An interdisciplinary perspective of riverwork projects in the Upper Hunter Catchment, NSW: has river rehabilitation begun?

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Abstract

River rehabilitation and management activities in the upper Hunter catchment, New South Wales over the last 50 years are presented from both a geomorphic and social perspective. 517 riverwork projects have been implemented in the upper Hunter catchment from 1952-2000. Nineteen different types of works were used. Projects were concentrated along laterally-unconfined rivers and were largely implemented after major phases of geomorphic river change. Since 1952, river management activities have evolved from an engineering-based paradigm towards an ecosystem-based approach. However, the same types of works were applied across all types of river. Riverworks addressed the symptoms, not the causes of river change, focusing upon bank erosion rather than bed instability. Findings from interviews with local landholders are used to appraise the community's knowledge, views and opinions on riverwork projects and management actions. Several fundamental challenges to successful rehabilitation are identified, including alienation, communication, ownership and use of science in management and decision-making processes. The results confirm the concept that effective rehabilitation and management require meaningful collaboration between all stakeholders. The evolution of rehabilitation techniques, use of science and community perspectives discussed provide insight into the long-term outcomes of past management activities. By assessing the outcomes of rehabilitation investments, a constructive way forward can be achieved which integrates the science of river management, community values and involvement in rehabilitation processes. Findings presented suggest that in the upper Hunter catchment, true rehabilitation is yet to begin.

Keywords

River rehabilitation, riverworks, cross-disciplinary, geomorphology, community values

Introduction

In the past, the role of river rehabilitation has generally been associated with channel stabilisation, sediment control and flood mitigation. To date, rehabilitation strategies and management practices have been largely experimental and viewed more as an art form, rather than practices based on scientifically sound knowledge. Application of traditional river engineering techniques has sought to stabilise the channel through structural measures (Sear *et al*., 1994; Williams, 2001).

Today it is recognised that past aims and assumptions, made in terms of notions of equilibrium and stability, do not achieve sustainable, beneficial outcomes (Sear *et al.*, 1994). Rather than repairing damage after it has occurred, contemporary rehabilitation projects are proactive, aiming to promote and enhance recovery processes, and embrace complexity and variability (Wohl *et al*., 2005). To achieve this it is essential that rehabilitation and management abandon their reactive and parochial approach and move to an acknowledgement and understanding of the dynamic and complex nature of river systems and their catchments (Leeks *et al.*, 1988). Framing rehabilitation projects within a geomorphic context enables a holistic view that places reach-based applications within their catchment context (Rutherfurd *et al*., 1998; Brierley & Fryirs, 2005).

Successful rehabilitation entails monitoring the outcome of past, present and future projects to obtain information on the feasibility and success or failure of the different techniques and approaches applied. Despite their rapidly growing number, very few river rehabilitation projects conduct systematic post-project evaluation (Bernhardt *et al*., 2005). Without undertaking such evaluation and publishing the findings, lessons cannot be learned from the successes and failures. This makes it difficult for the field of river rehabilitation to advance (Bernhardt *et al*., 2005).

Engagement of the community from the beginning of the rehabilitation process is critical. Through involvement, the community can provide local knowledge, which assists in setting practical and achievable goals and enhances collaboration in on-the-ground works and monitoring. Such inclusion increases the community's knowledge and understanding of the project, and empowers them as advocates (Selin *et al*., 2000). Through application of a 'duty of care', communities are best placed to take action on issues that affect them, rehabilitating their river and ensuring that goals are socially appropriate (Carr, 2002; Gillilan *et al.*, 2005).

Hence, river rehabilitation and management is not solely a scientific process. It is also a social process. However, given that the area has inherent cross-disciplinary interests and potential, there are surprisingly few practical examples of interdisciplinary collaboration (Ormerod, 2004). The significance and relevance of this paper lies in the combination of scientific and social interaction in an analysis of long-term outcomes of past management activities, examining the question: has river rehabilitation really begun in the upper Hunter catchment?

Methods

The research process firstly involved a review and analysis of government and academic literature (Spink, 2006). This was followed by the examination of departmental data and historical photographs relating to riverwork projects and management activities within the catchment. Thirdly, examination of parish maps and scenes of historical aerial photographic interpretation was undertaken to firstly determine and analyse the location, timing, and nature of channel change; and secondly, to relate the location and timing of riverworks to channel change. River Styles classification was based on Spencer *et al.* (2004). Fieldwork was then undertaken, involving primarily the construction of numerous channel cross-sections at sites of incision and resurveying at riverworks sites, to determine the timing and extent of channel incision, and/or aggradation. Lastly, statistical analysis, including a hierarchical cluster analysis and an analysis of similarities, was conducted using the software program Primer 5 version 5.2.0.

