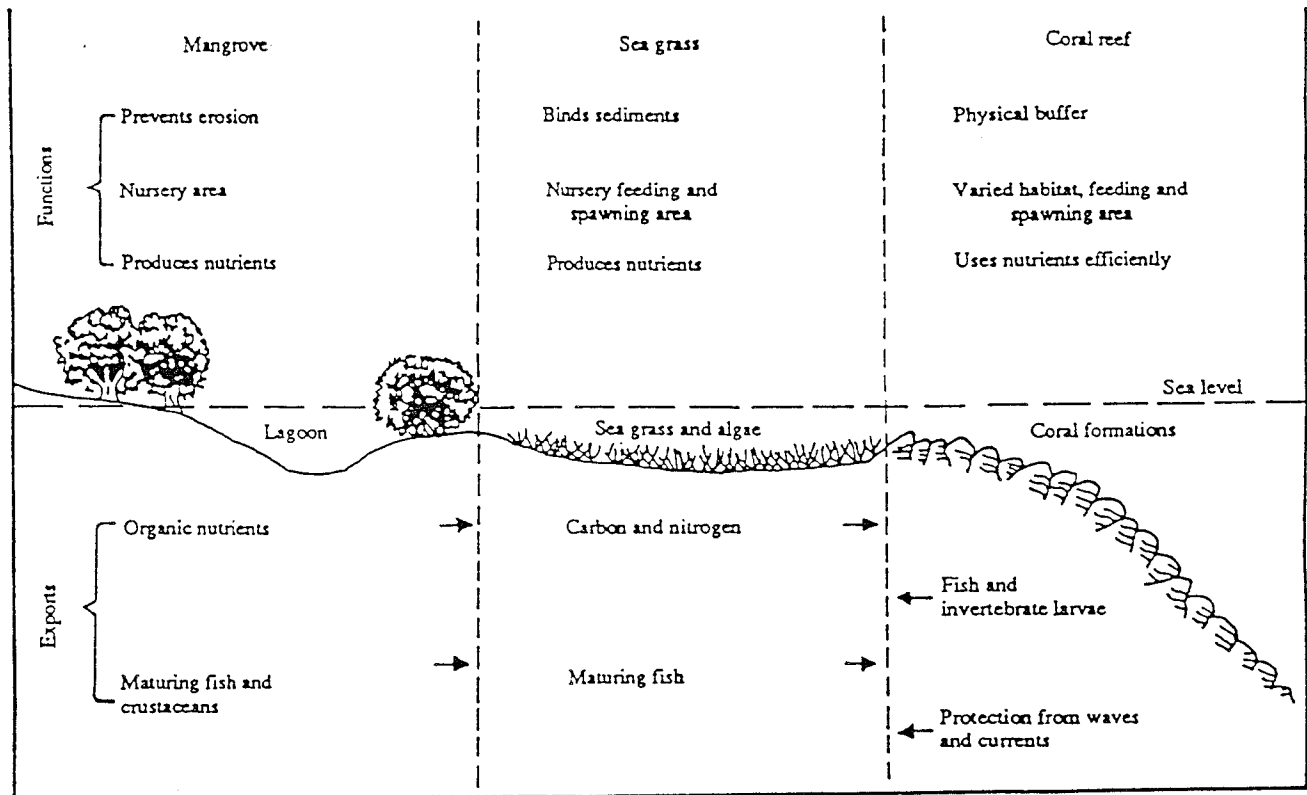


Figure 2: Mutual Benefits Among Mangrove, Sea Grass and Coral Reef Ecosystems

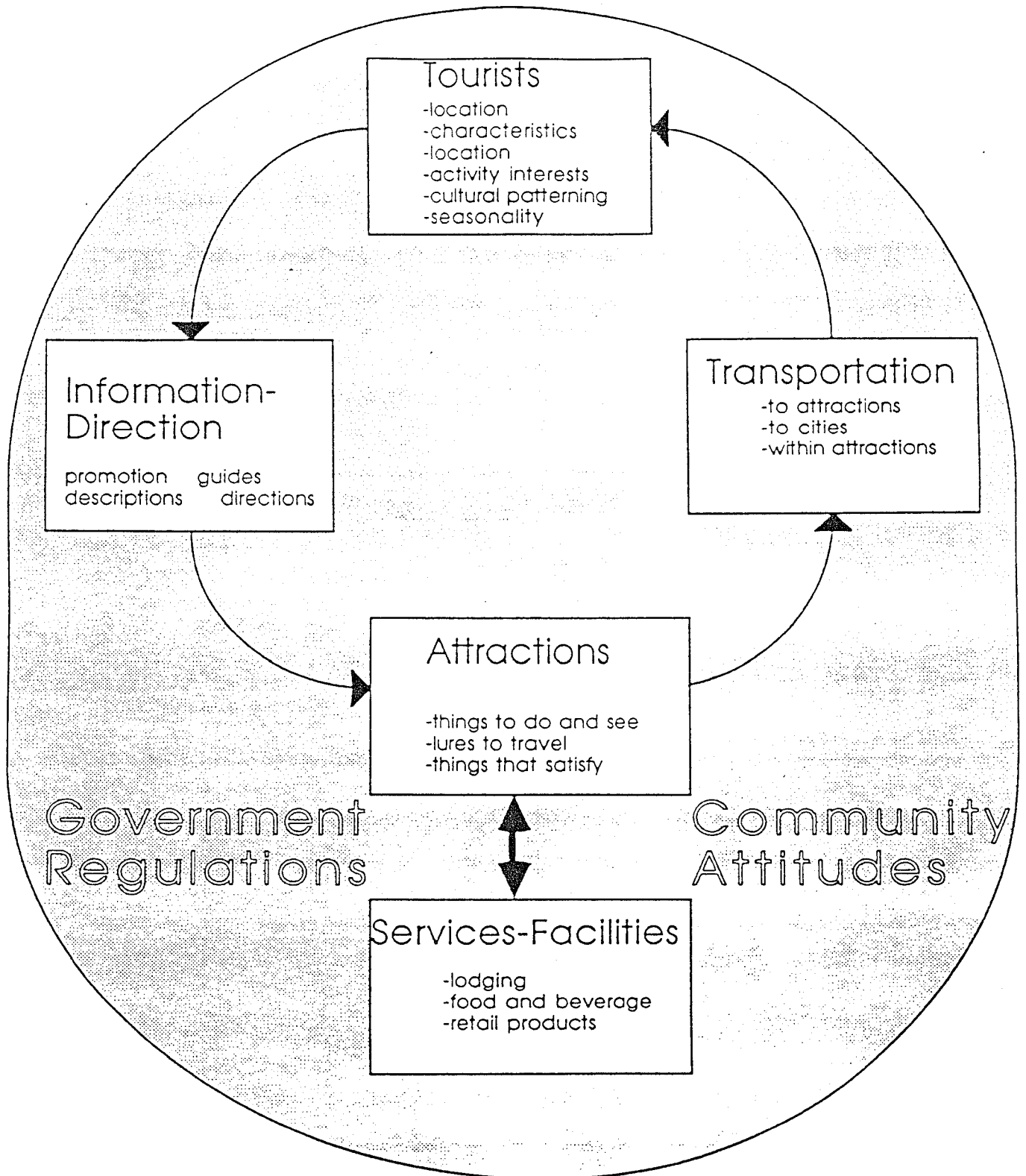
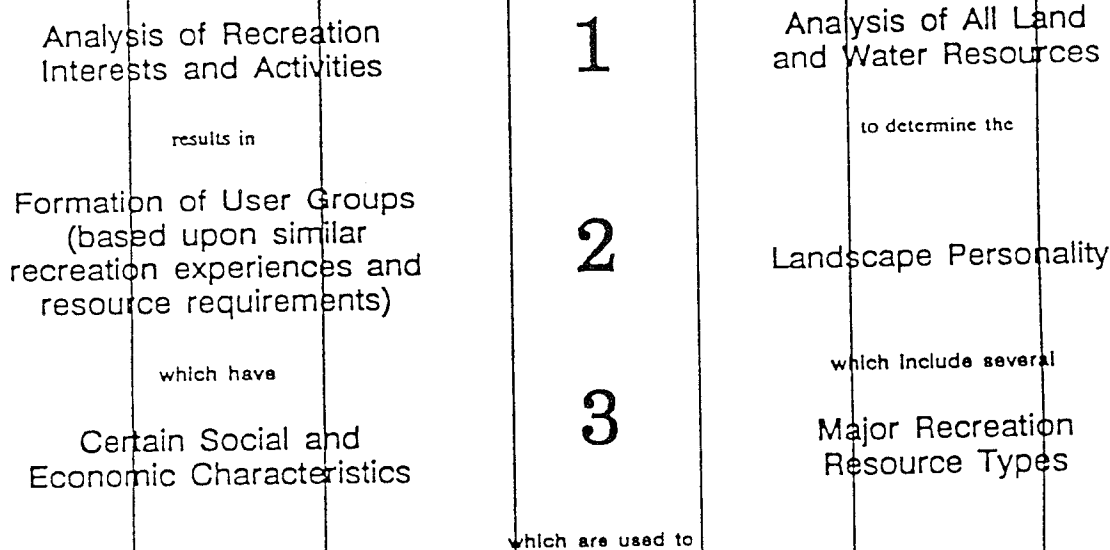


Figure 3: The Tourism Functional System

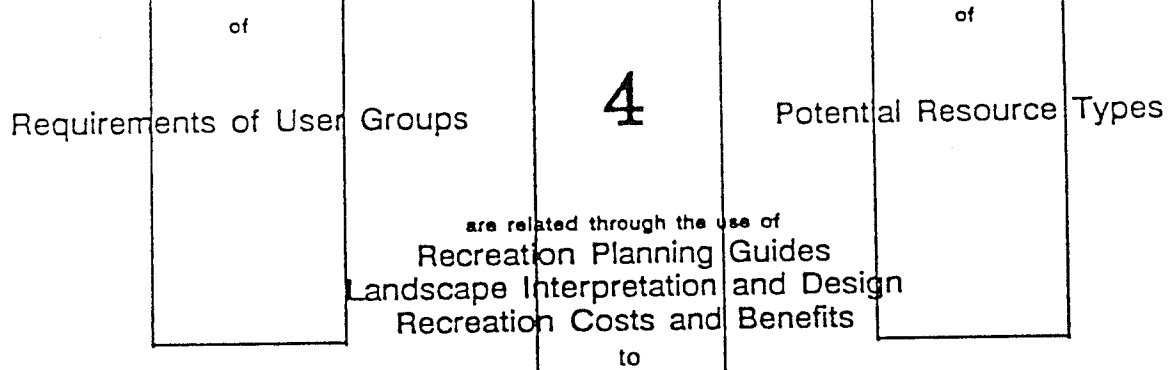
A

IDENTIFY RECREATION USERS AND RESOURCES



B

ESTIMATE RECREATION DEMAND AND SUPPLY



C

PROPOSE A RECREATION PLAN

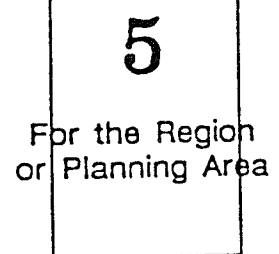


Figure 4: Recreational User Resource Planning

attractions/services/facilities represent the supply element. These elements must be brought together via transportation and information activities. However, these major components must occur within a particular policy and management atmosphere to truly function.

To properly plan and carry out nature based tourism, an understanding of both the user and the resource base is needed (Figure 4). Resource management should be considered "people management". Linking people's needs with available resources and examining the mix for conflicting uses will produce the greatest benefits with the least amount of negative impacts.

The following sections will describe Kosrae with respect to the nature tourism and the components noted above. First, the resource base will be described and the activities currently supported. Then, potential activities and possible locations will be presented. The tourist component and information/transportation considerations will follow and management considerations will end the discussion.

THE RESOURCE BASE

Kosrae is situated within the equatorial countercurrent and experiences northeast trade winds from December to April and southeast trades from July to October. The wet season occurs during the period of southeastern trades. The climate is warm and moist but tempered by cool ocean breezes.

Kosrae is actually two high, volcanic islands with several coral islets located on a narrow fringing reef (Frontispiece). These combine to produce a total land area of about 109 square kilometers (42 square miles) (U.S. Army Corps of Engineers, 1989). The small island of Lelu is connected to the main island by a long causeway. The steep, highly eroded interior of the larger island is fringed by a relatively narrow coastal margin which only accounts for about 30% of the total land area of Kosrae (Whitesell, et al, 1986). From the base of the basaltic uplands, a somewhat broad carbonate platform, probably of recent coral reef origin, extends 2 to 5 kilometers (1 to 3 miles) seaward to the north and west and less to the east and south. A pattern of volcanic uplands and lowlands, freshwater swamp forest, mangrove forest, strand/coral land, and open seaward shoreline is repeated along most of the coasts, although small mangrove stands may extend out from the open seaward shoreline in a few locations (Frontispiece, Figures 5-6). Each component is present in different degrees depending on whether the coast is a windward or leeward one.

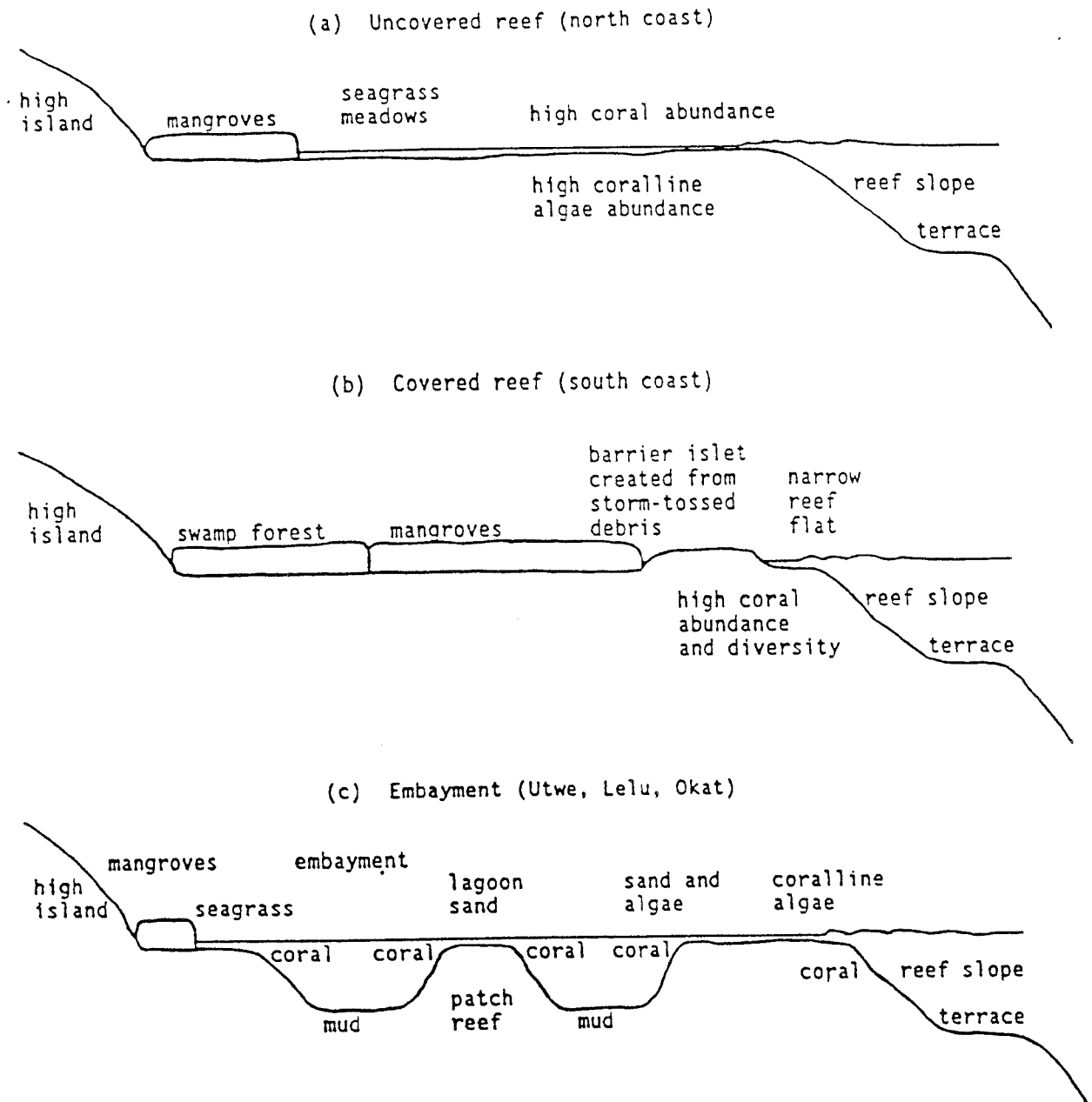


Figure 5: Digagrammatic Representations of "Typical" Cross Sections

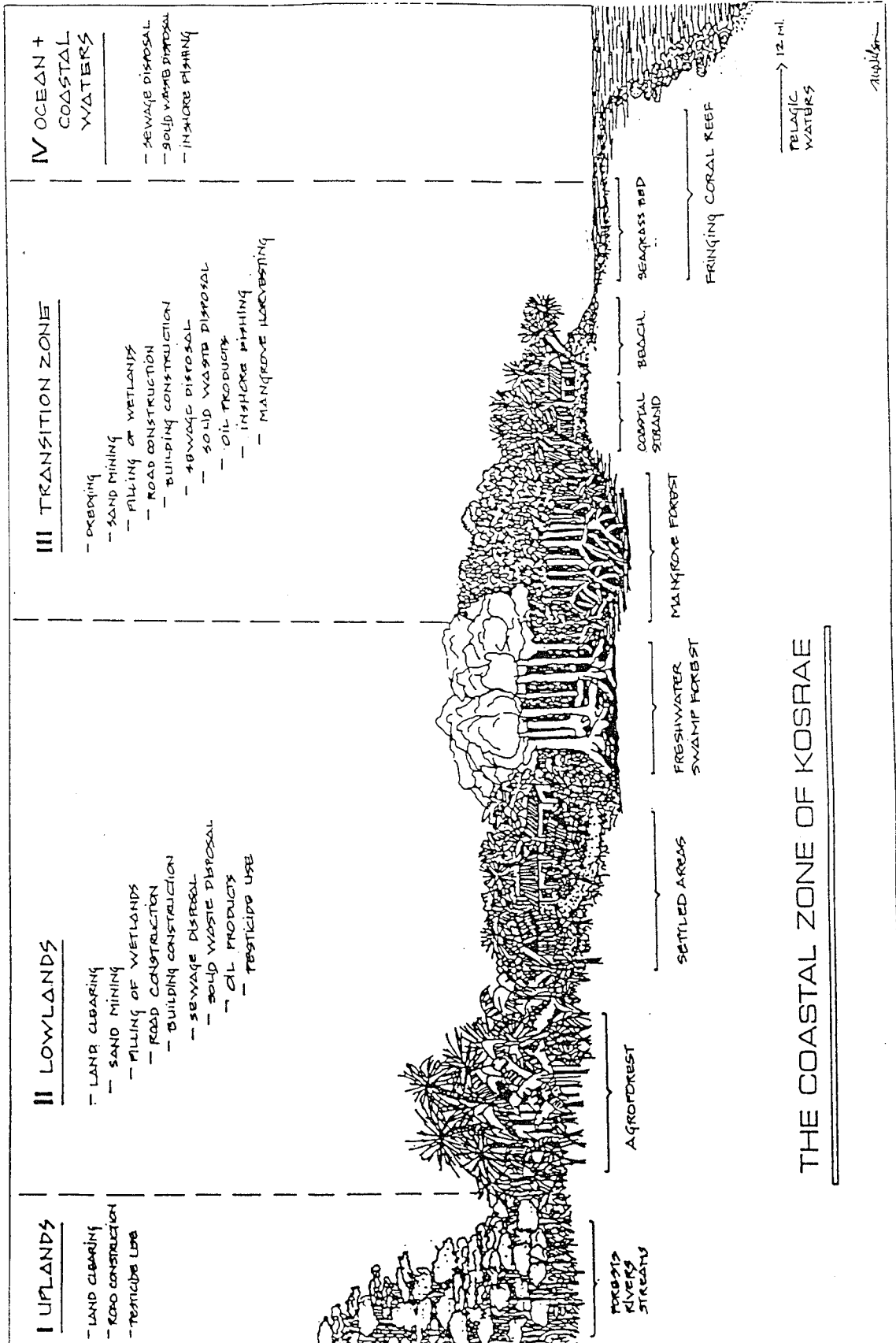


Figure 6: The Coastal Zone of Kosrae

Three small embayments cut through the carbonate platform: Lelu Harbor off the east coast, Port Lottin or Utwe Harbor off the south coast, and Okat Harbor off the northwest coast (Frontispiece). The floors of the embayments are generally deep and covered with fine muds and silts. Deep passes cut through the reef at the entrance to the embayments, and are flanked by steep, talus slopes with variable coral cover. The inner slopes are dominated by lagoon or quiet water coral species and show less diversity and abundance.

The inner reefs are usually open reef flats dominated by coral sand and rubble which support productive seagrass beds. The middle to seaward portion of the open reef platform is frequently covered by coral rubble (or shingle), and some large limestone reef blocks.

On windward (north and east facing) reefs, the outer surf zone of the reef platform is abundantly populated by robust corals and coralline algae forming spur and groove systems (Figure 7). Steep reef slopes and terraces with very luxuriant coral growth and high coral diversity extend beyond the spur and groove formation.

On leeward facing reefs the spur and groove formations are less developed or absent altogether, and a coral-rich reef slope extends seaward before descending abruptly beyond the outer edge of the reef flat. The southern reefs are much narrower in width and show a high concentration of coral rubble, sand, and other reef deposits which may be the result of heavy wave action from storms. This material has a ready source from the high abundance and diversity of reef corals along these reef fronts.

To date, only two major environmental surveys have been conducted on Kosrae's marine flora and fauna, but both surveys revealed a profusion of marine life (Eldredge, et al., 1979; U.S. Army Corps of Engineers, 1989). The majority of Kosraeans gather food through reef gleaning of invertebrates such as sea cucumbers and trochus, and fishes from the fringing reef flat and reef edge. Pelagic species are abundant in the surrounding oceanic waters and include wahoo, barracuda, tunas and mahimahi. Much of the pelagic resources have yet to be tapped.

The coastal wetland vegetation include mangrove and tidal swamp forests. Kosrae differs from other Caroline islands in that much of the mangroves occur behind a protective coastal strand, except on the northwestern side (Stemmermann and Proby, 1978). Seven different forest communities or alliances can be named on the basis of the dominant species (Lal, 1989). The development of these groupings depend upon the complex interaction of factors such as: the degree of wind protection, water currents, tidal influences, level of river discharge and freshwater runoff, types of sediments, etc. (Lal, 1989). In the

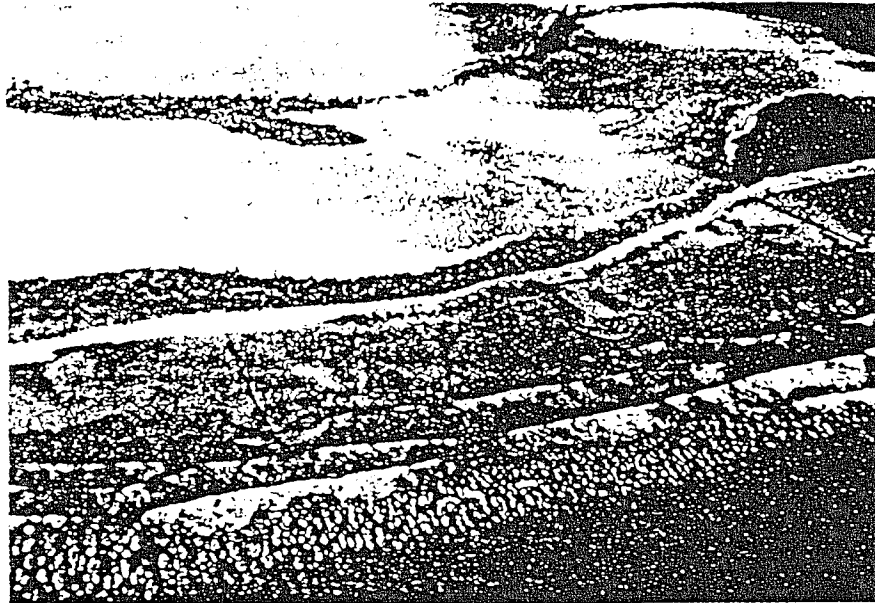


Fig. 10 Tarawa Atoll, Kiribati, northeastern corner. Spurs and grooves. Fishing weirs on reef flat. Beach rock in the beach (Photo A. Guilcher)



Fig. 11 Scilly Atoll, Society Islands. northeastern rim. Outer spurs and grooves in *Porolithon*; reef flat; sandy accumulations near inner edge, adapted to overwash flowing to open sea when lagoon is overfed by southern swell. See Fig. 120 (Photo A. Guilcher)

The outer edge of reefs on the windward side, from the surface down to a few meters, are generally cut by systems of more or less spaced grooves, separated by ridges of coral and coralline algae. The species growing in these formations thrive in heavy surf. The grooves are characterized by heavy surge. These formations characterize reefs on coasts exposed to high wave energy and are poorly developed on more sheltered coasts (Guilcher, 1988).

Figure 7: Spur and Groove Systems

mangrove forest, four alliances are found: *Sonneratia*, *Rhizophora*, Mixed Mangrove, and Nipa. In the swamp forest, three groups are identified: *Terminalia*, Mixed Swamp, and Freshwater.

There are several major, significant areas of mangrove and swamp forests in Kosrae. The tallest *Sonneratia* trees in all the Caroline archipelago are found in the northwestern mangrove forests of the Okat and Yela basins (Stemmermann and Proby, 1978). Additionally, the Okat Basin contains the single largest mangrove and swamp forest on Kosrae. While this forest has a mixed alliance, there is poor regeneration of *Terminalia* ("ka"), one of the best commercial timber resources in Kosrae. In contrast, the Yela Basin adjacent to the Okat has the best strands of ka (immature and mature trees) with good natural regeneration. The western portion of Utwe District is known for its trees of mangrove carving wood and Nipa palm.

A number of spectacular and important species are associated with the mangrove. These include the Monitor lizard (reptile), seabirds such as the tropic bird, terns and noddies, and the tasty Mangrove crab (crustacean). Mangrove crabs are the only faunal species taken commercially from the forests to date.

The following section will deal with characterizing specific municipality districts and sublocations for tourism, recreation, and protected areas management. Factors assessed included, but were not limited to the following: physical resource features such as wind, currents, surf, beach slope and grain size; biological elements including diversity, density, and color; aesthetics; public access and land tenure; jurisdictions over marine resources and waters, infrastructure, cultural and social desires and perspectives.

Characterization by Municipal Area

Lelu

Northern Lelu (the barrier islet) has sandy beaches but these are not as extensive or as fine grained as those along Tafunsak due to their more windward exposure. The barrier islet is heavily trafficked due to the presence of the circumferential road. This road is currently unpaved and creates considerable dust and noise especially when large construction vehicles pass. Several hotel sites are either cleared or will soon be under construction. The road is often positioned very close to the beach, sometimes located right on the "dune". Some erosion is occurring, particularly at either end of the islet.

Inya Insrefusr (behind the barrier islet) is mostly passable by boat or canoe at mid to high tides. At low tide, the sandy-silt creekbed at the

northern end is exposed and the southern reaches are wadeable. The creek is fairly wide at the Lelu Harbor (southern) side but is quite narrow and overgrown near the northern end. It takes approximately two-three hours to make a round trip by motorized boat or canoe.

Lelu Reef (south of the islet) was divided into an outer and inner portion when the causeway was constructed across the reef flat. Circulation to the inner reef was further diminished when the middle culvert was blocked in the construction of the old runway. The inner reef area receives considerable amounts of sediment from several creeks and is slowly becoming impassable at low tide. The offshore reef flat is heavily used by residents for reef gleaning activities and the small reef hole nearest the causeway is frequented by residents and some visitors for recreation. Not many use the larger seaward reef hole at the moment which has some interesting geological (pillars and small caves) and biological formations and a resident group of rays. Both holes have poor visibility due to suspended sediment. With intensive use the reef hole closest to the causeway may not receive sufficient flushing. The larger, seaward hole appears to have inputs of cold water on the southern end, possibly from passageways through the reef.

Lelu Harbor, whose entrance is in excess of 90 feet, is a good, deep harbor. However, heavy residential use restricts shoreside space for port facilities expansion. It is known for several wrecks (large ship, airplane, etc.) that could accommodate diving during rough weather and offshore seas although water clarity is poorer here than in offshore areas.

Malem

Malem possesses some unusual mangrove features with individual trees growing in the surf. Surfing activities are possible in this location, however, the break can be hazardous due to reef topography and short wave intervals. Ocean access is difficult in this district except from the village of Malem where the surf breaks almost on the doorsteps of the community. Outside of the village a number of paths lead from the coastal road through the mangroves to the shoreline. Large coral shingles were deposited in the area due to storm activity during past typhoons and the beach is littered with coral debris and driftwood. There is evidence of coastal erosion along a good portion of this coast that may possibly be due to redirection and channelization of streams (Cripe, 1989).

Malem District does not have as much marine tourism potential as the other districts on Kosrae, but fortunately, Malem residents do not appear to have as much interest in developing marine activities as do communities in Utwe, Walung and Tafunsak. Activities revolve around agriculture in the coastal plain inland of the village.

On the other hand, coastal tourism activities such as walking, bicycling, and visiting historical/cultural attractions could emerge as important complementary enterprises in the area. The district is known for Japanese artifacts from World War II. Additionally, farm tours or botanical gardens could be developed to diversify tourism attractions. This level could support a variety of recreational, craft, or cottage industry facilities as well. The central location along Kosrae's circumferential road enhances Malem's role as a auxiliary tourism support center (agricultural products, manpower, alternative activities).

Utwe

The eastern portion of this district has almost no fringing reef (mostly open coast with rocks near shore and coral outcrops below water surface slightly terraced, about 10-25 feet for quite a ways offshore). Shore entries are possible for snorkelers and divers although the shoreline consists of coral rubble, sand, and other reef deposits. The beach deposits may be the result of heavy wave action from storms particularly during the wet, southeastern trade season. The southern reefs are much narrower in width than those on the windward coasts but the reef fronts show a high diversity of reef corals.

Molsrons Utwa and Taf in central Utwe District lead to a sheltered harbor which is accessible for most of the year except during the most severe storms of the wet season. The proposed small boat harbor at Utwe village will be able to accommodate about 20 of the popular catamarans which are used for fishing and limited diving activities. Parking is limited but private land owners may be persuaded to offer parking for a fee. Utwe Village lies right at the water's edge in a coastal area which is quite low and can get inundated at high tides and waves.

The embayment at Utwe is part of an exceptional recreational and biological system. A series of offshore coastal islets shelter a large body of water which is known for its productivity, protected waters and scenic features such as small mangrove islands which dot the "lagoon". Several species of seabirds and mangrove forest birds inhabit the mangrove forests lining this body of water. Inya Walunga connects the western part of the "lagoon" to the Walung area of Tafunsak District and provides for access into parts of the surrounding mangrove forest as do a number of smaller creeks.

Tafunsak

Walung (southwestern portion of Tafunsak district) is a rural area with a peaceful, quiet atmosphere. Access is mainly by boat from Okat although some canoes venture from Utwe via Inya Walunga and two overland trails exist: one through the hills and one along the barrier

islets. The village of Walung is fronted by a sizable reef flat with seagrass almost uncovered at low tide; an extensive, fine-grained, sandy beach fronts the main village and a picturesque pocket beach is located just north of the village. Mangroves and Nipa palm inland of the beach provide additional resources for the village.

Activities possible in the area include a hike to Walung waterfall (about 1.5-2 hour round trip), and a coastal walk along the barrier islets (Tukunsru) which can be rigorous depending upon the length of the hike. Snorkelers could find the oceanside of the islets to be intimidating in the surge channels. At low tide, it is difficult to get to and from beach from open water snorkeling areas due to the height of the nearshore reef.

The intervening coastal area between Okat and Walung has a number of distinctive features. Reef holes, passes, and walls of Yela reef provide exceptional diving spots, and the mangroves contain some of the tallest *Sonneratia* found in Micronesia. The Okat River is a majestic resource with an exceptional volume of freshwater effecting both a spectacular mangrove and swamp forest as well as a spectacular scenic feature. The river basin of Okat and the neighboring Yela contain important fisheries, forestry and recreational resources.

While a large portion of the Okat reef was taken over for the new airport and harbor facilities, the remaining reef still provides substantial marine resources on the outer reef slope. Lagoon holes stressed by construction of the airport and port are beginning to recover. The boat channel created through the reef flat has and should continue to maintain good water quality in the boat basin. The adjacent dredged area which is undeveloped at this time needs better access from the parking area to accommodate both tourists and residents. Currently, boat users must scramble down a steep bank of loose dredged material and there are no pier or slip facilities to which boats may be tied. This dredged area can be used for recreational activities for some time until commercial and motorized boat traffic become congested or water quality becomes fouled from boat discharges, e.g., oil, fuel, bilge or fish waste).

Northern Tafunsak is blessed with many sandy beaches although those at Walung are of much finer grain and broader width. At low tide, reef rock and substrate lay exposed and the reef flat can be used for wading and reef walking. Tidepooling is not of great significance due to the predominance of sand and coral deposits and the lack of volcanic features in the fringing reef area. This portion of the district has good potential for tourism development due to its location between the airport and the governmental/commercial centers in Tofol and Lelu and easy access to the ports of Okat and Lelu.

Tafunsak boasts two coastal attractions in addition to their shoreline. A cave serving as home to hundreds of swallows and a waterfall. Villagers are somewhat concerned, however, that visitors could pollute the creek associated with the waterfall which is the main source of water to the village of Tafunsak.

Current Activities, Locations and Services for Tourism and Recreation

Six small hotels currently operate on Kosrae (Wilson, 1989). Most of these are located in Tofol and Lelu town, but two of the largest are situated in Tafunsak District midway between Tofol and the airport (Figure 8). The Tafunsak hotels are positioned on the beach next to the circumferential road. These inns can offer limited beachfront activities due to the shallow nature of the fringing reef fronting the establishments and the extreme tidal ranges (up to six feet or more) in Kosrae. Other than covered picnic areas, little is presently offered to enhance the use of the beach or water areas. Most visitors must provide their own beach and water recreational equipment.

In addition to the beachfront activities, fishing and diving charters and occasional canoe trips are the extent of marine tourism activities offered (Table 3). These must be pre-arranged through word-of-mouth or through the Office of Tourism in Tofol. Currently, only a small number of boat operators are available for charter and they are generally unfamiliar with the requirements of international fishing travelers.

Small boat harbor facilities and services are available from the Okat and Lelu harbors and from the Utwe village area. Choice of harbor will be somewhat dictated by weather and seasonal conditions. However, due to the good coverage by these three harbor sites (Frontispiece), charters and boat trips should be possible at almost any time of the year.

Offshore game fishing is blessed by high pelagic species productivity due to Kosrae's location near the equatorial countercurrent. Popular species such as wahoo and barracuda can be found from September through March, and tunas are available from late spring through the summer. Fishermen need not travel far from port to avail themselves of these pelagic species, however, they will need to provide most of their own fishing gear. Additionally, while Kosraens do not possess the large cabin cruisers of larger, more prominent sportfishing areas like Kona, Hawaii, Australia, or the mainland United States (Figure 9), the small Yanmar catamarans locally available could serve as interim fishing vessels. The larger, expensive boats would become attainable in a few years once demand and participation increased. Fishing travelogues and sport fishing videos that ^{are} currently available and shown in a variety of visitor markets may spark tourism interest from locales such as Hawaii, Australia, Japan, and Guam.

Table 3: Available Activities for Marine Tourism

Activity	Service/Location	Comments
Boating access	Yes. Lelu Harbor, Utwe Bay, Okat Harbor	Embayments serve boating needs for fishing & diving. May also serve in future as base for charters (sportfish, sailing)
Charter fishing: reef, pelagics	Yes. Okat, Walung, Tafunsak, windward coasts	Location near equatorial counter current means high pelagic species productivity
Scuba diving	Yes. passes reef slopes/walls reef holes/patch reefs Lelu, Okat-Yela wrecks	
Snorkeling	Yes. Reef holes at Lelu, Okat, patch reefs, central/eastern Utwe	
Sailboarding	No. Lelu harbor, Okat harbor, Utwe lagoon	Fringing reef system and extreme tides make most locations difficult or treacherous
Surfing	No. Malem, Lelu	Surf breaks close to reef edge and coasts make most locations treacherous
Tideflats	No. Tafunsak, Lelu	
Swimming	No. Fringing reefs, reef holes, Utwe lagoon	
Beach walks	No. Tafunsak, Walung	
Sunbathing*	N/A. w. Utwe, n. Lelu, n. Tafunsak	
Demonstrations: throw net, canoe building	No. Tafunsak, Walung, Utwe	Utwe does not have the extensive reef flat for throw net demonstrations

* Visitors should check with hotel operators concerning appropriateness of attire and bathing locations.

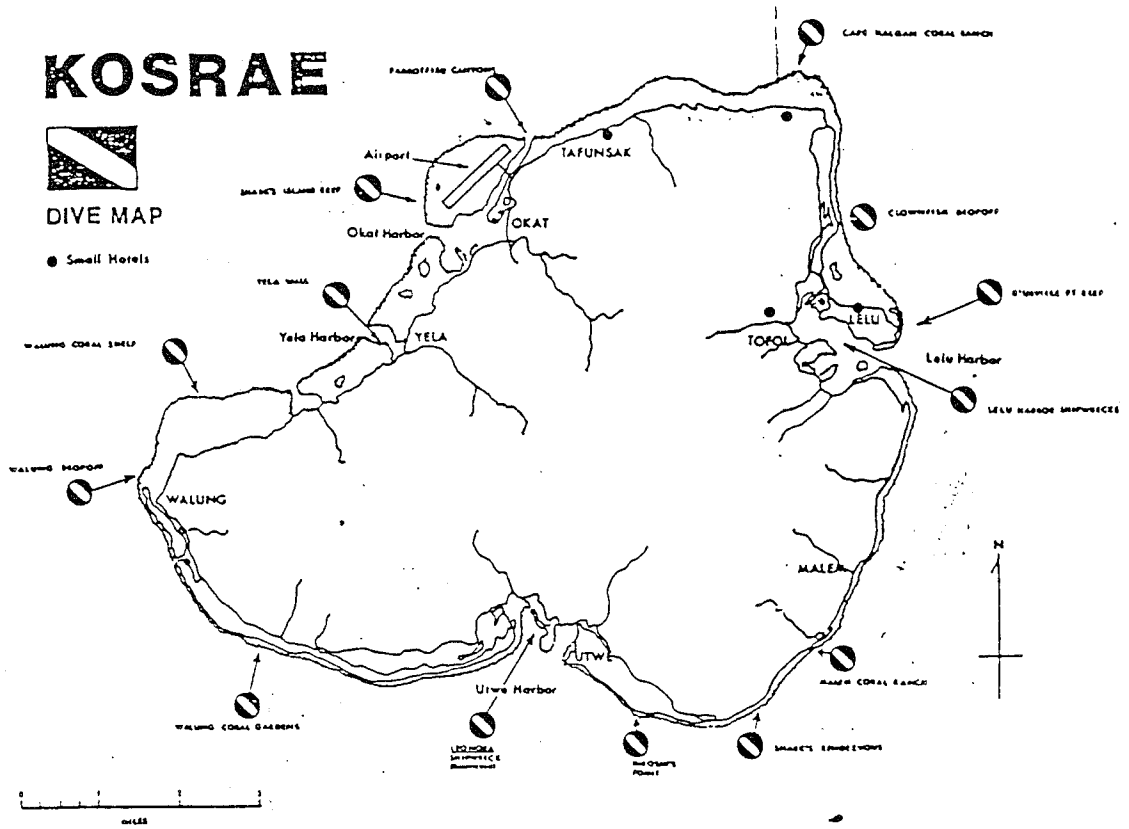


Figure 8: Hotel and Dive Spots on Kosrae

ILLUSION
 Sport Fishing
 Kohala-Kona Coast
 36' Topaz
 Captain Juan Waroowers

We're located minutes away from
 the major hotels at Kawaihae Harbor

BOX 3300
 HONOKAA, HI
 808-775-9960
 800-982-FISH

1987 Boone Award
 Winner

THE BILL COLLECTOR
 Sport Fishing Kona Style
 38' Egg Harbor
 Capt. Lew Mims

BOX 1243
 KAILUA-KONA, HI 96745
 808-329-4116

SEA GENIE
 Harris 36' Fiberglass
 Twin Diesel Sport Fisher

P.O. BOX 4126
 KAILUA-KONA, HAWAII 96740
 808-329-7287

SEA STRIKE

(808) 329-8135
 CAPT. DALE LEVERONE

P.O. Box 3645
 Kailua-Kona, HI 96745

Figure 9: Kona Style Charter Boats

Diving can occur on most outer reef areas, in passes and within Lelu and Utwe harbors (Figure 8). Several large reef holes in the Lelu reef and between Okat and Yela rivers will provide interesting dives for less experienced users. However, visibility in these holes tend to be limited by suspended sediments. Still, unusual formations, caves, large sting rays and tropical fish make for interesting dive experiences. The small catamarans used in Kosrae would serve the dive charter operator quite well. In fact, the existing dive business, Kosrae Aquatic Systems, does lease/rent boats as opposed to owning it's own vessel. In this way, it has the flexibility of using a variety of ports which diminishes the influence of weather and sea conditions upon operations and affords outside income to a number of fishing boat operators.

Shore dives are possible in a couple of locations. The reef off of east Utwe is gently terraced and spectacular formations of coral gardens are available to divers or snorkelers from shore. On calm days, shore dives are also possible from Lelu island and southern Malem. These locales have a cobble beach which makes entries and exits reasonable. Snorkel and scuba diving equipment is generally not available for rent and most snorkelers and divers are expected to provide most of their own equipment except for tanks. This service problem applies to boat as well as shore dives.

The tourism office provides a referral service for tourists that are aware of its location or telephone access. They have generally arranged for fishing, diving and canoe trips. Scheduling of canoe trips are greatly hampered by tides but mostly by the limited availability of guide and boat. The most frequent trip, although longest, is from Okat to Utwe which passes over reef flat through mangrove creek and lagoon during the passage.

A few residents own sailboards, surfboards and boogie boards. The former are sometimes seen in Lelu and Okat Harbor and could also be operated in Utwe lagoon. Only extremely experienced sailboarders should attempt the open seas due to the lack of rescue and safety services. Surfing can be attempted off of Malem where there is a moderate surf break near shore. Reef passes on the windward shores are also possible surfing sites. However, none of these surf spots would classify as world class breaks.

Landside attractions include several waterfalls in various districts, a Wiya Bird (swallows) Cave in Tafunsak, overland trails through the mountainous interior and archaeological/historical sites such as Lelu Ruins and the Kosrae Museum in Lelu (Wilson, 1989). Walung village represents a microcosm of traditional Kosraen life and could function as a cultural attraction if so desired by its inhabitants. The village also

Table 4: Available activities in coastal tourism.

Activity	Location	Comments
Hiking/walking	shoreline, farm roads, mountain trails	Trails need to be maintained and well marked to preclude visitors losing their way
Bicycling	farm roads	Not well developed
Sightseeing	circle island, n. Lelu, Sleeping Lady (mountain), Utwe by-pass	Includes Wiya Bird Cave, Boro Hill, and Lelu Ruins
Cultural	Kosrae Museum, Walung Village	

Source: Wilson, 1989

fronts on some of the best sandy beaches on Kosrae, has a attractive waterfall within an hour's walk, and several spectacular diving spots just offshore. It is also secluded from vehicular traffic and is sparcely populated as compared to other village areas on Kosrae.

Analysis of Current Status of Services

Services and facilities for recreational activities are nonexistent for the most part. "Infrequent" and "available upon demand" characterizes most commercial recreational activities in Kosrae. Scheduling procedures are in the process of being formulated, but communications among clients, service operators and the State Tourism Office remain tenuous. Operating and investment capital is low, resulting in little in the way of rental equipment or charter vehicles such as vans or large commercial boats. Guide services are beginning to be developed but the trainees have few clients at the moment and may require refresher or supplemental sessions.

Commercial recreational service is minimal due to the lack of demand and neophyte status. However, the natural friendliness and helpfulness of Kosraens is a positive feature which will substitute in the near term for sophisticated interpretive techniques, exhibits and equipment. Operational standards should be devised along with training and problem-solving workshops provided for businesses and employees as numbers, needs or sophistication of visitors increase.

For future success in providing recreational attractions and activities for tourism (the travel variant of recreation), logistical and scheduling procedures will be of paramount importance to meet the needs of tourism levels predicted for the next decade (Table 5). Until tourism becomes an established industry, visitor guidelines should be worked out so that tourists can arrange trips quickly and as painlessly as possible. The current pattern of visitor trips indicate relatively short stays, mostly for business. Limited free time stipulated by these short business visits will require quick response times by commercial recreation operators. Because commercial trips are dependent upon availability of guide or vehicle, an extensive list of alternatives will need to be put together, along with procedures or contingencies for communication problems. Information brochures should be made available at hotels, restaurants and hotels listing ways visitors could make recreational arrangements. As demand increases, recreational reservations could be listed with travel agents to facilitate arrangements before the visitor arrives.

The six small hotels and bungalow operations on Kosrae provide about 34 guest rooms. They range in size from 1-12 rooms (Wilson, 1989). Most hotel operations are characterized by little intrusion on or interaction with the visitor. Few offer activity desks or information racks. Two operations, the Coconut Palm and Ahwanee, have associated food services in or adjacent to their operations in Tofol. A couple of other small restaurants also operate in Tofol. While operations in Lelu town do not have food services associated with them, several large, well-marked

Table 5: Projections-- Non-Micronesian visitor arrivals

State	Actual	Projected
	1987	1995
Kosrae	1,870	4,010
Pohnpei	5,670	12,150
Truk	5,060	10,850
Yap	2,140	4,590

markets are close by. In other village areas, the markets are tiny and often unmarked.

The lack of international class accommodations and the limited number of available guest rooms and facilities can be a major deterrent in the development of tourism in Kosrae. Several small facilities (under 25 rooms) are proposed or are under development at the moment which will ease the shortage. However, at least one moderate facility (40-50 rooms) which offers international class services and accommodations will be needed to attract the assistance and attention of transportation companies and travel promotion associations and writers.

Some assistance or incentives should be provided by the Division of Tourism or State Tourism Office to prospective developers regarding siting and size of development. The Tourism Office should prepare guidelines and criteria for facility siting which incorporate state and municipality guidelines or policies concerning community intrusion, impacts on infrastructure, and feasibility. Monitoring procedures, even simple ones such as a map with dots representing locations and size, should also be devised to assess cumulative impacts of the impending development interests by residents and outside interests. In the meantime, improvements to visitor amenities and front desk services could be undertaken to enhance current visitor experiences.

Public transportation is generally nonexistent but currently residents will give lifts to those requesting rides. Rental cars are available but are limited in number. Pickup trucks are popular among the locals for carrying farm produce or guest riders. Local style public transportation could be devised from the existing pool of vehicles, along the lines of the private taxi system in Pohnpei state or Majuro township or following the example of "Le Truc's" of Tahiti.

Other limitations to tourism development include the low frequency and cost of flights to Kosrae, limited road access and other public infrastructure, as well as limited manpower in the Division of Tourism and the State Tourism Office. The service by a wide bodied plane since the early 1980's has made Kosrae more accessible and visible to other areas of Micronesia but Kosrae needs to work on joint marketing ventures with other states in FSM to draw visitors from the Pacific Rim and elsewhere. Special packages and direct flights from Guam or Saipan would increase visibility and accessibility. Contacts need to be made or improved with those dominant, metropolitan countries who, as air carriers, effectively and selectively control the international links between the market and the destination (Lundgren, 1972; Pearce, 1987). Incremental increases of influxes of visitors should be coordinated with increases in numbers and quality of visitor accommodations.

Road access has been continually improved with the construction of the paved, circumferential road that should be completed within a few years. Road construction is not without problems (Edington and Edington 1986; Mathieson and Wall, 1982) including sedimentation of nearshore reef resources, disturbance of water flow from the watershed basin through the freshwater and mangrove swamp forests, barriers to species migration, increased traffic and noise, and greater access to forest and coastal resource products. In north Lelu, the road has been placed upon the barrier islet which is also one of the feasible locations for intensive tourism development due to its location between the airport and commercial and governmental centers and proximity to population centers and infrastructure lines. The road alignment completes for prime facility or activity locations on the barrier islet. Perhaps before paving is initiated, landowners and the Tourism Division could identify and prioritize potential development sites where road position might be realigned or noted for realignment. Existing grading could be incorporated into the foundations or infrastructure for visitor or commercial facilities and be considered part of government incentives for local development.

Alternatively, this section of road could be left unpaved during a feasibility assessment for re-routing the circumferential road along the route of existing and proposed farm roads from Sialat to Mutunnenea. The barrier island would still be accessible via the existing unpaved road and could be paved as residential and commercial projects were identified. The re-routed circumferential road would open up additional areas of Tafunsak and Lelu for commercial or agricultural development which could also be supported by development of the proposed hydroelectric projects in the area.

Concentrated or intensive tourism development (i.e., a large number of developments in a small area regardless of size) could adversely impact the ability of cesspools to regulate the amount of effluent seeping into the nearshore waters. Recreational waters, however, require high water quality ratings (see Appendix 1) equal to that for the support of aquatic life. North Tafunsak, north Lelu, and Malem will benefit from the completion of a proposed sewerage project in Lelu, e.g., supporting tourism development. However, the system may not provide any remedy for the many piggeries located along or over mangrove channels in the same areas and which introduce considerable amounts of feces into shoreline waters. Public facilities will need to be developed for visitors both in villages and at shoreline areas.

Tourism also strains solid waste systems. Locating sanitary landfills away from the shoreline and providing visual and odor corridors should be a priority. Presently, landfills exist immediately adjacent to the main road with little or no concealment. Screening and or moving landfills further from the main road or to locations off a farm road should be considered.

Increases in the Tourism Division may be appropriate and feasible in the future if tourism increases significantly. However, the existing personnel and services need to be made more readily and easily available to current visitors. Development of the master plan (Wilson, 1989) is an appropriate step but activities and expenditures must be prioritized to make the best use of available personnel and scanty dollars.

Potential Tourism/Recreational Activities and Possible Locations

Possible Visitor Facility Areas

The barrier islet in northern Lelu District has the potential to be a popular tourism site with a limited number of moderately-sized (25-50 room) hotels, along side of small, upscale lodges, bungalow resorts and cottage units. The islet conveniently lays between the airport and the commercial center. It is within cost effective distance of the proposed sewer outfall and the power generators as well as populated areas which could provide labor sources and miscellaneous visitor services. It also has access to boat marinas at Okat and Lelu and is only an hour from Utwe. However, the road occupies most of the higher elevations with beach to one side and mangroves to the other. At times the road sits in a site which might be suitable for a building. An option to consider is realignment of parts of the road if tourism were to be considered a high priority for the area by government officials and landowners.

