AUSTRALIAN TOURISM IN A WATER CONSTRAINED ECONOMY

Research Agenda

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Abstract

In January 2009 Sustainable Tourism Cooperative Research Centre (STCRC) commissioned the development of a research agenda to deal with the needs of the tourism industry in the policy context of a water constrained setting. A research team from partner universities undertook a literature review of the existing work and reached a view that the paucity of research in this field had made it difficult for the tourism industry to be fully engaged in the policy debate. In order to verify the research agenda an industry reference group was formed to provide input at critical points during its development. Several iterations between the research team and the reference group led to an agenda that comprises four main themes:

- access to inland water for tourism and recreation—where complementarities, conflicts and trade-offs exist for ecosystem health and human well-being;
- the 'value' of tourism and recreation—challenges in articulating a cohesive message;
- political and institutional dimensions to tourism water research;
- human behaviour, water and tourism.

It was also resolved that case analyses were an essential component that would provide salient examples and deal with the considerable hydrological variability that typifies this continent.

SUMMARY

In January 2009 Sustainable Tourism Cooperative Research Centre (STCRC) commissioned the development of a research agenda to deal with the needs of the tourism industry in a water constrained environment. A team from partner research organisations undertook a literature review of the existing work in this field and reached a view that the paucity of research had made it difficult for the tourism industry to be fully engaged in the policy debate. In order to verify the research agenda, an industry reference group was formed to provide input at critical points during its development.

Key Objectives

In broad terms the project had three core aims:

1. to map the process for increasing our understanding of fresh water as an input in the production of tourism outputs
2. to illustrate the modelling required to establish the trade-offs and complementarities between the use of water for the production of tourism versus other outputs (e.g. agriculture, urban/industrial, environmental)
3. to test and explore the range of policy and institutional responses that would be required to deliver an optimal allocation between competing water demands—including those arising from activities related to tourism.

Methodology

The project broadly adopted an iterative process involving research on the academic front and subsequent testing of ideas and themes with industry practitioners. This process was intended to lead to a progressive refinement of research themes and to give some indication to their relative importance to the sector at large. A three-stage methodology was originally planned.

Stage 1: Understanding water as an input in tourism production

Initially, a literature review was conceptualised as addressing a number of specific areas around water as a productive input. The purpose of the literature mapping was to systematically assemble the existing work that covered theoretical and empirical components in major areas of interest.

Stage 2: Catalogue and prioritise modelling approaches that allow for co-production and rivalry between sectors

A preliminary review of the existing research on water and tourism revealed two main deficiencies: a lack of understanding of the role played by water in different tourism settings, and; a lack of robust modelling techniques that would permit tourists' demands for water to be incorporated into ex-ante models of water allocation. The purpose of the second stage was to address the latter weakness.

Stage 3: Testing and building policy responses and institutions

Decisions about water are heavily influenced by political economy considerations. In that regard it was considered important that the emerging research agenda be grounded in an understanding of the political economy that circumscribes decision making. This stage of the project would thus allow some assessment of the extent to which the existing policy framework falls short of the optimal allocation **inclusive of the needs of tourism.**

Key Findings

Two broad gaps were consistently cited from the literature and persistently resonated with industry stakeholders. These comprise of:

1. the lack of technical information that maps the relationship between the various dimensions of water and the components of visitation
2. a paucity of institutional and policy knowledge that can be harnessed to make the most of the technical data (were it available in the first instance).

Within this broad framework several important observations were made during the first workshop about the research area and its context. These included:

- The hydrological resources of the Australian landscape vary markedly such that it is not feasible to offer a single response to the water demands of the tourism sector at a national level.
- The tourism industry is itself diverse and the sub-sectors do not automatically assume the same water demands. Accordingly, there needs to be some means of bringing these competing elements into a single message if there is to be a shift in the policy environment.
- The industry with the strongest claim on national water resources (agriculture) also exhibits marked within-sector variations. Notwithstanding these differences, the agricultural lobby appears to have achieved a generally consistent response to policy makers which has arguably resulted in a policy outcome that favours this group.
- The distinction between different forms of visitation, with regard to recreation and tourism, is not always conducive to achieving a policy change in favour of the tourism industry. Many of the water demands for recreation are synergistic with the demands of tourism, although this is not always the case
- There was a consensus that the views and concerns of the tourism/recreation sector have not been overtly considered in the formulation of water policy, particularly as the resource has become increasingly scarce.

Future Action

The topics that were ultimately settled upon as the foundation of the research agenda fell into four groups.

Access to inland water for tourism and recreation: Where complementarities, conflicts and trade-offs exist for ecosystem health and human well-being

This topic covers several critical issues relating to water allocation and access (or restriction of access) to inland freshwater systems for tourism and recreation. The topic also touches on the link between tourism, ecosystem services and human well-being; the concept of trade-offs to achieve optimal outcomes; and an analytical framework to assess complementary or conflicting situations relevant for water-based tourism and recreation. The framework includes evaluation of:

- aquatic ecosystem features that have appeal for visitors;
- the ecosystem service(s) relevant for that visitation;
- the processes that change ecosystem features (by compromising the ecosystem service);
- the relationships between visitor experience and changes in aquatic ecosystem feature; and
- the trade-off(s) made when ecosystem services relevant for visitation are compromised.

To better guide the discussion around this topic the relationship between aquatic features, ecosystem services and the human processes that modify those services requires mapping. This could then lead to a greater understanding of the relationship between visitor experiences and changes to the aquatic feature and (where any compromise is made by choice) provide some indication of the trade-offs embodied in a decision.

The ‘value’ of tourism and recreation: Challenges in articulating a cohesive message

Evidence from fisheries and forestry suggest that non-market values for tourism can be larger than the commercial fishery or timber production values. However, at the outset, this research problem is plagued by problems in definition.

The research problem, though stated simply, is not straightforward. A few immediate questions spring to mind. What is value? What are we valuing? Where do tourism benefits start and stop? Should the ‘value’ of tourism and recreation be more than a strict financial aggregation of expenditure? On the surface, there would seem to be value in an afternoon of fishing or the value associated with time spent in a winery overlooking a wetland watching birds. For each of these activities, for the individual engaged, the overall benefits should exceed the financial sum of expenditures. If this is the case, economics has developed a whole set of tools which can elicit and unpack these values.

Political and institutional dimensions to tourism water research

One of the substantive challenges for the tourism sector is harnessing the assembled knowledge (and the emerging knowledge) in a manner that can then optimise its use. This raises important questions about the role of science and its relationships with the polity generally and thus a sub-theme of the research agenda emerges. In addition, two sub-themes emerge around organisational cooperation within the sector generally and the role of

property rights and markets.

Human behaviour, water and tourism

The water-using behaviour of tourists has shown to differ considerably from that of non-tourists. And yet little, serious behavioural analysis has been undertaken in this context, especially in Australia (Lehmann 2009). An important practical consideration is the operational demands that then flow to the management of all dimensions of the water cycle. What is largely absent from this topic is analysis of the responsiveness of tourists and those involved in recreation to a range of triggers and incentives. Finally, there is a need for this behavioural research to be integrated with water resource planning. Presently, demand is largely assumed and infrastructure designed to meet it. The feasibility of continuing in this mode is questionable and the types of research advocated above could substantially improve the outcome.

The importance of case analyses

The industry reference group was strongly of the view that a range of case analyses is needed to capture the variability of natural conditions in this country. These analyses are well placed to highlight the advantages likely to be bestowed on those industries more adaptable to fluctuating water availability. In simple terms case analyses provide a powerful demonstration of the effectiveness of tourism and recreation that is in sync with natural water availability and should form an important part of the research agenda.

Conclusion

This report has traced the formulation of a research agenda to facilitate enhanced representation for the tourism and recreation sector in the contested arena of water policy. From the outset, examination of various policy initiatives revealed the virtual absence of these sectors at the policy table, notwithstanding the importance of water in both its consumptive and non-consumptive uses for the sector. Not surprisingly, this was attributed to the heterogeneity of the sector along with the complex sets of relationships that exist between the various uses and users of the water resource. Through a process that included extensive collaboration with industry experts, a thorough review of the extant literature, and the development of a series of indicative papers, several salient areas of research were identified. The research gaps fell into two broad categories. First, the lack of technical information that maps the relationship between the various dimensions of water and the components of tourism and recreation; and second, the paucity of institutional and policy knowledge that can be harnessed to make the most of the technical data (were it available in the first instance).

A series of papers was developed, grouped loosely under these two categories. This included:

- an exploration of the complementarities and conflicts between ecosystem services and human well-being;
- a survey of valuation techniques and findings in the context of tourism and recreation;
- an examination of alternative institutional and political models of engagement;
- discussion of the potential for collaborative market based approaches to achieving improved policy outcomes for the sector; and
- an analysis of the role of importance of the specification of property rights in securing particular outcomes.

Whilst these areas of research are by no means definitive, they provide a useful illustration of the types of research that may yield benefit for the sector.

The project has also revealed several additional areas of research that appear vital to an expanded understanding of the sector. In particular, the behavioural nuances of tourists and recreators and more specifically their potential responses to triggers and incentives appears poorly understood. The behaviour of individuals in this context carries with it important implications for pricing, infrastructure planning and institutional decisions. A more general point relates to the degree of hydrological and contextual variability within Australia that would appear to indicate that a ‘one size fits all’ formula would be of limited use to the sector. Instead, an approach that gathers a series of case analyses, that capture the continent’s geographic and hydrologic variability, might therefore provide a useful way forward. It is clear that there is much fertile ground for future research efforts that will inform the sector in its endeavours to secure increased influence in the policy arena.

