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Introduction

In 1992, the NSW State Government introduced an Estuary Management Policy aimed at managing the growing pressures on estuarine systems. Under the policy the then Department of Natural Resources (now Department of Environment and Climate Change, DECC) is responsible for coordinating, in cooperation with local Councils, the preparation of Estuary Management Plans (EMP). The procedure for developing an EMP is set out in the Estuary Management Manual (NSW Government, 1992). The current revision of the procedure follows an 8 step process;

1. Form an Estuary Management Committee
2. Identify issues and set goals
3. Assemble existing data
4. Carry out an Estuary Process Study
5. Carry out an Estuary Management Study
6. Prepare and review the Estuary Management Plan
7. Adopt and implement the Estuary Management Plan
8. Monitor and review the management process

In accordance with this process, Kempsey Shire Council has formed a local Estuary Management Committee (EMC) with representatives of all key stakeholder groups. In March 2006 Kempsey Council convened a community meeting and with assistance from DECC and the EMC drafted a brief for the preparation of a Data Compilation and Processes Study for Korogoro Creek.

This study, the Korogoro Creek Data Compilation and Processes Study and Report, addresses Steps 3 and 4 in the Estuary Management Process.

Aims

The major aims of this study and report are to;

- Identify and collate all available existing data sources of relevance to the management of the Korogoro Creek estuary (including reports, proceedings, journal articles, digital data sets, aerial photographic records, etc) and compile into a web-accessible electronic register.
- Review the data sources to determine their usefulness and adequacy for addressing the issues identified by the Council (including issues identified by the EMC, DECC, and the community).
- Determine gaps in the data and information set that are potentially limiting to the development of the Estuary Management Plan.
- Undertake a Processes study to identify the catchment, hydrodynamic, entrance, geomorphological, ecological, and water quality processes driving estuary function and health
- Make recommendations as to what additional datasets or investigations are required to be collected during subsequent stages of the EMP, particularly the Estuary Management Study and Plan phases (Stage 5 and 6)

Consultation

The EMP process was commenced on 7th March 2006 with a community meeting held at the Hat Head Surf Lifesaving Club. The meeting was an open meeting designed to inform the local community of the Kempsey Council's intention to commence preparation of the Korogoro Creek Estuary Data Compilation and Processes study and to receive feedback from community members on which issues were of local importance. This information was used to assist the preparation of the consultants brief for

the study. A local Korogoro Creek Working Group was formed after the meeting to assist future liaison between Council, the consultants, and the local community.

GECO Environmental was appointed to undertake the study in August 2006. On the 26th August, a creek walk was held with 5 members of the Korogoro Creek Working Group, during which issues such as bank erosion, recreational access, water quality, fishing, estuary ecology and flood mitigation were discussed.

The issues raised at the initial community meeting and during the creek walk with the Korogoro Creek Working Group were used to develop a Community Values and Issues survey for distribution to local residents and visitors during the 2006/07 Christmas holiday period. Feedback through the survey was sought over a 10 week period between 11th December 2006 and 19th February 2007. Seventy-one responses were received.

Direct consultation has also been undertaken with a number of local long-term residents throughout the study.

The Draft Korogoro Creek Estuary Data Compilation and Process Study Report was provided to Kempsey Council for distribution and review by stakeholders on the 23rd July 2007.

As the final phase of community consultation for this study an open community meeting will be held on 23rd August 2007 at which the findings of the study will be presented to the Hat Head community.

Report Format

Part 1 of this report details the factors that have influenced the evolution of the Korogoro Creek estuary including the natural landscape evolution and anthropogenic factors that have shaped the estuary as it is seen today.

Part 2 reviews the current state of knowledge of the estuary, its processes, its health, and its use and management. The main findings of this review have been categorised under the following process headings:

- Climate data
- Catchment processes
- Geology, geomorphology, soils and sediments
- Estuary Hydrodynamics
- Entrance behaviour and management
- Water quality data
- Estuarine ecology data
- Recreational and cultural use (Aboriginal and European Heritage).
- Climate change and sea level rise
- Community values, expectations and issues

Part 3 summarised the findings of the data review and identifies knowledge gaps and issues to be addressed in the process study component of the report (Part 4).

