Comparing the institutions that have evolved to deal with

water scarcity

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The system of defining, monitoring and enforcing the right to use water is critically important in a country like Australia, where rainfall is low or highly variable, with periods of real and perceived scarcity of water. Water rights play a pivotal role in facilitating the efficient use of water, including the ongoing transfer of water to more highly valued uses. A well-defined system of rights is also the key to achieving a balance between the economic, social and environmental interests of the nation in managing water resources.

Water is an important economic input, with irrigated agriculture contributing about one-quarter of the value of Australia's total agricultural production. However, it is widely acknowledged that the current rate of water use in some Australian river systems is not commercially or environmentally sustainable. There is also evidence that much water is not used efficiently.

Th Productivity Commission recently released a report to increase awareness of the similarities and differences in the complex water rights systems operating across Australia and in selected jurisdictions overseas.

Coverage of the study

Five Australian jurisdictions that share the Murray–Darling Basin — NSW, Victoria, Queensland, South Australia and the ACT — were included in the study, along with five overseas jurisdictions — California and Colorado in the United States, Chile, Mexico and South Africa. The overseas jurisdictions have climatic and land use similarities with Australia, and have established water rights trading. A number of them also have arrangements for inter-jurisdictional sharing of water, as in Australia. (see Figs 1& 2)

The systems studied were examined by dissecting them into their key organisational and process components. Features of those components were then compared, to highlight their relative strengths and weaknesses (see box 1). Terminology varies considerably across jurisdictions. Consequently, we used terms that have literal meaning. Some common terms are set out in box 2 and illustrated in Fig. 3.

Legal frameworks

The right to the use, control and flow of water is vested in the government in all of the jurisdictions studied — and in some jurisdictions, this extends to the ownership of water

Box 1 **The approach to benchmarking in this study**

A form of 'process benchmarking' was used for this study. In process benchmarking, aspects of organisation and process are examined and compared, to provide an informational basis for identifying potential improvements. For this study, key organisational arrangements and processes of water resource management were compared against identified best practice attributes.

A comparison of strengths and weaknesses of individual attributes of a system does not necessarily lead to clear-cut findings:

- A conclusive assessment of the best arrangement for any component of the systems compared requires trade-offs involving social and political judgements, which the Commission is not in a position to make.
- Further, it is not possible to arrive at a 'best practice' model of resource management by looking at individual components of the systems, because of the inter-relationships between most of the components compared.

Despite these limitations, process benchmarking can offer a structured way to simplify comparisons between very complex arrangements. The information presented in such a fashion can increase awareness of the policy options available to improve water rights arrangements. It should also facilitate informed debate on any new policy initiatives put forward.

itself. In most jurisdictions, individual right holders do not 'own' water resources as property. Rather, they acquire a right to use an amount of water at a particular time and place, and to retain the benefits of that use.

That said, in the Australian jurisdictions studied, and in Mexico and South Africa, water rights can be withdrawn or altered — without any statutory guarantee of compensation in most cases. Whether there is a common law right to compensation for confiscation or modification of a water licence, and under what circumstances, has not been settled in Australia.

In contrast, water rights cannot be withdrawn nor can the benefit derived from their use be diminished in California and Colorado, provided that the water continues to be put to beneficial use. Water rights are also permanently conferred in Chile. In these jurisdictions, the title to the water is recognised as private property that cannot be impaired by other users or the state.

Constitutional responsibilities

Many of the jurisdictions studied are moving toward an integrated approach to land and water management, in recognition that water-related outcomes cannot be achieved in isolation. This integrated approach is generally pursued through the establishment of catchment-level resource plans. In Chile, Mexico and South Africa, the national government has primary responsibility for both water resource and environmental management. In Australia, these are mainly state government responsibilities — with the

Commonwealth Government responsible only for environmental matters that are of national significance.

Box 2 **Water right systems: some key terms**

Adaptive management — The process of continually reviewing and setting aside water for environmental purposes as conditions change over time, such as in the understanding of environmental needs.

Appropriation — The act of diverting water from a natural surface stream or body and applying it to a statutorily recognised 'beneficial' use.

Environmental flow requirements — Minimum and maximum flow targets, for certain locations, times of the year and periods.

Return flows — Water that returns to its original source after its extraction and use, mostly by irrigators and non-consumptive users.

