

28 A robust framework for sharing water in northern Australia

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1. KEY POINTS

1. Several advocates view the National Water Initiative (NWI) as a task to implement ecologically sustainable development at the whole of basin scale. The relatively unmodified status of most northern Australian basins presents an opportunity to design and establish a management approach based on the concept of ecosystem services.
2. An ecosystem service approach recognizes interdependent provisioning, and non-provisioning (cultural, supporting and regulating) goods and services derived from ecosystem functions. Water can be extracted as a provisioning stock (the extractive pool) to produce additional goods such as food and fibre. Non-provisioning services (the environmental pool) are linked to the functional integrity of the water system.
3. All services confer perceived, vicarious or tangible value and depend on maintaining the functional integrity of the water system. Generally, the value of provisioning goods is more often expressed by market prices; non-provisioning services remain generally non-monetized.
4. A science based and consultative water plan determines the level of accepted modification to a water system. Choices are made that establish the volume and extraction rates of water assigned to provisioning services and the allowable modification to the water system. This is the arena where the accepted proportional shares of the environmental and extractive pools are established.
5. Despite recent advances, crafting water plans that establish a judicious and equitable balance between the environmental pool and the consumptive pool remains a substantial challenge.
6. We lack information for the majority of northern Australian river and groundwater basins about the hydrological system, Indigenous knowledge and values and the need to cater for future claims and aspirations of Indigenous people, the environment and consumption. As a consequence only four basins have water plans.
7. As a precaution against limited knowledge we propose a reserve pool, in addition to the environmental and consumptive pools. The reserve pool is comprised of unassigned water that can be distributed to future Indigenous, environmental or consumptive interests as required, without compromising requisite environmental or cultural needs.
8. Robust design principles, embedded in the NWI, imply that institutional arrangements are capable of sustainable water management across basins of variable hydrological attributes, varying developmental stages, meet the criteria of fairness and efficiency and manage the circumstances of a changing world.
9. Robust design principles have been combined with the ecosystem services approach and basin closure to develop a typology that classifies northern water systems as examples of a river modification; basins are classed as:
 - *Customary Management*: described by an ambient balance of ecosystem services and limited water extraction for additional provisioning purposes; these may or may not have a water plan;

- *Open*: with a water sharing plan, some water extraction and un-assigned entitlements; i.e. there is remaining water in the reserve pool; initial assigning of water interests may take the form of licenses specified as either an irrigation area basis or as a volumetric extraction requiring measurement; and
 - *Closed*: and sustainable basins characterized by fully assigned entitlements requiring re-distribution of scarce water resources amongst competing interests. In this case the reserve pool has been exhausted and there may be opportunities to develop trading in entitlements and seasonal allocations.
10. The typology can be applied to a basin's current status or to potential, future changes to the amount of extracted water and consumptive use.
 11. We evaluate the potential for the co-management of the environmental pool by Indigenous Traditional Owners, (along similar lines as Indigenous participation in NORFORCE¹), National Park management and seasonal fire management by Traditional Owners.
 12. When the water plan prescribes a consumptive pool, we evaluate the effectiveness of alternative mechanisms to equitably assign consumptive water entitlements to both Indigenous and non-indigenous individuals and communities. Entitlements assigned in this way indicate a potential role for water to promote and enable Indigenous enterprises and community autonomy.
 13. There are three basins that cross state jurisdictional boundaries in northern Australia and are unlikely to be of major concern. The constitutional relationship between the Commonwealth and the Northern Territory means that any basin conflicts that do arise can be negotiated between the Commonwealth and the State (e.g. NT with either Qld or WA), as opposed to State to State negotiations in the Murray darling Basin.
 14. A potential exists for a closer working partnership between the Commonwealth and managers in the Northern Territory. The relationship could be used to trial implementation ideas which could then be proposed to the two states as evidence based working models.

¹ The NORFORCE (North-West Mobile Force) is an infantry regiment of the Australian Army Reserve and is one of three Regional Force Surveillance Units employed in surveillance and reconnaissance the remote areas of northern Australia

2. INTRODUCTION

Consensus on the science of water sustainability coheres around a problem-driven understanding of the dynamics of coupled social-ecological systems. A principal challenge of sustainable water management is the development of predictive models of system-change, which enable society to reliably evaluate options to manage the present and mitigate the risks to future generations, alongside current adaptive capacities. Contributions from the natural, physical and behavioural sciences are essential in the management of northern Australian basins. Enduring solutions also require Indigenous knowledge coupled with institutional analysis and an understanding of the roles of different systems of governance.

In chapter 14, the introductory chapter to the Institutions and Governance section of the Taskforce report, we introduced institutions as systems of established and prevalent social rules that structure social interactions and manage conflict. They are the rules of the game that coordinate individual actions into socially acceptable, collective outcomes. Rules in turn are a function of social norms, values, ritual, beliefs and conventions.

Institutions exist in a dynamic state of tension between stability and modification needing to be malleable enough to accommodate change, balanced within a predictable and stable framework. Formal water managing agencies and organisations are an important subset of this wider more polycentric view of institutions.

Governance systems encompassing legislation, regulation, policies and processes represent the operational dimension of institutions and their dynamics, determining how change is enacted. The study of governance requires an understanding of the institutional processes which dictate how communities adapt, transform and sustain their environments. Governance success depends on the alignment of policy instruments, incentives and arrangements with existing community attitudes and motivations.

Institutions and governance play one of the pivotal roles in resolving the tensions that occur when the imperatives of conservation and economic development coincide. Intensifying demands and the multiple, synchronous benefits derived from water are likely to amplify the importance of that role. Institutions and governance are pivotal in three key areas of water management: firstly, the degree of acceptable water system modification is a result of institutional process i.e. water planning.

Secondly, institutional processes assign entitlements to water interests: i.e. they enable some, constrain others and establish the means of sanction and enforcement. Entitlements, expressed as property rights, represent a social contract by determining what an entitled water interest must and must not do, what they can and cannot do and what others must and must not do.

Lastly they establish who is responsible and how the system is to be managed and adapted to change.

The National Water Initiative (NWI) (1) is an ongoing response by the Council of Australian Governments (COAG) to rectify over extraction, with a focus on irrigation in the Murray Darling Basin (MDB). The objectives articulated in the NWI represent a water management template underpinning water development objectives in the context of regional needs and values.

The urgency to re-distribute entitlements to the environment and to high value uses in a chronically over-assigned MDB system has led many commentators to view the NWI from an almost exclusively

economic perspective, which has much less to offer for northern Australia. Over assignment of water entitlements is not typical in the north and as a consequence is not a current policy imperative (2).

In this chapter we have focussed on northern Australia water planning based on the principles of robust design, recognising that planning for the possibility of water trading needs to be incorporated earlier rather than later. Robust design principles enable institutional and governance arrangements capable of sustainable water management across basins of variable hydrological attributes and an array of development stages. Importantly robust institutions can manage water in the circumstances of a changing world.

Chapters 18 through 21 have reviewed the state of water planning in northern Australia, indicating that only four of 64 basins have a completed water plan as required by the NWI. Negotiating, committing to and implementing a water plan to share water resources amongst diverse interests is the initial and arguably most important step set out in the NWI. Without an agreed water plan that prescribes the acceptable level of surface, groundwater or connected system modification, water impoundments and diversions are restricted to stock and domestic use.

Despite substantial advances in water planning, the process of balancing the cultural and environmental needs of basin communities with those of developing commercial enterprises and impending food security remains resource intensive and complex (3). The challenge of water planning is supported by The National Water Commission Biennial Report, which states that the progress and extent of water planning agreed to by the States has not been fulfilled and is an aspect of highlighted concern (4).

The fact that relatively few northern Australian basins have operational water plans has guided the focus and content of this chapter. By way of background, Sections 2.1 through 2.3 summarise robust design, the NWI and planning instruments and statutes for northern Australia respectively. Section 2.4 discusses the three basins subject to inter-jurisdictional management in northern Australia.

A major theme of the NWI is the importance of taking a whole-of-hydrological system approach to water policy, an aspect which is often ignored or overlooked. The objective of NWI consistent water planning is to negotiate and implement a science based, socially acceptable and sustainable level of surface or ground water modification (5). Water planning institutionally differentiates a water system into two separately managed "pools": the environmental and consumptive pools. While clearly physically connected, each pool is characterised by distinct resource attributes, value sets and appropriate management instruments.

Consideration of the institutional processes involved in determining what is a socially acceptable level of modification raises three important questions. What is being modified, what needs to be measured and subsequently what needs to be managed? The volume, timing and rates of altered flow regimes are obvious and measurable attributes. However flow regimes are neither readily translated, nor necessarily commensurate with the full suite of social benefits values derived from surface and ground water systems.

In response, the discussion in Section 3 proposes that the water planning process can be centred on the modification of ecosystem services derived from the water system.

An ecosystem service approach recognizes interdependent provisioning, cultural, supporting and regulating ecosystem functions expressed as jointly produced goods and services. Water can be

extracted (i.e. the consumptive pool) to produce additional provisioning goods such as food, timber and fibre. Interdependence implies that water for additional provisioning services generally depletes non-provisioning services (the environmental pool), which are more closely aligned with the functioning of the water system. All ecosystem services confer perceived, vicarious or tangible value and depend on maintaining the functional integrity of the water system. Generally, the value of provisioning goods is more often expressed by market prices; non-provisioning services remain generally non-monetized.

Provisioning and non-provisioning services correspond with the planning objective of defining the extractive and environmental water pools respectively. They also align with the resource attributes of each pool (private good and common pool) as well as appropriate instruments and governance (e.g. private entitlements coupled with markets and co-management). The unified approach allows a more systematic negotiation process and aids in understanding the interaction between these four key areas of northern Australian water management. In many respects the framework for northern basins is closely allied to integrated river basin management, discussed in chapter 22 of the Taskforce report.

The primary outcome of the discussion is the high likelihood of uncertainty in key economic, social and scientific parameters. We have proposed the introduction of an additional institutionally determined “reserve pool” to buffer cultural, economic and scientific uncertainty.

Northern Australia is characterised by a relative absence of the powerful historical legacy of institutions and patterns of behaviour that has worked against whole-of-system policy implementation in the MDB. In contrast to southern Australia, it will be much easier to create the pre-conditions in northern Australia for NWI compliant water management. This should be prioritised earlier rather than later.

Section 5 introduces the concept of basin closure combined with robust design and the ecosystem approach, as a typology to trace potential modification or development pathways for northern Australian basins. A series of schematics compare the development pathways of the MDB with potential pathways of northern basins. The comparison points to cogent lessons for the north.

The appendix includes a previous suggestion for water planning and the assignment of entitlements for the Miriung Gajerrong Native Title Holders to share in the benefits derived from the water development in the Ord Stage 2. The principles of robust design, modified for northern water management, have informed the water plan.

3. WATER PLANNING

3.1 Robust design and separation

A primary objective of robust design is to establish institutions and governance systems with a capability to cope with change. Robust institutions and governance are self maintaining, resilient to political influence and able to adapt easily to levels of identified development potential or river modification. Robust systems are characterised by the use of separate instruments for each distinguishable component of the terrestrial water cycle and water use system. The separation of water interests into component parts facilitates more efficient accounting and management, providing for the adjustment of one system component without disrupting another or reconfiguring the entire institutional framework. .

Robust separation of rights was developed in the context of rural surface water systems and has contributed to the NWI reform process (6). The separation of rights provides the opportunity for the multiple water policy objectives of distributional equity and economic efficiency in a changing world to be managed independently. As a result, the environment, cultural values and water extracted for commercial enterprises are entitled as legitimate users of water.