In-depth interviews were used to collect information from local landholders concerning the community's knowledge, views and opinions on riverwork projects and management actions. The community responses were acquired from a total of twenty landowners who live along Dart Brook, the Hunter River, and the Pages River. Interviews were planned around five key themes: namely river change, riverworks, issues and concerns, goals of river management, and the role of the community, scientists and the government in addressing river rehabilitation. The themes were then interrogated through QSR NVivo 2.0, a qualitative data analysis software program.

Results

Riverworks and relationship to river type and river change
Installation of riverworks commenced in 1952. In the period up to 2000, 517 separate riverworks projects have been undertaken. Within riverwork projects, 19 different types of works were used (Table 1). Seven of the thirteen rivers in the catchment have had works implemented. These rivers are Dart Brook, the Hunter River, the Isis River, Kingdon Ponds, Middle Brook, the Pages River, and Rouchel Brook. Across the catchment, the majority of projects were concentrated along channels in laterally-unconfined valley-settings, with a ratio of one project for every 0.38 km of river (Table 2). The greatest concentration of projects was along the laterally-unconfined low sinuosity gravel bed reach, which averaged one project every 0.3 km.

From 1952 until 1980, projects were heavily influenced by engineering techniques (Figure 1). However, between 1971 and 1981, there was a sharp decline in engineering works, coupled with an increase in heavy machinery and a significant increase in vegetation works. This escalation in vegetation works resulted in the widespread establishment of willow, oak and poplar plantations within riparian zones. Such a shift away from engineering approaches may have been influenced by recognition, within the wider scientific community, of the need to move towards more ecologically friendly techniques.

Table 1. Riverworks used in projects.

Engineering	Heavy Machinery	Vegetation
concrete blocks and cable	channel diversion	brush cuttings
cable and brush	earthworks	burn off
groyne	levee construction	desnagging
mesh	rock works	lopping or removal of willows, oaks and poplars
piles		planting of natives
piles and grid mesh bays		planting of willows, oaks and poplars
piles and rolled mesh		stock proof fence
skirting		

Table 2. Concentration of projects within each valley-setting and River Style.

Valley-Setting and River Style	Total River Length (km)	Average river length per project (km)	Average valley-setting distance per project (km)
Confined			
occasional floodplain pockets	21.47	1.19	1.19
gorge	2.37	0.00	
steep headwater	22.43	0.00	
Partly-confined			
bedrock controlled discontinuous floodplain	243.83	2.71	1.42
meandering planform controlled discontinuous floodplain	117.09	0.89	
low sinuosity planform controlled discontinuous floodplain	25.04	0.51	
Laterally-unconfined			
low sinuosity gravel bed	23.50	0.30	0.38
low sinuosity entrenched gravel bed	5.31	1.06	
meandering gravel bed	22.42	0.36	
meandering entrenched gravel bed	31.87	0.45	

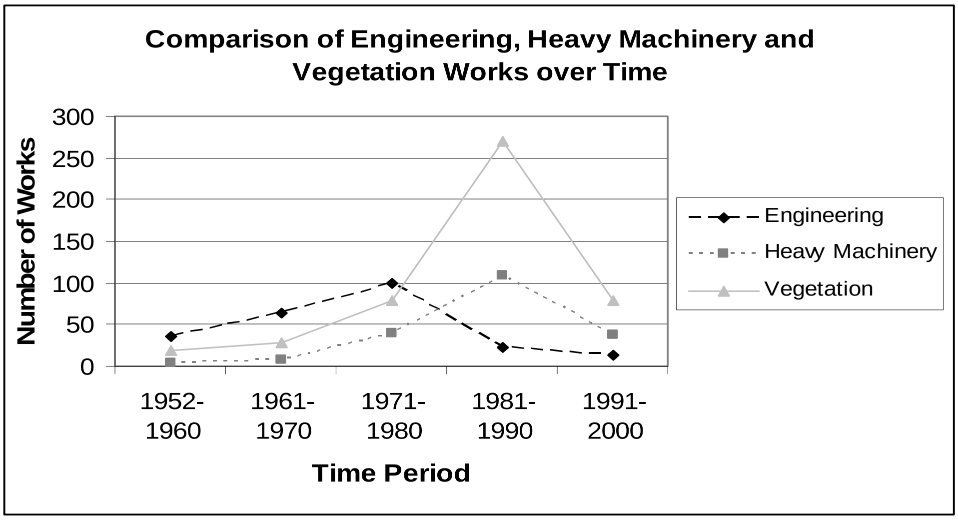

Figure 1. Relationship between engineering, heavy machinery and vegetation works.

