Australian National University
NORTH AUSTRALIA RESEARCH UNIT

DISCUSSION PAPER

COASTAL MANAGEMENT: CHALLENGES AND CHANGES IN THE TORRES STRAIT ISLANDS

Monica E Mulrennan

No. 5

April 1992

OFFICE OF INDIGENOUS AFFAIRS

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ISSN 1037 5112
ISBN 0 7315 1364 9

NORTH AUSTRALIA RESEARCH UNIT

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Cover designed by M Aye and printed in Canberra by ANU Printery

ABSTRACT

The indigenous Islander communities of the Torres Strait are today facing many difficult challenges. An infrastructural development program rushed into effect since 1988 has seen the building of airstrips, landing barge ramps, etc. On the tiny islands of the Strait these operations, their siting and their ancillary requirements, have produced major environmental problems, some of immediate effect and some with longer term impacts on subsistence livelihoods. Insufficient advance thought appears to have been given by government to these matters, although they threaten to increase the effects of coastal change and sea level rise which are already worrying the Islanders. The Islanders, through the development of a comprehensive conservation and sustainable development strategy, are actively seeking to come to terms with these unprecedented changes. This paper highlights issues of environment and development which are of particular concern. Some principles and guidelines are put forward which may assist in the establishment of a more effective and appropriate approach to environmental management and protection.

Acknowledgements

My special thanks to Peter Jull for his constant encouragement and helpful discussion throughout the writing of this paper.

I would also like to express particular appreciation to the Torres Strait Island Co-ordinating Council (ICC) for its support and cooperation. I am especially grateful to Vic McGrath who acted as chaperone during my recent visit to the outer islands and provided many valuable insights into the region. I also thank Mr Getano Lui Jnr, Chairman of the ICC, Ms Joan Staples, Executive Secretary of the ICC, staff of the ICC, and the Council Chairmen, Councillors and residents of Coconut, Warraber and Saibai Islands.

My thanks to NARU Executive Director, David Lea, for his support and constructive criticism, and to my colleagues, Marjorie Sullivan and Ian Moffatt, for their useful comments on drafts of this paper. The work of Colleen Pyne, Nicki Hanssen and Ann Webb in the final preparation of this paper is also much appreciated.

Notes on contributor

Monica Mulrennan has been a Post Doctoral Fellow at the North Australia Research Unit, Australian National University, since April 1991. She graduated in 1990 with a Doctorate in Geography (Coastal Geomorphology) from University College, Dublin, Ireland. She also worked as a Consultant Geomorphologist to Dublin County Council on coastal management issues throughout her postgraduate years. The Irish recipient for the 1990 Australian-European Awards Program, she spent her first year in Australia with the University of Wollongong researching the geomorphic development of tropical estuarine environments in the Northern Territory. She is presently continuing this work and is particularly interested in the management implications of her geomorphic studies.

COASTAL MANAGEMENT: CHALLENGES AND CHANGES IN THE TORRES STRAIT ISLANDS

Monica E Mulrennan

Introduction

The Torres Strait is a 150 km wide passage between Cape York Peninsula and the southwest coast of Papua New Guinea. It incorporates the northernmost part of the Great Barrier Reef, other extensive reef areas, islands, islets, cays and mangroves, as well as some of the most extensive seagrass areas in the world. Nietschmann describes the region as:

> *the most ecologically complex area of one of the world's most extensive continental shelves... Containing volcanic, continental, coral and alluvial islands, and fringing, platform and barrier reefs, the Strait offers a multitude of habitats and niches for the Indo-Pacific marine fauna, which itself has the greatest diversity of the ocean world (1985, 134).*

The maintenance of these ecologically complex and environmentally sensitive habitats is of critical importance to maintaining the biological productivity of the Torres Strait.

The region is also noted for its cultural diversity, being home to Australia's Melanesian minority group — the Torres Strait Islanders. These people have a strong seafaring and trading tradition and hence a unique relationship with the tropical seas, coast and regenerating reefs of the region. Today there are an estimated 6,245 Islanders residing on sixteen islands within the Strait, as well as two additional communities on the northern tip of Cape York. Approximately 15,296 Islanders also live on the Australian mainland, although there are increasing indications of a steady return migration to the islands (Arthur 1990).

Despite the remoteness of the region, the Torres Strait Islanders feel increasingly threatened by existing and proposed mining operations, oil terminals, pulp mills, and nuclear power stations on shores and up rivers which drain into the Torres Strait, and by international shipping through their hazardous reef-strewn waters. The potential for serious environmental degradation in the region cannot be over stated. However, there are already in place potentially effective mechanisms to deal with some of these regional environmental concerns. The Torres Strait Treaty, a bilateral arrangement between the governments of Papua New Guinea and Australia, is particularly significant in this regard (Babbage 1990).

It would be incorrect to assume that the only threat to the quality of the Torres Strait environment comes from external sources to the north. Increasingly a range of local factors impinge on the environmental quality of the region, most notably the inhabited islands and the offshore fringing and platform reefs which surround them. These concerns include a history of increased flooding of many islands, resulting in the dislocation of Islander eco-refugees to the Cape York Peninsula in the 1940s. Problems associated with coastal erosion and control have, for long, been part of Islander life. More recently, however, fears and rumours abound regarding the anticipated impacts of greenhouse-induced sea level rise and the future of many of the islands, particularly the low-lying sand cays of the central group and the northwestern mud islands, is no longer assured.

Scientific research into the rate and nature of environmental change has become increasingly urgent as the Islanders enter a new phase of economic development. Substantial investment in community infrastructure during the 1980s led to the provision of airstrips, community water supplies and funding for roads and housing on many of the outer inhabited islands. The pace of infrastructural development is continuing to rise, increasingly associated with excavation and earth moving, blasting, dredging, land reclamation and vegetation clearing. Such activities impact on the aesthetic, ecological and ultimately the cultural values of the environmental quality of the islands.

Article 13 of the Torres Strait Treaty explicitly provides for the protection of this marine environment. Article 13(5) relates specifically to the assessment of potential impacts of planned activities on the marine environment while Article 13(6) provides for control over existing activities which already impact on the environment. However, Australia has no legislation in place to enact Article 13 and implementation currently depends on the goodwill of the Queensland Government to require adequate environmental protection measures for developments and to consult with the Commonwealth. Frustrated by the present system, the Torres Strait Islanders are actively seeking assistance to come to terms with the current environmental crisis themselves. Appended to a letter to the Queensland Premier (May 16 1991), the chairman of the Island Co-ordinating Council included 'Principles and Objectives for the Future of Torres Strait' which proposed that:

> *A comprehensive conservation and sustainable development strategy is needed as the foundation for future public policy and economic development in the Torres Strait region. A Torres Strait Marine Conservation Strategy would be the largest element in this approach, building on the unique relationship between Islanders and the sea. This relationship is as important for cultural traditions and social forms as for our livelihoods and future well-being.*

The climate for such initiatives seems right. Throughout Australia ecologically sustainable development, coastal management and indigenous self-reliance programs have become national priorities while the 1992 Columbus Quincentenary, 1992 UNCED and 1993 International Year of Indigenous People are focussing world attention on aboriginal-ecosystem relations as never before.

This discussion paper aims at providing a starting point for the proposed Conservation Strategy, serving to highlight some of the major environment and development issues currently affecting island communities and their environment. The objective is to develop a set of ecological guidelines which will not only provide for the conservation and protection of the natural environment but will also permit optimum exploitation of the region's limited resource base, consistent with the needs of the Islander peoples who inhabit the area.

The discussion is based on preliminary observations and findings of two brief visits to the Torres Strait. The first of these, in July 1991, provided an opportunity to meet with several members of the Island Co-ordinating Council (ICC) and individual Island Councils and hear many of the local concerns about the environment and development. A second trip, in December 1991, included visits to some of the outer islands where I met with the Island Councillors and spoke to local residents about their observations of coastal change. Preliminary field observations were also made.

Physical environment

Evolutionary history

The Torres Strait, as we know it, formed in the early Holocene between 8 500 and 6 500 years ago when post-glacial sea level rise flooded the Sahul shelf and breached the pre-existing land bridge between Papua New Guinea and Australia (Barham & Harris 1983). Transgression of the 200 km shelf was probably completed by 2–3 000 years BP. Today, the Strait occupies a shallow shelf, 10–15 m deep along a north/south axis which follows the western islands and approximates the position of the old land bridge. Water depths are less than 30 m within 100 km to the west and exceed this depth to the east only where isolated troughs occur.

