17 A primer for water institutions and governance: *concepts, definitions and measures*

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1. KEY POINTS

1. Institutions are the systems of established and prevalent social rules that structure social interactions. As conventions that shape human interaction and manage conflict, institutions exist in a dynamic state of tension between stability and modification. They need to be malleable enough to accommodate change, balanced within a predictable and stable framework.

2. Governance systems 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.

3. Water simultaneously provides multiple benefits and services. Water resources are fugitive, have both consumptive and non-consumptive uses, constitute market and non-market values, include private good and common pool values and confer a diversity of social and cultural values.

4. Sustainable water management requires governance systems that can be adapted to dynamic social and biophysical systems, operate at multiple scales and respond to changing levels of modification.

5. Effective water policies consist of three key features: generally-agreed and achievable targets; appropriate and adaptive instruments capable of steering towards those targets; and monitoring mechanisms to provide feedback on progress towards targets.

6. Interests in water broadly refers to the rights and obligations that a party has over water. They represent a social contract by defining what a rights holder must and must not do, what they can and cannot do and what others can and cannot do. Assigned interests confer rights of access, withdrawal, management, exclusion and transfer.

7. Water rights should confer obligations and responsibilities on the right holder such that the exercise of a right does not interfere with the ability of others to exercise their own existing rights.

8. The movement of water through the landscape holds implications for property rights regimes and institutions established to manage water resources. In addition to overcoming monitoring and measurement difficulties, water managers need to account for water flows above and below surface, quality changes across the landscape, seepage and evaporation.

9. Mechanisms are needed that can reallocate water amongst competing users in the context of resource scarcity and variability. They may be either statutory (manifest as water laws and vested in the state), vested in the community, or private and hence potentially tradeable.

10. 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 the state, the market, the consensus based and the empowerment approaches.

11. Different regimes confer comparative advantages in achieving specific policy objectives, for example, efficiency, effectiveness, equity, distributional justice and the scale of water diversions. Different arrangements are appropriate for water systems at different stages of modification, and need to have the capacity to change as the system changes.

12. Robust institutions, capable of persisting and adapting to ever-changing hydrological, social and economic circumstances, are necessary to underpin market, regulatory and water planning processes for effective water management.

13. In dealing with competing interests, the quality of the process of governance is important as well as the quality of the results (procedural fairness and justice are important elements of sustainable water management).

2. CONCEPTS AND DEFINITIONS

The objectives of the primer to water institutions are firstly to introduce and explain the important concepts, definitions and measures that Taskforce members are likely to encounter in an exploration of contemporary Australian water management. Our primary concern here is to avoid variable interpretations and possible semantic debate that may distract from the important task of guiding northern Australian water management.

Resource characteristics

- Water is frequently a common pool resource (rivalry in use, difficult to exclude users) that renders it vulnerable to over-exploitation and to the dissipation of net economic benefits from its use.
- Water is a fugitive resource such that its movement through and transformation within the landscape complicates management and creates enforcement difficulties.
- The variability of the supply of water affects its use as well as its quantity and quality.
- Surface-groundwater interaction is a key hydrological feature of most water resources, including those in northern Australia.

Property rights

- Development of property rights differs from region to region resulting in a wide range of property rights regimes adapted to local hydrological and institutional contexts.
- There are six key characteristics of property rights: (i) exclusivity; (ii) duration; (iii) flexibility; (iv) quality of title; (v) transferability; and (vi) divisibility. These characteristics differ in importance according to the resource in question, patterns of use, and management regimes.
- Water rights can be 'unbundled' into three main categories: (i) 'temporary' water (opportunity to use); (ii) 'permanent' water (long-term interest) and (iii) actual use (permission to use).
- Water rights should confer obligations and responsibilities on the right holder such that the exercise of a right does not interfere with the ability of others to exercise their own existing rights.

Institutions

- The evolution of water reform is a search for institutions that are dynamically efficient, have low administrative costs and are robust.
- Characteristics of successful water management institutions include clearly defined institutional and hydrological boundaries, a locally appropriate management regime, clearly enunciated objectives and attendant instruments, the capacity to monitor and evaluate outcomes in real time, and conflict resolution mechanisms.
- Transitioning from one institutional arrangement to another usually involves considerations of both efficiency and equity. Transitions should occur within transparent and accountable frameworks and be guided by community needs and expectations.
- Adoption of water planning tools such as water metering and accounting and water registers can greatly assist in management even in locations where water is not yet scarce.
- High political and economic costs are likely to arise from a 'retrofit' of institutional arrangements and changed water allocations after over use or misuse of water resources has occurred.

Effective water policy

- Additional demands on water cannot be accommodated without affecting existing rights – most water basins are effectively in an 'era of limits'.
- Economic efficiency, equity and sustainability are the three key pillars of water policy. Successful water management effectively integrates these three factors and will require the 'balanced use' of both markets and regulation, with the role and scope of each defined through water planning processes.
- Reallocation of existing access and use rights to water is likely to produce economic and political dislocation, which creates the need for clearly articulated public values.
- Water management policies include three key features: (i) generally-agreed and achievable targets; (ii) appropriate and adaptive instruments capable of steering towards those targets; and (iii) monitoring and evaluation mechanisms that provide feedback on progress towards targets.

Water planning

- Effective water planning is characterised by a holistic approach to water resources, a complementary blend of instruments to achieve policy goals, and adaptive institutions and processes.
- Institutions should reflect the natural complexity of water and its diverse uses. This includes matching management boundaries to the hydrological boundaries of the resource, incorporating surface-groundwater interaction, water quality concerns and relevant land uses.
- Water management institutions should not be fragmented, but rather integrated within and coordinated across hydrological and institutional boundaries.
- Effective water management requires adaptive strategies and institutions that can respond to changing social values and hydrological, environmental and economic conditions.
- Stakeholder collaboration is an effective method to tailor water policy to local situations and needs and to assist in the effective implementation of water plans.

Role of markets

- Water has important environmental, cultural and social properties, but is also an economic resource with an economic value.
- Profligate water use and inefficient water practices are encouraged by not charging water users for the full opportunity cost of the water they use.
- Markets facilitate the reallocation of rights from lower value users towards higher value uses, through mutually beneficial trades.
- Markets require a number of conditions to allocate resources optimally including: (i) scarcity of supply; (ii) physical ability to trade; (iii) well-defined property rights; and (iv) moderate or low transactions costs.
- Water markets should operate within a comprehensive understanding of local hydrology, including surface-groundwater interaction, and understanding of sustainable limits of water extraction.
- Institutions are required to establish, regulate and support water markets, for example by supporting the exclusivity of property rights and resolving conflicts.
- Institutions are ultimately responsible for addressing market failures and protecting the strong public interest in water.

Robust design

- Robust separation describes a rigorous and systematic approach to define a property right regime that accounts for the environment as a primary, legitimate water entitlement holder and facilitates secure, economically efficient and low cost trading and administration.
- A Water Plan establishes the community values and science-based guidelines to appraise the state of a water system and prescribe the rules to determine the environmental and extractive “pools”.
- The first policy instrument defines the characteristics and number of unit shares of the extractive pool and the distribution of shares to individual interests.
- The second instrument defines an independently managed process to periodically allocate the amount of water to each share, and accounts for a variable water supply. The third instrument prescribes or proscribes the obligations of water use and takes into account existing water users and third party effects.

3. INTRODUCTION

This chapter aims to provide a general understanding of the nature of water as a resource, with particular attention to those characteristics that affect the institutional and governance arrangements that affect its management and use. Here we set out the research outline of the ensuing institutional and governance chapters to assist the Taskforce to navigate and locate key topics (as depicted in Figure 1) and also indicate the research links to Section 1 (the biophysical, ecological and hydrological assessment) and Section 2 (the evaluation of economic potential) of the overall Taskforce report.

