

1 Adaptive Management

Adaptive management has become the preferred method of natural resource management (NRM) in Australia over the last two decades. Adaptive management is a scientific approach to management and aims to achieve goals and objectives by applying an efficient and effective *learn by doing* process to address the risks and uncertainties inherent within unpredictable systems like natural ecosystems and socio-economic environments.

A resilience framework was adopted in the review of the Wheatbelt NRM Strategy, to better reflect the complex interactions that exist between socio-economic and environmental systems within the region. A scientific and adaptive approach to management, such as that provided by adaptive management, is necessary when applying a resilience framework to regional NRM. Resilience recognises the complexity of the systems being managed, the interactions that exist between potential multiple management pathways, the high degree of uncertainty inherent in our natural and social systems and the urgency with which we need to respond to current negative trends in resource condition.

1.1 Definition

Adaptive management is based on incorporating flexibility into plans and designs to account for underlying uncertainty. It involves designing monitoring programs to better define and manage uncertainty and maintain the ability to adjust programs in response to new information learned from active observation of the systems being managed.

Adaptive management relies on the following interrelated system attributes:

- *Development of performance-related hypotheses reflecting the current understanding of the system being managed including predictions about how the system is expected to respond to implementation of proposed actions*
- *Link active monitoring of the system being managed to goals and objectives, assessing these monitoring results, and using the results to improve understanding*
- *Adjust design/operation of projects, programs and structures in direct response to observations, or to test theories or to better assess how the system responds to stimulus.*

Adaptive management engages a scientific approach to management, and is therefore reliant on access to accurate and relevant information. Central to the adaptive management model is a robust and effective decision support system. This system needs to be integrated into the organisation's management structure and be designed to effectively capture, store, organise and interrogate information and to inform subsequent management and investment decisions. The decision support system typically contains an effective geographical interface (Geographic Information System – GIS), allowing for effective integration and thematic management of spatial data.

1.2 How is Adaptive Management Applied?

Natural resource management is characterised by scientific and technical, socio-economic, political and financial uncertainties. In addition, a high degree of urgency is associated with the need to act to preserve many of our natural and socio-economic systems. We simply do not have the time or

resources to develop certainty in implementing management responses. Achieving NRM outcomes within this environment demands the adoption of effective flexible and adaptive management approaches embracing the decision-critical uncertainty inherent within NRM. Decision-critical uncertainty relates to those elements of the system being managed that we have not quantified effectively or that we don't entirely understand but are likely to significantly impact the outcome; as opposed to those elements that we do understand or that are less likely to influence the outcome of proposed intervention options.

The central element to adaptive management systems is robust and astute project design. For adaptive management to be effective the principles need to be entrenched throughout the project cycle, from project inception through planning, implementation and evaluation.

Five core principles are typically employed within the project planning and implementation cycle (USACE, 2000):

- *Promote stakeholder engagement, interagency collaboration, and establish processes for conflict resolution throughout the planning process, starting with formulation of goals and objectives*
- *Employ a formal, science-based approach to develop system models and hypotheses, identify scientific and technical elements and define decision-critical uncertainty likely to affect the outcome of goals and objectives*
- *Incorporate flexibility and robustness throughout the project cycle, including planning, design, construction and operations, with the objective of addressing identified decision-critical uncertainties*
- *Continually incorporate scientific information into the decision-making process to allow for changes as implementation proceeds*
- *Seek to use the most cost-effective approach to maximise ecosystem restoration.*