A proposal for a small boat marina off the old airstrip in Lelu harbor must take into account the increasing siltation of that area of the

harbor by several creeks. The turning basin and boat slip areas may require annual or biannual dredging to maintain sufficient water depths for the boats. Boats for the Marine Resources Division are also moored in this area.

North/east Tafunsak have similar qualities which would make this area a potential tourism development district. It already is the site of two of the larger tourism facilities on Kosrae although neither has food services presently associated with them. However, a number of markets are located nearby and if kitchen facilities or cooking utensils and small electric devices (fry pan, coffee maker, toaster oven) were made available, the dearth of restaurants would not be a critical problem.

With the construction of the road, the interior of Utwe District has been opened up to both residents and visitors. The access and views from the roadway and adjoining land create excellent opportunities for scattered cottage/bungalow development. The moderate distance from the airport and commercial centers would appeal to those visitors seeking a more rural, quiet vacation setting. The residents of the area could also obtain income from the provision of recreational and food services to users of the lagoon. However, the distance from sewerage and power facilities reduce the potential for intensive development.

A small boat marina with marine and tourist related facilities has been posed as a use of the dredge spoil in the Utwe area once the road construction has ended. Sedimentation of adjacent reefs and the Bully Hayes wreck from this activity has slowed but productivity of the nearby waters still remains below previous levels. The spoil deposit continues to hinder the flow of water into and out of the mangroves as well as the migration of species. While the proposed facilities would enhance the tourism industry, the impacts due to the physical presence of the spoil and ancillary activities should be analyzed.

In Walung, a few, small tourism facilities could be implemented with the approval of the local residents who prefer a quiet, subsistence-style lifestyle. While residents are interested in developing their cash economy they are concerned with use of their natural resources by "outsiders". Road development or increased boat access could change their rural, traditional lifestyle now accommodated through isolation or at least limited entry. Two projects, a lodge and a bungalow project, appear to be underway. If the villagers' lifestyle preferences change in the future, additional facilities could be considered, although costs to construct infrastructure support could be high.

The pocket beach north of Walung proper has great potential as a stopping point for boat trip originating from Okat. Transient visitors could enjoy snorkeling or walking over the seagrass beds in the sandy

nearshore. At low tide, the area could be accessed via the Mwot River and a short walk through a mangrove tidal area or via wading along the shoreline.

In lieu of developing facilities, visitors could be brought to Kosrae to participate in "safari" expeditions. A variety of locations could be found around Kosrae to distribute opportunities to a greater number of people. Housing would consist of tents or thatched shelters with air mattresses or coconut husk bedding. Water seal toilets could be installed at a variety of locations to serve this business sector as well as provide public facilities to other visitors. Land owners could build the necessary facilities and rent them to one or a number of "safari" businesses on a scheduled basis. Alternatively, cooperating enterprises could lease several areas, install the needed infrastructure, and collectively maintain and use the sites.

Possible Visitor Activities

Inya Insrefus in northern Lelu would make a reasonable 3-hour round trip or 2-hour one way tourist ride. The southern portion of this inya is broad and placid with thick but low growths of *Sonneratia* and interesting formations of incense cone shaped pneumatophores. The northern portion of the inya is becoming blocked by sand being pumped into the creek by wave and tide action. At low tide about 150 yards is almost completely dry. It may be difficult to pass through some areas at low tide with a deep draft boat, but kayaks, inflatable rafts or canoes should be able to make it. Smaller groups would also be advised for low tide visits. The bottom of mixed sand and sediment makes walking reasonably easy at those points where boat must be lightened to cross sand bars in the inya or at the northern end when it is impassible due to low water level. Alternatively, boardwalks could be constructed for short walks through the mangrove for interpretive purposes - describing interesting formations and varying compositions of mangrove/coastal strand vegetation and to circumvent the wet area between the point where boats must stop to the ocean exit of the inya. Vegetation changes are quite obvious. This interpretive program would enhance the trip and introduce visitors to the mangrove and coastal stand environments.

Positive points include: unusual pneumatophore presentation, small islands in middle of the creek, brackish water fish and monitor lizards, and a couple of shipwrecks. Negative considerations at the moment include: shallow creek depth due to a lot of sand in the channel coming from ocean breakwater, outboard engine noise diminishing trip experience for some visitors, and some visual intrusion from construction projects in the mangroves where accessed from coastal road. Channel sand could be mined to facilitate boat access through the creek. This resource may need to be cleansed of the organic material

which would decompose when exposed to air. However, the sediment could be sold for construction material or used for sand replenishment at eroding beaches. Motorized trips could be restricted to certain days of the week or certain hours of the day to permit visitors to experience the beauty of the area. The noise of motorized boats may not be a problem if traffic or development increases in the area.

The reef flat accessed from the northern outlet of the inya could also be included as part of the trip. At high tide, snorkeling activities could be supported. At low tide, demonstrations could be given of net casting as well as hermit crab and shell identifications. Beach and sunset picnics would also be viable accommodations to the varying tidal heights in the creek.

Utwe lagoon and Inya Watunga have extensive possibilities for tourism and recreational activities. The lagoon runs east to west and is well protected from trades and "Kona" winds by mountains to north, barrier islets to east and on southern exposures. The wide expanses of water could possibly and comfortably accommodate several hundred water users. The barrier islets are narrow but vegetated with coastal strand and could provide weather protection as well as serve as activity centers and rest areas. A wide variety of activities could be integrated such as snorkeling, diving, sailing, sailboarding, paddling of canoes and kayaks, rafting and simply relaxing in the sun. To maintain water quality and clarity, it will be important to consider the siting of comfort stations, solid waste material, as well as the offloading and disposal of bilge material from the cruise and charter boats.

Deep-sea charter boat fishing as well as boat diving trips would be possible from Utwe boat harbor. Sunset cruises and snorkel/sail cruises would also be possible activities from the harbor. Outrigger canoes or small motorized craft could be used as water taxis/shuttles across the lagoon and harbor. Speed boats, jet skiis, and towing activities (waterskiing and inflatables) which generate a high level of noise and hazards should be carefully considered before being permitted. Operational guidelines should be established and enforced for public safety reasons as well as impacts on nearby residential areas and other water users. The confined spaces of the tree lined lagoon could accent the noise from these craft rather than disperse it. The high speeds at which these craft are operated are more appropriate for open bodies of water which have few users. Also some fishermen believe that these craft are not compatible with marine life and drive them away from their usual locations.

Inya Watunga is about 10-12 feet wide for some distance westward of the lagoon but mid to high tides would be necessary to traverse its

entire length. The inya is quite scenic due to presence of Nipa palm right at the water's edge. Carving wood mangroves are found in greater profusion here than in any other locale. Intertwining tree branches and a profusion of ferns add to the beauty of the area. Monitor lizards and seabirds can be observed along the inya as well as many types of invertebrates, although the most evident are the crabs.

A highly possible location of mangrove tourism activity lies within the Okat River Basin. Okat River and its 2 main tributaries are excellent marine/coastal tourism resources. At high tide both are very accessible; at low tide the left (northern) branch remains serviceable. The northern channel is wider, more open with Nipa and the tallest *Sonneratia* in Micronesia, while the southern channel is somewhat narrower with more *Rizophora* (prop roots everywhere). These are very different in feel and composition. Both have birds which presently are not intimidated by the sound of small outboard motors. Bird calls abound (swallows, honeycreepers, herons, etc.). The temperature is cool due to breezes flowing over the wide expanses of water.

This tourism attraction would be highly impacted by changes in water volume and quality that flowed through the area. Sedimentation due to forestry or agricultural activities in the watershed could impair the system such that the water channels would fill or close in. The unique *Sonneratia* could be lost due to changes in water flow patterns or by pollutants from the port and industrial discharges. Therefore, strict monitoring of adjacent activities should be implemented to protect this valuable scenic, biological system.

Activity Summary

Mangrove trips via motorized canoe or self propelled canoes, kayaks and rafts are an unexploited tourism activity which could prove relatively easy to implement and produce sizable revenues once participation grows. Mangroves are the basis of successful tourism activity in a number of locations (Hamilton and Snedaker, 1983). These trips, however, should emphasize the wetland ecosystem. "Trails" should be managed to maintain visual corridors (landscape values), water volume, and unique fauna and flora associations. The variety of subhabitats result in a variety of trips in different locations to provide income opportunities for a number of residents.

Sail/snorkel/dive trips should prove popular Kosraen activities. These could take the form of half and full day trip or "live aboards". The latter combines recreational activity with living facilities but may not be feasible due to Kosrae's small size and relatively short travel distances

around Kosrae; this format is really more appropriate for use in areas with outlying atolls or islands. Sunset cruises have proven popular in many other destinations such as Hawaii and the Caribbean basin. Glassbottom boat rides in the form of outrigger canoes, catamarans or other vessels should also prove successful in the Utwe district or Okat area. As boating activities increase, day use mooring systems (surface or subsurface) should be implemented to prevent coral damage from boat anchors.

In devising recreational opportunities, several points should be considered. These include: proximity to tourist areas (market), accessibility, consumptive and nonconsumptive uses of the area resources, and uniqueness or combinations of flora, fauna and landscape, vessel capacity and appropriateness, training and interpretive/operating standards.

DISTRICTS FOR RECREATION, TOURISM AND PROTECTED AREAS

Districting Concept

Districting (a term preferred in Kosrae over "land-use zoning") is a variation of land use planning and zoning. This task is accomplished by ranking specific sites on the basis of existing and potential ecological and socio-economic values, and ecological vulnerability (Ham, 1989; Lal, 1989). Criteria adopted here for districting include: IUCN criteria for protected areas, present and potential uses of fauna and flora and environment, present use patterns and future demands.

Use of protected area designation and management has become an increasingly important tourism tool in resource-based tourism destinations. Natural resource depletion through over-exploitation has led to the breakdown of basic ecological processes threatening the maintenance of life supporting systems of the biosphere and the human environment (see Appendix 2 for an overview of environmental impact issues related to tourism). As a region, the equatorial Pacific still enjoys a comparatively high level of environmental quality and mostly has escaped the environmental disasters which have struck the tropical and subtropical continents and large islands in other regions. However, there is ample evidence that "development" activities and increasing populations are leading to the over-exploitation of resources, the destruction of habitats, loss of key species and breakdown of natural systems which have preceded the environmental disasters occurring in other parts of the world (Thomas, et al., 1989).

Steps should be taken to manage and conserve the natural resources of Kosrae. A system of managed resource areas would ensure future generations with continuing

Table 6: Main objectives of proposed district.
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Reserve or Sanctuary	Protection of ecosystems, natural habitats, specific species, groups of species, communities and physical features of local or national importance. Natural restocking of adjacent consumptive use areas. Establishment for scientific and educational purposes.
Marine Recreational Park	Actively managed area of outstanding, largely unmodified and highly scenic features primarily for the protection of those features and for recreation, tourism, education and scientific purposes. Traditional uses of the area for subsistence gathering recognized. Specially designated areas are set aside for development, habitat and species protection.
Traditional Use	Protection of resources is initiated by landowners or local community for the conservation of specific living resources.
Historical/ Archaeological	Protection of surface and subsurface remains and the locations of important cultural significance. Managed for thorough investigation of the site, removal of artifacts for safekeeping and for development of education.
Commercial/ Tourism	Designated and managed for commercial exploitation of local scenic and recreational resources. Maximization of recreational opportunities.

Source: (Patterned after Lal (1989); Hamilton and Snedaker (1983))

quality coastal and marine environment as well as providing economic benefits to the community (Ray, 1978; Sherman and Dixon, 1989). A range of protected area categories were defined by the International Union for the Conservation of Nature and Natural Resources (IUCN). The following presentation generally follow their guidelines but incorporate some adaptations to meet the needs of the state of Kosrae.

It is recommended that five types of districts (Table 6) be designated for development of recreation and tourism in Kosrae. The following section will present the primary objectives and the preferred and alternative location for each district type. A short discussion on management considerations for each district type is supplied for each district category. Table 7 presents the compatibility of recreational uses within the proposed district categories; Appendix 3 presents some additional comments related to resource use conflicts. The categories and locations recommended for a managed area system in Kosrae are:

Reserve or Sanctuary (IUCN: nature or marine reserves, wildlife sanctuaries)

"Reserves in this category are designed to protect ecosystems,

Table 7: Compatibility of uses within proposed districts

ACTIVITY	Resrv	Rec	Trad	His	Com
Development-type:					
Intensive					✓
Dispersed		✓	✓	✓	✓
Activities:					
Day use		✓			✓
Snorkeling	✓	✓	✓	✓	✓
Diving	✓	✓	✓	✓	✓
Surfing		✓	✓	✓	✓
Sailboarding		✓			✓
Sailing	✓	✓	✓	✓	✓
Glassbottom boat	✓	✓	✓	✓	✓
Sunset cruises	✓	✓			✓
Paddling	✓	✓	✓	✓	✓
Jetskiing		✓			✓
Waterskiing & related		✓			✓

natural habitats, specific species, groups of species, biotic communities and physical features of local or national importance. Provision is made to allow controlled use for scientific, educational and recreational purposes. Access may or may not be controlled. These reserves and sanctuaries will be rather discrete areas. Sanctuary generally is an area set aside predominantly for the protection of a specific species while the term reserve is used for protection of habitats."

Preferred site: (Tafunsak) Okat-Yela reef inland to Okat basin

The Okat River and its two main tributaries are excellent marine/coastal tourism resources. The northern channel is wider and more open with Nipa and the tallest *Sonneratia* in Micronesia, while the southern channel is somewhat narrower with distinctly more *Rizophora* prop roots in evidence. These are very different in feel and composition. Both have birds which presently are not intimidated by sound of small outboard motors and the calls of swallows, honeycreepers, herons, etc. abound. The temperature is generally cool since the height of the trees keep out the direct sun except at the sun's highest point.

Advantages: a trochus sanctuary which extends seaward to the edge of the reef platform is already in force (the sanctuary designation would require an expansion in scope to cover additional types of resources and habitat to be managed, i.e., include mangrove and freshwater swamp inland and include reef slope to include tridacna "giant" clams, lobster and fish resources); residents seem to agree to need and support efforts; Okat river has impressive features which would support tourism activities; proximity to MRD substation; lagoon holes for snorkeling; easy access by boat from a small boat marina.

Disadvantages: land ownership question; future impacts from a proposed cross-island road; increasing farming activities in the Okat basin; proposed location of industrial activities at harbor site, including a tuna packing plant

Alternative reserve: (Tafunsak) Yela basin and Yela-Mwot reef

Yela River is almost impassible at all tides even with shallow canoes. Extensive clearing of low growth would be needed to open the channel for any kind of passage. The flat, lower portion of the river is very limited as a volcanic ridge lays about 150 yards inland. The area is marshy with little breeze and lots of mosquitoes and swamp bugs (heavy freshwater influence). There are some archaeological remains near the river mouth which could be interpreted. A small farm lays on the southern bank of the river and could provide refreshments (e.g., bananas, citrus, coconut) to visitors. A trail could be blazed through the vegetation and a shelter could be erected upslope to provide views of the

sea but it would not provide broad vistas of the adjacent lands. It may still be plagued by insects.

Advantages: location is more distant from airport/harbor/industrial area and is less likely to be impacted by spills, etc. from that area.

Disadvantages: land ownership question; little recreational/tourism potential; more isolated from access points and populated areas; insects; terminalia stands would be highly desirable for harvesting.

Management considerations:

The Yela river basin is further from populated areas than the Okat and has some unique forest resources. Thus, the Okat's forest resources would be more tempting due to their relatively closer proximity to population centers. The Okat, however, appears to have a greater potential than the Yela to provide alternative economic opportunities such as tourism revenues for resources taken out of strict consumptive use. On the other hand, the Okat would be more susceptible to pollutants and upland perturbations than the Yela due to its location near the airport, port and proposed industrial site.

Monitoring of the Okat reserve would be easier than for one in the Yela. The close proximity of the proposed Marine Resources Division substation at the port would allow staff to use a spotting scope to monitor the seaward portion of the reserve from their office. Periodic visits of the mangrove area by water or by road to check resource quality or to monitor use activities would not require extensive travel time. Tour operators could be persuaded to assist in monitoring activities within the mangrove area once they were aware that their revenues depended upon high resource quality in the Okat basin.

Marine Recreational Park (IUCN: parks)

The principle objectives of this category is the active management of an area with outstanding, largely unmodified and highly scenic features primarily for the protection of those features and for recreation, tourism, education and scientific purposes. However, the category recognizes traditional uses of the park for subsistence resource gathering and provides for continued traditional uses of non-critical resources within the framework of a management plan. Controls on harvesting could be exercised. Within the park, specially designated areas are set aside for development, specific habitat and species protection, controlled traditional resource harvesting and for recreation and tourist activities.

Preferred site: Utwe lagoon and Inya Watunga

The lagoon runs east to west and is well protected from trades and southern winds. The wide expanses of water could possibly accommodate several hundred users. The surrounding vegetation and the location of small mangrove islands keep the area from being intrusive upon Utwe village to the east. The expanse however permits sufficient breezes through to keep the area pleasant even during mid-day and would also enhance wind-driven recreational equipment such as sailboards and small sailing vessels. The enclosed nature of the lagoon would provide protection from surf and ocean swells and reduce the possibility of visitors drifting out to sea.

The barrier islets are narrow but vegetated with coastal strand. These islets provide protection for the lagoon area but could also serve as activity centers and rest areas. The sandy/cobble beaches make ocean and lagoon snorkeling areas accessible to users of the lagoon.

The inya is about 12-20 feet wide for some distance westward and is quite scenic due to presence of Nipa palm at water's edge. Carving wood mangroves are in greater profusion here than in any other locale and giant collections of ferns grace the limbs of the mangroves. Monitor lizards can be observed along the inya as well as many types of invertebrates, although the most pronounced are crabs. High tide would be necessary to enter the inya for any great distance.

Deep-sea charter boat fishing would be possible from Utwe boat harbor as well as boat diving. Sunset cruises and snorkel/sail cruises would also be possible activities from the harbor.

Advantages: wide expanse of protected waters, lined by mangrove forests with varied topographical backdrop of mountain range; easily serviced by Utwe villagers from town or various access points along northern shore (tidal creeks accessed from road; access also permits use by visitors staying in western Utwe; barrier islet can serve as day use areas with access both to lagoon and to nearshore diving/snorkeling; visual corridors and barriers.

Disadvantages: possible conflict with traditional fishing and mangrove harvests; intrusion on or disruption of village lifestyle.

Alternative site: eastern Utwe (west of southern point of island)

This area would be limited in the types of ocean recreation activities which could be offered. Snorkeling and diving are definitely possible with sailboarding on calmer days. Paddling could be offered in

Utwe harbor but would be visible to villagers. Beaches are rather steep and cobbly and less conducive for sunbathing.

Deep-sea charter boat fishing would be possible from Utwe boat harbor as well as boat diving. Sunset cruises and snorkel/sail cruises would also be possible activities from the harbor.

Advantages: in protected lee of the island but has direct access to offshore waters.

Disadvantages: possible danger to users once they pass outside of the wind line - will need extensive, consistent monitoring by safety personnel; possibly more contact with and impingement on villagers.

Management Considerations:

The physical area would be able to support recreational activities for several hundred people but planning for (spacing, size, locations, service requirements) and providing adequate numbers of comfort stations will be important in maintaining water quality in the lagoon and embayment. So will the handling of bilge water, fuel leaks and waste material from the cruise and charter boats. Additionally, facility development on the barrier islets and in the mangroves should be regulated to prevent any reduction or loss of coastal strand and islet which provides storm protection. Piers and other shoreline structures must be well researched and designed to prevent shoreline erosion, undertows or strong nearshore currents.

High speed craft in the lagoon can generate a high level of noise and use of these kinds of vessels should be carefully considered before being permitted. Narrow, or confined, tree lined areas of the lagoon could accent the noise from these craft rather than disperse it. The high speeds at which these craft are operated are more appropriate for open bodies of water which have few users.

Some fishermen believe that certain kinds of recreational craft or activities disturb marine life. While research findings in this area is limited, the Marine Resources Division might consider establishing some resource monitoring areas. Additionally, the Public Health Division might include water samples from the lagoon area in their monitoring program.

Maintenance of the landscape values and recreational potential may require restrictions or controls placed upon activities conducted in adjacent mangrove areas. For example, it may be desirable to restrict timber or firewood harvesting within a minimum distance of the boundaries of the proposed recreational park. Agricultural and

construction activities which could induce sedimentary runoff may need to be regulated or be required to restrict the amount of erosion created.

Traditional Use District: Walung (IUCN: Resource Conservation Area)

"This category of protected area is established at the request of the landowners or local community in cases where there is concern over the plight of one or more of the living resources of the area. Its aim is to provide a category of protected area which is established voluntarily for the conservation of specific living resources (plants, animals, fish, etc.) and managed locally with the assistance of the appropriate management agencies according to a jointly agreed management plan."

Preferred Site: Walung Village Area

While the residents are not adverse to consumptive uses of the resources of the area, they are concerned with overharvesting, particularly by people outside of the district. These resources are the economic mainstay of the community since other commercial activity is not present in this rural community.

Advantages: exceptionally scenic location; relatively undeveloped; currently sustainable natural resource base; relatively isolated by landscape and infrastructure from outside intrusion; quiet, village lifestyle.

Disadvantages: isolation from public services other than educational services for children.

Management Considerations:

Several inherent landscape and cultural features provide not only for a more rural and quiet lifestyle but invites tourism development. Villagers must be encouraged to assess their economic and cultural values and develop local policies which protect these values. If individuals pursue tourism activities or facilities, these should be kept to the periphery of the village, e.g., at the pocket beach to the north or south of the village at the barrier islets. While this action would exclude tourism activities from most of the broad sandy beaches, a number of properties could be developed. Recreational activities should be carefully selected to prevent disruptions of village life.

Historic/Archaeological District (IUCN: Historic/Archaeological Reserve)

"These areas provide for the protection of surface (including buildings, etc.) and subsurface remains and the locations of important cultural significance. The area would be managed for thorough

investigation of these sites, removal of artifacts to safe keeping, and the possible development of the site for educational purposes."

Preferred site: Lelu Island

The existence of the Lelu Ruins and Kosrae Museum creates immediate potential. A sizable amount of information is available and some have been put into written and visual formats. But the location of the resources within a space hungry township requires extensive planning and coordination efforts to prevent any loss of these resources.

Advantages: visible, accessible resources.

Disadvantages: space needs of village; easily vandalized; lack of local financial resources.

Alternative Site: Malem District

Malem was the site of Japanese occupation forces during World War II. Numerous artifacts remain and could be turned into interpreted resources. The area is relatively flat and within reasonable distances from commercial and tourism areas. A sizable population is available to act as guides and to provide ancillary services (food services, souvenir and craft shops) to visitors.

Advantages: location; service population available; underutilized artifacts.

Disadvantages: unidentified resources and locations; access must be developed; interpretive materials must be produced and primary messages identified.

Management Considerations:

If the Malem area is to be highlighted for agricultural development, cultural, historical and archaeological sites should be identified and assessed as soon as possible before they are destroyed. A series of sites could be developed to provide for single or multiple stops by visitors or used for educational purposes. Farm roads could be used to link stops but buffer zones will need to be established around sites to screen them from surrounding development areas. Some sites could be linked by walking trails to diversity the visitor experience. The present method of farming which incorporates planted areas into native vegetation provides landscape values to the roadway and opens up certain amounts of viewplanes.

The Historic Preservation Office has proposed excavating a number of historic and archaeological features and canals related to the Lelu

Ruins. These sites could serve as the basis of educational/volunteer work excursions offered by a number of "ecotourism" organizations such as National Geographic Society and the Smithsonian Museums. Drainage and re-siltation difficulties may need to be resolved if not planned for during execution of the work. Ponding water would increase levels of mosquitoes and sand fleas found in the area. Erosion of channel walls could cause stabilization problems for adjoining residential properties as well as introduce additional sediment into the harbor. Sedimentation of the area adjoining the old airstrip could make implementation of a small boat marina difficult to pursue; repeated dredging could add to operating costs. Most of the siltation seems to be caused by the sediment loads from the creeks draining into Lelu harbor rather than from erosion in and around the township.

Commercial, Tourism District (IUCN: No Related Category)

There is no protected areas designation or objectives for this type of district. However, coastal tourism planning criteria can be substituted. These include:

- ✓ shoreline location with protected waters
- ✓ adequate set back from water's edge to avoid erosion
- ✓ adequate space for multi-storied facilities
- ✓ easy access from airport
- ✓ easily serviced by populated and commercial areas
- ✓ easily connected to infrastructure (water, power, sewer)
- ✓ access to easy, short-lived activities

Preferred Site: Eastern Tafunsak and North Lelu

Tafunsak Municipality east of the main village has fairly broad sandy beaches and reef flat areas. Seagrass beds cover extensive portions of the inshore parts of the reef while reef rock is found in the seaward half. The coastal plain extends inland for some distance and is currently used for agriculture. Considerable development is occurring due to the presence of a paved portion of the circumferential road and the location between the airport and the governmental center. The road, however, generally follows the shoreline except around Tafunsak village itself.

Oceanside of the barrier islet of north Lelu are narrow beaches on which coarse sand grains and cobbles can be found. These beaches are

backed by coastal strand vegetation in front of mangrove vegetation lining the Inya Insrefusr.

Both of the above described locations will be able to provide numerous marine and coastal activities. These include mangrove trips to Okat and to the nearby inya, diving, charter fishing and sailing trips from Okat or Lelu harbors, walks into the coastal uplands, visits to the Wiya bird cave, and throw net demonstrations. Tafunsak village might consider developing a passive attraction for rainy days or early evening hours.

Advantages: accessible locations; close to infrastructure, manpower, and commercial services; potential small scale hydroelectric schemes identified for the Infals Mutente (Tafunsak village), Tofol (government center) and Pukusruk (n Lelu).

Disadvantages: some areas are eroding; sizable properties beside of the road are rare.

Alternative Site: Utwe, Walung

Advantages: sizable natural resource areas; highly scenic

Disadvantages: village reticence, distance from infrastructure

Management Considerations:

In both locations, but particularly on the barrier islet, construction should occur far enough removed from the water's edge to avoid causing erosion or being subject to erosion or natural fluctuations of the beach width. This "setback" should include any berm and backshore deposits which will provide storm protection for the developments. There may be some difficulty for some landowners to adopt this measure if their property extends laterally along the shoreline rather than inland. Perhaps a joint venture between shoreline and backlying property owners could be arranged to benefit all landowners as well as protect the shoreline.

On Lelu islet which face^s the trades more directly than Tafunsak locations, lower height facilities should probably be considered to take advantage of the natural wind breaks by existing or introduced vegetation.

Erosion is a problem in two locations in this "commercial district": just seaward of Tafunsak village due to the dredge pits, and the area fronting the CAT Headquarters and Sandy Beach Hotel. Both appear to be the result of construction activities (reader referred to Cripe, 1989).

Some Economic Issues Related to the Establishment and Management of Protected Areas

The following are excerpts from a report for the Asia and Near East Bureau, USAID/Washington by Paul B. Sherman and John A. Dixon, Environment and Policy Institute, East-West Center, Honolulu, Hawaii.

***Villager Involvement and Buffer Zones¹**

Once an area is given protected status, villagers [may be] prohibited from continuing many traditional ... uses of protected area resources (for example, collection of plants, animals, and other forest products is banned in parks and wildlife sanctuaries). On the other hand, villagers receive few of the benefits from protection of the area.

Direct regulation and police measures have not been very successful in curtailing this pattern of use [especially among villagers who are] quite poor and cannot easily afford to give up this income. There is no easy solution to this problem since, if left uncontrolled, many traditional uses would eventually threaten the resources within the protected area. Proper attention to local needs however, can help reduce the potential for conflict.

First, local residents should be included in the planning process prior to the establishment of the protected area. Although they do not have veto power, their input may be essential in minimizing future conflicts, and various accommodations can be made by the protected area authorities to meet villager needs. For example, where a limited amount of a certain use would not threaten the protected area, an agreement can be arranged detailing allowable levels of use.

Second, wherever feasible, nearby residents should receive preference for jobs generated within and by the park. Local residents often have detailed knowledge of the area and the resources it contains and can be valuable in park protection and research. Park maintenance also provides potential job opportunities. When tourist development is undertaken, local residents should be hired to the extent possible. If necessary, training should be provided to increase opportunities for local residents to fill more of the available positions.

Third, it may be necessary to establish a buffer zone around the protected area where "illegal" uses are permitted, even if only informally. This compromise recognizes that local villagers are being asked to pay a substantial price in terms of lost access to resources within the protected area. It also acknowledges that a policy which relies solely on strict enforcement is not possible without unacceptably high social costs.

Ideally, a clearly identified, formally established buffer zone should be designated just within or beyond the protected area boundary. The shape and amount of area required will depend on the specific

¹ Management of buffer zones is also discussed in McNeely (1988), MacKinnon et al. (1986), Oldfield (1988), and McNeely and Miller (1984).

requirements of nearby residents. Planning, development, and management of the buffer zone should be performed in close consultation with the local residents to ensure that it will serve its intended purpose."

Park Fiscal Policies

There can be problems capturing the benefits from protection: "admission fees, accommodation charges, and other revenues [can be] very small when compared to the sizable benefits enjoyed by those using certain protected areas. Admission fees, when either nonexistent or so low that they are not considered in individual decision-making about the use of protected areas. Other protected areas [that] provide important habitat, research, or hydrologic benefits, [may not compensate] for and, therefore, are often not reflected in management budgets.

Budget allocations, however, are in part a reflection of the policymakers' perception of the importance of the unit concerned. Since protected areas generate little in the way of revenues, they are considered as a drain on financial resources, especially when compared to "productive" resource uses like logging or mining. Improved understanding of the economic importance of the wide range of social benefits provided by protected areas is one step in the process of justifying increased budget allocations for protection. Another important step, if only for psychological reasons, is increasing revenue from direct (and indirect) uses of protected areas."

Some options for dealing with the question of increasing the financial returns from protected areas include:

- ✓ promotion of greater nonconsumptive use of protected areas, such as tourism and research, should be encouraged and admission fees/gate charges either established or increased;
- ✓ develop some mechanism whereby those areas that generate large revenues receive partial credit for their contribution, e.g. by allowing individual protected areas to keep a portion of any fees collected to provide management support to that area;
- ✓ if and when fees are charged, it may be desirable to develop some form of differential pricing whereby those who are better able to pay are charged more. This could be via a differential charge for foreign as opposed to local visitors or by higher fees for tourist vehicles.
- ✓ some portion of accommodation taxes could be used to supplement management funds.

The reader is referred to the full paper for a more detailed discussion, with examples, of economic costs and benefits related to establishment of protected areas used for tourism and recreation. The reader is also referred to Appendix 3 which illustrates some of the economic benefits and costs related to resource use conflicts, particularly with respect to logging, fisheries and tourism.

UNDERSTANDING THE VISITOR

In order for tourism to occur, potential tourists must have the motivation to travel and the ability to do so (i.e., time, money). With regard to the former attribute, destinations can offer particular tourism features which attract specific types of tourists who will meld best into the local customs and lifestyle. In one of the earliest discussions of tourist travel motivation, Gray (1970) identified two basic reasons for pleasure travel - "wanderlust" and "sunlust" (Table 8). Wanderlust was defined as "that basic trait in human nature which causes some individuals to want to leave things with which they are familiar and to go and see at first hand different exciting cultures and places...The desire to travel may not be a permanent one, merely a desire to exchange temporarily the known workaday things of home for something which is exotic." Sunlust, on the other hand, "depends upon the existence elsewhere of different or better amenities for a specific purpose than are available locally". Another expression for this motivation is "a hunt for the sun" (Pearce, 1987).

Sunlusters fit in well with tourist enclaves, where they are content to remain for the most part at their hotel and its associated beach and activity areas. Wanderlusters, on the other hand, will be interested in traveling to numerous locations and are also attracted to man-made or cultural attractions and features. These visitors could be used to carry the word about new destinations to less adventurous tourists. Those visitors who appreciate different environments and cultures could fit in well with local lifestyles but they may seek to interact more with a community than other groups of visitors.

A person's personality will also influence a tourist to seek different travel experiences and to select particular forms of travel and types of destinations. Plog (1973) described tourists along a continuum from "psychocentrism" to "allocentrism" (Table 9), where

"at the one extreme are the 'psychocentrics', who tend to be anxious, self-inhibited, nonadventurous and concerned with the little problems in life. In contrast, the 'allocentrics' are self-confident, curious, adventurous and outgoing; travel, according to Plog, is a way for them to express their inquisitiveness and curiosity. The travel characteristics of the two

Table 8. The attributes of wanderlust and sunlust travel.

Sunlust

- ✓ Resort vacation business
- ✓ One country visited
- ✓ Travelers seek domestic amenities and accommodations
- ✓ Special natural attributes a necessity (especially climate)
- ✓ Travel a minor consideration after arrival at destination
- ✓ Either relaxing and restful or very active
- ✓ Relatively more domestic travel
- ✓ Relatively more international travel

Wanderlust

- ✓ Tourist business
- ✓ Probably multi-country
- ✓ Travelers seek different culture, institutions and cuisine
- ✓ Special physical attributes likely to be man-made; climate less important
- ✓ Travel an important ingredient throughout visit
- ✓ Neither restful nor sportive; ostensibly educational

Source: Pearce (1987)

Table 9. Travel characteristics of psychographic types.

Psychocentrics

- ✓ Prefer the familiar in travel destinations
- ✓ Like commonplace activities at travel destinations
- ✓ Prefer sun 'n' fun spots, including considerable relaxation
- ✓ Prefer novel and different destinations
- ✓ Low activity level
- ✓ Prefer destinations they can drive to
- ✓ Prefer heavy tourist accommodations, such as heavy hotel development, family type restaurants and tourist shops
- ✓ Prefer familiar atmosphere (hamburger stands, familiar type entertainment, absence of foreign atmosphere)
- ✓ Complete tour packaging, appropriate heavy scheduling of activities

Allocentrics

- ✓ Prefer non-touristy areas
- ✓ Enjoy sense of discovery and delight in new experiences, before others have visited the area
- ✓ Prefer flying to destinations
- ✓ High activity level
- ✓ Tour accommodations should include adequate-to-good hotels and food, necessarily modern or chain-type hotels, and few 'tourist' type attractions
- ✓ Enjoy meeting and dealing with people from a strange or foreign culture
- ✓ Tour arrangements should include basics (transportation and hotels) and allow considerable freedom and flexibility

Source: Pearce (1987)

groups differ so that different types of travelers will visit different destinations." (Pearce, 1987).

Using this model then, it would be predicted that psychocentrics would probably be less tolerant of different lifestyles and be more demanding of destinations to provide familiar foods, types of accommodations, and levels of service. For example, an American ordering a hamburger would insist that lettuce and tomato were important ingredients, whether or not these ingredients were readily available locally.

Based upon existing services and facilities in Kosrae, it is believed that tourists who should be approached are allocentrics with either wanderlust or sunlust reasons for travel. Thus, marketing programs would be designed to attract these particular groups of tourists rather than those interested in mass tourism facilities and attractions. A possible strategy to follow would be to develop multi-stop travel packages in the Federated States of Micronesia which highlight the unique features of each location. These circuit trips would attract wanderlusts and allocentrics. These early "pioneer" tourists often are responsible for spontaneous development of tourism demand (Pearce, 1987). Thus, early promotional materials should highlight activities and cultural attractions which would appeal to these "pioneers". During this period the visitor plant, or facilities and services, could be improved and expanded to eventually cater to more sunlusts and even psychocentrics.

Potential Conflicts

Tourism provides steady employment and adequate income for many. Increases in employment opportunities can stabilize or reverse out-migration for an area. It has been generally agreed that with regards to tourism, economic benefits have proven positive, while environmental impacts have been mixed but social and

cultural influences have been somewhat negative. It is more pronounced in destinations which are making a transition from dependence on agriculture to tourism. The transition can be likened to an expanding spiral (Figure 10).

"In the beginning, or center (of the spiral), a few tourists are accommodated in private homes with limited facilities and virtually no tourist amenities. As the number of tourists increases, more rooms are built for tourists and perhaps a small hotel or pension is established, and some roads and additional tourist facilities and amenities are constructed. With feedback, this spiral continues to grow along the sectors shown in the accompanying figure: tourists, accommodations, personal and community indebtedness, governmental subsidies and

incentives to construct community infrastructure, tourist facilities and amenities which serve as attractions. Marketing is increased to secure more tourists. These developments are accompanied by landscape changes...parking structures and more hotels, apartments, homes, stores, and business buildings are erected in the community. Additional roads are constructed as the community expands and tourism becomes more important. In addition, some surrounding agricultural land is abandoned." (Kariel, 1989).

A number of unexpected and less desired effects have been noted (Pearce, 1982; Pearce, 1987). Tourism can induce higher prices for basic necessities of life, as well as for other goods, services, and land. Local residents often have to bear much of the cost of constructing and maintaining community and infrastructure as well as tourism-oriented recreational facilities such as swimming pools and leisure centers.

Another problem was that people may no longer be willing to volunteer their labor or time for community projects, i.e., community service. Additionally, young people are subject to the tourist lifestyle (people on holiday are perceived to have unlimited money and leisure time). More specifically in Kosrae, cultural differences concerning dress codes and Sunday activities need to be given attention to reduce chances of conflict. Shifts in food preferences are also likely to be seen and, if the raw materials for these different tastes are not available locally, the need to purchase supplies from off-island could lead to greater trade

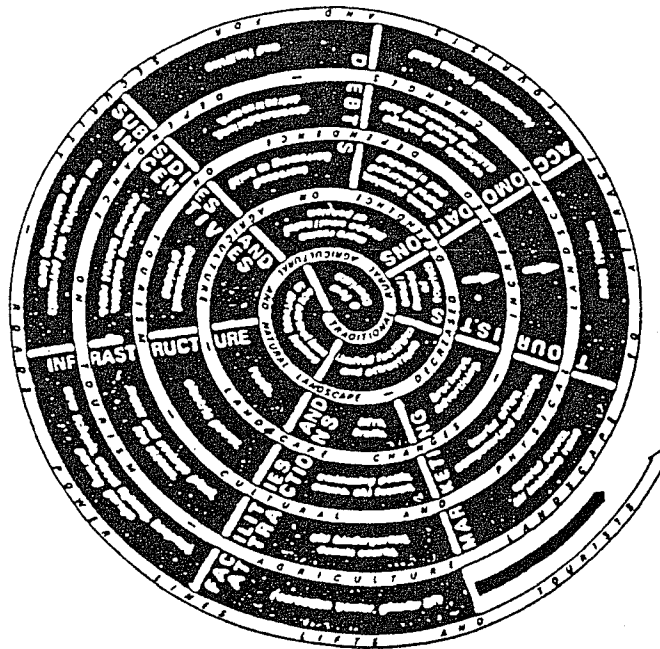


Figure 10: Transition From Agricultural Dependence to Tourism Dependence

imbalances rather than reduce them.

The lack of experience in catering for an international tourist market has often made difficult the entry by local entrepreneurs into the nonlocal and foreign tourist industry. Areas of concern expressed by residents of tourism areas include: big hotels run by international chains usually have little interest in promoting the welfare of the community and less of the money brought in by tourists remains locally; managerial positions are usually filled by outsiders and most purchasing is done on a large scale from external sources.

On the positive side, the sharing by foreign and domestic guests of tourist accommodations/destinations can reduce social conflicts and lessen economic differences. Additionally, local residents heighten their awareness of and pride in their own history and culture during the development of interpretive or visitor programs, and they assume the role of host rather than servant. Interpretive programs also increase a visitor's knowledge of the host culture and ease the barriers or misperceptions that may form.

The development of visitor activities and attractions should begin with those which differ least from existing activities, such as providing canoe rides and fishing trips. Small scale developments will assist in the transition from a predominately rural lifestyle to a more commercial one which includes tourists. A "soft" approach to tourism may better accomplish goals for tourism outlined in the long-range development plan: to limit tourism growth to a level that will not create negative impacts on the Kosraean lifestyle and environment; to maximize the scale and spread of tourism-related economic benefits among all Kosraeans; to not outstrip the state's limited infrastructure and to integrate tourism activities that encourage contact between visitors and locals. This tourism development approach stresses small-scale developments rather than large-scale hotels and other facilities, educates the tourists about proper behavior, and scales down the size of facilities and activities. The end result will be a majority of residents who actively choose and have an opportunity to make a living. To date, Kosraen residents' perceptions of the social implications of tourism have helped to prevent overdevelopment and can play a major role in the integration of tourism into Kosraen lifestyle.

MANAGEMENT CONCERNS AND INSTITUTIONAL ARRANGEMENTS

At the moment, only tidally influenced resources, i.e., the reefs and mangrove forests, are under the jurisdiction of the government while most lands are still in the hands of private landowners. Management policies or regulations concerning resource use are beginning to evolve.

Tourism development is occurring in somewhat of a laissez-faire fashion and the focus has been on development of facilities without equal, accompanying effort in programs. It appears that this trend may be moderating according to the draft Kosrae Tourism Master Plan which outlines several strategies for tourism development including training and marketing projects.

According to the plan, all governmentally oriented tourism activities originate from the Division of Tourism in the Department of Conservation and Development. The Division handles the planning and development of tourism ventures and oversees promotion and visitor contact services of the Kosrae State Tourism Office. Interactions with a number of resource and marketing agencies are facilitated since Tourism is housed in the same department as the divisions of marine resources, agriculture/ forestry, history and culture, as well as land/surveys and production/marketing. Liaisons are being developed and maintained also between the Department of Public Works (road and infrastructure), Department of Health Services (environmental health and sanitation, environmental protection), and the Bureau of Planning and Statistics.

Some mechanism will need to be developed which allows the Division of Tourism to monitor and perhaps have a say in where and how much future hotel developments will occur. This review could occur in two areas, either during financial assessment for loans or during application for earth moving permits. Included in this decision area would be whether ancillary activities such as food services, attractions, and infrastructure, are available. This involvement is proposed not as a regulatory action but one which will assist a prospective enterprise to achieve success.

There does not seem to be a clear mandate for any one governmental agency to develop or manage recreational or tourism activities and sites. Although the Division of Tourism has responsibility for promoting tourism ventures, its charge does not involve establishing guidelines for or regulating how and where these ventures or activities take place, introduce pollutants, modify the landscape, etc. With regard to protected areas which might offer recreational and tourism opportunities, the Division of Marine Resources appears to have the mandate to create protected areas but will need to liaison with the Division of Tourism regarding siting and selecting allowable activities.

It is suggested that a interagency coordinating committee consisting of officials from agencies including tourism, marine resources, forestry, history/culture, environmental protection and health, and public works might be appropriate. This group could meet periodically to work out coordination details or to develop policies and guidelines for

interagency issues. The proposed Development Review Committee and the Island Resource Management Commission may be the desirable alternative to the coordinating group proposed.

At the least, the Division of Tourism, Marine Resources and Forestry should form an ad hoc or standing committee within the Department of Conservation and Development to coordinate plans for resource areas and their use. This group could prepare an integrated management plan and strategies which coordinate consumptive and nonconsumptive uses. This committee could propose areas or districts for development, protection or multiple-use and present these concepts to the local communities and councils for review. Due to the low level of development at the moment, these concepts could encourage development in appropriate locations and reduce the risk or undesirable action of regulating or refusing an action. Locations which might be initially addressed would be the proposed Okat "sanctuary" and the proposed Utwe "marine recreational park."

Imposing parks or protected areas on rural communities can have negative consequences including restriction of access to traditionally-used resources, the disruption of local cultures and economies by tourists, and displacement of peoples from their traditional lands (Hough, 1988; Sherman and Dixon, 1989). Avoidance of resentment and hostility which could accompany such consequences is essential for the success of the establishment of protected areas.

Eight key obstacles to establishing processes for the effective management of park-local people conflicts were identified by Hough (1988) in a review of the literature on the management of environmental conflicts:

1. parks are a "western concept" and so are many of the management arrangements
2. lack of trust between park authorities and local communities
3. difficulty of communication between park authorities and their surrounding human communities
4. number of different parties, or stakeholders, involved
5. large difference in power base
6. degree of risk and uncertainty involved in entering into discussions aimed at reducing conflict, i.e., objectives being set and how information will be used

7. problem of binding, or enforcing, any agreement on both the local people and the government
8. set of alternatives, for all parties involved, to participating in the process

Hough suggested that the development of communication and trust between the park/protected area authorities and the local communities would alleviate most of the problems noted above. An additional action would be to involve the local community in the planning and management of the park areas. Establishment of protected areas will not ensure that these areas will be effectively protected; however, involvement of local communities in the design and management of the areas will enhance that success.

Since few protected areas are "privately beneficial" and thereby protected and managed by individuals (Sherman and Dixon, 1989), mechanisms should be developed by which private owners participate in the development of revenues from and decision-making for the protection of resources. Local communities or participating landowners will thus have greater incentive to maintain the protection of the area. Resource compatible activities such as tourism, recreation and scientific research can provide useful benefits (economic as well as physical and social) and should be incorporated into management objectives as often as possible.

Recommendations

1. Kosraens should retain local control over the land itself or its resources.
2. Development should keep pace sustainable by the local people without resort to substantial amounts of external capital, since external capital usually involves some degree of external control.
3. Take positive steps towards visitor-host relations including: retaining friendly relations; providing the type of facilities which guests desire, with an emphasis on quality rather than quantity, and keeping prices as low as possible in order for tourists to feel that they are obtaining value for their expenditures; desirability of having some distinctive community attractions to serve as an identifying characteristic and special attraction.
4. Consider tourism, recreational and scientific activities for protected areas which will generate revenues to offset the removal of consumptive activities.

5. Develop mechanisms by which a portion of the revenues generated by recreational or tourist use of protected areas are returned to the participating landowner and possibly to the management agency.
6. Create buffer zones between major resource use districts such as recreation and forestry, industrial and protected.
7. Develop interagency coordination procedures.

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APPENDIX 1

Water Use Classification

Trust Territory of the Pacific Islands (TTPI) classification of coastal water uses (from Part 5 of Title 63, Chapter 13, Subchapter VII, as amended 31 march 1986).

PART 5 Water Use Classification

(A) Classification of Coastal Water Uses

Coastal waters are classified in accordance with uses to be protected in each class as follows:

(1) Class AA Waters

The uses to be protected in this class of waters are oceanographic research, the support and propagation of shellfish and other marine life, conservation of coral reefs and wilderness areas, compatible recreation, and other aesthetic enjoyment.

It is the objective of this class of waters that they remain in as nearly their natural, pristine state as possible with an absolute minimum of pollution from any source. To the extent possible, the wilderness character of such areas shall be protected. No zone of mixing will be permitted in these waters.

The classification of any water area as Class AA shall not preclude other uses of such waters compatible with these objectives and in conformance with the standards applicable to them.

(2) Class A Waters

The uses to be protected in this class of waters are recreational (including fishing, swimming, bathing, and other water-contact sports), aesthetic enjoyment, and the support and propagation of aquatic life.

It is the objective for this class of waters that their use for recreational purposes and aesthetic enjoyment not be limited in any way. Such waters shall be kept clean of any

trash, solid materials or oil, and shall not act as receiving waters for any effluent which has not received the best degree of treatment or control practicable under existing technological and economic conditions and compatible with the standards established for this class.

(3) Class B Waters

The uses to be protected in this class of waters are small boat harbors, commercial and industrial shipping, bait fishing, compatible recreation, the support and propagation of aquatic life, and aesthetic enjoyment.

It is the objective for this class of waters that discharge of any pollutant be controlled to the maximum degree possible and that sewage and industrial effluents receive the best degree of treatment practicable under existing technological and economic conditions and compatible with the standards established for this class.

The Class B designation shall apply only to a limited area next to boat docking facilities in bays and harbors. The rest of the water area in such bay or harbor shall be Class A unless given some other specific designation.

APPENDIX 2.

Resource use conflicts.

Source:

Carpenter and Maragos, 1989.

Economic development often involves using the same natural resource in several ways that may not be compatible. For example, agricultural land is attractive for human settlements; waterways are used to dilute and carry off sewage and for fishing. EIA, especially when complemented with extended economic analysis, can point out these conflicts and reveal the trade-offs necessary to maintain sustainable development. See Section III.E for the techniques used.

An illustration is the conflict generated by logging, which increases sedimentation of coastal areas and thus damages fisheries and tourism. Countries in Oceania and the Pacific Rim with marine resources potentially at risk in this manner include Fiji, Papua New Guinea, Samoa, Solomon Islands, Vanuatu, French Polynesia, Indonesia, Malaysia, the Philippines, and Thailand. The following is excerpted from Hodgson and Dixon (1988:xi-xii).

In 1985 a logging operation was begun in the watershed bordering Bacuit Bay (El Nido), Palawan, Philippines. Bacuit Bay is also an important resource for two other foreign exchange earning industries--tourism and marine fisheries. The effects of logging-induced sedimentation on the bay's previously pristine marine environment were the subject of a 1-year ecological study. By the end of the study, only 11 percent of the available commercial forest had been logged, but high rates of accelerated erosion due to logging had already resulted in dramatic increases of sediment transport and discharge into the bay. Sedimentation damage to bay coral reefs and associated fisheries was rapid and severe [see Figure I.2].

In order to examine the economic effects of sedimentation pollution on tourism and marine fisheries, predictions of future revenue production based on two development alternatives are presented. The development options are (1) to ban logging in the bay's watershed or (2) to allow logging to continue as planned. The first option would prevent further damage to the bay's ecosystem due to logging-induced sedimentation and thus the tourism and marine fisheries dependent on it. The second option would maximize logging revenue but reduce revenue from the other industries.