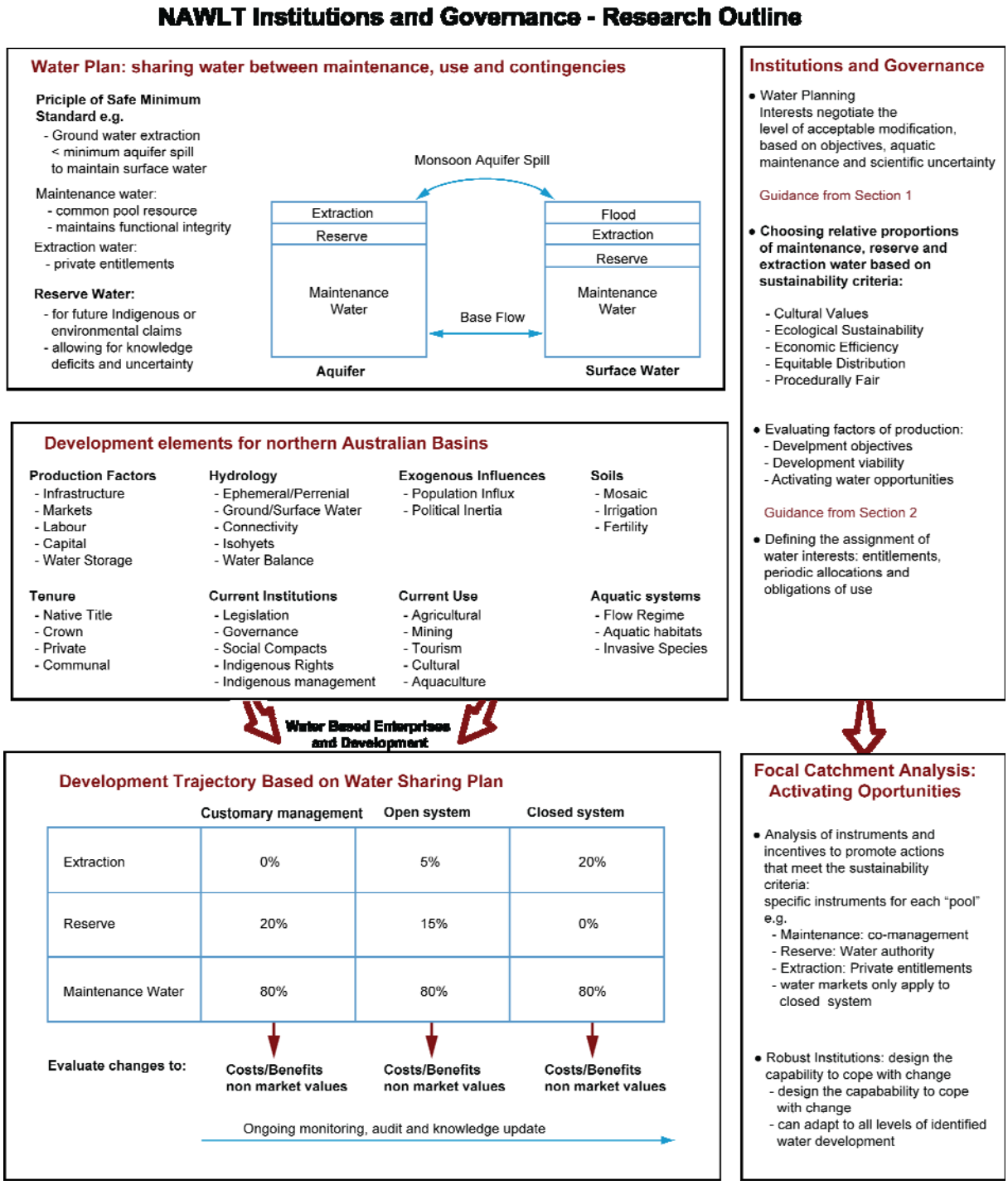

Figure 1 Research outline of NAWLT institutions and governance
Source: Ward, J. CSIRO 2009

We have defined institutions as the systems of established and prevalent social rules that structure social interactions. As conventions that shape human interaction and manage conflict, institutions exist in a dynamic state of tension between stability and modification. They need to be malleable enough to accommodate change, brought about by social consensus, balanced within a predictable and stable framework. They must be in accord with the value system of society, without substantial variance, or they run the risk of social divergence resulting in excessive monitoring and compliance costs and at the extreme, civil disobedience and anarchy (1).

Governance systems 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.

The National Water Initiative (NWI) is an ongoing process to correct the mistakes of the past and to achieve the sustainable management of Australian water resources. A synthesis of the lessons to be learnt from the historical development of the Murray Darling Basin and applied to northern Australia can be found in Chapter 14. Through the NWI water planning process a water body is partitioned into two institutionally differentiated “pools”: referred to as the environmental or maintenance pool and the extractive or consumptive pool. These remain physically and hydrologically connected, although the distinctive resource characteristics and associated use objectives of the pools require different institutional responses, incentives and management instruments. The planning process articulated in the NWI and the progress made by the northern Australian States is detailed in Chapters 18 - 21.

The top diagram in Figure 1 illustrates a schematic of the water planning process. Institutions are vital planning components as this is when choices are determined regarding the level of socially acceptable modification to water systems. That is the negotiated water planning decision to best meet the social objectives of conservation, development and to account for uncertainty. The level of accepted modification determines the relative shares of water to meet the cultural and environmental needs of participating communities and the extractive needs of commercial and developmental interests. Chapters 15 and 16 discuss the importance of correcting the neglect of Indigenous institutions, knowledge, needs and interests in Australian and International water management respectively.

Economic efficiency, equity and environmental sustainability are the three metrics and key pillars of water policy. These pillars are enshrined in the concept of Integrated Water Resource Management (IWRM) that provides an overarching framework for water management globally and are detailed in Chapter 34. The possibility for tension between these three pillars highlights the role of institutions and governance to ensure well-defined societal values guide the formulation and implementation of water policy.

The diagram depicts a connected ground and surface water system typical of northern Australian aquatic systems. The maintenance pool maintains the functioning and capacity to provide all the services and values derived from the aquatic system at a level determined from the planning process. It has the characteristics of a common pool resource and provides mutually shared environmental benefits to both the beneficiaries and non-beneficiaries of extractive rights. It is prohibitively costly to exclude access to these mutual benefits (a characteristic shared with public goods) and they are subject to rival or subtractable consumption (a characteristic shared with private goods). Expanded definitions of these and other terms are provided in the balance of this chapter.

The extractive pool is characterised by enforceable, exclusive, excludable and transferable rights to access and utilise a defined share of total available water. Based on the principle of safe minimum standards we have proposed a precautionary reserve pool, in addition to those specified in the NWI. The reserve pool represents a residual of the total extractive pool so that its eventual assignment does not interfere with the functional integrity of the maintenance pool. The reserve pool is intended to provide sufficient water to satisfy future native title claims and to address inherent scientific uncertainty in understanding minimum water flows. Hence the reserve pool may be assigned to Native Title claimants, to the maintenance pool or the extractive pool. In a discussion of the three focal catchments, Chapter 22 points to the operational aspects of the reserve pool and the buffering role it plays in reducing current and future water use tensions.

Access to extracted water is only one of several elements or factors necessary to activate commercial water dependent enterprises. Chapter 14 details an extensive historical analysis indicating that non-water factors are likely to be absent or prohibitively costly in many northern Australian regions. As a corollary, an extractive pool determined in isolation does not necessarily result in the development of commercial enterprises. The green box of Figure 1 locates institutions and the role they play when the factors or elements necessary to utilise extracted water are sufficiently viable. When access to an extractive pool and the factors of production align, the NWI specifies the role of institutions in determining:

- the assignment of water entitlements as unit shares of a specified volume;
- seasonal allocations and the assignment of risk; and
- the obligations of final water use to avoid impacts on third parties.

These outcomes are founded on the principles of robust separation, described in section 4.1 of this chapter and applied in the analysis of the focal catchments in Chapter 28.