Chapter 1

INTRODUCTION

Fresh water resources and their allocation and assignment to competing users and uses have seldom attracted more attention in Australian polity. Over the last three decades policy makers have been actively dealing with water reforms, largely driven by the maturation of the water economy. A mature water economy is characterised by inelastic supply of 'new' water and the need for expensive rehabilitation of ageing projects (Randall 1981). Adding to the necessity to more actively engage in 'water management' is the scientific knowledge emerging on the impacts of climate change on Australian hydrology. In simple terms, Australia's rainfall is expected to decline in much of the southern portion of the continent and to become markedly more episodic in nature across the nation generally (CSIRO 2008). These predictions are set against the existing hydrological 'boom and bust' cycles that typify much of this landscape. More specifically, the rainfall of this country is so variable in geographic and temporal terms as to require the average water storage to be twice that of the global norm to deliver the same level of reliability (Smith 1998).

One of the major turning points in water reform in Australia was the decision by the Council of Australian Governments (CoAG) to include water as part of the competition reform agenda in the early 1990s. The upshot was the *Water Reform Framework* of 1994 which comprised five main elements:

- the introduction of pricing practices aimed at recovering costs, being consumption based and removing (or at least making overt) cross-subsidies;
- the development and implementation of a system of volumetric and tradeable water allocations that were separable from land and which recognised the needs of the environment;
- the separation of regulation, water service delivery and resource management functions;
- two-part tariffs were adopted for urban water users, where practicable; and,
- all future investments in water infrastructure were to meet both economic and environmental sustainability criteria.

Subsequently, the *National Water Initiative* (NWI) was approved by CoAG in 2004 and continues to act as the guiding framework for managing water in this country. The NWI seeks to achieve national compatibility in water markets, regulatory and planning schemes with the aim of securing sustainable management of surface and groundwater. The NWI specifies that consumptive use of water requires a water access entitlement which should be described in legislation as a perpetual share of the consumptive pool of a water resource (NWI paragraph 28). The NWI also recognises:

- the continuing national imperative to increase the productivity and efficiency of Australia's water use;
- the need to service rural and urban communities; and
- the importance of ensuring the health of river and groundwater systems, including the establishment of clear pathways to return all systems to environmentally sustainable levels of extraction (paragraph 5, NWI).

Notwithstanding the apparent breadth of these initiatives, the sectored coverage and treatment of water interests is hardly comprehensive or complete. Even a cursory review of the projects sponsored by the National Water Commission (NWC) as part of the NWI would reveal that most attention has been given to the potential trade-offs that need to be struck between agriculture, as an extractive user of water, and environmental interests, which would generally prefer to limit extractions.

Whilst a noticeable shift occurred between the 1994 and 2004 reforms with more detailed treatment of urban water use, nowhere in the NWI are the particular water demands of recreation and tourism specified. A search of the NWC website supports this view and details of the funding provided to projects under the Raising National Water Standards Program provided in Table 1 are offered as evidence.

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Perhaps ironically, the most prominent contribution of 'tourism' in this regard was the *Water Reform and Industry* publication that considered the implication for water reform on the minerals, petroleum, energy, pulp and paper sectors having been prepared by the Department of Industry, Tourism and Resources (2007).

Table 1: Value of National Water Commission projects under the Raising National Water Standards Program by beneficiary sector and state/jurisdiction

Sector beneficiaries	**Value of funding ($A) #**
Generic* (e.g. wider planning and framework development)	88,468,348
Urban/industrial water users	9,007,450
Agriculture+	15,346,600
Environmental interests	19,610,098
Jurisdictional beneficiaries	**Value of funding**
National	63,799,557
Multi-state~	28,992,788
Murray-Darling Basin States	14,271,000
NSW	5,207,000
VIC	13,883,850
WA	2,418,883
QLD	999,418
NT	300,000

Source: NWC 2008

Notes:

Efforts have been made to avoid double counting projects although it is not entirely clear where the NWC may have cross-classified projects (e.g. with the groundwater section of this program and the National Groundwater Action Plan).

* Where a project would appear to benefit more than one sector it has been categorised as generic. Whilst tourism interests may indirectly benefit from these projects there is no apparent effort to support tourism-related projects in their own right.

+ This relates only to projects funded under the National Water Standards Program. Considerably more funding for the agricultural sector has been provided under different programs administered by the NWC.

~ The NWC makes no distinction between multi-state and Murray-Darling Basin based projects. A distinction has been attempted here, albeit on the basis of the limited available data on the NWC websites.

Despite difficulties associated with defining the tourism industry and its associated activities, the sector remains an important contributor to the Australian economy. In particular, many regional areas have a significant investment in the tourism industry and rely heavily upon its health. The tourism industry employed 482,800 people and its gross value added of $32,306 million in 2006–07 represented 3.7% of Australia's GDP. This roughly commensurates with the contribution of agriculture, which sits at around 3% of GDP (ABS 2008). Despite their roughly equal contributions, the extent to which water policy choices have been formulated with both sectors equally in mind is questionable.

The apparent disconnect between the economic significance of tourism/recreation and the standing of these interests in water affairs might be traced to several factors. Amongst these is the paucity of research into the nexus between water and tourism, especially in the Australian context. Consequently, relatively little has been done to include the interests of the tourism sector when designing policy and crafting administrative institutions, often because so little is understood of these relationships. Moreover, on the few occasions when the interests of tourism have been raised, these arguments have been substantially weakened by the absence of robust research on the linkages between water resources and tourism itself (see, for example, MDBC 2008).

It was against this background that Sustainable Tourism Cooperative Research Centre (STCRC) commissioned a scoping project to draft the water-related research agenda for the tourism industry. The project was primarily concerned with the relationship between freshwater and tourism, notwithstanding that the nexus between tourism and seawater is also important.

In broad terms the project had three core aims:

- to map the process for increasing our understanding of fresh water as an input in the production of tourism outputs;
- to illustrate the modelling required to establish the trade-offs and complementarities between the use of water for the production of tourism versus other outputs (e.g. agriculture, urban/industrial, environmental);
- to test and explore the range of policy and institutional responses that would be required to deliver an optimal allocation between competing water demands—including those arising from activities related to tourism.

This report represents the final outputs from that project and is loosely arranged around the above aims. The report is divided into five additional chapters as follows:

Chapter 2: Background to Tourism Water Research

Chapter 3: Methodology for Developing a Research Agenda

Chapter 4: Findings

Chapter 5: Research Priorities

Chapter 6: Concluding Remarks

Appendix A: Water and Ecosystem Services

Appendix B: Valuation Studies in the Murray-Darling Basin

Chapter 2

BACKGROUND TO TOURISM WATER RESEARCH

Tourism Versus Recreation

Earlier it was noted that defining the tourism sector is a challenge in its own right and these difficulties come to the fore when considering the relationship between tourism and fresh water. According to the Australian Bureau of Statistics (ABS) (2009), tourism is defined according to the status of the customer rather than the nature of the goods and services produced. For instance, the purchase of a meal at a restaurant is only included as tourism expenditure if the patron is not a local resident. In essence, tourism is an activity undertaken by individuals in pursuit of certain outcomes (relaxation, adventure, socialising etc.) but those individuals must be sufficiently removed from their local domain to be classified as tourists.

One of the problems with focusing solely on the tourism dimension of water is that it runs the risk of substantially ignoring complementary activities that constitute recreation rather than tourism per se. It is also likely that the value of recreational activity is not easily distinguished from tourist activity in many cases. Take the case of a group of anglers fishing a waterway or stream. Invariably some of these anglers will have travelled beyond their domicile boundaries to undertake the activity while others may be locally based. Unless a valuation methodology like **travel cost method** is used to value this activity it may not be feasible to disaggregate local demand from tourist demand. Furthermore, disaggregation may serve no useful purpose if the intent is to gain an understanding of the total value of the experience for anglers. Similar arguments can be mounted for a range of water-based or water-related activities and in that context the notion of 'visitation' may be more usefully employed.

A particularly glaring example of this dilemma relates to the 'closure' of water catchments located close to major centres of population. As noted in the STCRC brief, much recreation and tourism demand arises in peri-urban areas. Not surprisingly then there is, at times, non-trivial conflict between the use of these areas for recreational/tourism pursuits and their status as 'protected areas' for the preservation of water quality. In order to fully appreciate the magnitude of this trade-off it would be important to consider the demands of recreation (i.e. individuals located relatively close to the area) and tourists (those individuals more removed) collectively, by regarding all such activities as 'visitation' and relevant to this investigation. To ignore one of these groups in the process of developing the research agenda would seriously impact on the usefulness of this work. In that regard, this report does not deliberately delineate between the recreation and tourism interests in water.

Production relationships

The project sought initially to survey the theoretical and empirical approaches that have previously been employed to define the water/tourism production function. The logic of this approach was twofold.

- In order to influence policy outcomes in favour of the industry it is necessary to understand the relationships between value generated by tourism/recreation and water inputs. This relationship is what economists commonly refer to as a production function.
- Almost all other sectors that have gained demonstrable influence over water policy have used the production relationship approach to good effect. For instance, agricultural interests have been able to demonstrate the impact on irrigation outputs and then apply standard input/output models to illustrate community impacts (Horridge, Madden and Wittwer 2005). Similarly, environmental interests are now actively involved in a similar debate—illustrating the 'productive' impacts on ecosystems of particular water management regimes (MDBA 2009).

To further understand the rationale of this approach it is helpful to briefly consider the work of Smith (1994) where water is conceptualised as a primary input used in the production of intermediate inputs (facilities) that are, in turn, used to generate intermediate outputs (services) and final outputs (experiences). A schematic of Smith's (1994) framework and some illustrative examples pertinent to this project are provided in Table 2.

Table 2: The tourism production function and pertinent examples

Primary inputs (resources) →	**Intermediate inputs (facilities) →**	**Intermediate outputs (services) →**	**Final outputs (experiences)**
Water	Swimming pools	Instructions	Education
Water	Boats	Boating	Relaxation
Water	Parks	Tours	Memories
Water	Resorts	Conventions	Social contact

Source: Adapted from Smith 1994

Clearly, tourism constitutes multiple outputs and examination of Table 2 shows that water can underpin the production of intermediate inputs, intermediate outputs and final outputs. It is also important to appreciate that tourism/recreation demands on water for the production of different outputs are not always complementary. For example, tourism centred on the consumption of irrigated wine (where water is required in the summer months) is likely to be at odds with fishing of inland waterways (where fish species are more populous if flows are concentrated in winter/spring). This has important implications for the manner in which the collective voice of tourism/recreation might be heard in policy circles (discussed later).