Robust design relies on a negotiated water plan in concert with a three tiered “unbundled” or separated system of instruments to distribute and allocate volumes of water efficiently over time. These include:

1. Water Plans establish the community values, rules and science based guidelines to appraise the state of a water system and subsequent to that appraisal, prescribe the rules to determine the environmental and consumptive “pools”.
2. The first policy instrument defines access entitlements as secured, long term unit shares of the consumptive pool and the distribution of shares to individual interests. This allows water managers to distribute entitlements, subject to periodic allocations, to available consumptive water and resolve tensions related to equitable distribution and use. Unequivocally defining the assignment of risk of a variable water supply clarifies where responsibility lies, under what circumstances compensation is due, and the processes for obtaining redress with minimum cost and controversy.
3. The second instrument defines an independently managed process to periodically allocate an amount of water to each share. This allows water authorities to manage the consumptive pool when faced with changing ambient conditions independently of entitlements. Allocations are determined based on an agreed process specifying the timing and volume of water availability, typically on an event, seasonal or annual basis, contingent on science and the state of the resource.
4. The third instrument prescribes or proscribes the obligations of water use. Since the impact of water use varies according to geography and activity, this allows the environmental and health impact of water use to be managed independently. Specifying the obligations of water use, addresses the management of externalities accounting for the interests of third parties, future generations and the environment.

The introduction of debit and credit water accounting, guaranteed recording of financial and other formal interests on a register, formal market transaction mechanisms to exchange entitlements or allocations and the irreversibility of market transactions complete the design process for robust water institutions and governance (as discussed in detail in chapter 14).

The protocols used in the initial assignment of water entitlements have been critical in the management and compliance performance of international river basins. Northern Australia is likely to be no exception. The specification of the interests in water broadly refers to the rights and obligations that a party has over water. Assigned interests confer rights of access, withdrawal, management, exclusion and transfer of a defined share of a basins extractive pool.

Water as a shared resource has been defined by different notions of property and as a consequence managed according to various governance regimes. Regimes can be generally classified as state, market and consensus based and relate primarily to water as a common pool resource or private good.

Different regimes confer comparative advantages in achieving specific policy objectives, for example, efficiency, effectiveness, equity, distributional justice and the scale of water diversions. In terms of northern Australia, different regimes are appropriate for water systems at different stages of modification, and will need to have the capacity to change as the system changes. Applying the concept of robust design and polycentric institutions to water management implies that the environmental and extractive pools will be best governed by independently managed instruments. Below is a brief, but by no means exhaustive, discussion regarding governance options for the environmental and extractive pools. They are generally in accordance with NWI and robust design principles, nuanced in consideration of northern Australia.

1. The environmental pool or base flow in the case of connected groundwater systems in northern Australia is a common pool resource. The costly exclusion of private interests generally excludes markets as an appropriate governance regime. Alternative governance arrangements for managing the environmental pool include:
 - a. A traditional regulatory (rules based) approach relying on environmental legislation, standards and natural resource statutes;
 - b. Socially crafted institutions that coordinate individual actions into collective governance by applying rewards and sanctions to members according to their conformity with or deviation from social norms (7). Community crafted arrangements tend to rely on social norms that reinforce collective action such as trust, reciprocity, reputation and prestige, personal and community pride and the avoidance of group sanctions. Successful socially crafted compacts that utilise communication are reinforced by self monitoring, strong reciprocity or conditional cooperation and a series of escalating, credible sanctions (*ibid*).
 - c. A combination of regulation and collective governance or co-management. The combination of native title, obligations of customary law and traditional knowledge warrant further exploration of co-management as a viable alternative. Co-management would provide the opportunity for Traditional Owners and communities to autonomously meet their obligations as traditional owners and manage the environmental pool on behalf of the Australian public. It is envisaged this would proceed along similar lines as for example NorForce participation, National Park management and seasonal fire management.

- d. The NWI makes allowance for independently managed environmental entitlements. If the environmental requirements of statutory water plans are administered with integrity there is no need for independent environmental entitlements. Environmental entitlements are unlikely to be necessary for northern Australian basins in the foreseeable future.
2. As the majority of northern basins do not have water plans, there has been minimal emphasis on the process to assign entitlements. The initial assignment of entitlements in the extractive pool for a basin can be managed through two main approaches. Regardless of the approach, distribution must be seen to be procedurally fair, equitable and provide a secure perpetual share in the extractive pool subject to the rules of seasonal allocation and final use.
 - a. A bulk entitlement: effectively one entitlement that could be accessed and distributed to members who form a version of a water co-operative (this may be appropriate to northern basins subject to claims by multiple native title holders); through licensing specifying secure fixed term “leasing” arrangements; or volumetric licensing requiring measurement.
 - b. The assigning of entitlements to individual water interests. The initial assignment of entitlements can be achieved through either distribution at no cost or auctions: both have advantages and disadvantages, with attendant advocates and opponents.

3.2 National Water Initiative

To assist with policy design to manage northern Australian water resources, we have described a unified framework of policy instruments drawing on the principles of the robust separation of water interests. Consistent with these principles, the NWI (8) recommends the independent management of water access entitlements specified as unit shares, periodic water allocations and the impacts of use. The framework defines water access entitlements as perpetual unit shares of a defined consumptive volume of a water resource, periodic allocations are made in accord with annual inflows, storage volumes and in proportion to the number of shares held. Final water use accounts for variability in biophysical attributes and activity. The risk of variable water availability is prescribed and assigned between users and the Government.

The NWI (clause 38) provides that States and Territories can determine water plans and their content, as well as the frequency with which plans are reviewed and the resources assigned to developing and monitoring the plan. The NWI stipulates that water plans must consider projected consumption and the consequences of not having a plan in place.

The NWI sets out the following elements of water planning (9):

- (i) identifying environmental and other public benefit outcomes from specific water resources and implementing management regimes to maintain them (clause 37)
- (ii) establish security for users as well as allocation and trading rules with the potential to adjust for over-allocated systems (clauses 37 and 43)

- (iii) create a risk management framework that allows for adaptive measures, linking this with independent monitoring and reporting (clause 25, 40, 79)
- (iv) employing community and stakeholder consultation and engagement, particularly with Indigenous communities (clause 52, 95)
- (v) balancing allocations between competing uses (including the environment), protecting existing entitlement holders, with decisions based on best available technical and scientific information, feedback from community and socio-economic analysis (for example Schedule E4)

The NWI lists a range of factors that should be considered in making water sharing decisions. These include among other considerations, the variability of supply and level of reliability for entitlements, economic and structural issues, risk sharing (clause 97) and Indigenous socio-cultural aspirations (clause 36).

3.3 State water planning legislation

Each northern Australian jurisdiction has approached water planning in different ways. In Western Australia (WA) the *Rights In Water Irrigation Act 1914* (RIWI) and in Queensland (QLD) the *Water Act 2000* prescribe a water planning process that specify the contents of water plans. In the Northern Territory (NT), the *Water Act 1992* is the relevant legislation and is less prescriptive on the features of water plans.

In the NT there are no statutory requirements for commencing a water plan. A water allocation plan can only occur within a water control district, which is an area gazetted by the Minister for intensive water management. Public notice must be provided that a plan is to be developed and a water advisory committee to be established. Plans in the NT consider social and cultural values, environmental provisions and a scientific panel examines the requirements of dependent ecosystems. Sustainable yield of the resource is estimated in relation to meeting beneficial uses through hydrologic reports.

In QLD a Water Resources Plan (WRP) prepared for a catchment is a statutory binding instrument. The Minister must present a notice of intent to prepare a plan, identifying the location and an intention to establish a Community Reference Group (CRG). Environmental, social and economic assessments are required during the development of a WRP which is implemented via a Resource Operations Plan (ROP).

There are three types of development regimes for northern Australian basins in declared conservation zones. They range from prescriptive in Queensland where the *Wild Rivers Act 2005* (and 2006, 2007 amendments) limits the nature of in-stream development in rivers, including Cape York; to moderately prescriptive in the Northern Territory with guidelines to conservation and clearing of native vegetation; and regulated in Western Australia, where there is environmental protection legislation but no prescriptive rules on development. Details of the legislation can be found in Chapter 29b.

There is no statutory process to initiate plans in WA. A water basin may be objectively identified by the Department of Water as a priority for planning if it is under stress, or there is competition among different users (including the environment). Regional plans identify broad allocation and water sharing objectives, while management plans apply these in a local context, as well as define

trading rules. At present both plans are non statutory. The respective statutes, processes for sharing surface and groundwater, and regulations to account for connectivity for the Northern Territory, Queensland and Western Australia are described in Table 1.

Table 1: Institutional, legislative and regulatory framework for water sharing in the north

	Northern Territory	Queensland	Western Australia
<i>Water Sharing</i>			
Legislation	<i>Water Act 1992 s. 22</i>	<i>Water Act 2000 ss. 10-11</i>	<i>Rights In Water Irrigation Act 1914 s 4</i>
Policies	Multiple policies.	The Water Plan (QLD) 2005-2010	Policy No.3 (Water Sharing), Policy No.5 (Environmental Water Provisions), Policy No.6 (Water Trading), and Policy No.11 (Unused Water Entitlements).
Department responsible for plan	Natural Resources Environment The Arts and Sport (NRETAS)	Department of Environment and Resource Management (DERM)	Department of Water (DoW)
Overarching purpose of water plan	Provide for beneficial uses within the estimated sustainable yield s. 22 B (5)	Advance sustainable management and efficient use of water resources.	Enhance the sustainable use of water and protect the environment, as well as promote orderly, equitable and efficient use.
<i>Water sharing mechanisms</i>			
Independent Scientific and Technical Assessment	Yes. Tindall independent review of groundwater model	Yes. Technical Advisory Panel.	The Ord plan: independent Ord Scientific Panel to determine options for water sharing under a range of different flow and allocation regimes.
Stakeholder Committees	Yes. Provide advice and guidance to plans.	Yes. Identify who may sit on the CRG	Stakeholder workshops
Public Submissions	In draft.	Yes. Required to report on these submissions.	In draft

Water sharing mechanisms	Northern Territory	Queensland	Western Australia
Indigenous input and access	Yes, representative on water advisory committees, consultation with land councils and an Aboriginal Reference Group in Daly.	Yes, Indigenous working group. There are also cultural commercial licenses available to Indigenous groups in some plans	The Ord Final Agreement contains Indigenous aspirations and values to the Ord. In the La Grange there are various processes to involve Indigenous people in the development of the plan.
Social and economic impact	Various cultural values studies. The water advisory committees provide feedback on performance on social, environmental and economic indicators.	Various studies commissioned during the preparation of a WAP. Annual reports and stakeholder committees detail performance on social, environmental and economic indicators.	Indigenous cultural studies and economic analysis of Ord
Groundwater Management			
Entitlements	No entitlements. Volumetric licenses (mostly metered) that are temporarily tradeable within plan areas. Security categories for licenses from 100% to 15% reliability in plan areas. No inter aquifer trade	Yes volumetric tradable entitlements in supplemented systems. Unsupplemented systems with multiple groundwater systems only volumetric licenses for specific purposes (i.e. irrigation)	No entitlements. A licensing regime exists with approvals process with the Department of Water. Proponents may have to develop operating strategies depending on the size of their license volume.
Allocations	In plan areas allocation is dependent on base flow of Katherine River on November 1 each year. In unregulated areas licensees are entitled to a volume of water that is consistent with the property development plan (assessed against industry water use standard).	Developed groundwater areas managed under WRP and rules for allocation laid out in ROP. No plan: the sources are managed under the <i>Wild Rivers Act</i> or management agreements. Monitoring ensures that volumetric limits are adhered to.	Groundwater managed in regional or management plans, depending on level of development. Groundwater outside of plans is managed under state-wide policy. The La Grange draft plan in WA sets allocation limits in line with monitoring of aquifer condition, if the source deteriorates then the allocation levels are reduced.

Groundwater Management	Northern Territory	Queensland	Western Australia
Use Licenses	Stock and Domestic, and small volume groundwater (less than 5 ML per year) are exempt from licensing s 14.	Must state a purpose for use licenses and these include, stock and domestic, irrigation and agricultural uses. Groundwater proponents must get approval from <i>Integrated Planning Act 1997</i>	Unlicensed use for stock and drinking water.