Importantly, the construction and management of southern water impoundments and delivery infrastructure has traditionally been 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. It is more likely that aquifers will be the primary mode of water storage, and extraction and distribution costs borne by private interests. However public funding or subsidisation of co-development infrastructure such as transport or enabling labour pools remains outside the purview of this report.

According to the resource characteristics that are of interest, water as a shared resource has been defined by different notions of “property”. As a consequence water has been managed according to various governance regimes, which are generally classified as the state, the market, the consensus and the empowerment approaches. Different governance regimes confer comparative advantages in achieving specific policy objectives, for example, efficiency, effectiveness, equity, distributional justice and the scale of water diversions. Tailored and sequenced institutional arrangements are appropriate for water systems at different stages of modification, and need to have the capacity to change as the system changes. Chapter 22 provides a discussion of these integrative principles buttressed by several international examples of river integrated basin management.

The bottom diagram in Figure 1 depicts the role of institutions and governance in conceptually linking the biophysical and economic analysis into potential development trajectories for the Mitchell, Fitzroy and Katherine-Daly catchments. In our conceptual institutional framework, development or modification trajectories should be considered as a continuum. “Customary Management”, “Open”

and “Closed” are nominated examples of the continuum, that illustrate characteristics that initiate different institutional arrangements appropriate to the level of system modification.

Customary management can be characterised by either a negotiated water plan depicting the maintenance pool, reserve and extraction pools, or the lack of a water plan. In both cases, customary or co-management is an enduring institutional arrangement. If a water plan has been negotiated, either traditional obligations to sustain country or the lack of non-water development factors result in none of the extractive water being activated.

An Open system is characterised by a water plan, the opportunities to activate extracted water are present and are being utilised. Some or all of the reserve pool remains intact, either for future Indigenous claims or to account for scientific uncertainty regarding the response of the aquatic system to changed flow regimes. 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 extractive pool have been assigned to water interests.

A closed system is characterised by a water plan, fully assigned entitlements in the extractive pool and the absence of a reserve pool. Assuming hydrological connectivity and sufficient numbers of willing buyers and sellers, water markets are likely to be 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.

In critically modified systems, water planning is rudimentary or does not reflect the functional needs of the environment, water projects are initiated based on political motivation with weak economic rationale, entitlements are poorly defined, entitlements to extract water are over-assigned, and readjusting allocations between use and non-use is a difficult and contentious process that imposes substantial transitional costs

A primary objective of robust institutions is to design a system with a capability to cope with change. Robust institutions and governance are self maintaining, resilient to political influence and able to adapt to levels of identified development potential or river modification. In a robust system each policy objective can be managed independently without disrupting the entire institutional framework. In Chapter 28, we report an assessment of these principles when applied to the three focal catchments.

4. CHARACTERISTICS OF WATER

The following sections highlight how the characteristics of water affect institutional design and operation, governance arrangements, property right structures and water management regimes.

4.1 Resource characteristics

Defining the resource characteristics of water in the context of contemporary Australian water management is complicated by the simultaneous provision of multiple benefits and services.

The multiple characteristics of water include those of a common pool and private good resource, movement through the landscape, variable supply in time and space and the conflicts and tradeoffs between use and non-use. The connectivity and potential conjunctive use of northern Australian ground and surface water systems adds an additional layer of uncertainty.

Water transgresses agency, state and national jurisdictions; it seeps, drains, evaporates and flows regardless of prescribed statutes and boundaries. Water exists as solid, liquid and gaseous phases within different facets of the hydrological cycle and is characterised by a dynamic, stochastic supply according to meteorological and biophysical parameters.

Water resources have both consumptive and non-consumptive uses, constitute market and non-market values, include private good and public good values and are characterised by a high likelihood of external effects. Water can be defined as a non-renewable stock resource, such as groundwater and surface water subject to chemical changes and permanent depletion when abstractions exceed recharge rates. Water is also classified as a replenishable flow resource, such as unimpeded natural flows used for recreation, cultural values, maintaining riparian environments and the re-entry of consumed water into the terrestrial hydrological cycle.

Water rights have quality attributes that significantly affect their value, which have often been disregarded in the determination and specification of both formal and common property rights. Water quality is a function of, *inter alia*, sediment and turbidity, pathogen content, salinity, biologically available oxygen and contaminate levels. Different users can tolerate different water qualities. The same consumer can tolerate different qualities when applied to different uses, for example safe pathogen and chemical free drinking water compared to non-potable water suitable for sewerage and drainage.

4.1.1 Water as a common pool resource

Many water sources are common-pool resources in that their use is rivalrous and it is difficult or prohibitively costly to exclude others from access and use (2). Rivalry or subtractable consumption exists when water use by any person negatively affects the use of others, either through reducing the volume available or affecting the quality of the remaining supply. Excludability is a measure of the ease with which others can be prevented from using a resource. It is related to the costs of monitoring and enforcement and the ability of a water source to move through the landscape.

When joint outcomes depend on multiple actors contributing inputs or actions that are costly and difficult to quantify, and policy instruments are deficient in restricting usage, incentives exist for

individuals to act opportunistically. Opportunistic actions lead to resource over appropriation, often at a level where aggregate overuse and reduced benefits occur. A social dilemma and contestability arise when competing individuals are tempted by short term gains to over appropriate the common pool resource, thereby imposing group shared costs on the common pool community (3). Individual over-appropriation will eventually lead to reduced benefits for all (4).

In the absence of effective management over-exploitation of water supplies arises, individuals have incentives to extract the resource with little or no consideration of the effects on others or in terms of long-term sustainability of use.

4.1.2 Movement

Water is frequently a 'fugitive' resource such that it is not easily or cheaply contained within a defined spatial area (5). In these situations, water managers face difficulties in monitoring and accurately measuring resource volume and quality (6).

The movement of water through the landscape holds implications for property rights regimes and institutions established to manage water resources. In addition to overcoming monitoring and measurement difficulties, water managers need to account for water flows above and below surface, quality changes across the landscape, seepage and evaporation.

4.1.3 Variability

The availability of water depends on the storage capacity to retain it, the size and timing of inflows (7) and evapo-transpiration. Significant storage infrastructure has been constructed in southern Australia to 'even out' the water supply and better align resource availability with the needs of water users. Northern Australia experiences high inter and intra-annual variation in inflows with most occurring in the 3-4 month wet season. Unlike the south, northern Australia has very few built water storages of any size, and for about ten months of the year evapo-transpiration exceeds the rainfall.

4.1.4 Water quality

Almost all extractive and non-extractive water uses are dependent on water quality (8). Three key components affecting water quality are: (i) salinity, (ii) nutrient levels and (iii) turbidity (9). High salinity, nutrient levels and turbidity reduce the utility of water for most uses — consumptive, environmental, agricultural and industrial — and increase the costs of its treatment (10). Saline water, in particular, is of much reduced utility for agriculture due to its adverse effect on crops, soils and stock watering.

Water quality is strongly correlated with levels of rainfall and runoff, albeit in contradictory ways. Irrigation salinity (a measure of dissolved salts) is negatively correlated to rainfall and runoff because additional water within the system dilutes the amount of salt present. By contrast, nutrients (such as phosphorous and nitrogen) and soil particles (including colloids) are leached into water courses by rainfall and runoff, and thus these nutrient levels and turbidity share a positive correlation with rainfall and runoff (11).

Water pollution originates from both point and non-point sources. Return flows from industrial processes typically occur from a fixed and detectable point in the landscape, where as farm runoff is more diffuse and varies according to local hydrology.

4.1.5 Surface water-groundwater interaction

The surface water observed in rivers, lakes and wetlands comprises only a relatively small volume of the world's total freshwater resources (12). As the availability of surface water has declined in many parts of the world, attention has increasingly turned to groundwater resources to provide a reliable source of freshwater.