The dendrogram plot in Figure 2 shows that all River Styles have at least 23.5 % similarity in terms of the number and type of works implemented. Laterally-unconfined meandering entrenched gravel bed reaches and partly-confined meandering planform controlled discontinuous floodplain reaches had 81.4 % similarity. Such similarities between River Styles highlight that works implemented were not tailored to specific River Styles or valley-settings, with works applied to five of the eight River Styles being almost 50 % similar. In addition, the R-value calculated from an analysis of similarities was 0.193; indicating that there is higher works similarity between each River Style rather than within each River Style. This suggests that the same types of works were applied to different types of river.

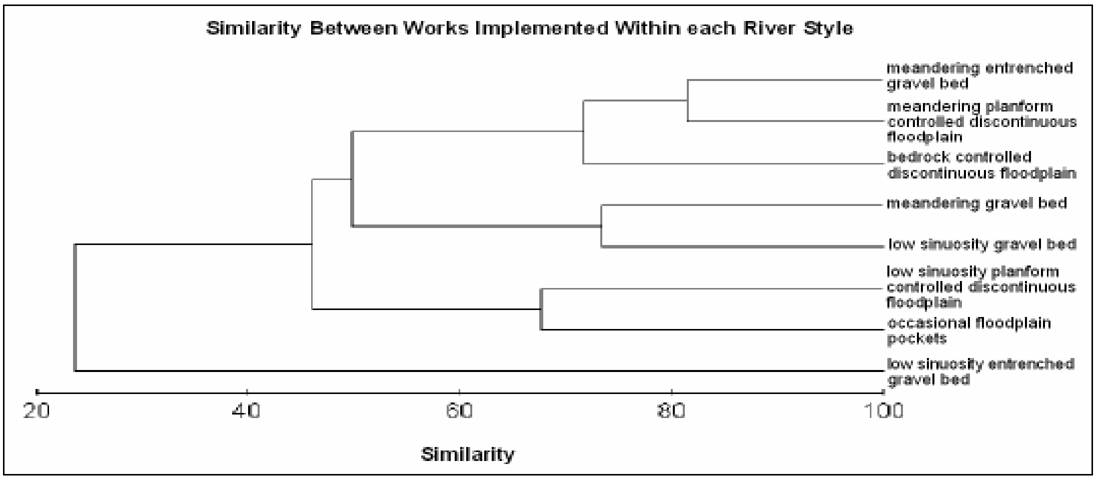

Figure 2. Similarity between each River Style based on the types of works implemented

At the catchment-scale, 88 % of all riverwork projects were implemented at locations of channel adjustment. Significant channel change consistently occurred within the lower laterally-unconfined reaches of Dart Brook, the Hunter River and the Pages River. Extensive channel expansion occurred from 1938-1955 at these locations. These reaches were also areas where riverworks for erosion control and bank stabilisation were constantly undertaken, with progressive upstream implementation of projects. This is particularly evident along Dart Brook, where riverworks were consistently undertaken from 1971 onwards, even though the last significant phase of planform channel change had occurred from 1938-1955. Across the catchment, from 1952-2000, no bed control structures were established to address channel incision. Projects attempted to address planform channel adjustments through bank stabilisation techniques. However, these planform adjustments were river responses to channel incision.

Community knowledge, understanding and involvement

Results from interviews indicate that the community in general does have a degree of knowledge and understanding regarding the various types of riverworks, as well as the reasons for their implementation. Many of the participants were aware of past riverwork projects. However, respondents were sceptical as to the projects' effectiveness. Many people found it difficult to perceive the advantages of such projects. Aligned with this, some people believed that although the works were effective in achieving their goals, they were not in the best interests of the river.

A number of concerns and issues emerged in relation to government departments. These included: communication within government departments, as well as with the community; equality and fairness regarding the prioritisation process for riverworks; the dismissive nature of departments relating to community members' concerns and views on management actions; and finally, the lack of the application of 'science'. The concerns and issues raised by participants highlight the barriers between the community and the government. These barriers have produced feelings of dislike, frustration and powerlessness. These feelings have not only stemmed from the personal experiences of the respondents, but also from their observation of management plans and measures adopted by departments.

In addition, participants were also asked about any concerns and issues they had towards the community's views and attitudes regarding the river. Their responses highlight a perceived need to address concerns as a community in order to effectively participate and communicate with scientists and government departments. Identification of concerns, such as the community's lack of care and connection to the river and the difficulty in addressing river problems within a diverse community, indicate that participants are aware of the challenges.

Respondents' vision and goals for the river indicate that there is an understanding of the need for cooperation, ownership and shared knowledge within the community, as well as with the scientists and the government departments. Strategic planning, cooperation and participation, ownership of knowledge and understanding, as well as working within an adaptive management framework, were identified as important components towards achieving better outcomes for the river. These responses demonstrate that the community does possess the foundations on which goals for river rehabilitation and care can be built.