Supply reliability exchange rates — Exchange rates to adjust for differences in the supply security of water in different locations.

Water bank — An institutional arrangement for depositing and lending water.

Water right — A legal authority to take water from a water body and to retain the benefits of its use. The nature of such rights varies greatly. They are referred to in different jurisdictions as licences, concessions, permits, access entitlements, or allocations.
See also Fig 3.

In the United States, the allocation of water resources is the responsibility of state governments. However, the Federal Government has wide-reaching environmental protection responsibilities. This separation of responsibilities has been a factor in the sometimes separate management of water rights and the environment.

Classes of rights

There are many types of rights, including surface water rights (the right to access water in streams and rivers) and groundwater rights. Within these types of consumptive rights there are further classes of rights.

In all of the jurisdictions, water rights are available for stock watering and domestic purposes (for reasonable use at most times) to those who have direct access to water — either because of ownership of land adjacent to a stream (in the case of riparian rights) or from the ownership of overlying land (in the case of groundwater).

In most of the jurisdictions studied, water rights are classified into several priority classes. A water right confers on its holder access to a share of the water available to that class. Water rights are defined in volumetric terms, with a statement of the probability that the nominal volume will be delivered in full in any given year. Under these water sharing arrangements, some water is available to all right holders in most seasons. In the event of water shortages, low priority water right holders bear equally the shortage of water availability.

In contrast, rights (other than riparian) in California and Colorado are defined for access to a specific volume of water. Water is supplied to right holders in order of their date of appropriation — 'first in time' has priority — until all available water is taken. In effect, there is a large number of rights, differentiated by their priority. Under these arrangements, the initial risk of water being in short supply is borne mostly by right holders with later-dated rights.

Water resource management

Some of the key elements of water resource management in the jurisdictions studied and the main differences in the arrangements are summarised in table 1. The jurisdictions can be broadly categorised into three groups. Although there are similarities among the jurisdictions studied, the main defining difference is the degree of certainty of the benefits attached to water rights — that is, the duration of the right and the predictability of the volume of water received (to most right holders). Many of the differences arise because the governments of some jurisdictions — California, Colorado and Chile — do not have the power to alter water rights once they are issued.

Government involvement in water allocation

Historically, water in Australia and in many other countries was obtained by a potential user applying to a state water resources agency for a licence to extract water. Governments had the power to control water use by restricting the number of licences issued and the quantity of water that could be lawfully extracted. The issuance of licences was not always administered adequately. The most important example is that water in some systems (such as the Namoi River in NSW) has become over-allocated to consumptive uses, so that the extraction of the total licensed volume would leave little or no water for the environment or for downstream users.

In California and Colorado, rights were issued on the basis of users' appropriation of that water — provided that the act of appropriation did not impair the existing right of an existing water user. In many rivers, downstream water users appropriated the return flows of upstream water right holders. Over time, many rivers (including the Colorado River) were over-appropriated — more water rights were issued than there was water available.

Allocation between consumptive and non-consumptive uses

The over-allocation of water in most jurisdictions has resulted in efforts by governments to re-allocate or to encourage the re-allocation of water to non-consumptive (environmental) uses. In most Australian jurisdictions, planning is undertaken by the water resources agency to allocate water between consumptive and non-consumptive uses, based on an assessment of economic, social and environmental benefits and costs.