While the framework of Smith (1994) provides a useful starting point for thinking about water and tourism/recreation outputs it suffers from several deficiencies. Amongst these, water is not always strictly a private good when used as an input in tourism/recreation. For instance, a bushwalk in a public space might be enhanced by the presence of a pristine waterway or stream[1]. To understand the impact of water on this 'output' there is a necessity to be able to value the output itself (which may occur in a non-market space) and measure the marginal contribution of the water (which may itself be un-priced) in that setting.

Marcoullier (1998) makes some general progress on this front by considering the role of natural resources, such as water, as latent primary factors of production in tourism. One of the difficulties with Marcoullier's (1998) approach is that it considers the private and public good dimensions of resource management as being at odds. Thus, as the private good components expand, the public good components contract. However, with water, complex feedback loops exist between private and public good components especially in the context of recreation and tourism.

These complexities probably explain why relatively little theoretical or empirical work has been undertaken to expand on all components of Smith's (1994) tourism production function framework, particularly in the context of water. Rather, ad hoc studies have been undertaken that shed some light on components of these relationships, particularly the link between the quantity of water at a particular point in space and time and the value that users place upon it in that context. International examples of this type of work are relatively common. For instance, Laitila and Paulrud (2008) recently analysed the relationship between the removal of a dam in order to restore 'natural' water flows and the willingness of Swedish anglers to pay for this change to occur.

In the United States, heightened concern over recreation and tourism has driven environmental regulation and legislation to protect habitat (Douglas and Johnson 2004), and the value of the water resource for tourism and recreation has assumed a prominent role in the protracted resource allocation disputes that have occurred since the early nineties. For example, a study conducted in Washington investigated the impact of dam breeching to protect salmon and noted several complementarities between tourism, recreation and environmental benefits (McKean, Johnson, Taylor and Johnson 2005)[2].

Studies of this form are less common in an Australian context. However, Crase and Gillespie (2008) report the results of an empirical analysis that contrasts different water levels with recreational visits and expenditure at Lake Hume, situated at the headwater of the River Murray. Other emerging approaches include the use of **hedonic pricing** to tackle the relationship between recreational green space and the value of housing infrastructure. Hatton MacDonald and others in CSIRO are leading this work. Similarly, Brennan, Tapsuwan and Ingram (2007) used a production function for turf to estimate the financial imposts of water restrictions for the population at large, and this approach could be easily modified to focus directly on the impact on tourism assets.

[1] It is worth noting that the tourism/recreation experience might also be negatively impacted; say if the water is polluted or harbours annoying, dangerous or poisonous species of wildlife.

[2] Using the travel cost method, they calculated the willingness to pay for current non-angling recreation uses.

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Whilst the setting of these types of studies is of more relevance, again it is clear that the extant literature provides only a partial coverage of the role of water in the various tourism contexts.

Valuation

We argue that the ability to make rational decisions about the development, allocation and use of water resources requires, as a minimum, an understanding of differing production relationships. However, to generate these production functions and to employ them in a meaningful sense, it is also vital to have some way to measure the economic value of water in its alternative uses (Ward and Michelson p. 442). From an agricultural perspective this can be achieved by reference to water markets (at least since the mid–1990s) or product markets but this approach has some serious limitations, particularly for other sectors. First, the water markets in Australia fall well short of the competitive model to which neo-classical economists defer. The insistence by state governments that water exports be capped from communal irrigation districts is a case in point. Second, not all water users are equipped to bid in the water market. For instance, a heterogeneous sector like tourism is not always able to coordinate in a manner that would allow it to express its values through the water market. Third (and perhaps most significantly in the context of water), water markets in this country have been created almost exclusively around volumetric property rights. And yet volumes can be largely meaningless for tourism/recreation interests who may have more interest in flow, or the timing of flows.

As a result decisions about the allocation of the water resource typically fall in the political realm. Moreover, despite the existence of several well-established empirical methods to calculate the value of water in different contexts[3], these have been seldom employed to establish the value of water for tourism. Accordingly, the Australian policy maker is not well placed to meet Ward and Michelsen's (2002, p.423) imperative to develop '… conceptually correct and empirically accurate' estimates of value for water to facilitate '… rational allocation of scarce water across locations, uses, users and time periods'.

Water is an integral part of the ecosystem, a natural resource and a social and economic good. These elements render the valuation of the water resource a complex task, particularly given the multiple dimensions of water as a resource. Quantity is the simplest and most frequently used metric in any estimation of water value, but there are other aspects to consider in a valuation exercise. High quality water is critical for most uses, but particularly for domestic use, and for the industrial and recreation sectors. In agriculture the value of water for irrigation is partly dependent on salinity levels, but the sheer availability of water is usually the focus for most studies on irrigation. Return flows from an irrigation system may also degrade the resource and impact on the cost of supply and its environmental, social and cultural value (p. 429). Nevertheless, despite its importance, estimates of water value seldom take into account the quality of the water.

Timing is also a key element. For example, the efficacy of environmental flows depends as much on timing as it does on quantity (see, for example, Hillman 2008). Irrigation is most valuable when applied according to the critical phases of plant growth, typically in the hottest and driest months. Full reservoirs are of little use to water skiers in the dead of winter. The building of dams represents an attempt to capture enhanced benefits in time from a given quantity of water (Ward and Michelson 2002). Related to this is the concept of location utility (or benefit) which is enhanced through the building of irrigation systems that ensure flows of water where it is deemed most in need. Accordingly, water values vary widely across geographical areas and the cost of transferring water from one location to another must also be accounted for.

To further complicate the valuation exercise, whereas other natural resources, once used, are usually depleted and therefore not available for consumption by others, the use of water in one context does not necessarily preclude its use further downstream. Hydrological relationships between surface and groundwater make accounting for the water cycle fraught with difficulty and the physical interdependence among users complicates evaluations of the benefits and costs of any program that changes use patterns. In particular, policy makers require information about the reuse potential particularly where water rights are transferred, as this is likely to be attended by third party effects that are usually unanticipated.

In this context it is useful to categorise water uses as 'consumptive' which removes water from the current hydrological cycle and 'non-consumptive' which returns the water for potential reuse. Water also has 'non-use values'. Non-use values or existence values are benefits that are derived from contemplation of its existence. Despite the fact that one person's diversion of water does not necessarily preclude another's use of the resource in another time and/or place, allocating water to one user also has the potential to adversely impact upon the

[3] Prominent examples include contingent valuation, the travel cost method and hedonic pricing.

quality, timing, reliability and location of supplies for other uses. Some water uses are also likely to be complementary, for example hydroelectricity and some forms of recreation. The challenge is to assemble sufficient information to ensure that all material interests in water are included in the allocation decision, or have in place institutions that allow those interests to be willingly expressed.

Potable water and tourism

The literature on the production nexus between fresh water and tourism/recreation is patchy. Much is site specific and often ignores important feedback loops and/or the nuances of hydrology. The studies described above show a predilection to focus on the non-consumptive relationship between recreation/tourism and water. Here water acts as a complement to a recreation or tourism activity either via underpinning the activity itself (e.g. rafting/houseboats) or indirectly because of the ecosystem services that it provides which in turn add to overall recreational/tourism outcomes (e.g. bush walking in the presence of streams/lakes).

Another important dimension relates to the consumptive relationships between recreation/tourism and water[4]. In this regard it is worth noting that the water-using behaviour of tourists has significant infrastructure and planning implications. This has manifest in a number of administrative and policy responses, primarily aimed at influencing the behaviour of tourists (see Figure 1, for example).

Figure 1: An example of the response to concerns regarding water-using behaviours of tourists

Internationally, these concerns have garnered a response from the research community, with most studies showing that per capita water use by tourists far exceeds that of local residents (see, for instance, Narasaiah 2005; De Stefano 2004). Oddly enough, however, a similar level of research enthusiasm is not evident in this field in Australia. This is peculiar insomuch as the hydrological variability of this country implies even greater need for understanding on this front. Some preliminary work is being undertaken in this area in Australia (see, for instance, Lehmann 2009) although there would appear to be considerable scope for more research.

At an aggregate level, the behaviour of tourists has implications for the adequacy of the resource and for the infrastructure required to deliver water and wastewater services. In this respect engineering and planning disciplines have contributions to make and some local research has occurred, primarily in the context of locations where connection to large-scale reticulation schemes is not feasible. For instance, Kavanagh (2003) surveyed the water and wastewater activities across resorts not connected to mains water/wastewater in New South Wales and Queensland and found that less than 50 percent pursued best practice. Recent work involving the Ningaloo Coast is also a salient example. Nevertheless, the literature is far from comprehensive and very little work is available on the institutional dimensions of these problems.

Some examples of institutional and policy work can be found within the agencies and regulators concerns with water and wastewater supply (see, for example Westernport Water 2009), but little of this is founded on

[4] These two distinctions are not strictly enforceable. As noted later, the way potable water sources are managed (for consumptive purposes) has implications for the non-consumptive recreational uses of water in water supply catchments.

theoretical or rigorous empirical study. The upshot is that the pragmatic approach to issues like water pricing are not always aligned with other policy goals or the findings of research into pricing structures and tariffs (see, for instance, Crase, O'Keefe & Dollery 2008). For instance it is common practice in popular seasonal locations to place a greater emphasis on the fixed charges for water and wastewater services. This provides a degree of revenue surety to meet peak demands during any influx of tourists. The corollary of this is that the price signal to those using water is relatively mute, a problem that is now being addressed in most 'conventional' price reviews, albeit at the risk of greater revenue variability for water utilities (see, for instance ESC 2009).