The results of the economic analysis are striking and project a reduction in gross revenue of more than \$40 million over a 10-year period with continued logging of the Bacuit Bay watershed as compared with gross revenue given implementation of a logging ban [see Table I.1]. The difference is due to projected losses from tourism and fisheries. Present value analysis was performed using both a 10 and 15 percent discount rate. Even with the higher discount rate, the present value of lost revenue exceeds \$11 million under Option 2--continued logging. Sensitivity

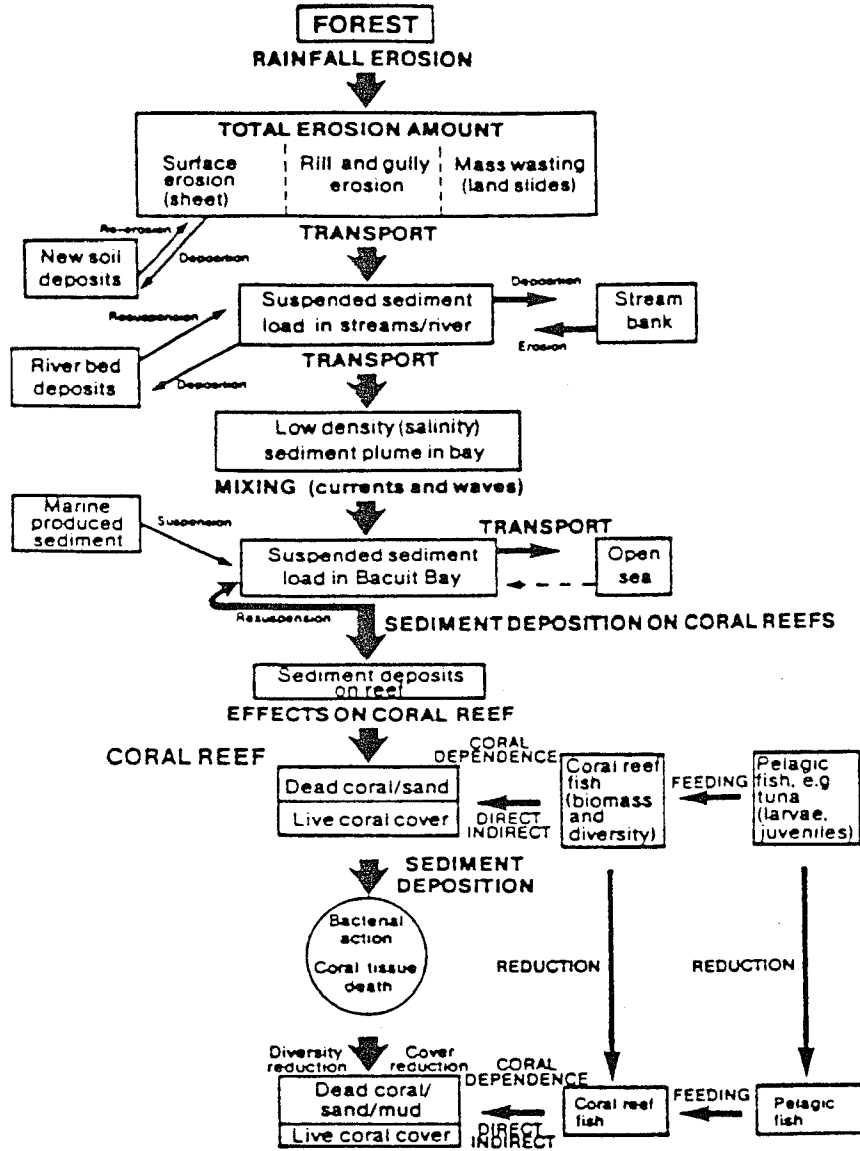


Figure I.2. The predicted pathway of soil eroded from the forest floor as it passes to the sea. Note the many locations where soil can be temporarily stored and then later rejoin the transport process. Upon reaching the sea, sediment settles to the bottom. If coral reefs are present, the living corals may be damaged by sediment deposition. Since fisheries are linked to the coral directly and indirectly, they will be reduced by losses of living coral cover (Source: Hodgson and Dixon 1988:5).

Table I.1. Tourism, fisheries, and logging industries: Ten-year sum of gross revenue, present value of gross revenue (x \$1000) using 10 and 15% discount rates

	Option 1	Option 2	Option 1 minus 2
<u>Gross Revenue</u>			
Tourism	47,415	8,178	39,237
Fisheries	28,070	12,844	15,226
(with tuna)	(46,070) ^a	(21,471)	(24,599)
Logging	0	12,885	-12,885
Total	75,485	33,907	41,578
<u>Present Value (10%)</u>			
Tourism	25,481	6,280	19,201
Fisheries	17,248	9,108	8,140
(with tuna)	(28,308) ^a	(15,125)	(13,183)
Logging	0	9,769	-9,769
Total	42,729	25,157	17,572
<u>Present Value (15%)</u>			
Tourism	19,511	5,591	13,920
Fisheries	14,088	7,895	6,193
(with tuna)	(23,122) ^a	(13,083)	(10,039)
Logging	0	8,639	-8,639
Total	33,599	22,125	11,474

Source: Hodgson and Dixon (1988:58).

^aTuna revenues (in parentheses) are not used to calculate the totals.

analysis shows that significant deviation from predicted effects of sedimentation damage do not alter the conclusion. In addition to these quantitative results, consideration of qualitative factors reveals that the social, economic, and environmental benefits of fisheries and tourism outweigh those of logging in this location.

The study demonstrates that the combined use of ecological and economic analyses can provide useful information for government planners seeking to maximize net economic benefits while minimizing social and environmental costs.

A full EIA encompassing alternative sites and designs for logging may have led to proposals that would have avoided or reduced impacts to tourism and fisheries. In any case, the EIA would have predicted the effects of logging, which, in turn, may have led to new or revised decisions on logging.

APPENDIX 3.

Section IV.C. Tourism.

Source:

Carpenter and Maragos, 1989.

(prepared in part by John Harrison and Rory Frampton)

1. General Considerations

a. Development Objectives. Resorts are primarily developed for their financial return. Economic benefits to local communities through enhanced employment opportunities are cited most often as the principal advantage of such projects. In fact, weighing costs and benefits in resort assessments usually comes down to balancing jobs against other impacts.

Tourism is the development sector where financial success and environmental quality are most clearly aligned. The very features that attract customers are those threatened by careless development. The justification for expenditures to protect the environment should be obvious. In fact, it may be necessary and profitable to do considerable cleanup work in order to produce an attractive tourist destination from a currently degraded site.

b. Components. The central components of a resort are the actual structures that house and support guests. Adjacent to rooms or cabanas may be various service and recreational amenities such as restaurants, golf courses, swimming pools, and tennis courts. The resort will require the provision of basic utility and service infrastructure such as water, waste disposal (sewage and solid), power, and roads. Another vital component of a resort complex is relatively efficient access to and from major tourist markets by major airports, roads, or ports.

As noted earlier, the success or failure of a resort project usually hinges on the natural amenities in the surrounding environment, especially in tropical environments such as found throughout the Pacific islands. Parks and natural resource areas, scenic vistas, archaeological and historic sites, beaches, and coral reefs are all potential attractions. Given the competitiveness of tourism in the Pacific islands, successful resort development demands that these natural amenities are maintained in a clean, pollution free, and safe environment. Recent marketing strategies for tropical tourism promote the location of resorts at or near white sand beaches. Placement of buildings and permanent structures near beaches often aggravate beach erosion, construction of shore protection structures, and property damage. Hence, resorts situated near beaches require proper siting and setbacks to protect beaches and resort property.

c. Environmental Factors Influencing, and Influenced by, Design and Site Location. Because of the nature of tourism, sociocultural factors influence resort development more than port and harbor or energy development. Certainly, aspects of the natural environment are important; but because the primary activity involves human interaction, the need for a good understanding of existing sociocultural characteristics takes on greater significance. Some important influencing factors are as follows:

- The quality of natural amenities in the area. As previously mentioned, these are the attractions upon which much of the success of tourism depends. The capacity of these amenities to withstand the intrusion of large numbers of tourists should be closely examined. The placement of permanent structures close to sandy beaches should also be controlled.
- Public works and utilities infrastructure. Resorts are dependent on infrastructure and services that closely resemble those available in the visitors' home country. Potable water, electrical power, and modern plumbing are virtual necessities. Thus, information is needed on the availability and capacity of existing infrastructure in and near the project area.
- Labor supply. Because it is service based, resort development is dependent on an adequate supply of labor. If local labor pools are insufficient, where will immigrant workers come from and where will they live? If labor is to be supplied locally, in what ways will this new type of work and associated living patterns affect traditional customs and social patterns? What

training opportunities for local residents will be provided to allow them to assume higher pay and higher skilled jobs?

- Existing uses of the surrounding area, especially those to which tourists will be attracted. For example, coral reefs, which serve as traditional fishing grounds or natural scenic areas and are of cultural or religious importance, may be subjected to heavy tourist use, disrupting traditional or artisanal activities. Additional activities or entertainment that tourists might pursue include traditional, religious, sacred, or culturally important sites, local crafts, art, music, and drama.

d. Impacts

Construction/short-term impacts. Activities include overall construction and residuals or waste disposal from these activities (e.g., bulldozer operations, cranes, supply trucks, workers, which generate minor oil spills, dust, sludge, and sewage). Oil spills and other wastes may contaminate soils and water supply when rains come. Runoff has the potential to contaminate ground, surface, and nearshore marine waters. Sewage from workers also poses a substantial threat to these waters. Contamination of water supplies could lead to human health problems, especially bacterially related ones from sewage spills. Contamination of water supplies could be very serious if a shortage of potable water occurs in the area. Therefore, there should be strict controls on disposition and monitoring of oil and sludge. Temporary lavatory facilities should be maintained for workers. During construction, a large amount of labor will be necessary; if this resource is not available locally, then workers must be brought in and housed. However, an influx of immigrant labor has the potential to introduce new diseases and different, conflicting morals and lifestyles. The increase in population will also place an additional demand on infrastructure and services. Temporary housing structures and roads could lead to erosion problems. If supplied locally, labor resources will likely be drawn away from primary productive activities of either economic or subsistence significance such as agriculture or fishing. Training and use of local residents as laborers should be maximized.

Operations and associated long-term impacts. Overall activities of day-to-day operations of a resort complex will require a certain level of infrastructure and public services. Demand will increase on existing sewer, water, waste disposal, and power facilities. If these facilities are not capable of handling this increase, sewer and waste disposal facilities could overflow or water and power could be diverted from existing uses. Serious deterioration could occur in either the physical or social environment. If local government is faced with the costs for providing new services, given the almost universal limited supply of government funds, the monies will have to come from other programs or from the private/development sector. Developers could contribute to or provide for their own services or pay the incremental costs to upgrade existing municipal facilities. However, caution must be taken to assure that private facilities are

not substandard. Effective land-use planning could guide infrastructure development compatibility with other large-scale developments both sequentially and spatially.

Tourist activities will increase access to traditional recreation, subsistence, or economic areas of importance. For example, activities on coral reefs for souvenir collection or for reef walks can significantly alter or destroy existing habitats unless controlled. Litter could also become a substantial problem unless there are regularly scheduled cleanups. Loss of available habitats could significantly reduce the local fish population, which might translate to a loss of an important economic or subsistence resource. Increased access for local fishermen could also lead to overfishing in an area. These negative impacts can be lessened through educational and public awareness programs on the fragile nature of these systems and of the potential damage that could be caused by certain activities. Resource inventories could also be accomplished to identify potential tourism attractions situated away from known important subsistence sites, thereby avoiding any conflicts.

A resort complex will also generate an increase in service-based employment, including a shift of resources, labor, and capital from primary production to agriculture; around the clock work shifts commonly filled with female workers; and an increasing reliance on cash income and new opportunities for social mobility. Depending on existing culture, the new employment and increase in cash income might also result in less reliance and obligation on traditional kinship ties. New work shifts will alter existing lifestyle patterns and family relationships. A widening of social gaps is possible if outsiders are given higher level jobs and locals are hired only for wage labor.

Table IV.4 summarizes the consequences to the environment of tourism development.

2. Case Studies

a. Large-Scale Tourism Development on a River Delta Island, West Viti Levu Island, Fiji

Background. The southwestern "Gold Coast" of Viti Levu has emerged as the major tourism region of Fiji. The gateway for visitors to the region is the Nadi International Airport near the northern end of the Gold Coast. Although the region offers a number of visitor amenities and attractions (shopping, condominiums, beaches, dunes, rivers, rainforests, offshore islands, and resorts), there were no luxury beach resorts in Nadi until recently. The town of Nadi is situated near the mouth of the Nadi River, which terminates into a large mangrove forest and delta system. White sand beaches are rare, and one of the nearest beach systems is located off the ocean side of Denarau Island, a large delta island off the northern fork of the Nadi River (see Figure IV.3). It was here that Nadi's first two luxury-class beach resorts were opened during the past 2 to 3 years. The island is low lying and the delta serves as a broad natural

Table IV.4. Environmental consequences of tourism

Activity	Consequences to environment	Ecosystem impacts	Human impacts	Mitigation
Tourism: Long-term concerns				
Solid waste disposal	See Ports & Harbors			
Sewage disposal	See Ports & Harbors	Increased groundwater contamination	Increased local infrastructure costs	User/impact fees
Land-use changes	See Ports & Harbors; enhanced access/high density usage			
Tourist activities	<ul style="list-style-type: none"> enhanced access increased contact with different cultures and lifestyles 	<ul style="list-style-type: none"> resource depletion change in ecosystem structure degradation of important cultural/historic or recreational areas 	<ul style="list-style-type: none"> Welfare losses commercialization of cultural or religious practices quality of life subsistence economic (fisheries) 	<ul style="list-style-type: none"> education and information ensure compatibility with community through participation compensation in money or land
Employment of local residents	<ul style="list-style-type: none"> shift of labor resources from production to service round-the-clock work shifts 	<ul style="list-style-type: none"> loss of productive capacity in other work change in lifestyle dependence on imported goods 	<ul style="list-style-type: none"> disruption of traditional family values cultural conflicts social differentiation reliance on cash income new mobility 	<ul style="list-style-type: none"> employee training and upward mobility
Employment of immigrant labor	increased population			
Landscaping	Fertilizer/pesticides	<ul style="list-style-type: none"> toxicity/habitat loss eutrophication 	<ul style="list-style-type: none"> housing shortages overburdening of infrastructure social gaps (outsiders fill high-level jobs) 	<ul style="list-style-type: none"> housing impact fees employee training employee interpretation
			<ul style="list-style-type: none"> public health risk welfare losses 1. subsistence 2. recreation 3. economic (fisheries) 	<ul style="list-style-type: none"> Chemical product management; intercept and treat runoff water

Tourism: Construction/short-term concerns

- Site clearance/
grading
- See Ports & Harbors
 - altered drainage characteristics
 - degraded and coastal surface
 - instream and coastal habitats/species loss
 - welfare losses
 1. subsistence
 2. recreation
 3. economic (fisheries)
 - catastrophic risk
 1. flood
 2. loss of landform stability
 - avoid stockpiling in natural swales
 - revegetation
 - grading controls
 1. drainage berms
 2. settling basins
- Construction activities
- See Ports & Harbors
- Labor importation
- See Ports & Harbors
- Landscaping
- introduction of exotic species
 - fertilizer/pesticides
 - displacement of indigenous, rare endemic species
 - toxicity: species/habitat loss
 - downstream eutrophication
 - natural/cultural resource loss
 - welfare losses
 1. subsistence
 2. recreation
 3. economic (fisheries, tourism)
 - use of native plants
 - management of chemical products

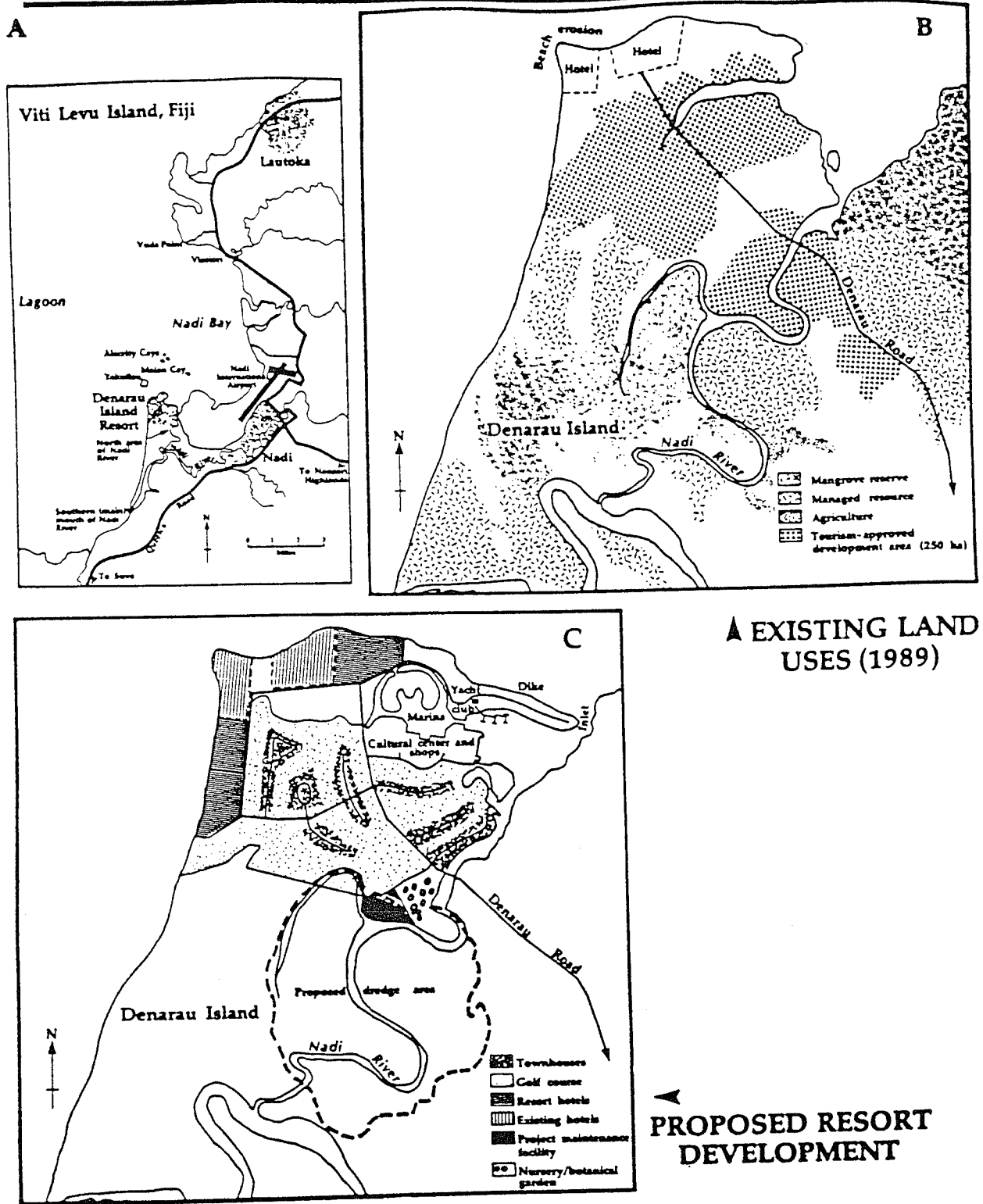


Figure IV.3. Proposed large-scale resort development on Denarau, a river delta island west of Viti Levu Island, Fiji. Map A is a vicinity map of the region where the proposed resort would be located. Map B shows the existing land-use designations and major resource categories including mangroves, lagoons, river, beaches, agricultural lands, and the existing resorts. Map C shows how the proposed resort features would modify the existing environment. The proposal includes three additional hotels, a protective dike, marina, townhouses, shopping center, cultural center, and a golf course. The proponents' preferred dredging area within the mangrove reserve is also shown.

floodplain during intense rainstorms. The delta islands and offshore coral islands in the lagoon are protected by a barrier reef system about 10 to 20 km offshore to the west. Nevertheless, the delta islands are vulnerable to typhoons approaching from the northwest and riverine flood inundation from the river. The interior of Denarau consists of floodplains, bottom lands, salt marshes, mangrove associations, and low lying dune systems closer to the beach. The Fiji Government has zoned most of Denarau Island for tourism and has approved additional proposed resort development for the island. To the southeast of the island closer to the river mouth are several hundred acres of prime mangrove forest designed as protected reserves (see Figure IV.3). Several small Fijian villages are situated in the delta, and many villagers claim fishery and foraging rights to the mangroves. The villagers own the delta island and mangroves, and resort development requires compensation for lease of lands and loss of fishery rights and other resources. A few of the villagers work at the existing resorts that include tennis courts, a beach boat landing to shuttle passengers to and from the offshore island resorts, and two 200-room hotels.

Proposed resort expansion. A major expansion of resort development encompassing the remainder of Denarau Island is now being proposed (as of June 1989), including three new 300-room hotels, a cultural center, a golf course, a shopping center, townhouses, a boat marina, utilities, drainage improvements, roadways, and shore protection structures such as a large dike to protect proposed resort improvements from storm surge and wave damage. The first phase of construction involves dredging and filling to raise the entire island (except for the existing resorts) by an average of 1 m. The proponents propose dredging 130 ha of the mangrove forest reserve to obtain most of the fill material to raise the island. The proposal would convert the mangroves into a large lake with a water depth of about 3 m. The proponents advocate the massive dredge-and-fill operation to protect the new resort from inundation from storms and possible sea-level rise from global warming. Alternative sites to obtain the fill material were only superficially examined. Large sand deposits are known to exist in offshore lagoon waters, but dredging operations would be less convenient and more expensive. The protective dike would be built on reclaimed lands to the east of the northern facing beach. The marina would be located to the south, behind the dike, and much of the dredged material to excavate the marina channel and boat basin would be used in the dike structure. No improvements are proposed for the existing hotels, which eventually would lie in depressions surrounded by higher elevated resort lands.

Recent observations and trends. As part of a June 1989 EIA training course, the class and instructors visited the existing and proposed resort complex at Denarau. The field trip revealed that the two existing hotels were built too close to the beach shoreline and on very low lying land. The beach system is not stable, and shortly after construction of the second resort at the corner of the sand bight, the beach retreated, causing shoreline erosion and threatening resort structures. In response, the resort management constructed a seawall along the west face of the beach and a massive groin off the

corner of the sand bight. However, the seawall itself was built too close to the ocean and is beginning to be undermined and damaged. The groin, although arresting further erosion along the west facing beach, has actually caused serious beach erosion along the north facing beach. A 2-m high erosional scarp is now present, and palm trees are now falling into the sea. During the day of the field trip, several truckloads of sand were being placed along the eroding beach to replace the sand constantly being lost to the sea.

In addition, new road grading and land raising at the proposed hotel site along the west facing beach have deflected drainage and floodwaters toward the existing resort during moderate rainstorms. These waters approach from the landward (eastern) side and inundate low lying resort areas, including underground parking and utilities. Neither of the two existing hotels has been around long enough to experience a heavy rainstorm or typhoon. It appears likely that both would experience damage from floodwaters, storm surge, and large waves. The existing resorts apparently are operating separately from the development of the proposed resorts, and no measures to protect or prevent damages to the existing resorts are being contemplated. Even without the new resorts, the existing resorts are clearly vulnerable to major damage from natural hazards.

Expected effects of the proposed resort. An environmental impact assessment (EIA) is being prepared for the proposed resort expansion by consultants for the developer. The EIA is not yet completed and many impacts have not been addressed in the draft, nor have alternative sites, designs, and mitigative measures yet been fully treated. The proposed resort concept plan has already been given tentative government approval. At issue is the ecological impact of the proposed dredging of the mangrove forests and the approvals required to dredge in a mangrove reserve, obtain leases, and calculate compensation to the villagers who own or use the mangrove and other island resources.

The proposed resort development provides a classic example of the value of treating the entire resort complex, both the existing and proposed resorts, as a system. There are clear interrelationships between the existing and proposed facilities and some major environmental effects on one component could be either reduced or aggravated by actions involving the other component, and vice versa. The training class and instructors raised the following questions which might be considered as part of the EIA process for the proposed resort expansion:

1. Why dredge the valuable mangrove areas rather than some other less valuable alternative sites? What other land reclamation options are available that involve less fill and the need for much less dredging?
2. How would the loss of mangroves affect the way of life of the Fijian village residents? What uses in terms of medicine, firewood, fish, shellfish, lifestyle, and culture would be lost?

3. What are the characteristics of riverine and coastal flooding for the delta region, and what are the contingency plans to protect occupants and property?
4. What effects on the lagoon ecosystem would result from the resort construction and operation, including possible use of an offshore dredging site in lieu of the mangrove site?
5. What effects would the proposed hotel development have on adjacent existing low lying resort properties and occupants, particularly during flooding or storm surge inundation?
6. To what extent and in what ways will the predicted sea-level rise affect the viability of Denarau as a tourism area--with and without the proposed resort expansion?
7. What net benefits of the proposal will accrue to Fijian society? How will local residents participate in decisions and obtain training and employment?
8. Will a small-scale model of the existing and proposed resort be constructed to better communicate to local residents the extent of the anticipated changes?
9. What are the plans for public access to the beach including parking and movement along the shoreline?
10. What are the construction stage impacts of the proposal, and how will they be mitigated?
11. How have the economic analyses for the proposed resort incorporated possible losses and damages from natural hazards, including maintenance and repair?
12. What alternative designs will be considered to reduce avoidable economic and environmental losses such as setting back resort structures farther from the shoreline, structurally raising the hotel's first-floor elevations, and reducing the elevation of reclaimed land for nonstructural amenities (e.g., golf courses)?

Although these questions reflect only some of the major issues raised during class discussions, they clearly point out the complexity of planning, designing, constructing, operating, and maintaining a large-scale resort in a river delta coastal area. Resort developers often overlook other options and designs for proposals and advocate a preferred plan. The preceding example points out the need to use a systems approach for large-scale development that incorporates alternatives, cumulative effects, indirect effects, and measures to reduce or avoid adverse environmental and socioeconomic effects.

b. Palau Resort Hotel. An environmental assessment was prepared in 1981 for constructing a 100-room international resort on 17 acres of a 63-acre parcel of privately owned land in Ngerakabesang Hamlet,

Arakabesan Island, Koror State, Republic of Palau. The principal developer was a Japanese businessman who has built numerous resorts throughout the world. A "Palauan motif" was used in the design, with the resort catering to international guests.

The project would include constructing two-story structures for guest rooms, tennis courts, a swimming pool, a coral sand beach and swimming area, jetties, and a seawall and pier to replace an eroding shoreline and enhance recreational opportunities at the site. Since public facilities are lacking in the area, the developer would provide electrical, water, telephone, and sewage/sewage treatment systems.

The resort site is located on the western side of the island at the head of a small embayment, referred to as Ngerdis Bay. The original shoreline of the bay--rocky and bordered by a low, narrow terrace--is characteristic of the island. The bay area has undergone considerable disturbances by construction workers, mostly during the war years between 1936 and 1943. Alterations included land filling and construction of a seawall, a seaplane ramp, causeway, and other related facilities at the head of the bay.

Dredging for the swimming area would involve removing about 11,700 m² of ". . . refuse-littered, rock and rubble intertidal and subtidal zone which is of only marginal use for any activity in its present state." Adjacent to the intertidal zone is a rich reef and marine environment in an expansive lagoon. As described in the EIA, the loss of the intertidal zone and subtidal zone would appear to be offset by the newly created swimming area. The creation of the sand beach is also described as beneficial because of ongoing wave erosion of the shoreline, which was filled land and causing high levels of suspended silt and sediment throughout the bay.

The dredging process itself was seen as potentially damaging the surrounding areas; however, it was stated that mitigation controls, such as silt curtains, would be used during the activity. Acquisition of sand for the beach could have had impacts similar to those of dredging processes; but it was stipulated that sand removal would take place at an expansive sand bar in the lagoon, where continual movements and shifting of large quantities of sand were normal.

Land clearing activities for the project site had the potential for coastal erosion problems and excess loss of vegetation. As part of the local government's permit process, a number of conditions were tied to an earth-moving permit in order to reduce the possibility for adverse effects. These included revegetating exposed slopes as soon as possible, no stockpiling in natural drainage areas, maintenance of storm-water controls, requiring that waste oil and sludge be properly disposed of, maintenance of natural vegetation downslope of all earth moving, and maintenance of on-site drainage systems with silt and sedimentation traps.

Construction workers, most of whom would be brought in to the island, needed temporary housing. The construction of these temporary houses and roads if not mitigated properly could have led to erosion

problems. Health measures would also have to be taken to prevent introduction of infectious diseases by these workers. Depending on their origin, contact with construction workers might also introduce the island residents to different or conflicting morals.

As mentioned earlier, a "Palauian motif" was used in designing the resort. A conscious effort was made to have the resort's structures blend in with the surrounding environment. This could be seen in the actual design of the structures themselves, as well as in the layout and landscaping of the site.

To ensure that the jobs provided by the resort would go to Palau residents, the developers stipulated that 109 of the 114 jobs created would be reserved for qualified local residents. Although this would ensure increased job opportunities for local residents, these opportunities could also come at some cost. The qualified applicants for the more skilled jobs might be drawn away from jobs that provided government services and operations. The lure of cash income could also attract people away from more traditional activities.

Traffic increases from the resort would overburden the few roads leading to the resort and would increase traffic congestion in Koror, a major town between the resort and airport. To help alleviate this traffic problem, a ferry system was proposed that would bypass the town. The ferry would be coordinated with airline arrivals and would also provide guests with a ". . . breathtaking introduction to the scenic wonders of Palau" (pp. 1-15).

c. Saipan Marina Hotel Resort, Garapan, Guam. An assessment for the Saipan Marina was completed in 1987. The project was a large-scale resort that would be built in conjunction with a marina. The hotel was considered dependent on the marina and other nearby ocean recreational opportunities that would serve as its drawing attractions.

Existing at the site was a fishing base used by local fishermen for unloading and shipping. The fishing industry was local and supplied fish for local consumption. Construction would displace this complex, which the developers planned to relocate.

Marine water quality in the area had been degraded in preceding years due to discharges of untreated sewage into ocean waters and cesspool overflow. Plans for disposal of the hotel's wastewater involved tapping into an existing system in the area. Concern was expressed about whether or not the worn-out system could handle the increase. An overloading of the system could increase sewage contamination in nearby waters and degrade the very attraction upon which the success of the hotel was dependent on.

Since the hotel would replace the existing ground cover with impermeable materials, such as concrete or asphalt, it would alter existing percolation and drainage patterns and dramatically increase surface runoff. Runoff from areas such as parking lots might contain contaminants and present a threat to water quality. It could also

lead to sedimentation or siltation problems. The developers proposed a drainage system to divert runoff into green areas, which would serve as natural filtering mechanisms.

A number of recommendations resulted from the assessment, including the following:

- Establish water quality monitoring programs before construction.
- Minimize pesticide and fertilizer use.
- Coordinate work shifts to avoid periods of high local use.
- Pump sewer-holding tank during low use.
- Allow local use of recreational facilities.
- Conduct educational programs for tourists on the history of the site.

Coastal Processes in Kosrae Their Implications to the State's Coastal Zone Management Policy

by
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INTRODUCTION

The coastal zone resources of Kosrae State are an integral part of the economy and lifestyle of the people of Kosrae. Located at 5 N of the equator in the Caroline Islands, Kosrae has a tropical environment. The coastal zone consists of extensive reef flats, sandy to rocky beaches, and extensive mangrove forests.

Though there is presently no pressure on Kosrae's coastal resources, future population growth and economic development will increase utilization of the resources. Accompanying this increase will be an increase in conflicts arising over resource utilization. To deal with conflicts, and preserve the natural and social environment while promoting development, Kosrae is in the process of establishing a Coastal Zone Management Program (CZMP). The formulation of a CZMP demonstrates the value that Kosraean's place on the environment and their willingness to make the difficult but very worthwhile effort to manage the coastal zone.

The first step for a CZMP is formulating CZMP policies and legislation. Once these are established there must be processes and information available to CZMP personnel to make wise decisions concerning land use planning and development. All land use and development proposals will have both benefits and costs. These include social, economical, and environmental benefits and costs. A benefit is anything that provides an advantage or improvement such as increase in employment or preservation of the environment. A cost is any negative impact or disadvantage such as pollution or erosion. It is the goal of the CZMP to weigh the benefits and costs of each proposal and determine which projects are most beneficial to Kosrae. It is also important to

make recommendations and impose restrictions which will reduce the "costs" of a project. The CZMP is especially concerned with the social and environmental costs.

The benefits of a project are usually well known; a hotel will provide employment and promote tourism, a conservation area will preserve and promote the natural beauty of the environment. It is not always simple to put a monetary value to these benefits, but it is simple to understand their importance. While not all monetary cost of a project can be foreseen, the basic economic cost of a project can be determined before the project is implemented. The social and environmental costs are harder to predict. To predict the social costs of a project requires a clear understanding of the community and its culture. Likewise, to predict the impacts of a project on the natural environment requires a clear understanding of natural processes and their interactions. There must be a method for CZMP personnel to predict environmental costs of a project so that wise decisions can be made. It is not possible for all persons involved with the CZMP to be experts on coastal processes. It is the goal of this report to give a brief explanation of coastal process and to provide tools and methods which can be used to assist CZMP personnel in predicting probable impacts of projects on the natural physical environment. With this information and information on social and economic impacts, effective management of the coastal zone can be accomplished.

SECTION I: INVENTORY OF COASTLINE

There are different types of shorelines around the island of Kosrae. Inventory and classification of these shorelines will reduce the number of policies and laws which must be established for coastal zone management. Because general policies can be developed for large areas rather than individual sites the process of coastal management is simplified.

The classification of the shoreline can be based on many different characteristics of the shoreline. The stability of the beach, the size of sediment particles, the wave climate, or the direction and rate of sand movement, are all examples of different ways of classifying beaches. Some of these characteristics are related. For example, a beach with very strong, high wave action will most likely have large-size sediment. Fine material is washed away by large waves. Energy in the waves and currents is used to transport sediment. As the wave height increases the energy in the wave increases and, therefore, the size of sediment that can be transported also increases. There is generally also a greater rate of sediment transport when large waves are present. The categories of classification depend on the purpose of classification. For a coastal zone

management policy, the beaches should be grouped into categories which will be effected in similar ways by human activities. The impact of human activities is related to the natural physical characteristics of a shoreline.

There are basically four types of coastlines in Kosrae State. These are 1) the mangrove/muddy shoreline, 2) the sandy shoreline, 3) the cobble shoreline, and 4) the rocky shoreline. Each of these shorelines can be characterized by different sediment size, wave and current action, and topography. The locations of the four types of shorelines on Kosrae are shown in figure 1.

1.1 Mangrove

The first type of shorelines are those with extensive mangrove forests. This includes the leeward side of the island and the inner shores of the bays and harbors. Areas with a few scattered mangroves are better classified as type three or four.

The mangrove shorelines occur in areas where the wave action is very small. There is very little energy present and therefore very little sediment motion. Very fine sediment is present. The fine sediment is further stabilized by a network of mangrove roots. If the wave climate is increased along a mangrove coastline either due to a storm, dredging of the reef, or other activity there will most likely be a significant increase in the sediment transport because very little energy is required to move fine sediment.

Because it is a low energy environment, activities in one area of a mangrove coast will most likely not have major geological impacts on other areas of the mangrove coastline. An exception is seaward flow of water through the mangrove forests.

Because there is a large supply of fine sediment along these coastlines, any large-scale seaward flow may cause this fine sediment to wash out over the reef. Therefore projects considered for the mangrove coastlines should consider any changes in the seaward flow of water and the resulting outwash of sediment which might occur. Large scale outflows should be reduced or spread out over a wider area (to reduce the energy in any one single outflow) if the negative impacts will be great.

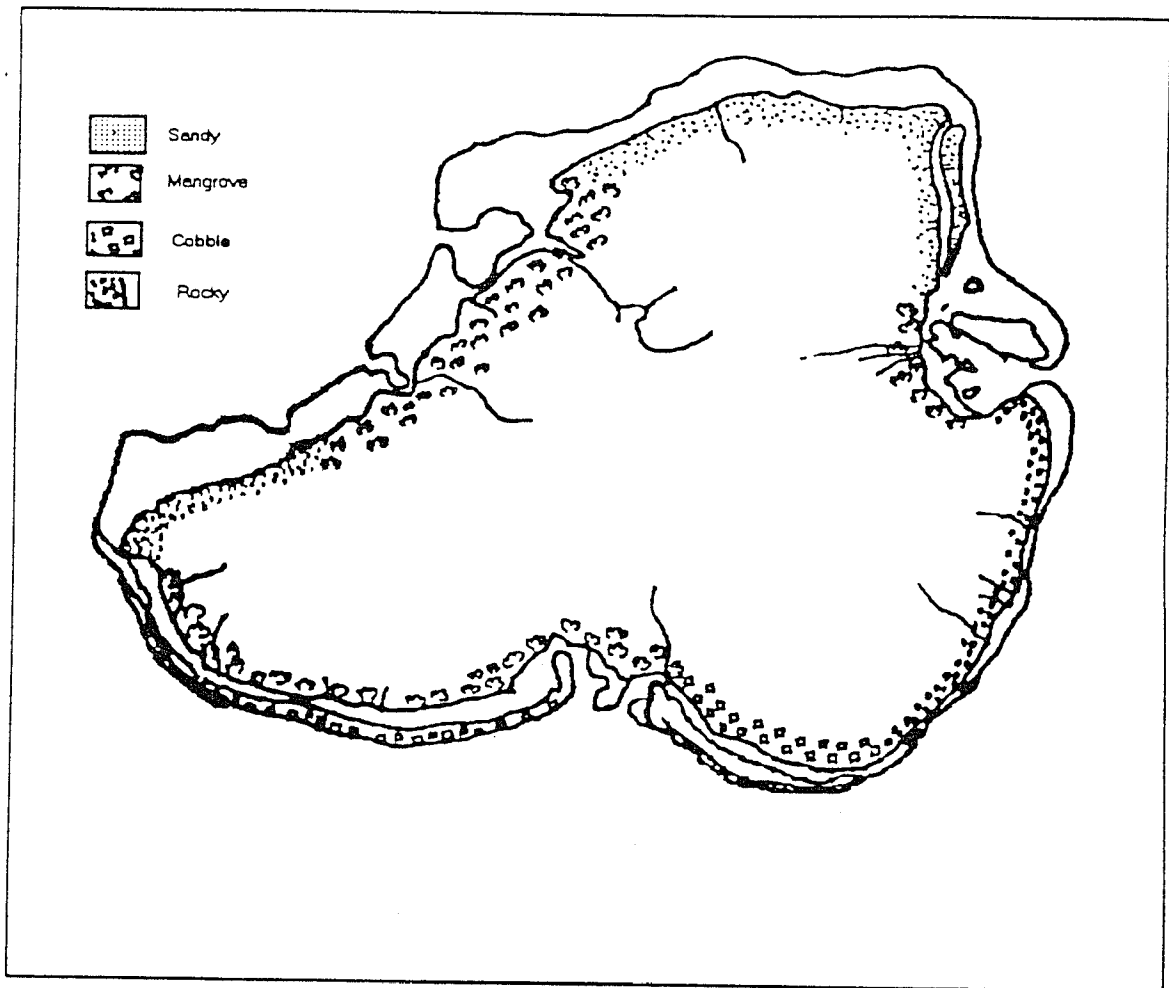


Figure 1: Types of Shoreline

1.2 Sandy

The second type of classification is the sandy shoreline. This shoreline is characterized by low to moderate wave action, and fine to sand size sediment. Examples of this type of coastline are Tafunsak and Lihk areas. These areas are generally well suited for recreational uses and sand mining. The wave action here is strong enough to wash away material which is finer than sand.

A berm is often present with a well-developed vegetation cover. The berm is only effected during storms and periods of extreme high tides. Storm waves can cause major movement of beach material because of the small sediment size.

Along the sandy shoreline there is also enough energy to transport sediment both on/off shore and along the shore. Activities in one area can have impacts in other areas of the shoreline. These impacts depend on the particular sediment transport characteristic of the area.

1.3 Cobble

The third type of shoreline is the cobble beach. This beach is characterized by sand to cobbled-sized sediment and medium to high wave action. The east coast near Malem is a good example of this type. The beach often has a steeper slope than the sandy beach and frequently has one or more steep berms. These berms have been formed recently and have little or no vegetation cover. This shoreline is very dynamic with large sediment transport, therefore, activities at one site will effect an adjacent section of the shoreline. This dynamic environment has an impact on the types and extent of man's activities possible along these coastlines.

1.4 Rocky

The last type of beach is the rocky beach with a very high wave energy climate. The beaches along the southern shore are good examples of this type. Because of the narrow reef flat a lot of wave energy reaches the shoreline. Fine and sandy material is washed away, and the beach tends to be very steep with large sediment sizes. Occasionally there will be a small "pocket" sand beach between rocky headlands. These pocket beaches may be used for some activities such as swimming. Generally because of the harsh environment there is little construction or human activities along the rocky coastlines.

SECTION II: COASTAL PROCESSES

Coastal processes are the environmental conditions and actions along a shoreline. They include a variety of processes; physical, biological, and geological. The purpose of this report is to discuss some of the physical processes which occur along the shoreline of Kosrae. The other processes as well as the interaction between the processes are very important as well, but will not be discussed here.

2.1 Wind

The main energy input into waves is from the wind. As the wind blows across the ocean it imparts energy into the water which then travels in the form of a wave towards the coastline. It is the energy contained in the waves that has a great impact on the shoreline. By studying the wind patterns and intensities in an area an estimation of total energy contained in a wave field can be approximated. There are three important factors which relate the wind characteristics to the wave heights; 1) the duration of the wind, 2) the fetch, or distance over which the wind is blowing, and 3) the velocity of the wind.

The wind for Kosrae is recorded at the airport and tabulated by the National Weather Service. The main weather patterns are the northeast tradewinds during winter, and the southwest trades during summer.

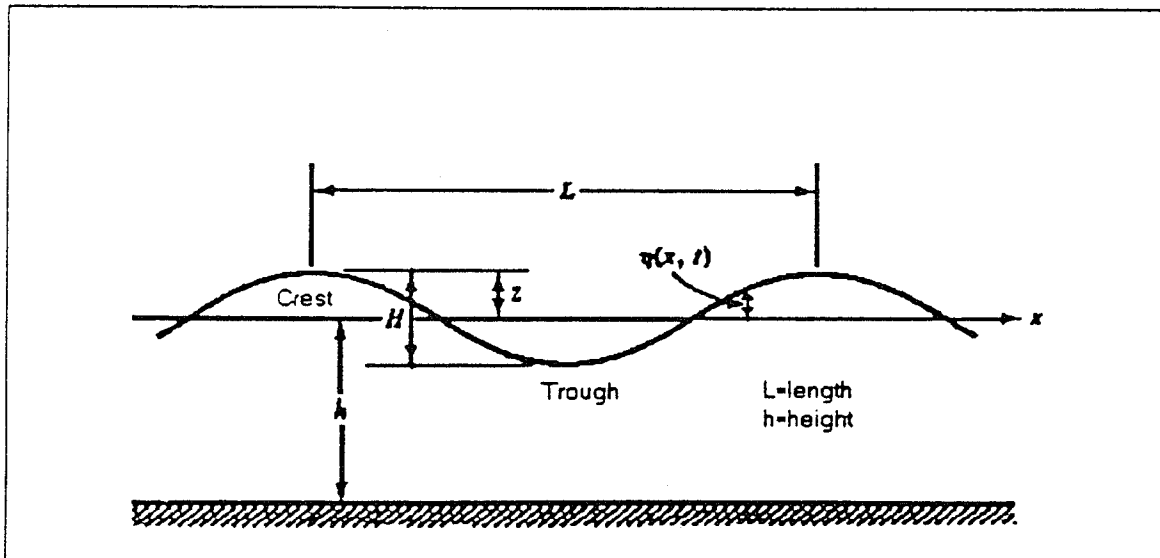


Figure 2: Wave Characteristics

2.2 Waves

Some basic definition of wave characteristics are wave height, wave period, and wave length. Wave properties are shown in figure 2.

The main energy at the shoreline is contained in waves and wave-induced currents. The energy in a wave is proportional to its height squared. Therefore a wave twice as big will have four times as much energy. Waves are formed out in deep water and travel towards shore. As a wave reaches shallow water energy is lost as the wave breaks, through heat and turbulence. Wave energy is also used to transport sediment. Waves may also create currents both parallel and perpendicular to shore.

As a wave form travels through deep water the actual water particle motion is in circular orbits. As the wave travels into shallow water it will begin to "feel" the bottom and the orbital pattern may change to elliptical orbits, figure 3.

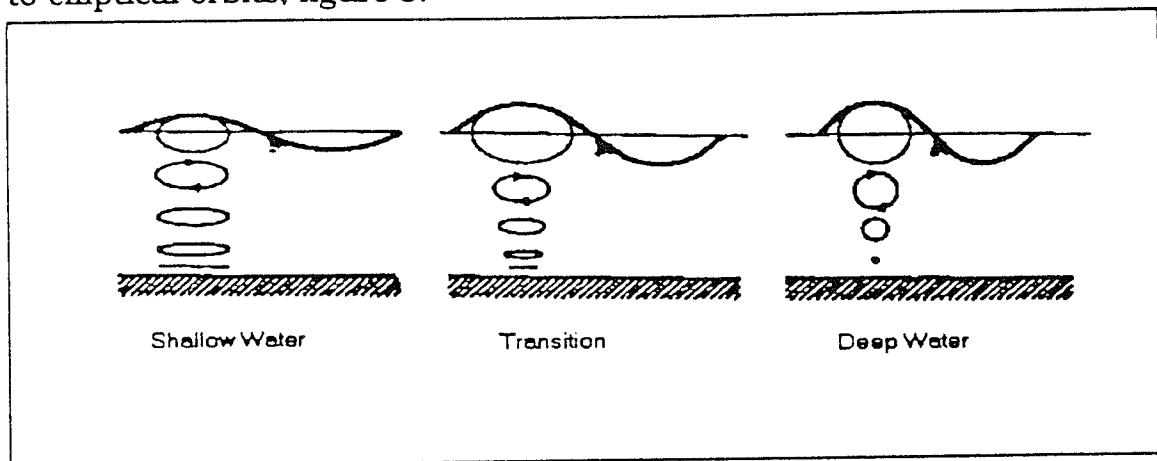


Figure 3: Wave Particle Motion

In shallow water, the orbital water motion will stir up the sediment into the water column where the currents can then carry the sediment. Also, in shallow water the water particle motion is not complete circles but has some net transport forward, figure 4. During periods of low calm seas with long period waves there is a net transport of water and therefore sediment towards the shore.

During high wave conditions this transport of water towards the shore is so large that a unsteady condition is created with the water piling up at the shoreward edge. A return current flowing along the

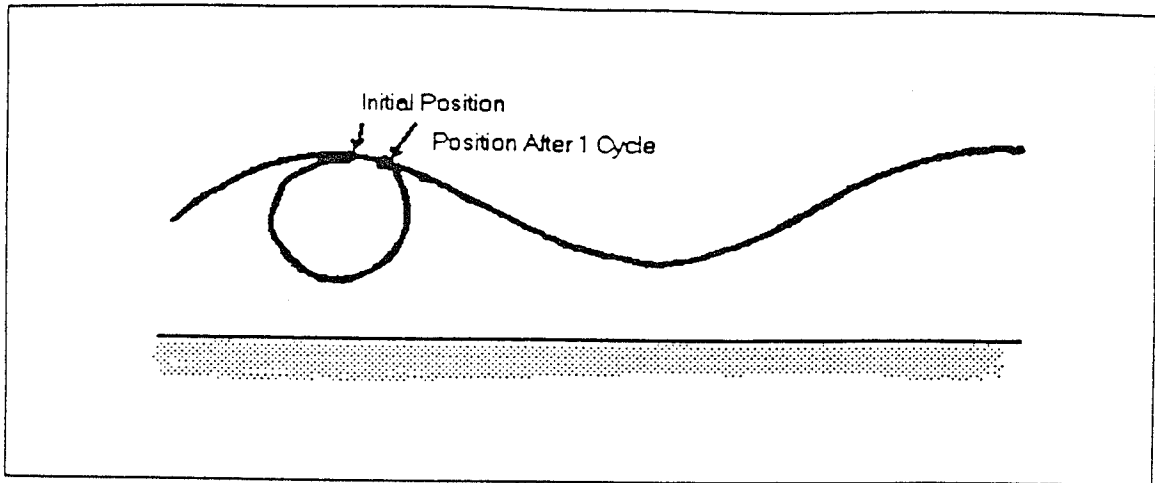


Figure 4: Net Motion of a Water Particle

bottom out towards sea is then formed to return the water back to sea, figure 5.

Sometimes strong "rip" currents form throughout the entire water column to carry excess water back out to sea.

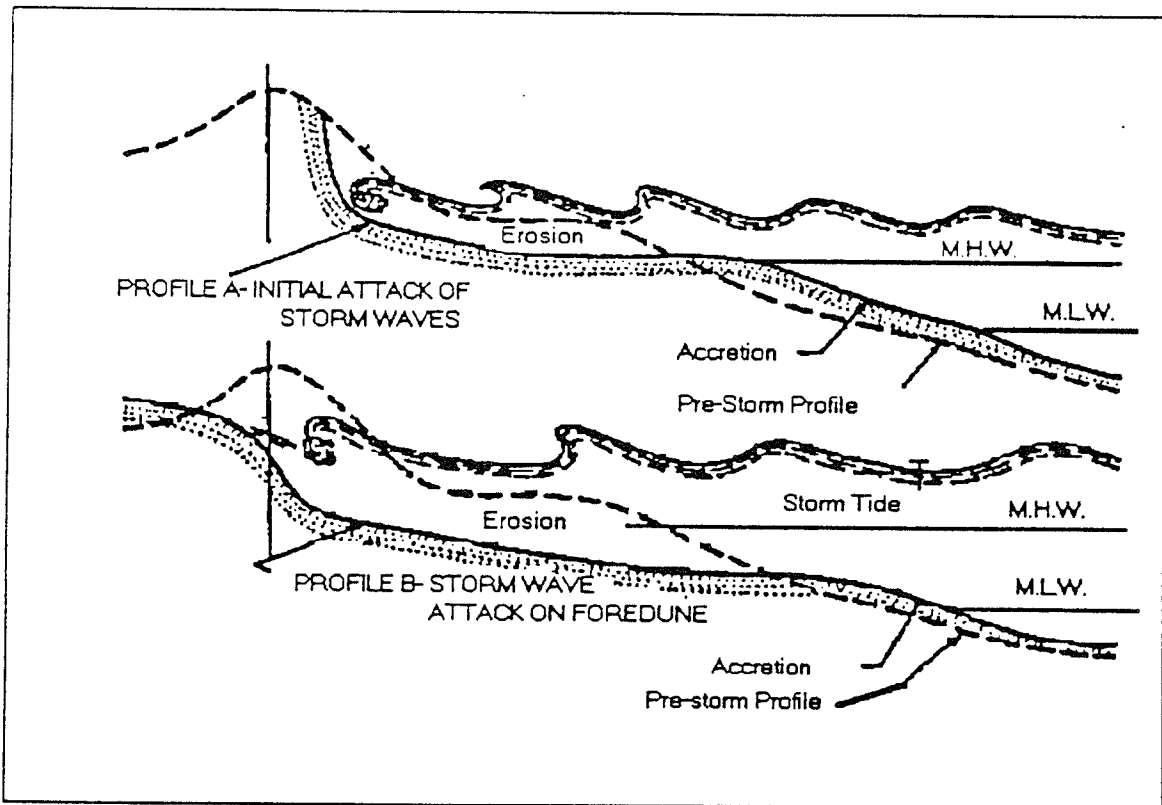


Figure 5: Storm waves

These rip currents often form in natural channels in the reef, or near headlands where wave-induced currents cause a concentration of water, figure 6. Rip currents are variable, they do not always occur at the same location or at regular time intervals.

Currents are also associated with strong tidal changes. Strong offshore currents were detected with the ebbing tide at Malem through a natural reef channel just north of the village and at Tafunsak in the east of the dredged pits, figure 7.