Table 1 **Water rights arrangements at a glance — by jurisdiction, 2003**

Characteristic	*NSW, Queensland, South Australia, ACT, South Africa*	*Victoria, Mexico*	*California, Colorado, Chile*
Legal framework			
Government power to reduce or cancel rights	Yes, compensation may not be required	Yes, compensation may not be required	No, government must purchase right
Power to limit rights after issue	Yes	Yes	No
Government involvement in water resource management			
Administrative re-allocation of water between uses	Yes, by adjusting consumption volumes	Yes, by adjusting consumption volumes	No, government must purchase, harvest or save water
Agency responsible	Water resources agency	Water resources agency	Environmental agency
Environmental protection mechanisms			
Separate allocation for the environment	No (Qld, ACT), some specific purpose (NSW, South Africa)	Some for specific purpose	Yes
Environmental flow requirements (targets)	Yes	Yes, environmental allocations (Mexico)	Yes, for environmental allocations
Water rights			
Classes of main consumptive rights	One or two – 'high' and 'low' security	One – 'high' security[a]	Many (US), two – 'high' and 'eventual' (Chile)
Rationing variable supply	Adjust volume for consumptive use	Adjust volume for consumptive use	Ration by priority of right (US). Volume adjusted (Chile)
Water received	Shares of water allocated to class of right	Shares of water allocated to class of right	Fixed volume, subject to priority of right (US). Shares allocated to class of right (Chile)
Duration of rights	Fixed (South Africa NSW), ongoing (Qld, South Aust., ACT)	Ongoing but subject to review	Perpetual (subject to ongoing beneficial use in US jurisdictions)
Terms reviewable	Yes	Yes	No
Downstream rights to return flows	No	No	Yes (except Chile)
Trading			
Water rights linked to a particular source	No, except South Africa	No, except Mexico	Yes
Local restrictions on trading	Yes	Yes	Yes
Adjustments for seepage and evaporative losses	No (unknown for South Africa)	No (unknown for Mexico)	Yes

[a] Victorian 'sales' water is low priority.

In California, Colorado and Chile, the environment is protected outside the system of rights. There is no planning to allocate water administratively. In California and Colorado, environmental agencies develop plans to identify any additional volume of water required to protect the environment, and obtain this water by purchasing water rights, harvesting additional water or investing in water savings programs. For example, US$90 million was spent to purchase water rights to restore riverine health and protect fish populations in the San Francisco Bay–Delta in 2001–02. In addition, environmental interest groups have purchased and donated water rights.

In NSW, Queensland, South Australia, the ACT and South Africa, additional water for the environment can be obtained by reducing the volume of water attached to existing water rights. All Australian governments have the option to purchase water rights or invest in water savings programs.

Adaptive management

An inherent problem with planning is the need to identify and weigh up the disparate interests within the community in the absence of market signals to reveal preferences. Consequently, there is community representation on advisory and decision-making bodies involved in water resource planning in most of the jurisdictions studied.

The resource management approach, such as that adopted in NSW, Queensland, South Australia, the ACT and South Africa, recognises that it is not possible to strike an efficient allocation with certainty. This approach to 'adaptive management' provides the water resources agency with the flexibility to address regulatory error, new scientific evidence, and changing community values. Adaptive management also has the advantage that large changes to allocations can be implemented gradually, in order to reduce adjustment costs.

Water resources are managed adaptively in all of the jurisdictions studied. However, only NSW, Queensland the ACT and South Africa make explicit provision for plans to be revised under a statutory planning cycle.

A problem with the adaptive management approach is that it can adversely affect investment and location decisions. The risk that governments may intervene in the future to reduce the water made available to right holders, or even to revoke rights, may impede investments that need to be amortised over long periods (longer than the term of the right).

In the NSW, Queensland and ACT systems, the potentially adverse effect of adaptive management on investment has been mitigated, to some extent, by locking in resource plans for a 10-year period. The NSW and Queensland Governments are not required under legislation to pay compensation if water is administratively re-allocated at the start of the next statutory planning cycle.

In California and Colorado, private investment is not affected by adaptive management because water rights are secured as legal property, and cannot be impaired without compensation — right holders sell at the value of their right.

Re-allocation by water trading

Australia's average rainfall is easily the lowest of the four continents covered in the study. Low rainfall, combined with very high evaporation rates, leads to low surface water flows and seasonal river systems. Despite Australia's low and variable rainfall, the per capita consumption of water in this country is the third highest within the OECD. Current sources and uses of water in Australia are indicated in Tables 2-4.

When water is in short supply, as it is in many parts of the jurisdictions studied, water trading has been encouraged as a means of efficiently re-allocating water among right holders. The trading of water rights (permanent trades) or of water flows (temporary trades) facilitates re-allocation of water from lower to higher valued uses, increasing the benefits obtained from the scarce resource. Figure 4 indicates the variation across agricultural industries in the importance of irrigation water as an input.

Water trading is most effective if there are no barriers to trade and there are low transaction costs. Prices also need to be signalled in open markets or regularly tested so that right holders are in a position to assess the 'opportunity cost' of retaining their water or right — the difference between the market price of water and the cost of supply.

