Anabranch management on a regulated reach of the Murray River

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Abstract

The development of anabranches on the Lake Hume to Yarrawonga (Lake Mulwala) reach of the Murray River has the potential to impact upon the social, economic and environmental values of the system. The strategic management of the anabranch networks throughout this reach is therefore considered a vital component to the overall management of this iconic river. Although challenging, the successful implementation of a strategic works program has the potential to delay the ultimately unavoidable capture of the main channel in most instances while providing overall benefits to the river system and neighbouring community. The Department of Natural Resources (DNR) is responsible for the implementation of an innovative, large scale works program on the Murray River between Lake Hume and Yarrawonga primarily focussed on channel change and anabranch management. Numerous constraints exist to the potential success of rehabilitation works including some, such as reversed flow seasonality and sustained high flow periods that are unique to such heavily regulated river systems. This paper investigates the strategic management options for anabranch management and reviews two management tools (rock beaching and timber pile fields) utilised in the management of channel change and anabranch development within this reach.

Keywords

Anabranch management, geomorphology, river rehabilitation, timber pile fields, rock beaching

Introduction

The Murray River has been classified as a *"Type 3: mixed-load, laterally active anabranching river"* (Nanson & Knighton 1996, pg. 225). This classification is applicable to the Lake Hume to Yarrawonga reach of the Murray River, defined by the Lake Hume dam wall through to the upstream extent of Lake Mulwala backwater, refer to Figure 1. The reach includes approximately 200 kilometres of parent river channel in addition to a significant anabranch network. Several regional cities and towns are located within this reach including Albury – Wodonga, Howlong, Corowa and Wahgunyah.

The rate and process of channel change within this reach has been altered by anthropogenic impacts due to the competing values and uses of the Murray River. Erskine *et al*. (1993) investigated channel changes on the Lake Hume to Yarrawonga reach of the Murray River and proposed that the changes having greatest influence on the physical form of the channels were:

- river regulation
- floods
- de-snagging
- changes in riparian vegetation
- boat waves

In recent times there has been a strong focus on managing these impacts on channel change along the Murray River. Anabranch development, although a natural process within this reach, is considered a significant management issue also. The development and evolution of anabranches involves the erosion and enlargement of a channel system until most, if not all of the flow has been captured from the parent channel. Anabranch development potentially has significant implications for the social, economic and environmental values within a reach.

Hume to Yarrawonga (Lake Mulwala) management strategy

In 2001 the key document used to guide the overall management strategy for the Hume to Yarrawonga (Lake Mulwala) reach of the Murray River was finalised, this being the *Scoping Study – Waterway Management Plan, Hume to Yarrawonga reach of the Murray River* (ID&A, 2001). This study provides a knowledge base and broad strategies to guide the management of the Murray River through this reach. The Scoping Study also acknowledges that some key management actions may be applicable to the entire Hume to Yarrawonga (Lake Mulwala) reach of the Murray River, whereas other key management actions may be applicable to individual sections or 'management zones' within the reach. Consequently the Hume to Yarrawonga (Lake Mulwala) reach of the Murray River was divided into fifteen management zones, primarily based on the major anabranch systems within the reach (refer to Figure 1).