2.3 Tides and Tidal Currents

The tides and tidal currents are very important when considering coastal processes. The tides are waves with very long periods caused by the interactions of the celestial bodies with the oceans. For areas with extensive reef flats such as Kosrae, the tidal currents may be as important or even more important in sediment transport as the shorter period wind waves. Once sand is stirred up into the water column by wave action the sediment can be carried by the tidal currents.

The tidal fluctuations for 1988 for Kwajelan, which are similar to Kosrae are shown in figure 8. The maximum tidal range is about 0.5 meters. The strongest tidal currents occur when there is a maximum change in tidal elevation from high to low.

There has been recent increase in the tide level in the past years. This may be due to the strong northeast tradewinds which have been causing water levels to rise in the Western Pacific.

2.4 Rainfall/Runoff

While rainfall is not directly related to the coastal processes, rivers located along the shoreline can have an impact on the shape and composition of the shoreline. The higher the rainfall the greater the flow in the river and the more sediment is carried to the shoreline. In many places such as the coast of the United States the majority of the beach sediment is alluvial (originating inland). On Kosrae the majority of beach material is biogenic calcareous (of reef origin) material.

In Kosrae the flow in rivers is very important as a source of calcareous material. Because the majority of rivers do not flow straight out to sea but meander along the coastal strand, during periods of high river flow, calcareous sand is scoured from the coastal river banks and deposited at the river mouth. These deltaic shaped deposits can be seen at the mouths of rivers on the northern shores of Kosrae, figure 9.

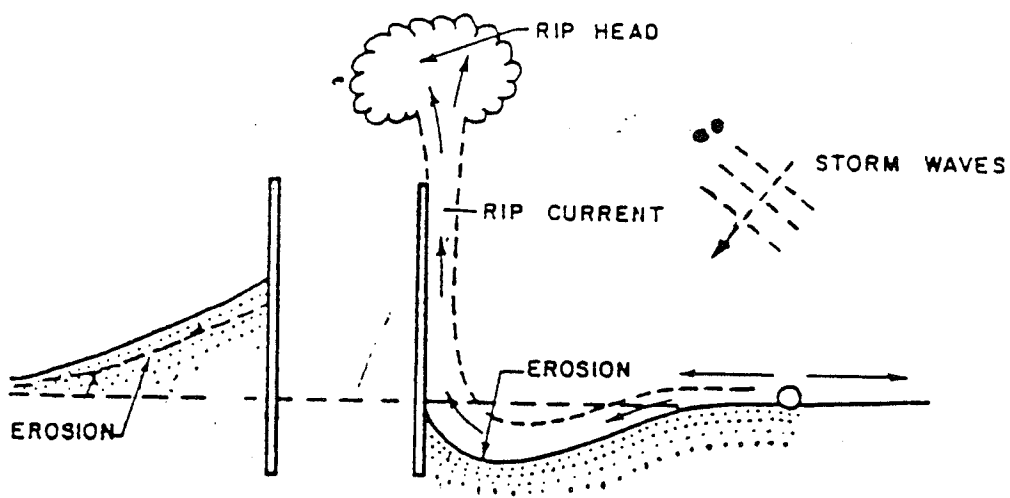
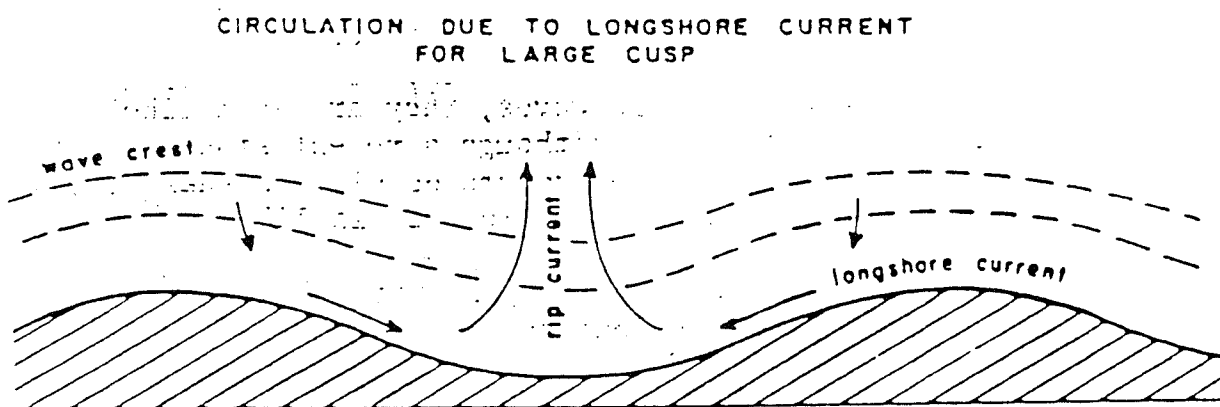
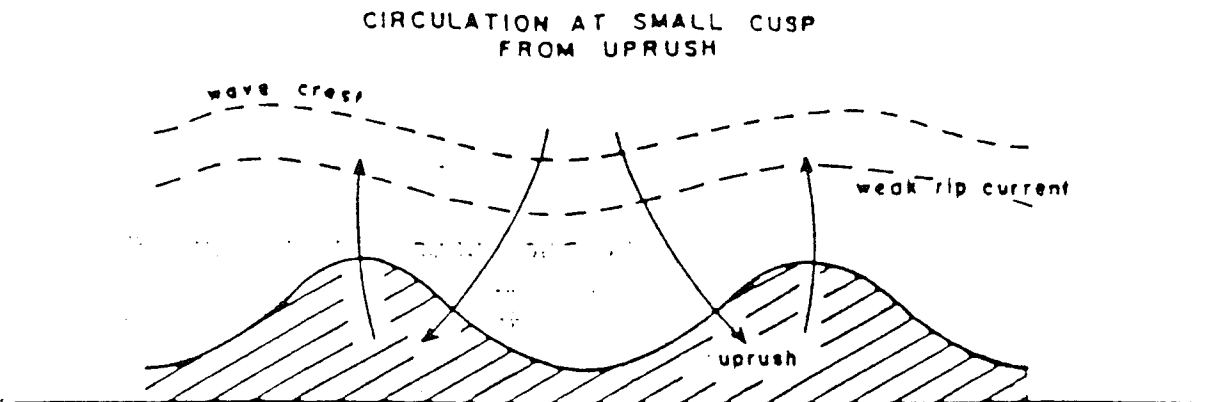


Figure 6: Rip Current

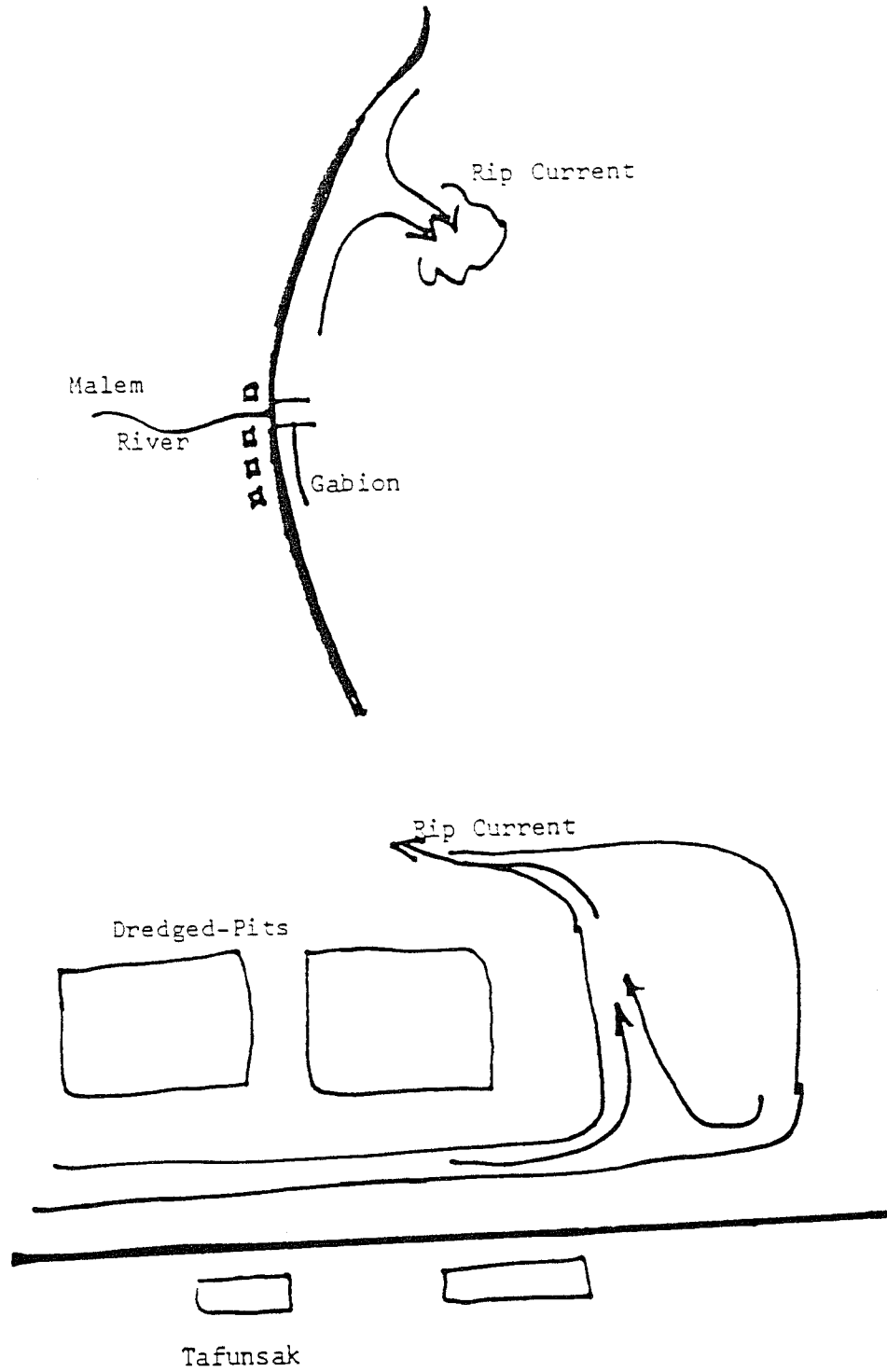


Figure 7: Rip Currents at Malem and Tafunsak

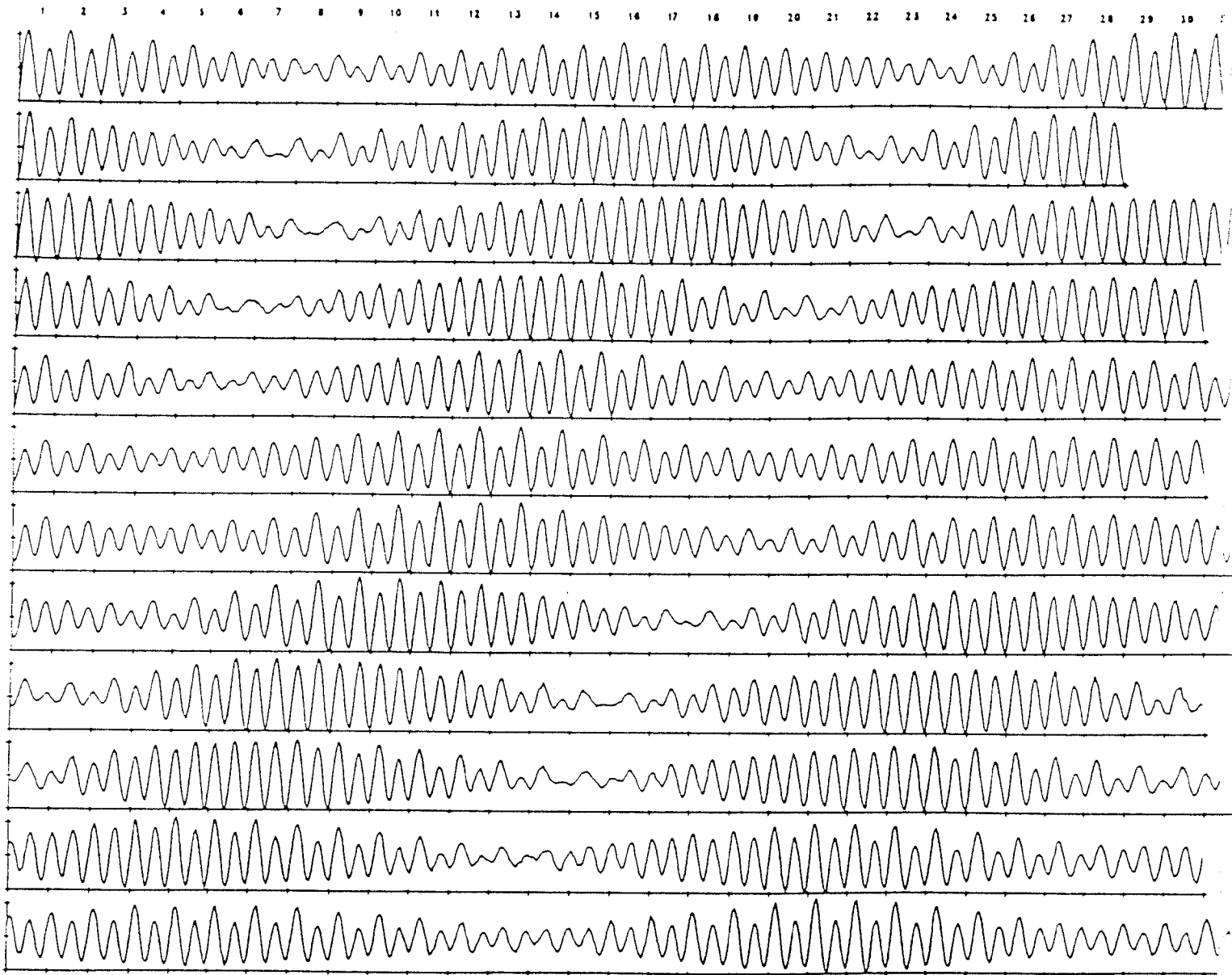


Figure 8: Tidal Chart

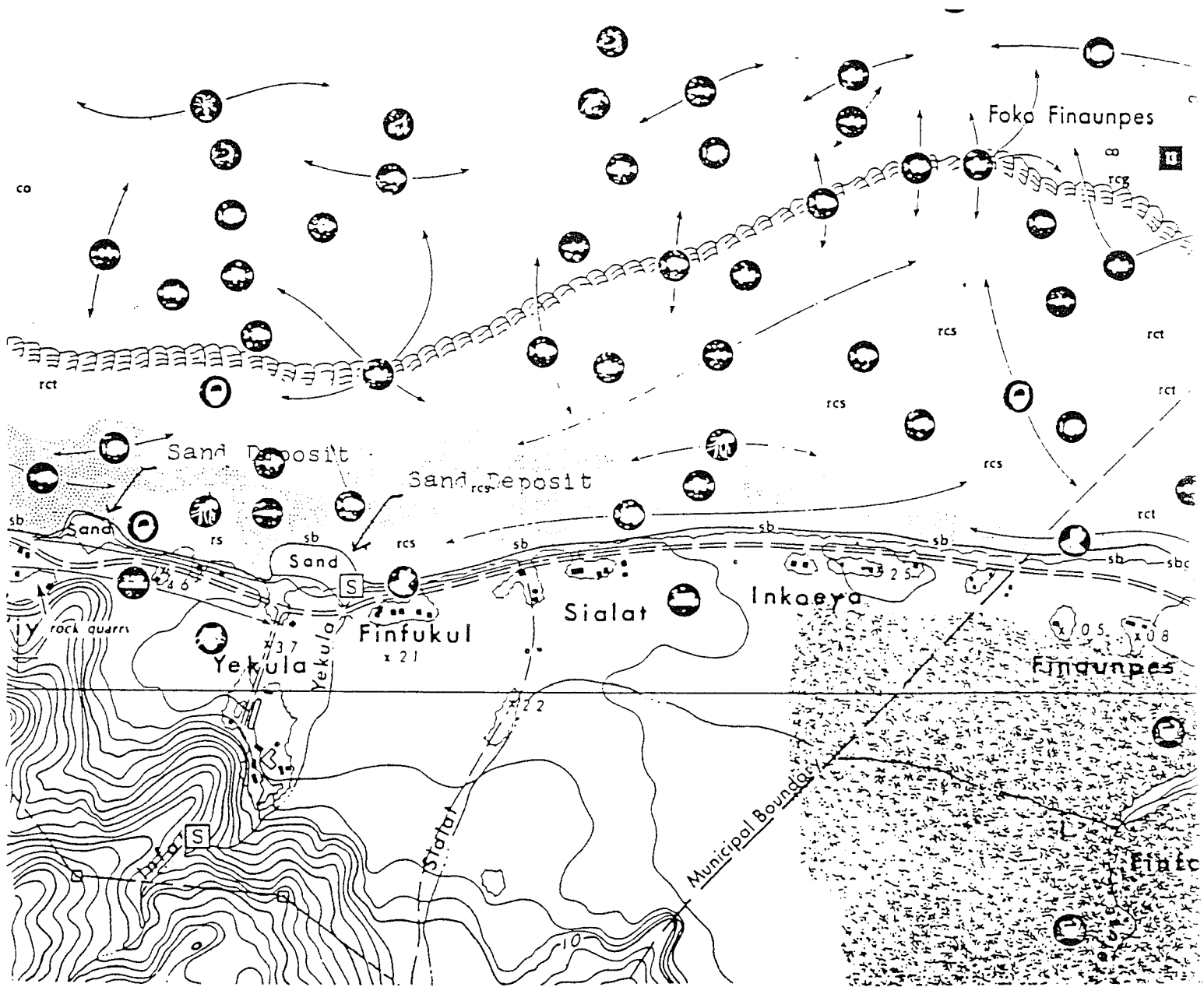


Figure 9: Deposits of Sand Near River Mouths

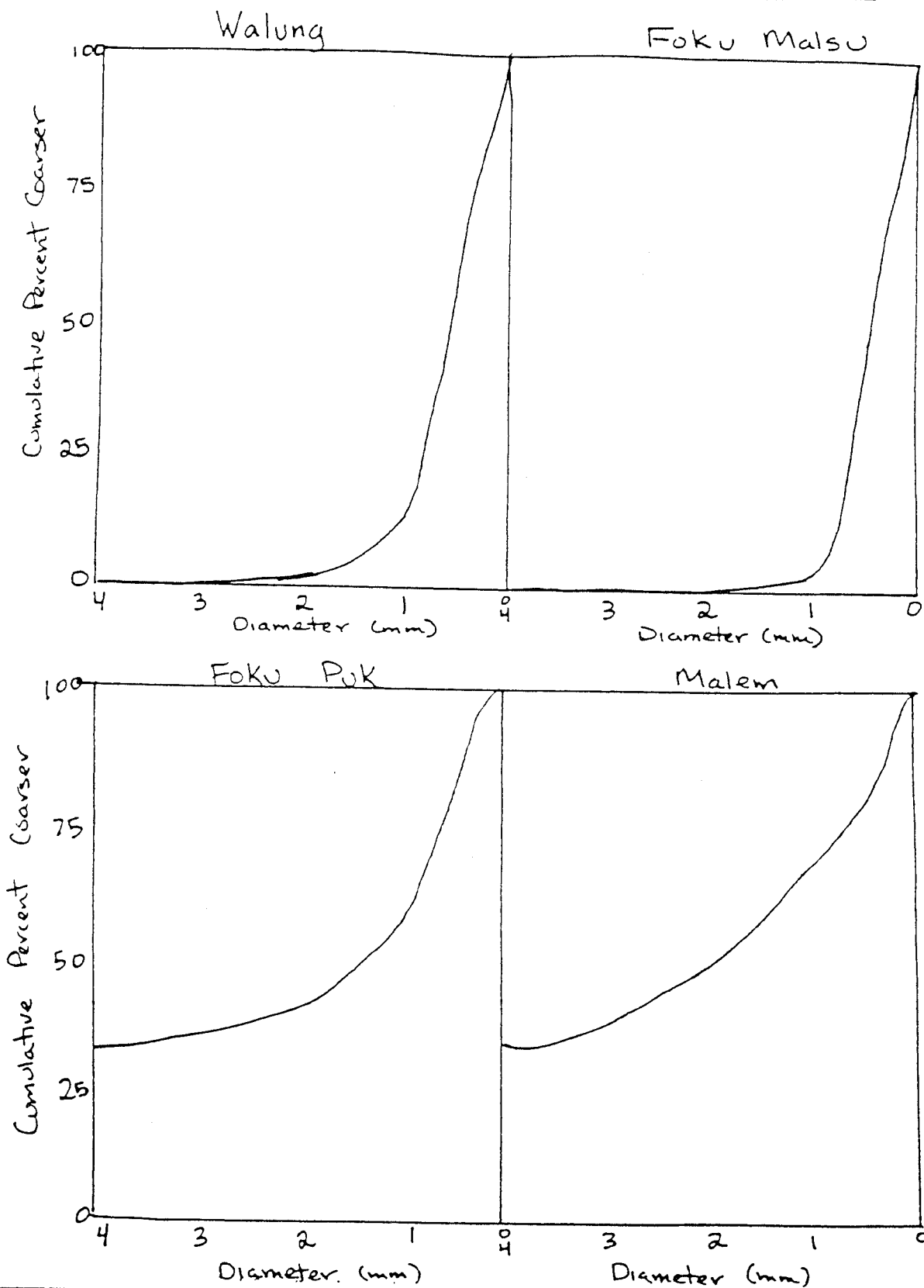
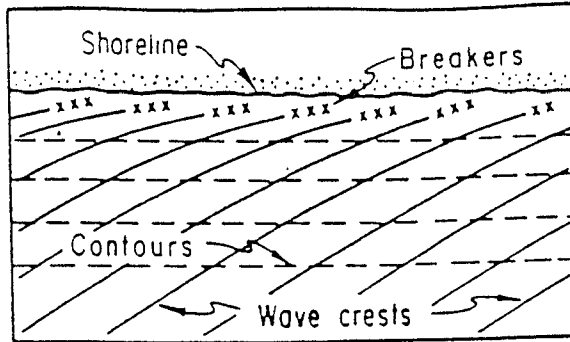
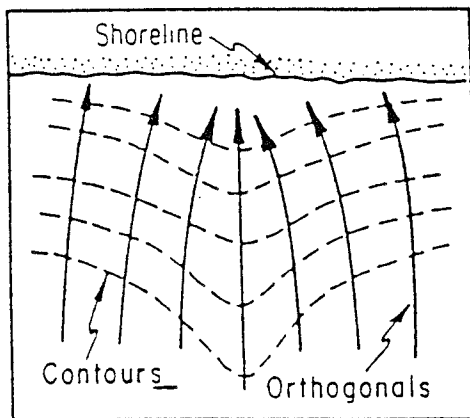


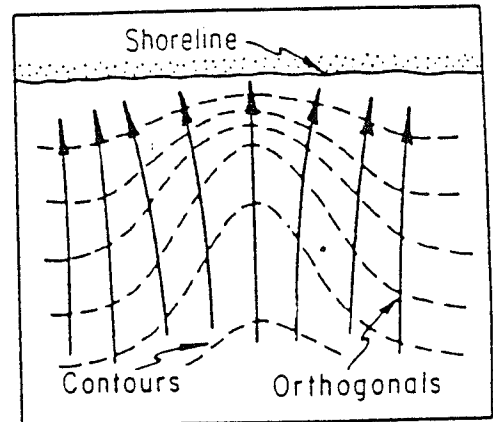
Figure 10: Grain Size Distribution



Refraction along a straight beach with parallel bottom contours.

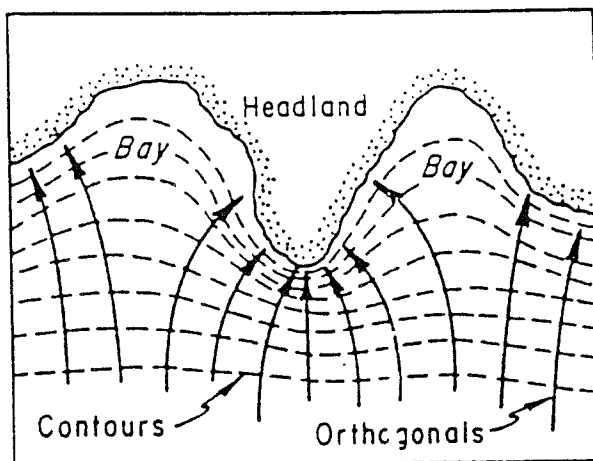


(a)



(b)

Refraction by a submarine ridge (a) and submarine canyon (b).



Refraction along an irregular shoreline.

Figure 11: Wave Refraction

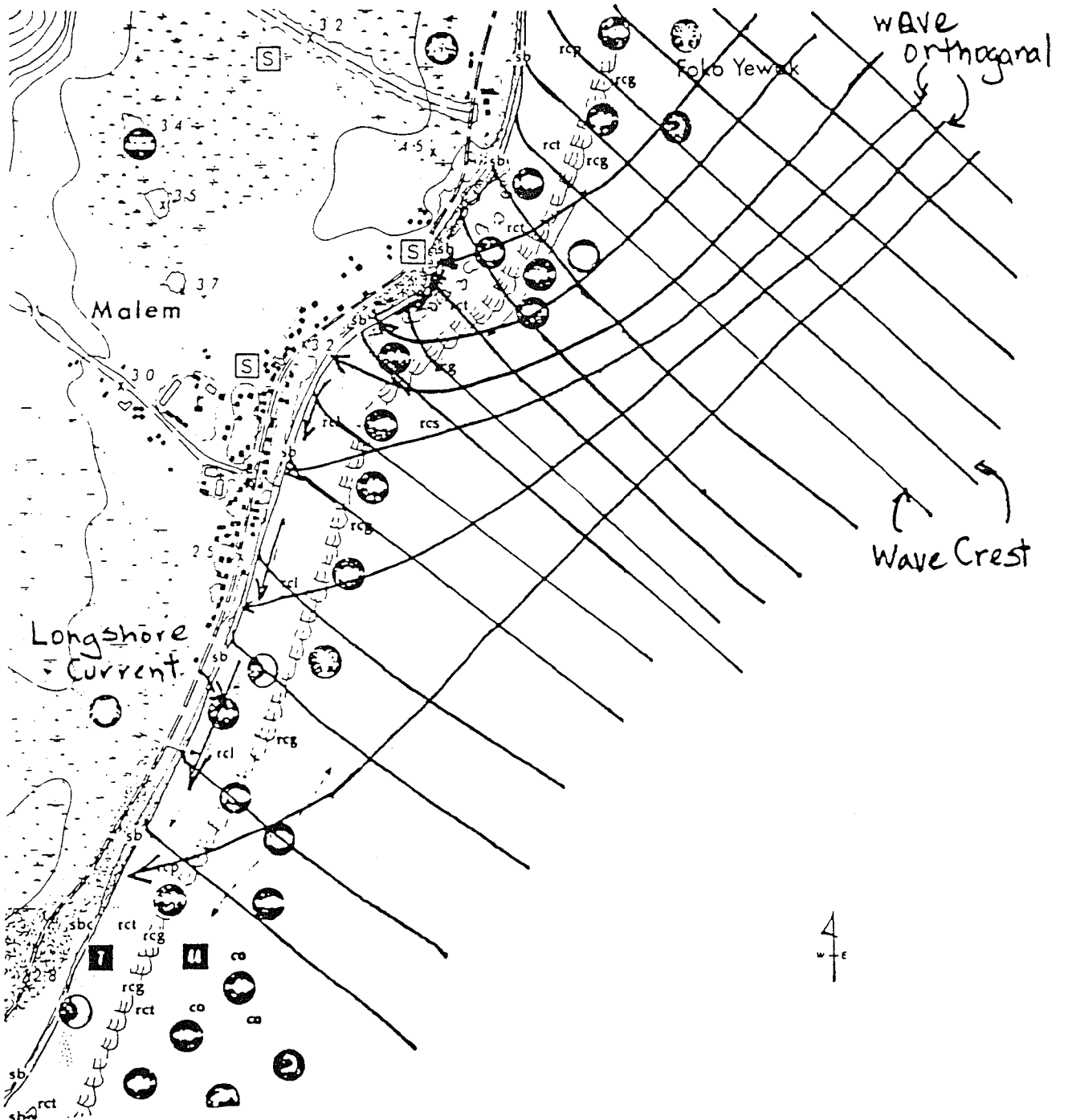


Figure 12: Wave Refraction for Malem Coastline

Rivers may also cause offshore currents or natural channels in the reef which will effect the local water and sediment transport characteristics of an area. It is believed that the natural channel in the reef to the north of Malem was created by the outflow of the Malem River before its outflow location was changed.

2.5 Sediment Characteristic

Sediment characteristics are an integral part of the study of beach processes. Two main characteristics of sediment are its size and composition. Other factors such as the shape and water content of the sediment may also be important.

The size of the sediment grains is related to the wave energy impinging on a beach. The larger the wave energy the larger the average sediment size present on a beach. Fine sediment is easily eroded away by the larger waves. Size distribution diagrams for four sediment samples from Kosrae are shown in figure 10. There is a greater amount of large sized material near Malem and finer sand at Walung and on the northern shore.

The composition of the sediment is a good indicator of the source of the sediment and can also be used for structural design criteria. The majority of beach material around Kosrae is biogenic calcareous material from the reef.

2.6 Beach slope and topography

The topography of the offshore area effects the wave patterns. The speed of a wave in shallow water is related to the depth of the water. A wave travels slower as the water depth decreases. The changing topography of the beach will bend the wave as it travels towards shore, figure 11. This is called refraction. The eastern coast of Kosrae near Malem consist of a few narrow bays. A possible refraction pattern for northeast tradewind waves for these bays is shown in figure 12. Wave refraction determines in which directions the majority of wave energy will impinge on the coastline. The pattern of refraction depends on the local topography and the direction and period of the approaching waves. If the wave impinges on the beach at an angle due to refraction, there will be a component of the wave energy directed parallel to shore and a longshore current will develop, figure 13.

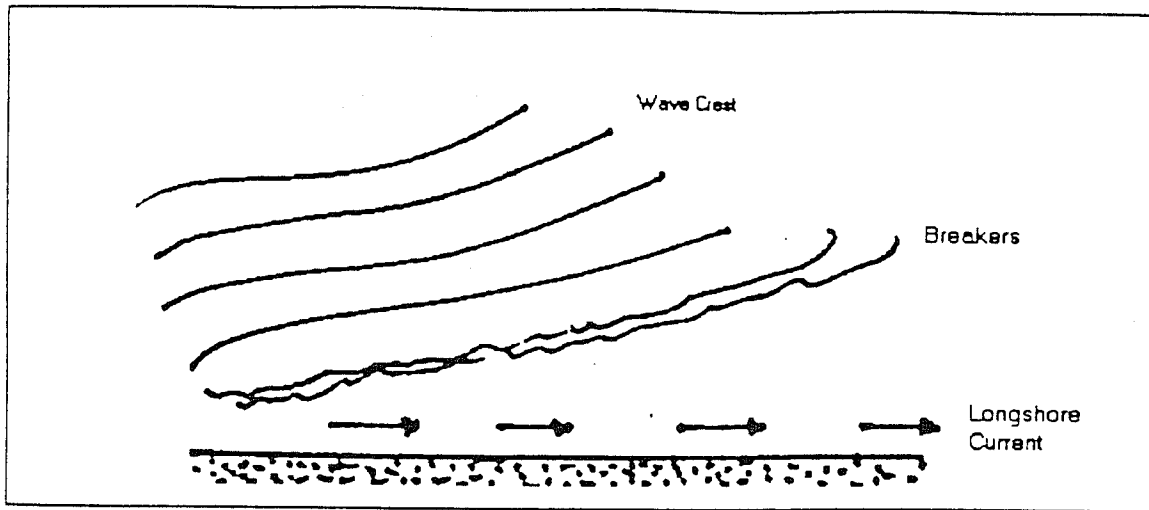


Figure 13: Longshore Current

2.7 General modes/Quantities of Sediment Transport

The beach is a very dynamic zone of interaction between land and sea. Because the sea is always changing, the beach is also changing. Sediment is almost always moving at the shoreline. Though it is hard to detect by eye, sediment movement can be detected by sequential photographs, sand traps, or the accumulation of sand at coastal structures.

There are two general directions of sand transport along a shoreline. On-off shore, and longshore. For an island such as Kosrae the sediment comes from the edge of the reef as onshore transport. The wave energy breaks off pieces of coral at the reef edge and transports it toward the shore. The transport is generally onshore during low, swell conditions and offshore during high sea conditions. There may also be onshore-offshore transport due to the tidal currents. Evidence of onshore transport on Kosrae is seen in the accumulation of sediment on the seaward sections of the man-made dredged pits in the reef off of Tafunsak.

Along many shorelines there is transport of sediment parallel to the shoreline. Longshore transport occurs when there is a current flowing parallel to shore. This could be either wave induced or tide induced. Along the eastern coast of Kosrae near Malem there is evidence that longshore transport from north to south is occurring. Sediment is accumulating on the northern sides of gabions built perpendicular to the shoreline.

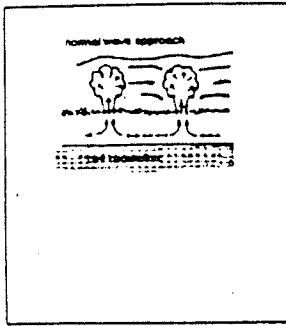


Figure 14:
Cell
Circulation

Often there is a combination of onshore-offshore-transport and longshore transport. These are often called littoral (coastal) cells, figure 14.

The most important aspect of sediment transport to shoreline stability is not the rate of transport but rather changes in the rate of transport along a shoreline. There must be a mass balance of sediment to have a stable shoreline; as long as what goes into the system goes out of the system the shoreline will be stable. If there is a change in the rate of transport there will either be erosion or accumulation.

River transport of sediment is also important to consider because it is an additional input into the mass balance of material of the natural beach system. Rivers may also cause a change in the transport rate because of the physical obstruction by the river of sediment movement.

2.8 Dynamical Characteristics of Beach Systems

The natural beach system consists of the reef flat, the sloping beach, the dunes and the backshore sand deposit areas. All of these areas are an integral part of the system and any alterations or use of any of one of these areas may have a profound effect on any of the other areas.

The reef is important in that it is the source of the beach materials, it is the reef over which the material is transported, and it provides a line of defence to the beach area by dissipating wave energy through bottom friction and breaking. The beach slope is the transition area between land and sea. The dunes are a second line of defense stopping the wave energy from reaching farther inshore. They are also a reservoir of material which is used to resupply the beach during high waves and storms. The backshore area is another reservoir of sand, supplying the beach with material through river flow and runoff.

2.9 Extreme Events

Though storms and other extreme events do not occur often when they do occur they can have very profound effects on a natural beach system. The beach is working for a long time to reach a stable condition with the day to day environmental climate. An extreme event greatly changes the environmental climate and therefore can greatly change the beach.

Storms have a major impact on the beach for a variety of reasons. The most obvious is that there are higher waves therefore more wave energy and erosion of sediment. One very important factor of a storm is storm surge. Storm surge is an apparent rise in water level due to a variety of factors which occur during a storms.

2.9.1 Storm Surge

Storm surge includes the water level setup due to a low pressure field, the setup due to wind, and the setup due to waves, figure 15. Storms are usually associated with low pressure systems in the atmosphere. Because there is a lower pressure the mean water level rises. As wind blows at high speeds over the water at a shoreline it will push the water on the shoreline and cause a rise in the water level. Large waves as mentioned before can also cause a set up of water along the shoreline.

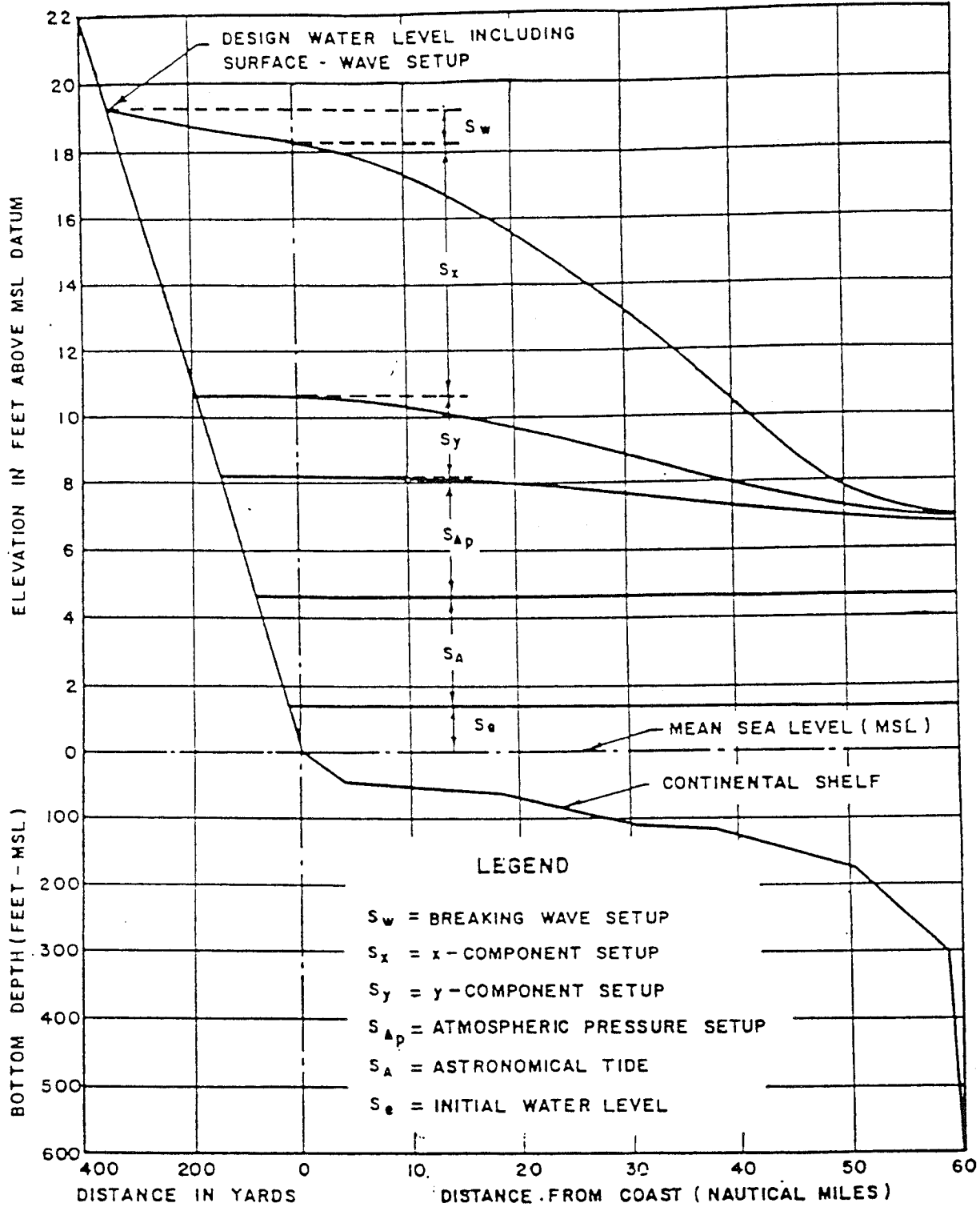
Storm surge is important for two main reasons. One because of the high water levels there may be severe flooding along the shoreline, especially on flat coastal plains. The second reason is because the point of wave breaking is dependent on the depth of the water, higher water levels cause waves to break closer to the shoreline. Thus the waves reach the shore with less of their energy dissipated and can cause extensive damage and erosion.

2.9.2 Tsunami

Tsunami are important because of the destruction of the shoreline which is possible during these large waves. Tsunamis are very rare for Kosrae.

2.9.3 Sea Level Changes

Sea level fluctuates over time both due to natural causes and due to man-induced causes. These fluctuations can be in the order of a few years to hundreds of years. The natural sea level changes are mainly due to the weather patterns. For example if the trade winds are exceptionally strong for a long period of time the water may pile up in the western part of the Pacific and there will be an apparent rise in the mean sea level.



Various setup components over the continental shelf

Figure 15: Wave return

Man-induced changes are related to the warming of the atmosphere by man's use of fluorocarbons and depletion of the ozone layer. As the temperature rises the glaciers at the poles melt and the sea level rises. The rate of rise is still disputed, but even a small rise could effect a large portion of the world's flat coastal plains.

SECTION III: RECOMMENDATIONS FOR KOSRAE COASTAL ZONE MANAGEMENT POLICY

This paper is part of a Sea Grant project which was created to assist the government of Kosrae State, Federated States of Micronesia, with technical assistance on the formulation of a state Coastal Zone Management Plan. The author of this paper spent two weeks in Kosrae State studying coastal processes. The following recommendations are based on these limited observations and on talks with the local residents. The recommendations are in accordance with the technical background of coastal engineering and physical oceanography, and are based mainly on the current physical conditions of the shoreline. As much as possible the rationale behind the recommendations along with alternatives will be listed so that the recommendations will be used merely as guidelines for the officials who are making the actual decisions for the coastal zone management policy. It is hoped that the members of the CZM committee and others involved will view these recommendations as bringing to light environmental criteria that may be overlooked in the CZMP, and to suggest ways to further increase the knowledge of Kosrae's coastal processes. Environmental criteria, along with social, economical, and other factors known best to the citizens of Kosrae state, will be applied to reach the final aspects of the CRZM plan.

3.1 Historic Uses

The coastline of Kosrae has been and is used for a variety of purposes. The major uses of the shoreline areas are house and other building sites, sand and coral mining, reef gleaning, fishing, mangrove wood harvesting, and recreational. The majority of these activities have not interfered with the natural physical properties of the coastal environment.

The major man-induced impacts on the natural beach system have occurred with the siting of structures, sand mining, coral dredging, and realignment of river mouths. All of these projects have been important to the economic and social conditions for Kosrae.

3.2 Future Uses

The use of the shoreline area in Kosrae is expected to increase in the near future. There are proposals for new small boat harbors, light

industries, ^{and} increased tourism with corresponding infrastructure development. Marine preserves and conservation areas have also been discussed.

Again the major man-induced impacts on the physical coastal environment will be the construction of facilities (buildings, seawalls, harbors, etc.) along the shoreline, realignment of river mouths, sand mining, and coral dredging. Wastewater management, biological environment impacts, and competition for resources are other areas which will be impacted in the future.

3.3 Recommendations for Areas of Particular Concern

The beaches of Kosrae are relatively stable and do not have any major erosion problems except in a few areas. The major causes of erosion are storms and man-made structures. Both of these can drastically alter the beach shape and size. Areas where long term erosion is currently taking place may be designated as Areas of Particular Concern. These areas may include the beach at Tafunsak, behind the coral dredge pits, and the beach in front of Malem Village. The third area which is recommended for an Area of Particular Concern is the collective group of river mouths which empty onto the beach system. The area of Lihk and the beach near the CAT team headquarters may also be possible Areas of Particular Concern if the erosion continues for a longer period of time. Only areas where ^{there is} long-term erosion should be considered for this designation because beaches naturally fluctuate. It is difficult to say what exactly constitutes "long term" erosion. This is where accurate historical records of beach profiles can be invaluable.

3.3.1 Tafunsak

As stated, the majority of sediment on the beaches at Kosrae comes from the reef edge. At Tafunsak the movement of sand from the reef edge to the beach slope has been obstructed by man-made dredge pits. Because of the size of the pits and the slow rate at which the sediment is being transported onshore, it is most likely that the beach will continue to erode. There seems to be a slight longshore transport in the easterly direction, evidenced by the build up near the mangrove forests. The beach may continue to grow at the eastern end of the Tafunsak beach area. However, the process is very slow and most likely protective measures such as a seawall or protective mat may have to be provided. This area is very fragile. Because of the long period of restabilization of the beach it is recommended that the shore should be designated an Area of Particular Concern

3.3.1 Malem

The area of Malem shoreline is also experiencing long term erosion. The erosion is most likely caused by a combination of one or more of the following; realigning the natural river channel, the old seawall at the northern end of the bay, the new seawalls at the mouth of the river, and the large scale operations of sand mining to the north of Malem for the construction of the farm road. Because the beach at Malem is in front of a village, ^{and} is subjected to a lot of wave action, and there is no single cause of the erosion along the shoreline, it is recommended that that shoreline be designated as an Area of Particular Concern.

3.3.2 River Outlets

The river outlets are important because they provide a mechanism for returning some of the backshore sediment to the beach. This supply of sediment is very extensive especially along the northern shore. It is believed that if the river is straightened or moved that there will be a smaller input of material to the shoreline. This reduction of material to the shoreline should be weighed carefully against the benefits of straightening the rivers in the coastal strand.

Another impact of controlling the river outflow by groins is disturbing the natural longshore transport of sediment. Examples of this can be seen near Malem and the CAT team headquarters. Thus possible impacts of groins at river mouths should be considered before building.

3.4 Recommendation for definition of set back lines

The area above high tide is an integral part of the beach. Any activities in the backshore area and on the berm can have large impacts on the beach face. A coastal management policy should acknowledge the importance of the entire beach system. The importance of the backshore area and berms can be recognized from the degree of acknowledgement of the importance of strict laws which prevent some or all activities in the area.

If a structure is built at the edge of a shoreline it may often cause erosion. As a wave hits a structure it is reflected, reflected wave energy carries the sediment at the base of the structure out towards sea. Thus it is advantageous to build inland of the point where the highest waves reach. This is very valuable land from a economic and esthetic view, and, therefore, a compromise is often utilized for the siting of structures.

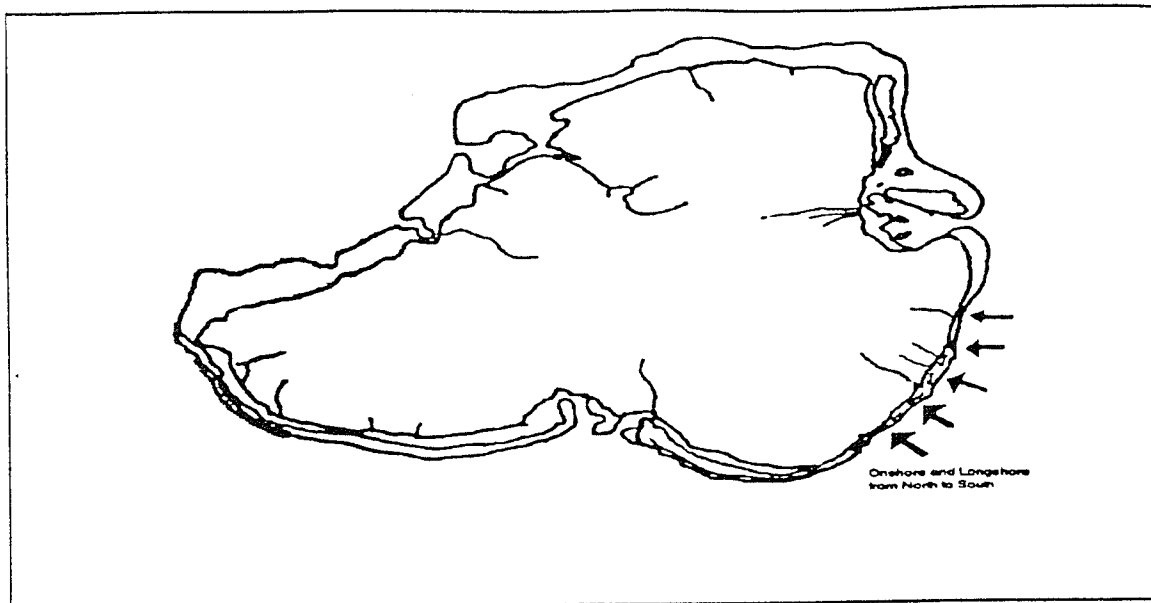


Figure 16: Sediment Transport Identified During the Field Study

Most developed areas along the shoreline have established set back lines as a means of protecting the backshore area and the beach face. Set back lines are imaginary divisions between the area directly related to the beach system and the inland area. It is important to have a line of division that is easily distinguishable when planning land use activities and development along the coast. A line that is often well known and surveyed is the mean high tide line. Using this line as a division between uplands and the shoreline (transition zone) does not, however, include the berms and backshore deposit areas in the beach system as they are above mean high tide. A way to include the berms and backshore deposits in the beach zone is to establish the division a set horizontal distance inland from the mean high tide line. This preserves the easily distinguishable line while including all the important areas of the coast. There are two policies of designating set back lines for an island. The first is to designate one given distance behind the high tide line for the entire island. The second way would be to establish different set back lines at each area which are correlated to that specific site. The first method has the advantage that in any area, at any time, the set back line can be determined without referencing the policy statement. This method may also be considered "fair" and therefore less likely to raise dispute because there is an equal restriction around the entire island. The disadvantage of the first method is that with one given distance, the variability of the shoreline is not taken into considerations. In some

areas the single set back may be too extensive, while in other areas the set back limit may be inadequate.

Whether a single setback limit is established or site specific set backs are established the most important task is to relate the setback to the specific characteristics of the geographical region with consideration for the entire ecological, social, and economical aspects of that region.

For Kosrae State the establishment of a set back policy is recommended as a very important step in managing the coastal zone. The idea of set back may be met with negative reactions from the people of Kosrae because land ownership extends to the mean high tide line. The set back will restrict activities on what is a very resource-rich section of property. It is beneficial that a setback be established sooner than later and that the public is educated on the significance and long term benefits of establishing set back lines. There are differing degrees of restriction that can be established, for example, only large scale facilities such as hotels, factories, etc. should be required to build inland of the set back limits, or the policy may state that all projects in this zone must be looked at in greater detail before approval.

After studying the topography of the natural beach system on Kosrae, a recommendation of 50 feet horizontal distance above mean high tide is recommended as the set back distance. This is based on the profiles taken at Tafunsak and Malem, and the distances of the backshore beach profile. The criteria in establishing the the set back limit include: 1) in all areas the berm is included in the set back limit and 2) approximately 25 percent of the backshore area was included as part of the beach system. This is only based on a few observations and measurements and it is recommended that if a set back is established that persons on Kosrae make the decision for the distance based on their knowledge. A possible alternative to a single distance would be to have a set back distance for each of the four different types of coastlines around Kosrae.

3.5 Structural Designs and Codes as Related to Coastal Processes

Knowledge of the coastal processes can be applied to the design of coastal structures and land use planning to make wise decisions which will minimize the negative impacts.