Oceanography

The Strait is located between the complex tidal regimes of the semi-diurnal Coral Sea to the east and the diurnal regime of the Arafura to the west. In the Strait, tides are predominantly diurnal, with a maximum spring range of 3.5–4.0 m. The pattern is complex and seasonally variable with net surface water movements to the west during the Dry and eastward during the northwest monsoon (Wyrtki 1960). Tidal current velocities often exceed 3 m/sec within the shallow bathymetry and restricted submarine topography around reefs and islands. These oceanographic variables control gross reef morphology as well as nearshore and onshore sedimentation patterns.

Climate

The Strait is within a sub-humid savanna environment, with a Dry season of 5.0–7.5 months duration and 95% of annual rainfall falling between December and April (Harris 1980). Seasonality is controlled by movements of the Intertropical Convergence Zone, a region of high and variable rainfall, which travels southward onto Cape York in December/early January and shifts back over Papua New Guinea in April/early May. The severity of the Dry season and timing of the onset of the Wet has important geomorphic and biogeographical implications for the region.

Wet season rainfall averages 1 600 mm at Thursday Island, but the monthly total for the wettest month, January (mean 430 mm), ranges from 167–863 mm (Barham 1985). Storm events (high magnitude/low frequency) are mainly associated with the northwesterly winds of the Wet season. Wind gusts at this time may reach between 60–70 knots, but strong winds are typical throughout the year, except during the doldrums (November/early December). Strong southeasterly winds over 35 knots average 10–12 days/month during the winter Dry season (May to September), associated with intense high pressure systems over central Australia. Cyclones are infrequent, only six cyclones having passed through the region during the last fifty years (Laurensz 1981).

Thermal contrasts are less distinct between seasons, ranging from a mean daily maxima of 31.2°C in November to 27.7°C in July and a mean daily minima of 25.4°C in December to 22.5°C in July.

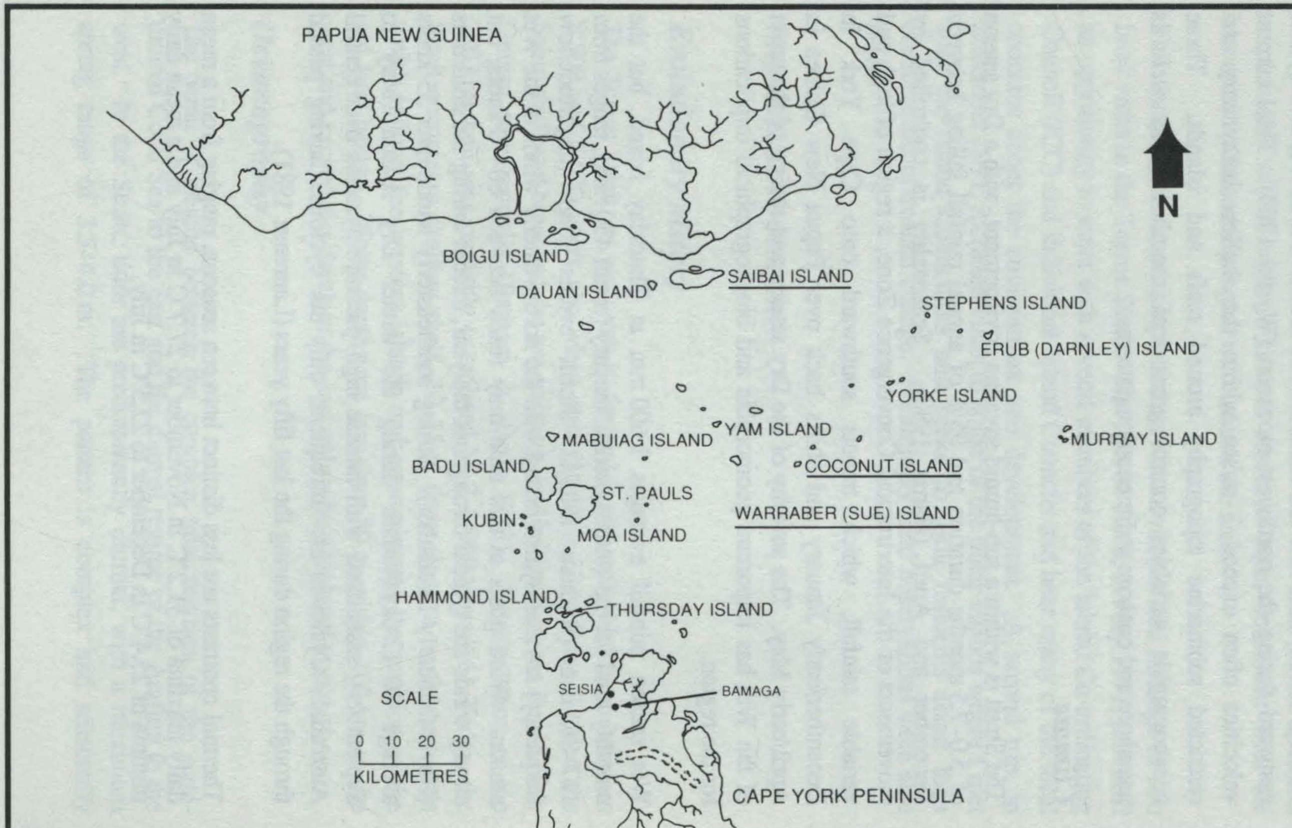

Fig 1: Torres Strait Region

Physiography

The Strait comprises a total area of over 40 000 km^2 of which approximately 2.6% is land, 6.2% tidally inundated reef-flats and 91.2% open ocean (Barham 1985). The land area is made up of more than 100 islands and islets which can be divided into four separate island groups (Fig 1), based on the palaeoenvironmental data of Barham and Harris (1983):

(i) an eastern group of high islands representing the eroded remnants of basic volcanic cones and including the three islands of Maer, Duar and Waier (the Murray Group);

(ii) a central group of low coral sand cays surrounded by coral reefs;

(iii) a western group of high islands of acid volcanic and granitic rocks;

(iv) a northwestern group of low islands where mangrove muds and peats overlie Pleistocene reef-limestone and clay surfaces.

The present discussion is concerned only with the inhabited low-lying islands of the central and northwestern groups. Field investigation has so far been limited to a brief visit to two of the central islands, Coconut and Warraber Islands, with a passing visit to the neighbouring island of Yam. Observations were also made on the northwestern low-lying 'mud' island of Saibai.

Details of the nature and rate of coastal change on the islands are derived from anecdotal evidence and personal field observation. Aerial photographic interpretation will provide a more complete assessment and verification of these changes and will be carried out in the near future. This type of information will be essential to understanding the natural dynamics of the island systems — that is, whether the cays are migrating across the reef platform through processes of erosion and deposition or whether there is a net loss or gain of sediment to the system. Having an appreciation of the natural dynamics is a primary pre-requisite to the establishment of appropriate management strategies in the region.

Central group

The coral cay islands of the central group have accumulated over the last 4 000 years in response to wave refraction patterns over surrounding platform reefs. Their present configuration is adjusted to local fetch and seasonal wind and wave regimes. The cays are between 3–6 m above mean sea level and comprise marine deposits of medium to coarse sand grain sizes overlying a cemented horizon of 'beachrock' at depths between 1.5–3.0 m below the surface. Limited dune development occurs on windward shores and local outcrops of intertidal carbonate beachrock are common.

Coconut Island is a long narrow shaped island (Fig 2), with maximum dimensions of 1 900 m by 300 m and a population of 130 (July 1989). It has a maximum crest elevation of 23 m but most of the island is between 5–6 m above the height of mean sea level. Situated at the northwest end of a large reef flat, the surrounding reef limits the fetch from predominant wind directions and provides much protection from incoming waves which can reach maximum storm heights of 1.8 m during a northwesterly.

The northern foreshore is generally composed of a layer of beach rock from the toe of the beach slope up to approximately mean sea level, providing an effective barrier to beach erosion. A medium grained coral sand beach overlies the beach rock and extends to the crest. In contrast, the southern shore is characterised by an extensive intertidal zone with an occasional isolated mangrove tree. Beach rock is limited in extent here and more karstic in appearance. A high dune ridge has developed along the central southern shoreline and it is here that the island reaches its highest point at 23 m. The ridge becomes lower towards the distal ends of the barrier and a tyre barrier has been placed at the end of the airstrip to reinforce the dunes.

