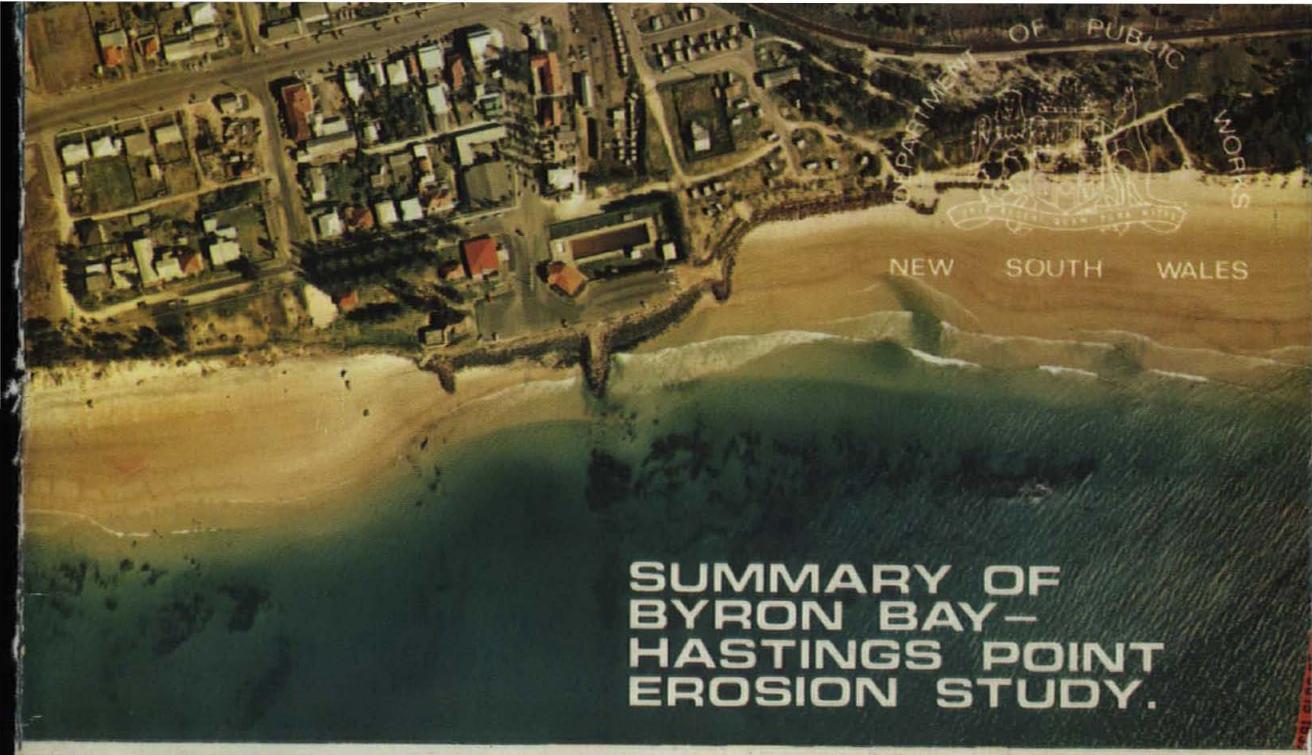


SUMMARY OF BYRON BAY– HASTINGS POINT EROSION STUDY.

N.S.W. DEPARTMENT OF PUBLIC WORKS.

V. E. ZVIRBULIS
PROJECT MANAGER
WATERWAYS PROGRAM

Minister for Public Works and Ports
New South Wales

This booklet contains a summary of the findings of the Byron Bay—Hastings Point Erosion Study. The study represents two years work by a multidisciplinary team of coastal experts and has succeeded in identifying and quantifying the causes of coastal erosion in the Byron Bay—Hastings Point region.

Possible management strategies are presented herein for public discussion prior to the implementation of a firm management policy. It is our belief that any such policy should be dependent not only on the Engineering and Economic criterion but also on a consideration of the Social and Environmental implications in this region.

It is hoped that the information in this booklet will provide an understanding of the scale and nature of the erosion problem in the Byron Bay—Hastings Point Region and will ultimately result in a rationalised management plan for the area which is acceptable to the local residents.

L.J. FERGUSON
Deputy Premier and
Minister for Public Works and Ports

FOREWORD

The Byron Bay Hastings Point Erosion Study was set up with the prime objective of gaining an understanding of the coastal processes governing erosion in the region. The full results of this investigation are presented in Department of Public Works, Coastal Engineering Branch Report No. PWD 78026, November 1978, which is available from offices of the Public Works Department.

Due to the size and complexity of the report it was decided to issue a smaller booklet containing a summary of the major findings of the study for wider local distribution.

Also included are the viable management options for the region. These are presented for public examination prior to the adoption of a firm management plan for the area.

Interested members of the public or local bodies are invited to submit comments in writing on the management options outlined in the study by the 6th April, 1979, to:

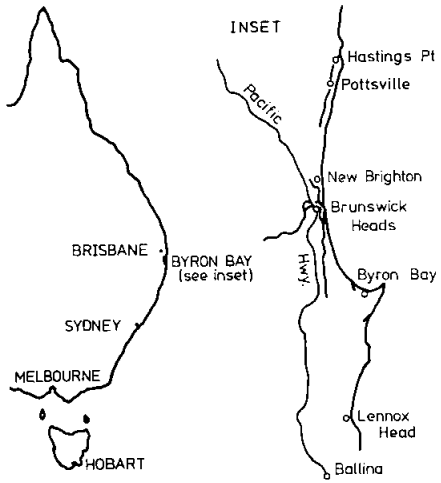
The District Engineer,
N.S.W. Department of Public Works,
186 Mollesworth Street,
Lismore 2480.

CONTENTS

REGIONAL SETTING

The rugged cliffs of Cape Byron, the most easterly point on the Australian mainland, form a geomorphological feature which dominates the local coastline.

To the north, a ribbon like beach of white quartzose sand delineates the boundary between land and sea. At the northern end of this shallow embayment lies the less austere rock outcrop of Hastings Point.



LOCALITY SKETCH

Apart from the two creeks; the Belongil which only flows intermittently and the Mooball whose entrance is maintained by training walls, the 30 km beach is only cut by one major feature; the Brunswick River. This river is of economic significance to the region in that it provides shelter to a fishing fleet and attracts water-sport oriented tourists.

The township of Byron Bay has a long and interesting history of development which has seen its fortunes rise and fall on a number of occasions.

Its remoteness from the major population centres of Sydney, and Brisbane has meant that much of the natural beauty associated with the beaches, coastal plains and heavily timbered mountain ranges of the hinterland, has been retained.

The tranquility and stability of the area is however under threat from a natural sediment imbalance which exists in the coastal process system. This imbalance is giving rise to a slow but insidious loss of sand which manifests itself as a landward movement of the shoreline; that is, beach erosion.

BACKGROUND INFORMATION

On the 15th May 1770 Captain Cook sighted a "tolerable high point of land" and named it after John Byron, grand father of the poet Lord Byron.

During the eighteen forties, the large stands of cedar in the northern N.S.W. coastal region attracted the attention of Sydney based timber merchants who subsequently fostered the early development of the area.

The 'cedar-getters' initially worked from the Brunswick River; the river being used to transport the logs to the coast where they were then hauled through the surf to waiting ships.

Within ten years squatters moved onto the coastal plains and by 1862 they were beginning to be replaced by selectors; persons who were legally entitled to occupy freehold land. The coming of the squatters saw the first serious attempt at farming and cattle raising.

The local economy strengthened in the 1870's with the discovery that gold could be extracted from the beach sands and many people were attracted to the area in the hope of making a quick profit.

A substantial timber jetty which was constructed in 1888 by the Public Works Department pointed to the regions growing importance as a commercial centre. With the advent of this port facility much of the trade of the far north coast was conducted through Byron Bay or Cavanba, as it was then known.

By 1890 it was apparent that the operation of the local dairy industry should be rationalised in order to take full advantage of the world markets which had been opened up by the improved transportation situation. To this end, and to minimise the variability of the milk quality, a co-operative venture was undertaken. Norco commenced operations in 1895 and was such a success that by 1909 it had expanded to Lismore and Murwillumbah.

In 1913 the Byron Bay Co-operative Canning and Freezing Company Ltd. was opened on the present meatworks site, however it immediately ran at a loss and was forced to close after a very short period of operation.