A final dimension of the potable water tourism/recreation interaction pertains to access to urban water supply catchments. In essence, this issue hinges on the perceived rivalry between access to water bodies for recreation/tourism and 'protecting' the suitability of that water for potable consumption. Substantial interest in this topic can be found in Western Australia, although the perceived conflict also underpins policy in eastern states. Melbourne's water catchments are essentially 'closed' for recreation and tourism, for example.

Illustrative of the research in this area is the work commissioned by the Department of Conservation and Environment and the Department of Sport and Recreation in Western Australia (Hughes, Zulfa and Carlsen 2008). Here the authors point to a range of institutional difficulties in managing access and policies and procedures founded on poor empirical evidence. For instance, the author's contentiously note that 'there is no published evidence linking recreational land use […] to negative impacts on downstream drinking water supply quality' (Hughes, Zulfa and Carlsen 2008, p. ii). Clearly, this is at odds with the blanket ban on recreational access to these sites. The exclusion of recreators has serious social and economic implications and the penchant for water planners to apparently ignore these factors raises interesting questions about institutional history and its influence over the policy status quo. Understanding and resolving these anomalies has important research implications.

Summary of Major Water/Tourism Research Issues

- The interests of recreation and tourism are best considered jointly as 'visitation' in the context of water since the value of a bifurcation along these lines is limited.
- Most research in other sectors has led to a clearer understanding of the relationship between water and the economic value generated by those sectors.
- No similar, comprehensive body of work is available for the tourism/recreation sector to influence policy outcomes in a meaningful way.
- The paucity of research is explained in part, by the complexity of water as an input and the difficulties associated with measuring outputs from tourism and recreation.
- Work should be done on measuring both inputs and outputs.
- Analysis of conflicts and trade-offs of water use and access has centred mostly on agricultural and environmental interests and, to a lesser extent, the demands of urban and industrial water users.
- Substantial scope exists for broadening this to include the interests of recreation and tourism, although many of the existing institutions, like water markets, do not make this easy.
- Continued urban growth and the recreational demands of large cities seem likely to form a major point of friction and research is required to assist decision makers.

Chapter 3

METHODOLOGY

The project broadly adopted an iterative process involving a literature search on the academic front and subsequent testing of ideas and themes with industry practitioners. This process was intended to lead to a progressive refinement of research themes and to give some indication to their relative importance to the sector at large.

As should be apparent from the earlier discussion, the initial starting point was the extant literature dealing with water as an input especially in an Australian context. The outcomes from this review were then to be simplified and assembled for the consideration of the team of industry experts. This was to be undertaken in a workshop forum using a semi-structured format.

Stage 1: Understanding Water as an Input in Tourism Production

Initially, the literature review was conceptualised as addressing a number of specific areas. Namely:

- water as an input in the production of nature tourism
- water as an input in the production of agricultural/farm tourism
- water as an input in the production of recreation
- water as an input in the production of recreational infrastructure (e.g. golf courses, swimming pools and the like)
- water as an input in the production of tourism infrastructure (e.g. vacation housing, holiday resorts and the like).

The purpose of the literature mapping in this form was to systematically assemble the existing work that covered theoretical and empirical components in the five areas of interest, listed above. This was to include studies undertaken in similar and related fields both in Australia and abroad.

In order to ensure that the resulting research agenda was grounded in the genuine concerns of the tourism industry, the stakeholder reference group was then asked to reflect on the findings from the literature review. More specifically, the group was asked to:

- review the mapping for comprehensiveness
- provide input on the geographic priorities for project
- prioritise the overall research agenda emerging from the mapping exercise.

Stage 2: Catalogue and Prioritise Modelling Approaches that Allow for Co-production and Rivalry between Sectors

A preliminary review of the existing research on water and tourism revealed two main deficiencies: a lack of understanding of the role played by water in different tourism settings, and a lack of robust modelling techniques that would permit tourists' demands for water to be incorporated into ex-ante models of water allocation. Stage 1 was intended to deal with the first of these matters insomuch as it was expected that this would highlight where work needed to be done and assign priorities within the research agenda.

The purpose of the second stage was to address the latter weakness. This required a review of alternative modelling approaches used in different sectors with the aim of identifying an appropriate technique capable of forecasting the benefits of redistributing water between sub-sectors of the tourism industry. An appropriate model was also likely to be suited to comparing the impacts of different water allocation scenarios on different sectors and incorporating the stock and flow components of water resources. For instance, it should be possible to model the relative benefits of retaining surface water in storage for particular recreational users and then contrast this with the benefits of flows for other recreational users, ecological outputs and irrigation.

Research Agenda

Of particular interest in this context are matters relating to:

- the relative economic contribution of tourism, agriculture, manufacturing and mining
- the economic and social values of tourism and of water itself
- amenity values of unconstrained water availability
- the effectiveness of water use between tourism sub-sectors.

As with stage 1, it was considered important to gain an industry perspective on the information generated from stage 2. Accordingly, a reference group meeting was anticipated to deliver some surety about:

- the comprehensiveness of the work
- priorities that deliver greatest relevance and usefulness to the industry.

Stage 3: Testing and Building Policy Responses and Institutions

Decisions about water are heavily influenced by political economy considerations. In that regard it was considered important that the emerging research agenda be grounded in an understanding of the political economy that circumscribes decision making. This stage of the project would thus allow some assessment of the extent to which the existing policy framework falls short of the optimal allocation **inclusive of the needs of tourism.**

The goal of this stage was to identify where existing policy instruments would suffice to meet the needs of tourism and to establish which policies and institutions required reform. Therefore the output from this stage was expected to generate an understanding of policies that fell into two main groups: those that can be adequately employed by the tourism sector in their current guise, and; those that require modification via the political process.

Again, and in keeping with the industry focus of this work, input from an industry expert group was expected to be useful in honing the research topics and themes.

Chapter 4

FINDINGS

Stage 1

Two broad gaps were consistently cited from the literature and persistently resonated with industry stakeholders. These comprise of:

1. The lack of technical information that maps the relationship between the various dimensions of water and the components of tourism and recreation.
2. The paucity of institutional and policy knowledge that can be harnessed to make the most of the technical data (were it available in the first instance).

Within this broad framework several important observations were made during the first workshop about the research area and its context. These included:

- The hydrological resources of the Australian landscape vary markedly such that it is not feasible to offer a single response to the water demands of the tourism sector at a national level.
- The tourism industry is itself diverse and the sub-sectors do not automatically assume the same water demands. Accordingly, there needs to be some means of bringing these competing elements into a single message if there is to be a shift in the policy environment.
- The industry with the strongest claim on national water resources (agriculture) also exhibits marked within-sector variations. Notwithstanding these differences, the agricultural lobby appears to have achieved a generally consistent response to policy makers which has arguably resulted in a policy outcome that favours this group.
- The distinction between recreation and tourism is not always conducive to achieving a policy change in favour of the tourism industry. Many of the water demands for recreation are synergistic with the demands of tourism, although this is not always the case.
- There was a consensus that the views and concerns of the tourism/recreation sector have not been overtly considered in the formulation of water policy, particularly as the resource has become increasingly scarce.

Using the two research gaps (described above) as a starting point, the following questions emerged as potentially important research themes during the initial workshop.

1. The lack of technical information that maps the relationship between the various dimensions of water and the components of tourism and recreation:
    - What are the water demands for different forms of recreation and tourism?
    - To what extent do these compete with each other?
    - To what extent do these complement each other?
    - To what extent do these demands compete with those of other sectors or users?
    - To what extent do these demands complement other sectors or users?
    - How do we value water in its application to various tourism/recreation settings?
    - What is/are the value(s) associated with the various relationships?
    - How might we model potential trade-offs within the tourism/recreation sector?
    - How might we model the trade-offs between tourism/recreation and other sectors?
    - Are there water quality dimensions that need to be accounted for, including the impacts of tourism/recreation on water quality and vice versa?
    - If so, how is water quality to be measured/valued in this context?
    - How do ecosystem services specifically interact with tourism/recreation and, in turn, with human health/well-being?
    - What are the specific values of water access from a tourism/recreational perspective?
    - How do we enumerate these values?
    - What are the unique water using behaviours of recreation and tourism?
    - How are these behaviours shaped and modified?
    - How are the demands on water and water infrastructure presently managed in the context of tourism and recreation?

Research Agenda

- Given the knowledge of production relationships, values and behaviours, are there alternative mechanisms for dealing with demands on water and water infrastructure?
- How does scale impact on the various relationships between water and recreation/tourism?
- Is it possible to develop predictive models to deal with these complexities at a scale that is meaningful?

2. Paucity of institutional and policy knowledge that can be harnessed to make the most of the technical data (were it available in the first instance):
    - What are the preferred institutional arrangements that could harness tourism/recreational water interests as a cohesive 'sectoral' voice?
    - What techniques are available to assist in the development of a consensus view amongst recreation/tourism interests?
    - What lessons are there from other sectors regarding the effective shaping of water policy and public policy generally?
    - What is the preferred operational model for managing the knowledge generation and knowledge brokering processes?
    - Given the existing forces at work within the water debate (e.g. increasing role of federal government, existing allocation of water rights and activation of water markets) what is the optimal organisational structure for delivering preferred policy outcomes for tourism/recreation?
    - At an operational level, what strategies are available to deal with water scarcity and for converting relative scarcities into a market advantage?

Notwithstanding the grouping of these questions under two main themes, there was a view amongst the industry participants that a sharper research focus was required than that which would result from dealing with each of these questions separately.

Stages 2 and 3

In order to better clarify these questions, and in the hope of consolidating them into a single agenda, a decision was taken to combine the second and third stages of the project and to invest greater effort by the research team into more detailed investigation of explicit themes. This was a specific response to the suggestion from the industry reference group that a narrower range of core topics was required.

