# ARC Linkage-Project

## Summary Final Report for LP0455080

## Title

Restoring hydrological connectivity of surface and ground waters: Biogeochemical processes and environmental benefits for river landscapes.

## Summary

This project examines the restoration of lateral hydrological connectivity to improve floodplain structure and function. The connections between stream flows and both shallow groundwaters and floodplains are critical in sustaining river landscapes. Degrading land and water management practices compounded by natural climatic extremes have severed this link. Restoring hydrological connectivity is vital for replenishing groundwater storage and increasing base flows that affect fundamental riverine processes. Using an innovative approach to sustainable agriculture, our project unites multidisciplinary scientific and industry expertise to investigate the biogeochemical and biophysical effects of secondary floodplain channels and in-stream structures on riverine groundwater processes.

## Research and Industry Participation

### *Investigators*

Professor Richard Bush, Southern Cross University (SCU)

Professor Ian White, Australian National University (ANU)

Professor Leigh Sullivan, Southern Cross University (SCU)

Professor Wayne Erskine, University of Newcastle (UoN)

Dr Greg Bowman, Department of Environment, Climate Change and Water (DECCW)

Dr Lee Bowling, Department of Environment, Climate Change and Water (DECCW)

Dr Annabelle Keene, Southern Cross University (SCU)

Mr Michael Cheetham, Southern Cross University (SCU)

Mr Peter Somerville, Australian National University (ANU)

### *Industry Partners*

New South Wales Department of Environment, Climate Change and Water (DECCW)

Hunter-Central Rivers Catchment Management Authority (HCRCMA)

G Harvey Nominees Pty Ltd (GHN)

# Key Outcomes

The major findings of our ARC L-P research undertaken in the Widden Valley are briefly stated here:

- Reduced sand mobilisation forms pools and riffles and causes bed armouring in straight, sand-bed streams.
- Natural bench formation is the most important geomorphic process in channel contraction.
- *Casuarina cunninghamiana* accelerates bench development and plays a synergistic role in channel contraction.
- Laser diffraction and sieve/hydrometer methods can be combined to provide consistent and comparable grain-size distributions for sand-dominated fluvial sediments.
- Ongoing alluvial deposition has occurred through the Holocene, preserving river terraces, indicated by a continuous chronology.
- Exceedance of geomorphic thresholds and catastrophic floods are the dominant controls on river terrace formation from non-synchronous, episodic incision events.
- Stream salt loads are highly variable, compounded by variable baseflow and underestimations of rainfall, in a dominantly recharging system.
- Mineral weathering is a major contributor to stream salinity, mobilised from river terrace sediments.
- Stream water and ground water are strongly connected in alluvial channel and floodplain sediments.
- Macroinvertebrate health has indicated the importance of maintaining pools for biological stream health.
- *Baramul* NSF stream works have facilitated sand storage, vegetation recovery and localised channel-floodplain hydrological exchange, important for pool-riffle development, channel contraction and hyporheic function.

The details of these key research outcomes are produced in our ARC L-P Final Report, which may be downloaded from http://www.scu.edu.au/geoscience/index.php/55/.

# Landscape response to NSF at Baramul, Widden Brook

By far the most common questions asked of our research project revolve around NSF, and how it has affected the landscape. Next are specific inquires on how NSF was implemented and where it is likely to benefit the environment and agricultural productivity. Our research focussed on the NSF management and interventions within the river and immediately adjacent floodplain. Aspects of NSF involving the broader valley landscape and agricultural productivity have been practiced at

*Baramul*, and these concepts described by Peter Andrews, but were beyond the scope of our investigations. A concise response to six key questions raised by the collaborators and broader public for our research program is provided below:

*Q: What is NSF?*

**A: As applied at Widden Brook, NSF is a sequence of flow control/bed stabilisation structures within the stream. NSF included limited stock grazing and revegetation with exotics and natural regeneration of plants.**

*Q: Where do you apply NSF?*

**A: NSF is most suited to areas dominated by local fresh ground water systems in highly transmissive floodplain sediments. The main consideration is the size of the stream and floodplain system. Small upper catchment streams and gully systems are best suited to the NSF approach.**

*Q: Does NSF affect the availability of stream water?*

**A: NSF had no measurable effect on stream flow in Widden Brook. However, this observation is very site specific and limited to the rainfall and runoff observed during the monitoring period.**

*Q: Can NSF reduce salinity?*

**A: NSF had varied effects on salinity in different landscape settings. Adjacent to the flow structures, a very localised decrease in salinity occurred due to increased lateral connectivity of the surface water with the shallow groundwater. In highly transmissive sandy floodplain sediments, the salt loads are low and NSF had no significant effect on stream salinity. However, where the stream or secondary diversion channels intersect with older salt laden terrace sediments, there was a high risk of increased salinity by NSF.**

*Q: Can native plants work as well as willows?*

**A: Native plants such as river oak (*Casuarina* spp) have proven extremely effective at stabilising stream beds and banks. Stock exclusion and limited grazing enhanced the establishment of native seedlings. The use of natives for this purpose is preferred over exotic weeds.**

*Q: Can you achieve the same environmental outcomes by excluding livestock?*

**A: Many of the observed benefits of NSF can accrue from excluding livestock, the most important benefit being the establishment and growth of riparian vegetation. However, other benefit such as short-term sediment storage will not be immediately addressed.**