Puglia 2003 - Final Conference
Project IGCP 437

Coastal Environmental Change
During Sea-Level Highstands:
A Global Synthesis with implications
for management of future coastal change

Otranto / Taranto - Puglia (Italy) 22-28 September 2003
Quaternary coastal morphology and sea level changes

Project 437

Grindrod J.[1], Barker B.[2] , Genever M.[1]

Holocene environmental change and human occupation on the northeast Queensland continental shelf, Australia.

[1]School of Geography and Environmental Science, Monash University, Australia,
E-mail: John.Grindrod@arts.monash.edu.au; mattgenever@hotmail.com.au
[2]Department of Humanities and International Studies, University of Southern Queensland, Australia,
E-mail: Bryce.Barker@usq.edu.au

Keywords: *palynology, mangrove coasts, archaeology, Holocene, northeast Queensland.*

Abstract

During the long human occupation of Australia, spanning more than 50 ka, Australia's extensive continental shelf has been both fully exposed and rapidly inundated by seawater. The last glacial marine transgression occurred from approximately 17 to 6 thousand years (ka) ago.

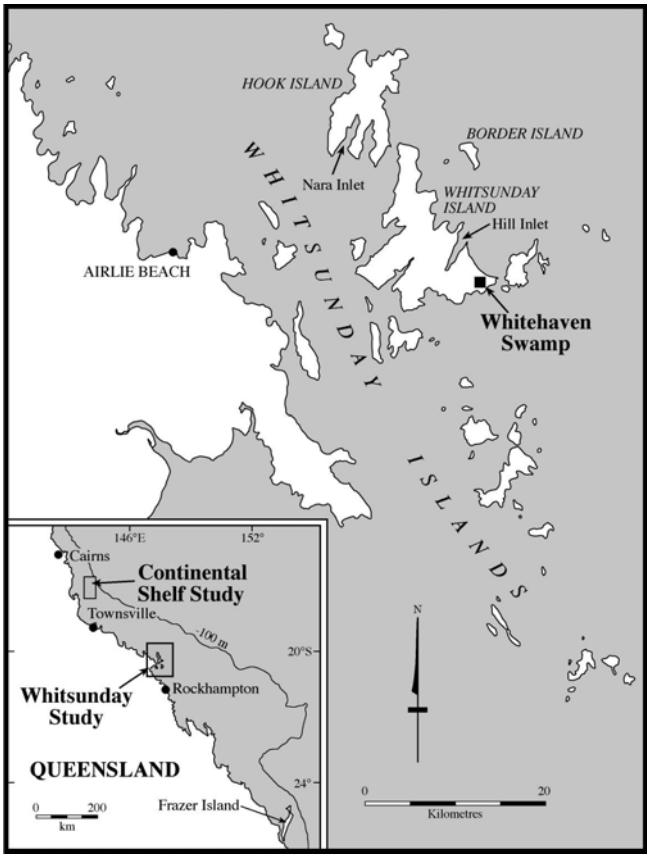

Figure 1. The northeast Queensland coast, continental shelf and study location.

In northeast Queensland initial sea level rise merely dictated up-slope migration of shorelines on the steep continental slope, but by around 12 ka inundation of the broad shelf had begun. Simultaneously, the imposition of Holocene humidity over long-entrenched Pleistocene aridity was under way. The combination of sea level rise and climate change would ultimately redefine coastal ecologies and the geography of coastlines at scales unprecedented in human experience. The ecological and social contexts of human response to these changes, is pertinent to our broader understanding of human-environment interaction, including present day human response to change.

This paper aims to reconstruct physical environments and climate on the northeast Queensland continental shelf during the early Holocene marine transgression until present, through pollen and sediment analysis of sediment cores from submerged marine shorelines near Townsville, and from Whitehaven Swamp on Whitsunday Island (Fig 1). The resulting palaeoenvironmental records are compared with detailed archaeological records of comparable age from the Whitsunday region.

Study location

The study region includes the section of the Queensland coast from Cairns in the north to the Whitsunday islands in the south. While the whole region lies within the southern tropics, considerable variation in climate exists. Humid tropical conditions (> 3000mm rainfall per annum) pertain in the vicinity of Cairns where mountain ranges rise at the coast. In contrast, much drier conditions (< 1500mm) with pronounced seasonal aridity feature around Townsville, where coastal topography is subdued. Further south, the central Whitsunday region receives a yearly average rainfall of 1900mm, though variability may be considerable across the mountainous island chain.

Continental shelf pollen records

Sediment cores from the continental shelf provide evidence of former shorelines during the last marine transgression (Grindrod et al., 1999; 2002). Pollen and radiocarbon analyses indicate that diverse mangrove communities (represented by *Avicennia, Bruguiera, Ceriops, Rhizophora apiculata* and *R. stylosa* pollen types) kept pace with sea level rise at least in estuarine environments from around 10 to 9 ka.