Other possible arrangements for re-allocating water include:

- Auctioning the right to extract a specific volume of water seasonally (auctioning of short- and long-term rights is being introduced for new rights in Queensland, the ACT and, in some instances, Chile).
- Administratively setting a price to reflect its scarcity value. 'Abstraction charges' (ACT) and 'drought surcharges' (Colorado) are collected from urban water users and are similar to resource rents and royalties. They signal the scarcity value of the water.

The price of a water right depends on factors such as the difference between the amount a water user is willing to pay for water and how much water users have to pay for the management of water rights and for water delivery. The price of a water right is a key determinant in the efficient allocation of water. If the prices charged for infrastructure services (for example, dams and channels) are not economically efficient, the prices of water rights will be distorted and trading will not ensure that water is allocated to society's highest valued uses.

Water for the environment

In Queensland, there are no allocations for the specific and exclusive use of water to protect and maintain the environment. In NSW, Victoria, South Australia and the ACT, there are environmental allocations to address specific environmental concerns in addition to limits on what consumptive users can take so that environmental flow requirements can be met.

In Queensland, water allocated to consumptive uses and other non-consumptive in-stream flows is distributed to right holders in a way that also meets a river's environmental flow requirements. This approach avoids the necessity of making a separate environmental allocation.

One disadvantage of this approach is that right holders may not get water when it is specifically required, or environmental flow requirements may not always be met. Another is that changes in the use of water brought about by trading (particularly upstream) could necessitate a re-allocation of water in certain parts of river systems in the longer term.

In California, Colorado, Mexico, South Africa and Chile, a specific allocation of water is generally made to protect the environment. Generally, where allocations are made and are issued as a water right, they are potentially tradeable.

A right is issued for most environmental allocations in California and Colorado. In Australia, this is uncommon. Exceptions include the Victorian bulk entitlements, such as those for the Murray Wetlands and the Barmah–Millewa forest. These entitlements provide for any unused portion of the allocation to be temporarily traded and the revenue used to cover the cost of infrastructure services.

In most of the Australian jurisdictions studied, it is difficult to determine whether environmental flow requirements are achieved. There is limited reporting of any monitoring that takes place. This could be a significant shortcoming where the distributor provides water to users on a commercial basis.

In contrast to the Australian jurisdictions, there are agencies in the US jurisdictions studied that are dedicated solely to managing environmental allocations. For example, the Colorado Water Conservation Board has the sole authority to own, distribute and enforce Colorado's instream flow and lake level rights. It is required to report regularly on the volume of water provided for the environment.

Definition of water rights

The water rights in each of the jurisdictions studied were examined on the basis of criteria that *ideally* define efficient water rights (see box 3). However, it has to be recognised that there are trade-offs among the criteria as well as implementation issues that militate against an ability to satisfy all the criteria simultaneously.

Consumptive rights in all of the jurisdictions studied are now divisible and transferable. This promotes trading of some or all of the water available under the right on a temporary basis, or even trading of the right itself.

Universality

Universality is achieved when there is a complete and integrated management of every water source within the water rights system — including surface, groundwater and overland flows. No jurisdiction has a universal water rights system. Most jurisdictions do not integrate the management of surface and ground water sources, and few jurisdictions integrate the management of overland flows in upper catchments with surface water.

It may not always be efficient to ensure universality is achieved, because the cost of implementing the necessary controls may exceed the benefits. However, water rights could be compromised over time if a water rights system falls too far short of universality. For

example, rights to surface water could lose their value if the uncontrolled growth of private dams or plantation forests diverted overland flows before reaching streams and rivers.

Box 3 **Criteria for efficient water rights**

Efficient water rights would *ideally* possess the following attributes:

- universality — all available water resources (as far as practicable) are covered by the system of rights;
- predictability of volume — users have a reasonable expectation of the volume of water that they can extract from a source;
- enforceability — the right can be protected from encroachment by others;
- certainty of title — there is legal recognition and protection of rights;
- duration — the time period over which users possess the right is specified;
- exclusivity — at the margin, the benefits and costs of possessing and exercising a water right accrue to the owner;
- detached from land title and use restrictions — the right is separate and free of any requirements to hold land or any restrictions on how the right may be exercised; and
- divisibility and transferability — the right may be sub-divided and is freely tradeable to others.