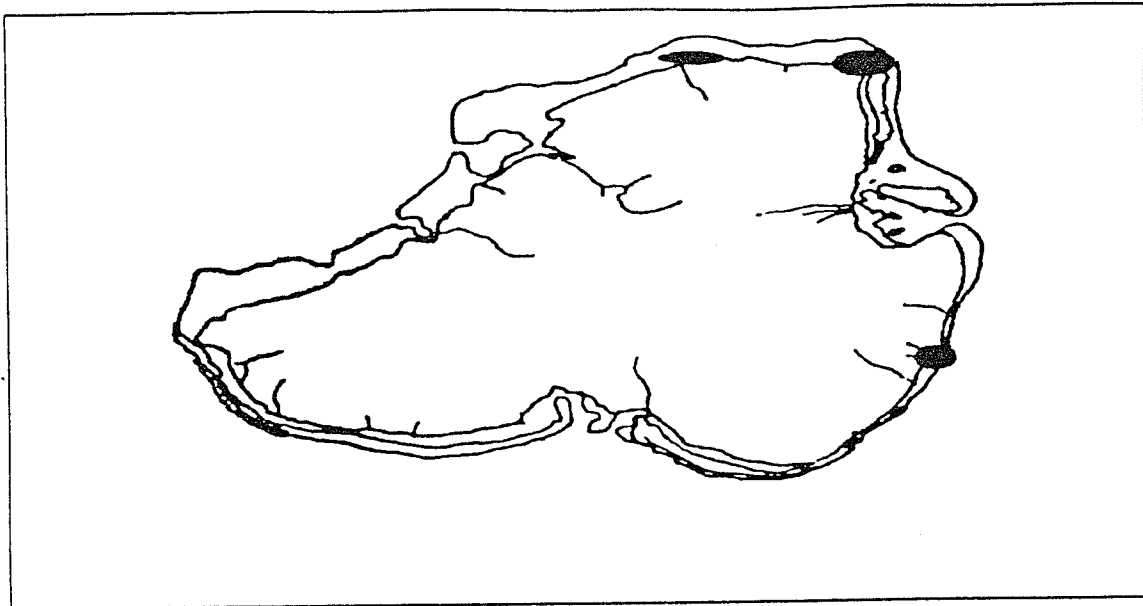


Figure 17: Areas Where Structure Perpendicular to the Shore Should Be Limited

3.5.1 Beach Erosion

By identifying the main direction and rates of sand transport, structures can be built which least interfere with the natural beach system. For Kosrae State the sediment comes from the reef edge moves onshore and in certain areas is carried by the currents and wave action along the shore. The basic patterns identified during the field study are shown in figure 16.

A most important environmental consideration when designing a structure or approving a land use activity is consideration of what changes in the sediment budget will occur and which areas will be effected. For example, in certain areas where there is a large longshore transport, structures built perpendicular to the shoreline such as gabions to straighten river mouths, piers or docks, seawalls, and breakwaters will interfere with the natural sand system and will cause erosion on the downdrift side. Adequate protection, renourishment, or stabilization of the beach on the downdrift side must be provided if the beach on the downdrift side is to be preserved. Areas on Kosrae where special consideration for approval for structures perpendicular to shore are shown in figure 17. These areas were chosen because of the important resources located down the shoreline from the area. It is also recommended that large scale mechanical dredging be restricted in these

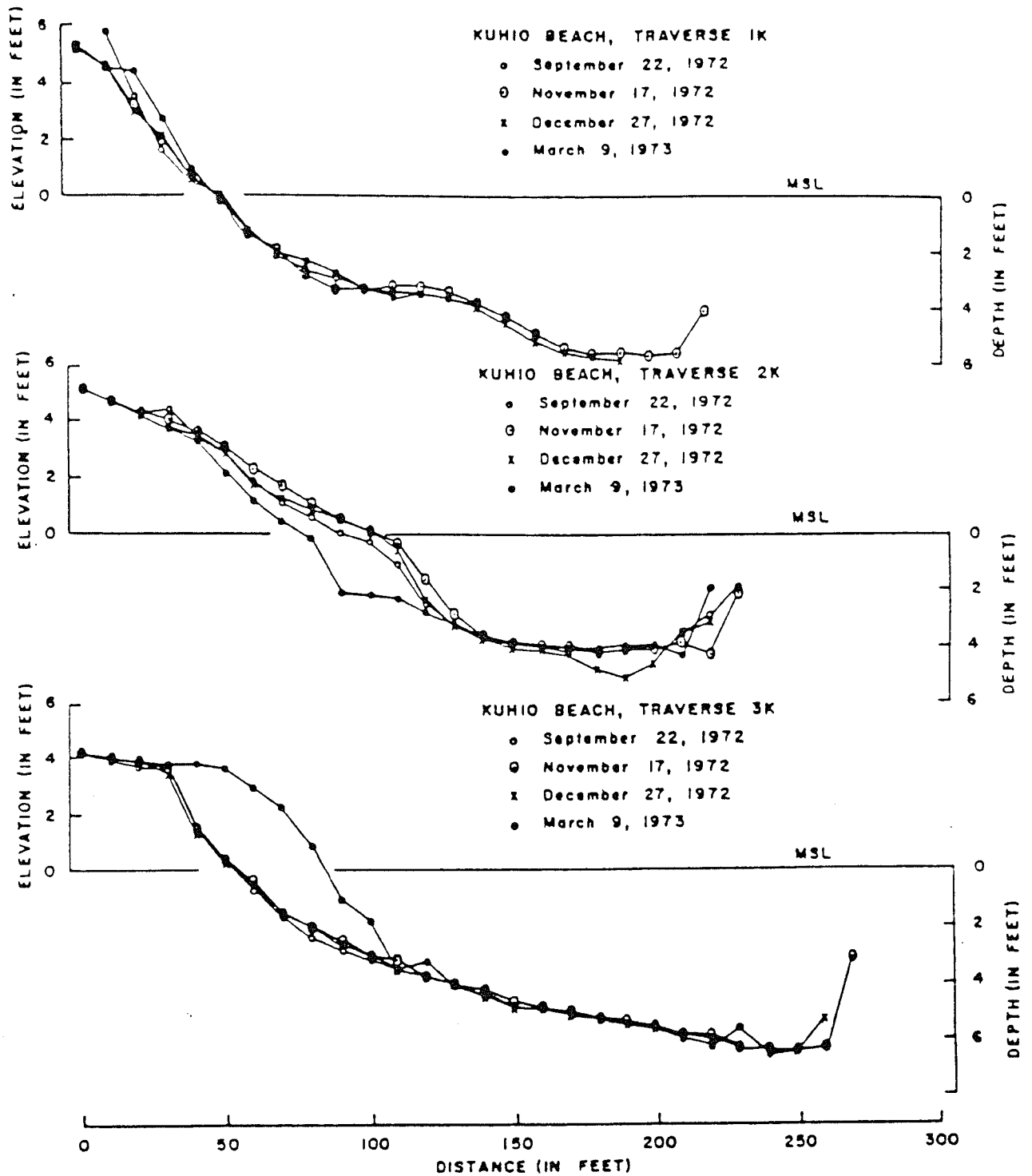


Figure 18: Profiles for Traverses 1K, 2K and 3K, Waikiki Beach, Oahu, Showing Natural Changes in Shoreline

locations. Because of limited time not all areas were investigated thoroughly. Additional areas of longshore transport may be identified in future studies.

The sediment on Kosrae comes from the reef edge and is brought onshore by waves and currents. Therefore, any obstruction, whether it be an excavation or structure built parallel to shore, will interfere with this onshore movement. It is recommended that any large scale dredging be conducted away from the main villages and populated coastlines. This may not always be feasible, but a thorough study should be conducted before any dredging to determine what effects a decrease in sediment supply may have on the area.

3.5.2 Coastal Evacuation Zones, Safety Measures, and Flood Protection

The occurrence of storms on Kosrae is very rare. However, when they do occur, because the coastline is highly populated, serious damage and casualties may occur. As part of the coastal zone management program it may be advisable to include evacuation zones or flood levels in the policy. In the future, if the flood levels are analyzed, certain restrictions may be imposed such as limiting such facilities as waste-water-management plants to be above the flood levels. Coastal evacuation zones are something to consider for the future as the shoreline-based infrastructure develops. The framework for evacuation zones and regulation of coastal facilities may be included in the coastal zone management policy or may be better addressed by a state safety and defense policy.

SECTION IV: RECOMMENDATIONS FOR COASTAL PROCESSES FIELD STUDIES, MONITORING, AND RESEARCH PROGRAMS

As shown above knowledge of coastal processes is important in many aspects of coastal planning and development. Since the coastal processes change with time just as weather patterns change, a long term monitoring program is vital to making wise decisions on planning and design. During the permitting processes it is essential that knowledge of the coastal processes, and the implications of these processes, be readily available, easily understood, and constantly updated. This can be accomplished by the establishment of a database of information and a program which seeks to add to this database.

4.1 Establishment of Coastal Resource Library

The establishment of a database of information on coastal environmental data is a valuable resource for wise decision making on present and future uses and developments which takes place along the shoreline. It is recommended that such a data base be established as a

Coastal Resource Library to be housed in the Department of Conservation and Development Office, the High School Library, or a similar location easily accessible to the Coastal Resource Commission, government employees, etc. The library should include such reports as the Soil Survey of Kosrae, the Coastal Reef Inventory and Atlas, aerial photographs, beach survey profiles, accounts of beach characteristics, and other letters and reports related to the coastal zone.

4.2 Field Data Collection

Because the beach is variable, documenting these changes is important. Also forecasting the impact of activities and development is greatly enhanced by a thorough understanding of beach processes. A coastal processes monitoring program that is continuous and long term is very important. Initially the program may be very small with a few specific tasks carried out by individual state departments on a annual or semi-annual basis, eventually may be under a coastal research center involving more studies. Recommendations for initial monitoring include: 1) beach topographic survey profiles, 2) current measurements, and 3) aerial photographs.

4.2.1 Beach Surveys

Beach profiles are simple, quick data measurements which can tell a lot about the changes in a beach. By comparing successive beach profiles taken over a period of time the natural changes of a shoreline can be determined, figure 18. If a structure is built and the beach changes, historical records of beach profiles can be referenced to see if the beach has changed naturally in that area before construction. If it has, this can possibly prevent unnecessary construction of costly protective measures and disputes over the cause of the erosion.

The field program recommended for Kosrae is to establish bench marks at the locations given in figure 19. The profiles should be taken at the same locations each time. The exact number of locations should be determined based on time and economic considerations. Profiles should be taken on a semi-annual basis at each of the benchmarks, once during summer and once during winter. The profile should extend from the backshore area out over the reef flat. The profiles should all be referenced and plotted in relation to mean high tide level. The plots should be kept readily accessible in the library so that when permitting is going on the natural change can be determined. An example of use of this type of information is in the siting of a hotel. If a hotel is to be built in an area and the maximum natural variation of the shoreline shown in the profiles is 55 feet, regulations may require a set back of the hotel buildings of 60 feet. These profiles can provide a lot of information with very little technical background or expense.

4.2.2 Currents and Waves

Currents can be measured by bouys or dye, a tape measure, and a stopwatch. The dye or bouy should be released at a particular site and its distance traveled recorded every ten to fifteen minutes. The average speed of the bouy or dye, as well as the path in which it travels should be recorded as well as the direction and speed of the wind and the tidal stage. Information on currents are important because they are related to the rate of sand transport and the direction of transport. This information is important for wastewater outfall locations, diving,

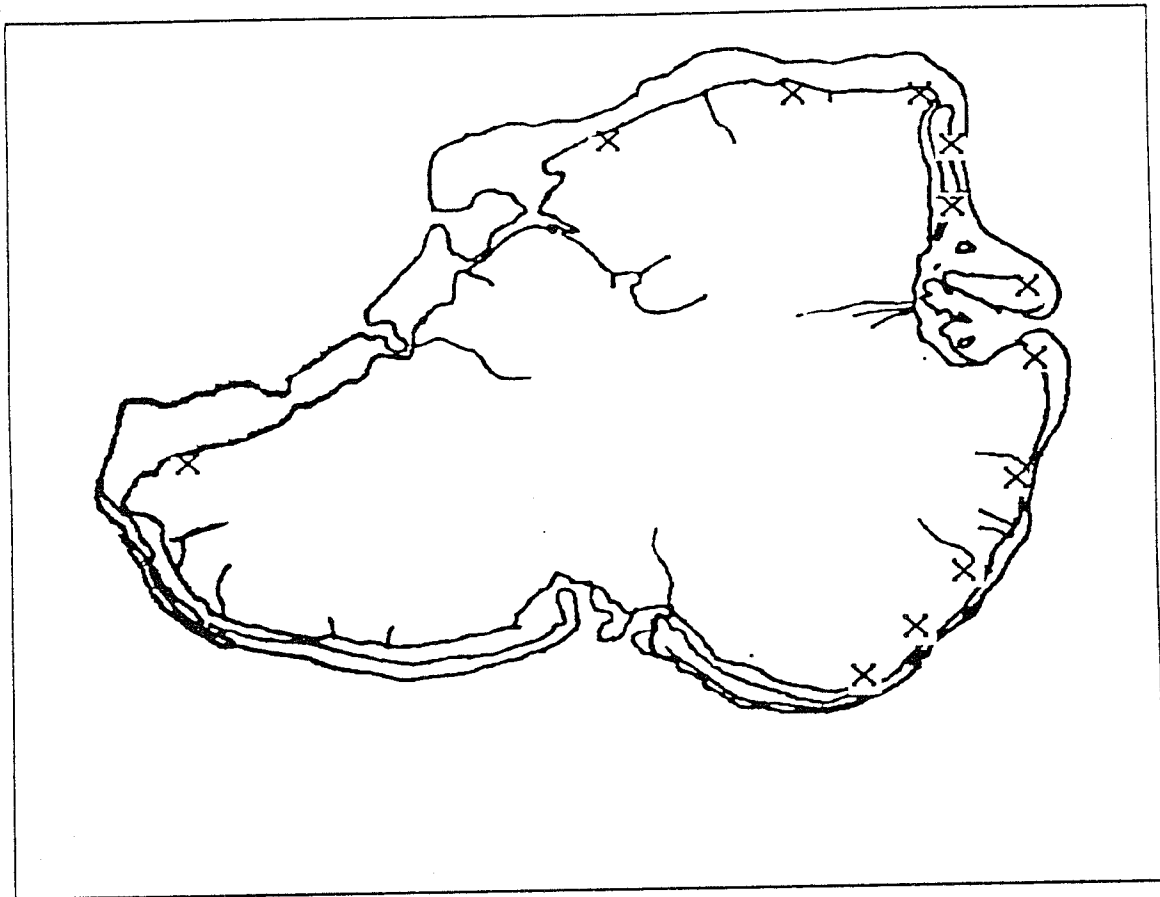


Figure 19: Recommended Areas For Beach Survey Profiles

recreational swimming, and boating. Visual observation and recording of wave height and direction of approach can also be useful for understanding coastal sediment processes. A monitoring program could consist of annual observations at a number of sites around Kosrae. A log

of the currents and their directions as well as wave conditions should be kept at the Coastal Resource Library.

4.2.3 Visual Observations and Aerial Photographs

Often the best way of seeing changes in a coastline is to compare historical photographs of the coastline. The majority of erosion studies utilize aerial photos to estimate rate and direction of transport. Aerial photos can also show direction of transport for example building up of sand on the east side of a gabion may suggest east to west transport. These type^s of observations can also be made from the shoreline.

It is recommended that aerial photos be taken when possible. The cost of aerial photography is high but effort should be made to collect photos when they are available.

SECTION V: SUMMARY AND CONCLUSIONS

Coastal processes are important for land use planning and development in Kosrae State. Coastal processes include wave and current action, sediment movement, changing beach topography, and extreme events such as storms and tsunamis. These processes, along with other ecological, social, and economical processes all have an integral part in the development of coastal zone management policies.

The basic types of coastlines on Kosrae consists of 1) mangroves, 2) sandy, 3) cobble, and 4) rocky. Each type is characterized by differing wave characteristics, sediment characteristics, and stabilities. The natural beach system consists of backshore sand deposits, berms, the beach slope, and reef flat. The waves and currents help to create the beach, dictate the grain size, and cause natural changes over time of the shoreline.

The sediment which is on the beach slope comes from the waves breaking down the coral at the edge of the reef flat. It is brought to shore by the action of the waves and currents. In certain locations the waves and currents also move the sand along the shoreline as longshore transport. Thus the beach is a very dynamic environment.

The shoreline of Kosrae is a very valuable resource. utilized for many activities and materials. Future development of Kosrae will add pressure to the shoreline resources in the form of increase^d activities, structural development, and increased competition for these resources. To protect the shoreline and effectively manage the coast a Coastal Zone Management Program is being established.

Recommendations for the coastal zone management policy based on limited field studies of coastal processes on Kosrae and interviews include the following:

1. Recommendation for Areas of Particular Concern: areas where coastal processes have/may create a fragile, unstable environment
 - a. Tafunsak
 - b. Malem
 - c. River outlets
2. Recommended Set Back Limit: zone where activities and development are regulated or restricted
 - a. 50 horizontal feet inland from mean high tide line
3. Recommendation for structural design and codes: based on transport directions and beach stability
4. Recommend that a Coastal Resource Library be established
5. Recommend that a coastal field monitoring program be established. The establishment of a CZMP is very valuable to the people of Kosrae.

The author wishes to commend the CZMP committee and the people of Kosrae for recognizing the importance of establishing a CZMP before large-scale development occurs and on beginning the process of developing a policy. The author wishes the best of luck to the people of Kosrae on this task and will happily provide any answers to questions or further clarifications of any aspect of coastal processes and coastal zone management.

Women's Use Of The Nearshore Zone On Kosrae: An Overview With Management Recommendations

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September, 1989

INTRODUCTION

This paper is one of six reports written for the Kosrae Island Resource Management Project which deals with issues related to coastal resources and development. The purpose of the project is to assist the Kosraean government in developing an island-wide management program which gives consideration to both the need for economic development and the need for protection of Kosrae's valuable coastal resources. In recent years, Kosrae has seen several development projects (e.g. the construction of Okat dock and airfield) which have had not only profound environmental impacts, but social and economic impacts as well. In order for economic development to continue and succeed on Kosrae, serious consideration will have to be given to the environmental protection and management of the island's resources. Coral reef ecosystems in particular contain a great number of marine organisms of ecological and subsistence importance which require wise utilization and management if they are to provide for future generations of Kosraeans.

This particular paper complements an earlier study by the U.S. Army Corps of Engineers in 1986. In addition to inventorying and assessing the physical and biological resources of Kosrae's coral reef system, the Corps conducted a number of interviews and village meetings with local resource users (i.e. fishermen). The purpose of the meetings was to locate and describe those marine resources of cultural, subsistence, ecological, or commercial importance to Kosraeans. Local participants were also asked to identify any resource use problems associated with the marine environment. The Army Corps of Engineers'

participants were also asked to identify any resource use problems associated with the marine environment. The Army Corps of Engineers' interviews targeted predominantly male fishermen. It was felt by the staff of the Pacific Program at the University of Hawaii Sea Grant Extension Service, that a separate study, which interviewed the female resource users (i.e. fisherwomen), was necessary in order to obtain a more comprehensive and accurate picture of Kosraean subsistence fishing practices and marine resource use. For this reason, an eight-week study involving interviews and discussions with Kosraean fisherwomen was conducted during the summer of 1989. As part of this study, the author accompanied a number of different women on fishing trips to observe first-hand the various techniques and gear used as well as the type of marine resources being harvested. In order to make certain the information obtained through individual interviews (both formal and informal) was as accurate as possible, that information was cross-checked with additional individuals by asking similar questions. The findings of that study are the subject for this paper.

THE PHYSICAL MARINE ENVIRONMENT OF KOSRAE

Kosrae's warm tropical waters contain three of the most productive yet fragile coastal ecosystems in the world: coral reefs and reef flats, mangrove forests, and sea grass beds. Each of Kosrae's coastal ecosystems are mutually interactive and are important habitats for numerous species of marine invertebrates and fish. Because of their high biological diversity and productivity as well as their shallow water accessibility, these environments are attractive areas for marine resource utilization and exploitation. Each ecosystem, and the resources contained within it, is vulnerable to disruption by activities such as overfishing, pollution (oil, chemical, and sewage), dredging for fill, and land clearing.

The Coral Reef Ecosystem

Kosrae's nearshore zone includes large areas of coral reef flat which are exposed during low tide. The inner reef flats are covered with coral rubble and calcareous sand and support expanses of sea grass beds. The outer edge of the windward-facing reefs form a solid reef platform which gradually turns into spur and groove terrain in the surf zone. On leeward-facing reefs, the slope is much steeper, descending abruptly beyond the outer reef flat edge, with a dense coral cover found to depths of twenty meters.

As physical structures, coral reefs act as breakwaters which help dissipate the energy of incoming waves. This is particularly important

during storms. Thus, reefs are shoreline protectors; without them much of Kosrae's present coastline would not exist. In addition, coral reefs provide a habitat for a variety of marine organisms.

Two major environmental surveys of Kosrae's marine flora and fauna have been made. Eldredge et al (1979) conducted an intensive survey, primarily of Okat Harbor, while the U.S. Army Corps of Engineers (1989) conducted a broader survey of Kosrae's marine resources. Both surveys revealed a profusion of marine flora and fauna. Within Okat Harbor alone (prior to the construction of the reef runway), 105 species of stony corals and thirteen species of soft coral were observed. However, combining the lists of observed species from both surveys indicate 181 species of stony corals and thirteen species of soft coral.¹ The major families of coral found in Kosrae are Acroporidae, Faviidae, Pocilloporidae, and Poritidae. In addition, the species lists from the 1979 survey indicate 150 species of molluscs and over 335 species of fish² Interestingly, the later survey revealed a much lower number of invertebrates and fish. Of the total number of fish, over 250 are consumed as food in Kosrae (U.S. Army Corps of Engineers, 1989). The more commonly found molluscs include Cypraeidae, Conidae, Neritidae, and Trochidae. Over forty families of fish are represented in Kosrae; some of which are Acanthuridae, Carangidae, Labridae, Scaridae, Serranidae, and others.

Mangrove Forests

Mangroves are the predominant vegetation type found along Kosrae's coastline and make up fourteen percent of all the vegetation on the island (Whitesell et al; 1986). Kosrae differs from the other Caroline Islands because much of the mangrove forest lies behind a protective strip of coastal strand vegetation (Stemmerman and Proby, 1978). *Sonneratia alba* is the most dominant and seaward species of mangrove. Other species include *Rhizophora apiculata*, *R. mucronata* and *Bruguiera gymnorhiza*. Other trees found in association with mangroves are *Xylocarpus granatum*, *Nipa fruticans*, *Terminalia carolinensis*, *Hibiscus tiliaceous*, and *Pandanus spp.*

In Kosrae, mangroves are an important supply of wood and other forest products. Like coral reefs, mangroves protect coastal areas from storm damage. As the prop roots from these trees develop and spread, they trap and stabilize terrigenous sediment, thereby building or creating land. Mangroves also support a diverse and ecologically important

¹While the earlier survey was concentrated in Okat Harbor, the latter survey included fifty stations around the island in order to target all major coral habitats.

²Interestingly, the later survey revealed a much lower number of invertebrates and fish.

community of fish, invertebrates, and marine plants and serve as a nursery for many important food fish.

Seagrass Beds

As previously mentioned, much of Kosrae's nearshore zone contains extensive areas of coral reef flat which support seagrass beds. These are particularly prevalent on the north, west, and southwest coasts of the main island and on the northern reef flat of Lelu island. The sand and mud on which the seagrass beds form provide a habitat for a variety of burrowing animals such as clams. The seagrass itself provides shelter and a grazing surface for small organisms. Like mangroves, seagrass beds trap and consolidate sediments, thereby aiding in the prevention of coastal erosion. The major species of seagrass found in Kosrae are *Enhalus acoroides*, *Cymodocea rotundata*, and *Thalassia hemprichii* (U.S. Army Corps of Engineers, 1989).

WOMEN'S USE OF THE NEARSHORE ZONE ON KOSRAE

Pre-Contact Fishing Methods³

On Kosrae, it is well known that women have traditionally been the main providers of seafood while men have concentrated more on agricultural activities. This is a somewhat unique division of labor in the Pacific since on most islands, these roles are reversed. The first Europeans to reach Kosrae commented on this. For example, Fyedor Lutke, commander of the Russian exploratory vessel, the *Senyavin*, made the following observations on Kosraean fishing in 1827:

"...[fishing] is almost exclusively reserved for the women; we saw, at least, very few men engaged in it." (Ritter and Ritter, 1981:128).

Friedrich Kittlich, senior naturalist aboard the *Senyavin*, noted the following:

"We especially saw the females, sometimes in large groups, engaged in it [fishing] almost daily. Only occasionally were the women...accompanied by the men." (Ritter and Ritter, 1981:172).

Traditionally, fishing in Kosrae has been confined to the reef flats and mangrove channels as opposed to deeper offshore waters.

"...deepsea fishing has apparently never been of special significance...the Kosraeans applied themselves all the more to reef fishery, which was in its heyday since time immemorial, and which is

³See Appendix 1 for a comparison of past and present fishing techniques.

pursued with virtually all the fishing methods commonly practiced in Oceania. In particular, the lucrative net fishery has developed in many and varied forms." (Sarfert, 1919:101)

Fishing Methods Practiced Since 1900

Traditional Fishing Methods

Observations made earlier in this century mention that fishing on Kosrae was a complex and varied activity. Of the fourteen different types of traditional fishing practiced by women in the early 1960s, only four are still practiced today: *moko*⁴, *tuptup*, *sul*, and *op*.

Moko is practiced at night, during a low tide and under a full moon. This style of fishing requires only one woman and a pair of handnets, *nek musra*. The *nek musra* was traditionally made from hibiscus fiber (*Hibiscus tiliaceus*). The nets were attached to two pieces of *fienkek* (*Premna obtusifolia*), a plant commonly found near the shore. One piece was long and curved while the other was T-shaped and had the edge of the net attached to it. The two pieces were lashed together with twisted lengths of hibiscus fiber. Similar nets are used throughout Micronesia and elsewhere in Polynesia. The *nek musra* are used in pairs by an individual fisherwoman. In *moko*, the nets are placed in a "V" around a loose coral head or rock. The coral head or boulder is turned over in order to force the fish out from underneath and into the nets. Only three women reportedly still practice *moko*. These women still use the traditional wooden frame but with a net made from old monofilament gillnet. This has the advantage of being both stronger and less visible than the traditional hibiscus net. The kinds of fish caught by this method include *kalsrik* (groupers), *mesrik* (parrotfish), *lasrfol* (surgeonfish), *mweosra* (rabbitfish), *andsisiyac* (goatfish) (see Figure 1).

Tuptup is another traditional fishing method still used today. *Tuptup* uses the same techniques and gear as *moko* and differs only in that it is practiced during the day.

Although earlier researchers commented that *sul* was a type of men's fishing activity (Wilson, 1968), *sul* fishing today is practiced by both men and women. This particular method is engaged in during a dark moon at low tide using a flashlight or kerosene lamp and a machete.⁵ Small rocks or loose coral boulders are overturned scaring out small surgeonfish, squirrelfish, goatfish, and even eel. The fish are then killed by a swift and well aimed blow of the machete.

⁴Italicized words are Kosraean names.

⁵In earlier times, a torch made from dry coconut fronds was used as a light source.

Op is the fourth traditional fishing method still practiced. Fish poisoning with *op*, a kind of root from a viney plant (*Derris spp.*) is done in conjunction with the monofilament gillnet (previously, the *nek musra* was used). The roots, which grow mainly in areas of swamp forest, are gathered and placed in a small bundle approximately eighteen to twenty-four inches long. The roots are first pulverized in order to release the milky sap (which stupifies the fish) and then fanned under a rock or coral head. The drugged fish are either caught by the gillnet or float to the water's surface where they are picked up by hand and placed into a basket (*foto in patur*). The women then move to a new location and repeat the procedure. According to Eldredge (1987), the active ingredient in the root of *Derris* is rotenone, a respiratory inhibitor which kills by depriving oxygen exchange. Rotenone stupifies and narcotizes most species of fish although most aquatic invertebrates appear to be unaffected by it. Poison fishing is widespread throughout Oceania and the world (Hornell, 1950).

An earlier researcher mentioned the use of another poison, *op bosbos*, which is made from the fruit of *Barringtonia speciosa* (*B. asiatica* according to Stemmerman and Proby, 1978); however, the use of this poison was not observed during the 1960s (Wilson, 1968) nor during my period of observation. A previously unreported fish poison is now being used, however. The leaves of *Callicarpa cardicans* (referred to by Kosraeans as *op sra*, meaning poison leaves) are crushed and mixed with sand, and thrown into a channel or deep hole in the reef at low tide. As with *op*, once the fish are stupified, they are gathered with a net or picked up by hand. *Op sra* is a more potent fish poison than *op*, killing both small and large fish as well as other marine organisms, a fact which has led to its being banned. When asked what the most serious resource use problem in Utwe was, most women responded by saying poisoning with *op sra*.

Modern Fishing Techniques

Gillnetting, *koa*

Gillnetting, or *koa* is the most common type of fishing technique used by Kosraean women today. According to the Kosrae State Marine Resources Division's Annual Fisheries Statistics Report for 1986-1987, gillnetting was the secondmost productive fishing method in the state, accounting for over twenty-four percent of the total catch. Most gillnets are 100 feet in length and three feet in width. The gillnet, which was introduced in Kosrae sometime in the early 1960s, works by snagging the fish by their gills. The size of the mesh, therefore, determines the size and the species of fish caught. Many of the older fisherwomen complained that one reason why people are catching less and less fish in the inshore area is because there are too many people fishing with

monfilament gillnets, which are significantly more efficient than the traditional handnets, *nek musra*.

Gillnetting, which is generally practiced at high tide, requires two to three women.⁶ The net is set across a reef flat or embayment with one woman at either end of the net. A third woman drives the fish into the net by kicking and splashing the water while walking towards the net. The fish caught on the reef flat and mangrove channels by this method include parrotfish (*muvesrik*), rudderfish (*won*), goatfish (*futfut*), groupers (*kalsrik*), emperors (*sriŋkap*), surgeonfish (*kwi, lasrfol, palpal*), and mullet (*ac, apel*) (see Figure 1). Reef fish are generally eaten raw with lime juice or are cooked in coconut milk and served over rice.

Most women spend anywhere from two to four hours gillnetting, resetting the net after each catch in a slightly different location. Once the fish have become caught in the net, the women pierce the area behind the head of the fish with their teeth in order to kill it. The fish are then gathered in the folds of the women's skirt or dress or in a plastic bucket. The quantity of the fish catch depends on the tide, the time of the month, and who you talk with. Many of the women reported that a typical catch ranged from ten to thirty pounds while others claimed to be able to catch up to 100 pounds in the same period of time. The Fisheries Statistics Report states an average of 9.1 kg caught per person hour. This figure, multiplied by four hours and converted to pounds gives

A different form of gillnetting is used in Utwe Harbor, the breaker zone at Utwe Man, and Lulu Utwe. The water in these areas is too deep for wading and thus swimmers are used instead.⁷ In this situation, two swimmers lay the net with plastic floats while a third swims towards the net kicking underwater to drive the fish into the net. Generally, the same kinds of fish are caught as in the shallower water but may also include deeper water fish such as jacks (*sraprap, lalot*).

Another technique which makes use of the gillnet is *kosr*. In this method, the net is set in a particular place for several hours and often overnight. The net is set just before the tide falls so that the fish, which are swimming to deeper water, become trapped in the net. The net and fish are then retrieved at low tide. One advantage to leaving the net out overnight is that there is the chance of netting nocturnal species of fish such as squirrelfish, *ollal*.

⁶Occasionally one may see a husband and wife gillnetting together, but generally speaking, this is a woman's fishing activity.

⁷In the case of the mangrove channels around Utwe village, the women paddle by canoe to the next fishing spot.

Handlining, *aya*

Although Wilson (1968) observed handlining, or *aya*, to be strictly a men's fishing activity during the early 1960's, the author observed women and children handlining as well. Wilson (1968) notes, "only the largest Kusalen canoes or whaleboats are used. This type of fishing is increasing in popularity except inside the reef". However, during the course of field work, the author observed this fishing technique to be used only inside the reef or at the reef front edge. In Lelu, nearly all handlining is done in several of the reef holes which can be easily reached from the causeway and, in Lelu Harbor. The primary gear for handlining consists of approximately twenty-five feet of monofilament line with a small steel hook at the end. The line is secured to and wrapped around an aluminum beverage can or plastic bleach bottle which acts as a reel. Sea cucumber (*wuror*) intestines are generally used for bait although pieces of cut up fish are also used. Several women reported that carnivorous fish are generally caught by handlining, whereas herbivorous fish are primarily caught with the *nek musra* or gillnet. Perhaps this is because the *musra* nets are used predominantly on the shallow reef flats where most herbivorous fish are found feeding on algae. Handlining is done in deeper water, often in reef holes where the larger carnivorous fish (e.g. jacks, squirrelfish) tend to be found.

Mangrove crabbing, *ti powa*

Ti powa is a popular fishing method in Utwe. The women there take canoes or skiffs to the area between Lulu Nefalil and Lulu Utwe and then walk over the highly arched prop roots of the mangrove, *Rhizophora* spp. and through sludgy mud, in search of the black mangrove crab, *Scylla serrata*. The crabs are often partially covered by a log or with mud, making them difficult to spot. Once a woman finds a crab, she pins it down with one foot and ties the crab's claws tight to its body with a piece of vine. The crab is left in a tree to be collected later, while the woman goes in search of more crabs. A fisherwoman from Utwe, who regularly goes *ti powa*, reported that April through July are the best months to catch crabs. The period after a high tide in the early morning is particularly favored.

The spawning period of *powa* and other crabs (*aieng*, *aié*) is during a full moon. At this time, it is not uncommon to see the coconut crab (*aieng*) crossing the road at night in order to lay its eggs.

Collecting mangrove clams, *fut popol*

Mangrove clams, or *popol*, are also found in the brackish water areas associated with mangroves. *Popol* are found only in one small area, between Lulu Nefalil and Lulu Utwe near Utwe village, which is

accessible only by boat or canoe. *Fut popol* involves searching and feeling in the black mangrove mud with one's feet in water that is up to the shoulders or neck. Several women stated that they can collect up to fifty clams in a one hour period while several elders claimed that in their time they could collect hundreds of them.

Several women reported that the time of the month (i.e. phase of the moon) made no difference on the harvesting of *popol*, although they mentioned that the season for *popol* is when breadfruit begins to ripen. There are over fifteen species of breadfruit on Kosrae, however, and not all species bear fruit at the same time, meaning that breadfruit can be found at any time of the year. It is possible that the correlation between ripe breadfruit and the season for *popol* originated when there were only a few species of breadfruit found on the island. Wilson (1968) notes that of the fifteen types of breadfruit recognized by Kosraeans, one is called *popool*; the *popol* clam possibly being a slightly different spelling of *popool*.

Octopus fishing, *sru koet*

Women are often seen on the reef flats during low tide jabbing a hooked piece of metal or wire into a small hole in search of octopus (*koet*). Experienced fisherwomen say they can detect the hole of an octopus by the pile of small stones and sand built up in front of it. Once snagged with the metal hook, the octopus is killed by biting an area between the eyes. A woman in Lelu, who's mother from Pohnpei introduced octopus fishing to Kosrae in the 1920's, states that every other year during the months of May, June, and July are best for *sru koet*. The woman mentioned that before metal hooks came into fashion, the hanging branches from the mangrove tree (*akak*) were used as a tool for catching octopus. *Koet* is both used for bait and also eaten. A woman from Lelu who is able to catch up to twenty octopus in one day, says she often sells part of her catch for \$1/lb.

Eel fishing, *sru semis*

An interesting yet simple method of catching eel (*semis*) which was observed in Utwe involved the use of a dried, narrow length of *Pandanus* frond with a nail (or hook) attached to one end of it. With a piece of fish placed on the nail or hook as bait, the frond was then set in several inches water on the reef flat or edge of the beach. One end of the dried frond was anchored under a rock or coral boulder while the end with the nail and cut up fish was allowed to float free. Within minutes an eel could be seen investigating the bait. As the eel approached the bait the fisherwoman would kill it by striking at it with a machete. Two eel were caught in this manner within a ten minute period. Although eel is presently a fairly popular food in Kosrae, during the early part of this

century it was considered tabu and was not eaten; a popular belief at that time was that if one killed an eel, it would come and sleep with the person, making them ill and eventually causing death (Sarfert 1919).

Miscellaneous fishing

In addition to fish, crabs, octopus and eel, a variety of shellfish and other invertebrates are also collected on the reef flats by the women. These include sea urchins (*el*), sea anemone (*lut*), sea cucumber (*wuror*), clams (*punak*), and a variety of shells such as cowries (*kawak*) and nerites (*kufal*) (see Figure 1). These organisms are generally not sought after specifically, except for the small money cowry which is used in the making of handicrafts. The collection of the shellfish trochus (*Trochus niloticus*) is forbidden except during certain "seasons" which are designated by the Kosrae Marine Resources Division. In earlier times, the *punak* shell was used as a scraper and as a weight for fishing nets.

Seaweed collecting was not observed by myself or previous researchers. Although this was a major activity of fisherwomen in Hawaii (Titcomb, 1952), the seaweeds found in Kosrae are not considered edible or desirable.

ENVIRONMENTAL FACTORS WHICH AFFECT WOMEN'S FISHING

According to the author's observations, the single-most important environmental factor affecting women's fishing activities in Kosrae appears to be the lunar tides, *ahlong*. Kosrae experiences semi-diurnal tides i.e. there are two high and two low tides in a 24 hour period, the mean range of which is 103.6 cm (3.4 feet). The height of the tide determines the type of fishing activity women engage in. For example, reef gleaning occurs on the shallow reef flats which are accessible only during periods of low tide, *mwes*. The period during which the tide is rising is referred to as *sonyak*. The 'speed' with which the tide rises is also of importance to fisherwomen⁸ as it determines the length of time in which reef gleaning can occur. A falling tide is called *mwesi* and a particularly low tide (which would typically occur during a new or full moon, *malem*) is called *mwes luhlap*. An exceptionally high tide is called *ahlong luhlap* and also occurs during a new or full moon. Gillnetting, which is commonly done within the inland water channels, requires a mid or high tide, *ahlonglong*, in order to prevent the net from snagging on the coral. In Tafunsak, it is not uncommon to see women reef gleaning on the reef flats during low tide and men cast netting or line fishing in the same area six hours later during the high tide. The tides and their

⁸The time and height of the tides is extremely important to not only fisherwomen, but also to those people residing in the village of Walung. Walung is situated on the west coast of Kosrae and is accessible only by boat during high tide. This of course has important implications with respect to emergencies and employment.

relationship to the seasons and moon phases are crucial to women's fishing activities as they determine the day and time that fishing can be done. In former times, the names for each night of the lunar month were known (Fig. 3) but now, most Kosraean women (and men) refer only to four phases: new moon, full moon, half moon, and quarter moon.

The weather is another important environmental consideration in fishing. The women in Utwe told me their decision as to whether to fish on the reef flat or in the channel depended on the weather; if there are no waves, they fish on the reef flats, but if it is windy or there are large swells they go into the channel (*inyoac*). Kosrae has two seasons during the year. The months of September through February, *enganen*, are associated with strong easterly winds, high waves, and less frequent rain (Sarfert, 1919). *Muis*, which corresponds to the months of March through August, is the period of little wind and wave action but more frequent rainfall. According to Sarfert (1919), this was the season for deepsea fishing in earlier times.

FREQUENCY OF FISHING

When asked how often or how many fishing trips women made per week, the most common response was, "it depends on the tide"; three to four times per week seemed to be the average, although the women who were sixty-five years of age or older claimed they would fish six times a week. In their time, fishing was forbidden on Sundays; even today, no one (man or woman) is ever seen fishing on this day. I asked a number of women if they tended to fish more, less, or with the same frequency as they did when they first began fishing. Most women commented that they fished for the same number of days in a week as they did in the past; what had changed was the number of hours spent per fishing trip. Several women stated that in order to catch the same amount of fish as they did ten to twenty years ago, they had to fish for more hours during each trip. The explanation they gave was that there were less fish to be caught and that those that are present are becoming difficult to find. On the other hand, some women noticed no difference in the amount of time spent fishing, nor did they recognize a difference in the number of fish being caught. The latter group stated that they knew of good fishing spots where they were always guaranteed a good catch.

Nearly all of the women interviewed stated that they began fishing between ages eight and thirteen and learned techniques and appropriate fishing times from their mother or grandmother. The women who were over forty-five years of age all said *neklap*⁹ was the method of fishing they

⁹Neklap was a traditional fishing activity that involved anywhere from nine to 100 women

first learned, while younger women stated that gillnetting was the type of fishing they first learned.

MARINE RESOURCES DIVISION SURVEY METHODS

Currently, the Kosrae Marine Resource Division surveys fishing activities on the island in three ways. One is a drive survey which is conducted by car using a pair of binoculars to locate individuals fishing along the reef. The circumferential road, which allows the surveyor to drive clockwise from Okat airfield on the north coast of the island to Utwe Harbor on the south coast, offers a relatively unobstructed view of the beach and reef areas. The surveyor notes the type of fishing activity and the number of individuals involved as well as the time of day and the level of the tide (the sex of the participants is not noted). The second survey is conducted by boat; it generally stays within 500 yards or so of the shore and proceeds counter-clockwise from Okat Harbor to the Utwe-Malem boundary. In this way, the westernmost portion of the island, which is currently inaccessible by road, is included. This survey notes the same fishing activity information as the drive survey. The third survey conducted determines the amount and number of fish caught by each fishing method. In this particular survey, the species and size of fish, the location of the catch, and the duration of fishing time is noted by the surveyor. The information gleaned from all three surveys is used to calculate catch per unit effort data on a month by month and year to year basis. Unfortunately, however, none of the surveys include the mangrove channel around Utwe District where most of that municipality's fishing takes place. Fishing activity in the mangroves is quite varied and includes crabbing, clamming, and gillnetting for various species of fin fish. In order to more accurately analyze and interpret fisheries statistics, the Marine Resources Division needs to include in its surveys the mangrove channel between Utwe Harbor and Walung village.

Table 1: Participation and effort of the more commonly practiced fishing methods on Kosrae, October-December 1986

Fishing Method	Avg. # Persons / Trip	Avg. # Gear / Trip	Avg. Hrs / Trip	Est. # Trips	Est. # Trip Hrs.	Est. # Person Hrs.	Est. # Gear Hrs.
Trolling	2	2	2.6	266	693	1306	1252
Gill-netting	2	1	4.2	715	3002	7075	2501
Reef-gleaning	1	1	2.3	270	620	971	566
Hook and line	1	1	2.5	139	348	348	320
Spear-fishing	1	1	2.5	123	308	308	185
Cast-netting	2	1	2.4	88	211	412	211

Table 2: Catch rates and catch from the the more commonly practiced fishing methods on Kosrae, October-December 1986.

Fishing Method	Est. # Trips	Avg. KG/ Trip-hr.	Avg. KG/ Person-hr.	Avg. KG/ Gear-hr.	KG	Est. % of Total KG
Trolling	266	13.4	7.0	7.5	9393	42.8
Gill-netting	715	3.4	1.3	3.7	9255	42.2
Reef-gleaning	270	3.1	2.9	3.1	1756	8.0
Hook and line	139	0.8	0.8	0.9	288	1.3
Spear-fishing	123	1.6	1.6	2.7	499	2.3
Cast-netting	88	3.3	2.3	3.4	716	3.3

Table 3: Participation and effort of the more commonly practice fishing methods on Kosrae, October-September 1988

Fishing Method	Avg.# Persons /Trip	Avg.# Gear /Trip	Avg. Hrs /Trip	Est. # Trips	Est.# Trip-Hrs.	Est.# Person-Hrs.	Est.# Gear-Hrs.
Trolling	2	2	3.8	9,088	34,536	79,977	61,801
Gill-netting	4	1	4.0	713	2,853	12,480	2,496
Reef-gleaning	1	1	3.2	743	2,379	2,751	2,751
Hook and line	2	2	3.2	514	1,646	2,726	2,314
Spear-fishing	2	1	2.7	108	291	507	270
Cast-netting	1	1	2.3	778	1,790	2,413	1,635

Table 4: Catch rates and catch from the more commonly practiced fishing methods on Kosrae, October-September 1988

Fishing Method	Est.# Trips	Avg.KG/ Trip-Hr.	Avg.KG/ Person-Hr.	Avg. KG/ Gear-Hr.	Est. KG	% of Total KG
Trolling	9,088	21.6	10.0	11.2	692,166	94.8
Gill-netting	713	4.6	1.6	5.3	13,299	1.8
Reef-gleaning	743	0.9	0.9	0.9	2,476	0.3
Hook and line	514	1.6	1.1	1.8	4,166	0.6
Spear-fishing	108	4.3	2.5	5.7	1,538	0.2
Cast-netting	778	3.5	2.9	3.3	5,395	0.7

SOCIO-ECONOMIC AND TECHNOLOGIC CHANGES ON KOSRAE AND THEIR EFFECT ON THE NEARSHORE FISHERY

Economic Dependence and Foreign Imports

The period of American influence (beginning in 1947) on Kosrae has seen a dramatic expansion of the cash or money economy as well as an increasing dependence on foreign aid and imported foods. The Kosraean economy has changed from one that was subsistence oriented to one that has become dependent on over \$10,000,000 per year (in 1989) in U.S. financial assistance (Kosrae State Government, 1985). According to the FSM Trade Bulletin (May, 1988) Kosrae imported over \$676,550 dollars worth of poultry and canned and frozen meat and fish in 1984. Imported fish alone accounted for over 20% of this figure. Imports are likely to continue and even increase given Kosrae's rapidly expanding population which is expected to double within the next twenty-three years. In addition to increasing the demand for imports, this increasing population will also place severe pressures on the island's natural resources, particularly the inshore or reef fishery which is extremely vulnerable to overharvesting. According to the Kosrae Five Year Development Plan, complete substitution of fresh fish for imported fish (canned and frozen) would increase the demand for locally caught fresh fish by 220,000 pounds annually.

There is no longer a chief or clan which controls or regulates the exploitation or marine organisms on Kosrae nor does it appear likely or even possible that a marine tenure system would ever be reinstated. Under the Japanese administration, a law was established which made all land below the mean high water mark, including mangrove areas, public property. According to Crocombe (1971:3):

One very widespread change since contact has been the diminution or disappearance of the traditional pattern of water rights. This has been partly due to increased mobility and to efficient fishing equipment which works over larger areas, as well as to imported and canned and frozen fish and meats which have made the sea less important. Moreover, following European precedents, many colonial governments have passed laws declaring lagoons, reefs, and coastal waters public.

Kosraeans are now accustomed to unlimited entry to the island's reefs and coastal waters. It has been suggested that one reason why government officials and fishermen throughout Oceania prefer unlimited access over a traditional marine tenure system is the belief that "opening up the fishing grounds to all comers will speed up economic development" (Johannes, 1978). This is probably true in the short term, but it is doubtful that the inshore fishery of Kosrae can sustain the island's rapidly expanding population over a long period of time.

Because Kosrae will no longer be receiving Compact money after 1998, the state government is under pressure to consider viable economic development activities. In Kosrae's Five Year Development Plan, the government states that it plans to develop its tourism, manufacturing, and business and commerce sectors as well as upgrading its transportation, water, and sewer systems. It is uncertain at this time what social and environmental impacts these development projects will have on the inshore fishery; however, they have great potential for degrading and even eliminating this valuable source of protein and marine fauna. The construction of Okat dock and airfield is one example of a development project that can have serious effects on the inshore fishery. Fishermen and women have stated that prior to construction, Okat Harbor was one of the most productive and important fishing grounds on the island. This immense project included excavation of a boat channel through the reef, dredging of large areas of reef flat for fill and channels, and the construction of causeways, bridges, and culverts to connect the reef airstrip and dock to the mainland. According to the U.S. Army Corps of Engineers (1989), the construction has greatly modified water circulation conditions over the entire Okat reef as the

Table 5. Import Values in U.S. dollars of Selected Commodities in Kosrae, 1981-1986.

Item	1981	1982	1983	1984	1985	1986
Frzn Chicken	32.8	117.3	177.6	220.1	333.2	332.6
Can Meat	53.0	74.0	100.0	74.5	136.1	125.0
Can Fish	69.0	119.0	95.0	136.8	87.7	89.5
Rice	182.1	156.6	148.7	155.5	136.7	190.1
Sugar	89.4	117.2	109.4	188.4	214.7	201.4

Source: Federated States of Micronesia Trade Bulletin, May, 1988.

runway now acts as a barrier to water flow. In addition, there has been a significant decline in the number of fish and abundance of live coral and sea grass. The degradation experienced at Okat Harbor could easily be repeated elsewhere on Kosrae unless future planning projects make environmental protection and marine resource management a top priority.

The development of roadways will also affect the inshore subsistence fishery by providing easier access to some of the island's more remote fishing spots. At present, what is referred to as the circumferential road on Kosrae extends from the Okat dock and airfield in the northwest to Utwe District in the south; a total of 15.3 miles. Currently, the road is unpaved, riddled with deep, large potholes, and either dusty or muddy (depending on when it last rained) making travel both slow and uncomfortable.

The Kosrae state government plans to complete the circumferential road by connecting Utwe to the Okat airport. There is currently much controversy over where to place the road with respect to the isolated village of Walung. Walung is located on Kosrae's westernmost tip and is, at present, accessible only by boat or canoe during high tide. Many of the residents in Walung are concerned about what will happen once their village becomes easily accessible to other Kosraeans. One major concern is the future of the area's marine resources. According to interviews with Walungese fishermen (U.S. Army Corps of Engineers, 1989), the fisheries in that area are already declining due to the increased use by fishermen from other municipalities. Extending the road to Walung would therefore further exacerbate this problem.

EFFECTS FROM THE INTRODUCTION OF NEW FISHING TECHNOLOGY

Changes in the marine environment and thus, the subsistence fishery, which result from economic development projects, are often immediate and quite visible. However, other seemingly beneficial changes, such as those in fishing technology, may also affect the inshore fishery in the long term. An example of such a change is the recent donation by the Japanese of over seventy motorized, catamaran-style fishing boats to Kosrae. These boats allow fishermen to troll for large pelagic fish species in off-shore areas. During the period of October through December 1986, trolling accounted for approximately 43% of the total fish catch on Kosrae with gillnetting accounting for 42%. However, during the same period in 1988, after the introduction of the new fishing boats, trolling accounted for over 94% of the total fish catch and gillnetting, 1.8% (see Tables 1-4). At this point, it is difficult to determine whether gillnetting will actually decline as a fishing activity because of

the introduction of the offshore fishing vessels, or whether these figures merely indicate that a greater number of fish are being caught overall. In either case, gillnetting should be closely monitored by the Marine Resources Division over the next few years to determine just how the offshore trolling boats have affected that and other inshore fishing activities.

Another important introduction has been the outboard motor. Previously, fishing beyond the reef was constrained by such factors as time, periods of calm weather, and distance. By attaching an outboard to a canoe or other small craft, the time required to travel to and from a particular fishing spot has been significantly reduced and previously underexploited marine resources are now much more accessible. However, capital is required for the initial purchase of an outboard and petrol is needed to run the engine. There are also repairs to consider. Parts are not easy to come by in the insular Pacific so that repairs may take weeks or months to complete. This has significant affects on semi-subsistence fisherfolk who rely on selling a portion of their catch in order to purchase rice, flour, or sugar. Furthermore, these individuals must sell more fish in order to pay for petrol or other expenditures for an outboard motor.