Both the North Coast Steam Navigation company and the local fishermen were heavy users of the jetty facility and so when it became unservicable, pressure was brought to bear to replace it. The new jetty was opened in 1928 and in the same year Norco bought the old canning works and leased them to A.W.

Andersons. Andersons later purchased the factory and expanded its operations.

Mining of beach sands re-commenced in the 1930's but this time zircon and rutile were the minerals of interest, rather than gold.

In 1945 the Byron Bay Fishermans Co-operative was formed. The fishing fleet used the jetty facility for loading and unloading operations and, during extreme storms, large cargo cranes were used to lift the fleet onto the jetty, out of the reach of the waves. This method of operation was not particularly successful and the industry suffered severe setbacks with the loss of 6 boats in 1948, 15 boats in 1952 and 26 boats in 1954.

The February 1954 storm destroyed the seaward end of the jetty and with the north coast railway now providing an alternative method of conveying produce to the markets, it was not considered worthwhile to repair the damage.

The undamaged section of the jetty was pressed back into service and in the same year Byron Bay became a bay whaling station for the catching and processing of humpback whales. The quota for the station was 150 killings per year but by 1962, the lack of whales and the heavy overseas competition forced its closure.

By this time the dairy industry on the north coast was also having some difficulties and in 1963 Norco moved its head office to Lismore. Shortly after this the Byron Bay factory was closed altogether.

With the loss of the jetty at Byron Bay, the fishing fleet moved to Brunswick Heads. The fickle nature of the Brunswick River entrance with its complex sand shoals and offshore bars had led to the loss of many vessels since the earliest times of development. Hence it became necessary to carry out extensive river training works in order to make the river more suitable for the successful operation of the fishing fleet.

In late 1960, construction of the Brunswick breakwaters marked the start of a major initiative to provide a workable fishing port in the region.

The economy of Byron Bay suffered a near fatal blow in 1967 when adverse market conditions caused a closure of the meatworks forcing more than two hundred men out of work.

A rapidly rising demand situation in the meat industry the following year however saved the situation when F.J. Walker Pty. Ltd. took over the factory and recommenced operations. Walkers, aware of the fluctuating nature of the meat industry successfully undertook a diversification programme and were

INSIDE THE BRUNSWICK RIVER, 1860.
Pictured is the "Emma" constructed at Brunswick Heads in 1851. Prior to the entrance improvement works in 1960, the treacherous entrance bar was responsible for many wrecks.

BRUNSWICK RIVER ENTRANCE, 1955.
Prior to construction of the breakwaters, the exposed rock reef at the entrance was already causing realignment of the beach in the Sheltering Palms region.

BRUNSWICK RIVER ENTRANCE, 1962.
On completion of the breakwaters, sand bypassing of the entrance across the entrance bar commenced immediately. The realignment of the beach to the south is complete.

THE WRECK OF THE WOLLONGBAR, BYRON BAY, 1921.

The "Wollongbar", the pride of the North Coast Steam Navigation Company, carried on trade between Byron Bay and Sydney on a weekly basis. She was driven up on the beach during a storm in 1921, and the wreckage may still be seen in front of the swimming pool at low tide.

THE SECOND JETTY AT BYRON BAY, CONSTRUCTED IN 1928.

The original Byron Bay Jetty constructed in 1888 became unsafe and was replaced by the new jetty in 1928. The fishing fleet which worked from Byron was lifted onto the jetty by cranes for protection during severe storms. On occasions damage to fishing boats did still occur.

DAMAGE TO JETTY AT BYRON BAY, 1954.

Byron Bay's days as a trading port came to an end when the jetty was destroyed during storms in February 1954. Twenty-six fishing boats were destroyed and the Fishermen's Co-op moved to Brunswick Heads. Subsequently the jetty was shortened and used in conjunction with the whaling station. When whaling operations ceased in 1962 the jetty fell into a state of disrepair and was eventually removed in 1972.

able to expand the factory so that it now employs some 400 people.

Mineral sand extraction reached its peak in the period 1963 to 1969 with two companies, Cudgen RZ and Associated Minerals Consolidated Ltd. dominating the activity.

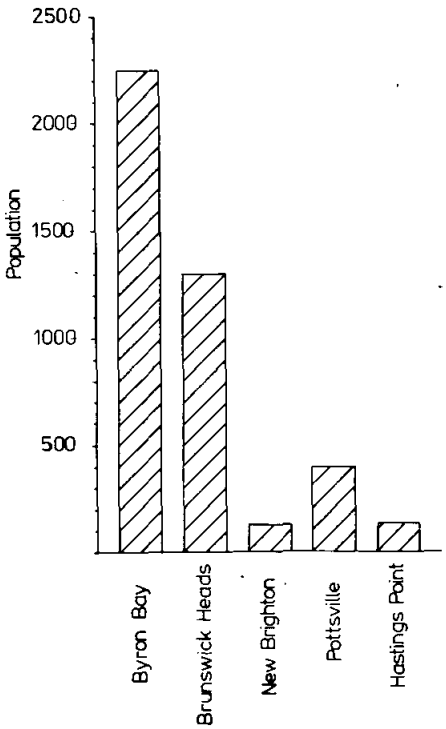
The success of the meatworks, fishing industry and mineral extraction companies in the late 1960's, combined with a sharp increase in tourist activity created an atmosphere conducive to large scale investment. The Ocean Shores Development at Brunswick Heads and the Globetrotters Leisure Village at Byron Bay testify to this time of prosperity and business confidence.

As economic conditions in Australia began to reflect the world wide down-turn of the 1970's, rapidly expanding areas such as Byron Bay and Brunswick Heads experienced a sudden withdrawal of private investment.

Mineral extraction became uneconomic, meat and fish prices stabilised and then fell, and development projects ground to a halt.

At about the same time the erosion of the shoreline reached the first row of houses. Cyclones and storm activity in the early 1970's began to claim houses; the loss of Sheltering Palms Village provided the community with a vivid insight into the problems they may face in the future.

At present the meatworks dominates the regional economy with an annual turnover of $10,000,000. The Byron Bay-Hastings Point Region has a combined turnover of some $30,000,000 however much of this money has been brought to the district by the meatworks and the tourist industry.



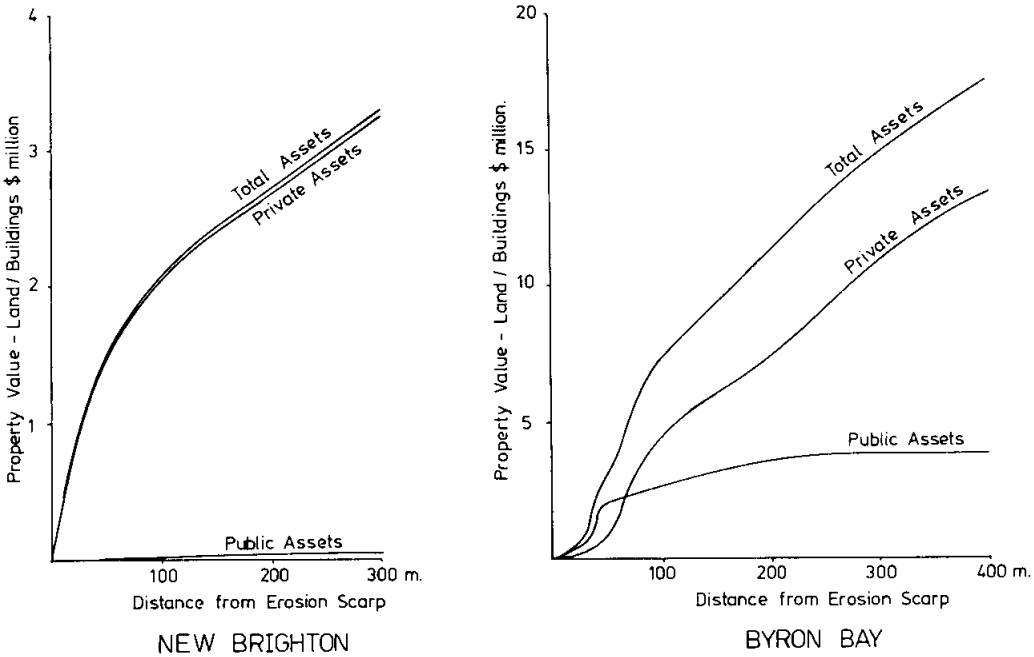
POPULATION DISTRIBUTION BYRON BAY TO HASTINGS POINT

With mineral extraction almost non-existent and a relatively stable fishing industry worth $1,000,000 per year, the major economic growth area is tourism.