Predictability of volume

The management of water resources and the operation of water rights systems is complicated by the variable supply and demand of water, which is difficult to predict. This is a particular problem in Australia, because of the great year-to-year variability in rainfall.

As mentioned, in most jurisdictions, the water resources agency manages seasonal variability by adjusting the volume of water that is to be shared among right holders. In several jurisdictions, the *time* of extraction can also be delayed to satisfy both downstream consumptive demands and environmental flow requirements (maximum and minimum flows at specific times and locations).

In California and Colorado, the variability of water supply is managed by recognising prior appropriations (including for the protection of the environment) and turning on and off low priority right holders' access to water.

Enforceability

Effective and efficient enforcement is critical to any system of rights if the benefits are to be protected from encroachment. In the jurisdictions studied, monitoring and enforcement is generally undertaken by agencies with multiple and conflicting interests, potentially compromising the function.

Water right enforcement agencies do not seem to be strongly accountable for their performance. There is little reporting on compliance strategies or enforcement outcomes in all of the jurisdictions studied.

Certainty of title

The integrity of a system of rights depends on procedural fairness and sound administration that prevents rights being used for purposes other than those intended. In the US jurisdictions studied and in Chile, courts are actively involved in enforcing water rights and maintaining the integrity of the system and procedural fairness. In Australia and the other countries studied, procedural fairness is tested on a more *ad hoc* basis under administrative and common law.

In all of the jurisdictions studied, registration systems have been (or are being) introduced. Some are being modeled on the high security Torrens Title system used for land.

Duration

There is great variation across jurisdictions in the nature of the right to access water — ranging from an annual permit that can be revoked or modified, to secure 'perpetual' rights in California, Colorado and Chile.

Perpetual or long-term rights improve the certainty of users' benefits over time. Lesser terms may create disincentives for efficient investment in activities in which water is used, depending on the renewal process. However, short-term water rights allow for an adaptive management approach to the re-allocation of water for environmental purposes.

In NSW and Mexico the majority of water rights apply for a defined fixed term. The water resources agency has the option of not renewing water rights at the end of the statutory period. In Queensland, South Australia and the ACT, the majority of rights are issued as 'ongoing rights'. There are statutory provision for them to be reviewed and modified as part of a planning process.

The long-standing bulk entitlements in Victoria are regarded as ongoing rights. The Victorian Government does have the power to change the volume of water allocated to a bulk entitlement, but only under defined circumstances.

Generally, the water resources agency that develops resource plans and acquisition programs also reviews these plans and programs. This has the potential to affect the integrity of the reviews. It is also likely to be a less transparent process than if a separate agency undertook the review.

Exclusivity

Rights have the characteristic of exclusivity if, at the margin, they limit third-party costs or benefits arising from exercising the right to a socially acceptable level. If water rights do not have this characteristic, right holders may be unaware that they are causing damage to other water users or to the environment.

One environmental third-party effect results from the over-extraction of water from water bodies. As already noted, this is addressed through the provision of environmental flows.

Another third-party effect is that arising from the change in water quality — such as the use of water in irrigation and its subsequent discharge. However, arrangements for addressing these effects — which can be environmentally significant — were not examined in this study. In all of the jurisdictions studied, these effects are addressed separately, rather than by placing conditions on consumptive rights.

In some of the jurisdictions, there are policies to introduce prices that reflect third-party environmental damage and restoration costs. For example, the Council of Australian Governments has agreed that, prior to the establishment of the new water right systems, prices should be set to signal environmental costs to water users. However, none of the Australian and overseas jurisdictions studied have introduced environmental damage charges.

Trading water, water rights and scarcity

As noted, for water trading to be effective it needs to overcome a number of impediments to trade — both natural and artificial. One natural impediment is the conveyancy loss that occurs with long-distance trading. In the River Murray system, traded water rights are currently assigned to a new location without any adjustment for water losses between the original and new locations. The pooling of distribution losses affects decisions relating to the irrigation of crops and pastures. In contrast, right holders in California and Colorado receive water net of any losses.

Another impediment to trade is the treatment of differences in hydrological characteristics that exist between catchments and jurisdictions. In the Australian jurisdictions studied, water rights are defined in terms of the catchment or supply system into which they traded. Third-party effects on other water users are created when water rights are traded between catchments. Exchange rates are applied to the transferred water right to address those effects, but the calculation of such exchange rates is complex and currently lacks transparency.