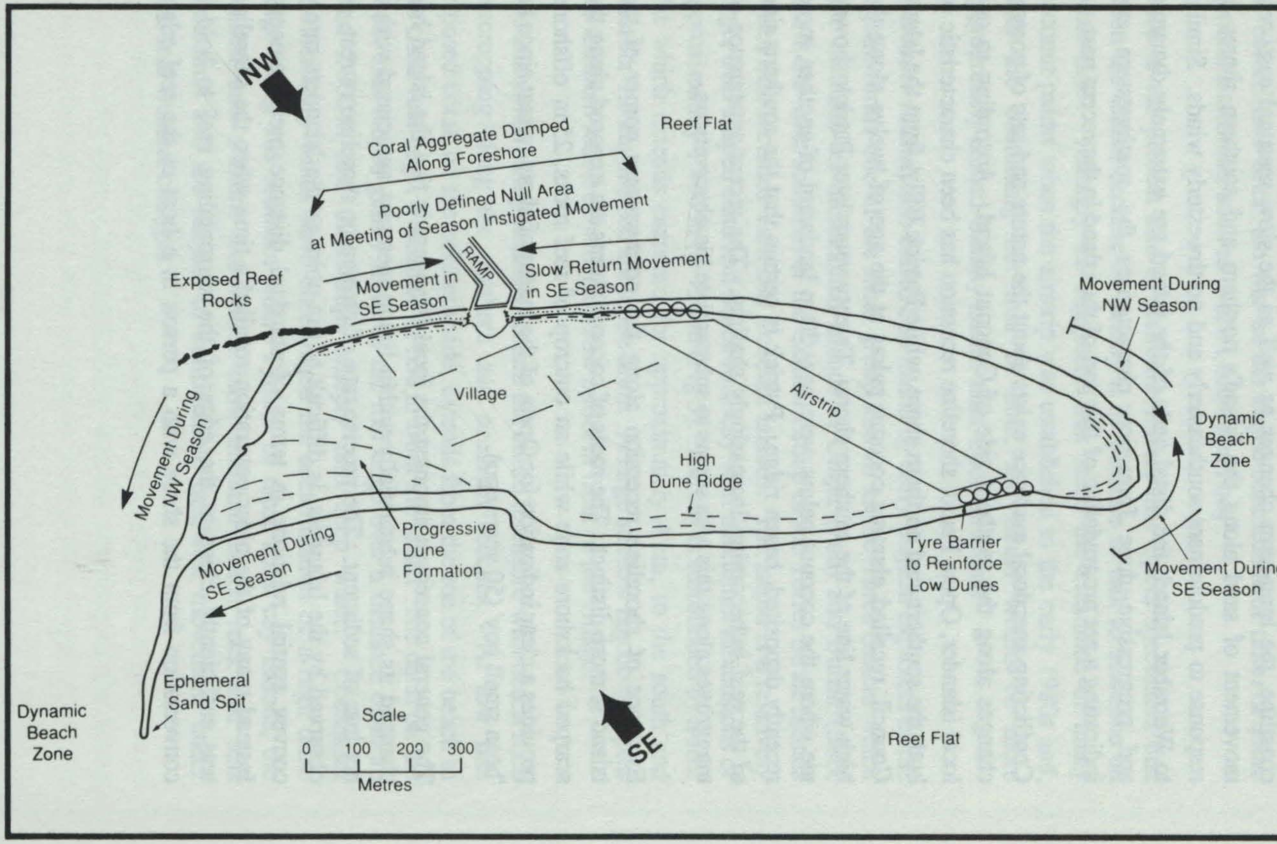

Fig 2: Coconut Island

The Islanders are very much aware of the dynamic nature of their coastline, the long-term changes as well as the slow seasonal east/west movement of sand along the island's northern and southern shores in response to predominant southeasterly and northwesterly winds. Similar to Warraber Island, the distal ends of the island are extremely dynamic and progressive dune formation characterises the southwestern end indicating a net progradation of this part of the island in the recent past.

Conflicting anecdotal evidence exists about the nature and rate of coastal changes along the southern side of Coconut Island. According to one local islander, Opeta Fauid, shoreline recession has been characteristic of both the southern and northern shore, while Patrick Billy, from the Island Council, recalled planting coconut palms at the age of twelve along the high water line of the southern shore. Twenty years later Patrick showed me where the coconut palms were now 20 m landward of another, more recently deposited, beach ridge. Patrick is certain that the southern side of the reef is becoming increasingly shallow. The recent appearance of mangroves along this area seems to substantiate his observations.

Evidence of shoreline recession along the northwestern corner of the island is more distinct. The roots of coconut palms are exposed along the scarped backshore zone while an outcrop of reef rocks, 25 m offshore, provides a clear indication for Opeta of the extent of shore retreat since he 'been small boy' (50 years ago).

The general consensus amongst the local Islanders is that the island has changed its shape substantially within living memory, associated with a net loss of sediment. The precise rate of change or shoreline retreat, as observed by the Islanders, is difficult to pin-point as the Islanders rarely convey spatial relations in terms of standard distance measurements. Instead many of the older generation recalled a time when the shoreline was sufficiently close to the edge of the surrounding reef to hold a conversation from the shore with a person in a boat at the reef edge.

Likewise the Islander perception of time is somewhat imprecise, referring to 'before' and 'after' the war as the major benchmark of time, or more general statements such as 'when I been small boy'.

Such is the present rate of shoreline retreat that Opeta speculated that 'soon the island become so skinny it be possible to talk to someone on other side'. Jokingly he suggested that since the clearance of many coconut palms when the airstrip was established in the early 1980s and, with the continuing net loss of land, the island would be more appropriately named 'Skinny Island' than 'Coconut Island'.

Warraber Island, also called Sue Island by early English explorers of the region, forms one of the local group known as the Three Sisters which also includes the uninhabited islands of Guijar (Poll) and Burrar (Bet), and is the most southern of the Central Group of the Torres Strait Islands which also includes Yam and Coconut Islands. The island is a relatively large, oval shaped sand and beach rock cay with maximum dimensions of approximately 1 400 m by 750 m (Fig 3). The cay is surrounded by a reef flat which extends eastward for approximately 4 km, to the south and west for 1.5 km and 0.6 km to the north. A large shallow lagoon occupies the northern reef area with a narrow outlet in front of the village.

The island has sandy beaches around the entire foreshore with beach rock outcropping along the northern and southern beaches. At low tide exposed coral, on the northern side, extends from the toe of the beach to the coral reef edge, a distance of 550 m from the shore. The coral on the south side slopes gently towards the reef edge over a distance of more than 2 000 m and then drops sharply into deep water. Consistent southeasterly winds have encouraged the accumulation of a high dune ridge along this southern side. Typical of these coral cay islands, the eastern and western extremities have minimal beach rock and less protection and are subject to considerable east/west movement under seasonal weather changes.

