Geomorphology 114 (2010) 161–174

Contents lists available at ScienceDirect

Geomorphology

journal homepage: www.elsevier.com/locate/geomorph

Sediment sources and channel dynamics, Daly River, Northern Australia

R.J. Wasson [a,*], L. Furlonger [b], D. Parry [a], T. Pietsch [c], E. Valentine [a], D. Williams [d]

[a] Charles Darwin University, Casuarina Campus, Ellengowan Drive, Orange Building 2, Level 4, Darwin, NT 0909, Australia
[b] Rio Tinto Alcan Gove Operations, Gove, Australia
[c] Australian Rivers Institute, Griffith University, Brisbane, Australia
[d] Australian Institute of Marine Science, Australia

ARTICLE INFO

Article history:
Received 12 February 2009
Received in revised form 26 June 2009
Accepted 29 June 2009
Available online 8 July 2009

Keywords:
Daly River
Sediment sources
Channel change
Hydrologic change

ABSTRACT

The Daly River occupies a mainly undisturbed large catchment in the Australian wet–dry tropics. Concerns about possible increased sediment input to the River from clearing and cropping have motivated this study of fine sediment sources. Using geochemical tracers for both modern sediments and alluvial bench deposits, it is shown that, for the last ~30 years, 89–97% of the fine sediment originates from erosion by gullying and channel change. There is no discernible input of top soil from the cleared land adjacent to the Daly River in the study area. The analysis and OSL dating of the alluvial benches have also provided data on the age of (and inferences about the causes of) bench formation, flood frequency change, sedimentation rate change, and episodes of sand transport. The benches are being destroyed as the channel widens (contributing sediment to the river) and the bed of the Daly appears to be shallowing, both responses to increased overbank flows. The sediment source created by channel widening is almost all the result of hydrologic change, with no discernible role for land use.

1. Introduction

In this paper we aim to identify the source of fine sediment both in transport and deposited in floodplains in the middle reaches of the Daly River, Northern Australia, particularly to determine if the cleared land between the Douglas River and Stray Creek on the right bank of the Daly River is a major fine sediment source. It will be shown that most fine river sediment comes from channel and gully erosion rather than from sheet and rill erosion. To understand the main channel as a sediment source, the other aim of the paper is to determine the history, nature and causes of channel change. Additional information is generated about the history of floodplain formation, and the frequency of floods.

The Daly Region Community Reference Group (DRCRG, 2004; also see Jackson, 2004) identified sedimentation and habitat degradation of the river as key risks to ecological sustainability. Sedimentation in the river is mostly by coarse sediment, but habitat degradation is the result of both coarse and fine sediment. DRCRG (2004) recognised that '… relative contribution from each sediment source is still unknown…' (p. 103), identifying cleared land, grazed land, river bank erosion, and gully erosion as the possible sources.

There is a great deal of interest in agricultural development in the Daly River catchment, with competing interest from agriculturalists, conservationists, recreational fishers, and local Indigenous people (the Wagiman). The findings of this paper will contribute to sound decision making about the future use of the catchment. In addition, there are few studies of the erosion system and channel dynamics in largely undisturbed large river catchments in the wet–dry tropics. This study will help to fill this gap in understanding.

2. The Daly catchment

The catchment has an area of ~52,500 km^2. The focus of this study is the central to lower part of the catchment, between Stray Creek and the Daly River Crossing (Fig. 1). Much of this is the traditional land of the Wagiman people, and is known by them as Guwardugan (Liddy et al., 2006).

Mean annual rainfall rises from 600 mm in the south of the catchment to 1350 mm in the northwest near the Daly River Crossing (Fig. 1). Most of it falls during the summer monsoon between December and April, with occasional incursions by tropical cyclones (Chappell, 1993). Mean annual depth of runoff at the Nancar gauging station (G140003) (Figs. 1 and 2) is 148 mm, of which 135 mm is from surface runoff and 13 mm from regional groundwater (Jolly, 2002). Baseflow throughout the Dry Season of 7 to 20 m^3 s^{-1} makes this river ecologically different from most others in Northern Australia, but the geomorphic impact of the baseflow is likely to be minor.

The baseflow is largely the result of seepage from the limestone aquifers of the Daly Basin. The rocks are of Cambrian age and underlie almost all of the study area (Fig. 1). At the downstream end of the study area are Mesoproterozoic platform cover sedimentary rocks. At Mt. Nancar, a strike ridge of Depot Creek Sandstone forms the margin

* Corresponding author. Tel.: +61 8 8946 6868; fax: +61 8 8946 6587.
E-mail address: Bob.Wasson@cdu.edu.au (R.J. Wasson).