In the overseas jurisdictions studied, a water right is permanently defined for a particular source. Third-party effects on other users do not arise when water rights are traded between supply systems, and there is no requirement to calculate and apply supply reliabilities. This suggests the possibility of water users assembling a portfolio of water rights, from different sources, with different reliabilities, rather than having all rights converted to a ‘uniform currency’ via complex exchange rate calculations.

Another possible impediment to efficient trading that exists across all the jurisdictions studied, is the limited universality of the water rights systems. Trading may be distorted, if users have opportunities to exploit other water sources, say by harvesting overland flows. This has the potential to affect the value of existing rights as well as the efficient management of the whole resource.

Other artificial barriers to water trading are common across the studied jurisdictions. These include embargoes and limits on trades from irrigation areas and from the jurisdiction. For example, in Victoria there is a 2 per cent limit on the volume of water that can be permanently traded out of the state in any year. Similarly, no water rights may be traded outside the South Australian Renmark Irrigation Trust area.

One of the reasons given for these restrictions is that trading could lead to higher prices for water and higher infrastructure service charges to remaining users.

Restrictions placed on the volume of water traded out of some irrigation districts are a potentially serious impediment to the efficient use of water. These restrictions can limit the opportunity for existing right holders to sell water when others value it more highly, limiting the scope for efficient structural change.

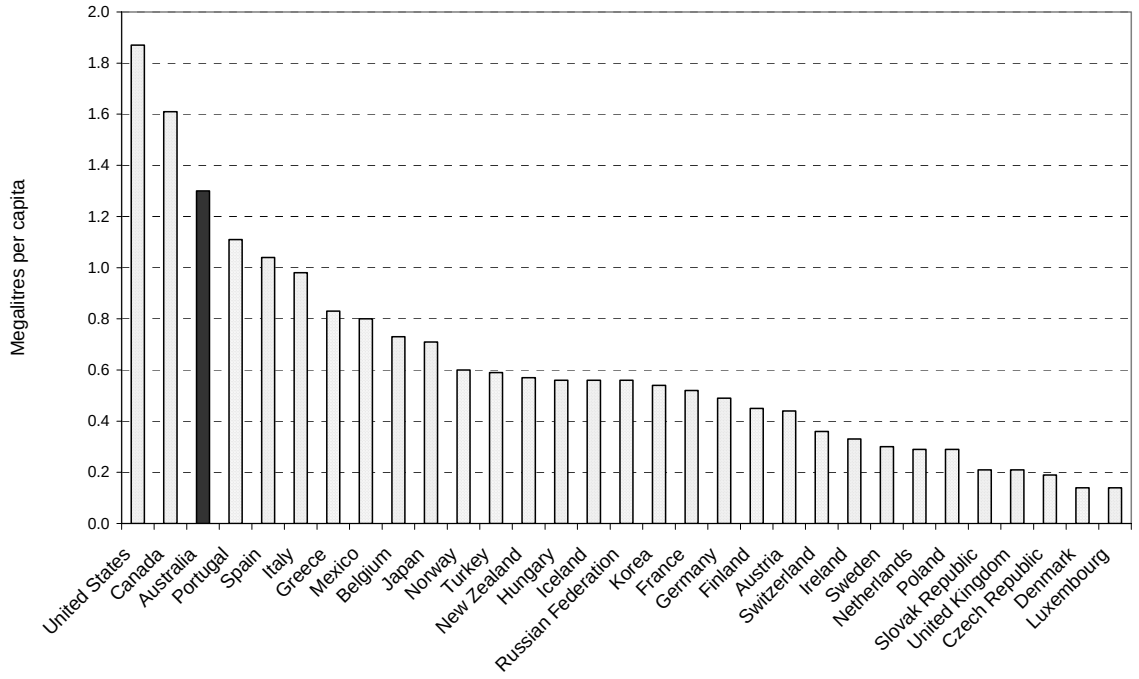
There is a wide variety of transactions costs associated with water right trading. In California and Colorado, trade in water rights has been constrained by the legal notification and approval requirements that accompany the transfer of a water right. As trades in water rights must not injure the vested rights of other water right holders, and because downstream users often depend on the return flows of upstream users, there are often high transaction costs as parties negotiate to prevent, minimise or compensate for the injury to downstream right holders. Recently, some of these costs have been ameliorated with the establishment of water banks that borrow and lend water.