The reference panel also expressed the view that a synthesis of modelling activities, as originally proposed, would not yield the types of information most valuable to industry. Rather, it was seen as the role of the researcher to determine the relative merits of differing modelling approaches to answer core questions. Greater effort was therefore required to identify the core questions and topic areas without being constrained by existing modelling approaches applied in other contexts.

In this regard the research team and the industry reference group undertook to identify a series of topics that could be used to develop formative scoping papers. These would then form the basis of focused discussions at a final workshop. The topics were identified by interaction with the reference group and follow-up email and phone communications. The outline papers themselves were then assigned to the members of the research team.

These papers did not attempt to cover all dimensions of the above questions. They were also not intended to be comprehensive and discrete pieces of research. Rather, the aim was to use the papers as a vehicle for informing future researchers and to highlight the types of work that is urgently required.

The topics that were ultimately settled upon as a result of the initial workshop fell into four groups. The title of each is provided below along with a brief summary of the discussion that ensued:

Access to inland water for tourism and recreation: where complementarities, conflicts and trade-offs exist for ecosystem health and human well-being

In managing Australia's water resources, emphasis has been placed on securing drinking water and water for primary industry. With extended drought conditions affecting many areas of Australia, social and cultural values associated with water are receiving more attention. Management of diminishing water allocation and access is generating new models of collaboration.

The aesthetic and functional appeal of water-based tourism and recreation is well recognised. Distinction is made between water-dependent activities such as sailing, fishing, swimming or water skiing and water-enhanced activities where the experience of bushwalking, camping, sightseeing or picnicking may be heightened by views of water. Tourism facilities with views of rivers and lakes are often cited as preferred environmental settings and are extremely popular landscape and cultural tourism destinations.

This topic covers several critical issues relating to water allocation, and access (or restriction of access) to inland freshwater systems for tourism and recreation. The topic also touches on the link between tourism, ecosystem services and human well-being; the concept of trade-offs to achieve optimal outcomes; and an analytical framework to assess complementary or conflicting situations relevant for water-based tourism and recreation. The framework includes evaluation of:

- aquatic ecosystem features that have appeal for visitors;
- the ecosystem service(s) relevant for that visitation;
- the processes that change ecosystem features (by compromising the ecosystem service);
- the relationships between visitor experience and changes in aquatic ecosystem feature; and
- the trade-off(s) made when ecosystem services relevant for visitation are compromised.

To better guide the discussion around this topic the relationship between aquatic features, ecosystem services and the process that modify those services require mapping. This could then lead to a greater understanding of the relationship between visitor experiences and changes to the aquatic feature and (where any compromise is by choice) provide some indication of the trade-offs embodied in a decision. A draft table indicating the range of relationships that could be covered as part of this research agenda appears as Appendix A.

The 'value' of tourism and recreation: challenges in articulating a cohesive message

In the water policy debate, has the value of tourism relative to irrigated agriculture been overlooked? Is it possible that tourism values could be as large as (or even larger than) irrigated agriculture? Evidence from fisheries and forestry suggest that non-market values can be larger than the commercial fishery or timber production values. However, at the outset, this research problem is plagued by problems in definition.

The research problem, though stated simply, is not straight-forward. A few immediate questions spring to mind. What is value? What are we valuing? Where do tourism benefits start and stop? Should the 'value' of tourism and recreation be more than a strict financial aggregation of expenditure? On the surface, there would seem to be value in an afternoon of fishing or the value associated with time spent in a winery overlooking a wetland watching birds. For each of these activities, for the individual engaged, the overall benefits should exceed the financial sum of expenditures. If this is the case, economics has developed a whole set of tools which can elicit and unpack these values.

Again, to give some notion of the scope of this topic summary data have been assembled in tabular form and appear as Appendix B. In this instance, the table provides a review of the types of valuation studies undertaken in the Murray-Darling Basin to give some indicative values and to prompt deployment of empirical techniques in other water-relevant contexts.

Political and institutional dimensions to tourism water research

As noted earlier, one of the substantive challenges for the tourism sector is harnessing the assembled knowledge (and the emerging knowledge) in a manner that can then optimize its use. This raises important questions about the role of science and its relationships with the polity generally and thus a sub-theme of the research agenda emerges. In addition, two sub-themes emerge around organisational cooperation within the sector generally and the role of property rights and markets. Each of these is described below:

Science, policy and knowledge: is there a better way for tourism?

The management of Australia's mature water economy is inextricably linked to scientific and technical knowledge. Much of this information is derived from predictive computer models. Our reliance on this purpose-built knowledge is taken so for-granted that the way it is generated rarely attracts attention. And yet, knowledge-making is contested terrain. This messiness is obscured behind rhetorical representations of the separation of facts from values (Jasanoff, 1987; 1990). Research from the field of Science and Technology Studies (STS) has demonstrated that such representations are tenuous and difficult to defend (Jasanoff, 1987, 1990; Irwin and Wynne, 1996). This sub-theme should be used to examine how a range of analytical tools from STS might be utilised (Jasanoff, 2004; Cash, 2001; Cash, Clark, Alcock and Dickson 2003; Cash, Borck and Patt 2006) by the tourism and recreation sector. Questions to be addressed are:

- How could the tourism and recreation sector reconceptualise, renegotiate and redraw the existing knowledge/policy boundaries in terms of water policy?
- What knowledge would need to be constructed to harness the complementarities this sector has with other water uses and users and potentially resolve conflicts arising from partial complementarities?

Collaborating and coordinating disparate interests: lessons from water trusts

In the context of extreme variability of water supplies, the definition, monitoring and enforcement of water rights becomes crucially important. Water rights facilitate the efficient use of water and its ongoing transfer to more highly valued uses, and assist in achieving a balance between economic, social and environmental interests. In both Australia and the United States the environmental movement and the broader move to a service economy has redirected conservation goals toward recreation and ecosystem protection and has led to recognition of the importance of in-stream flows (King 2004; Grafton, Landry, Libecap & O'Brien 2009). These developments have meant that attention has increasingly turned to more market based strategies in pursuit of environmental outcomes. One result has been the development of alliances between environmental and recreation interests which express their preferences for increased in-stream flows through water market transactions (i.e. water trusts).

In this research sub-theme, the question is posed as to whether the Australian recreation sector might benefit from the adoption of similar institutional arrangements.

Property rights and how they shape the involvement in the water market

Under this sub-theme interest centres on the initial specification of water rights in volumetric terms and how this subtly influences the market power of participants. This sub-theme lends itself to a consideration of the detail of property rights in water and allows for greater attention to the Coasian solutions for resolving resource competition and trade-offs. The manner in which rights are specified has non-trivial implications for the operation of water markets, especially for environmental and recreational interests. This is not to argue against the use of markets but rather the ambition is to encourage a more thoughtful debate about property rights in water in order to allow a broader set of interests to influence market outcomes.

At a practical level research on this front provides a vehicle for contemplating alternative rights arrangements that emphasise the timing of flow between points of regulation. This alternative might then underpin speculation about the outcome from institutional changes offered in previous sub- theme.

The importance of case analyses

The final research theme derives from the preliminary observations that 'the hydrological resources of the Australian landscape vary markedly such that it is not feasible to offer a single response to the water demands of the tourism sector at a national level'. The industry reference group was strongly of the view that a range of case analyses needed to be undertaken to capture the variability of natural conditions in this country. These analyses were well placed to highlight the advantages likely to be bestowed on those industries more adaptable to fluctuating water availability.

This 'boom and bust' character of the Australian water landscape was viewed as epitomising the future of successful tourism and recreational ventures, and even providing a useful analogy of how these ventures must adapt. In this context the successful business generated by the filling of Lake Eyre and the growth of trailer boating as 'boaties' abandon fixed infrastructure in search of more plentiful water supplies were illustrative of the breadth of this 'flexible' phenomena. In simple terms case analyses provide a powerful demonstration of the effectiveness of tourism and recreation that is in synch with natural water availability and should form an important part of the research agenda.

Notwithstanding the value of case analysis in its own right, it was also recommended that case selection be undertaken in a manner that considers the other main themes. For example, it may be feasible to use case sites that provide valuable insights about the local variability of water supply but also highlight institutional nuances that are important to tourism or provide useful data on the value of an activity.

Unresolved matters

Whilst the agreed research themes/topics provide a useful grounding for the development of the research agenda, it is far from comprehensive. The specific interests of the constituents of the industry reference group and the expertise of the research team also arguably shape the topics.

At the conclusion of the final workshop members of the reference groups expressed their broad satisfaction with the outcome, although there was consensus that more needed to be done in the area of human behaviour, water and tourism. This is discussed in greater detail in the following chapter.

Chapter 5

A PRIORITISED RESEARCH AGENDA

Effort was made to use the reference group to assign priorities between the four main themes described in the previous chapter. However, the overriding view was that no particular theme was of more significance than the others and, since the research agenda was not considered sequential or linear, attention could be devoted simultaneously to each theme.

One important caveat pertains to this. The sub-theme '*Science, policy and knowledge: is there a better way for tourism?*' offers considerable promise for re-conceptualising the way research itself is undertaken and therefore involves scrutinising the way priorities for research are established. Were this theme given initial support, it may yield useful findings that could provide the tourism sector with a competitive advantage in the research stakes. The corollary of this is that the research sub-theme itself is complex and gaining support from the industry generally for a program of research in this domain may prove problematic.

In light of the view that the major research themes identified failed to adequately account for human behaviour elements that relate to water and tourism, this is discussed as a separate theme here.

Human behaviour, water and tourism

As noted in Chapter 2, the water-using behaviour of tourists has been shown to differ considerably from that of non-tourists. And yet little serious behavioural analysis has been undertaken in this context, especially in Australia (Lehmann 2009). Rather the focus has been primarily on finding pricing or engineering solutions that can cope with the 'peaky' demand that stems from an influx of tourists.