Another example of a change in fishing technology comes from the introduction in the 1960s of the monofilament gillnet. The introduction of the gillnet drastically improved fishing efficiency. New technologies such as this will result in increased pressure on marine resources if not monitored and regulated. Many older fisherwomen complained that one reason why people are catching less and less fish in the inshore area is because there are too many people fishing with the monofilament nets, which are significantly more efficient than the traditional handnets. Other fishing cultures have experienced problems following the introduction of monofilament gillnets as Cordell (1973:31-32) relates with respect to the coastal areas of Brazil:

Trouble began in fishing soon after the state fisheries agency introduced nylon nets to the area. No one bothered to ask how the traditional fishing system worked...how production was organized in local communities, or what impact, intensified fishing would have on marine resources. In the long run, too many nylon nets were added, and too few water spaces were available to accomodate them...

On Kosrae, the introduction of the gillnet has drastically improved fishing efficiency. New technologies such as this will result in increased pressure on marine resources unless they are monitored and regulated. Biological data such as catch per unit effort is extremely important in order to determine whether or not a particular resource can withstand an increase in fishing pressure. According to a survey conducted by the

Marine Resources Management Division (MRMD) in Yap (1988), the greatest proportion of the fish caught by gillnets were in the immature and young stages of development. The Yap MRMD suggests that the use of small mesh sizes such as one to two-and-a-half inches be discouraged in order to allow juvenile fish to reach maturity and thus spawn before their capture. Yap MRMD therefore recommends that fishermen use a minimum mesh size of three inches for reef fishing. A parallel situation exists on Kosrae where most women use gillnets with mesh sizes of one to two inches. On many occasions I witnessed the taking of fish as small as three inches long, and asked why they were not thrown back to mature. The women informed me that the smaller fish, particularly the *lasrfol* (*Acanthurus triostegus*) and *apel* (*Mulloidichthys spp.*), were considered a delicacy among Kosraeans. The taking of such small fish will eventually have significant impacts on future fish yields as more and more people begin to gillnet in Kosrae's inshore waters. To avoid overharvesting, a state regulation which addresses mesh size is necessary. A first step toward establishment of such a regulation would be an intensive survey which measures the number and size of locally caught species of reef fish.

This raises an important point: all coastal resource management plans should take into consideration cultural attitudes and preferences. While this study revealed some of the more general attitudes and motivations behind subsistence fishing, further research ought to examine Kosraean fishermen and women regarding their reasons for fishing as well as their attitudes towards fisheries development and management schemes is essential because they are the individuals who should be benefitting from such projects. Furthermore, it is important to understand the nearshore fishery not only from a biological standpoint but also from a standpoint of economics and social interactions. Without such a holistic understanding of the role of the nearshore (and offshore) fishery within the Kosraean community, any management efforts will necessarily be less effective than they could otherwise be.

Successful coastal resource development projects require that the chosen technology be consistent with the social organization of the communities to be involved in its application. A cultural orientation is necessary not only in the choice of coastal resource development technology. Research, planning and management also must be undertaken with active [emphasis added] reference to the culture of the community involved. (Baines, 1982:197).

Fishery management does not directly regulate the resource but instead, "involves regulating the behavior of the people whose activities affect that resource" (Johannes, 1988:1). Furthermore, fishery management requires the collection and analysis of data regarding harvesting impacts on fish stocks.

Loss of Marine Environmental Knowledge

A different type of threat to the nearshore reef fishery comes not from new technology, but from the loss of old knowledge. The younger generation of Kosraeans today retain but a fraction of their ancestors' knowledge of the marine environment. This is evidenced by the disappearance of a traditional marine tenure system, the discontinued use of the lunar phase calendar¹⁰ (see Appendix 2), the discontinued practice of previously known fishing techniques, and the limited knowledge of the habits and life cycles of marine organisms. A number of the elder fishfolk reported that the younger generation was ignorant of and uninterested in learning many of the finer points of fishing. When asked if they had a "secret" fishing spot where they caught special or preferred species of fish and other marine organisms, the older fishermen invariably answered in the affirmative while the younger women answered in the negative. This may be an indication of a loss of knowledge of the marine environment. In order to net a specific or desired species of fish or to collect a particular kind of shellfish or other invertebrate, one needs to know something of that organism's behavior, habitat, and life cycle. The younger fishermen today are not in possession of such intricate and detailed knowledge. The young people in Kosrae today are educated in public schools and therefore spend very little time under the tutelage of their elders learning traditional environmental knowledge. This situation is unlikely to change given that more and more Kosraeans are taking "nine-to-five" jobs or are leaving the island for educational and employment purposes. Further education and public awareness programs on Kosrae should stress the importance of understanding what the long-term effects of overfishing, pollution, habitat destruction, etc., will have on coral reef, mangrove, and seagrass ecosystems. Older Kosraean fishermen and women have a wealth of knowledge about the marine environment. These individuals should be encouraged, involved, and consulted in fisheries development projects and education programs that emphasize sound environmental practice.

RECOMMENDATIONS FOR COASTAL MARINE RESOURCES IN KOSRAE

The following recommendations are made in the interest of avoiding the overharvesting of marine resources within the nearshore area and assuring that fishing will remain a viable subsistence activity on Kosrae.

¹⁰The lunar phase calendar assigns a specific name for each lunar date as well a description of the activities which are best suited for that day.

1. Expand the area currently surveyed by the Kosrae Marine Resources Division in its ongoing fisheries statistics program to include the mangrove channel between Utwe Harbor and Walung village. Although this represents logistical difficulties due to its remote location, it is important that this area be monitored as most of the fishing activity in Utwe District takes place there. It is therefore recommended that the Marine Resources Division explore the possibility of training a local resident(s) in data gathering and recording techniques.
2. As previously mentioned, the mesh size of the gillnet should be restricted to prevent the capture and taking of juvenile fish before they can mature and spawn. The Yap M.R.D. has recommended a minimum mesh size of three inches for that island. This may or may not be an appropriate size for use in Kosraean waters. Additional regulations establishing a minimum length and maximum number for fish and other harvestable marine organisms should be considered. Furthermore, it may eventually become necessary to place a restriction on the total number of gillnets used in Kosraean waters as well as a restriction on gear type used in the inshore areas. Any restrictions of this type should be established in cooperation with local fishermen and women.
3. The Kosrae Five Year Development Plan mentions "improving existing and adopting new fishing techniques" as one strategy for increasing the catch from subsistence reef fishing. It is recommended that extreme caution be exercised before introducing any fishing technique which will improve on the efficiency, and thus yield, of present methods (see section on the Effects from the Introduction of New Fishing Technology, this report).
4. Kosrae's rapidly growing population will place increased pressure on the inshore fishery. As a result, it may become necessary to establish fishing seasons and restricted areas in order to prevent the overharvesting of fish and other marine organisms. However, such restrictions should not be established without more data on and a better understanding of Kosrae's inshore fishery, and should be established in cooperation with local residents.
5. The export market for marine organisms such as mangrove crabs should not be expanded until stock assessments of those organisms are made. The Kosrae Five Year

Development Plan states that the mangrove crab, *Scylla serrata* is perhaps the most important and suitable marine product for export as it matures "in less than two years and harvested crabs are quickly replaced by the recruitment of new individuals". This is, however, based on laboratory findings. Maturity rates in the "wild" may vary considerably more, due to a number of environmental factors. In addition, the capture of female mangrove crabs should be prohibited.

6. The export of fish should be restricted to pelagic species. The inshore fishery should be managed primarily for subsistence fishing activities with some consideration given to local marketing (i.e. to restaurants and hotels). The export of reef-fish and other inshore marine organisms is not advisable due to the vulnerability of overharvesting of that fishery and the importance of the reef fishery for local consumption. No aquarium fish trade should be undertaken due to its low success rate in other areas.
7. A review process should be established for all future shoreline development projects. Proposed developments should be reviewed by the Coastal Resources Management Committee or another interdisciplinary group to ensure that development projects do not adversely impact coastal ecosystems and the inshore and offshore fisheries. This review process should involve a wide representation from throughout the Kosraean government and community; the Coastal Resources Management Committee's broad representation serves as a good example of such an approach. In this way it is hoped that Kosrae can move toward a self-supporting economy while at the same time protecting and conserving the resources and way of life which the people currently enjoy. (See section on, The Effects of Economic Development Projects on the Inshore Fishery, for the adverse effects of dredging, filling, and road construction.)
8. Better sanitation practices, particularly on Lelu Island, should be investigated and instituted. The improper treatment and disposal of human and animal wastes which enter coastal waters can not only cause illness to people who swim and bathe in these waters but also contaminate fish and shellfish. Untreated sewage degrades and damages coral reef, seagrass bed, and mangrove ecosystems which in turn means a reduction in fisheries yields.

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9. The potential for aquaculture should be explored. An increase in the human population will necessarily mean a greater pressure on local marine resources. Aquaculture could serve to reduce some of the pressure from the inshore fishery and also decrease the present dependence on imported seafood. In all cases, aquaculture projects should emphasize locally available species of fish or shellfish. The introduction of any new species of marine organism can have disastrous effects on the native population. However, more fisheries statistics and research is needed before any projects are undertaken.

 10. The most important long-term need is for environmental education and public awareness programs. Such programs should stress an understanding of the long-term effects of overfishing, pollution, and habitat destruction on coral reef, mangrove, and seagrass ecosystems. Older Kosraean fishermen and women have a wealth of knowledge about the marine environment. These individuals should be encouraged to become involved in education programs that emphasize sound environmental practice in combination with an awareness of Kosraean culture.

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Appendix 1. Fish and Other Marine Organisms Collected by Kosraean Fisherwomen in the Nearshore Zone

Kosraean	English	Scientific
kaput	surgeonfish (general)	Acanthuridae
lasfol	convict tang	Acanthurus triostegus
kwi	lined-surgeonfish	A. lineatus
palpal rangrang	yellow tang	Zebrasoma flavescens
kalsrik	groupers	Serranidae
mulap	rabbitfish	Siganidae
nuesron	"	"
ollol	squirrelfish	Holodentridae
srol	cardinalfish	Apogonidae
ariaf	butterflyfish	Chaetodontidae
alsru	wrasse	Labridae
foul	triggerfish	Balistidae
mwesrik	parrotfish	Scaridae
won	rudderfish	Kyphosidae
srinkap	emperorfish	Lethrinidae
kuraf	milkfish	Chanos chanos
polyah	"	"
ac	mullet	Mugilidae
apel	goatfish (juvenile)	Mullidae
futfut	goatfish (adult)	Mullidae

Appendix 1 (Cont'd.)

Kosraean	English	Scientific
mokol	flying fish	Cypselurus spp.
ik sok	"	"
srihnac	snapper	Lutjanidae
ku	"	"
lalot	jack	Carangidae
srapsrap	"	"
semis	salt water eel	Echidna nebulosa
koet	octopus	Cephalopoda
powa	mangrove crab	Scylla serrata
aie	coconut crab	Birgus latro
aieng	land crab	Cardisoma spp.
wurur	sea cucumber	Stichopus variegatus
el	sea urchin	Echinoidea
lut	anemone	Cnidaria
kuku	jellyfish	Cephalopoda
netula	giant clam	Tridacna gigas
takasungai	trochus	Trochus niloticus
kawang	cat eye	Turbo argyrostoma
kufal	nerite	Nerita spp.
punak		Asaphis violescens
wal		Strombus gibberulus
popol	mangrove clam	Anodontia edentula

Source: Interviews; Rooston Abraham, Kosrae Marine Resources Division.

Appendix 2. Lunar Schedule and Fishing Dates.

1. maspang:	fong in af	new moon
2. masulum:	fong in af	new moon
3. musaan:	fong in af	new moon
4. museit:	sikyak mwo ke patur	good day and night for fishing
5. musaool:	koluk ke patur u a oalla	not a good day for fishing
6. latlato:	(same)	(same)
7. matail:	pal lun ngoe	good day for catching turtle
8. sriafong:	koluk ke patur u(srensrenfong in kofu)	not a good night for fishing (phosphorescence in water)
9. arfoko:	areni ik in kais siefoko mweoa	fish begin gathering in groups according to species
10. sukanpur:	mwo ke pakpuk sukanlom u	good day for gathering wood for house construction
11. lafsan:	fong in aieng semeet mwo ke patur(koa a neksisi)	first night to catch crab, also good for fishing
12. otwen:	fong in aieng ak luo (2) oapana fong se meet an	
13. fwaklong:	mwo ke kain patur nu kewa	good day for any kind of fishing
14. mesr:	len in yok (san)a kapak mwo mesmesma fako an	good day to begin planting crops
15. ell:	siepa len in yok sra san an a ellalalik na e infok an	(same)

16. luti:	fong in ngunin losr se meet (mwo ke patur)	good day for fishing
17. kawula 1:	mwo ke patur	good day for fishing
18. kawula 2:	(same)	(same)
19. sopasr:	ik u mutawauk in bia (akola nu ke srupup)	fish have eggs and begin to make one school of one species
20. apnuk:	apun rauni inkofu suk iku in toeni in (srupup)	each species of fish looking for their individual school
21. sopasr:	sessesla bien iku	eggs are really full inside of fish
22. oslun:	ik u osun	all the various species of fish have grouped into their perspective groups
23. kusaf:	safra forfor lun ik u	no more fish roaming about searching for their specific group
24. sunak:	ik u sunakin in tiya lieyuk ku sruo	fish are trying to hide from people catching them
25. sroanpur:	ik u fwasr wukwuk sroan saku	fish hiding underneath branches that are hanging over the water's edge
26. eirpi:	pal in u fwasr in som sista bia insialos an	time for fish to release their eggs
27. ii:	illa nu meoa	fish return to the sea or deeper water
28. srupup:	srupup	regrouping of fish species
29. lungani:	fong in losr 1	
30. lungalum:	fong in losr 2	

Source: Rooston Abraham, Kosrae State Marine Resources Division, personal interview 1989.

Appendix 3. Comparison of Past and Present Fishing Methods.

Observer: Sarfert, 1919

Fishing Method	Gear Used	No. of People	Where Practiced	Time
neklap	nek musra	lrg. grps of women	reef	high tide
sul	nek musra, torch	women	reef	night, low tide
matan eot	nek musra	2-3 women	reef	night, low tide
moko	nek moko	women	reef	night, low tide
taptap	nek pukok	lrg. grps	near beach	night, full moon

Fishing Method	Gear Used	No. of People	Where Practiced	Time
neklap	nek musra	9-100 women	reef	falling tide,
taptap in neklap	nek musra	9-100 women	"side of the land"	high tide at its peak
eelael	nek musra	3-10 women	reef flat	darkness until moon-rise
moko	nek moko	1-2 women	reef flat	night, low tide
patlir	nek moko op	1-2 women	reef flat	day, low tide
punkunse	nek moko op	2-5 women	reef	day, low, low tide
meku	nek moko	1-5 women	reef flat	rising tide in late afternoon
tu	nek moko	1-2 women	mutun eka	morning, high tide- low tide
ta	nek musra ta (stone fish trap)	1-2 women	shallow area w/ no reef flat	night, falling tide
pukok	nek pukok	24-60 men & women	shallow areas	falling tide; rising tide; high tide
taptap in pukok	nek pukok	24-60 men & women	"side of the land"	high tide at its peak
ka	ka	3-5 men & women	shallows	rising tide, falling tide
kamile nek musra	kan op	100 men, women & children	specific places	falling tide
kaluk	nek kaluk, torches	30 women & men	ocean near Utwe	night, March-August
op	nek musra, nek moko, op	30 women & men	mangrove channel	low tide

Coastal Resources in Kosrae: An Undeveloped Economic Resource

by

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July, 1989

INTRODUCTION

The coastal resources of Kosrae are a unique and largely undeveloped economic resource. The easternmost and physically most isolated of the four states comprising the Federated States of Micronesia, Kosrae is notable for its small size (about 42 sq. miles), small population (less than 7,000 people), and the pristine and largely undeveloped nature of both its coastal resources and, more broadly, its economy (see frontispiece).

Coastal resources are Kosrae's most valuable physical asset. The fact that they are largely untapped and undeveloped presents both challenges and opportunities. Opportunities exist for development of various industries, the creation of jobs and income, and a sound basis for future growth. A challenge also exists since coastal resources are fragile, easily degraded or spoiled, and frequently subject to competing uses as development proceeds. If Kosrae is to both develop economically and protect its single most valuable natural resource, this challenge will have to be met.

People and Resources

The true source of wealth for any nation or state is its population and how the people manage their resources to meet social needs. Kosrae's small population (6,600 according to the 1986 census) means that population pressure on the island's resources is not yet a problem. I say yet because the age distribution, with fully 47 percent of the 1986 population less than 15 years old (and almost 60

percent under 20) means that future population growth, even if birth rates drop, will be rapid (FSM, 1989). Many more people will soon be relying on the same resource base to earn a living. Resources will still be plentiful but the cumulative impacts of larger populations will begin to be felt in terms of the quality of the environment and coastal resources.

At present Kosrae's natural environment is largely unaffected by human activities. Ocean water and air quality are good, and pollution is a localized problem. With rapid population growth and economic development this will change.

Coastal resources (here defined as the surrounding ocean, the reefs and reef flats, the mangrove and freshwater swamps, and the circling band of flat land) serve both as a passive receiver of wastes and trash and as an active producer of goods and services. This paper will examine these resources, their present use and their potential roles. The focus will be on the ways in which coastal resources can play an active and positive role in Kosrae's economic development.

AN ECONOMIC RESOURCE

By many measures Kosrae does not have a modern economy. The expenditures created by the State and National government, and the Compact funds that make them possible, account for almost the entire money economy. In 1986, the last year recorded in the 1987 Statistical Yearbook (Kosrae State, 1988), government employment totalled 725 people or 11 percent of the total population. The private sector employed another 388 individuals, about 6 percent of the population. Most of the private sector employment represents service jobs directly dependent on government employees expenditures (eg., motor vehicle repair, restaurants, petty trading). Average wages in the private sector are considerably lower than in the public sector. Total employment, 1100 people or about 17 percent of the population, represents the money economy of Kosrae. This is about one third of the total population in the 15 to 64 year age bracket, male and female. The rest of the population is either young (under 15), older than 64 (a very small number, less than 200 people), or not actively employed in the money economy.

The trade figures clearly illustrate the nature of the economy. Imports have averaged over \$3 million per year since 1983, reaching \$3.8 million in 1985 and declining to \$3.5 million in 1986. Food is the largest single item (35 to 40 percent of the total) followed by manufactured goods, machinery and vehicles, and beverages and tobacco. Petroleum products are not included but are substantial.

averaging \$700 to \$800,000 per year. Exports, on the other hand, are tiny. Almost entirely agricultural or marine based, exports totalled less than \$50,000 in 1986 with an increase in agricultural exports in 1987. The commodity composition and levels of exports fluctuate widely year by year.

With the opening of the new airport and docks at Okat, exports are expected to increase but they still account for less than 2 to 3 percent of the level of imports. Clearly Kosrae has a major balance of payments challenge!

Kosrae does not look unusually poor, however. The traditional patterns of sharing among the extended family, the farms owned by most families, and the availability of fish and other marine products from the reef and nearby oceans mean that people presently enjoy a standard of living and quality of life considerably higher than suggested by the income and employment data. An important point, however, and the crucial one for future developments, is that the present monetary economy is almost entirely dependent (90 percent or more), directly or indirectly, on government expenditures and not on the production of marketed goods or services.

As long as government monies (and Compact funds) are available, this pattern can continue. However, even if the Compact is renegotiated and the level of funding does not decrease, it is unlikely that the level will increase enough to maintain, let alone increase, the per capita level of expenditures. In short, as population grows and today's children start their own families, the present ability of government expenditures to finance the money economy will, of necessity, decline. The exploitation of coastal resources, therefore, becomes a prime opportunity for expanded employment and productivity growth.

Production of Goods and Services

Coastal resources, especially if broadly defined to include the many farms on private holdings, provide an important and wide-range of products to the people of Kosrae. Because many of the goods produced are not bought and sold in a market, their contribution to incomes and general well-being are largely unmeasured. (The recent 1988-89 Household Income and Expenditure Survey contains some useful data. This source is explored in more detail in the appendix to this report.)

Small farms produce bananas, taro, citrus products and breadfruit, important components to the diet of many Kosraens. The mangroves yield mangrove crabs, some fish and crustaceans,

firewood, and building materials. The reef flats provide fish, shells, and other products. The nearshore and offshore waters produce various fish, both large and small. And almost none of these products are sold in a market.

Lack of markets and sales does not, of course, mean lack of value. Coastal resources are valuable economic resources at present, but ones that go largely unmeasured. One challenge, therefore, is to obtain more detailed data on the present level of coastal resources extracted from the ecosystems, both in order to understand what could be lost if resources are degraded, and to examine possibilities for future growth.

Coastal resource systems yield two major categories of benefits; economists call these goods and services. Goods are tangible, physical products that can be bought and sold. Services may be either intangible (e.g., scenic beauty) or environmental services (e.g., mangroves as storm surge barriers, reefs as shoreline protection).

One typology of the range of goods and services produced from coastal resources is given in Table 1. Although not specifically developed for Kosrae, the table contains most of the goods and services found there (Dixon, 1988). The various goods and services are differentiated by their location: on-shore, in the transition zone (the mangroves and reef flats of Kosrae), or near-shore (areas that are always submerged). In addition, the various items are differentiated by whether or not they are commonly bought or sold (marketed or marketable) or not usually marketed. Services are usually quite intangible and frequently do not have easily observed market prices. Another way to consider this wide range of items is whether their use is direct or indirect.

Direct use of coastal resources (CR) produces goods that can be harvested, consumed, or sold. One thinks of fish and seashells, mangrove crabs, firewood, construction material, and agricultural products. The various components of the CR system can be managed in either sustainable or unsustainable ways. Sustainable resource use is usually defined as not decreasing the physical stock of the resource over time, or not decreasing its ability to yield goods and services. Unsustainable resource use leads to decreasing stocks of a resource over time-harvesting more mangrove crabs than the annual natural increase, overfishing a certain fish species, cutting mangrove trees in excess of natural regeneration.

Unsustainable resource use is not, by definition, bad. In some cases it is a rational decision. For example, certain mangroves may be cleared and converted to other land uses; sand may be mined at a

Table 1: Coastal Resources Uses: Goods and Services

RESOURCE	LOCATION			TYPE OF GOOD OR SERVICE			
	On-shore	Transition Zone	Near-shore	Marketed Good	Good	Non-Marketed Service	
Mangroves/nipa swamp	✓	✓		✓	✓	✓	
Aquaculture	✓	✓		✓			
Capture fishery			✓	✓	✓	✓	
Coral		✓	✓	✓	✓	✓	
Seaweed		✓	✓	✓	✓	✓	
Agriculture	✓			✓			
Minerals	✓		✓	✓			
Oil and gas	✓		✓	✓			
Salt		✓		✓			
Sand	✓	✓		✓			
Beaches		✓				✓	
Habitat	✓	✓	✓			✓	
Land for development	✓	✓		✓			
Coastal vegetation	✓					✓	

greater rate than naturally replaced. The important consideration is to use resources unsustainably only when the implications of such patterns have been clearly thought out.

Equally important as direct use are the indirect uses of Kosrae's coastal resources. These are largely the services provided by the CR ecosystem and include a wide range of tourism and recreation related activities such as swimming, diving, hotels, boat tours in mangrove and coastal waters, and general scenic beauty. The key feature of many of these uses is that they are non-consumptive, that is, if properly managed they use the resource without harming it or decreasing its quality and quantity. As such the resource can be "sold" over and over again without reducing its stock.

A second major set of services provided by CR are environmental services. These include shoreline protection provided by reef flats, storm surge protection from mangroves, and natural water purification provided by various aquatic ecosystems. The monetary costs to replace many of these "services" by engineering measures would be very large. Man-induced coastal erosion at Tafunsak and Malem are just two examples of the costly effects of careless resource use.

OPTIONS AND CONFLICTS

As outlined here, coastal resources already play an important role in the economy and life of Kosrae. Even though much of the benefits derived from coastal resources do not enter any market and, therefore, are not quantified in government statistics, their role is substantial. In addition, the quality of life is heavily dependent on the goods and services, especially the latter, provided by Kosrae's coastal resources. Open access to the reefs, the oceans and the mangroves is taken as almost a birthright. Being able to fish and farm or glean the reef is also an integral, and economically important, part of life.

Data on subsistence use of coastal resources and its value are difficult to obtain. In the 1988-89 Household Income and Expenditure Survey (Taverner, 1989), subsistence consumption was defined as "food products (fruit, vegetable, fish, animal) taken from the local environment rather than purchased, which were eaten or used by the selected household during the survey period." Values for subsistence consumption were estimated by the respondents or were based on market prices.

The value for subsistence consumption was very large: \$97 per household per week, or about \$5,000 per year. In comparison cash

income reported in the survey was \$168 per household per week, or about \$8,760 per year. Subsistence consumption, therefore, provided over 36 percent of the total value of income plus subsistence consumption. Even if its value is somewhat inflated, the subsistence consumption products, largely produced by use of coastal resources, clearly play a major role in Kosrae's present economy; annual cash expenditures in Kosrae totalled just over \$8 million based on the survey results. Subsistence consumption added the equivalent of another \$4.7 million. (These numbers are explored in more detail in the Appendix).

And yet, with economic development, many of these same benefits will increasingly move from the non-monetary to the money economy. Other resources that are not yet extensively exploited (e.g., pelagic fish, certain mangrove products) will begin to be used more intensively. There are large monetary benefits to be derived from increased coastal resources development, but these developments also pose potentials for conflicts and decisions among alternative growth paths.

Not all CR uses are compatible, especially when use intensifies. Sand extraction for construction, for example, affects sand transport and coastal erosion. Increased residential, tourism, or commercial development along the shoreline may affect water quality and scenic beauty. These impacts in turn may affect fish or reef productivity.

In assessing potential environment or resource impacts of various activities it is not uncommon to focus on large projects, such as the reef runway at Okat or the circumferential road. This is, of course, necessary and important, and large projects are increasingly planned and constructed so as to minimize environmental impacts. However, the cumulative effects of many small activities and projects, almost none of which are traditionally regulated or examined, may have a major negative impact on the environment and on the productivity and quality of the coastal resources.

As Kosrae develops, therefore, it is necessary to pay attention to the small individual actions (e.g. home or store construction, waste water disposal, siting of facilities) in order to help preserve and protect the coastal resource base. In a state where almost all land is privately owned and where there is little tradition of (or acceptance of) government intervention, this intervention can lead to conflicts with land owners and developers.

Coastal resources management, therefore, is by definition needed because of these resource use conflicts. If there are no conflicts (and no individual actions that may be privately beneficial

and socially costly), there is little need for regulation or government management. The question, therefore, becomes one of what guidelines can one use to help create enlightened management of Kosrae's coastal resources without over-regulation.

The following questions need to be considered:

1. What is the appropriate level of extraction of goods? As described earlier, renewable resources can be managed in either sustainable or unsustainable ways. If a policy goal is sustainable management, it is necessary to determine the maximum extraction rate that can be allowed without degrading the resource. Mangrove crabs are one example. These high-valued and sought after crabs have both domestic and foreign markets. What is the present level of crab harvesting? What level of capture is sustainable? Similar questions can be asked of wood extraction from mangroves, sand mining or coral mining for construction, and shell collecting. Data are limited at present and these questions are difficult to answer. With the present low level of CR extraction and use there may be a feeling that this is not an urgent problem. It may well not be, at least at present, but it certainly will be an important problem in the future. The goal is to avoid future problems by considering these issues now.

Fisheries are an obvious area for future development. The extensive near shore and offshore fish resources are largely untapped. With strong foreign markets for tuna and other pelagic species, the airport and docks, and the increasing worldwide demand for fish products, fish may be the largest, sustainable extractive industry that can be developed. The Division of Marine Resources is actively exploring various possibilities at present.

2. What level of environmental or resource services is both affordable and desirable? A more immediate concern is the protection and wise management of one of Kosrae's key economic resources-- its scenic beauty and pristine environment. This has important implications, both for the production of increasing quantities of goods over time, as well as for the maintenance of these "environmental services" and the tourism or recreational development that will surely come.

Important questions revolve around maintaining certain areas in their natural state, developing other areas, and protecting air and water quality, particularly water quality. Many options exist, but options also imply conflict if regulations or zoning take away individuals' rights to use certain resources.

Among the options that need to be considered are the following:

- Setting aside certain areas for development and other areas for protection. One could see tourism/visitor development along the north shore near Tafunsak while other parts of Kosrae, such as the stretch from Utwe to Walung, may be retained in a less developed state as a "cultural park." This idea will be discussed more fully in the Tourism report.
- Designating areas for industrial development and taking appropriate measures to provide environmental safeguards, especially with respect to water and "visual" pollution, and solid waste disposal. Parts of Tofol or Okat may be appropriate sites for industrial development.
- For any coastal zone construction, ensure adequate setbacks from mean high tide levels, enforce height limits (the "coconut palm rule"?) and, perhaps most important, ensure adequate waste water and sewage disposal. Kosrae's relatively clean water is a precious but fragile resource.

Development of both water and land based activities for tourists is important. Diving and snorkeling have great potential but are dependent on support services and clean water, live coral and a mixed fish population. Mangrove tours by canoe could be an important attraction, especially near Tofol and in the area from Utwe to Walung or south of Okat. Mountain hikes, although not a coastal resource per se, are also potentially valuable attractions.

Cultural changes may also be necessary, such as acceptance of tourists engaging in certain activities on Sundays (e.g., swimming, picnics, hikes, boat rides). If tourism facilities are developed in one area (e.g. Tafunsak) it may be possible to contain these activities geographically.

A Mixed Development Path

As Kosrae considers its options for future economic development and growth it appears that coastal resources can play a key role in the production of both goods and services. The fish, wood, crabs, and other materials extracted from the coastal zone yield useful products that have economic value for consumption or export. The potential size of the direct-use component of a coastal resource dependent economy may be limited, however. There are physical limits on the possible catch of fish, collection of reef shells or trochus, or extraction of wood products. Tourism, and a visitor related development can be a nice complement to the direct-use side.

Tourism brings in foreign exchange, creates jobs, and can be developed as a non-consumptive user of part of Kosrae's coastal resources--scenic beauty, clear water, mountains and mangroves. (Although not a coastal resource, the friendly people of Kosrae are another important attraction).

Tourism development also has its negative side: coastal sprawl, unplanned hotel and bungalow development, waste disposal problems, "cultural pollution," creation of low paying service jobs, and disruption of Kosrae's traditional lifestyle. Many of these concerns can be addressed with careful, balanced growth. As people constantly say, they don't want another Saipan or Waikiki (or the rural change of a Kuta Beach in Bali).

At the beginning of this paper I said that Kosrae faces both opportunities and challenges. It probably does not have the alternative of no change. Change, and development, good or bad, will come as a result of decreased Compact funding and rapid population growth. Coastal resources are the key element of this change and how they are managed (and conflicts resolved) will determine the future nature of Kosrae's economy and society.

Exciting possibilities exist and Kosrae has the advantage of not having made too many "mistakes" yet--most of the important decisions, and potential problems, are still in the future. This paper has sketched out some of the economic alternatives that I believe Kosrae faces, and some of the factors that need to be considered in evaluating alternative development scenarios.

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APPENDIX 1

Household Income and Expenditure Survey

INTRODUCTION

The recently completed draft report (Traverner, 1989) on the Household Income and Expenditure Survey for the FSM, 1988-1989, offers an intriguing glimpse of the subsistence and money economy of Kosrae and the other three FSM states. This appendix gives highlights of that report. The reader is directed to the report for greater detail.

The recent (1986) population census was relied on to obtain basic demographic data. In 1986 Kosrae had 838 households, 34 percent in Stratum 1, the commercial and government center, and the rest, 66 percent, in Stratum 2, the rest of the main island. (Kosrae has no outer islands). The number of households was estimated to have increased to 929 in 1989.

The survey consisted of a questionnaire and an expenditure/consumption diary, each covering a one week period. Definitions used for household, expenditure, and subsistence consumption are given in Table 1. Details on the survey methodology are given in the draft report.

RESULTS

Households were used as the main reporting unit, in part because of the importance of subsistence consumption and wealth (money and non-monetary) sharing among family members. Mean household size in Kosrae was 9.7, with half of the people (4.8) aged 15 or more. (Note that the mean is the statistical average of all observations, the median is the value that has 50 percent of all observations below it and 50 percent above it. For incomes, the median is usually lower than the mean because a few very high income earners will pull the mean up.)

The mean household income (cash income from all sources) was \$168 or \$8,759 per year. (The median hh income was \$122, or 27 percent lower). Most households reported some income from wages (77 percent of all households), while less than 20 percent of the households had business income (16 percent), income from interests or shares (20 percent), or grants (10 percent). Wage jobs, mostly from

government employment, accounted for \$133 per week per household, or about 80 percent of mean household income.

Subsistence consumption (see Table 1) was also very important. It had an estimated mean weekly value of \$97 per household, or \$5,028 per year. The combined value, therefore, of cash income plus subsistence consumption comes to \$265 per household per week, or \$13,787 per year. On a per capita basis, this figure for Kosrae (\$1,668 per person per year) is considerably higher than that for Pohnpei (\$1,276) but less than Yap (\$2,463). The Truk figures are not yet available.

Aggregate expenditures per household per week were almost exactly the same as cash income (\$166 vs \$168). There was virtually no savings. Givings at funerals were major expenditures in Kosrae and details are given in the report.

Only 11 percent of households reported sales of subsistence (own-produced) products. These may include pigs and chickens, fish, and agricultural products. The mean household value was \$18 for the survey week, with wide variation between families.

The breakdown of average (mean) household expenditure per week (\$166) is as follows:

local fruit/vegetables	\$ 5.45
local meat/animals	13.69
local fish	5.27
imported fruit/vegetables	1.63
imported meat	10.09
imported fish	2.75
imported dairy products	2.09
other imported food	29.39
beverages	7.42
tobacco	2.68
clothing/footwear	11.00
kitchen utensils	1.28
furniture/bedding	.72

household appliances	11.30
other goods and services	61.62
	<hr/>
TOTAL	\$166.38

CONCLUSIONS

Although preliminary, these very useful results yield valuable insights into Kosrae's economy. Among the conclusions that can be drawn are the following:

- Kosrae's economy is roughly two-thirds money based, one-third subsistence. Many of the subsistence products are obtained from the coastal resource base.
- Most households have one or more wage earner, who usually has some kind of government job.
- Subsistence goods sales, although small, exist and there is a local market for fruits, vegetables, meat and animal products, and fish. Most families, however, retain and consume most of what they produce or catch.
- Cash expenditures are very close to cash income. Over half of all expenditures are for various food or consumable items: locally produced food (14.7 percent), imported foods (24.6%), beverages and tobacco (6 percent).

Appendix 2.
Excerpts from ECONOMICS OF PROTECTED
AREAS IN DEVELOPING COUNTRIES: GENERAL
ISSUES AND EXAMPLES FROM THAILAND

by

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The status of certain protected areas (such as from national park to wildlife sanctuary) if such changes were warranted. Currently, such changes are rare even when existing designations may not be appropriate.

On the other hand, competition between divisions may yield certain benefits. By building some redundancy into the protected area system, competition may ensure that a greater overall budget is obtained than would be the case with a single unified institution. The United States follows this approach with protected area responsibilities divided between the Forest Service, the National Park Service, the Fish and Wildlife Service, and the National Oceanic and Atmospheric Administration.

An important issue in administrative structure is the need for strong regional offices and local decentralization to complement the central administrative agency. The role of the central office should be to set general policies and coordinate the national protected area

system. Regional offices should administer these policies, but use their knowledge of the communities to tailor policies to local needs. A two-way chain of communication from the central office to the regional offices to the superintendents of individual protected areas is needed to ensure that local needs and national objectives are both considered. Regional offices should provide the bridge between the local level and the national level.

Given the very strong centralized nature of the Thai bureaucratic system, however, decentralization will not be easy to implement. Nevertheless, it is obvious that more staff and resources are needed at the lower levels of the administrative structure, especially at the individual protected area level. Efforts should be made to encourage this and appropriate measures taken to closely monitor the results of such a program.

EFFECTS OF MACRO POLICIES

Protected areas are affected by a wide variety of policies made at the national level. Land use policies, land tenure, forestry policy, and agricultural policy will all have major impacts on protected areas.

Land tenure and property rights issues are very important in Thailand where more than one-third of the permanently settled land is used without any title or security (TDRI 1987). Another 47 percent of settled lands is covered by utilization certificates which do not provide for the ability to sell or transfer the land. Such areas often cannot be used for collateral and thus limit a farmer's ability to gain access to credit with which to invest in his or her land.

As a result, the actual productivity of these lands is much less than its potential, and farmers often employ practices that degrade the land. Both these factors increase the demand for agricultural land. The result is that forested areas, including protected areas, are cleared to replace abandoned lands or to supplement incomes from low productivity lands. Addressing the problems of land tenure and ownership would reduce the pressures which lead to agricultural encroachment of protected areas.

Agricultural and forestry policies also affect land use decisions. Although the interactions are complex, closer examination is needed of the resource management impacts of price ceilings, export taxes, input taxes and subsidies, and other sectoral policies. This information can then be used to redesign policies to stimulate more intensive agriculture, to promote soil conservation measures that

would help reduce the pressures which lead to agricultural encroachment, and to discourage deforestation and tree poaching.

VILLAGER INVOLVEMENT AND BUFFER ZONES

The largest single threat to most protected areas in Thailand is probably from villagers living near the borders of these areas. Once an area is given protected status, villagers often are prohibited from continuing many traditional (even if illegal) uses of protected area resources (for example, collection of plants, animals, and other forest products is banned in national parks and wildlife sanctuaries). On the other hand, villagers receive few of the benefits from protection.

Direct regulation and police measures have not been very successful in curtailing this pattern of use. The villagers are commonly quite poor and cannot easily afford to live on this income. There is no easy solution to this problem since, if left uncontrolled, many traditional uses would eventually threaten the resources within the protected area. Proper attention to local needs however, can help reduce the potential for conflict.

First, local residents should be included in the planning process prior to the establishment of the protected area. Although they do not have veto power, their input may be essential in minimizing future conflicts, and various accommodations can be made by the protected area authorities to meet villager needs. For example, where a limited amount of a certain use would not threaten the protected area, an agreement can be arranged detailing allowable levels of use.

Second, wherever feasible, nearby residents should receive preference for jobs generated within and by the park. Local residents often have detailed knowledge of the area and the resources it contains and can be valuable in park protection and research. Park maintenance also provides potential job opportunities. When tourist development is undertaken, local residents should be hired to the extent possible. If necessary, training should be provided to increase opportunities for local residents to fill more of the available positions.

Third, it may be necessary to establish a buffer zone around the protected area where "illegal" uses are permitted, even if only informally. This compromise recognizes that local villagers are being asked to pay a substantial price in terms of lost access to resources within the protected area. It also acknowledges that a policy which relies solely on strict enforcement is not possible without unacceptably high social costs (that have even included deaths of villagers and guards).

Ideally, a clearly identified, formally established buffer zone should be designated just within or beyond the protected area boundary. The shape and amount of area required will depend on the specific requirements of nearby residents. Planning, development, and management of the buffer zone should be performed in close consultation with the local residents to ensure that it will serve its intended purpose.

A number of potentially appropriate activities for buffer zones were discussed in Chapter 5. Management of buffer zones is also discussed in McNeely (1988), MacKinnon et al. (1986), Oldfield (1988), and McNeely and Miller (1984).

PARK FISCAL POLICIES

Our examination of the Thai protected area system clearly illustrates the problem the system has with capturing the benefits from protection: admission fees, accommodation charges, and other revenues are very small when compared to the sizable benefits enjoyed by those using certain protected areas. Admission fees, for example, are either nonexistent or are so low that they are not considered in individual decision-making about the use of protected areas. Other protected areas provide important habitat, research, or hydrologic benefits, none of which are compensated for and, therefore, are often not reflected in management budgets.

Budget allocations, however, are in part a reflection of the policymakers' perception of the importance of the unit concerned. Since protected areas generate little in the way of revenues, they are considered as a drain on financial resources, especially when compared to "productive" resource uses like logging or mining. Improved understanding of the economic importance of the wide range of social benefits provided by protected areas is one step in the process of justifying increased budget allocations for protection. Another important step, if only for psychological reasons, is increasing revenue from direct (and indirect) uses of protected areas.

The question of increasing the financial returns from protected areas was discussed in some detail in the first part of this report. In the case of Thailand, there are certain obvious possibilities for revenue enhancement; other options are more controversial but still worthy of study:

Promotion of greater nonconsumptive use of protected areas, such as tourism and research, should be encouraged and admission fees/gate charges either established or increased.

Admission and accommodation fees should be instituted in non-hunting areas and other protected areas where there are currently no charges in place. These revenues could then be used to offset the cost of maintaining and protecting these facilities.

Although it is not desirable to directly link budget allocations to it may be desirable to develop some mechanism whereby those areas that generate large revenues receive partial credit for their contribution. This could be done by allowing individual protected areas to keep a portion of any fees they collect, including entrance and accommodation fees, concession charges, and fines. The difficult part is to provide adequate levels of management support to all protected areas, including those without a commercially successful component, while still encouraging increased revenue generation, where feasible.

At present, when gate fees are charged at all they tend to be very low and are the same for all visitors. It may be desirable to develop some form of differential pricing whereby those who are better able to pay are charged more. This could be via a differential charge for foreign as opposed to Thai visitors or by higher fees for private vehicles and tourist coaches.

Budget and fiscal changes are never easy to implement. It is quite possible, however, to increase gate fees/admission charges and to charge for accommodations. Instituting a multilevel admission system may be more difficult. The partial linking of revenue generation with enhanced budget support will be administratively difficult but an idea well worth pursuing in the case of Thailand. As in other countries, certain popular protected areas will generate a "surplus" that can be used to help support other areas. The goal, therefore, is to partially reward those areas that have a large direct use component without penalizing inaccessible areas or those that do not permit much direct public use.

Possible Coastal Management Scenarios for Kosrae

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August 1989

INTRODUCTION

In response to requests initiated by the State of Kosrae, and as a project undertaken for the Pacific Islands Network (PIN), I was fortunate enough to visit Kosrae for approximately one week in June of 1989. The purpose of that visit was to meet with various government entities in order to assess and analyze the current development and resource protection procedures as a prerequisite to offering suggestions on development of a coastal zone management process.

While a tremendous amount of sophistication exists within Kosrae's land-use review and permitting process, the scale of development and potential development, the natural topography, and the pattern of land ownership would suggest that a westernized "zoning" process would be unnecessarily cumbersome and would not be acceptable to the community. The options that remain for achieving the goal of resource protection are still many, and a series of independent yet inter-relatable strategies may offer the flexibility and protection that is being sought.

To that end I would offer three approaches for achieving a "coastal zone management" scheme. There will, of course, be peculiarities to Kosrae's needs and abilities which will require some massaging of these ideas to fit the location, but, in a general sense, these scenarios are adaptable to any location.

AREAS OF SPECIAL CONCERN

Of the three approaches under discussion, this management tool, "area of special concern", (APC), is the most independent of the other approaches. In other words, this tool can certainly be used to

compliment and strengthen the other approaches, but it is not necessary to them.

APC's, also referred to as Areas of Critical Concern, are quite simply those geographically definable areas which require special developmental attention due to geologic or geographic considerations, biological considerations, hazard considerations (public safety), or economic/social considerations. For example, both the freshwater swamp forest and the mangrove forest require special development, preservation and management attention because they represent unique, limited and fragile ecosystems, because they provide natural protective barriers against the hostile side of the ocean environment, and because they represent a viable, renewable, economic resource from both the industrial and social usage perspectives.

Other areas which could be defined and managed as APC's could include:

1. Steep slopes. Normally, this concern would address itself to a rate of slope above which development or land alteration could create significant erosion. The rate of slope allowable would be dependent upon a number of considerations, including soil type and restrictions on development techniques.

I do not believe, from my observations, that slope development is a significant problem on Kosrae, but as outside pressures for development increase, the government may wish to consider an APC designation for slope.

2. Flood hazard areas. In the not too distant past, storm induced flooding represented a danger to crops and lives, but only a nuisance to housing. Prior to western contact, and in most cases up until World War II, housing was constructed to be easily replaceable. With the advent of concrete block and other expensive construction materials designed to stand for a long period of time, and with an increase in ownership of "things", such as televisions, manufactured furniture, wardrobes, audio records, etc., the need to address floodable areas in a different way has become necessary.

In establishing flood hazard areas as an APC, there are a number of elements which must first be established. First; to what level of flood hazard are management efforts being designed, 50 year flood levels or 100 year flood levels . Second, mapping of flood inundation areas for the level

protected must be accomplished not only showing the extreme boundaries, but the base flood elevations as well. Third, development, floodproofing requirements, which may be imposed, must be reviewed and assessed (including sealing of walls and foundations against seepage, strengthening of walls to resist hydrostatic pressure loads, elevation of structures on open columns, and installation of watertight windows and door closures). Finally; given the land tenure system of Kosrae, an economic impact assessment should be undertaken. This assessment should address the cost to the resident population in complying with building requirements vs. the historic cost or potential cost, in real and/or personal property replacement.

3. Resource reservation areas. It is entirely possible that an area of particular concern will be designated for a resource which requires protection in a "moving" manner. For instance, the Trochus reserve area which has been established to help ensure the viability of the commercial species could, in fact, be placed over different geographical areas at different times, but the APC rules and regulations could remain applicable to the species no matter where the reserve area happened to be at any given time.

These are but a few of the APC types which Kosrae may want to consider. It is important to remember that an APC is designated for areas or concerns which are deemed to require special attention from the government, hence are required to have more stringent and enforceable rules and regulations.

As a management tool, APC's, properly designated and managed, can be effective. They should not, however, be viewed as an alternate method for coastal zone management. Management of resources works best when it addresses the natural and human resources in a comprehensive manner. APC's are, by design, resource or concern specific, and therefore limited.

After an area of particular concern is identified for designation and the general approach to management of the area is developed, specific rules and regulations governing human use within the area should be drafted, and a government agency designated as the lead management agency for that APC. Those regulatory aspects must then be officially adopted by the government in a manner suggested as follows. The Land-Use Commission should, through Resolution, adopt the APC (mapped area) and regulations. This action should then be consented to by the Governor and the Legislature.

After adoption of an APC and its regulations, any permission granted by the Land-Use Commission should be viewed as a variance, and must meet the criteria for such, ^{as} explained in the section of this paper under Land-Use Commission.

LAND-USE DISTRICTING

While APC's are designed to protect natural and human resources, land-use districts are designed to concentrate development types within an area in order to allow a community to control its development destiny.

The concept of districting, as discussed with the various government agencies during my visit, involves designating areas, on an island-wide basis, which would be best suited for certain "types" of development. Because of the importance of land ownership, as practiced on Kosrae, districting should not attempt to designate single family home or agricultural use of land. In fact, for the foreseeable future, the only uses which should be designated in districting would be industrial development and resort (hotel) development. There could be one, or several areas established for each of these activities, and through such designation these activity types would be confined to the district.

The decision as to where these districts would be located should be based on several considerations including: ability of the natural resources to support and sustain the activity; definable, trackable and acceptable impact on the human community; land type needs of the activities being districted; and, infrastructure capabilities, either existing or realistically placeable .

One example of how districting could work on Kosrae would be as follows: The area near the airport, where Black Construction currently has its base of operations, could possibly be designated for industrial activity, which could include both light industry, such as small scale manufacturing , or heavy industry, such as construction equipment storage, junk yards, etc . The area is less suited than others for tourism activities because of the shoreline type, ^{which} has ready access to a harbor and the airport, contains a reasonable amount of flat land, which would allow for expansion needs, and is already being utilized for industry .

As an example of problems which must be overcome in designating an area, the shoreline near Walung would appear at first glance to be ideal for tourism/hotel development. The wide, sandy beaches are essential to most hotel development proposals, and the feeling of isolation lends the area to the most preferable type of tourism, (one which attempts to blend in with the environment to retain the feeling of isolation). The infrastructure problems, though, are significant. The

roadway, water lines, and power capabilities would need extensive upgrading. Environmentally, access from the sea may be undesirable because of the quality of corals in the area.

Infrastructure problems can be overcome in most cases through infusions of money. Environmental concerns, however, should be addressed thoroughly in creating a district.

The importance of creating a districting plan is several-fold. First, districting can ensure against the unnecessary wasting of resources (natural, governmental and economic). Second, creation of districts allows investors to better understand the requirements of the government and to expend their energies in creative development. Third, districts allow the government planners and decision-makers to more accurately project for future revenues and expenditures in all areas of government responsibility.

There is a very real "side effect" to districting, however, which should be understood. Districting, because of its predictability and (from the economic investment perspective) beneficial aspects of what must be considered an implied approvability for project development, private properties within the district will necessarily increase in value at a greater rate than other properties.

The results of that will be reflected as much in the "societal" aspects of the community as in the economic aspects. Neighbors who do not experience the same property value increases may resent those who do, and could resent the government for having developed the district around others lands. In some cases, property owners who could reap financial benefits will sell or lease their properties and relocate to another island or area. Even if they do not relocate, there could be an enlargement of gaps between economic classes, which would result in a fragmentation within the community.

These side effects must be recognized and addressed, but it must also be remembered that the districting system can and should have the result of protecting the community. How the people of Kosrae decide to protect themselves against the negative side is certainly up to them, but one suggestion to help reduce the worst aspect (sale of properties to non-Kosraens), would be to **allow only for leasing of property to outsiders**, for a generational period of time (twenty five year periods, with possible extensions under mutual agreement).

The type of districting described above is development driven. Another reason to develop districts is similar to the reasons for APC's, but from the economic perspective. That type of districting is for (economic) resource enhancement. For example, an area that has been

identified as **prime agricultural property** could be districted for agricultural use. Under this scenario, no usage which is more resource intensive would be allowed within the district. In other words, only farming and single family residential development would be allowed.

The difference between these two district types then, is that within an agricultural district the intent is to protect the land and to maintain traditional uses. Within the other districting type (industrial district or hotel/resort district), the intent is to guide outside investment to encourage new forms of employment opportunities, and to allow for buffers between the "family" community and intrusive development.

In summary, the purpose of creating land-use districts is reflected in increased planning capability and development practicality. With district designation and community acceptance of this concept, the ability of the government to intelligently plan for future infrastructure needs would be greatly enhanced. It would become possible to avoid conflicts with other land-use types by allowing the community to know, at all times, where these intensive activities would take place, and would give the government as well as the overall community a sense of direction and control, which is essential to the local development and investment in secondary opportunities such as restaurants, stores, service industries, etc. Additionally, through congregating similar intensive uses, the ability of private developers to fund the cost of necessary infrastructure is increased, as costs can be shared on an equitable basis.

From the community standpoint, the advantage to this "broad brush" approach to land-use, or resource control, is in the flexibility it offers. Districts can be revised, borders changed, or entire districts relocated as a function of planning response to changing conditions. Designation of areas does not preclude other lower density uses within the districts (single family homes, mom and pop stores, and other similar uses would be allowed within industrial or hotel/resort districts), but higher density uses would be prohibited.