Groundwater has several advantages to users (13), but its extraction poses additional problems for water managers if recharge rates are slow, variable across the landscape and are often less than extractions rates. Rectifying groundwater pollution can also be problematic after it has occurred while managers face significant challenges in monitoring and managing the rate of aquifer depletion. Aquifer recharge is one way to increase groundwater resources, but it is particularly difficult in northern Australia because of the geomorphology and shallowness of the aquifers

Effective management of water resources requires an understanding of surface-groundwater connectivity, interactions and the consequences of conjunctive use. In regions like northern Australia with distinct dry and wet seasons, surface-groundwater interactions are of special importance. In particular, groundwater resources are recharged in the wet season when there is an abundance of water. This, in turn provides base flows for rivers and wetlands in the dry season as groundwater supplies return to the surface. Falling water tables caused by rapid extraction of groundwater can potentially undermine this seasonal recharge with implications for surface-level water uses, and also for sites that are highly valued for their ability to provide year round water supplies and to maintain sites of cultural value and the health of dependent ecosystems.

4.1.6 Competing users and uses

Water is fundamental for human and non-human life and is a critical, often irreplaceable, component of industrial and agricultural production (14). In this sense, water is unique and ensuring a 'balance' between use and non-use is an important feature of sustainable water management.

When users can access and extract water from a common source without impinging or diminishing the perceived needs of other users, there is neither the need to define the rights to water nor the incentive to negotiate a redistribution of water (or voluntary exchange). In the absence of water scarcity (both actual or perceived), there is little pressure for the clear distribution of entitlements to water resources as all demands can be adequately met with current supplies, In these circumstances there is no need to coordinate individual action into an acceptable social solution. This suite of characteristics typifies many of the water basins and catchments in northern Australia referred to in this chapter as customary management.

As the level of relative scarcity increases, as in mature or closed water economies, an escalation in tension arises between competing uses, necessitating some form of adjudication to establish an equitable, judicious balance between users. The concepts of customary management, open, closed and critically modified systems as descriptors of catchment status are discussed in Chapter 28.

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5. INSTITUTIONS, GOVERNANCE AND MANAGEMENT REGIMES

5.1 Institutional models

The National Water Commission (15) states that:

"The term "institutional models" is generally taken to refer to the roles, powers, functions, incentives and accountabilities of the various entities or institutions involved in a particular sector or activity. A well-designed institutional framework can be defined as one that provides the right incentives and sanctions for entities to facilitate the optimal social outcomes (in this case the outcomes sought by Integrated Water Cycle Management). This requires clear objectives, well-aligned incentives, and absence of conflicts of interest."

The Commission's focus is on institutions as water organisations, agencies or entities. Although the objective of policy outcomes is similar, we rely on a definition of institutions, as prevailing social rules and norms (16). This is an important distinction in a discussion of entitlements, for the theory of cost effective or efficient resource allocation arising from assigned property rights is grounded in how institutions are defined. Merrey et al. (17) note that "*The tendency to think of institutions as things rather than as relationships and processes and to apply engineering metaphors and approaches rarely leads to effective institutional change*".

In a general review of the definitional variants of institutions, Hodgson (18) consolidates several disciplinary pedigrees and defines institutions as "systems of established and prevalent social rules that structure social interactions". We consider this definition to best reflect the spirit and intent set out in the National Water Initiative. A theme common to these notions of institutions is that it is important to take individual purpose, choices and preferences as partly moulded by social circumstances.

Institutions are the self-perpetuating 'going concerns' that order the relationships between individuals in society, providing the laws, constitutions, contractual regimes and moral and ethical precepts (19).

Water markets, implemented in the context of individual property rights, is itself an institution, subject to the same social conventions influencing the entire institutional framework.

5.1.1 Evolution in institutions

In recent decades, Australia has witnessed an evolution in the institutional arrangements established to manage water resources. There has been a general shift away from the ad hoc granting of water licences towards the adoption of water planning processes, the creation of secure entitlements as a share in available extractive water, the promotion of water markets and general devolvement of water planning to local levels (20). The main factors driving this shift include: (i) increasing water scarcity as resource demand approaches and even exceeds supply; (ii) expectations of greater variability in timing and quantity of supply with climate change; and (iii) growing recognition of the need to take the water requirements of the environment into account (21).

The evolutionary process of water reform can be characterised as a search for institutions that are: (i) dynamically efficient; (ii) have low administrative costs; and (iii) are institutionally robust (22). In this

sense robustness represents the ability of institutions to endure and adapt to ever-changing hydrological, social and economic circumstances (23). Institutions require robustness both in the sense of being able to adjust to the short-term realities of supply, but also to institutional learning and the revision of water management frameworks over the medium-term (24).

5.1.2 Governance

By governance we mean the structures and processes by which individuals and societies make decisions, share power and enact change. Governance is a broad term that includes institutions, organisations and the policy instruments that determine how change is enacted. The Global water Partnership (25) defines water governance as "*the range of political, social, economic and administrative systems that are in place to develop and manage water resources, and the delivery of water services at different levels of society*".

Governance involves three activities: the process of choosing trade-offs between consumptive and non-consumptive use and providing a vision of sustainability; management as the operational dimension of that choice - and monitoring to provide feedback and synthesis of current status and likely future outcomes (26).

5.2 Property rights in water

The specification of the interests in water broadly refers to the rights and obligations that a party has over water. Rights represent a social contract by defining what a rights holder must and must not do, what they can and cannot do and what others can and cannot do (27). They may be either statutory (administered by way of water laws and centrally vested in the state), vested in the community, or private and hence potentially tradeable. Assigned interests confer rights of access, withdrawal, management, exclusion and transfer.

5.2.1 Evolution of property rights in water

The establishment of property rights in water has occurred differently from region to region, resulting in a wide range of property rights regimes adapted to local hydrological and institutional contexts (28). Key drivers that support the recent development of water rights are high water variability and an over-allocation of the resource.

Property right regimes can be categorised as: riparian (or land-based) rights and use-based rights. Riparian rights give landowners rights to access and use water contiguous with their land (29). In locations where existing allocations exceed current water availability and supply is highly variable, riparian rights are generally regarded as 'inadequate for providing a sound basis for the management of multiple uses of the resource' (30).

Appropriative rights are use rights that separate land ownership from the right to use water and are defined in volumes of water use per period of time (31). Their specification as a right separate to land has promoted transferability and the development of water markets that have existed in the US South West since the nineteenth century. Different seniorities of use exist for appropriative rights whereby those with the highest seniority and who have the oldest continuous beneficial water uses

have their diversions satisfied before those with more junior rights. That is the rights are subject to the "first use: first access" rule.

In Australia, beginning first with the State of Victoria in 1886, states have transformed riparian water rights into statutory use-based water rights (32, 19). Seminal legislative changes made by Deakin in the Victorian *Water Act (1886*) addressed the deficiencies of riparian rights (based on English common law). Riparian rights were suited to stable English hydrology, but failed as an institution in managing highly variable Australian water systems. The Water Act continues to influence contemporary Australian water rights by:

- exclusively vesting the right to the use, flow and the control of water in any watercourse in the State(s)
- subordinated the rights of the individual in that private riparian rights could not compromise the cardinal rights of the State; and
- highlighted the need for the rights of the individual and the State be fully defined.

A discussion of the role and legacies of previous institutions in the evolution of Australian water reform can be found in Chapter 17.

By the 1980s an over allocation of statutory water rights in the southern Murray-Darling basin had led to increasing pressure by some irrigators for water rights to be separated from land and be tradable so as to access water that would otherwise be unavailable. Consequently, permanent transfers of water entitlements were introduced in the States of South Australia in 1982, New South Wales and Queensland in 1989, and Victoria in 1991. However, each state has developed its own statutory rules over the conditions of use trading across state boundaries that severely limits inter-state trade.

5.2.2 Property right characteristics

Property rights are highly articulated versions of water entitlements and act as one of the fundamental elements of the Australian water institutional framework. As private rights, they subsequently assign opportunities to some and place thresholds and restrictions on the rest of society through the specification and manipulation of property rights for social and economic purposes (33). They represent a defined interest in water rather than ownership of a defined volume of water.