Part 5 makes recommendations for future stages of the Estuary Management Process including the Estuary Management Study and Estuary Management Plan.

PART 1 HISTORICAL CONTEXT – KOROGORO CREEK ESTUARY

1.1 Evolution of the Korogoro Creek Estuary

As in other parts of the world, the southeast Australian continental margin has been affected by episodic sea-level fluctuations during the late Quaternary (last 350 ka or thousand years ago). Although glaciation did not occur extensively throughout Australia over this time period, periods of glaciation elsewhere produced dramatic effects on sea levels along the coast. During periods of glacial maxima (glacial lowstands) lower sea levels occurred, displacing the coastline seaward onto the continental shelf. Under these conditions rivers cut deep valleys as they flowed to the sea. In interglacial periods (glacial highstands), when sea levels are higher, the coastal river valleys become drowned forming embayments which then become progressively infilled from both land sources (catchment erosion) and sea based sources (waves and winds pushing sand into embayments).

Sea levels have fluctuated between about a maximum of 5 m above the present sea level during the last Pleistocene highstand (approximately 120 ka) and a minimum of 110-130 m below the present level during the Last Glacial lowstand (between 25 and 15 ka). Between about 20 ka and 6.5 ka the sea level rose rapidly reaching the approximate present sea level position (Figure 1-A). From 6.5ka to the present (mid to late Holocene highstand), the sea level has been relatively stable, remaining within 1-2 m of the present level (Figure 1-A; Troedson et al., 2004).

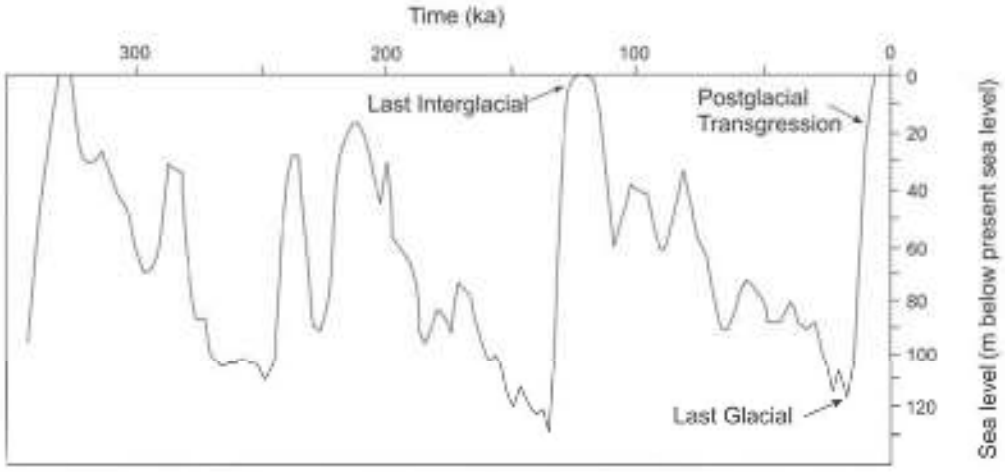


Figure 1-A *Late Quaternary and Holocene sea level history for southeastern Australia (Roy and Boyd 1996. Source: Troedson et al., 2004)*

The approximate position of the coastline during the mid Holocene (~6-5 ka) is shown in Figure 1-B (page 7). The sand sheets indicate Pleistocene barrier systems and dunes that were most likely deposited during the last glacial highstand. These Pleistocene barriers connected what were at the time offshore islands including the headlands of Crescent Head, Hat Head, and Smoky Cape and impounded large lagoons between them and the paleo-shoreline indicated by the land mass (Atkinson, 1999). Soil and geological investigations reveal that the area indicated as the Macleay lagoon is underlain by extensive estuarine deposits that are the source of potential and actual acid sulphate soils today. These lagoons have progressively infilled during the late Pleistocene and the Holocene period with fluvial sediments, a process which is still evident in the birdsfoot deltas prograding into some of the last remnants of the lagoon such as the Belmore and Kinchella swamps (Plate 1).