One final consideration, which is every bit as important, is the fact that districting is a simple process to undertake and to understand, and therefore, more readily acceptable to communities. Any land-use control imposed must be based in community need and community good. These goals can only be met if there is community understanding and acceptance.

ISLAND RESOURCE MANAGEMENT COMMISSION

Resource, or coastal zone management requires that controls be established to prevent development from unnecessarily degrading the

natural environment. Under the best of circumstances, these controls should, at the same time, encourage development. In a society where stringent land-use controls have not previously been established, any new management scheme will be viewed with suspicion and could fail if community support is not forthcoming.

It is precisely because of the need for support from the private sector that a "quasi-public commission" becomes necessary. Government agencies are viewed with a natural animosity toward government, and agencies tend to become territorial in terms of authorities, thus making a coordinated, responsive decision-making difficult.

There is a way in which the necessary, government review and input is assured, while allowing for (in some cases) the decision-making to be made by a community represented commission. This method requires the following elements, which will be discussed separately:

1. Committee of government agencies for initial review.
2. Development Commission, composed of appointed members.
3. Long-range development plan for the island.
4. Regulatory structure.

1. COMMITTEE OF GOVERNMENT AGENCIES:

While various agencies within the government of Kosrae now have the responsibility and authority for review of development or land-use activities, this process is uncoordinated. The result is a more than necessarily complicated and time consuming approval procedure for the applicant, and a lack of cohesiveness for the government agencies.

Of all the issues and possibilities connected with resource management, this problem is the easiest to resolve.

I would strongly suggest that all of the government agencies currently involved in development review, and all other agencies *with the task of* natural resource or cultural resource responsibilities, meet together on a regular basis, (once every one or two weeks, as necessary to expedite applications), to review and discuss all applications for development, earth moving or natural resource usage. These meetings should be formalized through the creation of a Development Review Committee, which could be accomplished by executive order.

THE COMMITTEE:

The Development Review Committee would be composed of one representative from each reviewing agency and ^{it is} suggested ^{that it be} chaired by a newly created coordinating position (Coastal Zone Administrator) under the Director of Department of Conservation and Development. Each member would represent the Director of their respective agency and would have the authority to speak for that agency on Committee matters.

This Committee would assume, as its first task, the creation of a single application form which would allow for all of the information needed by each agency on the Committee.

APPLICATION:

Any person wishing to undertake a development or resource project which is listed as requiring government permission, would pick up the application form from the Municipal Mayor's Office, or from any of the government permitting agencies. This form could either be submitted to the Coastal Zone Administrator, or to the Municipal Office, where it could be handled as follows:

The Administrator would conduct an on-site visit to each Municipal Office (one per day, Monday-Thursday), where he would assist applicants in completing their application and would collect all applications accepted by the Office over the past week.

REVIEW:

The Administrator would xerox enough application copies for each reviewing agency. The Committee would meet (as an example) on Friday of each week and would review the applications received by the Administrator the week before.

The agencies would review each application for their own concerns and could recommend three options: approval as requested, approval with conditions, or disapproval. As a committee, the agencies would then formulate a single opinion, which should address and support the concerns of all agencies. For instance, if one agency recommended disapproval, that position should be supported by all agencies until a resolution can be found. If one or more agencies recommend conditions, those should be included in the final committee recommendation.

After the Committee makes its decision, the applicant would then have several choices.

If the Committee recommends approval as requested, and the application is in line with all adopted master plans for the area or usage, all necessary permits could be issued.

If the Committee recommends approval with conditions and the application is in line with all adopted master plans for the area or usage, and the applicant agrees to those conditions, all necessary permits could be issued.

If the Committee recommends approval with conditions and the applicant disagrees with those conditions, the applicant could request a decision by the **Commission** (as discussed in the next section), or could request judicial review of the decision.

If the Committee recommends disapproval, the applicant would have the same options as above.

SUMMARY ON REVIEW COMMITTEE:

The idea of the Review Committee stands by itself and is not dependent upon any other change. There are several advantages to establishing such as committee, including:

1. It makes the permitting process more understandable and physically simpler for the residents of Kosrae. Because governments are ostensibly created to serve the people, this process simplification (and subsequent protection and management of resources) is a reflection of this.
2. It forces (at least at the outset) a cooperative and coordinative effort between government agencies. This directed effort can make government more efficient, and helps to ensure that agencies have the support (at least at the agency level) for their opinions and responsibilities.
3. It helps to make management and protection of resources and community values possible. It is only through such a coordinated effort and comprehensive approach that resource management becomes feasible.

2. DEVELOPMENT COMMISSION:

Because there is a natural animosity and distrust between the private and public sectors, developers and resource users are too often hesitant to fully participate in the permitting and review process. This is natural (although unwelcome) to all cultures. The private sector views the government and its workers as somehow foreign. It is for this reason

that the inclusion of the private sector at the top end of the decision-making process is important to resource protection and management.

THE COMMISSION:

The name of this Commission is unimportant at this point. It could be called the Kosrae Resource Management Commission, the Development Commission, the Coastal Zone Commission, etc. For ease of use, I shall refer to it simply as the Commission for purposes of this paper.

The Commission, because it deals in land, resource and (by decision) economic issues, will be one of the most powerful instruments of government. Decisions the Commission makes will affect everyone in the community for a very long period of time. For that reason alone, the selection of the Commission members must be based on more than just experience in land-use or resource use. There is no foolproof way of selecting a membership, but there is a way of increasing the chances of achieving a workable group. I would suggest that:

The Governor select one member from each Municipal district, to be confirmed by the legislature. Another four members, (one from each district), would be elected within the district. Those eight members would then, among themselves, select a ninth member who would act as Commission Chairman.

The Chairman would only vote to break a tie. All members would serve for a specified period of time (perhaps 5 years), and their terms would be staggered. This method is the best way of maintaining a "politic free" atmosphere for Commission members.

This is a large number of members, and ways of making it smaller may be desirable by the government. The general selection process, however, is workable because it allows selection voice by all elements equally.

The qualification for membership should be ^a community perception that the person is fair, ethical, knowledgeable about the island, its history and resources, and is capable of wise thinking.

APPLICATION:

The Commission would review and decide on all of the following, after the application has been reviewed by the government review committee.

1. All applications approved by the committee with conditions if the applicant objects to those conditions.

1. All applications approved by the committee with conditions if the applicant objects to those conditions.
2. All applications disapproved by the committee, if the applicant wishes to pursue his project.
3. All applications within Areas of Particular Concern, regardless of committee's recommendations.
4. All applications for development types not addressed in the master plan (explained in next section).
5. All applications for development in variance from the master plan.

REVIEW:

The Commission should convene its meetings on a regular basis, and those meetings should be advertised and open to the public.

In reviewing an application, the scenario may be as follows:

- a. Coastal Zone Administrator (who serves as staff to the Commission), should provide the application information and the written comments of the government agencies to the Commission sufficiently in advance of the Commission meeting so that the members can become thoroughly familiar with the application and can, if they so decide, visit the site of the proposed activity for familiarization.
- b. Commission would interview the applicant, ask any questions which they feel are important, discuss the Committee's recommendations with the applicant, discuss possible alternatives with applicant.
- c. Commission would then ask for any comments from the rest of the community. Views of neighbors are important and should be addressed, but because of the subjective nature of public comments the acceptance of this view should be tempered.

DECISION-MAKING

After completing the above, the Commission may wish to decide on some applications immediately. It cannot be overemphasized, however, that many applications will require that the Commission deliberate for some longer period of time, considering all they have heard and seen. For that reason, the Commission must be given flexibility, which can be accomplished by stating (in the Commission's legislative creation) that the Commission must make a decision within 60 days after hearing the application.

In deciding on an application, the Commission may make four decisions.

1. Approval without conditions.
2. Approval with conditions.
3. Disapproval.
4. Table application for further information or study. (If this option is used, there should be a time-frame stated for further hearing).

If the Commission alters or denies the position of the government review committee, the Commission should be made to state, in writing, that:

- a. There is no reasonable alternative to development siting, and;
- b. The stringent application of the law would place an undue hardship on the developer which cannot otherwise be mitigated, and;
- c. The government agencies cannot sufficiently support their position, and;
- d. The community's health, welfare, safety and cultural heritage will not be irrevocably harmed through approval, and;
- e. This development supports the intent of the land-use master plan and the five year economic development plan.

The Commission should be obligated to ^{place} conditions ^{on} development approval to the maximum extent practicable to achieve the goals of resource conservation and the rights of private property development. For example, to protect historic or cultural resources the Commission may impose conditions ^{by} establishing a reasonable time period for government survey of the site, and ^{by} establishing a reasonable fee to the developer to defray the cost of survey, data collection and/or artifact relocation.

After Commission approval, the government agencies may issue all necessary permits.

COMMISSION SUMMARY:

The importance of establishing what is essentially a "civilian" Commission to interact between the private and public sectors cannot be overstated. Resource protection (land management), and guidance of development growth to achieve community benefits and goals can only be achieved if there is community acceptance for the process.

The make-up and functions of the Commission, as outlined here, can work. That is only possible, however, if the legal framework and a projection for community development are established to guide the government, the Commission and the community. Those two issues are addressed below.

3. MASTER PLANNING:

In order to ensure that the government operates as efficiently as possible, that the public can be ^{made} aware of what their neighborhood and island community will look like over a generational period of time, that the Commission will have guidance in reaching their decisions, and, that potential investors and developers will know what the community desires and/or will allow; ^{therefore,} it is imperative that a master plan for Kosrae's growth be developed and adopted.

Because the Department of Budget and Planning is already mandated to complete five year plans which would serve as an "economic" basis for the master plan, I would suggest that ^{that} department be the lead agency in a coordinate^d government effort to produce a comprehensive master plan for Kosrae. The types of subjects which should be addressed in the plan would include:

1. Areas of wildlife habitat which must be preserved or protected. This could be addressed as levels of concern, depending upon the importance and viability of the habitat or the wildlife.
2. APC's.
3. Land-Use Districts
4. Historic sites, and specific measures of protection for each level of site quality, (or importance of era displayed).
5. Siting for major infrastructure, including roads, power, telephone lines, and projected infrastructure needs (such as sewage treatment, etc.).

6. Unique cultural aspects of the community which must be maintained.
7. Siting needs for support facilities, such as schools, fir and police, hospitals or clinics.
8. Resource identification and guidelines for cultural and economic exploitation, (mangrove forests, some types of fishes, shell fish, shells, etc.).
9. Development desired for the future, including levels of tourism or manufacturing or fishing which the people and government of Kosrae determine to be desirable.

The effort in developing this plan should include all government agencies, including the Commission, and must allow for public participation throughout plan development.

After completion, the master plan should be adopted through legislation, and the Commission, at that point, should become responsible for updating the plan on a regular basis (every x number of years), in coordination with Department of Budget and Planning.

The depth of the plan is important, but it must be remembered that the plan will serve as a guide for the Commission and the government. It is not meant to usurp government decision-making, but to guide it. It must be clear enough to provide that guidance, yet flexible enough to allow a variation of routes which may be taken to achieve the goals it sets forth.

Without completion and adoption of a master plan, growth will occur in haphazard and subjective manner. At some point in time, this lack of control will manifest itself in a degraded community, and control over the future of the island will probably fall into the hands of the investors, probably to the detriment of the community and the resources the government is attempting to protect and manage. Kosrae is (apparently) reaching out for outside investment which will help to sustain and improve the current lifestyle of the residents. That is positive, but only as long as the local government retains control. A master plan will allow the government and the people of Kosrae to retain that control and to determine their own future.

4. REGULATORY NEEDS:

The suggestions of this paper, and the necessary rules and regulations to implement them can be legalized in a variety of ways, of which three will be discussed.

EXECUTIVE ORDER:

This is, of course, the quickest and simplest method of implementation, but it is limited. Those avenues which can be best achieved through executive order include:

1. Creation of the government review committee (see Appendix A).
2. Creation of land-use and resource policies (see appendix B).
3. Creation of APC's (see Appendix C).
4. Creation of Land-Use Districts (see appendix D).

RULES AND REGULATION:

This method of adoption is usually necessary for the implementation of:

1. Government review committee.
2. Land-Use Commission.
3. APC's.

LEGISLATION:

This avenue should be pursued in formulating:

1. Development limitations (setback from shoreline, height, density per acre).
2. Creation and description of authorities of Land-Use Commission.
3. Protection of public rights and resources (beach access, hunting and fishing, shell and coral harvesting, historical objects).

SUMMARY OF REGULATIONS:

It will be a combination of these three types of control which will determine the effectiveness of the effort to protect and manage the resources of Kosrae. This section is not intended to redefine the way in which the government of Kosrae develops its own procedures, but merely to offer an example of a way which has worked (but not without problems).

Obviously, it will be up to the policy and decision-makers of Kosrae to determine the course to be taken.

CONCLUSION

It was my impression, during my on-site visit, that the government of Kosrae was very serious about establishing a coastal management regime. Further, I was extremely impressed with the government's in-place expertise and abilities to create a system which will be successful.

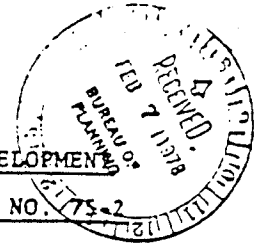
The ideas set forth in this paper^{are} intended to suggest approaches. Modifications to meet Kosrae's specific needs and abilities will, of course, be necessary, but the author believes the approach presented is basic, simple, expandable, and will achieve the private/public sector cooperation necessary^{for} control, management, wise exploitation, and preservation or enhancement of the natural and human resources.

I appreciate the opportunity to submit these ideas, and am always ready to answer any questions the government of Kosrae may wish to ask in regard to this paper.

Appendix 1

GOVERNMENT OF GUAM
OFFICE OF THE GOVERNOR
AGANA, GUAM

EXECUTIVE ORDER NO. 78-2



THE GOVERNMENT OF GUAM SUBDIVISION AND DEVELOPMENT
REVIEW COMMITTEE; REPEAL OF EXECUTIVE ORDER NO. 75-2

WHEREAS, there is a need for an effective inter-governmental mechanism for review and analysis of various development activities brought before the Territorial Planning Commission; and

WHEREAS, it is desirable that such review be coordinated through a committee composed of various representatives of government agencies involved in land use related activities; and

WHEREAS, changes in the responsibilities and titles of certain agencies since issuance of Executive Order No. 75-2, establishing such a committee, require issuance of this new executive order;

NOW, THEREFORE, I, RICARDO J. BORDALLO, Governor of Guam, by virtue of the authority vested in me by the Organic Act of Guam, as amended, do hereby order that Executive Order No. 75-2 be rescinded and replaced by this Executive Order which hereby establishes the Government of Guam Subdivision and Development Review Committee with the following duties and responsibilities:

1. (A) Requesting, compiling, coordinating, and providing official position statements by Government of Guam agencies on applications for:
 1. All subdivisions requiring improvements.
 2. All zone changes.
 3. All zone variances requesting more than a 10% variance from the applicable zoning provision.

4. Such agricultural subdivisions as deemed appropriate for review by the Territorial Planner or by a majority of the Committee members.
 5. Such conditional use applications as:
 - (a) Directed by the Territorial Planning Commission to be reviewed by the Committee; or
 - (b) Deemed appropriate for review by the Director of Land Management.
 - (B) Advising applicants of the procedures and requirements regarding proposed subdivisions, zone changes, and variances.
 - (C) Assisting government agencies in the establishment and adoption of policies, standards, rules and regulations relating to land use.
 - (D) Promoting and assuring the compliance of land development with all appropriate governmental land use policies and plans.
2. To establish such rules and regulations as necessary to effectively carry out those duties and responsibilities as outlined above.

The Committee shall be composed of representatives appointed by the respective agency directors from the following agencies or departments:

1. Planning Division, Department of Land Management, the Chief Planner of which shall be the Chairperson.
2. Building Permit Section, Department of Public Works.
3. Department of Public Works (other than Building Permits Section).
4. Guam Environmental Protection Agency.
5. Department of Parks and Recreation.
6. Public Utility Agency of Guam.
7. Bureau of Planning.

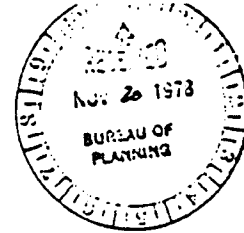
The Committee may designate as ex-officio members any other government agency or department it determines should be involved in the Committee's activities.

Appendix 2

GOVERNMENT OF GUAM
OFFICE OF THE GOVERNOR
AGANA, GUAM

EXECUTIVE ORDER NO. 78-37

GUAM LAND-USE POLICIES



WHEREAS, Public Law 12-200 requires as part of the Comprehensive Development Plan, a statement of specific policies for at least each of the following areas: social and human resource development, natural resource development, and utilization of environmental protection and quality, historical and cultural heritage preservation; and

WHEREAS, the Comprehensive Development Plan, as now completed by the Bureau of Planning embodies such specific policies; and

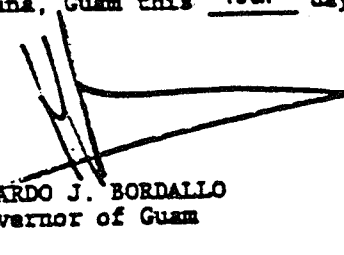
WHEREAS, prompt implementation of these policies is a desirable supplement to the land use districting system as established under Executive Order 78-23; and

WHEREAS, implementation of such policies at this time will facilitate federal approval of Guam's Coastal Management Program; and


WHEREAS, future federal funding of Guam's Coastal Management Program is contingent upon such approval;

NOW, THEREFORE, I, RICARDO J. BORDALLO, Governor of Guam, by virtue of the authority vested in me by the Organic Act of Guam, as amended, do hereby order the following policies, as embodied in the Guam Comprehensive Development Plan, to be implemented by all agencies and instrumentalities of the Government of Guam within the scope of their authorities.

Signed and promulgated at Agana, Guam this 15th day of November, 1978.


RICARDO J. BORDALLO
Governor of Guam

COUNTERSIGNED:


RUDOLPH G. SABLAN
Lieutenant Governor

A. Governmental Processes Policy

More effective administration of natural resource related laws, programs, and policies shall be achieved through:

- . revision of unclear and outdated laws and regulations,
- . improved coordination among local agencies,
- . improved coordination between territorial and federal agencies,
- . educational and training programs for local government personnel, and refinement of supporting technical data.

B. Development Policies

1. Shore Area Development

Only those uses shall be located within the Seashore Reserve which: (1) enhance, are compatible with or do not generally detract from the surrounding coastal area's aesthetic and environmental quality and beach accessibility; or (2) can demonstrate dependence on such a location and the lack of feasible alternative sites.

2. Urban Development

Uses permitted only within Commercial, Multi-Family, Industrial, and Resort-Hotel zones; and uses requiring high levels of support facilities shall be concentrated within urban districts as outlined on the Land-Use Districting Map.

3. Rural Development

Rural districts shall be designated in which only low density residential and agricultural uses will be acceptable. Minimum lot size for these uses should be one-half acre until adequate infrastructure, including functional sewerage, is provided.

4. Major Facility Siting

In evaluating the consistency of proposed major facilities with the goals, policies, and standards of the Comprehensive Development and Coastal Management Plans, the Territory shall recognize the national interest in the siting of such facilities including those associated with electric power production and transmission, petroleum refining and transmission, port and air installations, solid waste disposal, sewage treatment, and major reservoir sites.

5. Hazardous Areas

Identified hazardous lands including floodplains, erosion-prone areas, air installation crash and sound zones and major fault lines shall be developed only to the extent that such development does not pose unreasonable risks to the health, safety, or welfare of the people of Guam, and complies with land-use regulations.

6. Housing

The government shall encourage efficient design of residential areas, restrict such development in areas highly susceptible to natural and manmade hazards, and recognize the limitations of the island's resources to support historical patterns of residential development.

7. Transportation

The Territory shall develop an efficient and safe transportation system while limiting adverse environmental impacts on primary aquifers, beaches, estuaries, and other coastal resources.

8. Erosion and Siltation

Development shall be limited in areas of 15% or greater slope by requiring strict compliance with erosion, sedimentation, and land-use district guidelines, as well as other related land-use standards for such areas.

C. Resource Policies

1. Conservation of Natural Resources - Overall Policy

The value of Guam's natural resources as recreational areas, critical marine and wildlife habitats, the major source of drinking water, and the foundation of the island's economy,

- shall be protected through policies and programs affecting such resources.

2. Air Quality

All activities and uses shall comply with all local air pollution regulations and all appropriate federal air quality standards in order to ensure the maintenance of Guam's relatively high air quality.

3. Water Quality

Safe drinking water shall be assured and aquatic recreation sites shall be protected through the regulation of uses and discharges that pose a pollution threat to Guam's waters, particularly in estuarine, reef and aquifer areas.

4. Fragile Areas

Development in the following types of fragile areas shall be regulated to protect their unique character: historic and archaeological sites, wildlife habitats, pristine marine and terrestrial communities, limestone forests, and mangrove stands and other wetlands.

5. Living Marine Resources

All living resources within the territorial waters of Guam, particularly corals and fish, shall be protected from over-harvesting and, in the case of marine mammals, from any taking whatsoever.

6. Visual Quality

Preservation and enhancement of, and respect for the island's scenic resources shall be encouraged through increased enforcement of and compliance with sign, litter, zoning, subdivision, building and related land-use laws; visually objectionable uses shall be located to the maximum extent practicable, so as not to degrade significantly views from scenic overlooks, highways, and trails.

7. Recreational Areas

The Government of Guam shall encourage development of varied types of recreation facilities located and maintained so as to be compatible with the surrounding environment and land uses; adequately serve community centers and urban areas, and protect beaches and such passive recreational areas as wildlife and marine conservation areas, scenic overlooks, parks, and historic sites.

8. Public Access

The public's right of unrestricted access shall be ensured to all non-federally owned beach areas and all Territorial recreation areas, parks, scenic overlooks, designated conservation areas and other public lands; and agreements shall be encouraged with the owners of private and federal property for the provision of reasonable access to, and use of, resources of public nature located on such land.

9. Agricultural Lands

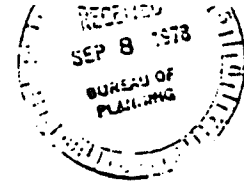
Critical agricultural lands shall be preserved and maintained for agricultural use.

Appendix 3

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GOVERNMENT OF GUAM
OFFICE OF THE GOVERNOR
AGANA, GUAM



EXECUTIVE ORDER NO. 78-21

PROTECTION OF WETLANDS

WHEREAS, Guam's wetlands are those areas that are inundated by surface or ground water with a frequency sufficient to support and under normal circumstances does or would support a prevalence of vegetative or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction; and

WHEREAS, the wetlands of Guam, including swamps, marshes, mangroves, natural ponds, surface springs, and estuaries, are natural habitats of high biological productivity and significant resource value; and

WHEREAS, the wetlands of Guam are extremely fragile, limited in number and difficult to restore once damaged; and

WHEREAS, wetlands provide a critical habitat for maintenance of native plant and animal life, including endangered and threatened species, and are valuable as locations for scientific and educational investigation; and

WHEREAS, wetlands act as floodplains during periods of excessive water flow and a source of fresh water for domestic and agricultural purposes; and

WHEREAS, mangrove wetlands act as a shoreline stabilization mechanism and prevent shoreline erosion and stormwave damage; and


WHEREAS, increased management attention to wetlands is essential in order to reflect the intent and effect of Presidential Executive Order 11990, regarding protection of wetlands, on non-federally owned property;

NOW THEREFORE, by virtue of the authority vested in me by the Organic Act of Guam, wetlands are declared to be an area of particular concern in the planning and management of Guam's land and water resources and the Territorial Planning Commission is hereby directed to officially designate, consistent with Guam's Land Use Plan and Coastal Management Program, Guam's wetland areas, and promulgate such rules and regulations as are necessary for the balanced development, protection, and conservation of such wetlands, consistent with procedures of the Administrative Adjudication Act.

This Executive Order shall be effective this date. Dated at
Agana, Guam, this 7th day of September, 1978.

RICARDO A. BORJALLO
Governor of Guam

COUNTERSIGNED:


RUDOLPH A. SABLAN
Lieutenant Governor of Guam

GOVERNMENT OF GUAM
OFFICE OF THE GOVERNOR
AGANA, GUAM

EXECUTIVE ORDER NO. 78-20

FLOOD HAZARD AREAS

WHEREAS, certain land areas of Guam are subject to flood conditions due to surface water drainage into sinkholes and low-lying basins, overflow of rivers and wetlands and stormwave inundation of coastal areas; and

WHEREAS, development within flood-prone areas in absence of adequate regulatory controls has historically resulted in recurring public expense for relief and repair of flood-damaged facilities; and

WHEREAS, uncontrolled development within flood-prone areas creates conditions which are hazardous to human safety, health and welfare; and

WHEREAS, open space use and low-intensity activities within flood-prone areas are necessary for water quality management, aesthetic quality and maintenance of natural wetland and shoreline ecosystems; and

WHEREAS, ample land has been identified, outside flood-prone areas, to accommodate needed urban residential, commercial, industrial and other high-density or heavily populated uses of land; and

WHEREAS, the high costs of flood-proofing structures and flood control engineering projects within flood-prone areas is an unnecessary financial constraint to economic development; and

WHEREAS, responsible flood hazard area management is a requirement of the federally-subsidized National Flood Insurance Program which is an essential source of disaster relief during times of flood damage; and

WHEREAS, local agency coordination is essential in recognizing the intent of Presidential Executive Order 11988 which directs all federal agencies to take actions which will reduce the risks of flood losses, minimize adverse impacts on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains;

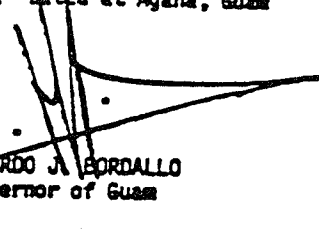
NOW THEREFORE, by virtue of the authority vested in me by the Organic Act of Guam, flood hazard areas are declared to be an area of particular concern in the planning and management of Guam's land and water resources and the Territorial Planning Commission is directed to:

1. Promulgate such rules and regulations as are necessary to meet the requirements of the National Flood Insurance Program and Guam's Coastal

Management Program in insuring that development in such floodplains does not endanger the public's health, safety and welfare.

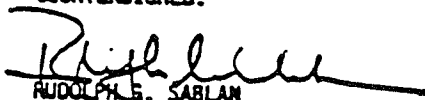
- 2. Designate as floodplain areas of particular concern those areas of Guam delineated as floodplains under the National Flood Insurance Program and such other areas as recommended by the Subdivision and Development Review Committee.

This Executive Order shall be effective this date. Dated at Agana, Guam this 28th day of August, 1978.



RICARDO J. BORDALLO
Governor of Guam

COUNTERSIGNED:



RUDOLPH G. SABLAN
Lieutenant Governor

Appendix 4

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GOVERNMENT OF GUAM
OFFICE OF THE GOVERNOR
AGANA, GUAM



EXECUTIVE ORDER NO. 78-23

LAND-USE DISTRICTS

WHEREAS, Public Law 12-200 mandates the establishment of generalized areas of use within an urban, rural, agriculture, conservation and resort context; and

WHEREAS, Guam's proposed Constitution and Public Law 12-200 both require preparation of a land-use plan which identifies those areas most suitable for urban, rural, agriculture and conservation use; and

WHEREAS, the Bureau of Planning, through an extensive research and public involvement program, has identified such areas on a Land-Use Districting Map as part of its Land-Use and Community Design Plans; and

WHEREAS, such plans have been approved by the Governor, transmitted to the Legislature and may now begin to be implemented; and

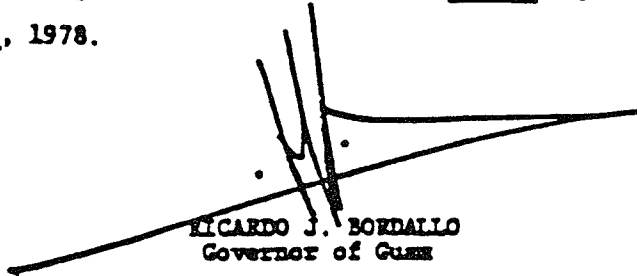
WHEREAS, incorporation of the land-use districting system into the Territory's land-use planning and zoning processes is necessary to insure the best use of its land and water resources; and

WHEREAS, utilization of land-use designations will ensure adequate and appropriate land is made available for agriculture, housing, commerce recreation, and protection of natural resources; and

WHEREAS, the use of land-use districts complies with, and supports, the goals and objectives of the Territory's Coastal Management Program;

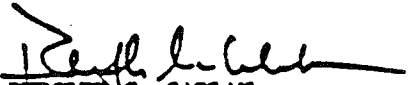
NOW, THEREFORE, I, RICARDO J. BORDALLO, Governor of Guam, by virtue of the authority vested in me by the Organic Act of Guam, as amended, do hereby order the attached guidelines and standards relating to land-use districts to be implemented by the Territorial Planning Commission and any other such commissions or agencies as may be noted or affected.

Signed and promulgated at Agaña, Guam this 5th day of
September, 1978.



RICARDO J. BORDALLO
Governor of Guam

COUNTERSIGNED:



RUDOLPH G. SABLAN
Lieutenant Governor

LAND-USE DISTRICT GUIDELINESSection I. Definitions.

- A. 'Commission' means the Territorial Planning Commission as established under Title XIV, Chapter III of the Government Code of Guam.
- B. 'Development' means on land, in or under water, the placement or erection of any solid material or structure; discharge or disposal of any dredged material or of any gaseous, liquid, solid, or thermal waste; grading, removing, dredging, mining, or extraction of any materials; change in the density or intensity of the use of land, including, but not limited to, subdivision of land and any other division of land including lot splits; change in the intensity of use of water, ecology related thereto, or of access thereto; construction or reconstruction, demolition, or alteration of the size of any structure, including any facility of any private, public, or municipal utility, and the removal of major vegetation.
- C. 'Standard' means any performance standard, rule, regulation, requirement, or other condition for the regulation of development.
- D. 'Persons' means any individual, organization, partnership or corporation, including any utility or agency of federal, territorial, or local government.
- E. 'Seashore Reserve' means that area of land and water is defined under Title XLV, Chapter V-A of the Government Code of Guam.

Section II. Land-Use Districts

Pursuant to Public Law 12-200, there shall be four land-use districts into which all lands in the Territory shall be placed: urban, rural, agricultural, and conservation. The Commission shall suitably group contiguous land areas for inclusion in one of these four major districts:

- a) Urban districts shall include those areas characterized by and designated for higher concentrations of people, structures and streets, proximity to basic services such as sewers, water, sanitation, police and fire protection power and other major facilities and areas of high intensity use.
- b) Rural districts shall include those areas composed of small farms mixed with low-density residential lots where urban-like concentrations of people, structures, streets and levels of services are absent. Rural districts may include those areas determined to be capable of adequately supporting services and population densities characteristic of urban districts in the future, but which are currently rural in character.
- c) Agricultural districts shall include those areas characterized by the cultivation of crops, orchards, forage and forestry; farming activities or

- uses related to animal husbandry; services and uses clearly accessory to the above activities including, but not limited to, living quarters or dwellings, storage facilities, processing facilities and roadside stands for the sale of products grown on the premises; and open recreation facilities.
- d) Conservation districts shall include those areas necessary for protection of watersheds and water sources, prevention of floods and soil erosion and preservation of archaeological, historic, scenic, and other natural and cultural resources; parklands, wetlands, beach and wilderness areas; areas necessary for conservation of endemic plants and animals; open-space areas which, because of their present use, natural condition or openness enhance the present or potential value of abutting or surrounding communities; areas of value for existing or future recreational purposes agricultural preserves as defined under Section 12603 of the Government Code; and other permissible uses and related activities found not to be detrimental to conservation policies and objectives.
- e) The Commission may include within the four respective land-use districts, areas of land which, though not characteristic of the district in which they are to be included, are of such a geographic or topographic nature as to be more suitable for inclusion within such district than classified as a separate district.

Section III. District Boundary Designation

The Commission shall adopt as the initial land-use district boundaries those designations as delineated on the Land-Use Districting Map included as part of the Land-Use Plan Guam, 1977-2000, as approved by the Governor.

Section IV. District Boundary Revisions

- a) Any person petitioning the Commission for revision of a district boundary shall submit a written statement to the Commission identifying the land area involved, the proposed district designation, and any documentation in support of such a revision.

No later than thirty (30) days following receipt of such a petition, the Commission shall hold a public hearing concerning the proposed revision, notice of which shall be placed in a newspaper of general circulation at least fifteen (15) days prior to the hearing date. Such notice shall indicate the time and place at which maps designating the proposed boundary revision may be inspected. All comments relative to the proposed district revision shall be submitted to the Commission no later than fifteen (15) days following such hearing.

Upon review of such comments, the Commission shall no earlier than fifteen (15) days, nor later than thirty (30) days following the district revision hearing either approve or disapprove the proposed district revision. No district boundary may be revised without the approval of at least four (4) Commission members. The Commission shall issue a written statement of findings in support of its decision addressing those issues raised by the applicant, Commission or other government agency staff, or resulting from the public hearing.

If approved, the proposed district boundary revision shall be transmitted to the Governor for approval or disapproval.

- b) No district boundary revision shall be effective without approval by the Commission and the Governor.
- c) Any district boundary revisions proposed by a Government of Guam agency be submitted to the Commission by memorandum, the date of which shall constitute the date of receipt for purposes of establishing a public hearing date.
- d) All district boundary revisions shall be consistent with the policies of the Territory's Coastal Management Program and land-use plans as approved by the Governor.
- e) The burden of establishing the conformity of the proposed district boundary revision with the Territory's official land-use policies shall be on the party proposing such revisions.
- f) Any district boundary revision resulting in 1) expansion of an immediately adjacent urban or rural district, or 2) establishment of a new non-contiguous urban or rural district shall become effective only upon final approval of the zoning designations within such district by the Commission and the Governor.
- g) The Commission may adopt such rules and regulations as necessary to carry out its functions under this Section, including extending time periods allotted for review of or comment upon proposed district boundary revisions.
- h) All officially adopted land-use district boundary revisions shall be filed with the Commission and Department of Land Management and recorded on the Government's Land-Use Districting Map accordingly.

Section V. District Boundary Revision Requirements

- A. Land not included in an urban district may, by amendment to a land-use district boundary, be classified as urban if the Commission finds, after considering the following factors, such amendments to be consistent with the purposes of these guidelines.
 - 1) The availability and adequacy of transportation systems, infrastructure, and other public facilities and services for the land included in the

- the proposed amendment, and the cost of providing transportation systems or other public facilities or services which are not available or the cost improving those which are inadequate for such land.
- 2) The extent to which development which has been proposed for such land will enhance employment opportunities or access to employment opportunities, or assist in providing a balanced housing supply for all economic and social groups.
 - 3) The extent to which proposed development for such land can be provided at the same or higher densities at locations within existing urban districts, comparing the cost of providing adequate transportation systems and public facilities and services within existing urban districts with the cost of providing comparable systems, facilities, and services for such land.
 - 4) The extent to which social and economic benefits, achieved by including the land in an urban district, balance potential harm from the loss of land in agricultural production, land which has a potential for agricultural production, or land which includes natural, environmental, recreational, scenic, historic, or other resources.
- b. Land not included in a rural district may, by amendment to a land-use district boundary, be classified as rural if the Commission finds that such amendment would serve to further community design and Government land-use policies and objectives and compliances with those rural district guidelines outlined in Section II of these guidelines.
 - c. Land not presently included in an agriculture district may, by amendment to a land-use district boundary, be classified as agriculture if all or a substantial part of such land is in agricultural production, has a potential for agricultural production, or is being devoted to a use which maintains that potential, or conforms with criteria established for agricultural preserves under Government Code of Guam Section 12604 and for agricultural districts under Section II (c) of these guidelines.
 - d. Land not included in a conservation district may, by amendment to a land-use district boundary, be classified as conservation if the Commission finds that (1) all or a substantial part of the land includes natural, recreational, scenic, historic, archaeological or other significant resources which should be conserved; (2) it is necessary that the land be classified as conservation so as to minimize the impact of development on land which includes such resources; or (3) rich land conforms to those conservation district guidelines outlined in Section II (d) of these guidelines.

Section VI Zoning Within Districts

- a) Following adoption of the final Land-Use Districting Map as described in Section III of these guidelines, the Commission shall have prepared a tentative revised zoning map designating the boundaries of permitted zones within the respective districts. Only the following zones shall be permitted within each of the respective districts: Urban: R1, R2, C, H, M1, M2; Rural: A, R1; Agriculture: A; Conservation: no zoning.
- b) Effective the date of this Executive Order No. _____, no land within a district may be zoned as, or rezoned to, any zone not permitted in that district, as specified in part (a) above.
- c) The tentative revised zoning map shall be presented for review and comment in at least one public hearing, notice of which shall be provided in a newspaper of general circulation at least fifteen (15) days prior to the hearing date. Such notice shall indicate the time and place at which the tentative map may be inspected prior to the hearing. All comments relative to the tentative map shall be submitted to the Commission no later than fifteen (15) days following the final public hearing concerning such map.
Upon review of such comments, the Commission shall no earlier than fifteen (15) days, nor later than thirty (30) days, following the date of the final public hearing adopt a final revised zoning map. Such map shall be transmitted to the Governor for final approval or disapproval. Upon final approval by the Governor, such map shall be deemed the official zoning map upon which all future zoning or rezoning shall be recorded.
- d) No zones shall be established within Conservation Districts. The Commission shall adopt such rules and regulations as necessary to ensure proper development within Conservation District consistent with these guidelines and approved government land-use plans and policies. Any development within a Conservation District, for which a building or grading permit is required, shall require approval by the Commission before issuance of such permit. No building or grading permit shall be issued within a Conservation District without approval of the Commission. The Commission shall approve only those permits which will result in development compatible with those policies, guidelines or standards for conservation districts as outlined in these guidelines or as adopted by the Commission.
- e) On the revised zoning map, all land within Agriculture Districts shall be zoned "A" and all applicable provisions of the Zoning Law, Title XVIII shall be enforced therein.
- f) The Zoning Law shall be fully enforced within those permitted zones within Urban and Rural districts.

- g) If a proposed development, because of its location, falls within the jurisdiction of more than one set of applicable standards or guidelines, the development shall be subject to the standards established for the area according to the following priority: (1) Area of Particular Concern, (2) Seashore Reserve, (3) Zoning and Subdivision Law. Where a conflict in standards cannot be resolved by the Commission through application of the above priorities, the Commission shall, by rule, determine the appropriate applicable standards.

Section VII. Compliance with Land-Use Policies and Standards

The following uses shall be approved by the Commission only if such uses are found to be compatible with such standards and guidelines, land-use policies or other applicable standards as approved by the Commission, Governor or Legislature:

- a) Any development within Conservation Districts;
- b) Any permissible or conditional uses, variances, or other uses within Agriculture Districts; and
- c) Any zone changes, permissible or conditional uses, variances, or other uses within Urban and Rural Districts.

Section VIII. Private Property Rights

This Executive Order is not intended, and shall not be construed as authorizing the Commission to exercise their power or grant or deny a permit in a manner which will take or damage private property for public uses, without the payment of just compensation therefore. This Executive Order is not intended to increase or decrease the rights of any owner of property under the Constitution of the Territory of Guam or the United States.

Section IX. Judicial Review

- a) Any person may maintain an action for declaratory and equitable relief to restrain any violation of these guidelines. On a prima facie showing of a violation of these guidelines preliminary equitable relief shall be issued to restrain any further violation of this title.
- b) Any person may maintain an action to enforce the duties specifically imposed upon the Commission.
- c) Any person may maintain an action for the recovery of such civil penalties as provided for in the Zoning Law, Title XVIII, of the Government Code of Guam for violation of these guidelines.

UTILIZATION AND MANAGEMENT OF COASTAL WETLAND RESOURCES IN KOSRAE

by

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University of Hawaii Sea Grant Program

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INTRODUCTION

Coastal wetlands, which include mangrove and tidal swamps, can play a vital role in realizing some of the development goals of the small island state of Kosrae. Some of the long term development plans for the state include: economic self sufficiency by reducing import of goods that can be produced locally; creation of conditions that will afford all households the opportunity to earn cash income; and an increased standard of living and quality of life within the framework of the existing culture (Kosrae's Five Year Development Plan, 1985-1990).

The strategies identified to attain these goals are: to increase production of agricultural goods, fish products and handicraft, and to commence production of new products that use locally available resources (Kosrae 5-year Development Plan.) These are to be adopted while protecting the environment.

Sustainable utilization of the coastal wetlands is particularly important and essential for a small island state where almost 70% of the total land is mountainous (Whitesell, et al 1986). The rest (30%) is comprised of alluvial flats, footslopes and bottom land, of which over 50% is covered in mangrove forest, tidal swamps and coastal freshwater marsh (see Table 1).

¹The field work for this study could not have been completed in the short time available without the assistance of Eric Waguk, whose dedication and hard work is gratefully acknowledged.

Wetland Resources

The wetland ecosystem consists of a number of valuable resources, which need to be utilized and managed on a sustainable basis, if Kosrae is to meet the aspirations of its present generation without jeopardizing the welfare of future generations. The most important component of the wetland ecosystem in Kosrae is the mangrove swamp which alone occupies over 82% (1,562 ha) of the total wetland area (see Table 1).

Wetland ecosystems are important for consumable and non-consumable goods and services which have ecological and economic value. Ecological values of the coastal mangrove swamp are not only derived from its highly productive biological ecosystem, but also from its physical services such as soil erosion protection and the filtration of nutrients and sediments. Further, Kosrae differs from other Caroline Islands in that much of the mangroves occur behind a protective coastal strand. Only, along the Northwestern side, the mangroves are not behind a coastal strand.

Coastal wetlands harbor a number of plants and animals that are considered valuable to man. The most commonly acknowledged product in Kosrae is the mangrove crab. In addition, various plant species found in the mangroves and swamp forests of Kosrae have been a valuable source of forestry products, such as firewood, timber for housing, and nipa for thatched roofs (see Table 2).

On the basis of the species that are found to be dominant, seven different alliances can be discerned within the coastal wetland region (see Table 3 and figure 1). Their development depended upon the complex interaction of factors including the degree of wind protection,

Table 1: Area of Land Type and Class in Kosrae

<u>Type</u>	<u>Area</u> (Ha)
Forest:	
Upland	5,090
Swamp	345
Mangrove	1,562
Dwarf	69
Secondary Vegetation	1,271
Agroforestry, coconut	2,585
Nonforest (urban, barren, grass, freshwater swamp)	263

Source: MacLean, et al, 1988

Table 2: List of major tree species of coastal wetlands, their local names and traditional uses

SPECIES	LOCAL NAME	USES
<u>Mangrove</u>		
<i>Sonneratia alba</i>	<i>fulofol</i>	timberwood for floors,
<i>Rhizophera apiculata</i>	<i>sukasrik</i>	firewood, poles, timber for canoe poles, poles for traditional house
<i>R. mucronata Lam.</i>	<i>karak</i>	firewood, poles for house
<i>Bruguiera gymnorhiza (L)</i>	<i>sral</i>	firewood, building material for house, wood for carving
<i>Xylocarpus granatum</i>	<i>tui</i>	wood for carving, furniture
<i>Nipa fruticans</i>	<i>fasiu</i>	thatching material, fruit occasionally used as food
<u>Swamp</u>		
<i>Terminalia carolinensis</i>	<i>ka</i>	used for canoe construction, timber used for house floors
<i>Horsfieldia nunu</i>	<i>nunu</i>	timber for construction
<i>Barringtonia racemosa</i>	<i>kengul</i>	stems used for making fences or barriers
<i>B. asiatica</i>	<i>busbus</i>	seeds used as fish poison, wood used for construction
<i>Hibiscus tiliaceus</i>	<i>puna</i>	sidepole for canoes
<i>Lumnitzera littorea</i>	<i>oi</i>	wood for floor
<i>Nipa fruticans</i>	<i>fasiu</i>	see above
<i>Pandanus sp.</i>	<i>meng</i>	handicraft

Source: Laird, 1983; Stemmerman and Proby, 1978

water currents, tidal influences, level of river discharge and freshwater runoff and types of sediment (Chapman, 1976).

In the mangrove forest, four alliances with different canopy cover and size classes are found. These are the *Sonneratia* Alliance, the *Rhizophora* Alliance, the Mixed Mangrove Alliance and the Nipa Alliance. Swamp forest can be divided into three groups: the *Terminalia* Alliance, the Mixed Swamp Alliance and the Freshwater Marsh Alliance.

These wetland species alliances ordinarily are found growing on two main soils series (Laird, 1983). Mangrove species are generally associated with the *Naniak-Insak* soil series, while the tidal and freshwater wetland flora are found mainly on *Inkosr-Nansepsep* soil series (see Table 4 and Figure 2).

All these soils have high salt levels and, except for *Inkosr-Nansepsep*, they all are not suitable for any agricultural crops (see Table 5). Thus, apart from *Nansepsep* soils occupying about 571 ha, most of the wetland soils are generally not suitable for conversion to agricultural crops. Wetland forest and its dependent fish and non-fish populations are important resources that could provide import substitutes and export earnings.

Wetland Forest Resources

Potential for the harvest of mangrove and swampland forest resource for firewood and timber products is substantial. Expected saw and pole timber volume from the wetlands equals that which could be derived from upland forest, even though upland area is almost five times in land area (see Tables 6 and 7).

Potential timber from 1,850 ha of mangrove and swampforest is about 175,000 m³ (see Table 7). In terms of timber volume by species, *fulofol*, (*Sonneratia alba*) is the most important with *Rhizophora sp* and *ka*, (*Terminalia sp.*) following suit (see Table 8).

One of the best strands of commercial timber resource is the *ka* forests along the Yela River. *Ka*, which is the preferred lumber species, was intensively logged in the Yela region during the Japanese colonial era. But since then, these forests have been relatively undisturbed (Miller nd.). In this region, *Terminalia sp.* is known to regenerate naturally which makes it a valuable area in terms of minimal forestry management requirements. However, if needed, replanting would be feasible on the *inkosr* soil type, on which *Terminalia* is found growing in the Yela region (Laird, 1983). Another extensive timber forest resource is found in the Okat River tidal swamp area, but this forest is variable in species types with a mixture of *nunu*, *ka*, *kengil* (see Table 9). Other areas with the presence of some *ka* trees, are found in the tidal swamp areas of Malem and Utwe (see map).

Table 3: Vegetation type and major alliances of mangrove and swamp lands

ALLIANCE	Vegetation Type Class*	Area (Ha)
<u>Mangrove Forest</u>		
Sonneratia Alliance		<u>454</u>
	MN 2 M.S	453
	MN 1 H.S	< 1
Rhizophora alliance		<u>324</u>
	MN 1 H.R	247
	MN 2 H.R	21
	MN 1 M.R	53
Mixed Alliance		<u>637</u>
	MN 1 H	88
	MN 2 H	458
	MN 1 M	21
	MN 2 M	73
Nipa Alliance		<u>85</u>
	NM 1 H.N	85
<u>Swamp Forest</u>		
Terminalia Alliance		<u>77</u>
	SW 2 H.T	77
Mixed Swamp Alliance	<u>205</u>	
	SW 1 H	6
	SW 1 M	26
	SW 2 M	72
	SW 2 H	102
Freshwater Marsh Alliance		15
TOTAL		1622

Note: Dominant species alliance if more than 20% of the trees belong to that species

*Type classes as in Whitesell, et al (1986). Numerals refer to size class: 1- trees less than 30cm dbh but larger than or equal to 12.5cm dbh; 2- trees greater than 30cm dbh.

Because of the limitations imposed by the soil conditions on equipment, species composition and seedling mortality, it is suggested that only selective thinning and natural regeneration be practiced in mangrove forests (Laird 1983). In the case of the swamp land, natural regeneration should be the practice unless the demand for timber

increases to the extent that specific replanting practices would need to be followed to sustain harvestability (Laird, 1983).

There are no estimates available on the volume of mangrove trees that are not considered to be industrial timber (trees that are less than 12.5 cm in dbh). Some of these trees are used for poles (2-5" diameter) in building traditional houses and/or firewood.

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PRESENT UTILIZATION: FOREST PRODUCTS

Firewood

The present uses of the forestry resource includes harvests for firewood, a small amount of lumber production, some harvest of nipa fronds for thatched roofs for houses, and wood carving. The wetland forest is harvested mainly for subsistence purposes, though semi-subsistence and commercial harvests are significant and growing.

Subsistence

Traditionally, all cooking was done using mangrove wood. *Sral*, *sukasrik* and *kara* (and at times *tui* if available) species were particularly preferred because of their clean burning properties.

Table 4: Dominant soil types associated with major species alliances

<u>Species Alliance</u>	<u>Dominant Soil Type</u>
Sonneratia Alliance	Naniak
Rhizophora Alliance	Naniak-Insak
Mixed Mangrove Alliance	Naniak-Insak
Nipa Alliance	Naniak
Terminalia Alliance	Inkosr
Mixed Swamp Alliance	Inkosr
Freshwater Swamp	Nansepsep

In the absence of any estimates on the subsistence wood volume consumption (and mangrove crab harvests), a household survey of all the five villages was undertaken to obtain information about the level of subsistence and commercial utilization of wetland resources for firewood, timber for traditional house material such as poles and nipa thatching.

and mangrove crabs. Slightly over 10% (93) of the total number of households (838 in 1986) were interviewed to elicit information about their activities involving mangrove and swamp forests (Table 10).

Table 5: Agricultural crop suitability of different wetlands

<u>Soil Type</u>	<u>Taxonomic Class</u>	<u>Suitability</u>
Inkosr	Fine, mixed, nonacid, isohyperthermic, Typic tropaquetps	not suitable for any crops except wetland and dryland taro
Insal	Sandy, carbonatic, isohyperthermic, Typic tropaquents	not suitable for any crops
Naniak	Fine loamy, mixed, nonacid, isohyperthermic, Typic Sulfaquents	not suitable for any crops
Nansepsep	Fine, mixed, nonacid, isohyperthermic, Aeric Tropaquept	raw crops can be grown if artificial drainage is applied

Note: Suitability refers to crops such as avocados, bananas, breadfruits, citrus, mangoes, papaya, pineapples, chins cabbage, corn, cucumbers, onions, sugarcane and sweet potatoes

Source: Laird, 1983

Effort was made to survey every tenth household whenever possible, though in some cases, such as the Walung village, whichever household members present were interviewed. (A number of households were in Tafunsak in relation to some church activities.) The interviews were informal but were guided by a questionnaire. The information obtained is derived from the recollections of average consumption patterns as estimated by the households themselves, and not based upon actual records. As a result, no effort is made to give statistical confidence limits. Only general use patterns can be discerned from the data collected which was constrained by limited time, finance and personnel. Effort was made to also interview those households which were known to be involved with semi- subsistence or commercial utilization of the mangrove swamps. The owners of the retail stores which were known to sell (at present or in the past) either the mangrove crabs or mangrove wood were also interviewed.