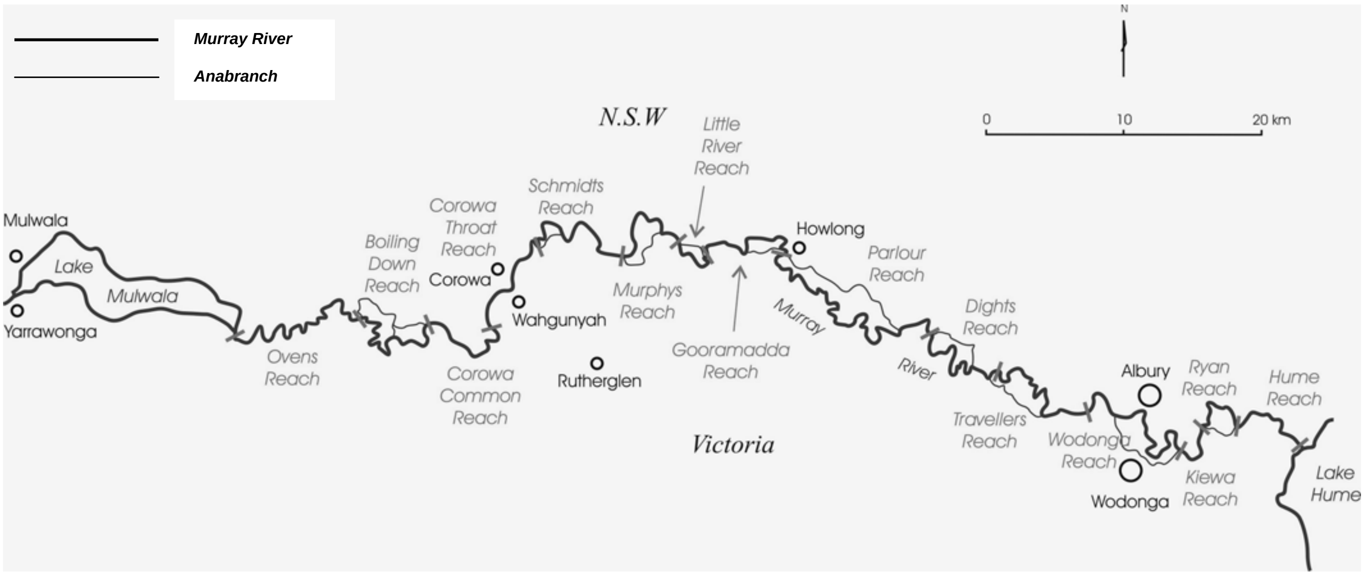

Figure 1. The fifteen management zones within the Hume to Yarrawonga (Lake Mulwala) reach of the Murray River. The management zones were primarily defined by the major anabranch systems within the Hume to Yarrawonga (Lake Mulwala) reach (ID&A, 2001).

Vision and objectives

The Scoping Study identifies a vision for the Lake Hume to Yarrawonga reach of the Murray River. This vision, thought of as being a broad objective to be achieved through the successful management of the river system, states 'The Hume to Yarrawonga reach of the Murray River shall be managed as a component of a self-sustaining ecosystem that maximises compatible economic and water supply opportunities.'

The vision highlights the competing values of the river (water conveyance, economic production and the environment) that need to be retained or improved and acknowledges that a balance needs to be achieved through compromises and trade-offs to successfully manage for the three competing values. The Scoping Study also identifies more detailed objectives and also states that the reason for intervening in the rivers physical form is to manage the altered rates of bank erosion, bed degradation or aggradation and anabranch capture and the implications those processes have for the ecosystem integrity and human amenity.

River management plans

The DNR is currently in the process of developing River Management Plans for all fifteen management zones. The River Management Plans assist the DNR in identifying the features, values, issues and management activities for the Murray River, and its associated floodplain features including anabranches that are affected by regulated flow within each management zone. The management activities identified in the River Management Plans include works activities which seek to manage both anabranch development and channel change within the Murray River. The implementation of these works activities identified in the River Management Plans commenced in 2002 and have been undertaken on an annual basis since. Works activities implemented prior to this time were largely undertaken on a site by site basis, independent of a reach based management plan.

In addition to the proactive management activities identified and implemented as part of the River Management Plan process, works activities are also undertaken by the DNR to address issues that develop from time to time which are identified independently of the River Management Plan process.

Strategic approaches to anabranch management

To effectively manage anabranch evolution on the Murray River between Lake Hume and Yarrawonga (Lake Mulwala) it is considered beneficial that an overall strategy be adopted based upon our knowledge of anabranch evolution, whilst also considering social, economic and environmental values. Three broad strategies for the management of anabranch evolution are discussed in more detail below.

Option 1 - Intervention to prevent anabranch evolution
This strategy refers to the implementation of works to stop or dramatically slow the processes of anabranch development. Rather than recognising how anabranches evolve and managing these processes, this strategy aims to prevent such processes from occurring. Such a strategy has been used in the past on the Murray River to manage anabranch evolution.