The importance of this new industry can be appreciated when it is realised that some $5,000.000 flowed into the area from this source during 1977-1978.

Problems associated with the changing nature of the economic base are matched by the social stresses induced by the markedly different origins of the people presently residing in the area. These range from long established rural based families through fishermen, meat industry workers, developers commercial operators, retired people and the so-called "alternative life style" groups — the people who have chosen to escape from city living.

But it is the longterm erosion of the coastal beaches which will pose the major problem. It is now apparent that both the economic viability and the very nature of the area may be changed unless a concerted effort is made to develop a rational management stategy aimed at allowing man and the natural system to co-exist.



PROPERTY VALUES AS A FUNCTION OF DISTANCE FROM 1977 EROSION SCARP

SHELTERING PALMS, 9TH JULY 1975

FORESHORE EROSION

Although evidence indicates that erosion of the Byron Bay to Hastings Point foreshores has been occurring for the last 3,000 to 6,000 years, and available records show it has been prevalent for the last 100 years, it has only been perceived as a problem in this region following the cyclones of the 1960's.

Shoreline fluctuations are not a problem in a totally natural environment; they are common place and merely reflect the dynamic nature of coastal systems. When such movements affect areas which are perceived by man to be of value, either as natural eco-systems or because they are the site of tangible assets such as buildings, a "beach erosion problem" is seen to exist.

The term 'beach erosion' is itself misleading. During storm events, sand located on the beach berm moves offshore to form bars and, subsequently, moves back onshore during favourable weather conditions. Research in this region typically extends from approximately 3 metres above mean sea level (the top of the berm) to 20 or 30 metres below mean sea level. Within these limits, erosion and accretion of the beach berm (usually termed the beach) is associated with the opposite trend in the nearshore region.

However.when a nett loss of sand occurs from this dynamic beach system, the existing profile is moved inland, the quantity of sand lost being re-established by erosion of the backshore deposits where they exist.

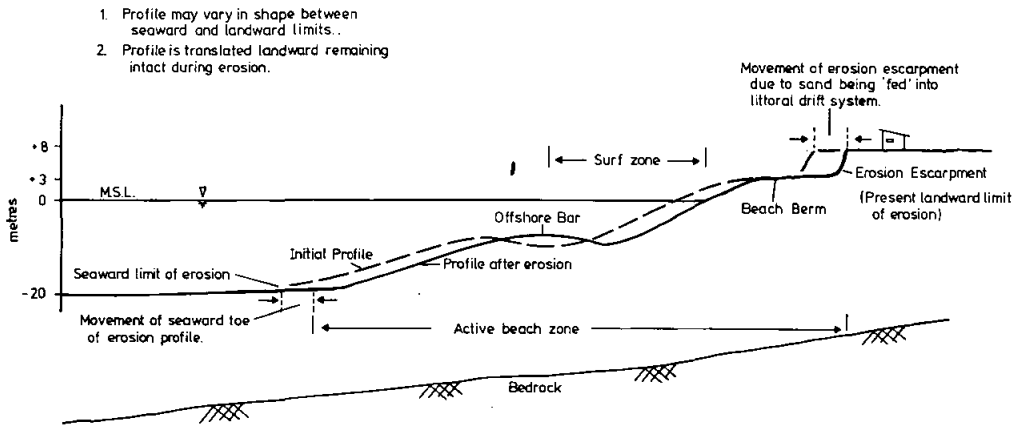
A geological appraisal of the Byron Bay – Hastings Point region indicates that with the exception of the rock outcrops at Cape Byron, Brunswick Heads, Black Rocks and Hastings Point, bedrock is generally in excess of 10 metres below the beach. The coastal plain backing the beach mainly comprises marine sediments which were deposited during a period of higher sea level some 100,000 years ago. This entire coastal plain, which is an average of 2 kilometres wide, consists of a highly erodible material, and offers no resistance to the active beach zone which is simply moving inland; evidenced as long term erosion of the coastal plain.

This longterm erosion of the backbeach area is characterised by the dune escarpment or "terrace", a feature which is not only evident on the present day beach, but which can also be easily identified on the earliest photographs and maps of the area.

A geological interpretation of information relating to the indurated sand (sandrock) which outcrops on the beach and in the nearshore zone and to the back beach deposits of sand, provides further evidence of long term coastal plain erosion.

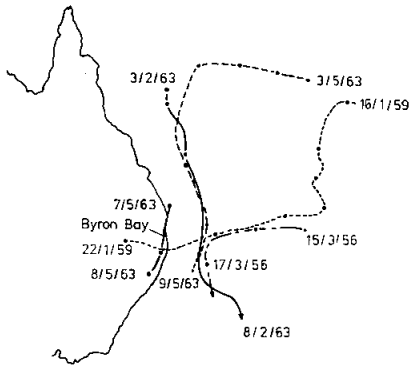
When Byron Bay and New Brighton were first developed, much of the subdivided area was sited well back from the beach. The result of this is that only in recent years have assets been threatened by erosion and hence attention drawn to the problem.

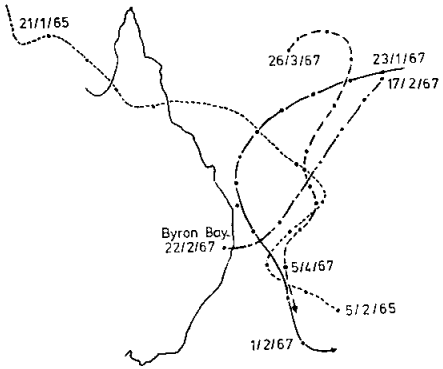
The severe cyclones of the late 1960's and early 1970's dramatically brought public attention to the shoreline recession problem as houses, roads and other public facilities were lost or threatened by the sea.

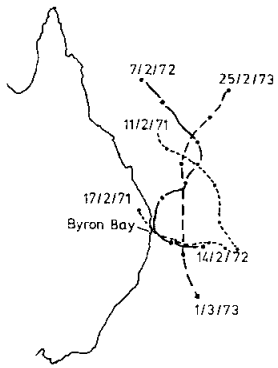


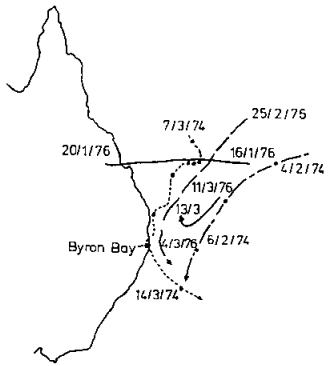
INTACT EROSION PROFILE CONCEPT

An appreciation of the magnitude of the problem facing present and future development of the area requires an understanding of the coastal processes causing the erosion. In the following explanation the erosion has been treated as a time averaged process. This implies that erosion is taking place at a continuous rate when, in fact, the coast recedes in large steps during infrequent but severe events and may recover to a degree during calm periods. This averaging approach has been adopted because it highlights the overall trend and puts into perspective the processes causing long term erosion.









	15/3 – 17/3/56
	16/1 – 22/1/59
	3/2 – 8/2/63
	7/5 – 8/5/63
	3/5 – 9/5/63
JUDY	21/1 – 5/2/65
DINAH	23/1 – 2/2/67
BARBARA	17/2 – 22/2/67
GLENDA	26/3 – 8/4/67
DORA	11/2 – 17/2/71
DAISY	7/2 – 14/2/72
KIRSTY	25/2 – 1/3/73
PAM	4/2 – 6/2/74
ZOE	7/3 – 14/3/74
DAVID	16/1 – 20/1/76
COLIN	25/2 – 4/3/76
HOPE	11/3 – 13/3/76

Dots indicate successive positions of the cyclones at 0900 local standard time of the relevant Regions.

(From TROPICAL CYCLONES IN AUSTRALIAN REGION JULY 1909 TO JUNE 1975. R.S. Lourensz, Bureau of Meteorology, January 1977.)