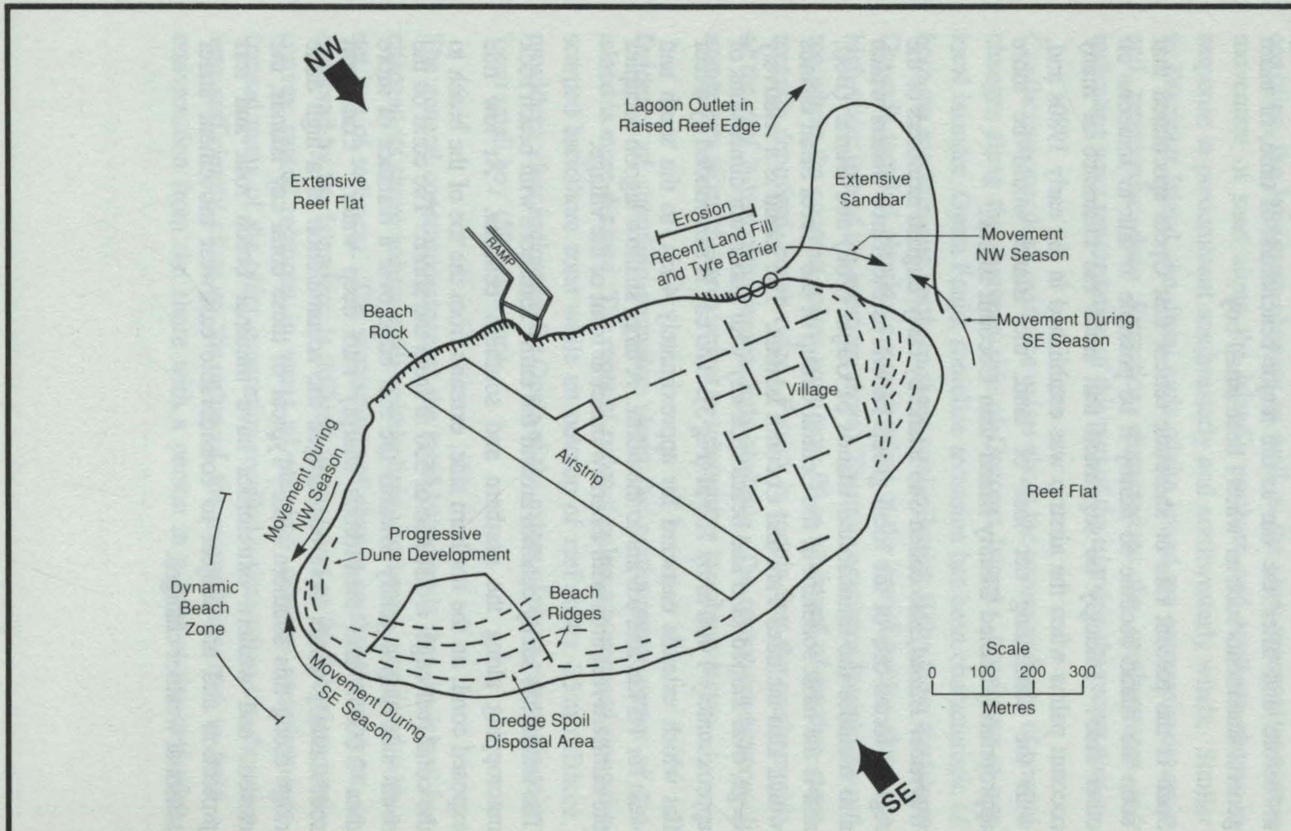

Fig 3: Warraber Island

In recent years, net sediment removal from the southern beach has been responsible for progressive dune formation at the western end of the island and has led to a substantial progradation in land area at the western end of the island. An extensive sandbank has meanwhile accumulated at the eastern end of the island, cutting off the usual east/west seasonal exchange of sediment and resulting in beach erosion in the northeast corner of the island. Tyres and rock baskets have been placed along this area to limit erosion and protect the beach.

The village is located on the eastern end of the island and had a population of 165 in July 1989. With an expected growth rate of 1.5%, the population is expected to increase to 190 people by the year 2000.

Northwestern Group

The northwestern group includes the low-lying islands of Saibai and Boigu. These islands are composed of terrigenous alluvial sediments washed down by the rivers of Papua New Guinea and are referred to locally as 'mud islands'. They are Holocene in age, having formed through the accumulation of organic intertidal and mangrove sediments on top of Pleistocene reef-limestone and clay surfaces (Barham & Harris 1985).

The islands are only 2–3 m above mean sea level and, with a local Spring tidal range of between 3.5 and 4.0 m, are particularly vulnerable to flooding. Inland of a wide mangrove fringe, the interior depression of the islands is made up of non-inundated clayland and freshwater/brackish swamps subject to seasonal inundation by Spring tides during the northwest monsoon.

Saibai Island is one of the largest Torres Strait islands being approximately 20 km long, east–west, by 6 km wide, north–south (Fig 4). The island is low-lying with a maximum height above sea level of about 2.7 m. Extensive mangrove habitats line the periphery of the island, except where they have been cleared in front of the village. Along the

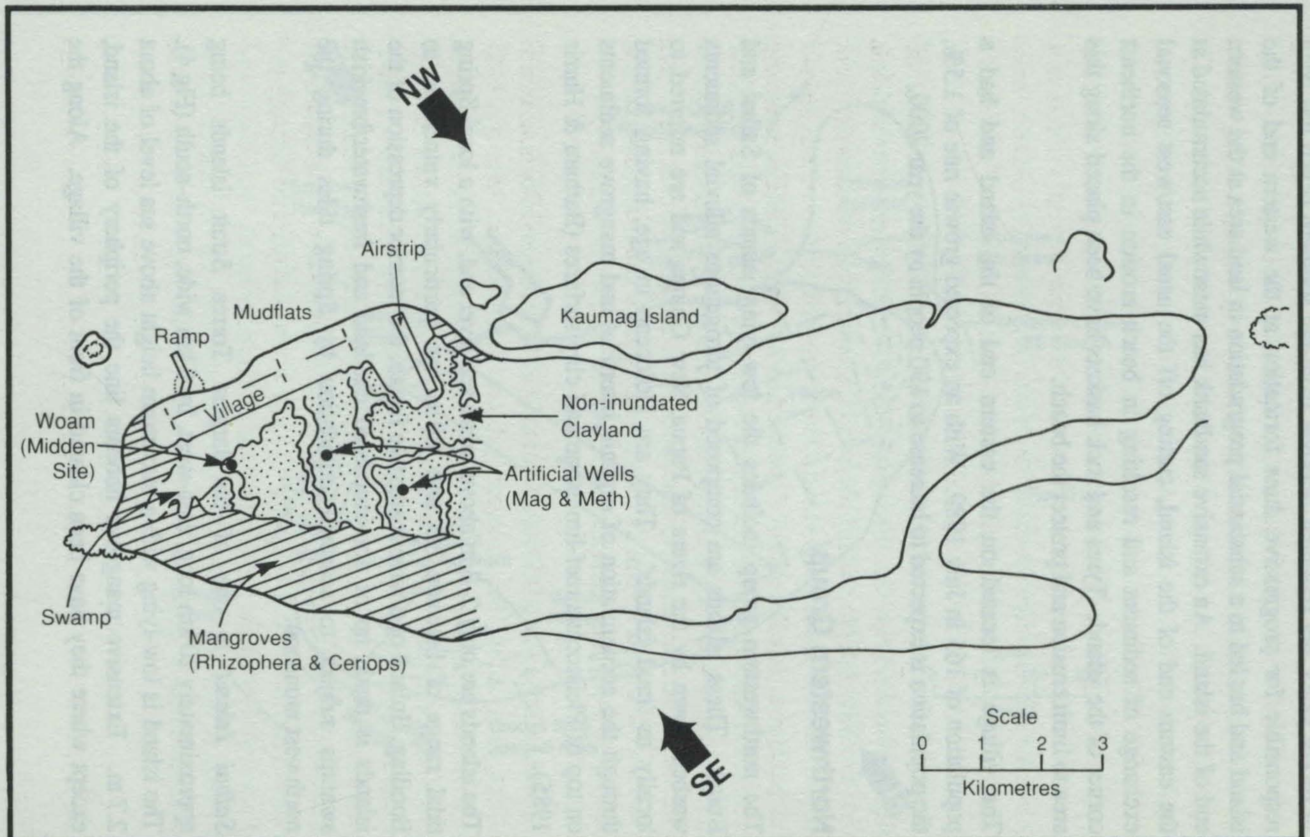

Fig 4: Saibai Island

northern foreshore a limited amount of reddish brown ferruginous beach rock occurs. Outcrops of an old coralous reef are found in front of the church and along the northern end of the airstrip. There are also limited areas of beach sand on the island including some at the eastern end of the community.

The village currently has a population of about 259 people. It is located on the northern side of the island, near the western end, on a narrow elevated strip or embankment of land between 1.7 and 2.5 m above mean sea-level. This embankment is relatively flat and tends to fall from the shoreline towards the swamp at the rear of the houses. The village is only 0.2 to 0.5 m above the water level in the swamp. Development of the community has, therefore, been restricted to the embankment, resulting in a long strip of 1.7 km with only sufficient width for a roadway and one row of houses at most locations. The narrowest section of this strip of high ground, only the width of the road, is known as Warupudamaizinga ('the point where the turtle and tortoise swapped places'). It is said (Teske 1988) that it was here that a saltwater turtle and a freshwater tortoise decided to exchange living places. However, both animals died. The turtle could not survive in the dry swamps and the tortoise was unable to dive deep enough in the sea for food.

A small tsunami in 1945 caused some beach erosion and flooding of low areas, followed by the abnormally high Spring tide of February 1948, which flooded the entire village to about 10 cm. This event led to a decision to evacuate some of the community to Bamaga on the Cape York Peninsula. A sea wall was started in 1956 to prevent further erosion along the village shore. However, as Saibai has no rocks or stones, all the material had to be brought in by boat from the reefs around the island and the adjacent islands. The same is true today resulting in long delays and high costs of repairing and maintaining the wall.

Changes to the village shoreline over the past 50 years have been dramatic and the Islanders can provide many details of the former position of buildings and trees relative to the retreating shoreline. For example, the large tree in front of the council building, referred to locally as 'Agari dani', now stands on the water's edge. In years past, the edge of the beach was many metres seaward and Saibai's first school, which was built from mangrove timber and woven Nipa palms, stood between the tree and the sea.