Particular examples of actions previously undertaken to prevent anabranch development in the Lake Hume to Yarrawonga reach include the construction of a weir across the bifurcation of Ryan Creek and constructing a wall across the bifurcation to Schmidts Creek. In these cases there has been quite drastic intervention to alter, primarily reduce, the flows entering the anabranches. Such intervention has other consequences such as a loss of continuity in sediment transport, a loss of fish passage and a reduction in connectivity for other riverine processes and biota.

In the past, works have also been undertaken in anabranches to address bank erosion. These works have been implemented in anabranches of low sinuosity and steep gradient where the bank erosion is not just occurring through channel widening, but also from lateral bend migration (concave bank formation). This lateral bend migration has the potential to increase anabranch sinuosity which in turn has the potential to decrease both flow capacity and erosion rates within an anabranch (Judd, 2005). Conversely, Judd (2005) also found that preventing erosion on concave banks and subsequently preventing any increase in sinuosity may actually increase overall erosion through widening.

Option 2 - Manage the impacts of anthropogenic effects on anabranch evolution
In anabranching river systems there is a natural tendency for some channels to develop and capture the parent river channel (Brizga & Finlayson, 1990; Erskine *et al*., 1990; Erskine *et al*., 1993; Schumm *et al*., 1996; Jones & Schumm, 1999; Nanson & Knighton, 1996). However, on the Lake Hume to Yarrawonga reach of the Murray River this evolution process has been altered by anthropogenic impacts such as flow regulation, vegetation clearing and de-snagging (Erskine *et al*., 1993). For example, Judd (2005) demonstrated that a change to the flow regime, such as that which has occurred on the Murray River (Maheshwari *et al*., 1995), will affect the evolution of anabranches.

The strategy of managing the impacts of anthropogenic effects on anabranch evolution involves works that are implemented to compensate for alterations to natural conditions. In the case of vegetation, this suggests revegetation programs should be undertaken to restore the riparian zone. With regulation resulting in more in-channel flow it might suggest that works are undertaken to dissipate flow energy, at least while vegetation is getting established.

The Scoping Study (ID&A, 2001) is consistent with this approach, stating that the reason for intervening in the rivers physical form is to manage the altered rates of bank erosion, bed degradation or aggradation and anabranch capture. The Scoping Study emphasises the need to manage the river in 'a manner that is consistent with its laterally migrating, anabranching morphology'.

Option 3 - Do not manage anabranch development
This strategy involves not intervening with physical works to alter anabranch development. Historically, it is a strategy that has, by default, effectively been in place across most of the Lake Hume to Yarrawonga reach.

Management tools

Numerous management tools have been utilised to date within the Lake Hume to Yarrawonga reach in an attempt to manage channel change and anabranch evolution. Two of these tools, timber pile fields and rock beaching are discussed in detail below.

Rock beaching

Rock beaching is a layer of rock (generally blasted and sorted angular quarry rock) placed against a stream bank to protect it from erosion. It has been utilised in many river systems, including the Murray River between Lake Hume and Yarrawonga. Additionally, rock beaching is the favoured management approach by many landholders as it usually a quick, successful tool for halting further bank retreat when compared to approaches that are more sympathetic to the alluvial environment such as pile fields and revegetation. Large scale rock beaching of banks is not considered compatible with the evolution of a laterally migrating, anabranching river system such as the Hume to Yarrawonga (Lake Mulwala) reach of the Murray River (Judd, 2005; Schumm *et al*., 1996). The medium term consequences of rock beaching include:

- prevention of natural adjustments in channel width. Channel width is an important determinant of sediment transport rates (Bagnold, 1977) and is important to the formation of pool-riffle sequences (Wilkinson *et al*., 2004)
- anabranching on the Murray River involves the sinuosity of evolving channels increasing until the channel is abandoned in favour of an alternate course (Schumm *et al*. 1996). Hence, rock beaching of the outside banks of meander bends is likely to lead to fundamental changes to the development of anabranches and the overall channel pattern
- meander bends not only extend laterally towards the edge of the floodplain, they are also translated downstream over time. Hence, the rock beaching of the outside bank of a bend will prevent one bend from moving whilst the remaining meander train moves downstream. Over time the sinuous plan form of the channel alters, eventually cutting off the rock beached meander bend
- the erosion of the outside banks of meander bends, leading to meander extension and an increase in sinuosity, fundamental to the anabranch evolution described by Schumm *et al*. (1996), facilitates a reduction in channel slope that may lead to a reduction in the width of the channel. Preventing bank erosion and an increase in sinuosity within a reach using rock beaching is likely to result in a net increase in erosion (Judd, 2005)
- the alteration of the near bank habitat that is important to aquatic fauna