Plate 1 *Birdsfoot delta formation on Kinchella Creek (Source: LIP 2003 1:25000 aerial photography)*

Korogoro Creek is located between an inner Pleistocene barrier and an outer Holocene barrier historically draining numerous saline and freshwater wetlands occurring in depressions along the coastal fringe and between the inland Pleistocene dune systems. Figure 1-C shows a stylised schematic of the likely stratigraphy of the quaternary sediments of the Korogoro Creek catchment.

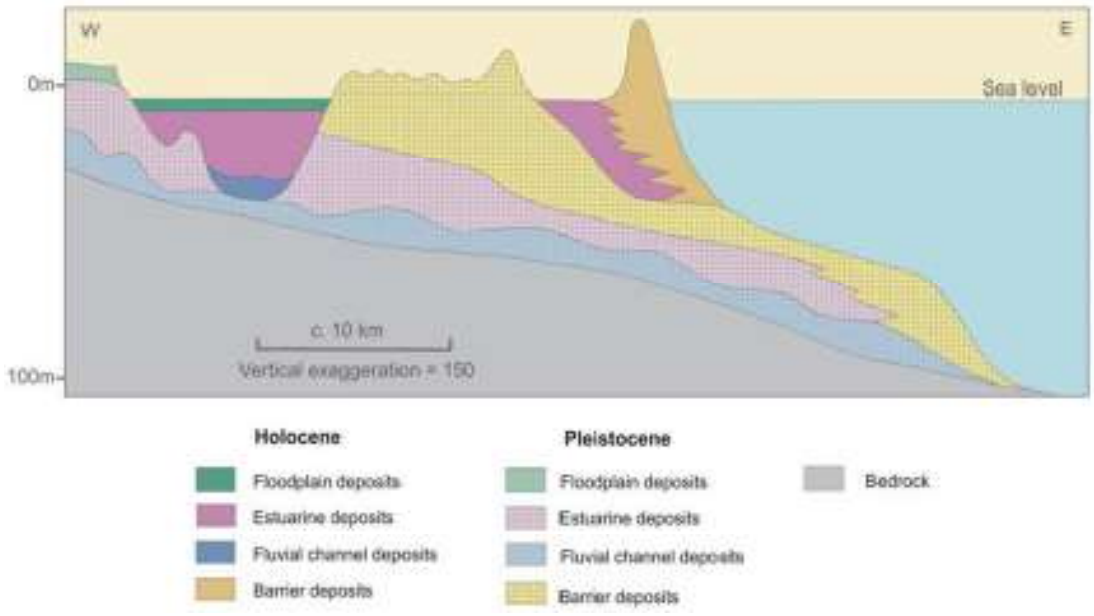


Figure 1-C *Generalised schematic of the relationships between Quaternary coastal deposits in New South Wales, modified after Roy (1998) (Source: Troedson et al., 2004).*

Korogoro Creek is unusual for such a small estuary in that it is generally believed to have a permanently open entrance. This contrasts to many of the small estuaries that occur in similar situations on the north coast of New South Wales which are known as Intermittently Closed and Open Lagoons and Lakes (ICOLLs). This is most likely due to almost northerly orientation of the Korogoro Point

headland which effectively interrupts the supply of sand through longshore transport process to the estuary mouth whilst also reducing wave and wind energy effects that would otherwise work to build a berm at the entrance. The presence of bedrock outcropping along the headland margin also promotes regular scouring of the entrance during large tides and the less frequent flows associated with large floods in the broader Macleay catchment.

1.2 Chronology of post settlement events and changes on the Korogoro Creek Estuary

The earliest available records of Korogoro Creek and its natural surrounds show that Korogoro Creek has undergone major changes since the mid 1950s. Aerial photographs from the early 1940s and mid 1950s show that Korogoro Creek was a smaller and more sinuous and heterogenous estuary system (Figure 1-D, p.8). The creek does not appear to be naturally connected to the Swanpool through surface water flow although groundwater interaction may have occurred. The estuary was flanked on both sides by a dense mat of sedges and rushes which extended out into the water beyond the mangrove fringe (Plate 2).

