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LATE HOLOCENE FLOODPLAIN PROCESSES

AND

POST-EUROPEAN CHANNEL DYNAMICS

IN

A PARTLY CONFINED VALLEY

OF NEW SOUTH WALES

AUSTRALIA

TIMOTHY J. COHEN BSC (HONS)

.

A thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy

> School of Geosciences University of Wollongong New South Wales, Australia May 2003

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Certification

I, Timothy J. Cohen, declare that this thesis, submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the School of Geosciences, University of Wollongong, is wholly my own work except where otherwise acknowledged. The document has not been submitted for qualifications at any other academic institution.

Timothy J. Cohen May 2003

ABSTRACT

The partly confined valleys of south-eastern Australia provide suitable conditions for the formation of vertically accreted floodplains with laterally stable channels. Three reaches in the Bellinger catchment in the New England Fold Belt on the mid-north coast of New South Wales (NSW) provide sites to assess the attributes of confined floodplains and the impact of European settlement on otherwise highly stable systems. The nature of Late Quaternary floodplain processes in a bedrock-dominated landscape are investigated, providing the evolutionary context for contemporary channel processes.

The Bellinger catchment is characterised by an assemblage of stepped Late Quaternary alluvial units. Late Pleistocene terraces represent large more competent rivers that reworked almost entire valley floors, however, a progressive decline in discharge since the Last Glacial Maximum has resulted in the abandonment of these deposits as elevated terraces or residual alluvium onlapped by contemporary floodplains. The Bellinger catchment exhibits evidence of intrinsic controls on floodplain formation superimposed over an early-mid Holocene climatic signature. A fluvially active period from 12 - 3 ka reworked Late Pleistocene terraces and is termed the Nambucca Phase. In the Bellinger catchment, two floodplain surfaces, one higher than the other, both started to vertically accrete from 4 ka onwards, but with some valley locations remaining vulnerable to episodes of reworking resulting in substantial units of younger alluvium. The high floodplain is dominated by horizontally laminated, vertically accreted sequences, while the low floodplain is characterised by pronounced cut-and-fill stratigraphy. In both instances, vertical processes are the dominant mode of floodplain construction. However, an extensive AMS radiocarbon chronology supplemented with a limited OSL investigation suggests that these two surfaces are not chronologically distinct. In contrast, polycyclic terraces and floodplains can share much the same elevation but be very different in age. The assumption that the continuity of terrace or floodplain profiles along a valley represents coeval formation is shown to be frequently invalid for such confined landscapes.

European settlement from c.1840 transformed the fluvial environment, initiating phases of channel metamorphosis that do not correspond to a previously accepted model of channel change based on proposed cyclical changes in flood activity termed flood- and drought-dominated regimes. Largely in response to deforestation, the Bellinger River has undergone rapid adjustment to changing boundary conditions including measurable channel straightening, a three-fold increase in width, a five-fold increase in channel capacity, bed level incision and a re-configuration of riffle-pool units. These changes have occurred in periods of above-and below-average flood activity and are a direct result of landscape clearance for agriculture, compounded by activities such as within-channel aggregate extraction. In the latter part of the 20th century, channel capacity has continued to increase despite recent increases in riparian vegetation and a decline in flood frequency.

Wide-scale post-settlement entrenchment has produced a diverse range of in-channel depositional and erosional landforms that are not the product of particular discharge return-periods. Deposited over gravel-bar platforms, a variety of cut-and-fill benches have developed and their stratigraphy and form are controlled by their position within the channel, local sediment supply and local energy conditions. Bench processes, along with continued channel expansion, are attributes of a highly disturbed post-European system that currently displays non-equilibrium characteristics.

This significant revision of our understanding of the controlling processes and changing environment in the partly confined coastal rivers of northern NSW has important implications for the management and future rehabilitation of these disturbed systems. The future success of river management in these valleys requires a reach-scale assessment of post-European channel responses, but framed within the context of the longer-term channel and floodplain formation processes.

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SYMBOLS AND NOTATION

The following symbols, notation and units are used unless otherwise specified:

ADR	average-dominated regime - referring to a given hydrological period	
AHD	Australian Height Datum (m)	
BP	conventional radiocarbon age - before present (i.e. AD 1950)	
DDR	drought-dominated regime	
D _{max}	maximum channel depth (m)	
D_{mean}	mean channel depth (m)	
d	intermediate (b-axis) clast diameter (mm)	
d _y	intermediate clast diameter of y percentile (mm)	
d _{5x}	mean size (intermediate diameter) of the five largest boulders sampled (mm)	
ENSO	El Niño Southern Oscillation	
γ	specific weight of water (ρg), assumed to be clear water: 9807 N/m ³	
FDR	flood-dominated regime	
IPO	Inter-decadal Pacific Oscillation	
ka	kiloan, 1 ka = 1000 years	
ka BP	thousands of radiocarbon years	
LGM	Last Glacial Maximum	
MSLP	mean sea-level pressure	
n	Manning's roughness coefficient	
Q_{bf}	bankfull discharge (m ³ /s)	
R	hydraulic radius (m)	
S	energy slope (usually approximated by water-surface slope, or bed slope)	
SOI	Southern Oscillation Index	
SST	sea-surface temperature	
$ au_{c}$	critical boundary shear stress (N/m ²)	
$ au_{o}$	mean boundary shear stress (N/m ²)	
W	water surface width (m)	
W _{bf}	bankfull width (m)	
ω	mean stream power per unit wetted area (W/m^2)	
V	mean flow velocity (m/s)	
XS _A	bankfull cross-sectional area (m ²)	

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