Bromley (34) states that negotiable water entitlements must therefore be specified in terms of secure, enforceable rights, articulating the duties of the right holder in order to claim the benefits from use, the obligations of those excluded from the right and the duties and obligations of the managing authority. In the context of a binding social contract, one of the primary challenges of water entitlements is to be flexible enough to respond to changing social consensus, whilst providing sufficient security for the rights holder.

The construct of property relies on the recognition by society of the legitimacy of the individual claim to a benefit gained by using water. Society is then prepared to forgo that claim and enter into a contract of compliance to enforce the rights to that claim. Property rights afforded to individuals are subordinate to the social recognition of those rights and can only exist where there is a social

mechanism that specifies duties and binds individuals to those duties. If the state, according to prevailing social norms, will not recognise and enforce the property right claim, then the right fails to gain legitimacy as an instrument (Bromley 1991). Private property rights are vested in the individual, and in the granting of that bundle of rights, the individual can anticipate state sanctioned enforcement against those that choose to lay claim without consent

Property right regimes reflect water's physical nature as well as the institutional and social structure in which it is used (35). There are six key characteristics of property rights: (i) exclusivity; (ii) duration; (iii) flexibility; (iv) quality of title; (v) transferability and (vi) divisibility (36). These characteristics differ in importance according to the resource in question, its use patterns, and the management regime within which property rights are located. Of the six characteristics, quality of title, divisibility and transferability are considered especially important for the effective functioning of markets in property rights.

The quality of title of a water right, which is akin to its security from interference, has traditionally depended on the right's legitimacy and enforceability. A poorly specified and unenforceable right is no right at all. Quality of title is closely linked to the strength of institutions (e.g. governments and the courts) to recognise and enforce property rights in water.

Divisibility and transferability refer, respectively, to the ability to separate a right into its component parts and the ability to transfer a component of a right, or the entire right, to another potential user. Transferability is an essential characteristic to enable the formation of a market for property rights (37) while divisibility assists in expanding the number and scope of trades. Both characteristics are often circumscribed by market trading rules and other regulations.

5.2.3 Flexibility, bundled rights and responsibilities

Flexibility

The flexibility characteristic of a water right can be delineated into three components: access rights, harvest rights and management rights (38). Thus the right to access the resource does not automatically confer a right to harvest or manage the resource. Further, delineation of a right is possible such that the right to use water on a property that is not contiguous to a river can be delineated into the right to access, divert, convey, store, use and dispose of the water (39).

Bundled rights

Property rights frequently exist as bundles of component rights rather than as individual parts (40). Private property rights are comprised of a complete bundle of property rights, which consist of rights of access, withdrawal, management, exclusion and transfer. The rights of access and withdrawal grant the individual the authority to access and make use of property. The right of management grants gives the individual the authority to decide the manner in which the property is used. The right of exclusion allows control of access to the property with expectation of state enforcement when required. The right of transfer allows the individual to sell, lease, rent, bequeath or otherwise dispose of the property.

Each of these bundled rights may be governed by separate laws and statutes that outline any limitations or requirements relating to the exercise of the right (41). The degree of divisibility and

'unbundling' determines the extent to which current or potential users can isolate and pursue the rights they require through the market or via regulatory processes (42). The benefits of unbundling a right needs to be weighed against the administrative costs of more complex monitoring and enforcement that are likely to result (43).

Water rights are frequently bundled into: (i) the time span of the entitlement (ii) the right to receive water according to a specified reliability of supply; (iii) the right to have a given volume of water delivered at a particular time; (iv) the right to use water; (v) the right to return water and (vi) the right to transfer water, (44). In Australia, water rights have, to a large extent been unbundled from land and separated into 'temporary' water (opportunity to use) and 'permanent' water rights that represent the long-term interests in the resource, and the right to actually use the water (45). These are referred to as allocations and entitlements respectively.

This has allowed for the transfer of water use rights defined for a discrete period of time (typically a year) without transferring the ownership of the ongoing right to water (46). Unbundling of the opportunity to use water from actual use has the added benefit that some forms of use that are detrimental to the environment can be regulated or priced to account for external costs.

Responsibilities

Rights usually confer obligations and responsibilities on the right holder (47). The most basic obligation is the 'no injury' rule — the requirement that the exercise of a right should not interfere with the ability of others to exercise their own rights (48). Responsibilities prescribed for water rights include the obligation to use the water for a particular purpose, and the obligation to maintain quality standards for water returned to sources used by others. Obligations on users of water rights are typically implemented via restrictions and limitations in terms of transferability and types of use (49).

5.2.4 Evolution of rights

Property rights are not static, reflecting the dynamic nature of changing social values and subsequently vary over space and time (50). Institutions represent the systems of established and prevalent social rules that structure social interactions, including property rights (51). The dependence of water rights on institutions to ensure their exclusivity means that as the social rules that define institutions change so too may the characteristics of the rights (52). However, factors that affect property rights may not affect each characteristic equally — for instance a change to the law that may promote the quality of title may also be at the expense of the right's flexibility.

Property rights regimes for water resources have developed in ways to account for variability in the timing and volume of water supply. Possible responses to variability are likely to affect the 'meaning and content' of property rights in those regimes (53). For example, attempts to deal with variability through adaptive management (e.g. adjusting allocations on the basis of recent rainfall) can diminish the exclusivity of property rights in water (54).

Case study: coping with variability

The Murray-Darling Basin (MDB) and Colorado Basin are located in semi-arid climates with high water variability and levels of extraction that are substantial proportions of net inflows. Despite these similarities, the water rights in the two jurisdictions have developed differently.

The statutory water rights in the MDB are called water entitlements (also called permanent water). They provide the owner with a share of a consumptive pool, but the actual quantities of water that holders of entitlements are permitted to divert every year depends on the seasonal allocation (also called temporary water) that is assigned each year to the water entitlement. The seasonal allocation assigned to a water entitlement is not fixed and depends on the water entitlement's level of reliability (such as 'High Security' or 'General Security' entitlements that determine the preferential access to the consumptive pool), the overall cap or limit on diversions in the MDB, expected inflows into the system and water storage levels. Based on historical inflows, 'High Security' water entitlements were thought to have reliability at 95-100% such that an entitlement holder would expect to receive a seasonal allocation equal to the full water entitlement 95 years in 100. By contrast, 'General Security' water entitlements have a much lower reliability, (and in the past four years because of on-going drought have received zero seasonal allocations.) Water users can develop a mixed portfolio of high and general water entitlements to adjust the security of their rights according to their needs (55).

In the Colorado Basin, the 'prior appropriation' doctrine remains at the heart of water law, notwithstanding the piecemeal extension of this doctrine over time within each jurisdiction (56). The presence of 'senior' and 'junior' rights persists and competition over the rights to use water has generally played itself out within the courts, often resulting in considerable acrimony between parties (and states).

The adaptability of these two property rights regimes is illustrated by their ability to allow minimum levels of 'environmental flow' (water that is not diverted and is used to maintain ecosystem health). In the MDB, attempts to secure these flows have explicitly occurred through water plans ('rules' based water) and, most recently, via government buybacks of water entitlements in water markets. By contrast, in the Colorado Basin the overlay of legal frameworks constructed from the prior appropriation doctrine has made the pursuit of environmental flows much more difficult for governments (57), and is implemented through the notion of the 'Public Trust Doctrine' that is typically enforced through the Endangered Species Act.

6. POLICY INSTRUMENTS FOR WATER MANAGEMENT

Section 4.1 introduces the robust separation of water interests as an overarching design framework for effective water policy before turning to discussion of the 'era of limits' and the need for adaptive policies. Section 4.2 reviews water planning processes to effectively manage water resources. Section 4.3 examines the role of markets in effective water policy, the conditions for markets to function and the role of institutions. The final section 4.4 reviews the measures of successful water institutions, governance and adaptive management.