Water Sharing Rules for Surface Water			
Licenses and Entitlements	<p>Water allocated between consumptive and non consumptive uses. Caps for sustainable yield are set in surface water areas.</p> <p>Trade can only occur in plan areas by those with access to land. No upstream trade in surface water unless proven that environmental values in the plan will not be compromised.</p>	<p>Most surface water management areas have a cap for sustainable yield. There are annual and daily volumetric limits for licenses in Gulf and Mitchell WRP's for specified purposes such as for irrigation and stock and domestic. A water license is attached to land and cannot be traded. In Sunwater schemes trade can occur in temporary and permanent ways.</p>	<p>In surface water areas sustainable yields set, with consideration of needs for the environment. Landowners may apply for licenses based on projected need. Trading can occur within Irrigation Cooperatives.</p>

<i>Water Sharing Rules for Surface Water</i>	Northern Territory	Queensland	Western Australia
Allocations among uses	A 20% limit is imposed on extraction and 80% must be left for the environment as a general guideline. There are no plans or surface water trading in the NT.	Flow objectives determined by nodes in streams or rivers. Imposed allocation conditions on influenced by flow in unsupplemented surface water areas. In supplemented areas, announcements are made for allocation based on a water sharing index.	Allocations determine the water required for Environmental Water Provisions and Ecological Water Requirements (EWR's). FLOWS methodology links values like EWR's and identifies whether they can be supported under various flow regimes. The Ord River Scientific Panel developed a scale for changes in the flow regime and impact on riparian values, with a 10% reduction in flow of least concern, and 25% of most concern.
<i>Rules for connected surface water</i>			
Managed as single resource	Yes. It is assumed in the Tindall plan that all dry season base flows in the Katherine River are fed by the aquifer.	Yes. There is a recognition in WRP's that there is connection between groundwater and surface water.	Yes. Ord plan aims to mitigate impacts (such as accession) on any groundwater resources, but no interaction identified between surface and groundwater
Rules	Established management zones for bore extraction close to the river (with a limit of 15% of all extraction) to reduce impacts on the aquifer and river. Extraction from aquifer can be limited if there are impacts on the river.	Enough water provided in plans to ecosystems in connected water systems. The Gulf Water Resources Plan seeks to determine stream flow impact on groundwater and vice-versa without offering further guidance.	No interaction between ground and surface water in the La Grange or Ord plan is identified.

Classification of plans	Northern Territory	Queensland	Western Australia
Proponent obligations	All plans require monitoring, there is metering in force in plans so that entitlement holders do not breach volumetric limits, with self accounting and reporting in the NT and the Controller of Water Resources providing oversight.	In Sunwater's scheme in the Gulf, Sunwater is responsible for monitoring and reporting	There is no metering (only a water wheel for discharges that can determine on farm efficiency). The Department of Water can reduce allocations to mitigate detriment to the resource (such as reduced water quality). No monitoring programs are identified in plans in the north. The Department of Water monitors water quality.

Classification of plans			
Risks	Yes, risk is shared through the license security categories which can be reduced back to zero extraction, with emergency powers of the Controller to restrict stock and domestic use in very dry time.	An index is used in supplemented schemes to determine allocation. Entitlements and licenses are clearly specified and allocations are tied to periodic announcements.	Broad statutory powers to restrict allocations, but irrigation is given priority in the Ord scheme to maintain the 95% reliability for the 5 year licenses tied to land in Ord Stage 1 and 2.
Compensation	No explicit compensation is identified for altering plan or reducing entitlements/licenses.	Compensation is only payable if the WRP is amended or replaced within its first ten years. No compensation made explicit for reducing entitlements/licenses	No compensation made explicit for reducing entitlements/licenses.
Duration	10 years	10 years	3 years
Review	≤ 5 years	≥ 10 years	7 years

Classification of plans	Northern Territory	Queensland	Western Australia
Statutory	Yes, the water allocation plan is statutory.	Yes, the WRP and ROP are both statutory.	No The Water Resources Management Bill provides for statutory plans.
Adaptive	Yes, the plan may be amended any time without compensation. Risk assignment framework with statutory power to reduce allocation to zero (and impose restrictions on stock and domestic) provides flexibility each year.	Yes, Risk assignment framework in supplemented schemes to reduce entitlements. The ROP may be amended at any time or replaced if required by the Minister. The WRP, if replaced within first 10 years may require the payment of compensation. Annual reports assess performance in meeting specific outcomes in plans (ss. 54-56).	A statutory process to reduce allocation if there is impact on the environment or to respond to changing conditions. The Ord plan can be amended, revoked, replaced according to statute.

3.4 Cross jurisdictional water management in northern Australia

The management of water resources bounded by State borders remains the responsibility of individual State and Territory Governments. Despite NWI guidance and ratification, water statutes and legislation vary between jurisdictions. As a consequence there are varying degrees of NWI consistency, and varying rates of progress to meet water reform objectives and inter-jurisdictional compatibility. Highly episodic rainfall, extensive water dependent ecosystems, ground and surface water connectivity, and typically ephemeral water systems introduce substantial challenges to northern Australian water management. Policy inconsistencies are likely to further complicate the management of cross jurisdictional aquatic systems, particularly the achievement of environmental and public benefit outcomes. This section summarises the extent of cross jurisdictional water systems in northern Australia and efforts to manage them.

The State Implementation Plans of the NWI specify governance arrangements for shared water resources. The states have agreed, under the NWI (10) to:

Establish effective and efficient management and institutional arrangements to ensure the achievement of the environmental and other public benefit outcomes, including:

- joint arrangements where resources are shared between jurisdictions; and
- common arrangements in the case of significantly inter-connected groundwater and surface water systems.

The Georgina River catchment on the Queensland-Northern Territory border and the Ord river catchment (with one-fifth of its predominantly Western Australian catchment area within the

Northern Territory (11) are the two surface water catchments that cross state/territory borders in northern Australia. Mapping of major inferred groundwater system boundaries (12) that correlate to major aquifers across the north shows that three of these systems, namely the Bonaparte, Ord-Victoria and Tanami, straddle the Northern Territory-Western Australia border. The McArthur and Georgina groundwater systems span the Northern Territory and Queensland border.

3.5 Examples of cross border management

Specific actions and timeframes to achieve the development of joint guidelines for cross jurisdictional basins are spelt out in the NT Government's Implementation plan (13) and include:

- Completion of a MoU with Queensland on cross-border water resource management arrangements - in the Gulf of Carpentaria region - by June 2007.
- Collaboration with South Australia to complete groundwater models for the Great Artesian Basin to determine environmental water requirements and predict impacts on mound springs from any planned development in the NT by 2007; and
- Participation in multi-jurisdictional coordination of Lake Eyre Basin water resource management as an ongoing commitment.

The NT plan goes on to say that this work is 'in train' and will be 'consistent with relevant NWI outcomes as appropriate to the issues in each region'. In the Implementation Plan prepared by the State of Queensland (14) cooperation with other jurisdictions centres on the Lake Eyre Basin Agreement where "inter-jurisdictional matters for the Cooper and Georgina/Diamantina catchments are handled". In addition where water resource plans are prepared for the Gulf and Great Artesian Basin, proposals for community reference panels include cross border representation. Western Australia's implementation plan (15) does not explicitly address nor detail any specific arrangements for managing water resources in an integrated manner across state-territory borders. The Ord Stage 2 and management of the Lake Eyre Basin are examples of cross jurisdictional arrangements between the NT and WA and Qld-SA respectively

The Ord River Irrigation Area – stage 2

One notable example of cross jurisdictional cooperation was the joint environmental assessment of the Ord River Irrigation Area Stage 2 proposal, which includes land in both the Western Australian (WA) and Northern Territory (NT) Government jurisdictions. The tasks these governments cooperated on included:

- A joint call for expressions of interest (16), selection of preferred developers;
- An agreement to jointly assess the proposal using the WA environmental impact assessment process, while incorporating the requirements of both jurisdictions; and
- Development of joint guidelines for the assessment (17).

Lake Eyre Basin

The final example of cross-border management arrangements is the Lake Eyre Basin (LEB) Agreement. Whilst the LEB consists of a different hydrology; the landscape, livelihood and institutional character of the LEB shows similarities with catchment areas to the immediate north. The LEB is characterised by extensive rangelands with reliance on groundwater resources, mining, tourism, long distances between small settlements and even longer between major urban centres, and pronounced ecological and Indigenous values.

The LEB includes large parts of three jurisdictions – Northern Territory, Queensland and South Australia. An intergovernmental agreement signed by the two State and Commonwealth Governments in 2000 established the LEB Ministerial forum in 2001 to develop and implement policies with the explicit intent to ‘avoid or eliminate...adverse cross-border impacts’ in the management of water and related natural resources (18).

The LEB Forum seeks complementarity between legislation, policies and planning in the three jurisdictions on river flows, water quality policy, water and related natural resources, water entitlements and resource development, research and monitoring and adopting a ‘whole-of-basin approach’. Further embedding the joint management approach, decision-making and policy functions of the Ministerial Forum require consensus decision-making (unanimous vote). The Forum is supported by structures for community advice and representation – the Community Advisory Committee, and scientific and technical advice – the Scientific Advisory Panel. These structures play key roles in developing and implementing specific strategies to coordinate management and protect the diverse values of the basin.

Although inter-jurisdictional conflicts can potentially occur in two basins in northern Australia they are unlikely to be of major concern. The constitutional relationship between the Commonwealth and the Northern Territory means that any conflicts that do arise can be negotiated between the Commonwealth and the State, as opposed to State to State contestation.

A potential exists for a closer working partnership between the Commonwealth and managers in the Northern Territory. The relationship could potentially be used to trial implementation ideas which could then be proposed to Western Australia and Queensland as evidence based working models.

3.6 Summary of state catchment water plans

Chapters 20 and 21 detail State water planning legislation, implementation and progress in meeting ratified NWI water reform objectives. Table 1 and this section summarise water planning in the Northern Territory, Queensland and Western Australia. Water sharing rules in surface and ground water systems are volumetric where plans exist. Periodic allocation are determined based on historical stream flow or recharge rates, which are subject to variable levels of reliability and redundancy due to the modelled effects of climate change. Apart from the regulated Ord scheme In WA there is limited development of surface water extraction in northern Australia.

The NWI Schedule E5 (ii) provides that an assessment of connectivity in water allocation plans should be undertaken. Across northern Australia groundwater is a year round source of water and the connection between surface water and groundwater remains poorly understood but the importance is recognised (19). In connected systems there are limited quantified estimates of volumes of water that recharge or discharge systems (Section 1 of the Task force report).

The NWI calls for flexible and adaptable water planning supplemented by risk assessment frameworks. Detailed plans such as ROPs in Queensland focus on developing specific rules for environmental management, specification of licenses or entitlements, trading and rules for operating infrastructure. A ROP is subject to change at any time without compensation for users located within the defined boundary. Water Resource Plans provide contextual guidance for ROPs by including other water sources and plans, land management and natural resource management strategies.

The security of entitlements or licenses is dependent on stream flows and connected groundwater in the Northern Territory and supplemented water in Queensland. Supplemented water represents in-stream flows, on farm storage and in some river systems, public storage. The Ord River plan in WA is focused on releases from Lake Argyle and flow is determined by the level of water in the dam. The Ord plan is distinct from other plans in northern Australia and considers variability of weather patterns.

Table 2: Water Plans in Northern Australia

Water Plans in northern Australia	Northern Territory (Water Allocation Plan)	Queensland (Water Resource Plan and Resource Operation Plans)	Western Australia (Regional Plans and Water Management Plans)
Completed	Daly-Tindall (2009)	Gulf WRP (2007) Mitchell WRP (2007)	Ord River WMP (2006)
Draft	Daly-Oollo Daly-Mataranka	Gulf ROP Mitchell ROP	La Grange Aquifer

The four completed water allocation plans in northern Australia and three draft plans are listed in Table 2. Typically, plans identify extraction limits, environmental rules (in the Northern Territory and Queensland), licensing/entitlement regime and water trading rules. Water Allocation Plans deploy a regulatory approach to sharing water and determine how basins are to be managed. Environmental monitoring and stakeholder committees determine the ongoing impacts of water extraction and use.