PATHS OF TROPICAL CYCLONES AFFECTING THE BYRON BAY TO HASTINGS POINT EMBAYMENT 1956 – 1978

CAPE BYRON, 1977

A ribbon like beach of white quartzose sand extends some 30 kilometres between the headlands of Cape Byron and Hastings Point. These two headlands were chosen as the boundary points for the erosion study in the region.

POTTSVILLE ENTRANCE, 1978.

The three river entrances which cut the beach in the embayment were shown to neither be important as point sediment sources nor sinks in the sediment budget of the region. No beach size material is being supplied by these rivers and estuary infill at the present time is insignificant.

HAND HELD ANEMOMETER, 1978.

To facilitate in the investigation, resident data collector Tom Kendall (pictured) has been gathering data on coastal processes in the New Brighton region. Similar data is collected by the Ghioni family at Byron Bay. This information is useful in comparing the littoral processes throughout the embayment.

OFFSHORE WAVERIDER BUOY, 1977

A waverider buoy anchored seaward of Cape Byron has been transmitting wave data to a receiver in the lighthouse since 1976.

WAVE POLE, 1978.

Estimates of wave height against a taut-moored reference pole anchored outside the surf zone have been made by resident data collectors.

TIDE GAUGE, 1978.

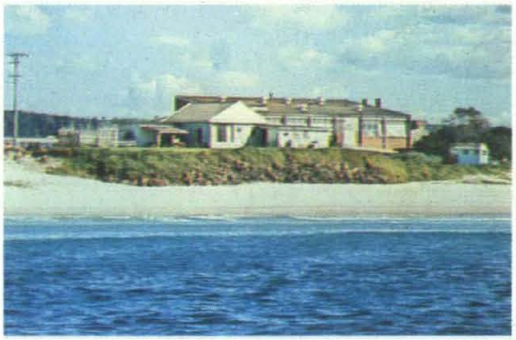
A comparison with tidal data at Fort Denison in Sydney was undertaken during field trips to Brunswick Heads between 1964 and 1977.

BELONGIL SPIT, 1978

This house is located on the erosion escarpment immediately south of the old jetty site on Belongil Spit. This building would not be expected to outlast another major erosion event. Housing along Belongil Spit and at New Brighton is located within 20 metres of the erosion escarpment.

WALKERS MEAT WORKS, BYRON BAY, 1978

Sections of the meatworks are located within 50 metres of the erosion escarpment. The Meatworks is responsible for one third of the business turnover of the Byron Bay – Hastings Point Region and directly employs 400 people at Byron Bay. Its loss to erosion would have severe repercussions for the region. Immediately south of the meatworks, the main North Coast railway line veers close to the coastline and is threatened by erosion.



AERIAL VIEW OF BELONGIL SPIT, 1978.

A thin spit of sand backed by Belongil Creek with an advancing erosion escarpment on the seaward side. Individual residents have attempted to slow the beach recession by dumping rock, car bodies and old tyres. Often the result of such unco-ordinated protection works is to increase erosion rates on the downdrift side of the protected property, whilst giving little protection against a major storm event.

AERIAL VIEW OF NEW BRIGHTON, 1978.

The village is spread along the foreshore, protected from the ocean by a very low foredune. The majority of the village is threatened by erosion with the front row of houses perched on the erosion escarpment. The rock groyne in the foreground built by local residents is not long enough to cause any significant beach realignment. The very low foredune in this area contributes to the high erosion rates.

SHELTERING PALMS, 1976.

If a management option of doing nothing is adopted, residential areas at Byron Bay, New Brighton and Pottsville face ultimate destruction from long term beach recession. This has already happened to the settlement at Sheltering Palms where individual attempts at halting the erosion had little impact.

ROCK REVETMENT, BYRON BAY, 1978.

A rock revetment placed to halt beach erosion will result in loss of the beach amenity. Continued steepening of the offshore slope will result in increasing maintenance costs for a revetment and eventually the coast will consist of a rubble shoreline. Unless a revetment is continuous throughout the region undergoing erosion, increased erosion on the downdrift side may cause outflanking and failure of the structure.

SOUTHERN END OF NEW BRIGHTON, 1977.

Several houses have been lost to erosion at the southern end of New Brighton. The row of telephone poles in the background used to be on the landward side of the road behind the beach. In this area there is a real danger of a breakthrough into the South Arm of the Brunswick River occurring which could seriously jeopardise the future of the Brunswick fishing industry.

VERTICAL SEA WALL, BALMORAL BEACH, 1974.

A vertical sea wall is expensive to construct. It will cause a reflection of wave energy with resulting scouring and loss of the beach amenity. On an eroding coastline, the offshore slpoe will continue to steepen and ultimately the wall will fail.

SAND NOURISHMENT, CRONULLA BEACH, 1977.

Sand nourishment provides a store of sand for future erosion thus protecting structures located behind the beach. This protection is dependent on the quantity of sand on the beach when a storm occurs and so requires a high maintenance expenditure in an eroding area. Considerable disruption to the beach amenity may be caused during the placement of the nourishment material.

GLOBETROTTERS CARAVAN PARK, 1978.

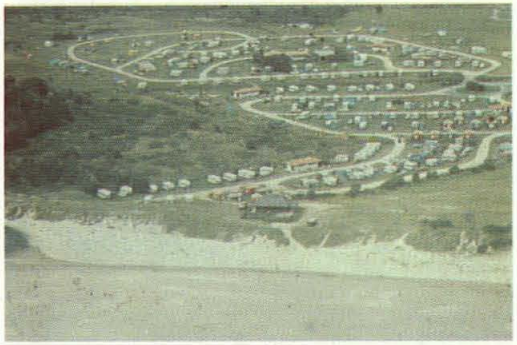
Recreational facilities constitute ideal usage of erosion hazard zones as a low capital outlay will allow a high usage of the beach amenity. Non-transportable capital investment should be kept to a minimum; e.g. bitumen roads, amenities blocks.

MILES STREET GROYNE, GOLD COAST, 1978.

Groynes may trap sand on their updrift side but cause accelerated erosion on their downdrift side. Initial nourishment is necessary, and a small terminal revetment may also be required to limit the landward fluctuation of the beach. A series of groynes will change the alignment of the beach to a scalloped appearance. Small pocket beaches form between each of the constructed groynes.

TRANSPORTABLE HOUSING, WAMBERAL, 1978.

Housing in erosion hazard zones should be designed to be portable in the face of an advancing erosion escarpment. This house was relocated to avoid destruction during storms in 1978. In this way personal loss is limited to the value of the block of land, the capital value of the dwelling being salvaged.