In a general sense, policy instruments are the tools available to policy makers to influence societal processes and behaviour such that they align with and remain compatible to defined economic,

environmental and social targets. These are made operational as policy objectives and their level of success expressed as measures of effectiveness, efficiency and equity. To avoid the social costs of poor policy performance, instruments are required to be aligned with individual values and motivations and account for specific resource characteristics. In many circumstances it may be prohibitively costly to address the non-exclusivity parameter of a common pool resource: viz. to assign individual defined property rights. In those circumstances either non-market based instruments or novel, carefully sequenced hybrid instruments are candidates likely to be superior in achieving policy objectives.

Markets (private and common property), regulatory instruments (state property) and social compacts (common property and common pool resources) are water policy approaches implemented to either resolve or reduce contestability.

Markets are attractive because of their ability to coordinate and truthfully reveal private information. They are effective economisers of information, expressed as precise price signals and coordinators of price signal responses into collective action. Bowles and Gintis (58) posit that when comprehensive and coherent contracts can be drawn and enforced at low cost, markets are superior to other governance structures; particularly "[w]here residual claimancy and control rights can be closely aligned, market competition provides a decentralised and difficult to corrupt mechanism that punishes the inept and rewards high performers".

In contrast, the state is relatively well suited for handling particular classes of problems where it alone has the power to make and enforce the rules that govern the interaction of private agents: e.g. if participating is mandatory (public health, education and defence)(ibid). An alternative arrangement proposes that common pool resources can be effectively managed if information, communication and sanctioning options are available to those using the resource (59).

Bowles and Gintis (60) argue that "…communities can resolve common pool dilemmas that states and markets are not well equipped to manage, especially where the nature of social interactions or of the goods being transacted makes contracting highly incomplete or costly". Adjudication on distribution, exclusion or enforcement initially relies on the revelation of dispersed private information, unavailable to the state. Socially crafted institutions coordinate revealed information into collective governance by applying rewards and punishment to members according to their conformity with or deviation from social norms *(ibid*).

Community crafted social compacts tend to rely on social norms that utilise incentives that reinforce collective action such as trust, reciprocity, reputation and prestige, personal and community pride and the avoidance of group sanctions (61). Examples include the traditional Balinese irrigation Subaks and Indian groundwater organisations, that have successfully managed complex and highly productive irrigation networks based on water as community property. Communication and the high probability of future interaction promote strong (or conditional) reciprocity and the avoidance of retaliation; sanctions reinforce the benefits of the social compact through reputation. Successful socially crafted compacts that utilise communication are reinforced by self monitoring, strong reciprocity or conditional cooperation and a series of escalating, credible sanctions.

6.1 Robust design and the separation of rights

A primary objective of robust institutions is to design a system with a capability to cope with change. Robust institutions and governance are self maintaining and able to adapt to levels of identified

development potential or river modification. In a robust system each element can be managed independently without disrupting the entire institutional framework.

The robust separation of water rights provides a theoretical design framework that has informed recent Australian water reform and the National Water Initiative (62). The NWI 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. Risk is assigned between users and the government and entitlements, allocations and obligations of final use are to be managed independently, ideally using separate policy instruments.

The separation of rights provides the opportunity for the twin water policy objectives of distributional equity (including the environment as a legitimate user of water) and economic efficiency in a changing world to be managed independently.

A system is defined as robust when it has demonstrated an ability to recover gracefully from the whole range of exceptional inputs and situations in a given environment.

A robust system of water management will:

- resolve the resource allocation tension between consumptive use and the environment: and amongst consumptive users, issues related to equitable distribution and use;
- provide secure, economically efficient trading associated with low costs and administrative feasibility, with regard to the consumptive pool;
- clarify the assignment of risk making it clear where responsibility lies, under what circumstances compensation is due, and specify the processes for obtaining redress, and
- address the management of externalities accounting for the interests of third parties, future generations and the environment – with minimum controversy.

A robust system also must pass the conventional tests of efficiency and fairness in a changing world.

These objectives are best achieved through the robust separation of water interests through:

- water entitlements specified as secured long term unit shares of a variable pool of consumptive water, subject to periodic allocation;
- an agreed process for the allocation of water when it becomes available, typically on an event, season or annual basis contingent on science and the state of the resource, managed independently of entitlements;
- a process to assign risk defining unequivocally where responsibility lies, under what circumstances compensation is due, and the processes for obtaining redress with non-controversial settlement;
- conditions and obligations specified in a separate water use licence, cognisant of third parties and mitigating negative external effects;

- the introduction of debit and credit accounting systems, water exchange rates and associated formal transaction mechanisms;

- the guaranteed recording of financial and other formal interests on a register, formal settlement procedures, and irreversibility of market transactions;

The following principles provide the formal, theoretical basis for robust design (63). Firstly there is a need for as many control instruments as there are policy objectives: i.e. there is a need for one instrument for the policy targets of entitlement distribution, one for allocations which reflect climatic variability and one for resource use that accounts for third party interests. Secondly to ensure stable outcomes, instruments need to be paired with objectives over which they have most influence. Finally, contingent on low transaction costs relative to benefits, efficient outcomes are achievable regardless of the initial distribution of tradable rights.

To achieve a robust framework for water access entitlements there must be at least one set of instruments for each significant water resource problem, especially in heterogeneous landscapes. That set is comprised of separate entitlement, allocation and externality instruments. Discrete sets of instruments are required when both individual and collective water decisions are feasible (64).

A three tiered “unbundled” or separated system of instruments distributes and allocates volumes of water efficiently over time. A Water Plan establishes 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”. This recognises the environment as a legitimate claimant to water entitlements and allows society to resolve the tension between the needs of the environment and consumptive use (65).

There is likely to be a number of viable interests in the same aquifer or water source. In the absence of coordination or cooperation, each interest potentially impinges on the access to water of others, on the total water available. When more than one person has an interest in the consumptive “pool” the first policy instrument defines the unit shares of the pool and the distribution of shares to individual interests. This allows water managers to distribute access entitlements to available consumptive water.

The second instrument defines an independently managed process to periodically allocate the amount of water to each share. This allows water authorities to independently manage the consumptive pool when faced with changing ambient conditions and to assign the risk of a variable water supply.

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.

A rule based approach that considers how to align the regional biophysical, cultural and economic characteristics into a unified robust framework suggests a systematic governance arrangement for northern Australian water resources. The framework allows for the independent and flexible management of separate and potentially exclusive policy objectives. Chapter 28 describes an example of the application of robust design to northern Australian basins.

6.1.1 Economic efficiency, equity and sustainability

Economic efficiency, equity and environmental sustainability are the three key pillars of water policy (66). These pillars are enshrined in the concept of Integrated Water Resource Management (IWRM) that provides an overarching framework for water management globally and are detailed in Chapter 24 (67). The possibility for tension between these three pillars (68) highlights the need for well-defined societal values to guide the formulation and implementation of water policy.

The choice among policy instrument for water management is sometimes characterised as either regulation or markets. In reality, efforts to achieve greater measures of efficiency, equity and sustainability will require the 'balanced use' of markets and regulation (69). In particular, water planning processes are a sound mechanism through which to assign appropriate roles and scope to both markets and regulation.

Rights to water in most basins are issued, administered and controlled by government agencies (70). The ways in which these allocations occur, as well as the relative importance of local judicial and political systems, varies from region to region and even along the same river (71). Recent trends, however, indicate a broad shift towards market-based policies, including full cost recovery pricing and the introduction of water markets, to assist in the allocation process (72).

6.1.2 Era of limits

As water basins around the world approach or surpass full allocation, scarcity has become the pervasive attribute of water (73). In these cases, additional demands on water cannot be accommodated without affecting existing rights (74). Institutions and policies of the past, which viewed water as an abundant resource and promoted its use for development of all kinds, have become outdated and inappropriate for modern water management (75).

The modern water challenge can be conceived as the dynamic reallocation of water in view of existing water allocations (76). Reallocation is, in many places, likely to produce economic and political dislocation that, in turn, creates the need for clearly articulated public values according to which reallocation should occur (77). Increased pressures on water resources continue to emerge from population growth, demands for water-intensive agricultural products and, in some locations, climate change.