Today, mangrove firewood is still used regularly. However, with an increase in number of salaried and wage earners, there is a definite shift away from the use of mangrove wood for regular cooking, substituted by the use of kerosene stoves. This is particularly noticeable in Lelu and Tafunsak villages, which are closer to the government center in Tofol. Nevertheless, because of Sunday Sabbath, at least 90% of all houses still make *umbs* on Saturdays. *Umb* is a traditional cooking style, similar to the Hawaiian *umu*, which takes three to four hours. Thus, it is not an unusual sight on Saturdays to find pickup trucks parked along the newly constructed circumferential road, with villagers loading them with mangrove logs cut from the nearby mangrove forests. Some households purchase wood from retail stores, found throughout the island, instead of collecting it themselves.

For an *umb* to feed a household of the average family of ten, 1-2 bundles of firewood are used. With approximately 90% of the households involved in *umb* preparation each week, an average of about 750 bundles of firewood per week is consumed. On an annual basis, over 41,000 bdl are burnt in *umbs* alone. A bundle of firewood is equivalent of 2.5 liters of actual volume or $2.5 \times 10^{-3} \text{ m}^3$. Thus 105 m^3 of mangrove wood is used in *umb* cooking alone.

For general cooking, consumption of firewood varies from village to village. Walung village in Tafunsak municipality is at one extreme. Almost all the households collect their own firewood, making an average of 1.5 -2 trips/week, harvesting *sral*, *sukasrik* and *karak*. Per week, 2-3 bundles of wood are used for *umb*, boiling of food, etc. This is supplemented by 1.5-2 gals of kerosene per month, used in emergencies and for occasional morning cooking. In Lelu, at the other extreme, less than 10% of the households surveyed collected their own firewood, mainly for their Saturday *umbs*. Most of the households rely on mangrove firewood sold through the retail stores, or by individuals selling from their homes in Utwe or Tafunsak (Table 11).

On average 5,548 --or if rounded to nearest hundreds-- over 5,500 bundles of mangrove firewood is consumed every month, either collected by the user or bought. This would translate into about 66,000 bundles or $1,617 \text{ m}^3$ annually (Table 12). This does not include special demands during funerals, births or other such occasions.

The bulk of the firewood is collected from Utwe and Tafunsak municipality. With the construction of the circumferential road, access to mangrove areas has improved, resulting in more households, particularly from Malem and Tafunsak villages, collecting their own firewood as compared with 1987/1988 period. This is also reflected in the decreased number of licensed firewood commercial operators

(Municipal firewood business licenses). In 1987, there were fifteen licensed commercial vendors of firewood as compared with eight in 1989 (Table 13). These figures do not include those retail stores which sell firewood under their general business licence; in fact, apart from the three retail stores that still sell mangrove firewood, two other stores in the Lelu region indicated that they used to sell mangrove firewood before (1987), but do not do so now. Also note that these figures don't include semi-subsistence operators who sell firewood to retail stores on irregular basis.

Semi-Subsistence and Commercial

A small number of households in the Tafunsak and Utwe municipalities supplement their income by supplying mangrove firewood to retail stores in Lelu and Utwe region. From the most remote village,

Table 6: Area (Ha) of timberland by forest type

Forest Type	Timber land	Other Sleep	Other Scrub	Total Forest
Upland	1,747	3,330	-	5,077
Mangroves	1,562	-	-	1,562
Swamps	388	-	-	388
Dwarf	-	-	69	69
All	3,697	3,330	69	7,096

Nb Timberland = forest land capable of producing at least 1.4 m³ per ha per year of industrial wood.

Source: Maclean, et al, 1988

Walung, at least two households regularly (once in every 2 weeks), supply wood to individuals who resell it. One household sells firewood to the local school for the school lunch program (At least six households in Walung are known occasionally to sell firewood.) On an average, the two regular suppliers sell 150 bundles whereas the third sells about 50 bundles a month. In Tafunsak village, one licensed firewood seller collects and sells on average 100 bundles per month, mainly in Tafunsak village itself and sometimes to Lelu residents as well. In Utwe, on average, 70 bundles are sold to retail stores in Utwe and Lelu and 50 bundles are sold regularly to Utwe school by three households. Thus, on a semi-subsistence basis, there is a minimum sale of 400 bundles per month to the general public, and over 100 bundles to the local schools.

Commercial

Full time commercial operations are at present limited to only one household residing in Malem but harvesting from the Utwe region. The commercial operator makes about three trips per week, cutting trees usually of 5-6" dbh and hauling timber in his pickup. At his residence, the timber is cut into logs of required lengths and made into bundles of ten pieces. Each piece is approximately 3" wide and 2.5 feet long. On average he collects 80-100 bundles a week for general sale to the public plus 275 bundles a month for firewood supplies to various elementary schools. The firewood collected for general use is sold to two of his relatives living in Malem and Lelu. In total, this single commercial operator produces 6,520 bundles of firewood per annum (Table 14).

Price of Mangrove Firewood

Mangrove firewood is sold in bundles. Each bundle contains 10 pieces of chopped wood measuring about 3" x 1" x 2.5'. Bundles are sold wholesale for \$1.25 at source or \$1.50 when delivered. On the other hand, the retail price varied between \$1.75 - \$2.00. Firewood sold to the School Food Services, is delivered to the schools for \$2.00/bundle. In total, present harvest of firewood has a shadow value of about \$130,000, with one full time employment and at least 11 households involved on a regular semi-subsistence basis.

Semi-Subsistence Traditional House Building

Traditional houses, generally measuring 30'x24'x12', are made using poles and beams of different sizes of *sukasrik*, *sral* and *loa* trees

Table 7: Volume of timber by tree component and forest type in Kosrae

Tree Component	Forest Type			Total
	Upland	Mangrove	Swamp	
Sawtimber	140,000	79,000	51,000	270,000
Poletimber	23,000	40,000	5,000	68,000
Total Volume	164,000	119,000	56,000	338,000

Note: Pole trees are trees greater than 12.5cm but less than 27.5cm dbh; saw timber trees are greater than 27.5cm dbh.

Source: Maclean, et al, 1988

plus *fasiu* leaves for thatched roofs. With increasing participation in the cash economy, traditional houses are being replaced by either concrete or imported wood (masonite) houses. In 1988, lumber and plywood imports were valued at \$198,000. The use of traditional houses as a main house is on the decline.

At present, almost all the households in the Walung have at least one traditional house, usually the cook house. In Tafunsak village only about one in every four households, and in Malem one in every six households have at least one traditional house. In Lelu traditional houses are very rare. Outside Walung, where traditional houses are still found, *fasiu* thatched roofs are being replaced by corrugated metal roofs.

Table 8: Wood volume by species in the mangrove and swampland

Species	Timber volume (m ³)
<u>Mangrove</u>	
<i>Sonneratia alba</i>	56,000
<i>Rhizophera apiculata</i> , <i>R. mucronata</i>	50,000
<i>Bruguiera gymnorrhiza</i>	13,000
<u>Swamp</u>	
<i>Terminalia carolinensis</i> , <i>T. catappa</i>	25,000
<i>Horsfieldia nunu</i>	26,000
<i>Barringtonia racemosa</i>	1,000
<i>Neubergia celebica</i>	1,000

Note: Timber estimation is for trees which are greater than 12.5cm dbh.

Source: McLean, et al 1988

Nevertheless, there is some demand for the supply of traditional houses. Three church groups from Walung at present supply material and labor for the construction of the traditional houses. Necessary poles and beams and thatched roofs are harvested from the Walung mangrove forests and transported by boat to Okat, and from there they are taken by road to the villages where the houses are built.

So far in 1989, two groups that were interviewed had between them six orders (two were completed). The third group could not be contacted. Each house is billed for \$400 plus a day's food for about 20

men. The revenue raised by each of the group is used towards households'

Table 9: Total area and volume of Terminalia forests

<u>Forest (Ha)</u>	<u>Volume (m3)</u>	<u>Comments</u>
Yela (68)	6,752	Best stands of <i>Terminalia</i> . Significant number of immature and mature trees, natural regeneration
Okat (90)	8,000	Single largest swamp forest; mixed swamp forest species dominated by <i>H. nunu</i> , <i>B. asiatica</i> , <i>T. carolinensis</i> ; forest variable in volume distribution; poor natural regeneration of <i>T. carolinensis</i>
Falve (50)	N/A	Mixed stands of <i>Terminalia sp</i> , <i>Barringtonia sp</i> , <i>Horsfieldia sp</i>
Finkol-Menka (26)	2,127	Mixed forest of <i>Horsfieldia</i> , <i>Terminalia</i> and <i>Barringtonia</i> ; highly variable in species distribution
Malem (18)	130	Mixed forest
Yawal (18)	900	Mixed forest
Sialat (15)	300	Mixed forest
Wiyu (10)	N/A	Mixed forest
Innam (5)	350	Mixed forest

Source: Miller, nd.

commitment to the church or to the community at large. Though traditional house building activity is slight, it would be important to ensure that the mangrove wood and *fasiu* forests are conserved such that the traditional lifestyle can be maintained.

Commercial Logging/Lumber Activity

Commercial lumber activity is also a one man operation, and is based in Utwe. Using a 16" chainsaw, the commercial mill operator cuts mangrove trees, particularly *fulofol* and *ka* species, from around the Utwe region. He harvests two to three days a week depending upon orders and for every week floats about ten logs of 2' dbh x 40-50' down the Utwe river/channel using bamboo rafts and a fiberglass double hulled boat (brand name Yanmar). Different size lumber is sawn on demand using his portable saw, which on average consumes about ten gallons of gas per day or about 30-50 gallons per ten trees harvested.

It is difficult to estimate the volume of wood harvested, or volume of lumber sold, as the records could not be located. However, using the estimated 10 trees per week, with each tree yielding a 2' dbh x 40' log, it is roughly estimated that 45,258 cubic feet or 1,286 m³ is harvested annually, which is less than one percent of the existing timber volume of 175,000 m³ (McLean, et al. 1988).

Table 10: Number of households surveyed, July 1989

Municipality	1896 Census Household Number	Number of H/H Surveyed
Utwe	139	29
Malem	204	20
Lelu	289	20
Tafunsak	206	24

Commercial Wood Carving and Handicraft

The wetland ecosystem is also a valuable source for the raw materials used in wood carving and handicrafts. *Tui*, (*Xylocarpus granatum*), which is used for carved objects such as sharks, dolphins, outrigger canoes, fish mobiles and spears, is found in clumps towards the landward side of the mangrove swamp. Handcrafted objects such as hats, fans, purses, and handbags, are made from the leaves of pandanus trees. While not specifically associated with mangrove swamps, pandanus is often associated with the coastal zone. Government exports of handicraft items and wood carvings from these two plant types, generated over \$15,000, which is about 75% of all the handicrafts exported in 1987.

In 1988 there was no officially recorded export of handicrafts and wood carvings. However, there are at least four known practicing woodcarvers making different objects.

Table 11: Fuel wood consumption pattern in Kosrae

Village	No. of Trips Per Months	Average Firewood Consumed (bdls/mo.)	Percent H/H Collect own wood	Amount Kerosene Used (gal/mo.)	Comments
Walung	6-8	8-10	100	1.5-2	
Tafunsak	1-3	4-10	85-90	4-5	5-10% buy mangrove wood
Utwe	4-12	8-20	>90	1.5-2	greater no. of plgs
Malem	4-6	8-10	85-90	2	5-10% buy mangrove wood
Lelu	1-2	4-8	<10	8-15	most buy mangrove wood from retail stores; some use kerosene or electricity

Table 12: Average volume (bundles) of firewood consumed by municipality

specializing in different items. Three of the four woodcarvers who were interviewed indicated that they sell their products locally to tourists. All three had some Pohnpeian connections and used axe, Japanese hand saw and tok. Selected *tui* trees were harvested. The number of crafted material derived from a tree varies depending upon the product. For example, from a 6" dbh x 20' pole, 11-12 carved dolphins and sharks could be made or 10-15 mobiles with 15-20 pieces each.

Municipality	Tafunsak	Utwe	Malem	Lelu	
No. of H/H	206	139	204	289	
Consumption per week/H/H	1.5-2.5	2	2-2.5	1	
Consumption/month		6-10	8	8-10	4
Total Consumption/Month		1,648	1,112	1,632	1,156
		TOTAL FIREWOOD		5,549	

* Computed using the lower monthly figure.

On average at present, a wood carver earns about \$300- 500 per month. Taking the lower figure, there is a local earning of about \$1,200 per month from mangrove wood *tui*, employing at least four woodcarvers. (Two of the woodcarvers had apprentices working on an informal basis. Their production and income are not included in the above figures.)

Table 13: Number of licensed firewood vendors, 1987-1989

Municipality	1987	1988	1989
Utwe*	7	6	5
Tafunsak	5	2	2
Malem	3	1	1
Lelu+	Nil	Nil	Nil

* At present only 1-2 active operators

+ Firewood sold through 3 retail stores

Source: Respective municipal councils

Again, though the actual volume of mangrove dependent Wood carving is not large, it is likely to increase with increased tourism. Further, as Kosrae does not have concentrations of *tui* trees, the supply of it would depend very much on the general conservation of the mangrove forests. With the anticipated increase in tourism, mangrove wetlands would be a valuable resource on which tourism supporting activities could rely.

Mangrove Fauna and Utilization of Mangrove Crabs

Very little information is available on the fauna associates of the coastal wetland and mangrove swamps. Mangrove crab (*Scylla serrata*), is the most commonly acknowledged and commercially important species caught amongst the mangroves. During the Okat survey, the species of fishes incidentally noted to be present were: *Apogon sp.*, *Lethrinus sp.*, *Gerres sp.*, *Siganus sp.*, *Mugilidae sp.*, and *Sphaeramid sp.* Also noted

Table 14: Volume (bundles) of mangrove fuelwood sold by the only full time commercial operator

	<u>Per Month</u>	<u>Per Annum</u>
Wholesale	320-400	4,320
School	275	2,200
TOTAL	595	6,520

Note: Wholesale figures were cross checked with volume sold by the two relatives; school sale figures are from the actual record.

to occur in the mangrove swamps were various species of gastropods, and fiddler crabs (see Table 15).

Subsistence fisheries are either directly or indirectly dependent upon mangrove swamps. A number of species (particularly rabbitfish and mullets) are either caught in mangrove swamps or from the nearby seagrass beds and reef flats, whose productivity also depends upon the exported mangrove detritus. However, the extent of this dependency is not known.

A detailed survey of the mangrove fish and crustacean fauna would be useful, but a stock assessment of the mangrove crab resource is urgently needed. This must be undertaken as soon as possible, if a detailed mangrove crab management plan is to be developed. As will be

seen below, mangrove crab is a valuable resource and the pressure on its exploitation is likely to increase to meet local as well as export demands.

Table 15: List of mangrove associated fauna

Crustaceans	<i>Scylla serrata</i> ; various species of fiddler crabs
Finfish	Species belonging to the genera of <i>Siganidae</i> , <i>Mugillidae</i> , <i>Gerridae</i> , <i>Lethrinidae</i> , <i>Leiognathidae</i> , <i>Gobiidae</i> , <i>Kuhliidae</i> , <i>Monodactylidae</i> , <i>Apongonidae</i>
Reptiles	Monitor lizard, <i>Varanus indicus</i>
Birds	Pacific reef egret, <i>Egretta sacra</i> ; grey duck, <i>Anas sp.</i> ; red junglefowl, <i>Gallus gallus</i> ; white tern, <i>Gygis alba</i> ; Micronesian pigeon, <i>Ducula oceanica</i> ; Carolines swiftlet, <i>Collacalia inquieta</i> ; cardinal honeyeater, <i>Myzomela cardinalis</i> ; blue-faced parrot finch, <i>Erythrura trichroa</i>
Mammals	Bat, <i>Emballonura sp.</i> ; fruit bat, <i>Pteropus molassina</i>

Source: Compiled from Eldredge, et al; Office of Planning and Statistics, 1979

Mangrove Crab Fishing

Mangrove crab is not only a highly prized fish product, but is also an important supplementary income earner in Kosrae. Today there is only a little subsistence harvest of mangrove crabs. Over 70% of the households surveyed indicated that mangrove crabs were specifically caught for subsistence uses only once in 2-3 months, usually on special occasions like family gatherings, guests or parties. Mangrove crabs for subsistence and semi-subsistence are caught by handline or by hand during low tides around full moon.

Generally, residents of Lelu and Tafunsak villages do not go crab fishing. Only one household each in Lelu, Tafunsak and Malem responded positively when asked if they catch mangrove crabs. Lelu and Tafunsak residents went crab fishing only once in 2-3 months. The Malem household which fishes for mangrove crab does so on a regular basis and supplies to one of the fish markets in Tafunsak. On the other hand, in Utwe nine households (out of 29 interviewed) did not go crab

fishing, whereas in Walung, all the households caught crabs regularly on a semi-subsistence basis.

Table 16: Household pattern of mangrove crab fishing

<u>Village</u>	<u>No of H/H active (no. surveyed)</u>	<u>Comments</u>
Lelu	1 (20)	Only subsistence fishing, once in 2-3 months
Tafunsak	1 (16)	Only subsistence fishing, once in 2-3 months
Malem	1 (20)	Active semi-subsistence supplier
Walung	8 (8)	Semi-subsistence supplier
Utwe	10 (29)	Semi-subsistence supplier to Hafa-adai store and local residents
	3 (29)	Did not do any crab fishing

Semi-Subsistence Crab Fishing and Local Crab Sales

Most of the households in Walung and Utwe that are involved in crab fishing do so on a semi-subsistence basis, which involves supplying crabs on order to retail stores or individual houses. On average, crab fishing is done over a two week period mainly around full moon. Specific orders are placed by the three main fish retail stores. On average about 15-20 orders per month are placed by each of the retail stores to different households. Each order is usually of 10-20 crabs, with an average weight of 1.6 lbs per crab. All the households surveyed in Walung supply crabs at least once in every 2-3 months, and up to four orders a year (see Table 16).

Three households regularly supplied 10-20 crabs a month to the two stores in Tafunsak. From the two month records of one of the retail fish stores, Sea-a-lot Fish Market, that were available for the period February -mid April, the store sold about 275 lbs of crabs a month. The owner of the other fish retail store, Julians Stores, also indicated that 250 crabs is his average crab sales per month. A similar pattern is found in Utwe, where local residents supply crabs to the Hafa-adai store. Seven of the households surveyed supplied regularly to the store while

Table 17: Average volume of crab retail sales per month

<u>Municipality</u>	<u>Amount per Month</u>	<u>Value (\$)</u>
Tafunsak	525	788
Utwe	100	150
Total Retail	625	938

three others sold directly to the local residents in Utwe. Occasionally, Lelu residents would travel to Utwe and purchase mangrove crabs directly from specific households. From an interview with the owner of the Hafa-adai store, it was found that between January and July 1989,

Table 18: Mangrove crab export 1986-1989

<u>Year</u>	<u>Weight (lbs)</u>	<u>Value (\$)</u>
1986	258	279
1987	1,554	2,211
1988	1,926	9,279
	(1,216)	(3,122) ⁺
1988 (Austin)	500	2,500
1989 (Jan-June)	909	2,554
1989 (relatives)	1,496	

*Compiled from the actual computer printout sales records available from the Division of Production and Marketing, Department of Conservation and Development

+Records from the Kosrae Statistics Book; figures don't compare with the actual sales records.

10 orders were placed. The maximum size of the order was 60 lbs, while on average it ranged between 40-50 lbs. The average amount of mangrove crabs retailed in Utwe is about 100 lbs a month. Thus in total at least 625 lbs of crabs are retailed per month, plus some direct sales by the households (see Table 17).

Local Crab Price

The price of mangrove crab, similar to the mangrove firewood, varied slightly depending upon where they were sold. Fishermen were paid a wholesale price of \$1 - \$1.25/ lb while the retail price varied between \$1.5 - \$2/lb as a function of supply.

Table 19: Volume of mangrove crabs "exported" to relatives and friends, Jan-June 1989

<u>Destination</u>	<u>Volume (lbs)</u>	<u>Freight (\$)</u>	<u>Value (\$)</u>
Guam	903	0.49	1,797
Kwajalein	93	0.25	163
Pohnpei	171	0.25	299
Saipan	270	0.56	556
Chuuk	59	0.25	103
TOTAL	1,496		2,918

Full time Crab Fishing

Only two households are known to be actively involved in full time commercial crab fishing, using traps supplied by Mr Ted Sigrah. Five to ten traps with fish or land crab used as bait, are mostly set in the Lelu and Mutennente region, and checked twice daily. On average 50-60 crabs a week are caught at least three weeks in a month by both of the two fishermen. By weight, about 160-200 lbs of crabs per week caught are either sold locally or exported by Mr. Sigrah, the supplier of the traps, and the revenue divided equally; 50% of the revenue as a crab trap fee. While Mr. Sigrah indicated that he "exported" (sold) about 200 lbs/week, records from the Air Micronesia show that for the period of January-June 1989, when 6 shipments were made, on average 150 lbs/month were exported. Therefore, the rest, about 450 lbs, were sold locally to restaurants and retail stores.

Therefore, the semi-subsistence (625 lbs) and full time commercial wholesale of crabs in Kosrae is on average about 1,075 lbs a month, which at the average market price of \$1.50/lbs is worth at least \$1,613 a month or \$19,350 per year.

Mangrove Crab Export

Locally it is generally acknowledged, and it was also realized for a short while in 1988, that mangrove crabs are a potentially important export commodity. In the past Samoan crabs, ^{known} as mangrove crabs in the export markets, were exported live or frozen to Hawaii, Guam or Saipan. Crab exports have steadily increased since 1986 with a sharp jump in the 1987-88 period when the now defunct Fish Cooperative operated. In 1988, between April and August, the Fish Coop had made 27 shipments, with an average of 44 crabs (71 lbs) per shipment, to Hawaii. However, due to apparent poor management and

financial problems, the Fish Coop is no longer in operation, though some exports still continue.

Private export of crabs still continues, but only in frozen form. During 1988, for a short while, there was some export of live crabs by private individuals. Over a two month period, Hafa-a-dai store exported a total of 500 lbs live crab to Guam. Mr. Sigrah is also known to have exported crabs, but no records could be obtained. Price paid to local fishermen ranged between \$1.75 - \$2.50/lb depending on whether frozen or live crabs were exported (see Table 18).

So far in 1989 (January - July), six shipments of frozen crabs totalling 909 lbs have been made to a single company in Saipan (compiled from Air Micronesia records). The export price is \$2.25/lb FOB, with the freight charges of 56¢/lb met by the importer. Thus, a total 909 lbs of crabs worth \$2,035 were exported during this six month period. If the export pattern does not change, then about 2,000lbs of crab are expected to be sent to Saipan during 1989 (see Table 18).

Another significant "export" of mangrove crabs from Kosrae is to relatives and friends living abroad. During the first six months of this year, a total of 1496 lbs of partially cooked and frozen crabs, have been sent to Kwajalein, Guam, Truk, Saipan and Pohnpei (compiled from Air Micronesia Records) (see Table 19). This does not include those that are taken on board the airplane as personal luggage.

With a shadow value of \$1.50/lb (local market price), plus the freight charges, the equivalent local value is about \$3,000.

POTENTIAL ACTIVITIES IN THE COASTAL WETLAND

Wetland Forest Resources

Coastal wetlands, as seen above, can and do provide a number of goods and services that are valuable to man. These include the existing consumptive uses of the resources such as firewood, timber for subsistence and local sales, and the harvest of mangrove crabs for home use and export. In total, the shadow value of all the products harvested (for subsistence, semi-subsistence or commercial purposes) from the coastal wetlands is over \$200,000 (see Table 20). This is small in relation to the nation's economy, which in any case is largely financed by the United States under the Compact agreement. Nevertheless, the present utilization can be made more efficient and increased to meet the aspirations of the present and future generations if a sustainable development philosophy is adopted.

Table 20: Present harvest of coastal wetland dependent products

<u>Activity</u>	<u>Volume</u>	<u>Value (\$)</u>
<u>Firewood:</u>		
Subsistence, semi-subsistence		
Commercial	60,000 bdls	
Schools	4,500 bdls	
SUBTOTAL	64,500 bdls	129,000
<u>Timber:</u>		
Lumber		8,400
Traditional housing	9	3,600
Handicraft: mangrove wood		20,000
pandanus (estimate)		15,000
SUBTOTAL		47,000
<u>Mangrove Crab:</u>		
Semi-subsistence and		
Local commercial sales	12,900 lbs	19,350
Export (commercial)	1,800 lbs	4,500
Export ("subsistence")	3,000 lbs	4,500
SUBTOTAL	17,700 lbs	28,350
TOTAL		200,350

Harvest of wetland plant species, such *fulofols*, *sral*, *sukasrik* and *ka*, can all be increased to provide import substitute lumber for houses. Lumber development plans are already in existence, but they need to be revised in order to be applicable to suit the local conditions and species (see Miller nd. b). Further, the government could provide soft loans to encourage a more efficient system of lumber production with less wastage. However, it is cautioned that the type of development such as the "ready-to-assemble" (RTA) kitchen cabinet making project, as proposed by the Development and Trade Assessment (DATA) group (Sleeper, et al 1987), is to be strongly discouraged. The major reason for this is that Kosrae does not have a forestry resource which could maintain a project like the RTA on a sustainable basis. The logistics of importing timber from elsewhere for processing in Kosrae, which is out of the usual international shipping or airline routes, is questionable. In any case, the local demand for forestry products already exists, and these should be met by small scale operations undertaken by the local community.

Greater encouragement could be given towards the use of Nipa thatched roofs, which are more suitable to the local conditions. It has

been reported that in some parts of Kosrae, such as Malem, corrugated iron roofs last no more than 2 years, whereas *fasiu* thatched roofs have a life time of about 4-5 years, and also provide much cooler conditions. Thus, not only would the use of *fasiu* thatched roofs increase the use of locally available and renewable resource (one of the development strategies), but also generate much needed local employment, reduce imports and provide a healthier environment to live in.

Similarly, the harvest of *sral* and *sukasrik* for firewood could be made more efficient by encouraging the use of branches and twigs apart from the logs which at present are mostly used. Further, with the introduction of smokeless stoves, a more efficient use of firewood is possible. This may reduce the shift towards the more convenient but imported kerosene stoves and fuel.

Mangrove Crab

Mangrove crab, as seen above, is socially and economically a valuable product. For subsistence or semi- subsistence purposes crabs are either directly collected by hand from the mangrove swamps or from the adjacent reef flats, or caught using baited lines from adjacent rivers or estuarine waters. Only a limited use of traps for the commercial harvest occurs. Mangrove crab is an important resource with a promising potential for increased harvest for local and export markets. The level of potential expansion cannot be predicted without an assessment of the present crab resource. This is urgently needed before a mangrove crab management policy and plan can be developed.

Charcoal Production

An important future activity could be the charcoal production using mangrove wood. Charcoal is produced by slow and incomplete burning of wood in kilns that allow only a small flow of air. It is believed that during the Japanese era, charcoal production was common. Today there is no known local production of charcoal, though some charcoal is imported to fuel barbecues.

In 1988 some 3,000 lbs of charcoal, and until July 1989, 1,200 lbs. were imported for local sales (compiled from the Importers Custom Records at the National Revenue Office). It is expected that with an increase in the number of salaried and wage earners, the demand for charcoal may increase. Nevertheless, charcoal could be produced for cooking and possible export to the neighboring islands.

There is already some local interest in charcoal production. In 1988, the sole commercial firewood harvester had submitted a loan application to the Development Bank, for the purchase of a pickup truck

for his firewood business. He also indicated his intention to start charcoal production for local sales at \$0.25/lb. Though part of the loan has been approved, charcoal production has not commenced.

Charcoal production could be facilitated perhaps with the assistance of the Northern Marianas Commonwealth Energy Office. Such a project could encourage greater use of local wood, particularly if the demand for firewood were to decline in the near future-- as the present trend seems to indicate. Charcoal production can be a single household activity without much capital outlay.

Charcoal can be produced using small-scale earth pits, though the charcoal quality can be low if proper control of air is not maintained. In the Marianas (Paeniu, 1988) (and in Fiji, Lal 1989), the traditional method of charcoal production involves a pit dug in the ground, stacking of various sized wood, and covering it with dirt and grass to seal the temporary kiln. A small vent is made on one side where the wood is lit. After the wood begins to burn, the vent is covered, leaving only a small inlet, allowing slow combustion overnight.

In general, logs 6" diameter are preferred for charcoal making in Fiji, though branches and twigs are also used in Malaysia, for example (Hamilton and Snedaker, 1983). About one cubic meter of wood typically produces over about 100 kgs of charcoal. A more permanent, yet easily transportable, charcoal kiln, such as the one designed by the Marianas Commonwealth Energy Office, could be used at an initial cost of \$3,000-4000.

Honey Production

Another new activity could be honey production, if honey bees were to be introduced as proposed for the purpose of increasing pollination and crop production (Crop Production Division, Department of Agriculture and Forestry, 1989). In some Asian countries, such as India, honey production is an important source of employment and income (Hamilton and Snedaker, 1983). A well managed hive in mangrove areas can produce up to 35-40 kgs/hive (75-90 lbs/hive.) It is cautioned that where local expertise and honey bees are not available, honey projects are not often very successful (Snedaker and Getter, 1985).

Tourism

Tourism is a likely development as it is one of the state's major objectives. For small island states with a limited natural resource base, tourism is an attractive potential generator of employment and foreign exchange earner (Dwyer, 1986). Mangrove wetlands, with their unique flora associations and a variety of sub-habitats on the land-water interface, already provide recreation opportunities for locals and tourists alike in a number of countries (Hamilton and Snedaker, 1983). A

nipa palms near the road are already being reclaimed for houses and urban development. This is particularly noticeable between the airport and Lelu. While conversion of mangrove wetlands is strongly discouraged, limited wetland area may need to be converted for these alternative uses. However, this does not represent the sustainable utilization of wetland resources.

RESOURCE ALLOCATION AND MANAGEMENT

Not all the activities discussed above are suitable throughout the island nor are they compatible with each other (see Table 22), which raises the problem of tradeoffs in resource allocation and management. The usually advocated market oriented resource allocation approach is not suitable in this case where the Kosraean economy is mainly a subsistence or semi-subsistence one with only some commercial activities. In any case, resource allocation on the basis of the interaction of the ecological, economic and social factors is needed. A purely economics approach is incomplete.

Instead, a standards approach is taken whereby resource allocation is done by land use zoning or "districting". A district could be an entire natural area². The boundary of a district is defined in terms of the interactions between ecological, economic and social factors and processes. Within a district, competing uses may be allocated according to the overall national policy and specific development objectives designed for each of the districts. It is within these districts that specific uses may be allocated on the basis of market forces using benefit-cost analysis (Turner 1988).

Districting is accomplished by first ranking specific sites on the basis of existing and potential ecological and socioeconomic values, and ecological vulnerability (Hirsch, 1988.) Then, the site specific values are evaluated in a broader geographic context before a final decision is made about allocation of the site to a particular districted use. For each of the districts, management guidelines are then developed. Most of the features of "districts" closely correlate with the criteria advocated for protected areas (McKinnon, et al, 1986) except that a district could include possible conversion of the habitat to other, non-renewable uses.

²A natural area can be defined as an ecosystem "where organisms, and their physical and chemical environment [interact] dynamically and within which a balance can be struck between inflow and outflow of materials and energy" (Cassells, et al, 1983). Thus a natural area could include the whole of a watershed or a relatively distinguishable sub-ecosystem, such as a wetland.

number of locations around the island can easily support recreational activities such as swimming and snorkeling, boating, canoeing, and nature and wildlife observations. Some of the attributes which are essential for recreational activities and which can easily be met in the coastal wetland ecosystem are the presence of life forms valued for consumptive and non consumptive uses, unique flora, fauna and landscape along with close proximity to tourist centers, easy and comfortable access to the sites (Hamilton and Snedaker, 1983 and McKinnon, et al, 1986.)

For recreation and tourism purposes the wetland ecosystem would need to be managed such that the landscape value is maintained and the resources are conserved. On the other hand, agricultural use of the land in the wetland habitat would require clearing and conversion of the wetland.

Conversion

With the availability of limited flat land suitable for agriculture, aquaculture and residential/urban development, potential demand and pressure for the conversion of mangrove and tidal swampland is inevitable. Conversion of wetlands is almost certain to occur if the government follows its development goal of increased agricultural production, particularly in Malem and Utwe (US Army Corps of Engineers, 1985) (Table 21.)

Table 21: Proposed development plans for various locations

<u>Area</u>	<u>Future Development Activities</u>
Lelu/Tofol/Pukusruk	Commercial, government, residential, tourism
Tafunsak/Mutunte	Port and airport residential-agricultural tourism
Malem/Tafuyat	Residential, agriculture
Utwe	Residential, agriculture

Source: U.S. Army Corps of Engineers, 1983

Some conversion of mangrove wetland is already underway. With the construction of the circumferential road, marginal wetland areas with

Table 22: Main Objectives of the Five Districts
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SANCTUARY	<p>Preservation of essential ecological processes, and of the unique and representative flora and fauna species.</p> <p>Natural restocking of adjacent exploited areas.</p> <p>Protection of commercial and recreational fisheries.</p> <p>Establishment of reserves for scientific and educational purposes.</p> <p>Maximization of recreational opportunities for locals and tourists.</p> <p>Maintenance of navigational channels.</p>
RECREATION/TOURISM	<p>Preservation of essential ecological processes, and unique flora and fauna species that would be of interest and enhance landscape value.</p> <p>Maximization of recreational opportunities.</p> <p>Permit only those consumable activities that don't destroy the landscape value of the district.</p>
TRADITIONAL	<p>Maintain the ecological process that would allow for a sustainable utilization.</p> <p>Maintain the traditional subsistence uses of the resource at a sustainable level.</p> <p>Encourage regulated semi subsistence uses of the wetland resources where it does not conflict with the subsistence harvests.</p> <p>Manage the resources such that optimum volume of wetland wood is available for various products such as, lumber, poles firewood, and charcoal, fasiu is available for roof thatch, and the harvest of crabs from the mangrove forests is maintained at a sustainable level.</p> <p>Discourage the use of <i>tui</i> as firewood and encourage its conservation for the more valuable Wood carving products.</p> <p>Maintain foreshore and river bank protective role in reducing the effects of wind, waves and tidal currents, and also allow a 30-100m buffer zone to support coastal fisheries production.</p>
COMMERCIAL	<p>Maintain the ecological processes that would conserve the habitat.</p> <p>To manage the forest resources such that optimum volume of wetland wood is available for various products such as, lumber, poles firewood, and charcoal, and in the harvest of crabs from the mangrove forests is maintained.</p> <p>Manage the forest to ensure natural regeneration.</p> <p>Maintain foreshore and river bank protective role in reducing the effects of wind, waves and tidal currents, and also allow a 30-100m buffer zone to support coastal fisheries production.</p>

The criteria adopted here for the districting include present and potential uses of plant and animal species, wetland plant associations and sub-habitats, soil types and their potential for alternative uses, present use patterns and future demands for the wetland resources. These aspects of wetland resources have been discussed above. The existing economic development plan is also considered (see Table 21) as is the potential of Malem to grow into another population center. Another important factor which is also taken into account is the potential small scale hydroelectricity schemes identified for the Infals Mutente, Toful and Pukusruk.

Proposed Coastal Wetland Districts for Kosrae

It is recommended that the coastal wetland of the island be divided into five districts according to the major development goals and objectives (see Table 23 and Figure 3). This would then allow different types and levels of human activities to be managed. On the one extreme

there is the Conversion District (agriculture/ aquaculture/ residential/ urban district) where initial felling of the trees and the conversion of the wetland into agricultural or other land uses are permitted. At the other extreme, there is the Sanctuary or the National Reserve, where no consumable use is to be allowed and only recreational and educational uses are permitted. Other districts (Commercial, Traditional and Recreation), allow varying degrees of extractable harvests of timber, *fasiu*, mangrove crabs and other fish and non-fish products which are compatible activities in these multiple use zones (see Table 22, below).

On the basis of the above criteria and the objectives of the various districts, different wetland areas around Kosrae were ranked according to their suitability (see Table 22, above). Specific characteristics of various sites are summarized in the Table 24.

Sanctuary or National Park District

The primary choice for the sanctuary or the national park is in the Okat region. This area includes the majestic looking *Sonneratia* forests with some of the largest mangrove trees found in the Caroline Islands and with a dense growth of epiphytes, at times with fronds of up to 5 meters, and the adjacent tidal swamp forest of *Terminalia* species. These sub-habitats in the Okat region were also identified by Stemmerman and Proby (1978) and Maxwell (1982) for potential preservation.

Administratively and ecologically this would be the logical extension of the existing sanctuary. There already exists a Trochus sanctuary which

Table 23: Compatibility of uses within recommended districts

ACTIVITY	DISTRICTS				
	I	II	III	IV	V
<u>Subsistence:</u> fishing, firewood, building	×	◐	●	×	×
<u>Capture Fisheries:</u> harvest of crabs, finfish	×	◐	●	◐	×
<u>Wood Production:</u> fuelwood, charcoal timber, wood carving	×	×	◐	●	×
<u>Honey Production</u>	×	◐	◐	◐	×
<u>Shoreline Protection</u>	▼	▼	▼	▼	▼
<u>Conversion:</u> agriculture, aquaculture, urban	×	×	×	×	●
<u>Sanitary land fill</u>	×	×	×	×	×
<u>Preservation:</u> scientific, education, aesthetics, "seed" stock reserves	●	◐	◐	×	×
<u>Recreation</u>	◐	●	×	×	×

Note: × - incompatible, ● - primary objective, ◐ - secondary objective, ✕ - not permitted, ▼ - important co-objective. Districts: I - Sanctuary, II - Recreation/Tourism, III - Traditional, IV - Commercial, V - Conversion

covers the area between the monuments in Salem and Finlum on the land, and the seaward boundary which extends "beyond the reef to the deepest part of the ocean." Also, there has been some discussion about the establishment of a giant clam sanctuary in this general region. A

Table 24: Ranking criteria for specific wetland sites

Areas	DISTRICT				
	I Sanctuary	II Tourism	III Traditional wood crab	IV Commercial lumber wood crab	V Conversion
Okat Mangrove Swamps	●	✕	✕	✕	✕
Yela-Mwot Mangroves	▷	▷	▷ (●)	✕	✕
Yela Swamp				●	
Yela-Tuknsru		●	●	○	
Tuknsru-Lulu Utwe		●	▷	✕	●
Infal Falwa swamp			○	●	
Lulu Utwe-Yenseng				●	○
Yenseng- Infal Kaa swamp				○	●
Infal Suganspaul		▷	○		●
Inya Mutunnenea ⁺		●	▷		▷
Infal Yekula-causeway		▷	▷		○

*Already the coral reef in the area is a trochus sanctuary. This could be extended to include all terrestrial and aquatic plant and animal species.

⁺This site may be affected by probable future development of hydroelectricity by the damming of the Pukusruk river (U.S. Army Corps of Engineers, 1985)

Key: ● - very suitable and main objective, ▷ - moderately suitable and secondary objective, ○ - marginally suitable, ✕ - not permitted

giant clam sanctuary was declared for the "depressed area in the reef flat on the seaward side of the Lelu causeway adjacent to the island Yenasr" (Endangered Species Regulations), though no specific management policies have been developed. This general concept of sanctuary could be extended to include the mangrove and tidal wetland areas.

However, there is some reservation about the sanctuary being so close to the newly constructed airport and Okat harbor, and possible industrial development in the region (see Table 21). There is already some ongoing discussion about siting a fish processing plant at the harbor and near the airport (Mike Molina, pers comm). Given that most of the time the trade wind blows in the south westerly direction, any industrial activity in the airport region would be potentially detrimental to the sanctuary. Management of the sanctuary would need to be undertaken at the state level.

Recreational District

Recreation districts are identified in two areas: between Tukunsru and Utwe, and around the Inya Mutunnenea. The Tukunsru - Utwe mangrove area, with the dominance of *Rhizophora* species and small pockets of nipa palms, is highly suitable for potential recreational activities such as boating, swimming, kayaking and snorkeling (see Auyong's study for more detail). On the other hand, Inya Mutunnenea with the presence of *Sonneratia*, *Rhizophora* and *Xylocarpus* species along with nipa palms, could offer an aesthetically pleasing half-day boating and perhaps boardwalk experience in an area close to present and potential hotel development in Lelu and Tafunsak municipalities.

While these locations have aesthetically pleasant landscape values and recreational potentials, they would place some constraints on other uses. In both these areas no firewood or timber harvesting should be allowed within at least 100m of the shoreline, whereas, crab fishing could be permitted as it does not involve destruction of the landscape. Future uses inland from Inya Mutunnenea, for agricultural purposes and a small scale hydroelectricity scheme on Pukusruk river, raises another concern. Mangrove habitats are very sensitive to changes in freshwater and salt water hydroperiods as well as sedimentation. Agricultural activities and hydroelectric plants can cause such changes. For the Inya Mutennenea to maintain its potential as a boating site, these activities will need to be carefully assessed in terms of potential costs and benefits.

Traditional District

The most effective subsistence, semi-subsistence district would be in the Walung region, between Yela river and Tukunsru, where the present and future traditional lifestyle is expected to continue with small

increases in population. Management of the wetland resources could be assisted by the existing traditional community network, which revolves around the church. As already discussed, semi-subsistence house building is undertaken by the Walung village organized in three "competing" groups. This organization could be used for managing the habitats and the harvest rates as determined by a sub-committee of the Forestry Division, Production and Marketing Division and the Marine Resources Division.

Commercial District

For the commercial harvest of timber resource, the most suitable area are the Yela tidal swamps, Infal Falwa swamps and Infal Lulu Utwe-Yenseng region. These areas, with extensive forestry resources, already have seen a substantial amount of commercial activity and has potential for further increases.

However, a carefully designed management plan would need to be developed ensuring that the forestry resource is harvested at a sustainable level and ensuring that it does not affect the important semi-subsistence and potential commercial harvest of mangrove crabs.

Management of the commercial district would have to be controlled at the state level in consultation with the municipal councils and the community.

Conversion

Though there a number of sites suitable (on the basis of soil type) for agricultural use, it is most appropriate in the Yensek-Infal Kaa swamp region. Given the projected future population center and the lack of other income activities in the Malem region, this area is recommended to be zoned as a future conversion district. This is also the area where intensive aquaculture may also be feasible. However, from the negative experiences in countries with a long history of aquaculture, it is not a recommended activity (Hamilton and Snedaker, 1984). Even if aquaculture were to be contemplated, the long term economic viability of such an activity needs to be conclusively demonstrated before an area is committed to aquaculture.

Another potential conversion area could be the tidal swamps in the Utwe region, where again the general soil type has some potential for agriculture. The Economic Development plan has already identified the Utwe region for future agricultural development. However, within its wetland the area that is suitable for agriculture, on the basis of soil types found, is very small.

Table 25: Summary of important characteristics for district classification

<u>District</u>	<u>Location</u>	<u>Characteristics</u>
<u>Sanctuary</u>	Okat	Ecological unit of mangrove and tidal swamp in one small location; largest trees of <i>Sonneratia</i> species found in the Caroline islands; aesthetically beautiful landscape; existing trochus sanctuary on the adjacent reef system
<u>Recreation</u>	Lulu Utwe	Tukunsru Distinct <i>Rhizophora</i> wetland system behind coastal strand; numerous small islets within; presence of reef holes, ideal for snorkeling; removed from population center; an area that administratively can easily be regulated
	Inya Mutunnenea	close to hotels, beautiful channel with a mixture of representative species, with potential board walking area; tourism development region as identified under current economic plan
<u>Subsistence, Semi-Subsistence</u>	Yela and Mwot River	Considerable subsistence uses of forest products and mangrove crab, potential of future subsistence uses continuing; relative to other villages, population pressure not likely to increase dramatically; soils generally not suitable for agricultural farming
<u>Commercial</u>	Utwe Lulu to Yenseng Infal	Extensive present commercial harvest of firewood and timber; potential increases in population and with this also the pressure for income generating activities; limited other resources
<u>Conversion</u>	Yenseng to Ka River	only extensive area in the coastal Kosrae where the soils have potential for agriculture; current agricultural activities; limited resources to support other income generating activities; need for agricultural development as identified for the region under current economic development plan

RECOMMENDATIONS FOR SPECIFIC MANAGEMENT ACTIONS

Institutional Arrangement

Management of the coastal wetland requires an interdisciplinary approach, not only in resource allocation, but also in the institutional organization which controls and regulates the human activities. Institutional arrangements (which include government and semi-government agencies, property right arrangements, local customs and traditions) provide the framework within which economic decisions are made (Bromley, 1982). All these institutions, not just the market oriented costs and benefits, have direct effects on the question of resource allocation and its environmental implications.

At present, the mangrove wetlands are owned by the state and as such are under the jurisdiction of the Forestry Division, though there has been some discussion recently of transferring responsibility to the Marine Resources Division. No legislation or regulations relating to the control of forestry utilization or the harvest of mangrove crabs are in place. A size limit of 6" carapace width on the harvest and sale of mangrove crab was proposed in March of 1988, but the decision on the proposed bill is still pending (Fourth Kosrae State Legislature, Third Regular Session, 1988, LB 6- 106).

Because the coastal wetlands are found on the land water interface, the ownership pattern is also not clearly defined. The landward boundary of this mangrove, which is considered to be public land, is the high water mark, while some nipa forests and the tidal swamps, which grow beyond the mean high water mark, are regarded as private land. Further, as the impact of man on the coastal environment does not know institutional boundaries, the management of the coastal wetland is more complex.

It is recommended that state and national economic development planning efforts be reviewed with the intention of identifying how an ecosystem approach can be adopted. This will help insure that the effects of human activities can be minimized while encouraging the sustainable development of the nation to meet the aspirations of the present and future generations. Perhaps this would be achieved through the ongoing institutional review discussions about the proposed Coastal Zone Management Authority. However, for the sustainable development of the wetland resources, an interdepartmental organization would be needed to control and regulate the uses of the resources. This needs to be examined concurrently with the discussions on the overall institutional arrangement of coastal resource management.

In the interim period, it is suggested that a sub-committee comprising of the Forestry, Agriculture (Productions and Marketing Branch) and the Marine Resources Divisions be established. This sub-committee should develop a coastal wetland policy which can be adopted by the state. The wetland can be managed by districting for different uses, as outlined above.

The sub-committee has to develop a detailed management plan and the strategies needed for each of the districts, in accordance with their specific objectives and the overall goal of sustainable development. Also needed would be detailed management plans for each of the resources under consideration, which can become part of the district plan. Further, the subcommittee could explore the possibility of the involvement of the local municipal councils, existing traditional community organizations and individuals recognized with some authority and say over the utilization of the resources (one such individual was identified to "control" the harvest of nipa palms in the Utwe region (Waguk, pers comm)), and in the development and the implementation of the management strategies and regulations. Different boards of trustees (with two or three members of the community already unofficially involved with the management of the resources) may be organized for each of the districts to work with the government sub-committee and develop detailed management plan and strategies.

Some general guidelines are given below which could facilitate the preparation of specific management regulations.

Mangrove and Tidal Swampland Forests

An effective management plan for a sustainable yield of forest products requires a specific knowledge of the growth and wood production rate of individual species. A research proposal to obtain growth information regarding selected wetland species is available as part of a five year plan for the forestry resource (see Miller nd. (b)). This needs to be expanded to include all the major mangrove and swamp forest species which are important as fuelwood and timber.

In the interim period, in the absence of specific information, it is generally advocated that total harvest from an area should not be greater than the annual production (Hamilton and Snedaker, 1984). In the case of selective cutting, the cutting cycle varies with the product

harvested. The cutting cycle is the time between two successive cuttings of a given plot or stand (Hamilton and Snedaker, 1984). Thus, there is a particular rotation period for firewood and another longer one

for lumber. The rotation period is the same as the cutting cycle when forest is clear-cut and no thinnings are made. However, in the case of selective cutting the rotation period is only part of the cutting cycle. In the absence of detailed growth information, an initial conservative rotation period of about 40 years for lumber harvest is recommended (Whitesell, pers comm), whereas for firewood and charcoal production 25- 30 years have been used (Hamilton and Snedaker, 1983). This needs to be revised once detailed growth information is obtained.

Hamilton and Snedaker (1984) identify a number of actions required for sustained wood production in mangrove areas. These include:

1. Emphasis on sustainable yield harvests. Hold the area harvested each year to only 1/40 th of the area under the management district.
2. Undertake thinning on a silvicultural schedule rather than on the end-use demand schedule.
3. Ensure that sufficient number of seed trees are maintained for natural regeneration.
4. Reduce slash size and volume not only to encourage more efficient use of the wood products but also to encourage natural regeneration.
5. Retain buffer strips along river and coastal waterways to prevent shore erosion
6. Develop a management strategy in consultation with the local communities, possibly appointing a "Board of Trustees" comprising government officials and members of local communities.

Mangrove Crab

A good management plan for mangrove crab cannot be developed without information about the present stock levels. This is urgently needed prior allowing any increase in the mangrove crab harvests. Until a stock assessment is undertaken, as a precautionary measure, no increase should be allowed in the use of the crab traps. Other types of regulation and control which need to be considered include a prohibition on the capture and sale of soft-shelled crabs, a prohibition on taking females, a requirement traps have escape ports to prevent excessive handling of undersized crabs and limiting the size of crabs landed (Perrine, 1976).

An important management action for mangrove crabs and other mangrove dependent fisheries products would be the protection and maintenance of the mangrove habitat. The nature and the distribution of the mangrove forests is determined by a complex interactions of factors such as topography, sediment type and hydroperiod (seasonal period of saltwater/freshwater inundation, and salinity patterns (Snedaker and Getter, 1985). The mangrove ecosystem is extremely sensitive to changes in any of these factors.

Thus, the conservation of mangrove flora and mangrove dependent fauna will depend largely on activities outside the mangrove ecosystem as much as within it. Therefore, integrated environmental planning is essential. Some of the important planning and management provisions that should be required for proposed developments outside and within wetlands include:

1. Maintenance of existing topography, forest substrate character and water channels.
2. Perpetuation of natural patterns and cycles of tidal activity and freshwater runoff. Coastal structures such as the circumferential road underway, should be designed to insure that these patterns are maintained. Mangroves require freshwater as well as saline water, and cessation of either of these would inevitably cause the trees to die and a definite reduction in the dependent fauna.
3. Minimization of changes in the clarity and transparency of water. Dredging near the spawning, nursery grounds that mangroves are should not be allowed. Dredge spoil disposal should not be permitted in the mangrove swamps.
4. Prevention of municipal waste disposal in The mangrove areas. Also the introduction of pollutants and excessive nutrients, such as from the fish processing plant, should be prevented.
5. Prevention of clearfelling of mangrove trees. Only selective cutting should be practiced. The harvest rate should not affect the production of the dependent fauna.
6. Maintenance of protected areas, such that natural (or artificial) restocking of the harvested areas is not jeopardized.

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