Plans must be reviewed every three years in Western Australia for the Ord, five years in the Northern Territory for the Daly-Tindall and in 10 years in Queensland although ROPs may be amended at any time without compensation for entitlement/license holders.

Prominent Indigenous social, economic and cultural interests are reflected in land tenure and cultural and environmental flows have an attenuated legal underpinning in the Native Title Act 1992 (20). The prominence of Indigenous interests is especially significant in the north, and Indigenous groups are seeking involvement in the management of water to potentially use water as a means to develop commercial enterprises (21). The three northern Australian jurisdictions have made attempts at integrating Indigenous values into water planning. Queensland Water Resource Plans informed by relevant Indigenous Working Groups have recognised sacred sites and assigned cultural access licenses of 10ML per year with a potential for commercial licenses. This process, however, may not be sufficient if water plans fail to link land management and water management (22).

Chapter 15 of the Taskforce Report has detailed the efficacy of the water planning process to recognise and incorporate Indigenous interest in water.

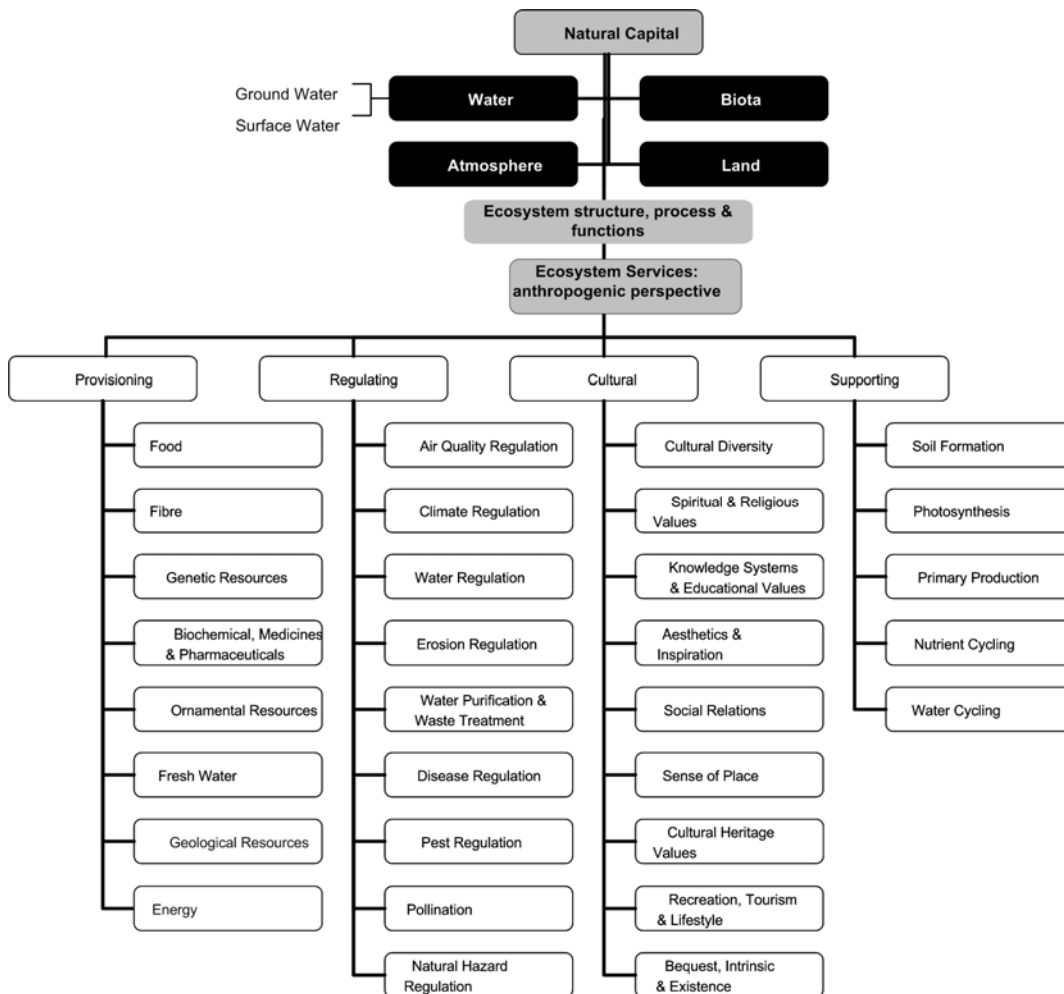
4. LINKING WATER RESOURCES WITH AQUATIC ECOSYSTEM FUNCTIONS AND SERVICES

The objective of NWI consistent water planning is to negotiate and implement an acceptable (and explicitly sustainable) level of surface and/or ground water modification. When modification involves diverted or extracted water, determining the rate and volume of extraction is necessary but not sufficient to capture the entire range of jointly produced benefits that water resources provide. Although the volume of the flow rate and timing of extracted water are easily measured and modified, it is not obvious what values are actually being affected or compromised. A question then is what is actually being modified?

This is particularly salient to the extensive water dependent aquatic and terrestrial ecosystems in northern Australia, adapted to highly episodic rainfall, seasonality and ephemeral water systems. Several authors have argued in this report and elsewhere (23) that the pattern of water development has been generally anarchic in the north and impervious to notions of systematic planning that attempts to account for a broader suite of values. Nugget Coombs reflecting on the North Australia Development Committee stated “...that growth was a good thing, that it could be achieved primarily by seeking to impose on the north a pattern of productive activity and a way of life essentially European in its origin and substantially European in relevance. There is little evidence.....of a genuine understanding of or an intuitive sympathy with the climatic and territorial environments of the North” (24).

Water resources can be considered as aquatic ecosystems comprised of a fund of natural capital stocks generating flows of intermediate and final goods and services through time (25). Water of course interacts with a more comprehensive suite of natural capital stocks include renewable and non-renewable resources such as biotic, geologic, water, atmospheric, and land resources. Flows are classified as supporting, regulating, cultural, and provisioning services (26). Figure 1 illustrates the range of services derived from ecosystem functions.

Figure 1 Schematic of natural capital, ecosystem functions and generated services



Source: Adapted from Raymond (27)

We propose that the modification of the relative proportions of supporting, regulating, cultural, and provisioning services derived from the water system is the primary question to be negotiated by diverse water users in the water planning process. A general rule, interdependence of these services implies that water extracted for additional provisioning services depletes non-provisioning services.

Institutions play a critical role, as this is a process of social decision making and choice. In the conceptual model we discuss in section 4, robust institutions and governance link the biophysical, economic and social analysis with potential modification (or development) trajectories for northern Australian catchments.

Natural capital stocks, aquatic ecosystem functions and the flows of ecosystem service are highly interdependent. Excessive water diversions (i.e. the stock) jeopardizes the future yields of flows (i.e. services), which, if beyond replenishment rates, in turn degrade the viability of the total water resource (28). The development of water resources has generated significant economic and social benefits but these benefits have often come at a high cost in the inundation of high value cultural sites, degraded aquatic habitat, reduced quantity and quality of fresh water, salinisation, and changes in species composition (29).

The assessment of water dependent ecosystem goods and services requires some degree of translation into ecosystem structure, composition and functions, as it is functions that produce the goods and services that are of value to humans (30). The *structure* of the ecosystem is considered to include the physical abiotic and biotic components of the system, including water as a part of natural capital. *Functions* are changes or reactions which occur naturally within the ecosystem, referring to the dynamics of physical, chemical or biological transformation (31).

The term of value to humans is critical in the context of ecosystem services. DeGroot et al. (32) assert that 'observed ecosystem functions are re-conceptualized as "ecosystem goods and services" when human values are implied'. That is, the concept is anthropocentric and "*it is the presence of human beings as valuing agents that enables the translation of basic ecological structures and processes into value-laden entities*" (*ibid*).

In the context of water planning, understanding the relationship between water flows and aquifer levels, ecosystem structure and function with the flows of ecosystem services is important for two main reasons. Firstly, if key ecosystem services are to be accounted for in the water planning process it is necessary to understand how the functioning of ecosystems relates to ecosystem services. An understanding of functionality provides a basis to estimate the continued capacity of water resources to provide ecosystem services. If functions are declining the level of ecosystem services is also likely to decline.

Secondly, the relationship between function and service is likely to be non-linear implying that one service may be the product of a number of interdependent functions or conversely one function may provide more than one service (33). Ecosystems respond non-linearly to perturbation and a system that appears to be providing a constant supply of ecosystem services may suddenly undergo dramatic and potentially irreversible change (34). Additionally ecosystem functions can remain undetected until valued services fail (i.e. functions remain invisible).

Extracted water acts as the primary input to produce additional provisioning goods or services such as fish, timber, fibre and food crops. Water as an input to mining production also contributes to a provisioning good in this context. By meeting the excludability and rival criteria of private goods, the values of these additional provisioning services are revealed through the price signals of market exchange. While provisioning goods such as fish and wildlife, which may or may not be traded in markets, are produced via non-diverted water it is extracted water that assumes prominence in water development decision making.

In contrast, cultural, regulating and supporting services are derived from the ongoing aquatic functions of non diverted or environmental water (called here base flow). For many *non – provisioning* ecosystem services the absence of markets implies that price signals do not accurately reveal their value, but can be revealed through society's willingness to pay or accept compensation for their loss (35). Other non-provisioning services that are important for northern Australia, such as tourism and recreation, are revealed by market prices.

Generally, the value of provisioning goods is more often expressed by market prices; non-provisioning services remain generally non-monetized.

Ready access to markets results in managers of privately assigned water entitlements preferentially producing marketed provisioning services potentially at the expense of non-provisioning services. Without adequate representation and management, over time this results in the under supply of the latter and the long term deterioration of aquatic systems (36).

From the perspective of NWI water planning, the ecological understanding of aquatic function needs to be at least partially translated into an expanded economic domain; inclusive of provisioning and non-provisioning services.

Despite the substantial advances made in Australian water planning, negotiating the balance between provisioning and non-provisioning services; between base/environmental flow and extracted water, remains a complex and highly challenging endeavour (37). The absence of commensurate values; non-linear relations between aquatic structure, processes, functions and services; the risk of potential irreversibility; lack of data and metrics and functional invisibility create a highly disparate decision environment.

Where the imperatives of aquatic conservation and commercial development coincide, three general models have been proposed to assist in the decision process. One model advocates a science based constraint on the preservation of critical level of natural capital, regardless of cost. Measures of critical natural capital can be thought of more in ecological than economic terms (38) and a defined set of physical indicators, for example minimum flow volumes and rates, are the only empirical requirement.

A second is the “threshold s of potential concern” developed and applied in South Africa. Chapter 22 of this report details the South African water management model. In brief, all water modifying activities are evaluated according to the effect on river flows, basic human needs are prioritised, basins are classified from natural to critically modified and are managed accordingly.

The third model is safe minimum standards (SMS). SMS proposes a socially determined delineation or threshold between the conservation of water and the trade-off of water exploitation (39). The useful application of the SMS approach relies on sufficient information and guidelines to determine the standards and levels of environmental thresholds. In the context of ecosystem services, even extensively studied water systems such as the Murray Darling Basin (MDB) are typically data and analytically poor, a situation amplified for northern Australian basins (see chapters 1 -4 of the report). Table 3 documents the state of biophysical, market values and non-market valuation for the MDB as of October 2009 (40). Despite extensive research effort, substantial gaps and uncertainty prevails in determining acceptable levels of river modification.

The difficulties of informally compiled or insufficient data are further compounded when establishing targets for aquatic ecosystems, demanding systems analysis as well as a full complement of individual values (41). Furthermore, thresholds that are socially determined implicitly need to include social welfare values and incorporate a forum for public decision-making. Chapter 15 has documented the lack of engagement with Indigenous communities in the north.