An important practical consideration is the operational demands that then flow to the management of all dimensions of the water cycle. For instance, increased water use is also usually associated with an increased requirement to treat wastewater. Failure to deal with this at an operational level can result in serious environmental harm and a loss of amenity in the destination. In some instances this can be complicated by the location of tourism and recreation destinations and their isolation from water and wastewater reticulation infrastructure.

STCRC has funded some work to consider the prospects of differing engineering technologies to deal with these concerns (see Kananagh 2002). However, this work needs to be considered in the context of broader water policy initiatives being undertaken by various jurisdictions. For instance, in Victoria, the Small Towns Water and Sewer Project is being used in some tourist destinations to expand and improve reticulation networks, and in an effort to identify alternative affordable technologies.

What is largely absent from this topic is analysis of the responsiveness of tourists and those involved in recreation to a range of triggers and incentives. For example, little is known about the impact of campaigns to encourage water-conserving behaviour while on holidays (e.g. see Figure 1). The price elasticity of demand is also not known for this group when it comes to water consumption. It may also be that destinations can use a water-conserving ethos as a draw-card but, again, little is known of the behavioural dimensions that would underpin the response.

Accreditation could play some part in addressing the information void and allow tourism/recreation customers to include the water-environmental nexus as part of their decision-making. However, work by STCRC shows that the level of understanding amongst consumers regarding 'green indices' is weak (Bergin-Seers and Mair 2008). Accordingly, some specific metric of water use may have limited influence over decision-making. In any case this is an area deserving of more research attention.

Finally, there is a need for this behavioural research to be integrated with water resource planning. Presently, demand is largely assumed and infrastructure designed to meet it. The feasibility of continuing in this mode is questionable and the types of research advocated above could substantially improve the outcome.

Chapter 6

CONCLUDING REMARKS

This report has traced the formulation of a research agenda to facilitate enhanced representation for the tourism and recreation sector in the contested arena of water policy. From the outset, examination of various policy initiatives revealed the virtual absence of these sectors at the policy table, notwithstanding the importance of water in both its consumptive and non-consumptive uses for the sector. Not surprisingly, this was attributed to the heterogeneity of the sector along with the complex sets of relationships that exist between the various uses and users of the water resource. Through a process that included extensive collaboration with industry experts, a thorough review of the extant literature, and the development of a series of indicative papers, several salient areas of research were identified. The research gaps fell into two broad categories. First, the lack of technical information that maps the relationship between the various dimensions of water and the components of tourism and recreation; and second, the paucity of institutional and policy knowledge that can be harnessed to make the most of the technical data (were it available in the first instance).

A series of papers was developed, grouped loosely under these two categories. This included:

- an exploration of the complementarities and conflicts between ecosystem services and human well-being;
- a survey of valuation techniques and findings in the context of tourism and recreation;
- an examination of alternative institutional and political models of engagement which touched on
    - the role to be played by science;
    - discussion of the potential for collaborative market based approaches to achieving improved policy outcomes for the sector, and
    - an analysis of the role of importance of the specification of property rights in securing particular outcomes.

Whilst these areas of research are by no means definitive, they provide a useful illustration of the types of research that may yield benefit for the sector.

The project has also revealed several additional areas of research that appear vital to an expanded understanding of the sector. In particular, the behavioural nuances of tourists and recreators—and more specifically, their potential responses to incentives—appears poorly understood. The behaviour of individuals in this context carries with it important implications for pricing, infrastructure planning and institutional decisions. A more general point relates to the degree of hydrological and contextual variability within Australia that would appear to indicate that a ‘one size fits all’ formula will be of limited use to the sector. Instead, an approach that gathers a series of case analyses might therefore provide a useful way forward.

It is clear that there is much fertile ground for future research efforts that will inform the sector in its endeavour to secure increased influence in the policy arena.

APPENDIX A: WATER AND ECOSYSTEM SERVICES

Table A1: Features associated with water and wetlands ecosystems likely to be of relevance for visitation, showing the ecosystem services that support, provide or emanate from them, the processes that compromise them, the way visitors might react to that compromise and where the compromise is by choice, the trade-offs that need to be made explicit. Parts of the table (processes that change the feature and visitor relationships) have been adapted from Hadwen, Arthington & Boonington (2008); ecosystem services after Ramsar Convention on Wetlands (2008).

Legend: S = Supporting; P = Provisional; R = Regulating; C = Cultural services

Aquatic ecosystem features (that have appeal for visitors)	Ecosystem service(s) relevant for visitation (and whether Supporting, Provisioning, Regulating or Cultural)	Processes that change the feature (compromise the service)	Relationships between visitor experience and changes in feature	Trade-off made when ecosystem service relevant for visitation is compromised
WATER				
Water quantity (availability of water — consumptive)	Drinking water for humans (P) Groundwater replenishment (R) Water for tourist services (P) Water sports (C)	Drought Over-extraction	Decrease in appeal, visitation/recreation opportunities. Insufficient water may make tourist facility unviable.	Go elsewhere (trading one tourist destination for another where process might be repeated)
Water clarity (clear water)	Water purification/waste treatment or dilution (R) Coastal shoreline and river bank stabilization and storm protection (R)	Sediment delivery —erosion from access points and trails. Catchment disturbance can increase DOC, nutrients	Decrease in aesthetic value and appeal. Potential for state change from clear macrophyte dominated to turbid plankton dominated.	Switching occurs among regulatory services
Water temperature (seasonal/aseasonal relevance)	Local climate regulation/ buffering of change (R)	Drought (loss of volume) Removal of riparian vegetation Removal of shade	If accompanied by nutrients—decrease in appeal, visitation/recreation opportunities. Increase in water temperatures may enhance appeal.	Redistribution of services: trading access (C) for water quality (R)
Water views	Drinking water for humans (P) Water for tourist services (P) Hydrological services (R) Flood control, flood storage (R) Aesthetic and 'sense of place' values (C)	Not enough water from drought and overextraction Too much water from upstream (where flood control/storage compromised)	Decrease in aesthetic value and appeal. Consequences might be to move infrastructure to where water view continues	Provisioning services have been enhanced at the expense of cultural services
Water quality (absence of odours)	Nutrient cycling (S) ***Soil, sediment and nutrient retention (R)*** Water purification/waste treatment or dilution (R)	Drought, exposure of previously anaerobic sediments. Eutrophication (nutrient delivery) Shoreline deposition of decaying algae/macrophytes	Negative—likely to lead to reduced visitation; certainly expect a reduced number of swimmers. Elevated perceptions of risk related to perceptions of ill-health.	Choices made to enhance cultural services at the expense of Supporting and regulating services
Absence of toxicants	Water purification/waste treatment or dilution (R) Maintenance of biogeochemical processes (R)	Discharge that over-rides assimilatory and regulatory capacities; change to biogeochemical processes that results in mobilisation of toxicants.	Negative if known or highlighted—likely to lead to reduced visitation; certainly expect a reduced number of swimmers.	Regulating services change in character, where particular ecosystem states are chosen over others.
BIODIVERSITY				
Absence of vector borne pathogens	Water purification/waste treatment or dilution (R) Biological control agents for pests/diseases (R) ***Soil, sediment and nutrient retention (R)*** Flood control, flood storage (R) Other hydrological services (R)	Trophic disruption (S):disruption or imbalance resulting in upsurge of vector numbers (including human or animal exposure). Emergent phenomenon possible due to new biological relationships, including new or chance human exposures.	Negative if known or highlighted—likely to lead to reduced visitation; certainly expect a reduced number of swimmers. May be event related—seasonal, aseasonal, catastrophic etc.	Regulating services diminished, where some supporting and provisioning services have been enhanced.

Aquatic ecosystem features (that have appeal for visitors)	**Ecosystem service(s) relevant for visitation (and whether Supporting, Provisioning, Regulating or Cultural)**	**Processes that change the feature (compromise the service)**	**Relationships between visitor experience and changes in feature**	**Trade-off made when ecosystem service relevant for visitation is compromised**
Absence of waterborne pathogens	Biological control agents for pests/diseases (R) ***Soil, sediment and nutrient retention (R)*** ***Maintenance of biogeochemical processes (R)***	Discharge that over-rides assimilatory and regulatory capacities and results in a biological response (including human or animal exposure).	Negative if known of highlighted—likely to lead to reduced visitation; certainly expect a reduced number of swimmers.	Regulating services diminished, where some supporting and provisioning services have been enhanced.
Emergent plants in water, over-hanging vegetation, riparian shade	***Soil, sediment and nutrient retention (R)*** ***Aesthetic and 'sense of place' values (C)***	Increased nutrient loads and changed flow regimes can influence aquatic macrophyte growth and abundance.	Visitors may respond positively to removal of aquatic plants, particularly if they want to partake in water-based activities. Bird watchers, recreational fishers may respond negatively to any loss of aquatic vegetation (habitat).	Multidirectional and context specific. Trade-offs occur between different non-consumptive uses of features.
Tree stumps in water (absence of)	Primary production (S) (nearby for 'large woody debris' [LWD]) Coastal shoreline and river bank stabilization and storm protection (R) Water sports (C) Aesthetic and 'sense of place' values (C)	Changes in riparian zone structure and function (and delivery of LWD). De-snagging activities by visitors or resource managers.	Visitors may respond positively to de-snagging activities, particularly if they want to partake in water-based activities. However, bird watchers and fishers may respond negatively to any loss of LWD and associated habitat.	To enhance cultural services means trading off supporting and regulating services, and perhaps even other cultural services.
Locally characteristic plants and animals	Primary production (S) Nutrient cycling (S) Biological products and resources, including genetic material (P) Aesthetic and 'sense of place' values (C) Nature study pursuits (C) Important knowledge systems, and importance for research (C)* Educational values (C) Cultural heritage (C)	Disturbances associated with overuse —too many visitors—can reduce species diversity. Disturbances can adversely influence the behaviour of animals; or result in introduction of weeds or other non-natives species.	Visitors are attracted to protected areas to experience native character of an area. Human-wildlife interactions can increase wildlife abundance (of some species) but decrease diversity. Relationships may be strongly seasonal.	Supporting and provisioning services are exchanged (by gradual erosion) for Cultural services. Arguably appropriate management might switch 'exchanged' to 'maintained'.
Recreational fishing (native species)	***Primary production (S)*** Species trophic interaction processes, including grazing, predation, competition (R) ***Recreational hunting and fishing (C)***	***Overfishing; Altered reproductive productivity; Species interactions (predation, competition, diseases); Changed aspects of dispersal.***	Enhanced visitation where fish stocks are present or sustained; or vice versa. Recreational fishing opportunities really only appeal to a sub-group of visitors and depend on demographics, provision of facilities may increase visitation levels or have no real change. Visitation likely to be event-related or seasonal. Fishing bans in some areas may significantly reduce visitor loads.	Overtaking means that cultural services are exchanged for supporting and regulating services.
Introduced fish	***Primary production (S)*** Species trophic interaction processes, including grazing, predation, competition (R) Biological control agents for pests/diseases (R) ***Recreational hunting and fishing (C)***	***Fishing opportunities may increase in some areas in response to fish stocking***	Interaction between introduced species and recreational taking. See above.	To enhance cultural services associated with fishing, means trading off supporting and regulating services, and perhaps even other cultural services. If species are introduced there is a trade off between the ability of native species to provide these services and the introduced species.