OVERALL COASTAL PROCESSES OF THE BYRON BAY-HASTINGS POINT EMBAYMENT

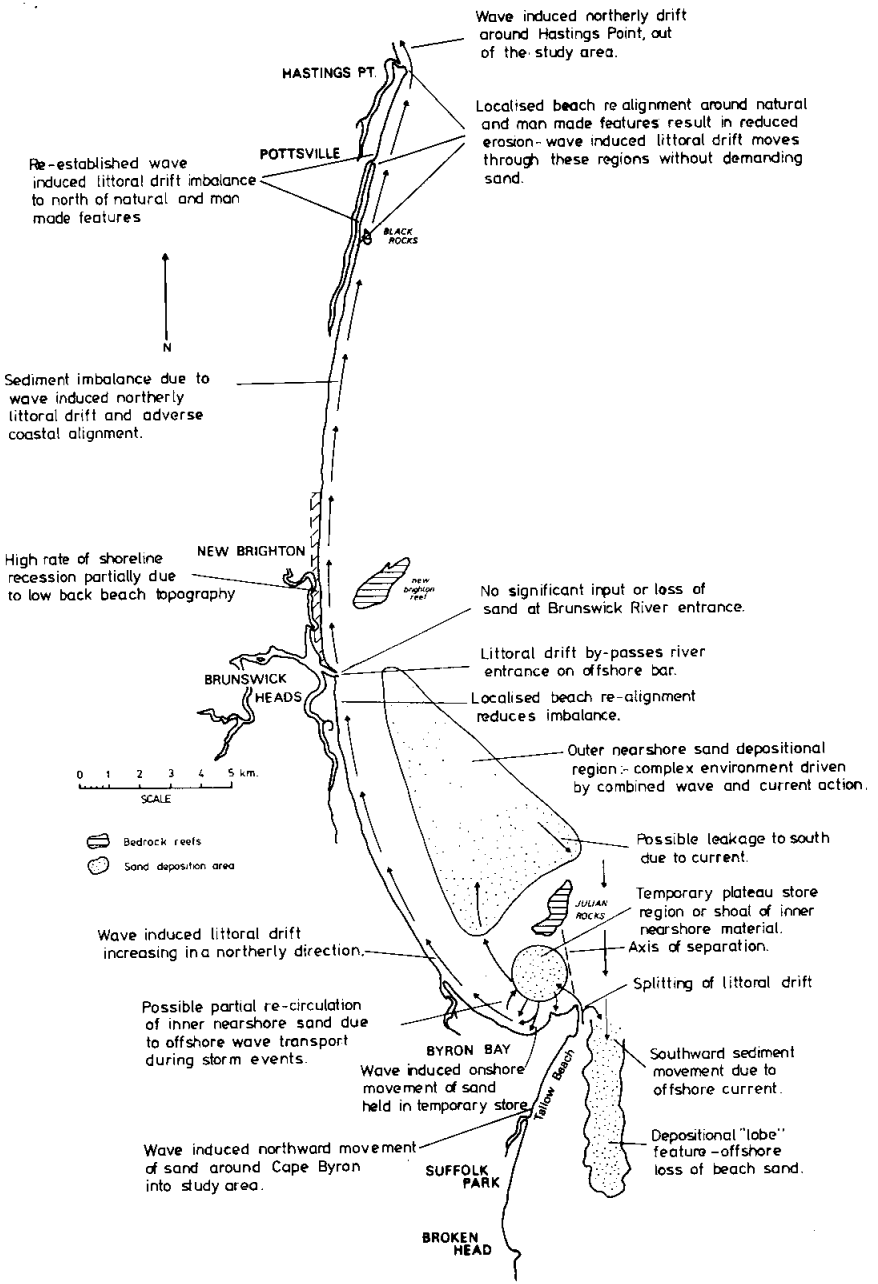
The predominantly south easterly wave conditions incident to this region of the coast cause a northerly sand movement along Tallow Beach.

At the northern end of this beach some 65,000 cubic metres per year of sand is transported by the littoral drift system into the shallow region off Cape Byron. At the tip of the Cape this sand stream experiences interference from an offshore current. This current is variable in both strength and location but tends to flow predominantly from north to south. Although no firm evidence has been found as to its origin, it is believed to be associated with the East Australia Current; a strong deepwater current which flows north to south down the N.S.W. coast off the continental shelf. Measurements taken immediately off Cape Byron recorded velocities of up to 1 knot, however reports from local fishermen indicate that at times it can be well in excess of this value.

This current is one important causal factor in the foreshore erosion being experienced at Byron Bay. It interferes with the northward bound sand supply and diverts an estimated per annum average of 50,000 cubic metres per annum offshore into deepwater from where it cannot return into the littoral drift system. Hence the majority of the sand supply which should be coming around the Cape onto the beaches of Byron Bay is lost into an offshore sink.

The sand which successfully negotiates Cape Byron under wave driven currents enters the Byron Bay—Hastings Point system and is deposited in a region between Wategos Beach and Julian Rocks. From here it is moved onto Wategos Beach in 'slugs' depending on the prevailing weather conditions. It then flows from here around and through "the pass" onto Clarks Beach where it initially appears as a sand spit which grows until a lagoon is created between it and the existing beach. This lagoon slowly fills in as more sand is added and at this stage Wategos Beach is left with little sand and hence appears to be in an eroded state.

In the hook of Byron Bay – Clarks Beach, the littoral drift is predominantly northward around the shoreline. With increasing exposure to the south easterly and easterly waves, littoral drift rates increase, resulting in a littoral drift differential along the beach. This drift differential creates a demand for sand which is satisfied by erosion of the foreshore.



CONCEPTUAL MODEL OF SEDIMENT MOVEMENT

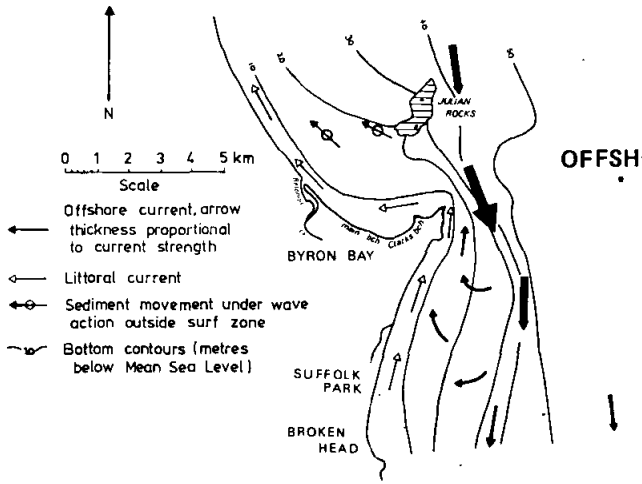
In addition to the erosion caused by the need for the littoral drift system to regain the sand lost off the Cape to the offshore current, the change in coastal alignment throughout the Byron Bay–Hastings Point embayment acts to increase the drift rates throughout the compartment.

This rate of change is rapid at first, increasing to 80,000 cubic metres per annum at Belongil Creek entrance – hence the high erosion rate at Byron Bay township – and to 120,000 cubic metres at the Brunswick Breakwaters.

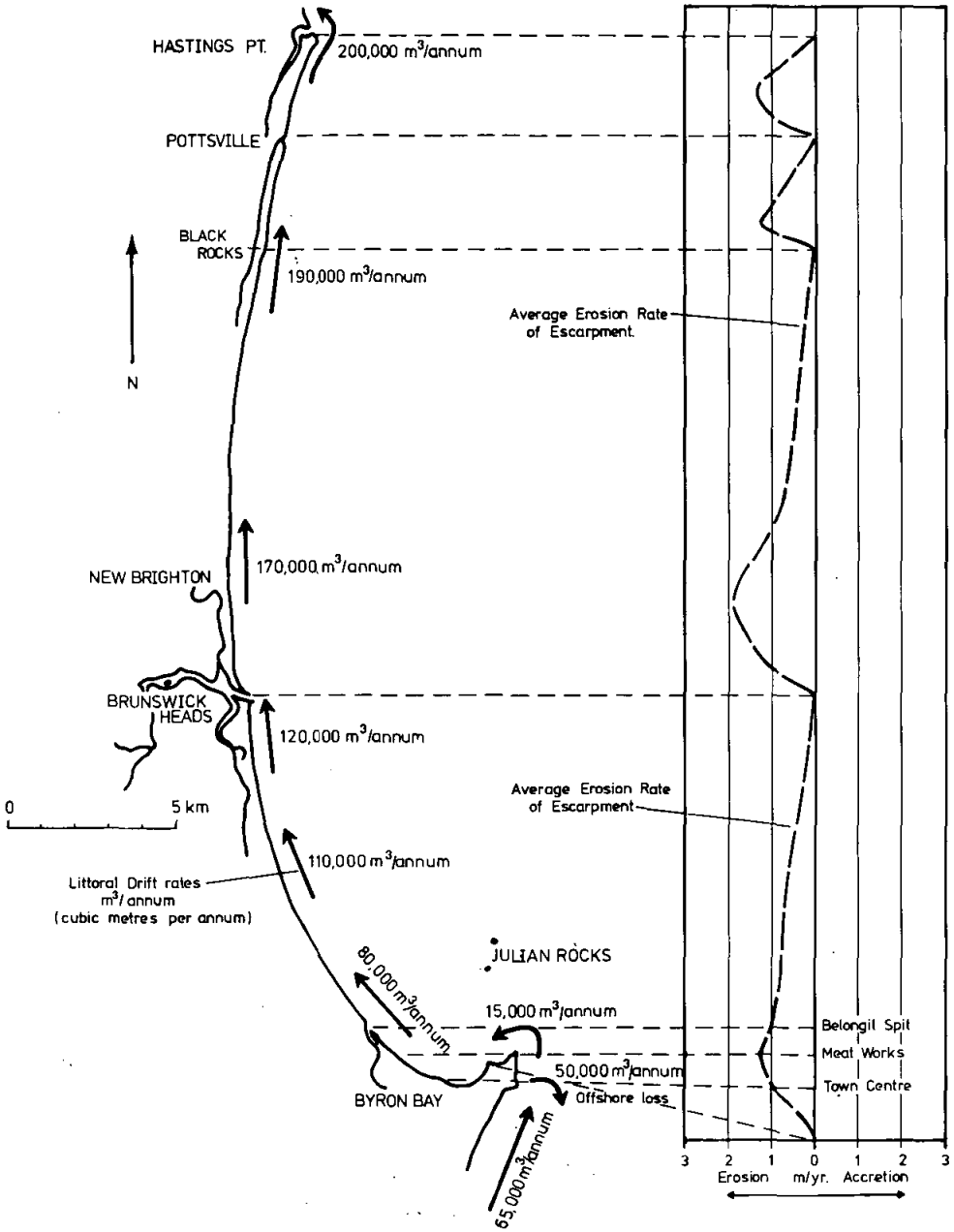
The misalignment of the beach at the Brunswick Breakwaters leads to a sharp increase in the drift rate immediately to the north in the vicinity of New Brighton – South Golden Beach; the drift in this area being 170,000 cubic metres per annum. The low foredune and back beach topography also means that erosion rates in this area are increased because greater recession must occur to supply sufficient material to satisfy the littoral drift "demand".