Finally, inefficiencies in the provision of infrastructure services, environmental flows and non-consumptive flows potentially reduce the benefits of holding water rights. Congestion in rivers and artificial channels are common in all jurisdictions and can result in economic and environmental costs — such as delays in delivery and the flooding of environmental and private land. A number of methods have been developed to prioritise access to the distribution network during congestion. In the US jurisdictions studied, priority (seniority) of the right is the basis for prioritising the timing of delivery if congestion occurs. No jurisdiction studied has sought to manage the congestion in natural and artificial channels separately from the management of water rights.

Reference

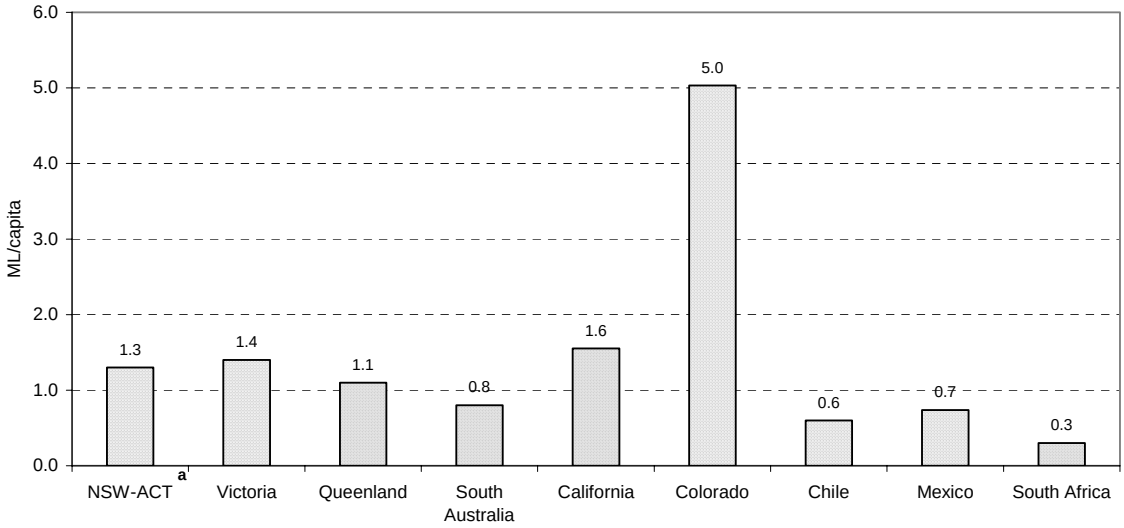
Productivity Commission, 2003. *Water Rights Arrangements in Australia and Overseas,* Commission Research paper, Productivity Commission, Melbourne.

Figure 1 **Water extraction per capita — OECD countries, 1999**



Source: OECD (2003).

Figure 2 **Water use per capita — Australian and overseas jurisdictions, various years**



Note Data for the Australian jurisdictions are for 1996–97. For California and Colorado, data are for 1995. Mexican and South African data are for 2000. **a** Water use data for NSW and the ACT are not available separately. The ACT accounts for around one per cent of combined use by NSW and the ACT.

Sources: ABS (*Water Account for Australia: 1993–94 to 1996–97*, Cat. No. 4610.0); USGS (1999); LAO (1996); DLA (2002); CNA (2001); Fernández and Medina (2000); DWAF (2002), p. 23; DSD (2000), p. 73.

Table 2 **Consumptive water use — Australian jurisdictions, 1996–97 (G L)**

	Livestock, pasture, grains & other agri.	*Vegetables*	*Sugar*	*Fruit*	*Grapevines*	*Cotton*	*Rice*	*Electricity and gas*	*Household*	*Other*	*Total*
NSW–ACT[a]	3405	194	0	279	242	1417	1643	23	580	385	8168
Victoria	3549	107	0	172	218	0	0	1192	419	365	6022
Queensland	725	122	1176	91	4	423	0	69	419	612	3641
South Australia	640	65	0	115	172	0	0	1	131	90	1214
Total	8319	488	1176	657	636	1840	1643	1285	1549	1452	19 045

Note Water use = mains water use + self-extracted water use. Electricity and gas is net of in-stream use of water, such as the generation of hydroelectricity. [b] The ACT accounts for around one per cent of total use in NSW and ACT.