Plate 2 Inscription on back of photo reads: [sic] "Crossing Korogora Creek at Hat Head, a little seaside resort between Smoky Cape and Crescent Head which will rival any beach along the coast, when a decent road is provided". 1925 (Photo by Magnus Everson, Source: State Library of New South Wales PICMAN database)

The timing of major changes to the creek system parallels changes to river and estuarine systems throughout the Macleay catchment and is linked to the disastrous floods of 1949 and 1950. The damage and hardships caused by these floods saw a major program of flood mitigation works instigated with the objectives of improving flood control by increasing stream capacity and efficiency thus reducing flood frequency; controlling floodwaters through the use of floodways, storage systems, and the development of new ocean accesses (eg. Korogoro Creek); reducing the inundation period by improving drainage and developing or improving ocean cuts; and minimising the effects of floods by developing an improved warning system, providing better road accesses, and through non-structural means such as flood proofing, flood insurance, and floodplain mapping (Anon.,1976).

Flood mitigation works relevant to the Korogoro Creek estuary occurred through much of the 1960s with the major works undertaken in 1968 (Table 1). These works included extending the creek system via drain construction to connect Swan Pool to Korogoro Creek, installation of floodgates (Korogoro Cut floodgates on Hat Head Road), the construction of levees along both banks, a control levee 2 km upstream of Hat head Road bridge ("The Choke"), an ocean cut known as Rowes Cut, and installation of minor floodgates and stormwater outlets providing for local drainage (Figure 1-E, p.9). Maintenance of these works is periodically required, however the scheme's operation is essentially unchanged since the major period of construction ended in the late 1960s.

Table 1 *Approximate construction timetable for structural works relevant to the Korogoro Creek system (Webb, McKeown & Associates Pty Ltd, 1997)*

Year	Works
Pre 1960	Kinchela to Longreach bank protection
1960 - 1962	Belmore Kinchela area, several drains and gates
1961	Belmore/ Kinchela headworks, drains, drainage improvements
1964	Belmore to Killick Creek waterway
1967	Frogmore – Darkwater drains extensions
1968	Korogora Creek headworks, drain and levees
1968	Kinchela Creek fabridam floodways and barrage

Figure 1-D (p.8) shows the alterations to the Creek that resulted from these works. Such works are now known to directly effect estuarine processes including tidal processes and sedimentation, geomorphology and aspects of estuarine ecology including floral distributions, faunal species richness and commercial fisheries production (Roy et al., 2001).

Permanent population statistics show a declining trend over the period 1991 to 2006. The latest census figures from 2006 record the permanent population of Hat Head as 297, whereas in 2001 it was 322, in 1996 was 334, and 1991 was 350 (http://www.abs.gov.au). This represents a decline in permanent population of approximately 15% over the period, defying the much discussed "seachange" phenomena. The 2001 ABS census data show that 48.4% of dwellings were unoccupied indicating seasonal population fluctuations. Additionally, 5.5% of dwelling structures were caravans and cabins confirming Hat Head as a holiday town with a large caravan park and numerous holiday rentals (KSC, 2005).

The town was sewered in 2001, resolving some long-standing issues with high bacterial loads in the estuary related to septic discharge.

Today the estuary is a significant focus for tourists and locals seeking a relatively safe swimming location, fishing opportunities, and other recreational pursuits. The estuary also provides an important ocean access for recreational fishermen and for a small locally based professional fishing operation.