At Hastings Point some 200,000 cubic metres per annum moves to the north out of the compartment which means that on average 185,000 cubic metres per annum of sand is removed from the coastal plain deposits of the Byron Bay – Hastings Point region.

Hence, the sediment imbalance which causes erosion of the foreshore in the Byron Bay – Hastings Point compartment is due to both an offshore loss of material which would otherwise enter the compartment from the south around Cape Byron and to the unfavourable coastal alignment which increases the littoral drift systems demand for sand.



OFFSHORE CURRENT DISTRIBUTION BYRON BAY



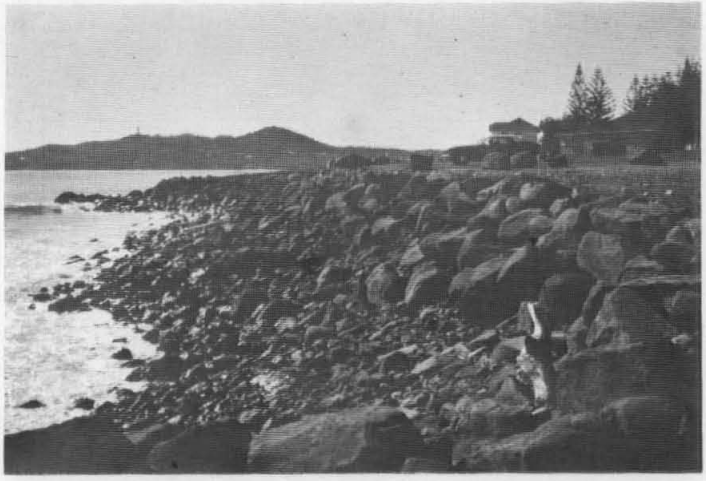
QUANTIFICATION OF EROSION RATES

IMPLICATIONS OF EROSION

Given the existing coastal system, and the geological and climatological data which shows that it is a long term and ongoing process, it can be reasonably expected that erosion will continue in the forseeable future.

An assessment of assets in Byron Bay, New Brighton, South Golden Beach, Pottsville and the regions between these which are presently under threat indicates that up to $14,000,000 worth could be lost in the next 50 years based on present day values. Of perhaps equal if not more importance, these assets include the meatworks and the north coast railway line. Hence not only will the erosion cause severe difficulties for the many individuals whose homes are in danger but it may also result in major economic and social hardship for the entire region.

In reality, erosion does not occur at an average rate and hence people tend to gain a false sense of security after extended periods of good weather. However a wide and seemingly secure beach berm can be removed in a matter of hours during a cyclone. With continuing bad weather massive erosion of the dunes follows in a few days. For example an average erosion rate of 2 metres per annum may in fact occur as a sudden erosion of 20 metres associated with a storm occurring once in a 10 year period rather than as a steady annual loss of beach material.



ROCK REVETMENT, BYRON BAY, SEPTEMBER 1977

SOLUTIONS

Any consideration of solutions to the problem of beach erosion necessitates a clear recognition of the problem itself:—

> the development of land which is subject to longterm erosion caused by a natural sediment imbalance in the region.

The second step requires an appreciation that the factors causing the erosion are unlikely to change in the forseeable future:—

> the sediment imbalance is due to conditions which have existed for several thousand years and which can only alter if there is a major change in the world climate, or, a significant geological movement of the coastal region.

This realisation places immediate constraints on any management plan to be adopted in the region as:—

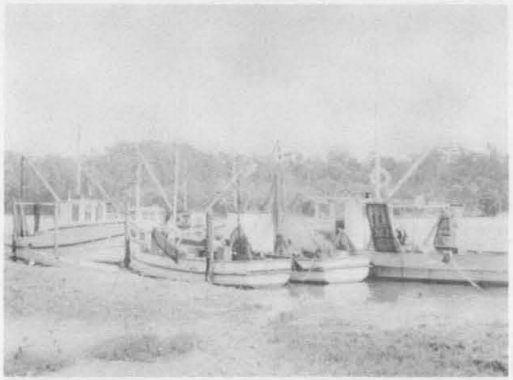
> the natural forces producing the erosion cannot be changed, only opposed, and opposition to such forces will prove expensive.

Within the constraints implied by the above factors, any management plan for the Byron Bay — Hastings Point Region should have two major aims.

1. Minimising the economic, social and environmental impacts of erosion on existing development.
2. The prevention of a further expansion of the problem. All future development in the coastal region in the Byron Bay — Hastings Point compartment should be in sympathy with the identified shoreline recession trend.

Minimisation of the erosion caused problems both present and future, can only be achieved by the implementation of an **overall management strategy** in which the coastal compartment is considered as a whole. When attempts are made to alleviate the erosion problems in any one area, the impact on other areas of these localised remedial works **must** be taken into account. Similarly, the future impacts of developing the presently undeveloped lands must be considered in the context of the coastal processes of the whole coastal compartment.

A number of management options have been outlined in the following table including some discussion of their relative advantages and disadvantages. These options are presented for public information. At this stage, no firm option has been recommended since the adoption of any overall management plan must take



FISHING FLEET, BRUNSWICK HEADS, 1977.

The fishing fleet now anchors in the harbour at Brunswick Heads. The tendency towards larger vessels is causing problems in navigation of the bar at the river entrance. The value of the Brunswick Heads fishing fleet is approximately $2M. with an annual catch throughput valued at $1M.

FISHING FLEET, BRUNSWICK HEADS, 1955.

Prior to the harbour construction the fishing fleet used to anchor in the main arm of the Brunswick River. The major fishing activity undertaken is prawning with a small quantity of high quality table fish also being taken.

AERIAL VIEW OF OVERTOPPING OF FORE-DUNE NORTH OF NEW BRIGHTON, 1972.

In areas where the foredune height is low there is the possibility of the dunes being overtopped by wave action during cyclones when the ocean water surface is elevated due to storm surge and wave setup. The mean water surface elevation may be up to +3.6 metres above mean sea level during an extreme event. This would result in salt water inundation of large areas behind the foredune in the New Brighton and Belongil Spit regions.

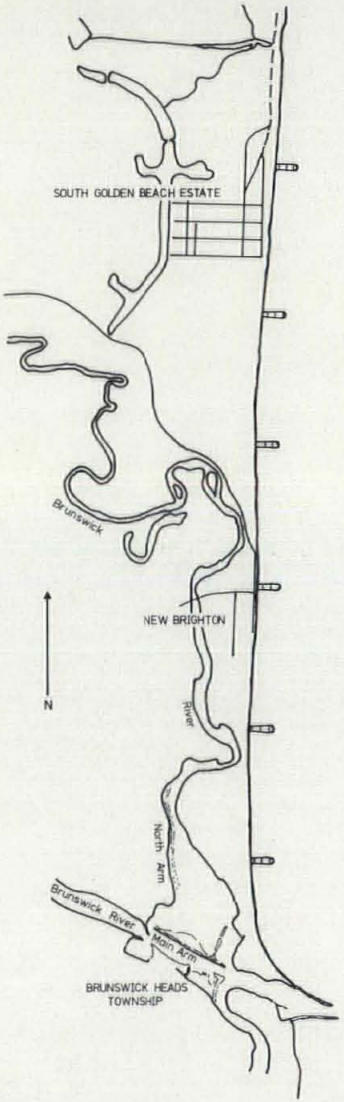
AERIAL VIEW OF SAND DUNE BLOWOUT, BYRON BAY, 1966.