Investigation of the interaction of the community, scientists and the government, revealed the need for cooperation and communication between the three groups. Respondents were concerned and frustrated by the lack of 'hands on' experience of both scientists and the government. They also perceived that the scientists and government agencies have limited local knowledge and, this in turn, affected the scientists and government's credibility. Additionally, respondents felt that both the government and the scientists have a responsibility to inform the community in an appropriate and meaningful way. Participants believed that these issues must be tackled to more effectively link the various roles played by each group, and consequently improve the outcomes of river rehabilitation and management.

Discussion

River rehabilitation techniques and management approaches in the upper Hunter catchment have evolved over time. During the 1950s, engineers designed and constructed river engineering works that would stabilise the channel, prevent further bank erosion, and realign the channel flow away from eroding banks (Reddoch, 1957). Between 1952 and 1984, this 'command and control' ethos was highlighted by the use of relatively hard engineering structures. In 1985 a significant shift occurred from a construction phase to a maintenance phase. This period to 2000 was dominated by vegetation based projects, accompanied by minimal structural works.

While there has been progress in the development of more ecosystem based riverwork techniques and management strategies, until very recently (i.e. since 2000), projects continued to address the same perceived problems of erosion control and bank stabilisation. The targeting of such problems was largely in response to extensive channel expansion that occurred between 1938 and 1955 within the lower reaches of Dart Brook, the Hunter River and the Pages River. However, the timing and extent of channel expansion and incisional adjustments indicate that bed level instability was the primary trigger for these secondary responses. Between 1952 and 2000, no bed control structures were implemented to address bed instability. Such limited appreciation of geomorphological processes has resulted in rehabilitation practices targeting the symptoms, rather than the underlying causes, of river change (Leeks *et al*., 1988; Rutherfurd e*t al*., 1998).

Within the upper Hunter catchment there is little evidence to suggest that geomorphological processes and linkages were effectively interpreted or recognised. The geomorphology of the various reaches and river systems was not used to guide the types of riverworks, the subsequent implementation of projects, or associated management practices. The narrow aims and single function application of riverwork projects occurred with limited recognition of the connectivity of the river system (Williams, 2001). Projects were repeatedly undertaken at the same locations, or sections of river. Riverworks were not tailored to the specific character and behaviour of different reaches. Rather, a 'blanket' approach was adopted, with the same riverworks implemented across the catchment, regardless of fluvial processes and functions.

Considerable challenges must be met to ensure that meaningful use is made of available knowledge. The upper Hunter community is concerned about the 'science' available to river management and its appropriate use. These concerns are shared by Lake (2001), who believes that available scientific knowledge is not being implemented correctly, due to social and institutional constraints which limit the capacity for effective management. Managers need to be facilitators in the use of scientific information which underpins successful implementation of river rehabilitation initiatives (Gillilan *et al.*, 2005; Wohl *et al*., 2005). The onus should not be placed on the community to ask for scientific information. Instead, more interaction between managers and the scientific community is needed so that practical experience is integrated with the science of rehabilitation (Gillilan *et al*., 2005).

It is increasingly recognised that support from a wide cross-section of the community is required if river management strategies are to work (Selin *et al.,* 2000). It is through liaison and involvement with the community that long-term socially and environmentally sustainable river management outcomes can be achieved. Failures to incorporate the community into rehabilitation and management programs have caused scepticism within the community towards government departments. The community believes that their alienation from implementation and decision processes is the result of government departments ignoring the community's local knowledge and resources. Focus now needs to be placed on the creation of a middle ground for the community, scientists and government departments (Carr, 2002; Brierley and Fryirs, 2005).

Conclusion

This interdisciplinary appraisal of river rehabilitation and management activities in the upper Hunter catchment prompts the question whether past practices can been seen as rehabilitation, or whether true rehabilitation is yet to come? Even though rehabilitation techniques have evolved, embracing advances in scientific understanding of river character and behaviour has been a slow process. Projects were largely a response to perceived problems. This resulted in the symptoms rather than the causes of river degradation. As yet, the upper Hunter catchment lacks a coherent, scientifically rigorous plan of action that is owned and shared by the community, scientists and government departments. The future of rehabilitation lies in the integration of the science of river management, community values and participation in decision-making processes. This assessment of past rehabilitation investments in the upper Hunter catchment suggests that a phase of true river rehabilitation has yet to truly commence.

Acknowledgements

The results presented form part of a recently completed Master of Science (Hons) thesis by Alexandra Spink. The authors acknowledge the comprehensive data made available by the Department of Natural Resources. Sincere thanks to the residents of the catchment who shared their knowledge and experience.

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