6.1.3 Adaptive policies

Policies in water management are likely to comprise at least three key features: (i) generally-agreed and achievable targets; (ii) appropriate and adaptive instruments capable of steering towards those targets; and (iii) monitoring and evaluation mechanisms that can provide feedback on progress towards targets (78).

There is a special need for adaptive policies in water management due to the temporal and spatial variability of the resource, as well as dynamic changes in the ways that societies make use of water. Policies that are too rigid or inflexible risk 'locking in' outcomes which, given hydrological, social or economic changes, no longer remain optimal or even appropriate. A key enabling factor for adaptive policies is adaptive institutions (79).

6.2 Water planning

Water planning processes are the primary vehicle through which water policies are formulated, implemented and revised. Water planning translates the overarching principles of water management that includes economic efficiency, equity and environmental sustainability, into useful and adaptive policies for desired objectives.

Water planning cannot be a one-off process, but rather needs to be revisited in light of changing hydrological, environmental, economic and social conditions (80). Effective water planning is characterised by: (i) a holistic approach to water resources; (ii) a complementary blend of instruments to achieve policy goals; and (iii) adaptive institutions and processes. Chapters 18 - 21 detail the NWI water planning processes and progress in northern Australia. Chapter 22 discusses the principles of integrated and international case studies of adaptive water management.

6.2.1 Holistic approach to water resources

A holistic approach to water resources establishes institutions that reflect the natural complexity of water and its diverse uses. This requires the matching of management boundaries to the hydrological boundaries of the resource (81). For instance, the river basin is the natural physical unit for water management (82), yet water management institutions are not always appropriately aligned with the resource (for example, the absence of an overarching entity managing the Colorado Basin). Where there is significant surface-groundwater interaction or land uses that affect water resources, integrated and complementary approaches are needed for effective management (83). Water management institutions should also be integrated across sectors as well as in a spatial dimension rather than fragmented (84) so as to avoid inconsistent and contradictory policies (85).

Water challenges cannot be tackled in ignorance of the boundaries of the wider resource, nor can they be addressed from a single water user perspective, such as agriculture (86). Institutions responsible for water planning need the capacity to manage this complex resource across geographical and sectoral boundaries, taking water's many environmental, social and economic values into account (87). For instance, water quality and water quantity are another example of a 'pair' of issues which are best dealt with by a single institution, capable of formulating an integrated approach (88).

6.2.2 Complementary blend of instruments

There are many potential advantages to using market-based mechanisms to allocate scarce water resources, including flexibility, adaptability and economic efficiency. The choice of policy instruments for water involves the 'proper assignment of responsibilities to each within an adequate social oversight framework' (89). For example, water management can, at least partially, incorporate the environmental value of water with water markets by the imposition of a total extraction 'cap' so as to ensure a desired level of ecosystem health. Cultural values of water may also be set aside as 'rules' based directly within water plans and/or as direct allocations of water rights to communities (90).

Given the diverse range of issues that confront managers of water resources, and the range of objectives they may wish to satisfy, a complementary blend of policy instruments is likely to be preferred. The optimum blend of instruments will differ from region to region according to the

particular challenges being addressed, although all instruments should ideally be adaptive to changing targets and monitoring feedback (91).

6.2.3 Adaptive institutions and processes

Adaptive policies require adaptive institutions (92). The ability of institutions to adapt and innovate enables the formulation and implementation of policies that accord with changing hydrological, environmental and economic conditions, and social values (93). The ability to adapt to these changes is necessary to ensure environmental sustainability, as well as to achieve the goals of water management (94).

Adaptive management allows water managers to continue to manage despite ongoing uncertainty and complexity (95). From an operational perspective there are a number of adaptive management approaches. Evolutionary adaptive management involves a trial and error approach: the hypothesis-experiment-analysis-hypothesis method. Passive adaptive management uses historical lessons to develop a single policy for implementation. Active adaptive management is learning focussed using the analysis of policy implementation as the primary heuristic (*ibid*).

Public participation is a crucial element of good water management (96). This involves both co-ordination (sharing of information) and co-operation (joint planning) between stakeholders. An adaptive co-management approach (97) encourages: (i) autonomous adjustment by water users and their communities; (ii) values different knowledge sets (tacit, traditional and scientific); and (iii) collaborative decision-making across key stakeholders. The ongoing engagement of water users in policy formulation and implementation is an effective method to: (i) tailor policy to local situations and needs; (ii) assist with monitoring and evaluation efforts; and (iii) facilitate changes to water management arrangements (98). The aim of water planning is usually to 'deliver fair outcomes through a procedurally fair and equitable process'. Stakeholder participation is also necessary to promote locally acceptable outcomes (99).

6.3 The role of markets

6.3.1 Key advantages of market-based mechanisms

Water as an economic resource

Although water has important environmental, cultural and social properties, it is also an economic resource because many of its uses have economic value (100). Water is said to have an opportunity cost when it is not available in sufficient volume to permit all water needs (including non-use). In many jurisdictions in the world water users are not charged for the full opportunity cost of the water they use (101). This, in turn, provides incentives for overuse and misuse (102).

The role of prices

Market-based mechanisms are one means to allocate scarce resources such as water. Markets function by assigning a price to water that reflects its scarcity value in use. A key advantage of market-based allocation of a highly variable resource such as water is that market prices

automatically adjust to reflect changes in resource scarcity (103). Prices are the principle mechanism through which the behaviour of water users is coordinated, affecting their levels of demand and providing incentives for the adoption of more efficient water practices (104).

Flexibility

Where water trades can occur quickly and with low transaction costs, markets provide an important element of flexibility for water users (105). When water is readily available for purchase, some water users might choose to supplement their allocated provisions with additional water, while others can sell water surplus to their needs to gain an extra source of income. This flexibility is particularly desirable for agricultural water users and managers of environmental water who can adjust their water allocations in response to the adequacy of prevailing patterns of rainfall and runoff.

Benefits from trade

The ability to transfer rights (trade) is what differentiates markets from regulating allocation systems (106). As different water uses have different values, markets facilitate reallocation of rights from lower value users towards higher value uses (107). This is important from an economic efficiency perspective and raises welfare for the market participants if water trades are voluntary (108). The gains from water trading can be very large, and are worth between $200 and $500 million/year in the Murray-Darling Basin (109).

6.3.2 Necessary conditions for functioning markets

Markets require a number of conditions to allocate resources optimally including: (i) scarcity such that the resource trades at a positive price; (ii) a minimum number of willing buyers and sellers to ensure competition; and (iii) the physical ability to trade (110). Necessary institutional features include: (i) well-defined property rights; (ii) moderate or low transaction costs relative to benefits; (iii) readily available information; (iv) an administrative capacity to register information on trades; (v) and acceptance of the market within the community (111).

Markets are best designed on a comprehensive understanding of local hydrology, including surface-groundwater interaction, and knowledge of water uses, which may involve adjacent land uses such as plantation forests (112). At the simplest level, water markets require a specified volume of water to be allocated over a given time period and with sufficient storage to allow upstream as well as downstream trade (113).

6.3.3 Key institutional roles

Supporting markets

Water markets are nested within regulatory and institutional structures (114). Institutions are required to establish, regulate and support water markets (115) by defining and supporting the exclusivity of property rights, resolving conflicts and dealing with externalities (116). Institutions also need to establish the scope and direction of permissible trades (‘trading rules’) within the market,

and respond predictably to changing environmental, social and economic conditions through water planning (117).

Given sufficient attention to market design, institutions can ensure the compatibility of trading systems across political boundaries. This, in turn, can lower transactions costs and increase the potential for economic gains through a greater range of possible trades (118).

Dealing with market failure

Institutions are ultimately responsible for protecting the public interest in water and addressing externalities where they occur (119). These externalities are market failures and include, the under-provision of water for wetlands and environmental flows that generate public benefits (120) and also the deterioration of downstream water quality from up-stream water trades. The presence of significant cultural and social values for water creates difficulties for markets when price is only based on use values and, thus, are unable to capture 'the full spectrum of costs and benefits' of water (121). A possible response to externalities is to attempt to 'internalise' the user costs on those causing the externalities via market-based instruments (122), although this can be difficult to implement.