VISITOR FACILITIES				
Accessibility to water bodies (short and safe when desired)	Coastal shoreline and river bank stabilization and storm protection (R) Geomorphological (landform) processes (S)	Access can be facilitated through geomorphological modifications (rock, sediment, water, infrastructure like jetties, boardwalks). These disturbances change water sediment interactions and provide for intrusions of other organisms. Access point modifications and changing facilities can influence the use and loads at key sites.	Some visitors will respond positively to improved access; boating in particular. Site 'hardening' can reduce the potential impacts of visitor use on focal sites. Some visitors to protected areas prefer to visit relatively inaccessible sites, so changes in accessibility may detract from overall appeal. However, some visitors do not like hardening, as it detracts from their wilderness experience. Nevertheless, provision of boardwalks for bird watching uses etc is a very popular application of sustainable management. The higher the degree of disturbance (litter, water quality, etc.) the more likely visitors are to select alternate sites.	Increased visitor numbers can lead to a need to change accessibility (spatial and temporal) at key sites. Supporting and regulating services are exchanged for cultural services. 'Improved' access is traded-off against increased numbers of tourists (mainly swapping cultural services i.e. improved access to educational services might degrade spiritual or aesthetic values).
Other visitors	Contemporary cultural significance, including for arts and creative inspiration, and including existence values (C)	Antisocial behaviours can be created by the nature of surroundings and facilities, the clientele encouraged to the site, and/or lack of respect for other aquatic features.	Non-linear relationships. Negative – spatial use (and impacts) of key sites is likely to spread in response to increased visitor loads as some visitors try and get away from the crowds. Positive – social encounters as part of satisfying encounters; numbers attract to a certain point. Neutral - some visitors feel that visitor numbers make no difference.	Trade offs between access, demand, and increases in visitor numbers at key sites.
Land-based infrastructure	Coastal shoreline and river bank stabilization and storm protection (R) Geomorphological (landform) processes (S)	Landform features prone to erosion	Popular sites may provide more resources (toilets, showers, boardwalks, carparks etc). When visitors are involved in water-based activities, the provision of land based facilities can be quite important.	As for accessibility above.

Legend: S = Supporting; P = Provisional; R = Regulating; C = Cultural services

References: Hadwen, Arthington & Boonington (2008). *Detecting visitor impacts in and around aquatic ecosystems within protected areas*: Sustainable Tourism Cooperative Research Council. "Healthy Wetlands, Healthy People", Ramsar Convention on Wetlands (2008). Resolution X.15. Describing the ecological character of wetlands, and data needs and formats for core inventory: harmonised scientific and technical guidance.

APPENDIX B: VALUATION STUDIES IN THE MURRAY-DARLING BASIN

Table A2: Valuation studies in the Murray-Darling Basin

Legend: Non-market techniques include WTP = Willingness to pay; CV = Contingent valuation; CM = Choice modelling; TCM = Travel cost method

Asset	Attribute	Ecosystem services	Scenarios/study	Marginal value	Total financial value or aggregation value	Site	Method	Authors
WATER	WETLAND	Recreational value	Value that Victorians place on being able to currently use the Barmah wetland		From $5.8 million to $7.4 million (AUD 92)	Ramsar-listed Barmah forest on the River Murray, Victoria	CVM	Stone 1992
WATER	WETLAND	Recreational activities (land and river based)	Overall benefits of recreational use	from $22 to $37/ visitor (AUD 1988)	$1.1m/year (AUD 1988)	Ovens and King Basin	Travel Cost survey	Sinden 1988
WATER	WETLAND	Recreational activities (land and river based)	Overall benefits of recreational use	from $12 to $16/ visitor (AUD 1988)	From $455100 to $592000 /year (AUD 1988)	Ovens and King Basin	WTP	Sinden 1988
WATER	WETLAND	Aquatic and terrestrial habitat for biodiversity/sense of place for non aboriginal people	Total preservation value of Barmah to Victorian residents		From $70.7 million to $89.7 million (AUD 92)	Ramsar-listed Barmah forest on the River Murray, Victoria	CV	Stone 1992
WATER	WETLAND	Aquatic and terrestrial habitat for biodiversity/sense of place for non aboriginal people/sites of high aesthetical values/maintenance of population	Implicit marginal price of wetland/household	$0.04 per additional square km of wetland, $4.16 per additional endangered species present, and $21.82 per 1 year increase in frequency of waterbird breeding (AUD 1997)	No	Macquarie Marshes in Central-Western NSW	CM	Morrison, Bennett, and Blamey 1999
WATER	WETLAND	Aquatic and terrestrial habitat for biodiversity/sense of place for non aboriginal people/maintenance of population	Marginal implicit prices of the wetland and aggregation WTP to the community to move from BAU situation to water management plan	$11.39 per 1000 ha additional healthy wetlands and $ 0.55 per 1% increase additional native birds and $ 0.34 per 1% increase additional native fish (AUD 2000/household)	WTP to the community to achieve water management plan (2460 GL additional water to flood wetlands) for the wetland = $5.98 million	Murrumbidgee River Floodplain in South-Western New South Wales	CM	Whitten, and Bennett, 2001a

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Asset	Attribute	Ecosystem services	Scenarios/study	Marginal value	Total financial value or aggregation value	Site	Method	Authors
WATER	WETLAND	Aquatic and terrestrial habitat for biodiversity/ Sense of place for non aboriginal people/ maintenance of population	Marginal implicit prices of the wetland and aggregation WTP to the community to move from BAU situation to wetlands and remnants strategy	$ 4.81 per additional endangered species and $0.92 per 1000 ha Additional remnant area (AUD 2000/household)	WTP to the community to achieve wetlands and remnants strategy (increase of area of healthy wetland by 160% and increase of area of healthy remnants by 200%, increase in , 22 threatened species that benefits, duck hunted increase by 200%) = $18.8 million	Upper South-East Australia	CM	Whitten, and Bennett, 2001a
WATER	WETLAND	Prevention of damage due to environmental disturbance	Estimate of the median value for avoiding damage to Tilley Swamp and the Coorong	$40 AUD 1997/person (one-off payment)	Aggregation for the SA population = $10 million (AUD 1997)	The Coorong in the Upper South-East of South Australia	CM	Bennett, Blamey,and Morrison<, 1997
WATER	WETLAND	Prevention of damage due to environmental disturbance (from rising salinity)/sense of place for non aboriginal people	Implicit marginal price of wetland and extrapolated regional value of the wetland	$8.80 AUD 1999 per household	$163 200 (AUD 1999)	Lake Gol Gol and Gol Gol Swamp in New South Wales (near Mildura in north-western Victoria)	CM	Bennett, and Whitten, 2000.
WATER	WETLAND	Sites of high aesthetical value	Recreational values for two sites of high aesthetical values	$AUD 2007/adult/trip = $529 (Barmah forest)/$503 Coorong	$m AUD 2007/year = $13 (Barmah forest)/$57 (Coorong).	The Coorong and the Barmah forest	TCM, CVM	Dyack, Rolfe, Harvey, O'Connell and Abel 2007.
			recreational values for two sites of high aesthetical values according different scenarios of change in access to these sites	$AUD 2007/adul/trip for each 1% in access change = $3.21 (Barmah forest)/ $11.8 (Coorong)			CB	

Asset	Attribute	Ecosystem services	Scenarios/study	Marginal value	Total financial value or aggregation value	Site	Method	Authors
WATER	WETLAND	Water purification	Filtration value of natural temporal wetlands /ha/year (assuming that natural wetlands provide between 50 % and 90 % filtration values of constructed ones)	between $1180 to $12700 /ha/yr (AUD 2008)	No	Lower Murray dairy swamps in South Australia	avoided cost	Schmidt, 2008
WATER	WETLAND	Aquatic and terrestrial habitat for biodiversity/aense of place for non aboriginal people/aites of high aesthetical values/maintenance of population	Implicit marginal price of wetland/household	from cents 3.4 to cents 3.9 per additional square km of wetland, from $3.86 to $4.27 per additional endangered protected species present and from $9.81 to $24.15 for the increase of the frequency of waterbird breeding by a year (AUD 2002)	No	Macquarie Marshed, New South Wales, Gwydir wetland, New South Wales	CM, (benefit transfer)	Morisson, 2002
WATER	WETLAND	Aquatic and terrestrial habitat for biodiversity/ sense of place for non aboriginal people/sites of high aesthetical values	WTP estimates for improving uncleared land (wetland) for habitat	$1.36/household /1000ha /year for 5 years (AUD 2005)	Aggregated value across the south Australian population = $1634/1000 ha (AUD 2005)	Upper South-East of South Australia	CM	Hatton MacDonald, Morisson, 2005
WATER	FLOW REGIME	Food production	Unspecified change on water allocation of flow regime from irrigation to the environment.		Farm profit fall by $2.9m AUD 2004/year	Murrumbidgee catchment (NSW)	market based approach	Jayasuriya, R. 2004.
WATER	FLOW REGIME	Food production	Allocation of **500 GL of water** from irrigation to environmental, pro rata water acquisition and targeted water acquisition (no interregional trade)		Net profit impact fall by $61 (pro rata)m AUD 2007/year, $34 (targeted) m AUD/year	Murray River	avoided cost	Qureshi, Connor, Birby, and Mainuddin 2007.