Other anecdotal evidence of changes to the local environment include observations of Saibailgaw Maza, a sandbank regarded as the border between Saibai and the New Guinea mainland. It is believed that the sand bar was previously coral but has accreted in recent years to become a more extensive sand bar (Waba Waigana, pers comm). This observation is substantiated by the term *maza* which means coral reef. Furthermore, local reports recall that coral was gathered by canoe from Saibailgaw Maza in the 1920s for the foundations and floor of the local church (Teske 1988). Changes to the natural sand spit, called Moemag, at the northeast end of Saibai have also been observed by the Islanders although there was some inconsistency in the reported direction and rate of change here.

There was little doubt about the nature and extent of changes to the interior swamp environment. The Islanders consistently referred to a progressive shallowing of swamps over living memory and an associated decline in fishing and mollusc collection. Today there are said to be less mangroves in the centre of the swamp and more on the periphery with other swamp grasses coming into the sequence instead. Large parts of the swamp which were previously bare mud are now comparatively well vegetated.

Barham *et al* (1985) suggested that changes to the contemporary ecology of the swamps, particularly die-back in the fringing mangrove habitats, may be part of a longer-term trend of rising swamps associated with sediment input. They also proposed that the current phase of instability may be partly related to the abandonment of the horticultural mound and ditch system around 1945. This abandonment was reputedly followed by an increase in uncontrolled burning of the claylands causing the destruction of coconut palms and other fire-tolerant vegetation which would formerly have provided cover. An acceleration in the rate and extent of vegetation die-back, in more recent years, is widely believed by the Islanders to relate to land use changes, specifically the construction of the airstrip which is discussed below.

Over the next 100 years, sea level has been predicted to rise between 0.5–3.5 m as temperatures rise between 0.5–3.0°C (Hansen *et al* 1988). These changes in temperature and sea level will severely affect the low-lying islands of the Strait, most of which are less than 4 m above mean sea level. More specifically, rising sea levels will result in inundation and fragmentation of islets and islands, salt contamination of low-lying vegetation and compression or contamination of hydrostatic freshwater lenses by rising salt water (Nunn 1990; Pernetta 1990; Sullivan 1990). Warmer temperatures are also predicted to be associated with an increased intensity and frequency of tropical storms and typhoons, as well as changes in atmospheric and oceanic circulation, evapotranspiration, humidity, precipitation, wind and upwelling patterns (Buddemeier & Oberdorfer 1990; McGregor 1990). Changes in the timing of the monsoon season would have serious implications for the continued existence of the extensive swamp environments on Saibai. At present maximum saltwater incursion into the swamp coincides with Wet season rainfall so that salinity is lowest at maximum tidal levels. The occurrence of juvenile fish and high densities of waterfowl is believed to be intimately connected to this annual tidal/salinity flux (Barham & Harris 1985). Any change in the regime would have serious implications for the local Islander community because, although the Islanders are increasingly dependent on the IBIS (Islander Board of Industry & Services) store, seafood is their staple diet.

Land-use activities and their environmental impacts

In August 1988, a *Report of the Interdepartmental Committee on the Torres Strait Islands* acknowledged that 'generally, the standard of infrastructure in the Torres Strait is well below that normally accepted in mainland communities' (O'Rourke 1988, 6.2).

Babbage (1990) suggests that this situation arose partly as a result of neglect, partly as a consequence of a long history of welfare paternalism and partly as a function of the weak local economy. Successive Commonwealth Governments have taken the view that State Governments have prime responsibility for the provision of essential services to all its citizens, including Aborigines and Islanders. In recent years, the Commonwealth has, nevertheless, entered into joint funding arrangements to facilitate accelerated advancement in the provision of basic essential facilities to Aborigines and Islanders living in remote areas, such as the Torres Strait. The Commonwealth has also developed programs of direct funding to Reserve Aboriginal and Islander Councils in an effort to promote greater scope for self-management (O'Rourke 1988).

As a result of initiatives by both the Commonwealth and Queensland Government, substantial investment in community infrastructure in the Torres Strait was made during the 1980s. This included the provision of light earth moving equipment, vehicles for Island Council use, airstrips, community water supplies and funding to enable councils to construct small bridges and stretches of road. The pace of infrastructural development has continued to rise. Following the *Report of the Interdepartmental Committee on the Torres Strait Islands* (O'Rourke 1988), the Department of Aboriginal Affairs made $23 million available over three years under the Priority Community Development Strategy to build and upgrade elements of infrastructure selected in close consultation with the Island Co-ordinating Council, individual island councils and community members. Most of these resources have recently been used to upgrade landing craft unloading facilities, wharfs and sewerage systems.

Some preliminary observations on the impact of two infrastructural developments are reported below. These include the environmental impact of airstrip construction and the more recent upgrading of sea transport unloading facilities. These developments were selected for initial discussion because the scale and associated impact of these operations, which frequently involve excavation and earth moving, blasting, dredging, and land reclamation through filling of wetland and submerged land, is more readily apparent on the landscape than problems associated with, for example, waste management and pollution control.

Airstrip Construction

Most of the inhabited islands in the Strait now have small unpaved airfields suitable for light aircraft operations. The airstrips vary in quality. The sand/grass strips on Coconut and Warraber Islands are well maintained and suitable for all-weather except tropical downpours, whereas the airstrip at Saibai becomes boggy and subject to closure during the monsoons.

The inherently extensive nature of airstrip provision (generally 60 x 800 m) means that their effect is disproportionately greater on small islands than on larger islands or the mainland. Residents of some islands, for example those on Boigu and Murray, suggest that the recent decline in gardening is because the best and most accessible land has been used to build airstrips (Arthur 1991). The airstrips on many of the coral cays extend from one side of the island to the other. On Warraber Island, an elliptical coral cay island, only 2–3 m above mean sea level and less than 750 m wide, the airstrip bisects the island along a northwest/southeast trajectory, providing a potential wind and wave corridor under storm surge conditions. The airstrip on Coconut Island is also orientated northwest/southeast, again creating a direct channel for potential exploitation under storm conditions. Such environmental criteria were apparently outweighed by the desire to avoid cross winds during take off and landing. On Yam Island, where the airstrip is aligned east/west, landing problems associated with prevailing winds are frequently encountered.

Infrastructural developments associated with air transport are also responsible for a deterioration in the aesthetic values of the islands through aircraft noise pollution. Furthermore, the construction of airstrips has been associated with the clearance of coconut palms on Coconut Island, to the extent that the Islanders now joke about the misnomer of their island's name. The destruction of mangroves and infilling of a tidal creek system at Saibai is related to the construction of the airstrip and a drainage culvert, both of which have altered the frequency of tidal inundation of the swamps and impeded drainage. Similarly, on Yam Island, the provision of the airstrip was responsible for a substantial breach in the coastal mangrove belt — one of the most biologically productive of all ecosystems, providing important habitats for fish breeding and nurseries, bird nesting and feeding in addition to protecting the land against winds and waves.

The decision to provide airstrips to most of the inhabited islands was taken on the grounds of significantly improving service and health facilities. From an environmental viewpoint, the Islanders might have been better advised to restrict the provision of airstrips to the larger islands, or to provide only one airstrip for each island group. A pilot project utilising hovercraft was introduced initially but proved unsuited to the local weather conditions. Ferries, such as the arrangement between Horn Island and Thursday Island could have provided the additional inter-island transport system and minimised the adverse impact to the environmental quality of the islands, although this would also have been restricted to certain weather conditions. Another alternative might have been to construct reef runways, as at Keehi (Hawaii), Moen (Truk), and Okat (Kosrae). Apart from the prohibitive cost of such operations, the adverse effects of dredge and fill, associated with this option are severe resulting in the smothering of reef and seagrasses and serious alteration of the local circulation pattern. A more realistic option, which the application of EIS procedures might have provided, would have been a compromise situation whereby some airstrips were aligned differently or constructed at one end of the island(s), rather than centrally.

Sea transport unloading facilities

The islands have also had extensive improvements to their wharf facilities and barge ramps over the past couple of years. Prior to these developments there were few all-weather landing facilities on the outer islands. This seriously complicated shipping operations and meant that nearly all unloading operations were weather and tide dependent. Conventional barge landings at Warraber Island, were particularly difficult due to the raised edge to the reef rim which limited the time available for offloading; the area of beach rock suitable for offloading was also very rough and provided poor access to the village roads; and the crossing time associated with the extensive width of the reef flat further reduced the available offloading time. Due to these time related constraints, landings were normally achieved by beaching the barge on one tide, offloading at low tide and leaving on the next high tide. Similar problems were experienced on Yam and Coconut Islands, while at Saibai Island the extensive mud flats in front of the village beach severely impeded landings and curtailed effective operations to the few hours either side of high tide.