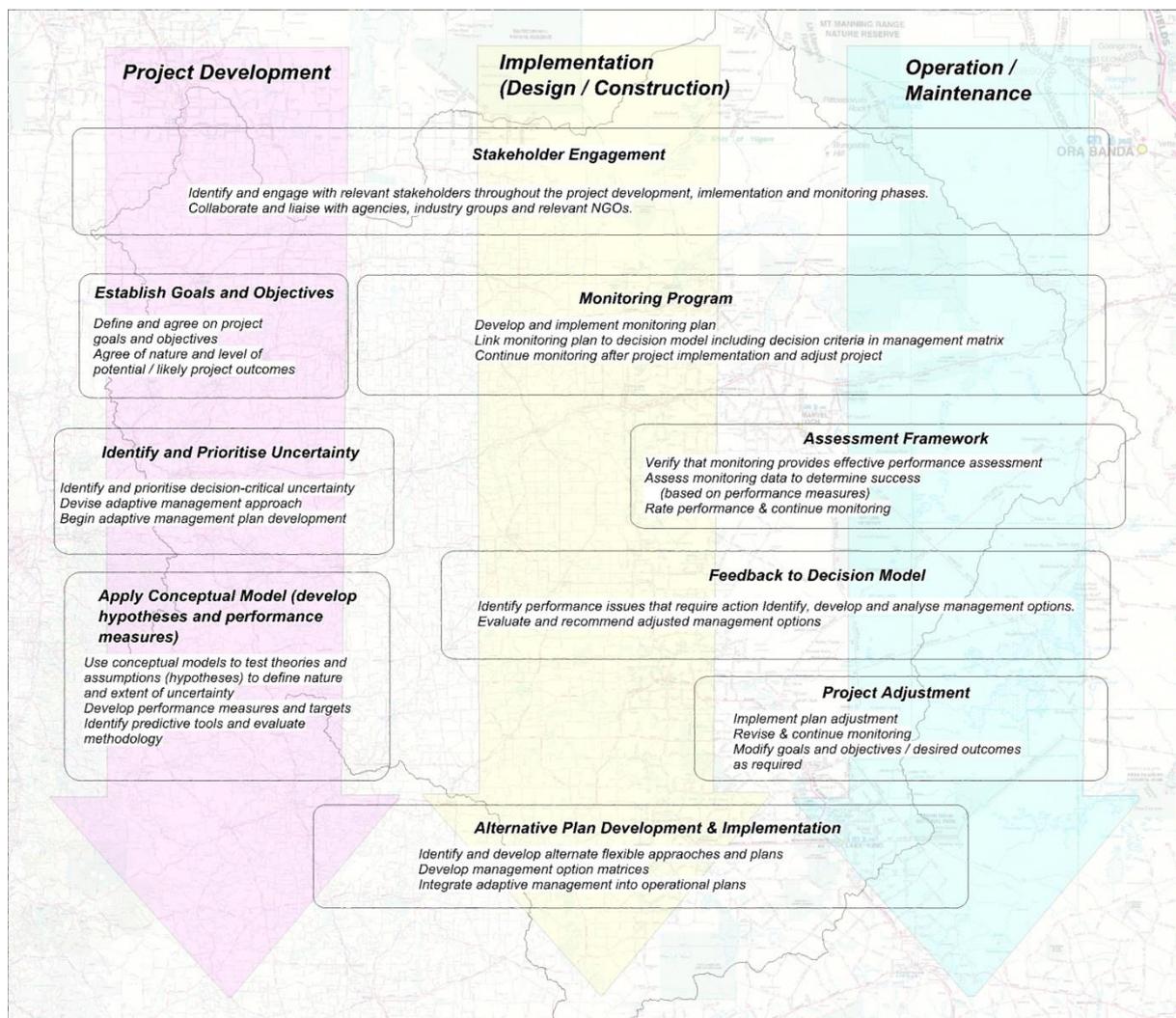
Examples of problems that involve planning constraints and would benefit from an adaptive management approach include how best to restore flow to a river reach, management of stressors such as industry drainage, and potential conflicts arising from a desire to achieve multiple objectives, such as how to operate large surface storage reservoirs to benefit the environment while also providing for flood attenuation to reduce flood risk and maximising water supply needs (USACE, 2000). In these and other adaptive management applications it is essential to develop real-time models of how the system operates, build flexibility into the physical infrastructure and operating systems, closely monitor the system's response and compare that to model results, and update models and management and operational guidelines for improved system operation and maintenance.

Scientific and technical uncertainties are typically addressed by incorporating robustness and flexibility into project design and operational plans, and by providing additional insight through monitoring and assessment to address identified decision-critical uncertainties. In order to provide useful information, monitoring and assessment should be focused on the most important parameters so that they can be measured at a level that can detect change (USACE, 2000).

Error! Reference source not found. illustrates an adaptive management framework used in the development and implementation of environmental projects. A core principle is the evaluation and prioritisation of decision-critical uncertainties as a focus of planning and monitoring project components.

Adaptive management focuses on understanding system interactions and on key elements of decision-critical uncertainty likely to impact project outcomes, reflecting the underlying nature of the systems being managed. Adaptive management is designed to challenge our paradigms about how systems operate by considering what we don't know about the system in addition to what we think we know, developing conceptual models of how we think the system operates, and then designing our management systems to account for the decision-critical uncertainty. We then adjust our operation and management systems to account for new insights gained from actively observing the system as we implement best-bet management strategies and subsequently revise our conceptual models, ultimately reducing the risk of potential management failure due to unidentified and/or unqualified variable and influences.