Source: ABS (*Water Account for Australia: 1993–94 to 1996–97*, Cat. No. 4610.0).

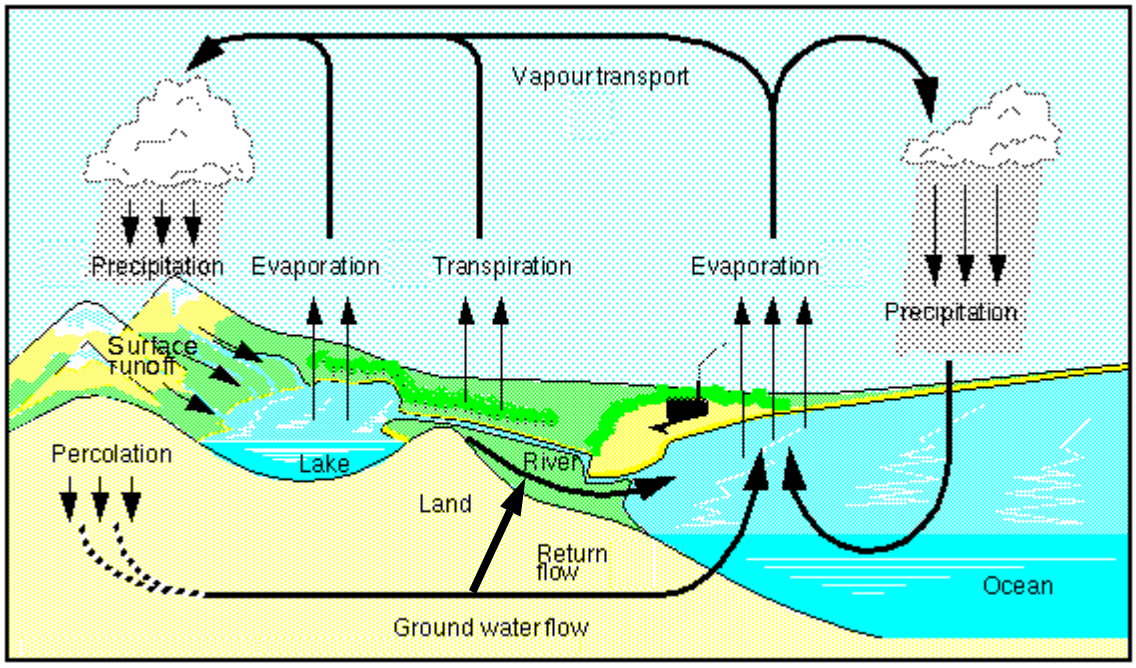
Table 3 **Consumptive water use — California and Colorado, 1995 (G L)**

	Commercial	*Domestic*	*Industrial*	*Thermo-electric generation*	*Mining*	*Livestock*	*Irrigation*	*Public supply*	*Total*
California	1906	5293	1134	291	105	635	39 922	866	50 152
Colorado	151	702	197	177	71	82	17 596	124	19 100
Total	2057	5995	1331	468	176	716	57 518	991	69 252

Note Water use = self-extracted freshwater use + deliveries from public suppliers. Public supply is consumptive use of water by the public supply industry and equals total freshwater extracted by the public supply industry minus total water deliveries.

Source: USGS (1999)

Figure 3 The water cycle



Source: University of Washington (undated).

Table 4 **Groundwater use — Australian and overseas jurisdictions**

	Estimated groundwater use[a]	*% of total use in jurisdiction*
	Gigalitres	Per cent
NSW	1008	12
Victoria	622	9
Queensland	1622	44
South Australia	419	33
ACT	5	7
California	15 500	30
Colorado	3143	16
Chile	na	na
Mexico	28 000	37
South Africa	na	na

na Not available. **Note** Australian data are for 1996–97. Data for California and Colorado are for 1995. Mexico data are for 2000. [a] Estimates because there is unlicensed use of groundwater that remains unquantified.

Sources: NHT (2001b); USGS (1999); CNA (2001).