Selection of the location of the new or improved barge ramp sites was generally determined by the location of shortest distance to deep water; availability of space for offloading; access to village; relative shelter from the north-westerly waves; and avoidance of zones of dynamic sediment movement (Edmiston & Taylor 1991). The precise nature of the ramp improvements varied between the different islands, but generally involved dredging of an access channel through the surrounding reef flat linking the shoreline with the deeper water off the reef edge. As the construction work on the ramps was carried out as recently as the dry season of 1991, it is too early to provide a comprehensive assessment of the impact of these structures on the local environment. However, Carpenter & Maragos (1989) suggest that the most common environmental impacts in tropical island areas associated with such developments include:

(i) degradation of water quality in the basin and berthing areas;

(ii) erosion of adjacent beaches and lands due to changed current and wave regimes attributed to the harbour structures;

(iii) inadequate safety due to channels too narrow, too shallow, or inadequately marked;

(iv) the unforeseen need for costly maintenance such as dredging and repair of protective structures; and

(v) ecological impacts from dredging, blasting, and filling.

The ecological guidelines developed by the IUCN (McEachern & Towle 1974) state categorically that 'inshore dredging may seriously disrupt, degrade or destroy complex, diverse and highly productive biotic communities of the littoral and sublittoral zones of island ecosystems.' The consulting engineers responsible for the work were aware of potential threats to the stability of the coral cay islands induced by the removal of local sand and beach rock outcrops. They state in their 'Infrastructural Development Plans' for Warraber Island that the design of the landing facility must, therefore, depend on fill material and armour rocks derived from the reef flat (Edmiston & Taylor 1991). There can be little doubt that the removal of this material will result in adverse impacts to the local hydrological, sedimentological and ecological regime, particularly at Warraber Island where the ramp site is located within the shallow lagoon of the northern reef flat.

The issue here is a complex one in that the socio-economic benefits of this particular development could well be considered to outweigh the environmental costs. The need for improved delivery service is obvious to anyone who spends time on these islands. The IBIS stores are totally dependant on barge deliveries and the irregularity and inefficiency of delivery is largely responsible for the poor nutrition of the Islanders arising from a limited and an unbalanced diet. Often store managers and CDEP (Community Development Employment Projects) workers are required to work through the night unloading the barge under high tide conditions. Unfortunately, however, during my recent visit to Warraber island where the recently improved ramp facilities had removed the dependence of barge landings on tidal stage, the IBIS barge arrived at 3 am, requiring the Islanders to get up and unload through the night. Similarly on Yorke Island, barge landings continue to be made throughout the night, more often availing of the old high tide landing facility than the newly constructed ramp structure. This situation reflects either a disregard for the local people which renders their ramp improvements pointless or it suggests a time lag in the adjustment of the scheduling of the barge company to the recently improved circumstances of the islands.

Even if the socio-economic justification for these improvements to the sea transport facilities is accepted, much could have been done to reduce the environmental disruption which will and, indeed, is already apparent as a result of them. Firstly, while some consideration was given to the coastal geomorphic processes operating on and adjacent to the islands (Edmiston & Taylor 1991), the final decision was determined largely by economic factors, such as the relative cost saving associated with dredging access channels at the location of shortest distance between the shoreline and the reef edge, or the apparent advantage of locating the ramp within easy access to the IBIS store and village. Such considerations may have much to recommend them in the short term but in the long term it will invariably be the ramp location and design that is most closely attuned to the local hydrological and sedimentary dynamics of the system that will prove to be most cost-effective and efficient.

A second important issue related to the recent improvements in ramp facilities is that of the disposal of coral aggregate excavated from the dredged access channels. Land disposal of dredged materials eliminates significant impacts to the marine ecosystem. However, on an island system such as Warraber Island, which is no more than 1 400 m long by 750 m wide, the location of spoil sites is a particularly important consideration associated with the loss of proportionately large tracts of limited land and resources. The associated decline in the aesthetic value of environmental quality is strikingly apparent as one flies over these islands. The ecological and cultural impacts are more difficult to identify but it seems likely that an extensive area of spoil would prevent or reduce the amount of groundwater percolation and thereby lead to changes in the freshwater lens. The spoil heap also covered an excellent sequence of Holocene beach ridges, a valuable record of coastal changes.

The decision to dump some of the excavated material along the high tide mark of the foreshore is one of the most disturbing aspects of the recent ramp improvement project as it not only reflects a lack of understanding of the natural dynamics of these environments but it also points to the failure of government bodies to consult effectively with the local people. The dumping of coral conglomerates and mud, which solidifies on exposure, along the foreshore adjacent to the village on Coconut Island is not only unsightly, it has made access onto the beach difficult, if not extremely dangerous, and it will serve little purpose against the ravages of the northwesterlies. Some local Islanders, in typically good humoured response, simply laugh at this useless beach remedial effort recognising in December 1991 that much of the material dumped along the high tide line would be strewn across the reef flat after the first monsoon season, leaving a lag deposit of the larger coral slabs across the foreshore.

A further example of the insensitivity displayed by the developers was revealed when I remarked upon the existence of a large unvegetated area along the backshore environment at the eastern end of Coconut Island, an area which is especially dynamic and sensitive to change. Apparently this was the site cleared and utilised as a camp site by the construction workers during their time on the island. Coconut palms had been cut down and all other vegetation was removed by camp fires or trampling leaving a large area of bare sand exposed for deflation by the subsequent monsoon season. No effort had been made to restore the area prior to their departure and no compensation was awarded to the local people for the disturbance caused to their environment.

Local environmental disruption

There are many examples of environmental intervention by the Islanders themselves. One commendable example is the dune stabilisation works under taken by the Island Council on Coconut Island. The remedial measures employed there represent an effective natural solution to a natural problem.

Less commendable, however, is the habit of dumping domestic rubbish, litter and old vehicles along the high-tide line. Similarly, as more and more diesel oil is required by the communities to fuel vehicles and backup power facilities, the risk of pollution will escalate accordingly. Concerns over the potential risks of a major oil spill from international shipping and offshore PNG oilwells are well voiced within the Strait. However, given that chronic, operational small spills from shipping and handling of oil account for more than 70% of oil in the marine environment, while dramatic, large accidental spills contribute less than 10% (Carpenter & Maragos 1989), the environmental problems specific to local fuel consumption and energy development should be carefully assessed and planned for.

Severe degradation of the foreshore and backshore environments of the coastal zone is directly related to the increasing use of tractors and motorbikes in these sensitive areas. Such activity disturbs existing vegetation and retards or prevents the recolonisation of vegetation, compacts the sediment making it unavailable for wind transport, and, most significantly, encourages the development of large gaps or breaches in the upper beach/dune ridge which permit a net loss inland of sediment out of the normal beach/dune sediment exchange system and may develop into extensive blowouts.

Prospects, principles and processes

The Torres Strait illustrates the confined space, conflicting pressures and unforeseen costs of development which are the lot of most indigenous peoples in the world today. Unlike many such peoples, however, the Islanders have a local and regional voice, and their leaders have begun to think in terms of a comprehensive approach to environment and development for the future. The 'Principles and Objectives', promulgated in May 1991, have environmental management at their centre, but they also include social, economic, cultural, proprietary and self-government needs. Many recent parliamentary and official reports in Australia have emphasised the need for comprehensive coastal zone management of the type urged by the Islanders. Yet the Islanders have had no positive response to their proposals. The Torres Strait Islanders are now beginning to look to constitutional and other higher-order remedies to their problems as appropriate departments of government fail to respond to their needs and proposals. The experience of other 'first world' indigenous peoples indicates that this may be their only effective course (Jull 1991).

Principles for environmental management

In recognition of the increasing influence of economic development on the region, a set of guidelines is proposed here as the basis for the planning and execution of economic development. These are intended to assist planners and decision-makers in weighing alternatives and thereby prove useful in minimising the negative impacts of development and protecting the intrinsic amenities and the biological integrity of the islands as both a human and natural habitat.

Ecological objectives are best achieved if guidelines form an integral part of overall development planning and are for this reason most effectively employed at the pre-investment stage when decision-makers are most amenable to considering the environmental consequences of a range of possible options of development and resource allocation. Unfortunately, in the case of the Torres Strait many infrastructural developments are already in place or underway and the application of guidelines is more difficult and less rewarding at this stage for two reasons. Firstly, options for future land-use are already limited and secondly, because large amounts of capital have been committed, present usage patterns are often irreversible. Nevertheless, development is at a relatively early stage and guidelines can still be useful in planning future development projects, such as the proposed improvements in sewage disposal and treatment, as part of the Priority Community Development Strategy. Guidelines can also be useful in repairing past damage. Indeed the scope for environmental rehabilitation and restoration in the Torres Strait should not be underestimated.