Strong mangrove development may be related to relative still stands in sea level if the stop/start model for sea level rise (Larcombe et al., 1995) is valid. Regional pollen components in the continental shelf pollen records also provide evidence of former near-coastal terrestrial vegetation and climate during the early Holocene. Strong representation of *Eucalyptus*, grasses (Poaceae) and saltmarsh (Chenopodiaceae) pollen types, and general lack of rainforest elements, suggest open woodland vegetation and relatively arid conditions, perhaps similar to seasonally arid sections of the present Queensland coast. This signal of relative aridity is consistent with claims for minimal stream discharges across the early Holocene exposed shelf, based on sediment and seismic analyses (Wolfe et al., 1998).

Whitehaven Swamp pollen record

Palynological results from Whitehaven Swamp provide the first Holocene palaeoenvironmental record for the Whitsunday region (Genever *et al* in review). Sediment stratigraphy and radiocarbon dating indicate continuous freshwater swamp conditions for approximately 7 ka until present. Pollen and charcoal analyses provide local and regional vegetation and fire histories for the site and surrounding area.

Varying representation of swamp elements, particularly *Leptocarpus* and Cyperaceae, reflect phases of permanent and ephemeral swamp. The record for regional vegetation is dominated by rainforest, sclerophyll and beach strand elements.

Strongest rainforest representation occurs around the mid-Holocene, while sclerophyll elements increase through the late Holocene to present.

Charcoal analyses indicate that fire has been a constant component of the Whitsunday environment throughout the period represented. Negative correlation between high charcoal and *Leptocarpus* pollen concentrations suggests a strong local component to the charcoal record and a history of on-site burning during ephemeral swamp phases.

The vegetation reconstruction suggests moister than present conditions at Whitehaven between approximately 7000 to 4500 BP. This is in keeping with claims for a warm and moist mid-Holocene relative to present (the so-called 'climatic optimum'), based on pollen records from the Atherton Tableland to the north (Kershaw 1983, 1995); but contrasts with suggested mid-Holocene aridity based on a surrogate lake level record from Fraser Island to the south (Longmore, 1997; 1998).

In combination the pollen records provide a picture of changing environments on the Queensland continental shelf and present coast during the Holocene.

The early Holocene exposed shelf was likely dominated by open savannah and sclerophyll woodland reflecting relative aridity at a regional scale.

Mangrove and attendant saltmarsh communities flourished in estuarine settings, apparently unimpeded by rapid sea level rise. The first signs of Holocene humidity appear around 7 ka, with the initiation of freshwater swamp at Whitehaven. In addition strong rainforest development at Whitehaven from approximately 7 to 4.5 ka indicates enhanced mid-Holocene humidity relative to today.

Comparisons with the Whitsunday archaeological records

Archaeological records for the Whitsunday region (Barker 1991, 1996, 1999, Barker and Schon 1994) span most of the Holocene, with ages of 8990 ka at Nara Inlet 1 on Hook Island and 6900 ka in Cateran Bay on Border Island.

The majority of sites however date within approximately the last 3000 years. The nearest excavated archaeological site to Whitehaven Swamp, at nearby Hill Inlet on Whitsunday Island, dates to 2770 ka. These records indicate a strong connection with a marine resource base as early as approximately 9 ka, when mountains in the Whitsunday region were rapidly becoming islands and mangrove shores were well developed.

While the continental shelf and Whitehaven pollen records cover the period and environments pertinent to the Whitsunday archaeological record, little direct correlation between identified environmental change and cultural change is apparent. Strongest evidence for change in the archaeological record is firmly established at around 3000 years ago. This includes increases in the density of discarded cultural material and range of species exploited, technological change and establishment of new sites.

The Whitehaven pollen record and regional supporting data indicate major changes in vegetation at times when little or no change is demonstrated archaeologically.

Further, claims for late-Holocene population intensification are not matched by changes in the charcoal record.

This may suggest that widespread vegetation burning was not a predominant feature of hunter-gatherer strategies that were focused towards marine resources, and/or that human-induced fire regimes were already well entrenched prior to intensification.

Long-standing assumptions that hunter-gatherer societies in Australia were ecologically pressured during periods of intense environmental change are not supported in this study, which documents cultural development independent of (as opposed to driven by) environmental changes.

The scale of environmental upheaval on the late Quaternary continental shelf is likely to challenge species with highly specific ecological requirements, rather than species that are ecologically generalised.

Humans are not only generalist, they are resourceful as well, in the sense of ability for learned behaviour and intelligent response to environment through cultural choice and technological innovation.

Indeed, it is possible that late Quaternary environmental change on the Queensland continental shelf provided significant ecological and cultural opportunities for people long accustomed to living with dynamic natural systems. Good prospects exist for a clearer understanding of the ecology of environmental change in relation to human experience and cultural development, through the continued integration of palaeoecological and archaeological research.

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