In contrast to the critical natural capital approach, SMS proposes that the predetermined levels of preserved natural capital can be breached if the social opportunity costs of conservation are unacceptably large. A number of participatory and economic methods can be deployed in water planning to estimate the trade-off between social benefits and costs (42). However the definition of unacceptable social costs is often contested, arbitrary and lacks consensus. Similarly, methods to determine the economic costs and benefits of non-provisioning services are often absent, are too diffuse or ill defined for pragmatic implementation (43).

In the introduction to this chapter we posed three questions that we considered important when adjudicating a socially acceptable level of basin modification: what is being modified, what needs to be measured and subsequently what needs to be managed? A consideration of ecosystem services provides a platform for a more comprehensive and tractable interpretation of what is being

modified. Non-linearity, interdependence, functional invisibility and coupled social-ecological systems introduce a substantial research challenge to answering the second question and one that we do not underestimate (44). The volume, frequency and duration of altered flow regimes are obvious and measurable attributes and may warrant further investigation as a proxy indicator. Estimating for example a minimum flow regime of monsoon aquifer spill sufficient to maintain connected surface water and downstream functions may act as a pragmatic heuristic (45).

A consistent theme to all three approaches is the constellation of analytical uncertainty in the key disciplines of economics and the biophysical and behavioural sciences. Common and Perrings (46) argue that decision makers acting on behalf of a society should decide on cautious outcomes, as individuals apply risk aversion strategies in decision making. The acceptance of this cautious approach is strengthened when outcomes are characterised by limited knowledge and potentially lead to irreversible environmental impacts (47).

To account for limited knowledge and to minimise the risk of modification that does not correlate with basin capacity we have proposed the introduction of a reserve pool in addition to the extractive and environmental pools proposed in the NWI. The reserve pool is intended to provide sufficient water to satisfy future unresolved native title claims and to buffer inherent scientific uncertainty in understanding the impacts on aquatic habitats of altered flow regimes. The reserve pool buffers against the ecological, social, economic and political costs of inappropriate basin modification.

Assessment of ecosystem services in the Murray Darling Basin

		PROVISIONING					REGULATING					CULTURAL			SUPPORTING												
		food production (crops / livestock)	fibre production	energy production (solar, wind, mineral, wood)	production of biochemical or natural medicine	wild plant and animal products	ornamental resources	aquatic and terrestrial habitat for biodiversity	aquaculture	drinking water for urban zone (people and industries)	fresh water for irrigation	air quality	climate regulation	prevention of damage due to environmental disturbances	water purification	carbon sequestration	maintenance of healthy and productive soils	maintenance of population (laundry) e.g. pollution / genetic resources	regulation of diseases and pests	recreational and tourism activities (land based)	recreational and tourism activities (river based)	sites of high aesthetic values	sense of place for Aboriginal people	sense of place for non-Aboriginal people	prevention of erosion	water cycling	
WATER	Water quality																										
	sediment accretion																										
	turbidity																										
	water quality - chemical data																										
	nutrient emission																										
	O2 concentration																										
	Salinity (catchment)																										
LAND	Flow regime																										
	different barriers of flow (dams, weirs..)			3																							
	Connectivity surface / ground water																										
	Water available- water quantity																										
	groundwater (extractions)																										
	surface water																										
	Wetlands - Floodplains																										
AIR	Soil quality																										
	sodicity																										
	acidity																										
	dryland salinity																										
	nutrient status																										
	organic matters																										
	Erosion / Sedimentation																										
BIOTA	Vegetation																										
	land cover - land use	4																									
	Crops and livestock	4	4	4																							
	Atmosphere																										
	gas concentration																										
	UV radiation			3																							
	temperature																										
trade of wind			3																								
BIOTA	Weather																										
	rainfall / runoff																										
	extreme events - drought																										
	Wildlife fishing, hunted																										
	Harvested fish																										
	Invertebrate biodiversity																										
	Iconic species including threatened species																										
	Invasive species																										
	Pests and diseases																										
	Biota with potential medicinal use																										
	Biota with potential ornamental use																										
	Pollinators and seed dispersers																										
Native vegetation																											

Black	N/A	White	1	biophysical data and reports	2	1 + GIS data	3	2 + models	4	values	5	3 + non market values
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Table 3 Assessment of ecosystem services in the Murray Darling Basin (Source Albouy, Rimbaud and Hatton MacDonald 2009 (48))

5. ZEN AND THE ART OF WATER CYCLE MAINTENANCE

5.1 Modification from customary management to basin closure

In the 1980s water management agencies in the Murray Darling Basin began to consider broader objectives. Water authorities no longer looked solely to the construction of dams to solve water issues; rather, they examined options of improving the allocation of existing water entitlements in conjunction with environmental and social policy objectives. Their objectives refocussed on promoting efficiency and equity of water allocation while protecting the environment.

By 1990, water authorities were compelled to address issues and policies related to the management of water resources in a mature water economy. The incremental cost of water supply and impoundment was increasing to historically high levels, intensified competition was intensifying in scale and diversity and escalating scarcity was occurring amidst increased interdependencies amongst water uses. Conflict was growing between the old developmental objectives and the newer economic and environmental objectives, but being played out within institutional settings geared to resource expansion rather than the optimal allocation of a scarce resource. Finally, awareness was growing of the severity of environmental degradation, its irreversibility in some cases, and the consequences including declining quality of the water resource.

There is a strong correspondence between the characteristics of the mature water economy that describes the MDB and a water development typology proposed by Molle et al. (49), that traces a development pathway from an open through a closing to a closed basin.

An open basin is able to satisfy the full suite of domestic, industrial, agricultural or environmental water commitments for the whole of the year. Environmental flow commitments include downstream allocations to meet societal needs, to dilute pollution, maintenance of aquatic ecosystems, flushing sediments and controlling saline intrusion (50). Open basins also have surplus water and are able to meet additional water demands.

Closing basins are unable to satisfy the full suite of domestic, industrial, agricultural or environmental water commitments for a part of the year. Basins are closed when water for all domestic, industrial, agricultural or environmental water commitments cannot be met during the entire year.

Figure 2 depicts the development trajectory of a river basin according to the open, closing and closed typology. If environmental flows are judiciously defined and complied with, a planned and well-managed closed basin can sustainably support agriculture, urban and ecosystem services. However, if a basin goes past the point of closure, non-provisioning ecosystem services will be lost unless water for provisioning services is reduced or supplies increased. In Figure 2 depleted water represents consumptive water used for provisioning services. Outflow represents the actual environmental water to sustain non-provisioning ecosystem services. Committed outflow represents the planned volume, time of release and flow rate of environmental water.

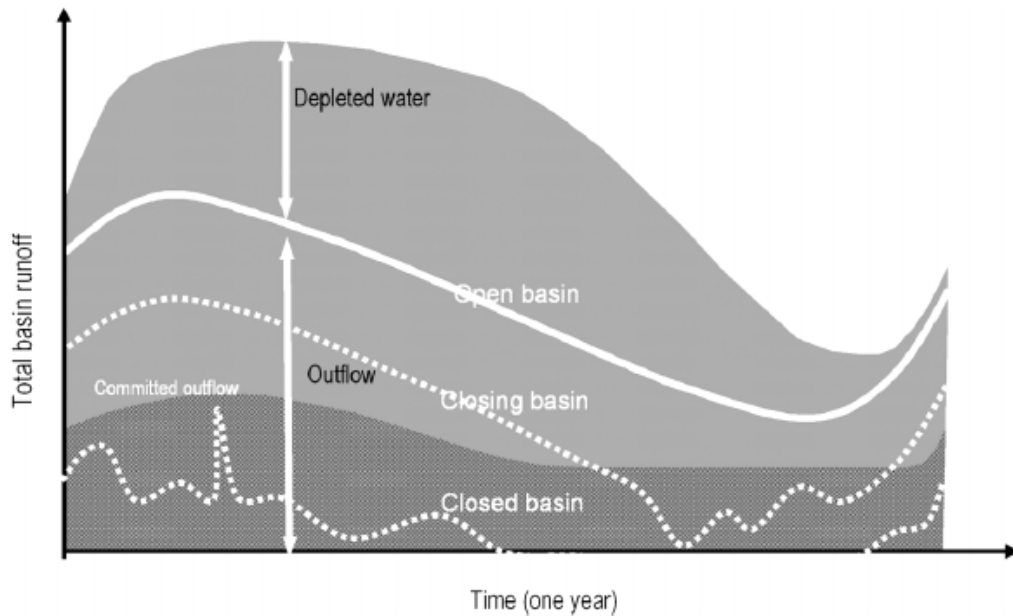


Figure 2 The process of basin closure through time. Open basins have water available for additional diversion and assignment. Closed basins are characterised by over assigned entitlements, and diversion levels compromise environmental flows and downstream users. (Source adapted from Molden 2007; Falkenmark and Molden 2008 (51)

We have modified the “open-closed” typology to reflect the development of the MDB and water reform objectives of the NWI, and as a template for the conceptual development of surface and groundwater resources in northern Australia. The modified typology integrates four key areas of northern Australian water management. Values are introduced as provisioning and non-provisioning services that correspond with the planning objective of defining the extractive and environmental water pools respectively. Differentiating ecosystem services as provisioning and non-provisioning also aligns with the resource attributes of each pool (private good and common pool) as well as appropriate instruments and governance (e.g. private entitlements coupled with markets and co-management).

The modified typology can be applied to both surface and groundwater systems at various stages of system modification and variable biophysical and economic attributes. We do however emphasise aquifer management as this best represents northern Australia water resources. In the institutional framework, development or modification trajectories should be considered as a continuum. “Customary Management”, “Open” and “Closed Sustainable” for example are nominated examples of the continuum, that illustrate characteristics that initiate different institutional and governance arrangements appropriate to the number and diversity of water uses.

Water development pathways: Murray Darling Basin and northern Australia

Figure 3 illustrates the modified typology for the development of water in the MDB. Chapter 17 discusses this topic more thoroughly. Note that the proportional relationship between extracted water and base flow are illustrative only and do not purport to represent actual volumes of any northern Australian surface or ground water system. The waved lines are indicative of inflow variation and are a graphic representation of the highly episodic and ephemeral water resources of the north. The elements of Figure 3 are:

- Base Flow represents environmental flow or committed outflow supporting ambient provisioning and non-provisioning services;

- Replenishment represents system inflows;
- Extraction is the volume of sustainable consumptive water use;
- Water Plan represents the equivalent of a negotiated NWI consistent plan establishing the accepted level of system modification: i.e. sustainable base flow and extraction volumes;
- Available for consumptive use is the total volume of stored water; and
- Actual consumptive use is the volume of water extracted at each phase of development for produced additional provisioning services.