Furthermore, it should be recognised that while principles and guidelines cannot always control the forces of change they can assist in mitigating the deleterious impact of many changes. For example, there is little that can be done in the geographically isolated region of the Torres Strait to turn back the rising tides associated with global warming. However, there is much that can be done to accommodate the likely impact of such changes by planning for them now.

The application of the concept of an 'island system', as recommended by the IUCN (McEachern & Towle 1974), will provide a useful framework and methodological tool in environmental planning and management within the Torres Strait. The concept applies to individual islands as well as to multi-island groups and their associated socio-economic and biological systems and is relevant in several respects (McEachern & Towle 1974, 12):

(i) it affirms that an island is not an homogeneous discrete entity, but from its highest point above sea level to the edge of its submarine shelf is in continuous interaction with the surrounding air and water;

(ii) it stresses the interdependence of island ecosystems; impacts on one will have repercussions in another, and although the extent of each will seldom conform to political boundaries or even to such convenient geophysical divisions as 'land' or 'sea', it is important to have some perception of each individual island's relationship to and within any island group; and

(iii) it allows a biocybernetic view of island growth and development, in which multiple feedback phenomena from effect-to-cause can be considered in addition to the customary cause-to-effect relationships.

The primary value of the 'island system' framework is in highlighting the need for a more comprehensive, integrated development approach rather than the narrow sectoral approach of traditional planning activity. By recognising sequential or causal links between specific parts of an activity and its effects, environmental managers may enhance opportunities for meaningful assessment and mitigation.

Environmental parameters

A number of general environmental parameters were identified during a brief period of field reconnaissance in the Strait. These parameters arise from complex interactions between local site conditions and the processes operating. They should be given prime consideration in land use decision-making.

(i) Interaction between shore and nearshore processes is contingent on varying storm frequencies and tides associated with the northwest monsoon of the Wet season and the southeast trades of the Dry. Seasonal movement of sediment associated with sediment removal under northwesterly storms and the return drift effect of the southeasterlies must be accommodated in developments along the coastal and nearshore zone. Clearance of northwest/southeast aligned corridors should be avoided.

(ii) The vulnerability of certain low-lying areas to high winds and storm surge events leads to flooding and saltwater inundation. The susceptibility of the island systems to coastal change must be acknowledged and planned for in all land-use decisions. Development should be avoided in unstable coastal zones. In particular, interference at or immediately alongshore of the dynamic distal ends of the coral cay islands is not recommended.

(iii) Nearshore currents and other physical oceanographic characteristics and processes should be assessed so that the likely effect of physical structures on processes such as shoaling and shoreline erosion can be established. The construction of solid structures which interrupt sediment drift and encourage leeward deposition and windward erosion should be discouraged. The construction of ramp facilities in areas of seasonal longshore and beach drift increases the likelihood of sediment infilling and siltation.

(iv) The composition and stability of beaches adjacent to ramp or wharf developments, as well as related coastal berm and dune formations, should be assessed in relation to possible shoreline erosion and accretion impacts. Unless groins and breakwaters are properly designed and located, they can cause more shoreline erosion problems than they solve. Structures such as harbours and landfills projecting offshore can inadvertently act as groins, causing shoreline accretion and erosion on updrift and downdrift sides of the structure, respectively.

(v) Modification of the shoreline and nearshore submerged lands by dredging and filling activities results in the destruction, by removal or smothering, of benthic habitats and lifeforms such as coral reefs and their associated fauna (Carpenter & Maragos 1989). Additional direct effects of dredge-and-fill operations include the generation of turbidity plumes and crushing of shallow reef communities by heavy equipment. Dredging, filling and other physical changes to habitats in the tropics have also been implicated as causes for the increased incidence and outbreaks of ciguatera fish poisoning (Carpenter & Maragos 1989). The poisoning is caused by a toxic dinoflagellate *Gambierdiscus toxicus* growing on macroscopic algae, which are eventually consumed by fish. The herbivores are eaten by carnivorous fish with the toxin passed up the food chain. Although mildly toxic to fish, ciguatera is severely toxic to mammals, including humans.

(vi) The use of beach/dune stabilising vegetation should be encouraged in preference to engineering structures.

(vii) The removal of natural sediment traps, such as mangrove or dune vegetation, should be avoided. Where land clearing is considered necessary, revegetation should occur as soon as possible. The visual impact of stockpiles of dredged material could be mitigated by planting vegetation.

(viii) Changes in reef and island geomorphology can greatly affect the size, location, recharge and flow patterns of groundwater supplies. Coastal erosion will have severe impacts on groundwater resources as decreases of island width will affect freshwater volumes semi-exponentially (Connell & Roy 1990).

(ix) The impact of all stages of the development project must be considered and planned for, from the construction stage impacts to the long-term suitability of the project under conditions anticipated to accompany global warming-generated climate change and projected sea level rise.

(x) The impact of a particular development may be manifest in subtle and indirect forms as well as in more obvious, direct ways. The response to a particular force of change is not necessarily linear either in time or in space.

(xi) To go against the natural functioning of the environment is, in the long term, a waste of both time and money.

It was mentioned above that ecological guidelines are most effectively applied at the planning and appraisal stages of a project. The development of tourism in the Strait would provide an ideal opportunity to 'get it right' in terms of exploiting the region or at least parts of it as a marketable tourist destiny without compromising the quality of the natural environment, the life-styles of the local inhabitants or the amenity attracting tourists in the first place.

The potential for tourism development is generally dependent on the ease and cost of access, scenic beauty, activity opportunities, and cultural attractions. The cost of air transport to and between the islands of the Torres Strait is a major limiting factor especially when compared with the Great Barrier Reef islands which have similar natural attractions. Activities such as snorkelling, fishing, bird watching and diving have much appeal but again these are not unique to the region and the winter tourist season coincides with a time of rough and dangerous seas in the Strait. An additional constraint is that many Islanders would prefer development to take place at some distance from their community village or on uninhabited islands (Arthur 1991). Such developments are likely to exacerbate existing problems with infrastructure and services, particularly in relation to potable water supplies, electrical power and modern plumbing.

Despite environmental limitations and the potential for intrusion on the lifestyles of the communities, the Islanders believe that it is only a matter of time before outside investors move in (*Torres News*, 5–11 July 1991, 1, 5). The Aboriginal Development Commission identified three strategies for tourism development, exclusive high cost/high standard tourist complexes, medium standard activity-oriented developments, and wildlife-based developments (O'Rourke 1988). A joint-venture approach between Islanders and major tourist operators was recommended as the most appropriate option in terms of effective control and efficient management (O'Rourke 1988).

Several pilot projects are presently under consideration. For example, Yorke Island Council is exploring the possibility of building a small exclusive resort, restricted to four to six tourists at a time, on the west side of the island away from the main village. The council at Kubin Village on Moa Island are also planning to build a small tourist development for about 50 people and a similar pilot project is presently under consideration on Warraber Island (*Torres News*, 5–11 July 1991, 1, 5).

The potential for the development of eco-tourism in the region has much to recommend it. This approach is generally compatible with the objectives of environmental protection and cultural resource management and could do much to foster the preservation of the unique ecological and cultural attributes of the region. At present the only cultural sites included on the National Estate Register are Possession Island, the church on Darnley Island and the Japanese Cemetery on Thursday Island. Midden sites, such as those excavated at Woam on Saibai Island, should be included. The relict horticultural mound and ditch system on Saibai is also worthy of a high level of preservation and some research. Similarly, local artifacts could be displayed and traditional crafts and skills encouraged. In this way the development of a small and sensitive tourist industry could do much to highlight the significance of the region and further initiatives aimed at the conservation and management of this unique environment and its associated resources.

Socio-economic considerations

To be credible, ecological guidelines for a specific development project must consider the socio-economic benefits that will accrue to an island from specific land-use activities and balance these against the importance and magnitude of the adverse impacts.

Many environmentalists maintain that lands of indigenous peoples should remain frozen in their 'natural' state, free from the technological developments of the twentieth century. Certainly many by-products of developments associated with tourism, extractive industries, and air and steamship transport can lead to a dramatic deterioration of the physical environment and ultimately to a decline in the quality of life experienced by the Islanders. But this need not always be the case.