6.4 Characteristics of successful water management institutions

Characteristics of successful water management institutions include, *inter alia*: (i) clearly defined institutional and hydrological boundaries; (ii) a management regime that is appropriate to the local hydrological context and water uses; (iii) clearly enunciated objectives and attendant instruments; (iv) an ability to reconcile water users' demands for security with the need for flexibility; (v) capacity to monitor and evaluate outcomes in real time; and (vi) conflict resolution mechanisms (123).

Attempts to match institutional boundaries to hydrological boundaries can also be difficult. A key factor that assists in the development of desirable institutional characteristics is the active involvement of resource users and the broader community in management of water resources (124).

6.4.1 Alternative water allocation regimes

Effective water management must, ideally, consider local hydrology (including surface-groundwater interaction and the expected impacts of climate change) and the nature of local water and land uses (where the latter impact on water) (125). A key requirement of water institutions in coming decades will be the capacity to reallocate water resources which are already fully allocated, and in some cases over-allocated (126).

Options for management and water allocation range from granting ad hoc licences through to application processes that ensure defined objectives are met and water use is consistent with existing water plans. Both water markets and water regulations require sound water planning processes to define their respective scope and roles, for example, through the use of trading rules. Effective water planning also requires robust institutions able to monitor and evaluate outcomes, accommodate new water uses and adjust to changing hydrological, social and economic circumstances – in other words the capacity for adaptive management (127).

6.4.2 Institutional design principles and performance measures

There is increasing attention amongst scholars of natural resource management to translate observed characteristics of effective working institutions into broadly applicable principles or conditions for designing and evaluating institutions and proposals for reform. In this section we describe and synthesise conceptual frameworks that list institutional characteristics that may serve as guiding principles in the context of designing water institutions in northern Australia. These examples are drawn specifically from research into both water institutions and institutions for common pool resource management.

The first section discusses the observed and hypothesised characteristics of successful water institutions, generally grounded in the principles of integrated water management. A consistent focus of all the models is the recognition that although water can be institutionally differentiated as either a common pool resource or private good, they remain physically interconnected and jointly produced. With reference to Australian water management these represent the environmental and extractive pools respectively.

The first suite of characteristics relate specifically to guiding the tactical reform of water institutions within an integrated water management policy setting (128). Recent adaptations and iterations (129) present the 'essential elements of sustainable and effective institutions' derived from both theory and practical experience of water management system world-wide.

Box 1: Merrey et al. Framework of effective Institutions.

1. Publicly available knowledge about resource availability over time and space.
2. Policies establishing allocations (i.e. the assignment of interests), rights to the resources, priorities, cost recovery, and governance (who decides and how the decision is made).
3. Rules, laws, and regulations codifying how policies are to be implemented.
4. Definition of roles and responsibilities (formal or informal organizations) for implementation of the rules.
5. Infrastructure to deliver the services in terms of the rules and allocations.
6. Incentives for people to participate and invest (relating especially to the profitability of water use in agriculture).
7. Capacity to adapt to changing circumstances based on lessons (learning organisation, adaptive capacity).

Source (129)

The underlying assertion is that for water management systems to perform well and be long-lived each of these elements need to be present and 'mismatches' limited. The proponents accept that in real-world application of these principles the relationships between these elements is dynamic and complex. Difficulties are generated by the rapidity of change in market and ecosystem conditions and the also difficulty of policy, infrastructure and organisational culture to adapt.

A closely aligned but alternative set of design features has been proposed primarily in response to the institutional arrangements observed in the MDB, but applicable to the northern Australian basins

(130). This suite of work is framed with a paradigm that seeks to explicitly minimise transaction and transformation costs associated with institutional design and change. These features have been applied in relation to water reform in the irrigation sector in Australia, focussing primarily on the opportunities for market exchange of tradeable rights. The capacity of a framework to jointly articulate a set of empirically-based criteria for evaluation, and as a set of decision-making rules of institutional design is argued to be indicative of superior institutional performance (131). Five design features or characteristics of successful water institutions have been identified and summarised in Box 2 (132).

Box 2: Pagan framework to design and compare effective institutions.

- Clear institutional objectives; including
    - Clarity of institutional purpose
    - Transparency in the process of adjustment where the purpose changes or evolves
- Connectedness between formal and informal institutions;
- Adaptability;
- Appropriateness of scale; and
- Compliance capacity

Source (132)

Agrawal has reviewed and synthetised several frameworks identifying the characteristics of successful institutions for the management of the commons (133). Box 3 summaries the synthesised and improved set of '*critical enabling conditions for sustainability on the commons'* (2002:62-3). Importantly these conditions apply to common pool resources as opposed to open access resources characterised by unregulated and rival consumption coupled with non-excludability. These enabling conditions consist of four sets of interacting conditions of 1) resource system characteristics; 2) group characteristics, and the interaction between 1 and 2; 3) institutional arrangements and the interaction between 1 and 3; and 4) the perturbations factors external to institutional environment.

Box 3: Agrawal synthesis framework of effective institutions

For institutional arrangements:

Rules are simple and easy to understand

- Locally devised access and management rules
- Ease in enforcement of rules
- Graduated sanctions
- Availability of low cost adjudication
- Accountability of monitors and other officials to users

Relationship between resource systems and institutional arrangements

- Match restrictions on harvests to regeneration (replenishment in the case of water) of resources

External environment

- Technology
    - Low cost exclusion technology
- Time for adaptation to new techniques related to the commons
- Low levels of articulation with external markets
- Gradual change in articulation with external markets
- State
    - Central governments should not undermine local authority
    - Supportive external sanctioning institutions
    - Appropriate levels of external aid to compensate local users for conservation activities
    - Nested levels of appropriation, provision, enforcement, governance

Source (133)

6.4.3 Sequencing institutional reform

Sequencing from one institutional arrangement to another requires transparent and accountable frameworks (134), and usually involve considerations of both efficiency and equity (135). The need for reform and the speed at which it occurs should be guided by community needs and expectations (136). Community engagement throughout the reform process is not only necessary to achieve a desired result with minimal political and economic cost, but is also an effective way of ensuring emergent institutions align with local motivations and values (137).

Institutional reform should recognise pressures for change before they become critical. Adoption of water planning tools such as water metering, water accounting and water registering can greatly

assist in the management of resources even in locations where scarcity is not yet apparent (138). The converse of this situation is also true – there can be a high political and economic cost of attempting to 'retrofit' institutional arrangements after scarcity or water quality pressures become acute (139).

7. SUMMARY

Water has a number of important characteristics (fugitive, variable in supply, rivalrous in use and costly to exclude access and use, multiple and competing demands with different values) that make it difficult to manage. A requirement for successful water management is institutions that are flexible and adaptive to changing hydrological, social and economic circumstances.

Overcoming the inherent non-exclusivity of water resources is necessary to establish effective property rights that are vested in the individual, secure, fully specified and transferable via market exchange. Recent developments in property rights for water have seen a trend towards 'unbundling', or separating out water rights into their component parts (for example, differentiating 'temporary' and 'permanent' water rights).

Water institutions should align with the hydrological boundaries of the resource and encompass surface-groundwater interactions, land use as well as water use, and water quality as well as water quantity. The ability to integrate across competing demands and boundaries is essential to ensure environmentally and economically effective water management. This requires integrated water planning and adaptive co-management that promotes institutions that are capable of adapting to changes in hydrological, social and economic circumstances.

A key requirement of water institutions in coming decades will be the capacity to reallocate water resources which are already fully allocated. Both market and regulatory mechanisms are likely to be necessary to achieve this reallocation dynamically and to be consistent with societal expectations of efficiency, equity and sustainability. Market-based mechanisms are one policy option that can assist in this process by facilitating the transfer of water rights from low-value to higher value water uses.

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