Figure 1. Adaptive Management Project Development Model (Adapted from RECOVER, 2010)



1.3 Examples of Adaptive Management

Adaptive management approaches have been successfully applied to NRM within Australia and overseas across a wide range of environments. Examples of application of adaptive management programs successfully implemented in the NRM field within Australia include:

- *Management of native vegetation and marine conservation parks* (Parks Victoria 2011)
- *Wild fisheries management* (Hauser & Possingham 2008)
- *Native vegetation clearing in the Daly River catchment in the Northern Territory* (NT Government 2009)
- *Surface and groundwater resource allocation* (Brodie et al. 2007)
- *Forestry management* (Bormann et al. 1993, Australian Forestry 2011)
- *Wetland management and recovery – Macquarie Marshes and Gwydir Wetland System* (LWA 2009, DECCW 2011)
- *Feral animal management* (BRS 2011)
- *Drought response* (ICEWRM 2011)
- *Urban water management* (Gilmour et al. 1999).

The principles of adaptive management were formally embedded in catchment and water management planning in Australia through the bilateral agreements that underpinned the National Action Plan for Salinity and Water Quality (NAPSWQ). Management of invasive plants, pest animals, river flow, soil health and biodiversity maintenance were all intended to be guided by adaptive management principles due to their underlying uncertainties.

Adaptive management principles also featured strongly in the 2006 Australian state of environment report (Beeton et al. 2006). The report identifies six key principles fundamental to the sustainable management of Australia's natural environment, and associated economic and social interests:

- *Effective research and monitoring*
- *The protection of natural and cultural heritage*
- *Identification and removal of barriers to implementing environmental sustainability*
- *Application of an adaptive management philosophy*
- *Effective data and information management*
- *Widespread adoption of sustainability within Australian society.*

1.4 References

- Australian Forestry 2011 *Benefits of adaptive management and synthesis of biodiversity*. <http://www.forestry.org.au/news/templates/ifa-article.asp?articleid=1846&zoneid=1>
- Bormann BT, Cunningham PG, Brookes MH, Manning VW, Collopy MW, 1993. *Adaptive ecosystem management in the Pacific Northwest*. USDA Forestry Services General Technical Reprint PNW-GTR-341
- Brodie R, Sundaram B, Tottenham R, Hostetler S, Ransley T 2007 *An Adaptive Management Framework for Connected Groundwater-Surface Water Resources in Australia*. Department of Agriculture, Fisheries and Forestry, Canberra.
- BRS 2011 *Adaptive Management of Feral Animals in Australia*. Australian Government, 2011 <http://www.feral.org.au/tag/adaptive-management/>
- DECCW 2011 *Gwydir Wetlands Adaptive Environmental Management Plan*. Department of Environment, Climate Change and Water, Sydney, NSW, ISBN 978 1 74293 088 6
- Gilmour A, Walkerden G, and Scandol J. *Adaptive management of the water cycle on the urban fringe: three Australian case studies*. Conservation Ecology **3**(1): 11. [online] URL: 1999. <http://www.consecol.org/vol3/iss1/art11/>
- Hauser CE, Possingham HP 2008 Experimental or precautionary? Adaptive management over a range of time horizons. *Journal of Applied Ecology*, Volume 45, pp. 72-81.
- ICEWRM 2011. *Response to Drought in South Australia: A Case Study in Adaptive Management*. International Centre of Excellence in Water Resource Management. Dec 2011.
- Land & Water Australia 2009 *Adaptive management of environmental flows in the regulated Macquarie River*. Available at: <http://lwa.gov.au/node/3213>
- NT Gov 2009 *Adaptive Management Framework for Native Vegetation Clearing in the Daly River Catchment* Daly River Management Advisory Committee http://www.nt.gov.au/nreta/natres/natveg/pdf/DRMAC_Adaptive_Framework_8APR10.pdf
- Parks Victoria 2011 <http://parkweb.vic.gov.au/park-management/environment/research-and-scientific-management/tools-for-adaptive-management>
- USACE 2011 *Comprehensive Everglades Restoration Plan. Recovery 2010 CERP Adaptive management integration guide*. Restoration Coordination and Verification, US Army Corps of Engineers, Jacksonville Florida Water Management District, FL. March 2011