This windblown mobile sand sheet at the southern end of Byron Bay was one of several areas in the embayment where windborne sand losses inland from the beach system may have occurred in the past. The area, now known as the "Sandhills Estate", was stabilised and sub-divided by the Lands Department to provide 170 building blocks. At the present time, the loss of beach sand inland under wind action is considered negligible.

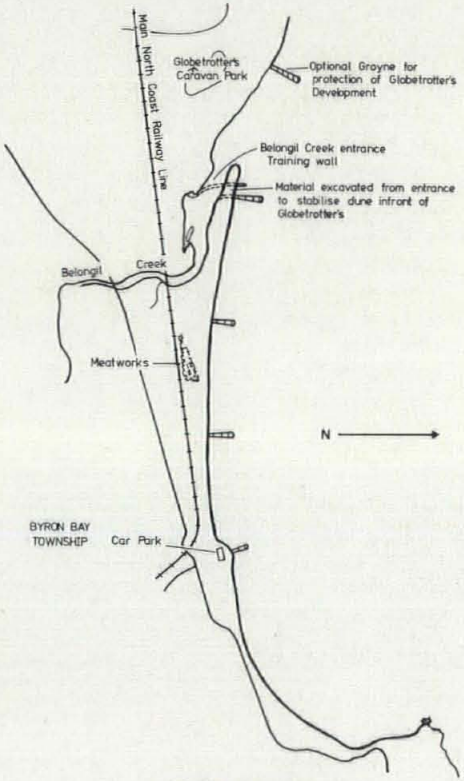
CAPE BYRON, 1954.
Sand moves around Cape Byron under southerly wave action in the form of a slug. Initially the sand appears on Little Wategos Beach immediately to the west of the tip of the Cape. From here it is transported, under wave action, to Wategos Beach. In this photograph Little Wategos Beach (right hand foreground) is depleted of sand while Wategos Beach (right hand middle ground) is comparatively full.

CAPE BYRON, 1973.
This photograph shows the reverse situation to that pictured above. Little Wategos Beach is full of sand while Wategos Beach is depleted. Observation showed that a slug of sand moving around the Cape will move from Little Wategos Beach to Wategos Beach then via the Pass onto Clarks Beach and hence into the littoral system of the Byron Bay-Hastings Point embayment.

into account the economic viability, the social and environmental impact locally as well as the effects of proposed solutions in any one area on the stability of the remainder of the compartment.



BRUNSWICK BREAKWATERS TO SOUTH GOLDEN BEACH ESTATE



SANDHILLS ESTATE TO BELONGIL CREEK ENTRANCE

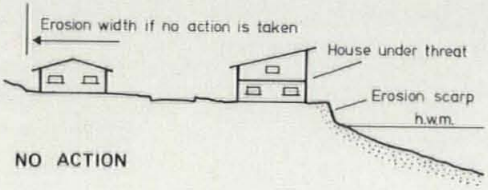
Proposed groyne

NOTE: Initial norishment of groyne field necessary to avoid interruption of littoral drift.
Maintenance norishment as required.

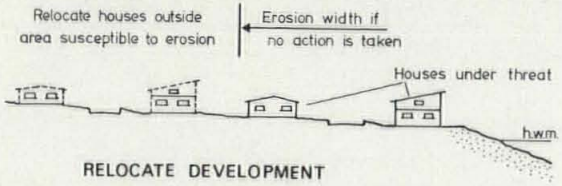
GROYNE OPTIONS

MANAGEMENT OPTIONS

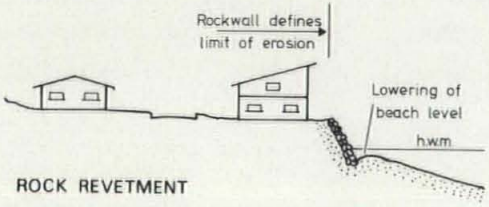
MANAGEMENT OPTION	ADVANTAGES	DISADVANTAGES
1. No action taken	Beach is allowed to behave naturally No expenditure is required on protective works.	Both public and private assets are lost to the sea. An increase in unwise development could worsen the problem.
2. Rezoning of area	Can easily prevent further unwise development. The onus for protection is placed on persons threatened rather than the whole society.	May involve compensation claims. Does not alleviate existing problems and public and private assets will still be lost.
3. Insurance scheme	Allows people and industry to remain in their present location as long as possible. Allows some cost sharing between affected persons and the society at large.	Would require subsidy to be workable. Would need to be restricted to existing development to discourage future development. Does not prevent piecemeal protection and will result in eventual loss of assets.
4. Relocation of Structures	Beach is allowed to behave naturally. Would retain the society as a whole by re-establishing in a more viable area. Would allow greater public access to beaches as private land is returned to the public.	Will cause social dislocation if carried out in stages. Will involve high expenditure. Landowners will lose their proximity to the beach.
5. Engineering Works (a) Rock Revetments	Well designed and constructed revetment can provide protection for many years.	Will change the visual amenity of the area. Will result in a gradual reduction in beach width until the area becomes a rocky shoreline. Increases erosion due to wave reflection. Will cause increased downdrift erosion as sand in the foredunes is no longer available for erosion. Ultimately requires high maintenance as offshore slopes steepen and toe water depth increases.
(b) Groynes	Retain the beach amenity in a modified form. Provide protection by maintaining a sandy beach. Provide hard points for more favourable coastal realignment.	Will change the visual amenity of the area. Will require longterm maintenance due to slumping. Will require constant sand nourishment. Increases downdrift erosion. May require additional work e.g. terminal revetments, to limit shoreward movement of erosion.
(c) Submerged Offshore Breakwaters	Provide protection by reducing wave energy attacking the beach without changing the visual amenity. Flatten beach slopes and reduce surf conditions providing sheltered beach for family bathing. Encourages reef type fish.	Very high initial cost. Adversly affect fishing industry by alienating fishing grounds. Will reduce surfing amenity. Will require longterm maintenance. Increases downdrift erosion.
(d) Sand Nourishment	Maintains visual amenity 'as is'. Low capital cost. No adverse impact on the overall littoral system as sacrificial material is provided for erosion.	Significant impact on source area of nourishment ment. Continued maintenance required and erosion problem will return as soon as nourishment is ceased. Placing of nourishment will disrupt beach usage. May require terminal revetment to limit landward fluctuations of erosion. Can result in windborne transport into developed areas.



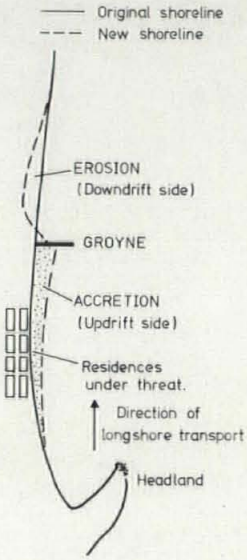
NO ACTION



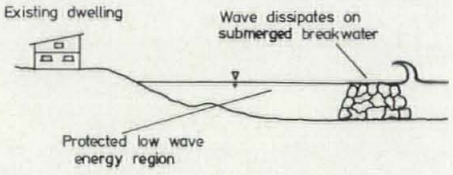
RELOCATE DEVELOPMENT

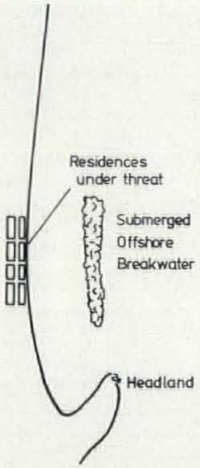


ROCK REVETMENT

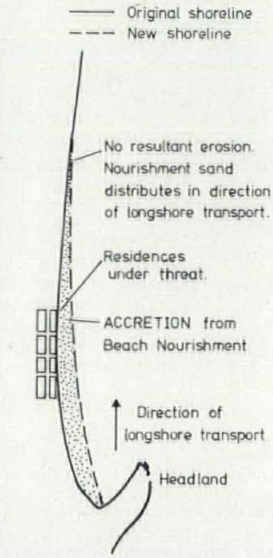


GROYNES





SUBMERGED OFFSHORE BREAKWATER



BEACH NOURISHMENT

MANAGEMENT OPTIONS

GLOSSARY OF TERMS USED IN THE STUDY REPORT

ACCRETION – A seaward movement of the mean water level on a beach, usually associated with the deposition of beach sand.