0169-555X/$ – see front matter © 2009 Published by Elsevier B.V.
doi:10.1016/j.geomorph.2009.06.022

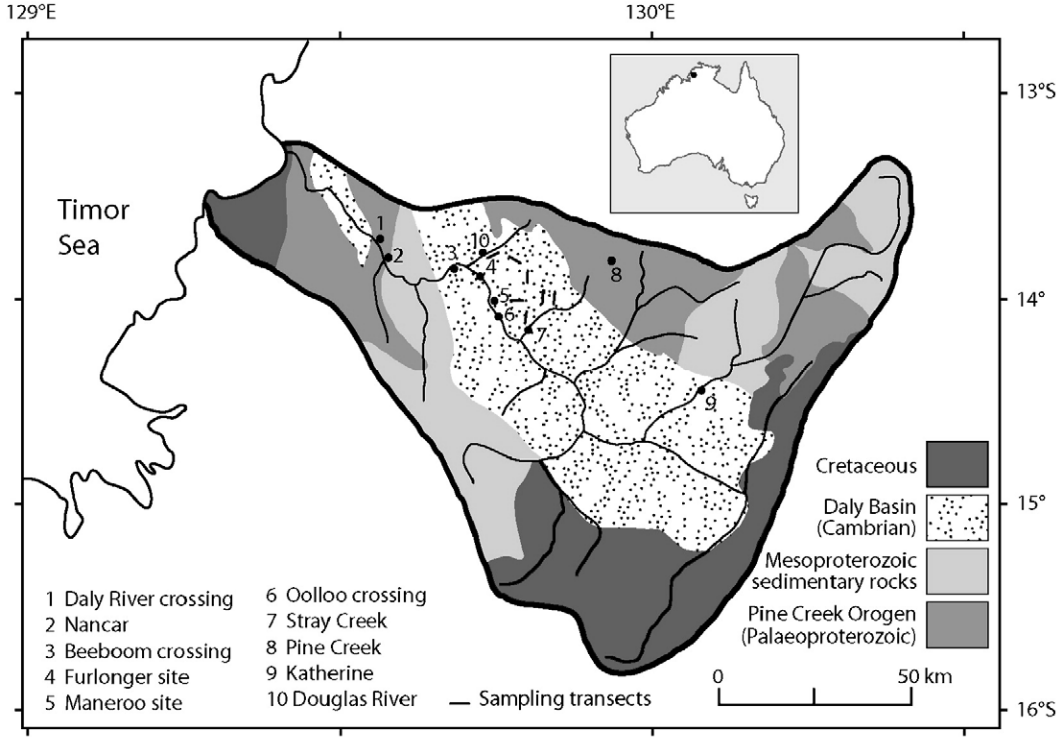

Fig. 1. Daly River catchment — location and geological map.

of the Daly Basin, and a stable site for a gauging station. Upstream of the study area are metamorphic and granitic rocks of the Palaeoproterozoic Pine Creek Orogen and remnants of Cretaceous marine and fluvial sandstone and siltstone.

Soils in the study area are predominantly red earths, with both sandy and loamy varieties, and lithosols on ridges (Aldrick and Robinson, 1972). Elliott et al. (2002) used ^{137}Cs to show that, in the Daly catchment, mean annual soil loss ranges from 228 to 673 t km^{-2} yr^{-1} under different land

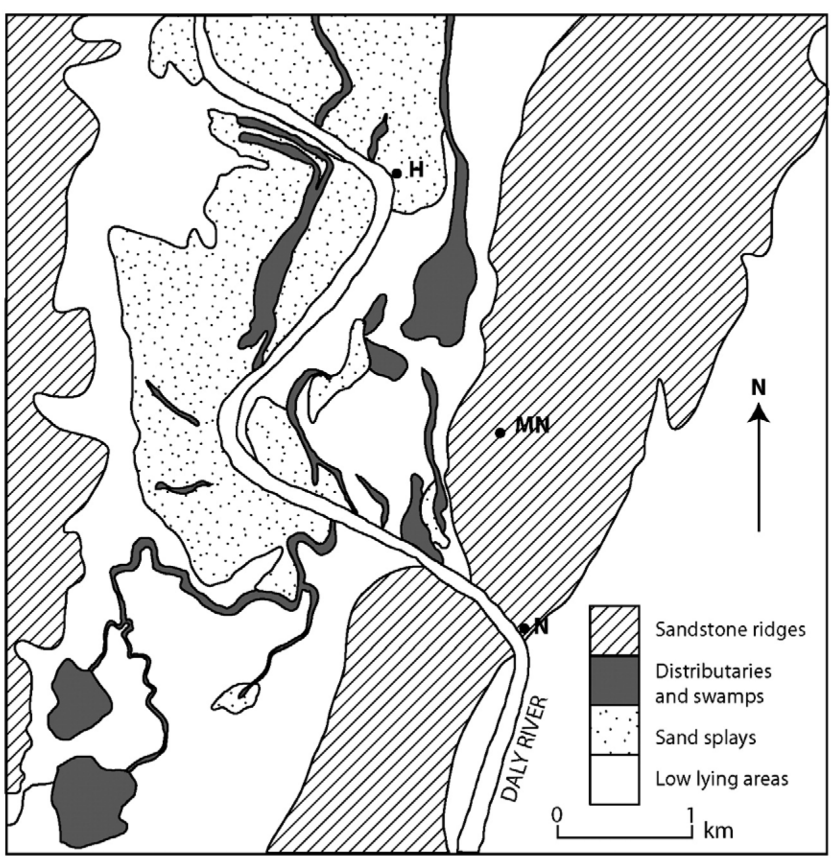

Fig. 2. Map of Nancar area. N — Nancar gauge. MN — Mt. Nancar. H — Nancar Hideaout.