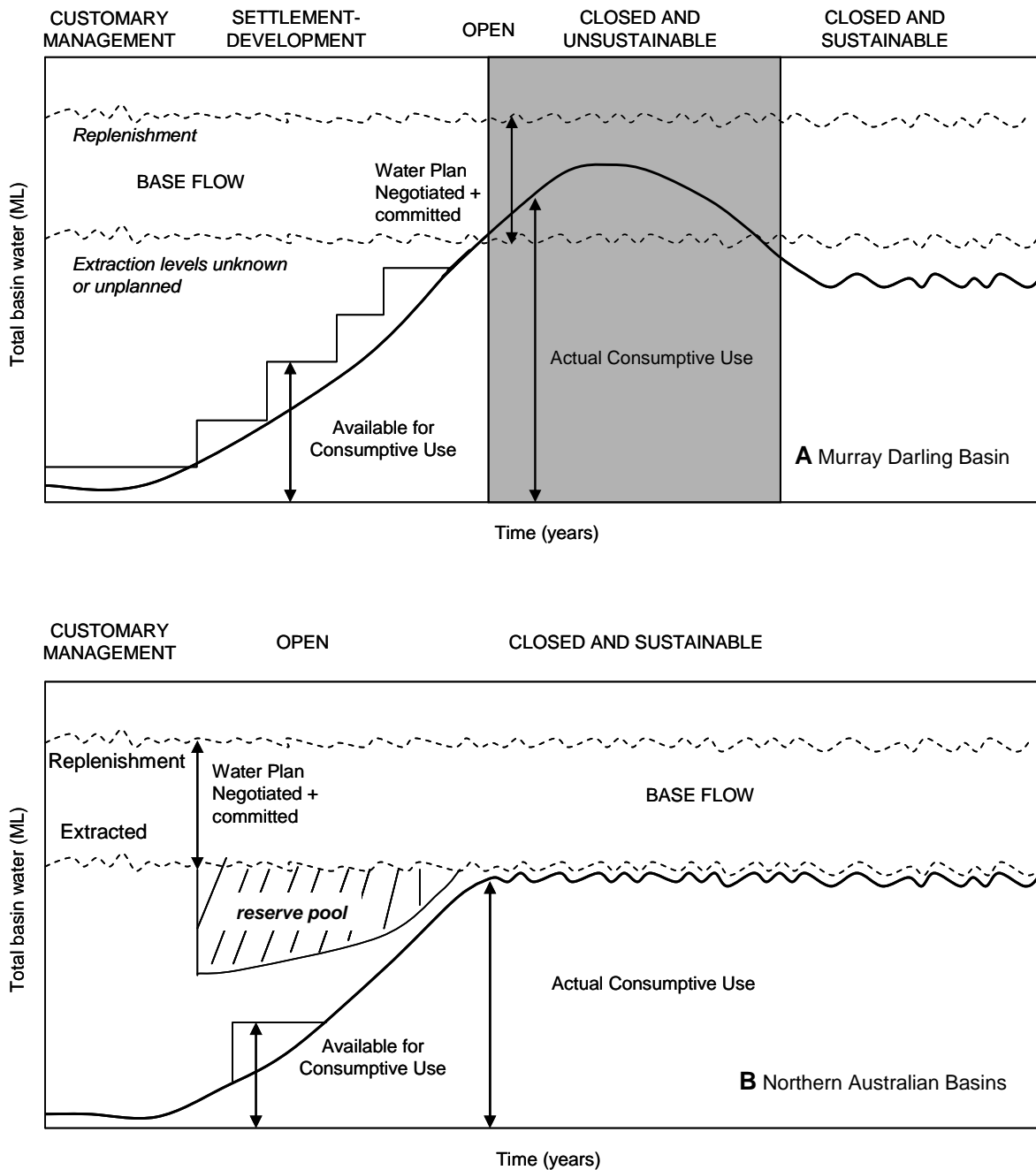


Figure 3 Modified Open Closed development pathways of the **A** Murray Darling Basin and **B** Northern Australian Basins (Source Ward and Albouy 2009 (52))

5.2 Water development pathways for the Murray Darling Basin

In Figure 3 A, Customary Management represents water managed according to traditional Indigenous custom and law, prior to European Settlement. Water management is likely to be focussed on maintaining in stream values in accordance with the obligations and responsibilities of customary law and traditions (53).

The Settlement –Development phase represents European settlement, the transition to water impoundment and the development of irrigation infrastructure. Plans to match extraction volumes with basin capacity to meet environmental were not negotiated or implemented and entitlements poorly defined. Water projects were often initiated based on political motivation with weak economic rationale. Traditional owners were not recognised, were not granted water rights and customary knowledge excluded from decision making or informing basin related science.

The Open phase is characterised by a water plan, the assignment of entitlements to water interests to extract a defined share of water and we assume opportunities to activate extracted water for commercial enterprises are present and are being utilised. Factors activating water demand are the non-water elements such as soil, labour and access to markets that give extracted water commercial viability. Generally there are surplus entitlements available in the open phase, however in the case of the MDB the open phase lasted for an extremely short duration before coinciding with the closing phase. During a closing phase the volume of extraction compromises the agreed environmental requirements for at least part of the year. The open phase in the case of the MDB is also characterised by a cessation of dam construction, constraining further increases in the supply of available consumptive water. Native Title had been recognised but customary claims to attendant water remained generally divorced from planning and legislation.

The closed and unsustainable phase is characterised by extracted volumes exceeding the functional needs of the environment for the entire year. Failure may be due to either planning deficiencies, over assigned entitlements relative to available water, inaccurate water accounting, a lack of monitoring or high levels of non-compliance. The chronic unreliability of seasonal allocations has been made more acute by the recent drought. The phase corresponds to Australian water reform manifest as the NWI; a response to basin closure. Readjusting entitlements between consumptive use and non-consumptive use remains an ongoing and contentious process that imposes substantial transitional, economic, social and political costs.

The closed sustainable phase is characterised by a negotiated and committed water plan, tradeable entitlements represent a secure unit share in the declared extractive pool and are fully assigned. Assuming hydrological connectivity and sufficient numbers of willing buyers and sellers, water markets are an effective means to allow the entry of new water users, the exit of existing users and the re-distribution of water to high value uses. Changing circumstances are independently managed at two levels: long term changes reflecting hydrological variance or changing social values are managed by changing the relative number of shares in the extractive pool; seasonal variance is managed through the process of allocation. The closed sustainable phase adheres to the general principles of robust design and the objectives of the NWI.

5.3 Water development pathways for northern Australia

A review of the development pathway of the MDB yields substantial lessons and advantages for water management in northern Australia. Figure 3 B is a graphic representation of potential northern Australia water management arrangements. There are a number of substantial differences between the two development–modification pathways.

1. We have proposed a precautionary reserve pool, in addition to the extractive pool and Base flow specified in the NWI. The reserve pool represents a residual of the total negotiated extractive pool so that its eventual assignment does not interfere with the capacity of the basin to meet all the demands of all water interests including Traditional Owners and the environment. The reserve pool is intended to provide sufficient water to satisfy future unresolved native title claims and to address inherent scientific uncertainty in understanding minimum water flows. The reserve also provides an opportunity to test compliance and sanctioning actions. Hence the reserve pool may be assigned to Native Title claimants, to the maintenance pool or the extractive pool. As a corollary the number of available entitlements is temporarily reduced, with additional entitlements potentially made available as the reserve pool is reduced in volume. Reduction in the reserve is a function of resolution of native tile claims and improved knowledge arising from monitoring of the system response to changed flow regimes.
2. Water planning is introduced early in the development pathway. That is the Open phase is of sufficient duration for the equitable and efficient assignment of entitlements, knowledge can be updated to reduce uncertainty about non-provisioning response to water extraction and contested native title claims can be resolved.
3. Importantly, the construction and management of MDB and delivery infrastructure was publically funded and assigned to government agencies and authorities. Opportunities for dams and channel delivery are severely constrained by the topography, rainfall distribution and physical characteristics of northern Australian basins. Hence the Ord scheme and Southfedge Dam are the only dams represented (54). It is more likely that aquifers will be the primary mode of water storage, and extraction and distribution costs borne by private interests.
4. The proposed framework minimises exposure to the adverse outcomes of the Settlement-Development phase, including failure to recognise Indigenous water interests and knowledge, unplanned extraction, political interference and development that is not economically viable.
5. The pathway avoids the substantial social, political and economic costs of the closed and unsustainable phase.

Customary management is one of three nominated development phases which is generally characterised by a negotiated, non-statutory water plan incorporating either customary or co-management arrangements. Such a negotiated water pan could encompass unforeseen traditional obligations to sustain country and be enduring given the long term absence of water demand activating factors.

For those basins which may move into a development/modification phase following the activation of water demand factors, we suggest that a statutory water plan be required.

In an Open System, a statutory water plan has been negotiated, some or all of the reserve pool remains intact, either for future Indigenous claims or to account for scientific uncertainty. Water markets are an effective means to re-distribute water in the extractive pool when there are no surplus entitlements. In an open system markets are appropriate when all of the entitlements in the available extractive pool have been assigned to water interests. This will be dependent on the number of willing buyers and sellers and localised spatial and temporal effects of aquifer drawdown. Accounting for third party effects on either surface water interaction or other aquifer users may have to be assessed and specified in entitlements (55).

The closed sustainable phase in Figure 3B is similar to the characteristics of Figure 3A, except for one feature. In the MDB example we have depicted the actual consumptive use as being substantially less than the declared extraction level. We assume the basins non-provisioning ecosystem services have not been fully restored after long term over assignment, leaving residual chronic degradation. For example, widespread reductions in water quality as a result of residual salinity or turbidity, may result in those effected not being able to utilise all of their entitlement.

Figure 4 synthesises the characteristics of a number of key parameters and variables consistent with the development pathway of the MDB. The variables cover the modification–development phase, biophysical status, policy and social objectives, metrics, viability of activating factors and prevailing institutions and governance approaches. Whilst not exhaustive, the values and attributes of the MDB variables can be compared with the proposed values for northern basins based on the principles of robust design illustrated in Figure 5. We have also introduced a simple schematic of the change in provisioning and non-provisioning ecosystem services to assist in the application of the conceptual management framework. The arrows in the aquatic ecosystem schematic indicate the status of functional interdependence between ecosystem service classes. Grey indicates functionality is retained; red indicates likely system failure.

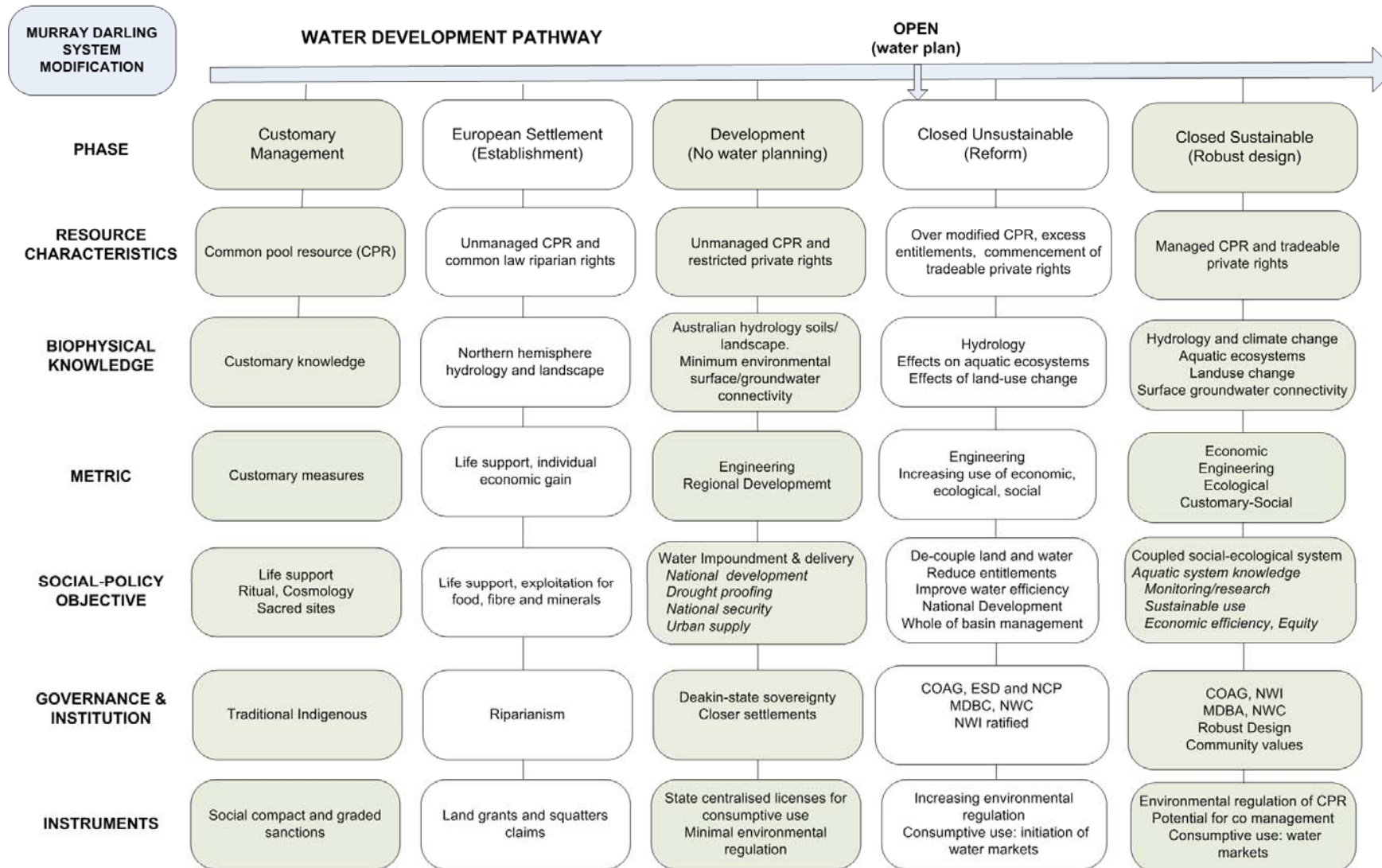


Figure 4 Water basin modification and development pathway of the Murray Darling Basin