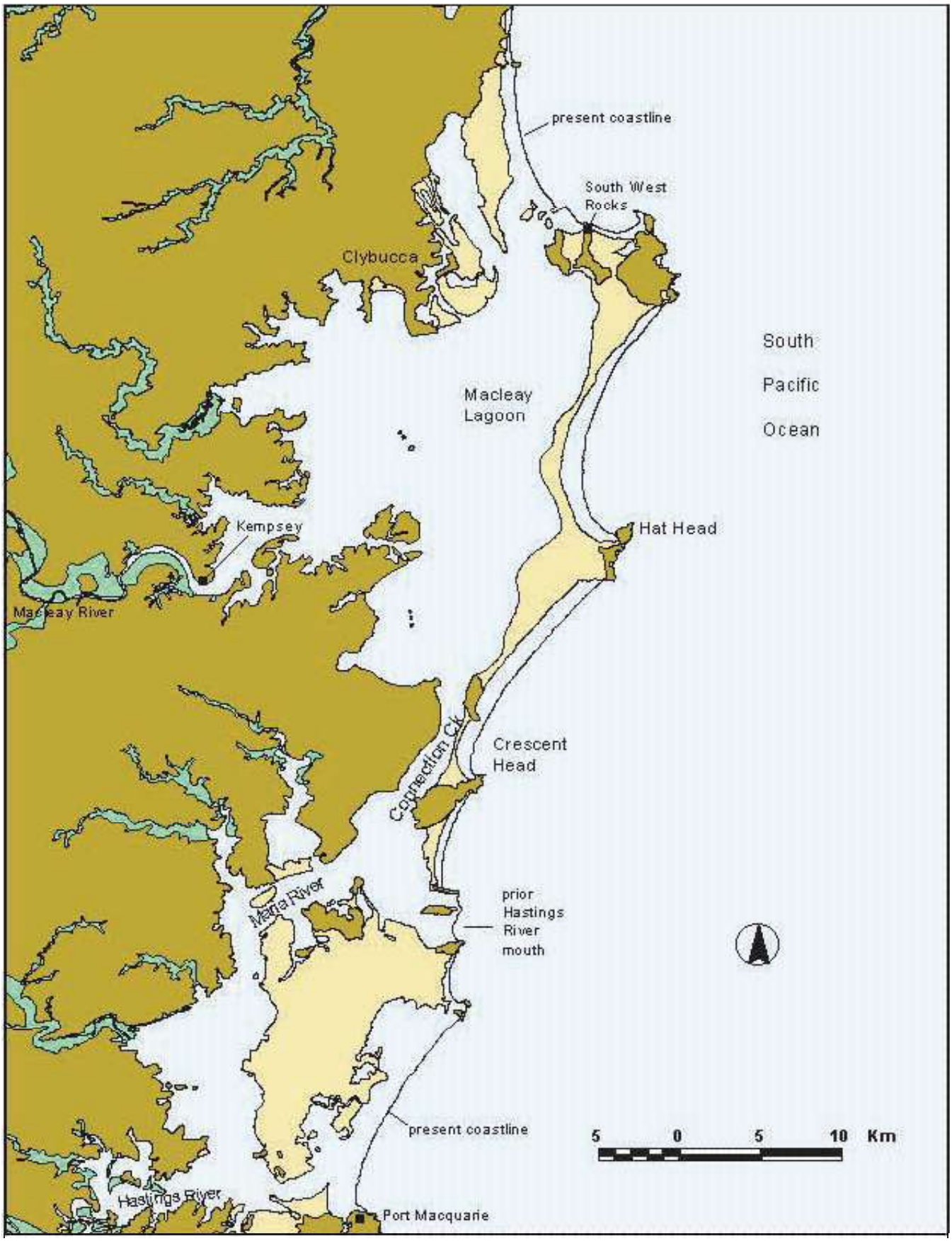


Figure 1-B

Schematic of the Macleay and Hastings Floodplains in the mid-Holocene (5,000-6000 years ago).

Land
Alluvium
Sand sheets

Derived from the Macksville-Nambucca and Kempsey-Korogoro Point 1:100,000 Soil Landsacpe maps

Prepared by M.W. Eddie
Department of Environment and Climate Change
Kempsey, NSW
January 2000