Hence, the continued rock beaching of banks on the Murray River and its associated anabranches within the Hume to Yarrawonga (Lake Mulwala) reach may prevent or retard the natural development of in-stream features and, in the long-term, the laterally migrating nature of the anabranching system.

Timber pile fields

The application of timber pile fields in the Lake Hume to Yarrawonga reach of the Murray River has involved the use of straight grained, native hardwood timber piles which are driven in rows angled in a downstream direction (Figure 2). Timber pile fields have superseded rock beaching as the most utilised technique in managing channel change and anabranch evolution within the Lake Hume to Yarrawonga reach of the Murray River.

Figure 2. A timber pile field site constructed on the Murray River in 2006.

The primary function of the timber pile fields is to prevent stream bank erosion which is occurring via processes related to either lateral migration or channel widening. The timber pile fields fit into the general category of river management works called distributed drag structures (Dyer *et al*., 1995). They act as an artificial form of flow resistance, replacing that which would originally have been provided by large woody debris and vegetation. These structures are designed to:

- decelerate flow surrounding the pile fields and stream bank, thus removing high velocity and high shear stress flow from the stream bank
- create a depositional environment which encourages bench formation and provides conditions suitable for revegetation and regeneration

Furthermore timber pile fields have been utilised in the strategic management of anabranch development to increase obstruction resistance within a reach of channel. Additionally, timber pile fields may increase in-stream habitat availability and diversity.

The establishment of vegetation is considered an essential element to the long term success of pile field sites as it is assumed that the timber pile fields have a limited life span of approximately 20 – 30 years. By this time it is expected that the revegetation shall be sufficiently established to stabilise the stream bank, replacing the need for pile fields.

Several constraints exist in relation to the implementation and potential success of timber pile fields to reduce rates of stream bank erosion and anabranch development. To date pile fields have been constructed during low irrigation flow periods within the river system to gain maximum availability to the river network. However in most instances access is limited to the top of the stream bank. Consequently the distance to which pile fields can extend into the stream is limited by the arm length on the excavator, which typically allows a maximum pile field row length of between 8 and 10 metres.

The successful application of timber pile fields in the Murray River system is compromised by the effects of river regulation. The consistency of high regulated flows create unfavourable conditions for vegetation establishment on the bank between the pile fields. Also, high regulated flow does not provide the fluctuation in discharge and stage that facilitates sediment settling out on the receding limb of the hydrograph.

Conclusion

Understanding the behaviour of anabranching river systems is considered vital in identifying and implementing an appropriate management strategy for anabranches. In the past, the management strategy for anabranches on the Murray River within the Lake Hume to Yarrawonga reach has largely involved activities which aim to prevent anabranch development. Similarly, works have been undertaken to prevent the lateral migration of bends on anabranches which is not consistent with the laterally migrating nature of the Murray River and according to Judd (2005) may in fact increase the net erosion within an anabranch. Our current knowledge of anabranch evolution suggests the most appropriate anabranch management strategy involves allowing anabranches to migrate laterally, whilst undertaking works to dissipate energy and manage channel width. Using this approach it is likely that anabranch evolution can be managed to result in a gradual increase in sinuosity and an associated stabilisation of channel width and overall channel form. Similarly, the key management tools used to address channel change and anabranch development need to be consistent with the behaviour of the river system. Whilst the success of these tools may be compromised by external influences such as regulated flow, recognition of these limitations allows adaptations to the design technique. Hence, implemented correctly these works can assist the rehabilitation of an anabranch network that has been impacted by anthropogenic influences, thus improving the environmental, social and economic values.

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