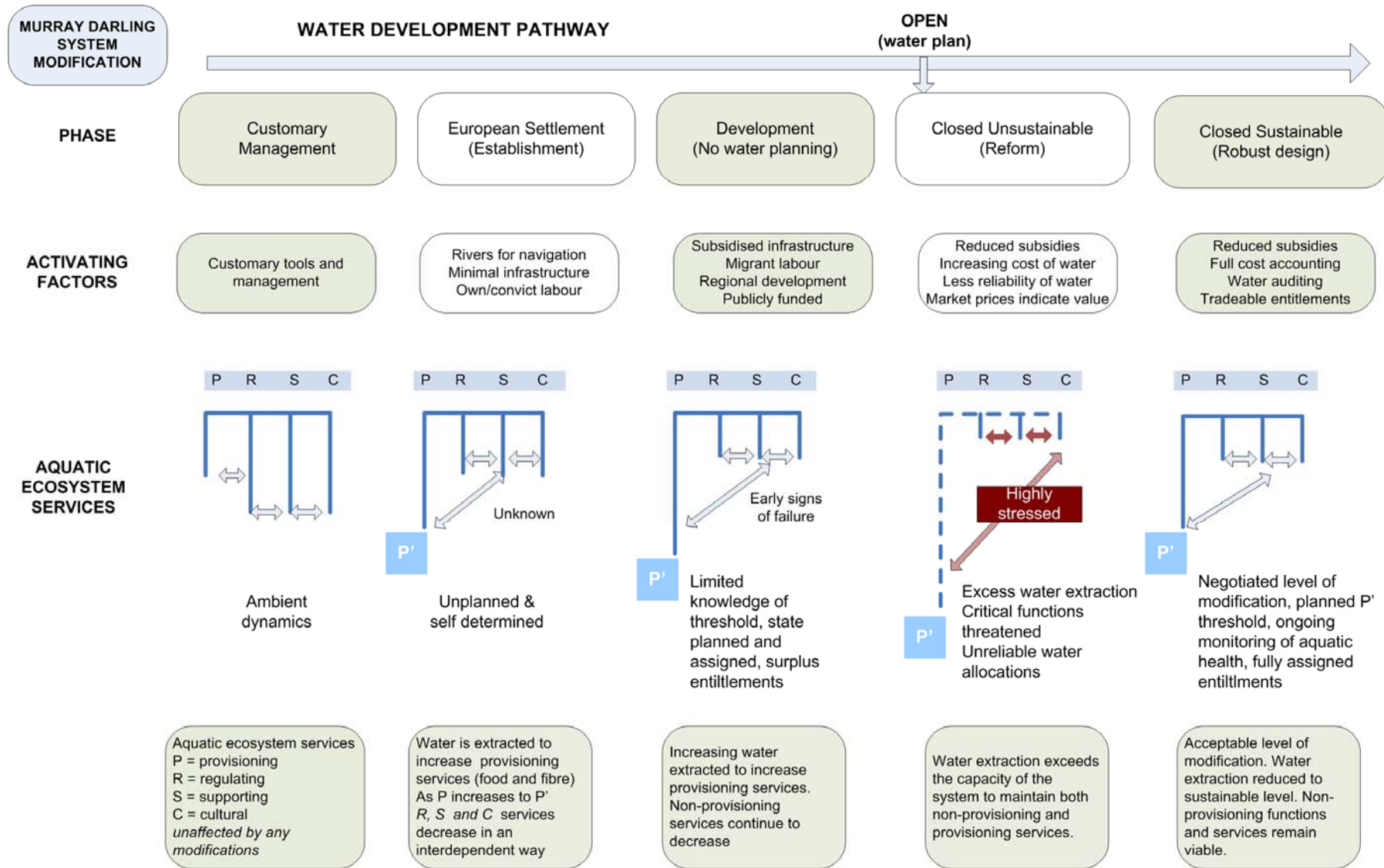


Figure 4 Modification and water development pathway of the Murray Darling Basin (continued)

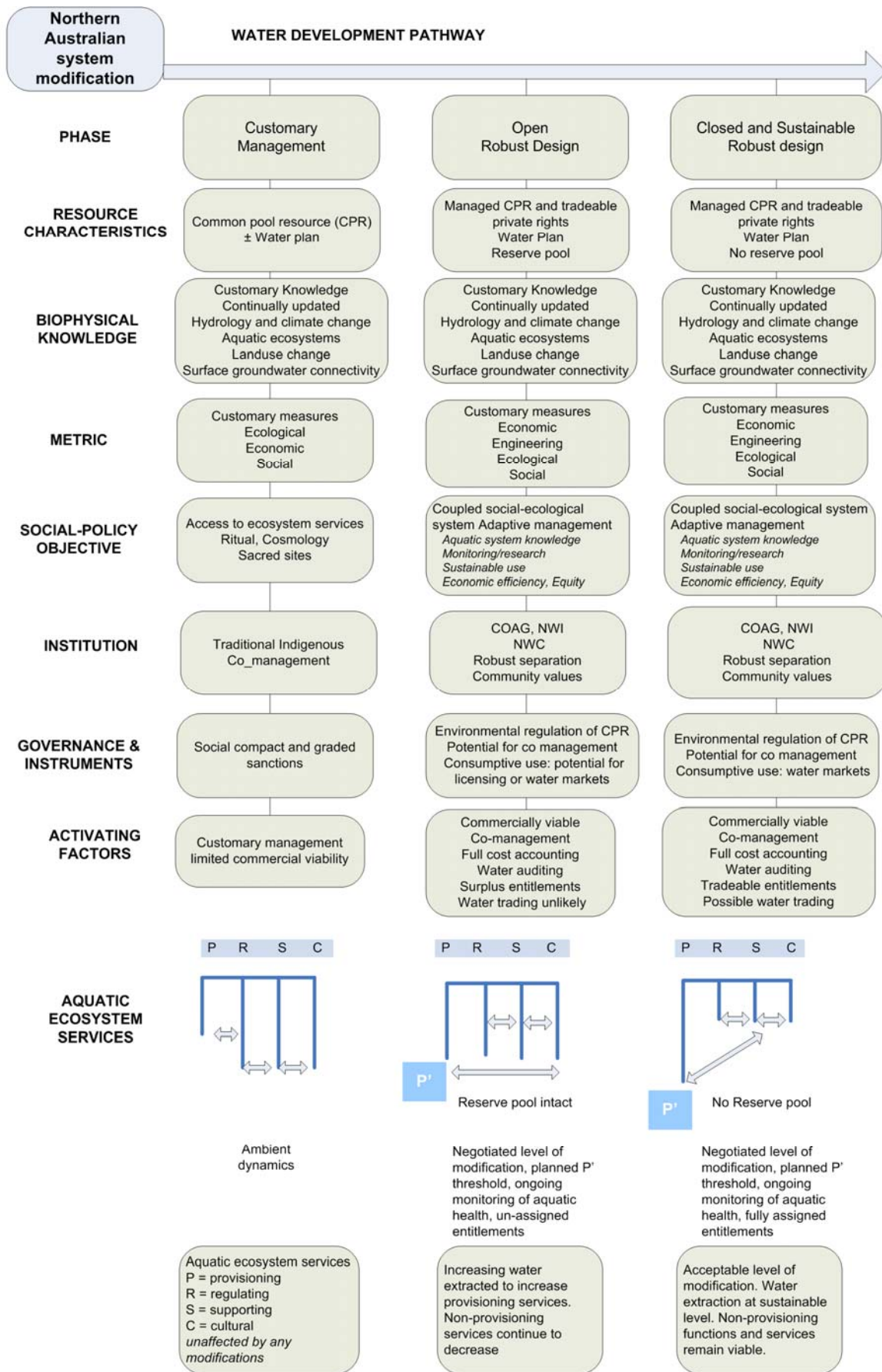


Figure 5 Modification and water development pathway of northern Australian basins

6. SUMMARY

In this chapter we have attempted to describe design principles to guide the development of robust water institutions and governance in northern Australia with an emphasis on the initial stages of water planning. These design principles are consistent with the characteristics of successful water institutions detailed in chapter 14, albeit nuanced for the episodic, ephemeral characteristics of northern Australia water basins.

Water planning involves negotiating a socially accepted level of basin or river modification when the imperatives of conservation and commercial development coincide. We posed three questions when considering this proposition: what is being modified, what needs to be and can be measured and what needs to be managed. To aid in the planning process and to help answer these questions we have proposed an ecosystem based (or the PRCS) framework that coordinates four key areas of water management. These are policy objectives to determine separately managed environmental and extractive pools; inclusion of a comprehensive set of benefits and values; differentiated resource characteristics of the two pools and appropriate instruments and governance that correspond to the resource characteristics.

Interdependent provisioning and non-provisioning (cultural, supporting and regulating) goods and services are derived from ecosystem functions. Water extracted to produce additional provisioning goods such as food and fibre corresponds to the extractive pool. Non-provisioning services correspond to the environmental pool and maintain the overall functioning of the water system. Generally, the value of provisioning goods is more often expressed by market prices; non-provisioning services remain generally non-monetized.

We have proposed the introduction of a reserve pool in addition to the environmental and extractive pools prescribed in the NWI. The reserve pool is intended to provide sufficient water to satisfy future unresolved native title claims and to address inherent scientific uncertainty in understanding minimum water flows. To avoid compromising the functional integrity of the water system the reserve pool is a residual of the extractive pool. The initial assignment of available entitlements is likely to be temporarily reduced, with additional entitlements made available as the reserve pool is reduced in volume. The reserve pool reduction is a function of resolution of native title claims and improved knowledge and monitoring of the system response to changed flow regimes.

In the chapter we also discussed the importance attached to the initial assignment of entitlements to water interests, which must be seen to be procedurally fair, equitable and allow for the potential of economic efficiency. Customary or co-management of the environmental pool or base flows are strong candidates for enduring institutional arrangements. Bulk entitlements potentially managed as a water cooperative or volumetric licensing involving measurement are prospects for the extractive pool. Entitlements vested to individual water interests are more likely and appropriate when water scarcity has increased and the number of unit shares in the extractive pool approaches full assignment.

By combining robust design with the ecosystem approach and classes of basin development and modification, we developed a typology that describes the potential modification of northern Australian basins. The typology nominates three sustainable development classes for northern Australia: customary management, open systems and closed systems.

There are cogent lessons from the MDB that can be applied to the north. One is to avoid the pitfalls of the unplanned, ad hoc water development of the settlement phase and the other is to be vigilant when basins approach closure to avoid the substantial social and economic costs of unsustainable extraction.

When we apply the typology to the Katherine–Daly in the Northern Territory, the Mitchell in Queensland and the Fitzroy in Western Australia we find that:

- The Katherine–Daly basin plan has declared 16 GI for extractive use. Current annual extraction is approximately 1.5 GI with future licence applications amounting to 75 GI. An additional 25 GI has been set aside for Indigenous use. The system would currently be classed as Open, but with a strong potential to rapidly approach closed and unsustainable if all licenses are granted and utilised.
- Groundwater is extracted in The Fitzroy basin, but is not currently described by a statutory water plan. The Kimberley Regional Water Allocation Plan was initiated in 1988 and is still under development. According to the typology the Fitzroy basin would be classed as an Open-unplanned system. Current groundwater extraction licences amount to 20.63 GL/year ranging from small community water supplies (<10 ML/year) to larger mining supplies (~4000 ML/year). The La Grange aquifers cover approximately 100,000 km² in the southern boundary of the Fitzroy and the La Grange Groundwater Subareas Water Management Plan is also under development.
- The Mitchell is described by a WRP and a draft ROP. Current use is approximately 8 GI/year, with a further 70 GI of un-assigned water (reserve pool) to be made available for future extractive use. The ROP makes provision for seasonal water trading. The Mitchell would be classed as an Open system with planning for a Closed and Sustainable system.