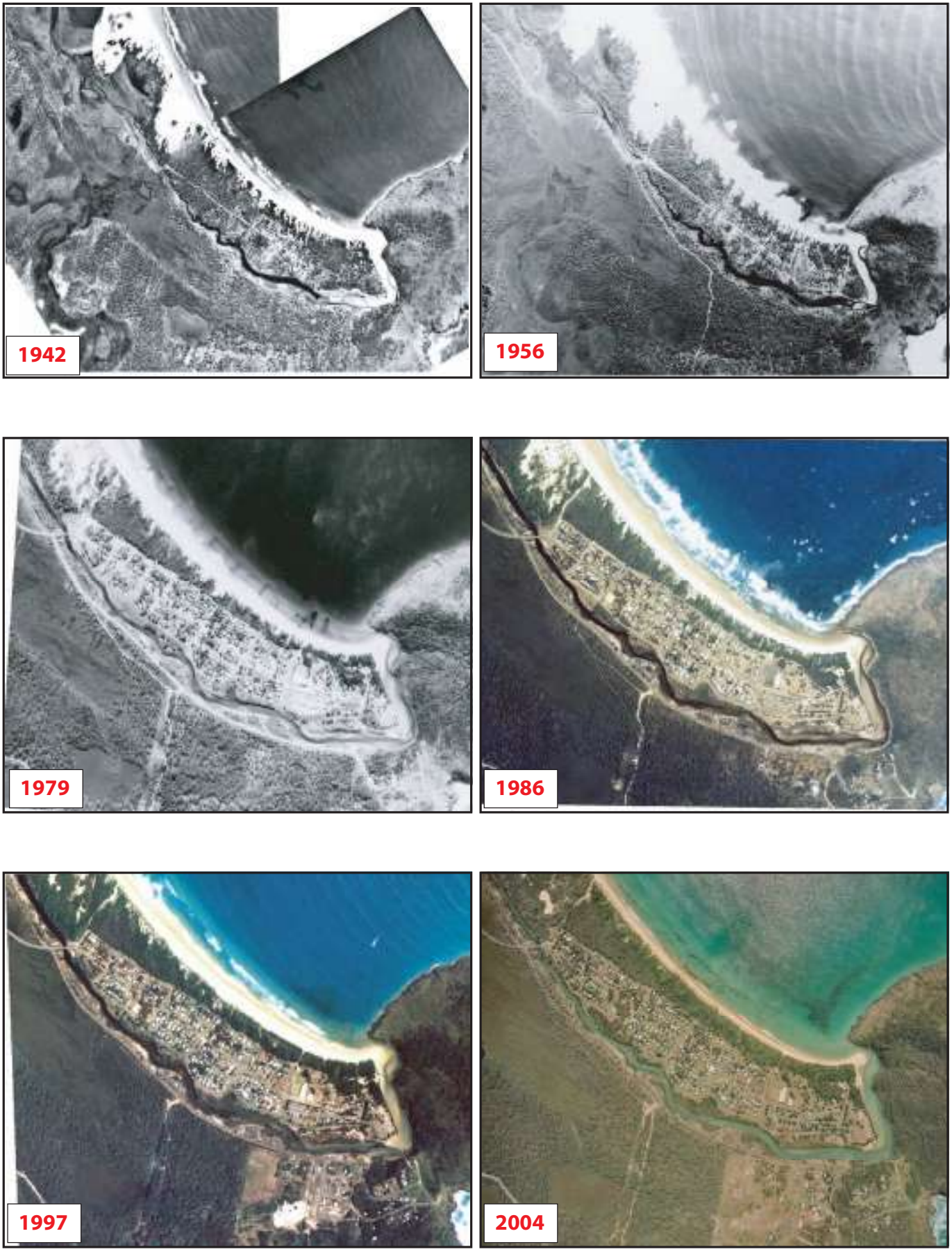


Figure 1-D

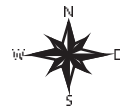
Korogoro Creek aerial orthophoto chronology 1942-2004

Created by:
Damon Telfer
GECO Environmental
Grassy Head NSW

Source: Base air photo images: 1942 - United Photo & Graphic, 1956-2004 - LPI, Dept Lands, Bathurst

LEGEND

- Approximate Catchment Boundary
- Roads
- Hat Head National Park Boundary



Approximate Scale 1:30,000

500 0 500 1000 1500 m

Figure 1-E

Korogoro Creek Catchment Features

Created by:
Damon Telfer
GECO Environmental,
Grassy Head, NSW 2441

Sources: Base orthophoto images: created from 1997 1:25,000 aerial photography LPI, Dept Lands, Bathurst National Park boundary and Cultural (Roads) coverages: Resource Information Unit, Dept Environment and Climate Change, Grafton