Since the advent of the concept of 'ecologically sustainable development', widely promulgated by the United Nations' Brundtland Report and published as *Our Common Future* (World Commission on Environment and Development 1987), there now exists a very real means of incorporating the long-term requirements of the environment into development projects. This is the only way forward for these indigenous peoples who are demanding some changes and the benefits of modernisation. The impact of colonialism, of national and international interests has resulted in trade restrictions, demarcation of boundaries, changes in technology and the whole basis of the local subsistence economy such that the Islanders no longer have the option of continuing their traditional lifestyles and conservation methods. Change and adaptation to the circumstances imposed upon them is as inevitable as it is necessary.

Following the recommendation of Gray (1991), the development of an appropriate set ecological principles and guidelines must start from the position of the Islanders and take a 'social ecological' perspective on their development and environmental issues. To do this is not to condone all forms of economic development but a practical acknowledgement of the reality of the present situation. A situation where modernisation of island communities is already underway. To be of real value, the approach must be one which above all recognises the right of the Islanders to make decisions about their own future and the future of generations to come.

Cultural context

Ecological guidelines must be sensitive to the cultural context of the Torres Strait because the basis of many land-use decisions is intimately connected with local tradition, customs and beliefs, and cannot be explained by environmental criteria alone. For example, the decision by the Islanders to move from the islands of Tudu and Gabba and establish permanent settlement on Yam Island was not based simply upon ecological principles, such as the relative availability of groundwater supplies or access to resources. It arose from the belief that Tudu Island was cursed by a local priest following the resistance of the Islanders to the new religion of the London Missionary Society. Similar stories of '*purri purri*' (make bad magic against) are said to explain the desertion of Gabba Island and several others (Teske 1987).

Traditional knowledge

Current improvements in service and infrastructure developments should recognise that there is still a valuable role to be filled by traditional practices and methods. Traditional ways have evolved over time and are in many ways more finely attuned to the local circumstances and peculiarities of the individual islands. Equally, many forms of modernity offer positive changes to the quality of Islander life. Real progress can only be measured in terms of the achievement of both sustainable development and minimal environmental disturbance — a combination of both traditional knowledge and modern methods may provide the most effective means to this end.

Consider the example of water provision — probably the single greatest problem experienced by the Islanders. In the past, local supplies of drinking water were primarily dependent on the freshwater lens which underlies each island system. Generally the extent of basal groundwater or Ghyben-Herzberg lenses is proportional to the size of the island (Manner 1990). Over-exploitation of this lens is a common occurrence on tropical islands, resulting in the evacuation of half of the Coconut Island community to Warraber Island in the 1940s. These days, the Islanders use fibreglass tanks to collect rainwater but if the rains fail this system is even more unreliable than the traditional approach. During a recent visit to Saibai Island (December 1991), it was interesting that the old dugout wells of Mag and Meth (exploiting a perched water table, dug to the limestone reef surface at 4.5 m) still contained water at the end of the dry season when all other supplies had been used up. This water was suitable only for washing because the wells are now used as watering holes by native deer which swim across from the Papua mainland. However, the Council is considering plans to fence them off again, acknowledging that a combination of modern technology with traditional methods is often the best approach to adopt.

There are other examples which illustrate the important contribution traditional practices continue to make to contemporary Islander life. The older style Saibai house has a raised timber floor, woven walls and a corrugated iron roof, adapted to the tropical heat and local flooding regime, and flexible to change if change is required. In contrast, many of the more recent housing developments are ground level pre-fabricated cottages subject to periodic flooding because the Government considers the cost involved in constructing elevated houses to be prohibitive. The remoteness of the region and difficulties of transport certainly make housing costs very high but again the short term financial saving must be balanced against the longer-term suitability of the housing design.

Apart from the obvious environmental impacts associated with the developments described above, an additional and equally serious consideration is the trend towards an increasing homogeneity among the different islands. In the past the Islanders manipulated and adapted to the circumstances and resources of their local environment. At Saibai, the Islanders converted part of a mosquito-infested wasteland into an elaborate mound and ditch horticultural system capable of maintaining drainage and retaining moisture during the Wet and Dry seasons, respectively. This field system is now relict but it provides a vital cultural connection to New Guinea where similar water-control systems were used extensively for 9 000 years (Golson 1972).

The distinctiveness of such features as the local building fabric and architectural design is also being replaced through the application of a standard package of infrastructural developments with little effort being made to encourage or maximise on the inherent local variability, both physical and cultural, of the different island systems and communities.

Several workshops, conferences and papers have focused on various aspects of traditional environmental knowledge (eg Ruddle & Johannes 1985; Gray & Zann 1985). The importance of preserving traditional environmental knowledge has been well acknowledged but the means of integrating that knowledge effectively into sustainable resource management systems appropriate to the present day is less clear. The development of the sophisticated mound and ditch system at Saibai illustrates the richness of traditional heritage and reflects an intimate knowledge of the local variability and repetition of natural phenomena. Other examples of traditional knowledge include the Islanders' intimate understanding of the surrounding sea and shelf (Nietschmann 1985). The concept of customary marine tenure is a particularly valuable marine conservation measure. Traditionally many nearshore water areas were owned or policed through native customs and tenure (Cordell 1992), thereby avoiding problems associated with unlimited free access to limited resources (cf. Hardin 1968). Today, these controls have been destroyed or weakened with the result that more and more reef, lagoon, seagrass and mangrove flats are being exploited. The recent expansion in the population of Islander communities has also undermined the potential of the traditional customary marine tenure system, with larger and larger family groups competing for the ownership and use of limited land units.

But even if we acknowledge the value of many of these past practices, we must also recognise some limitations (cf. Head 1990). Traditional methods or materials were not always more durable or more conducive to conservation than modern alternatives, and the Islanders, increasingly exposed to a market economy, now seek more efficient, labour saving and cost effective methods regardless of tradition or custom. It would be unfair for us to romanticise about past ecological relations between these people and their environment. A more positive approach would be to develop guidelines which might bridge the gap between economic development and tradition resource management systems — a gap which is rapidly eroding the confidence and viability of many indigenous Islander communities.

Population thresholds

Ecological guidelines can provide useful ways of mitigating the adverse impacts of development and thereby protect the quality of the lives of the local people. However, one factor can compromise the aesthetic, cultural and ecological values of environmental quality and render the most comprehensive of resource management plans useless. That is, excessive human population densities. At present an estimated 6,245 Islanders reside on 16 of the Strait's 150 islands (Arthur 1990). These islands are currently experiencing annual growth rates in population of more than 1.5%, with an average of two dwellings being constructed annually on each inhabited island. The establishment of what Beckett (1987) has called 'welfare colonialism' has eliminated the dependency on local resources and hence the apparent need to control population numbers. Improvements in medical facilities have also done much to increase the life expectancy of the Islanders. Furthermore there are early indications of a return migration of many Islanders from mainland Australia, where approximately 15 300 Islanders currently reside (Arthur 1991). This is due to a combination of improved island conditions and lifestyle and a down-turn in the mainland economy. But the island system is limited and vulnerable. It is in the interest of the quality of the environment and of its inhabitants that any ecological guidelines adhering to the concept of sustainable development place an effective ceiling on permanent and transient human populations.

Islander consultation

The intense interest and concern felt by Islanders in respect of environmental change and its attendant dangers, as well as their many valuable insights and knowledge of the past, make a consultation and communication component of any development project or study essential. One of the local issues most keenly felt is the lack of information Islanders receive from research and official bodies. Where information is available it is frequently in a format or style not readily accessible by the Islanders. Such omissions and failures poison the atmosphere for consultation, communication and research as a whole. It is desirable to work with the local people closely, the more so as they will ultimately be responsible in large part for the implementation and effectiveness of environmental solutions!

Conclusion

Much literature is presently available on the general theme of development and conservation in relation to indigenous communities but few comprehensive working examples exist. Similarly, any number of recent federal studies in Australia have identified coastal zone management and ecologically sustainable development as a priority, but tangible action has been slow.

The Torres Strait Islanders are actively seeking assistance to come to terms with these issues, proposing that a regional ecologically sustainable development strategy be developed for the Strait with marine and coastal ecosystems at its centre. This sort of initiative deserves the full support of senior governments but to date the response has been anything but positive.

It is ironic that indigenous Islanders should be amongst the first in Australia to take up the challenge of ecologically sustainable development and do so within the framework of a modern industrial state's political, administrative and legal framework. While we refuse to recognise officially the territories and legal rights of these inhabitants, they are taking responsibility for managing and protecting this remote region from the effects of our stewardship.

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