During the process of research for this chapter, several points relating to environmental needs of water systems and planning are worth noting.

The conceptual model as described in Figure 4 provides for the environment within the PRCS framework through:

- Quantifying the difference between replenishment and the extractive levels, and
- The establishment of a reserve pool as part of the total extractive water. These provisions are rules–based and provided they are administered with integrity should support the essential environmental needs of the water systems without the creation of environmental entitlements as specified in the NWI.

With regards to water planning.

- The resource requirements of statutory planning processes including extensive consultation, approval, and subsequent implementation, monitoring, evaluation and review are very substantial. Experience indicates that resource requirements will be ongoing and will need to be adequately funded.
- Experience clearly shows that several years are required to progress a statutory plan to the final approval. To a large extent, this long timeline is influenced by the need for extensive consultation, which is likely to be substantial in northern Australia.
- A substantial research and monitoring effort will also be needed to provide the necessary level of planning data for most of the river basins in northern Australia.

- Given these realities, some prioritisation of effort will be essential. A suggested approach on a river basin basis could be to:
 - Firstly, identify those basins likely to remain in the Customary Management phase for the foreseeable future with activating factors unlikely to emerge, and no need for a statutory plan; A co management agreement with agreed responsibilities could be incorporated into a non-statutory plan;
 - Secondly, identify those currently in the Open modification/development phase requiring a statutory plan (some plans may already be in place or being developed); and
 - Finally, identify those basins where activating factors show potential for development and available extractive water coincide, and are likely to enter the development phase in the foreseeable future.

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8. APPENDIX 1 - NEGOTIATIONS BETWEEN THE MIRIUWUNG GAJERRONG PEOPLE AND THE WESTERN AUSTRALIAN GOVERNMENT

The following document was originally dispatched in 2004 as part of negotiations between the Miriuwung Gajerrong¹ people and the Western Australian Government regarding the Ord Stage ii.

The Authors are Mike Young, John Ward, and Jim McColl

Proposal for a share for MIRIUWUNG GAJERRONG peoples in the economic benefits and participation in the economic benefits, of the Ord Stage II Irrigation Scheme Project Area (WA)

The MIRIUWUNG GAJERRONG peoples' requirements in this element of the package are designed to ensure that they:

- *Have access to a share in the economic benefits of the development of services provided from their land;*
- *Use these resources to provide them with an on-going independent and sustainable economic wealth;*
- *Are able to participate in economic development in the Lake Argyle region;*
- *Become partners with the State in the overall development of the Lake Argyle region.*

The Items above establish the MIRIUWUNG GAJERRONG peoples' interest in the Ord Stage II Irrigation Scheme Area defined within the Ord Global Negotiations Framework Agreement. These items are directly linked with the Ord Stage II project proceeding. They are designed to ensure the success of that project.

Other areas of economic benefit can be linked to the overall development of the region. These include:

- Benefits from the use of "resources" derived from MIRIUWUNG GAJERRONG peoples' land. In broad terms these include the economic returns from the utilisation or sale of **land, water allocations and entitlements, electricity generation, other licensed water uses** and/or from **produce** derived from the land and the water resources derived from the MIRIUWUNG GAJERRONG peoples' land.
- Benefits derived from MIRIUWUNG GAJERRONG peoples' direct participation in the regional economy.

The State-MIRIUWUNG GAJERRONG Peoples partnership concept as outlined also applies to the realisation of these benefits.

¹ (Specifically the Miriuwung Gajerrong customary owners, however this discussion is likely to apply to the Yawoorroong Miriuwung Gajerrong Yirrgab Noong Dawang Aboriginal Corporation)

Water and Electricity

3.1. A fair share of the future returns from the use of water from Lake Argyle, including all irrigation uses in Ord Stage I, Ord Stage II, CPC and Mantinea developments. Use is defined broadly to include the exploitation of water flows for hydro electricity generation, all other licensed activities associated with such practices as aquaculture and tourism development and any future uses that the water may be put to for economic gain.

The core resources for the project are derived from MG land. Rather than stopping development, the MIRIUWUNG GAJERRONG people propose to establish a business like development partnership that ensures the sustainable development of the Lake Argyle region in partnership with the State or private interests.

Under current arrangements, water is harvested from MIRIUWUNG GAJERRONG peoples' land and stored in Lake Argyle and some of this water is used for irrigation and hydropower generation. This land, and the rain that falls on it, supplies a service of values to others. It is now proposed to extinguish native title on the MIRIUWUNG GAJERRONG peoples' land below the dam and use this land for irrigation.

The water resource is the catalyst for the irrigation development that will alienate more of the MIRIUWUNG GAJERRONG peoples' land. The State and the many other users of that water resource receive an economic benefit. The proposed changes will come at a significant cultural and economic cost to the MIRIUWUNG GAJERRONG people. Consequently, it is not hard to understand why MIRIUWUNG GAJERRONG peoples see that they should receive a substantial benefit from the proposed development and alienation of their land and water resources.

3.1.1 Proposed arrangements to ensure that environmental and cultural benefits are not compromised

The Ord River and its associated systems are part of the cultural heritage of the MIRIUWUNG GAJERRONG people. The MIRIUWUNG GAJERRONG people are committed to ensuring that the environmental and cultural health of the Ord River, its wetland and estuary systems and the land associated with it is not compromised. They seek a set of permanent arrangements to ensure that the mistakes made with the development of water in other parts of Australia and the rest of the world are not repeated on the Ord River.

It is understood that entitlements to the supply of periodic allocations will be granted to irrigation users by the WA Water Corporation to irrigation users in the form of a license. Irrigators are then likely to be required to pay a volumetric charge for allocations that they use or are entitled to use. It is expected that these allocations and, also, the entitlements will be tradeable.

The MIRIUWUNG GAJERRONG peoples are aware that the compulsory purchase of land is a long term (permanent) decision and are consequently of the view that similar decisions can be made for water. This opinion is consistent with The National Water Initiative (NWI) principle to treat water separately from land. The MIRIUWUNG GAJERRONG people see an enduring solution.

Consistent with National Water Initiative Principles it is proposed that licensing arrangements be of a "long term" not an "*interim*" arrangement. In particular, and in accord with the NWI, **it is proposed that entitlements to the use of all water in Lake Argyle be defined as shares. These shares should be issued in perpetuity. Two broad classes of shares will be necessary**

- 1) A cultural/ environmental share**
- 2) A consumptive share²**

The MIRIUWUNG GAJERRONG people would further seek that consumptive shares be defined as a share of the “net” amount of water used not the “gross” amount that may be pumped with out attention to the amount of water that is being returned following use back to ground and surface water systems. That is, those who divert water for irrigation purposes and return of a significant quantity of water back to the River should be credited for the amount that they return. “Use” should be defined as the quantity of water that is either evaporated or transpired not as the volume that may be pumped or diverted onto an area of land for commercial use.

Details about the most appropriate way to define the environment’s share will need to be negotiated and defined so that fluctuations in annual rainfall, ground and surface water connectivity and long term climate patterns can be accounted for. The MIRIUWUNG GAJERRONG people would be pleased to contribute constructively to such negotiations.

The MIRIUWUNG GAJERRONG people consider that the cultural/environmental share should be held in a trust. The trustees responsible for this cultural, environmental entitlement should be appointed by the MIRIUWUNG GAJERRONG people as they are the logical guardians of this heritage. The trust would be a holding trust designed to ensure that this interest and heritage is not eroded without the consent of the MIRIUWUNG GAJERRONG people.

The trustees would be empowered to be involved in negotiations about the timing of water releases at the strategic level. In accord with principles of the NWI, they should not be involved with management of consumptive flows on a daily basis. It should be possible for them to allow the commercial use of some of this water.

In recognition of the importance of looking after the natural environment, the MIRIUWUNG GAJERRONG people propose that the environment’s long term share be defined at (for example 60%) of all water released or overflowing from the Lake Argyle Dam.

These arrangements are designed to ensure that the MIRIUWUNG GAJERRONG people working in partnership with water consumers ensure that the health of this river system is never compromised. From the outset of negotiations, the MIRIUWUNG GAJERRONG people consider that environmental and cultural sustainability should be the starting point for all negotiations. The **MIRIUWUNG GAJERRONG people** stress that the entitlement and allocation system should be based on sound hydrological principles and plan for significant climate change.

3.1.2 Securing a fair share of commercial benefits for the MIRIUWUNG GAJERRONG people

The other part of the package of benefits that the MIRIUWUNG GAJERRONG people seek to receive is a fair share of the benefits of using this water. For the purposes of negotiation, assume that 3000 shares in the entire system are issued.

- 60% of the 3000 shares would be assigned to the environment and cultural pool = 1800 shares
- 40% of the 3000 shares would be assigned to the consumptive pool = 1200 shares

Current information available to us indicates that around 24% of flow is being used for consumptive purposes (Hydro power generation is not considered a consumptive use). Implicitly, 720 shares have already been allocated to water users for consumptive purposes leaving a further 480 shares

to be assigned without the need to negotiate with the trustees of the Lake Argyle Environmental and Cultural Water Trust ³.

The simplest way to ensure that the MIRIUWUNG GAJERRONG people receive a fair share of the benefits of using water from their land above Lake Argyle is to require water users to provide an annual return to them ².

The mechanism that the MIRIUWUNG GAJERRONG people propose is one that is transparent, fair and equitable. Our aim is to set in place a mechanism that will not provide a forum for ongoing dispute and will not create opportunities for political interference. The MIRIUWUNG GAJERRONG people seek an enduring solution and an enduring future.

Consequently, the MIRIUWUNG GAJERRONG people propose that all shares in the consumptive pool be defined so that

- **every year (for example and to be negotiated) 10% of all consumptive use shares be surrendered to a pool that is to put up for auction and/or tender; and**
- **the revenue from this auction is to be made available to the MIRIUWUNG GAJERRONG people ³.**

Once agreement in principle to this arrangement is obtained, the MIRIUWUNG GAJERRONG people undertake to put arrangements in place so that those water users who choose to buy back a surrendered entitlement can do so without incurring a capital gains tax liability.

With regard to non-consumptive uses such as hydropower generation, aquaculture, the issuing of boat licences for tourism etc, the MIRIUWUNG GAJERRONG people consider that they should be entitled to 50% of licence fees and associated revenue collected by the government of Western Australia or any of its agencies or corporations.

3.1.3 MIRIUWUNG GAJERRONG peoples' interest in protecting the environment

MIRIUWUNG GAJERRONG people are concerned that unless irrigation and other consumptive uses of water are well managed, severe salinity problems, severe water quality problems and other environmental problems of concern could arise.

To avoid the emergence of such environmental problems, **the MIRIUWUNG GAJERRONG people consider that they should be represented on the body that issues use licences to water users and water consumers.** Consistent with world best practice, they consider that these should be issued separately from water entitlements and allocations. As a basis for negotiation, it is proposed that the people to do this be chosen from the people appointed to be trustees of the Lake Argyle Cultural/Environmental Trust.

²The MIRIUWUNG GAJERRONG people may be interested in adding development and calling it a MIRIUWUNG GAJERRONG environmental, cultural and development trust. They may also like to name it after some land or some-thing of value to them.

³10 % surrender pool implies that entitlements are renegotiated approximately every 10 years to account for changing scarcity value and climate regimes. Down the track we see a need to negotiate a reserve price arrangement to avoid collusion and collective rent seeking