AEOLIAN – Wind transported.

BAR – A mound of sand formed on the ocean floor parallel to the beach on which wave energy is dissipated by breaking.

BATHYMETRY – Description of the ocean bed.

BEACH RIDGES – Linear sand dunes marking the location of the beach at a period of higher sea level, stranded as sea level fell. Usually of Pleistocene origin.

CONCEPTUAL MODEL – An attempt to describe the active processes in a region in purely qualitative terms.

DIFFRACTION – The bending of ocean waves as they pass around some prominent obstruction e.g. island, headland.

EDDY – A spiral current flow caused by separation of the flow past some fixed boundary.

EROSION – A landward movement of the mean water level on a beach, usually associated with a loss of the beach sand.

ESCARPMENT – (Scarp, terrace) Vertical sand cliff at the back of the beach marking the landward most movement of erosion during recent storm events.

FLUVIAL SAND – Sand formed by river erosion which may be transported to the ocean.

GEOMORPHOLOGY – The description and interpretation of landforms.

GROYNE – A structure constructed perpendicular to the beach to interesect the movement of sand alongshore. May be constructed of rock, sheet piling, ti-tree stakes etc.

HOLOCENE – Term applied to post-glacial Quaternary sediments (approx. 10,000 years before present).

HYDROGRAPHIC SURVEY – Survey of ocean bed contours.

INCIPIENT FOREDUNE – Foredune which forms at the bottom of the erosion escarpment due to the accumulation of windblown sand across the beach berm.

INDURATED SAND – Sand cemented together by organic matter at some time in the past when the water table was higher. Characteristically black to red in colour.

LITTORAL ZONE – The environment between the highest and lowest spring tides.

MARINE SAND – Sand formed by the action of marine processes.

MATHEMATICAL MODEL – An attempt to describe the processes at work in a region in purely mathematical terms. Usually involves large scale simplification of the parameters.

NETT SAND MOVEMENT – The vector resultant of sand movement along a beach over a given period of time

NOURISHMENT – The placement of beach size sand to increase the beach width and provide a temporary buffer against future erosion.

PERCHED RIP CELL – A rip cell set up on the beach berm during high tides.

PLEISTOCENE – Term applied to glacial Quarternary sediments (approx. 2 million years B.P. to 10,000 years B.P.).

PREDICTIVE MODEL – A model to be used for predicting future coastal processes based on an ability to reproduce past events.

QUATERNARY – The geological period dating from 2 million years ago to the present. It includes the Pleistocene and Holocene.

REFRACTION – The bending of ocean waves due to the change in water depth.

REVETMENT – Vertical or near vertical wall which constitutes a barrier between the ocean and the land.

SEDIMENT BUDGET – A quantification of all sand inflow and outflow to a given defined beach region. For a stable beach the sum of inflow and outflow must be balanced.

SEGMENTED LAGOON – The area of water trapped between a bar welded to the beach at both ends and the beach berm. This may only be isolated from the ocean at low tides.

SINK – A mechanism whereby sand can be removed from the beach system in a region e.g. sand mining, offshore current loss.

SOURCE – A mechanism which provides sand to a beach system in a region e.g. river, eroding sand dunes.

WELDED BAR – A sand bar joined to the beach berm at one end. Usually formed as sand moves around a fixed headland in the littoral zone.

WIND ROSE – A diagrammatic vector representation of average wind conditions at a given location over a period of time.

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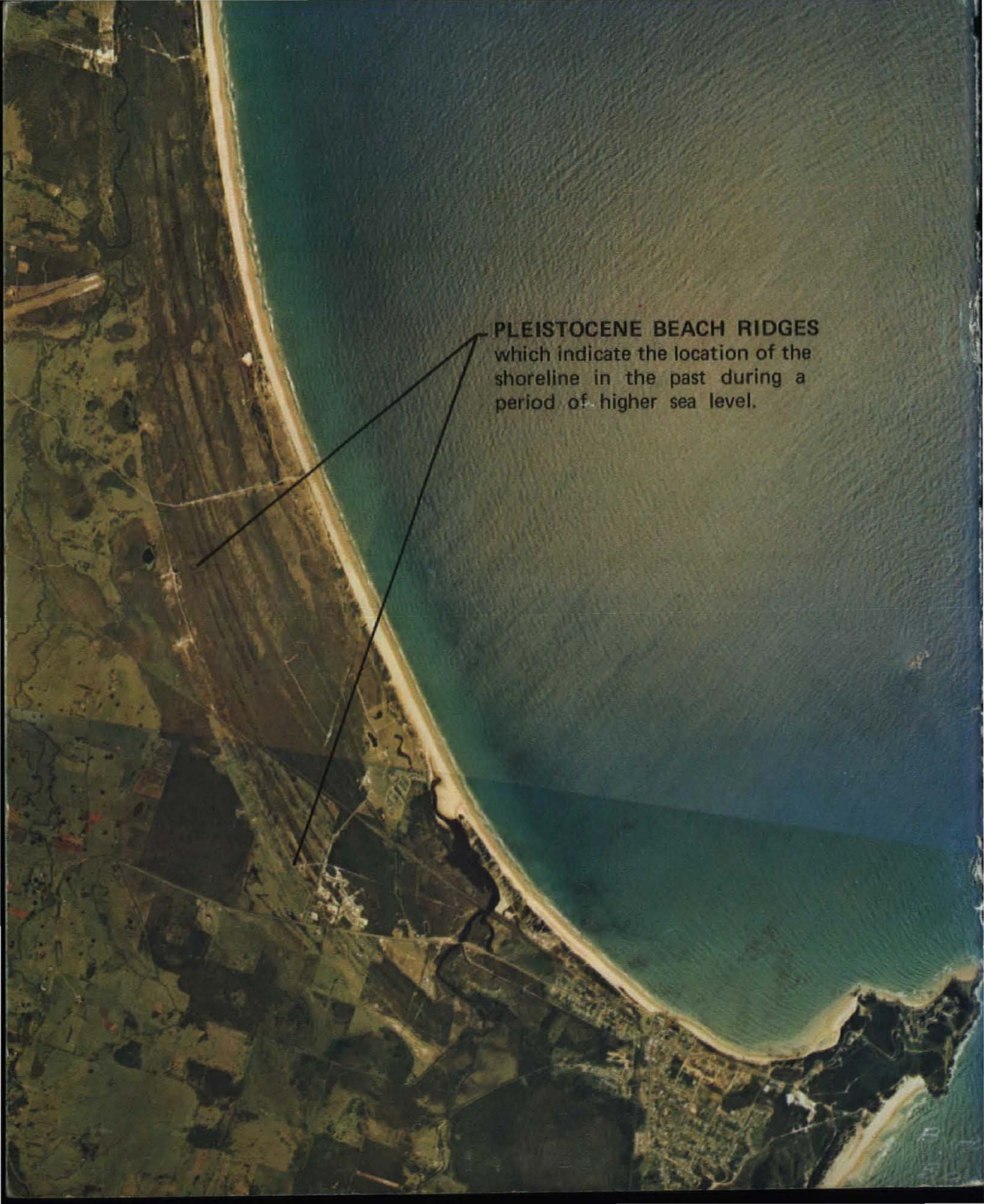
The major reports covering the findings of the study are:

- "Byron Bay—Hastings Point Erosion Study", A.D. Gordon, D.B. Lord, M.W. Nolan, N.S.W. Department of Public Works, Coastal Engineering Branch Report No. P.W.D. 78026 November 1978, ISBN 7240-2694-6.
- "Mathematical Model of Beach Evolution, Byron Bay to Hastings Point", D.N. Foster, C.T. Brown, B. Le Plastrier, University of New South Wales Water Research Laboratory Technical Report No. 78/9, December 1978.
- "Quaternary Geology and Offshore Sediment Budget for the Byron Bay Region", P.S. Roy, A.W. Stephens, Geological Survey of N.S.W., Department of Mines Geological Survey Report No. G.S. 1978/276, 1978.


PLEISTOCENE BEACH RIDGES
which indicate the location of the shoreline in the past during a period of higher sea level.