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Asset	Attribute	Ecosystem services	Scenarios/study	Marginal value	Total financial value or aggregation value	Site	Method	Authors
		Fresh water for irrigation	Allocation of 500 GL of water from irrigation to environmental, pro rata water acquisition and targeted water acquisition (no interregional trade)	net irrigation profit impact ($ AUD 2007/ML) = $121 (pro rata), $68 (targeted)				
WATER	FLOW REGIME	Food production	Reduction of 750 GL on water available from irrigation to environmental flows, (intra regional trade)		Net Present Value fall by $72 m AUD 2003/year	South Murray Darling Basin (Victoria and New South Wales)	market based approach	Eigenraam, Crean, Wimalasuriya, Jayasuriya, 2003.
WATER	FLOW REGIME	Food production	Reduction of 1500 GL on water available from irrigation to environmental flows, (intra regional trade)		Net Present Value fall by $153 m AUD 2003/year	South Murray Darling Basin (Victoria and New South Wales)	market based approach	Eigenraam et al, 2003.
WATER	FLOW REGIME	Food production	Scenario of change in allocation of flow regime for irrigations		Irrigated Agriculture net income fall by$17.5 m AUD 2003/year.	The River Murray	?	MDBC 2006.
WATER	FLOW REGIME	Recreational activities (river based)	Market values of recreational activities along the Murray River.		$ AUD 2005 = $2.8 BILLON		Market based approach	Howard 2008
WATER	FLOW REGIME	Aquatic habitat for biodiversity (river red rum)	Allocation of **61 GL** of water from irrigation to environment in targeted or non targeted zones, hence change in land use. (time horizon of 30 years).	NPV ($AUD 2009/ML) = $500–$2.200	NPV ($m AUD2009) = from $31.6 to $139.1	Torrumbarry Irrigation Area, Victoria	Cost Benefit Analysis	Crossman, Connor, Bryan, Summers, Ginnivan 2009.
WATER	WATER QUALITY (salinity)	Food production	Assessment of change in management of salinity trough change of land use (100 years scenario)	salinity damage cost ($AUD 2001/ML of drainage) = from $10 to $1240	Cost of salinity in base line case (no management of salt) ($m 2000 NPV) = $485	South Murray Darling Basin (Victoria and New South Wales)	Cost - Benefit analysis/damage cost	Heaney, Beare and Bell, 2001.

Asset	Attribute	Ecosystem services	Scenarios/study	Marginal value	Total financial value or aggregation value	Site	Method	Authors
WATER	WATER QUALITY (salinity)	Drinking water	Assessment of change in management of salinity trough change of land use (100 years scenario)		Cost of salinity in base line case (no management of salt) ($m 2000 NPV) = $47	South Murray Darling Basin (Victoria and New South Wales)	Cost Benefit analysis/damage cost	Heaney, Beare and Bell, 2001.
WATER	WATER QUALITY (salinity)	Food production by irrigators/drinking water for urban and industries	Study of avoided treatment cost due to **reduction of salinity of 91 µS/cm** in 50 years	marginal function of cost avoided = constant up to 78 µS/cm at $2 million AUD/EC unit, increase up to $8 million AUD/EC unit for 160 78 µS/cm	($m AUD 2007) = $353	Lower Murray Darling Basin	Cost-Benefit analysis/avoided treatment costs	Connor, 2008
WATER	WATER QUALITY	Recreational activities (river based)	Survey to know how much household would be willing to pay to improve water quality (river length) for recreational activities	$AUD 2008/household/1% increase in river length = $2		Goulburn river (Victoria) ,	CM	Bennett, Dumsday, Gillespie 2008
WATER	WATER QUALITY	Recreational activities (river based)	Survey to know how much household would be willing to pay to improve water quality (river length) for recreational activities (swimming/fishing)	$AUD 2004/ % increase in river length = from $51 to $101		Bega river (New South Wales)	CM	Morrison and Bennett 2004
				$AUD 2004/ % increase in river length = from $47 to $73		Clarence River (New South Wales)		
				$AUD 2004/ % increase in river length = from $45 to $74		Georges River (New South Wales)		
				$AUD 2004/ % increase in river length = from $30 to $104		Gwydir River (NSW)		
				$AUD 2004/ % increase in river length = from $28 to $75		Murrumbidgee (New South Wales)		
WATER	WATER QUALITY	Sense of place for non aboriginal people	1% improvement healthy waterways	6.28 AUD 2005/household/yr in 15 yr time	No	Murray Darling Basin (Queensland, Toowoomba)	CM	Windle and Rolfe, 2006
WATER	WATER AVAILABLE (water use efficiency)	Fresh water for irrigation	Scenario of efficiency in water use, scenario of 5 %uniform improvement in water use		Benefit of change ($,000 NPV) = $1 800 - $97 000.	South Murray Darling Basin (Victoria and New South Wales)	Cost-Benefit analysis	Heaney, Beare and Bell, 2001.

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Asset	Attribute	Ecosystem services	Scenarios/study	Marginal value	Total financial value or aggregation value	Site	Method	Authors
WATER	WATER AVAILABLE	Fresh water for irrigation	Approximate prices of high security permanent water entitlements	in 2007–08 : from 1588 $/ML (Kiewa catchment) to 2512 $/ML (Murray SA catchment)		Southern MDB	Market prices	Kaczan and Connor, 2009
WATER	WATER AVAILABLE	Fresh water for irrigation	Water consumption in 2005/06 for irrigation in the MDB * water prices (approximate prices of high security permanent water entitlements) (mean of Murray NSW, Murray SA end Murray Victoria)	in 2005–06 : 1470$/ML on average	2005–2006 : $m 11 350 (7720 GL * 1470 $/ML)	MDB	Market prices	ABS, 08 Kaczan and Connor, 2009
WATER	WATER AVAILABLE (water use)	Food production	Increase in water use in wet year of 1500 GL (unconstrained scenario)		change in agricultural return ($m AUD 2007) = from $2340 to + $3800	Murray Darling Basin	?	Adamson, Mallawaarachchi, Quiggin 2007.
WATER	WATER AVAILABLE (water use)	Food production	Decrease in water use in dry year of 1250 GL (unconstrained scenario)		change in agricultural return ($m AUD 2007) = from $2340 to - $322	Murray Darling Basin	?	Adamson et al. 2007.
WATER	WATER AVAILABLE (and flow regime and connectivity)	Drinking water for urban use (people and industries)	In 2004–05: industries = 17 170 GL and household = 189 GL			Murray Darling Basin	Market prices	ABS, 08
LAND	SOIL QUALITY	Sense of place for non aboriginal people	1% improvement soil condition	4.02 AUD 2005/household/yr in 15 yr time	no	Murray Darling Basin (Queensland, Toowoomba)	CM	Windle and Rolfe, 2006
LAND	SOIL QUALITY	Maintenance of healthy and productive soils	Implicit marginal price of land condition	Benefit of producing land condition = 2.28$/ha (AUD 88)	no	Farm land market of Manilla Shire, New South Wales	Hedonic pricing	King, Sinden 1988
LAND	SOIL QUALITY	Maintenance of healthy and productive soils	Benefits and costs of revegetation for salinity over 30 years	Benefits of 11.93$/ha for the avoided land salinisation and 13.57$/ha for the reduced salt load (AUD 2004) and total benefits from$820 to $4460/ha and total costs from $4620 to 15100/ha (benefits cost ratio from 0.1 to 0.8)	no	Australia	Modelling review (van der Lely)	Hill, 2004

Asset	Attribute	Ecosystem services	Scenarios/study	Marginal value	Total financial value or aggregation value	Site	Method	Authors
LAND	SOIL QUALITY	Maintenance of healthy and productive soils	Gross benefit from ameliorating acidic soils (agricultural cost)		$m 263/year (AUD 2002)	MDB	Market prices	National Land and Water Resources audit, 2002
LAND	SOIL QUALITY	Maintenance of healthy and productive soils	Gross benefit from ameliorating sodic soils (agricultural cost)		$m 648/year (AUD 2002)	MDB	Market prices	National Land and Water Resources audit, 2002
LAND	SOIL QUALITY	Maintenance of healthy and productive soils	Gross benefit from ameliorating saline soils (agricultural cost)		$m 23/year (AUD 2002)	MDB	Market prices	National Land and Water Resources audit, 2002
LAND	LAND USE /LAND COVER	Food production	Change in land use for reallocation of **61 GL of water** from irrigation to environment. Targeted or non targeted water acquisition. (time horizon of 30 years)	NPV ($ AUD 2009/ha) = from $1.697 to $98.490	Increase in NPV from baseline scenario ($m AUD 2009) = $-68 (non-targeted)/$184.6 (targeted)	Torrumbarry Irrigation Area, Victoria	Cost Benefit Analysis	Crossman et al 2009.
LAND	LAND USE /LAND COVER	Carbon sequestration	change in land use for reallocation of **61 GL of water** from irrigation to environment. Targeted or non targeted water acquisition. (time horizon of 30 years)	NPV ($ AUD 2009/ha) = from $4.377 to $5.404	NPV ($m AUD 2009) = $0 (non targeted)/$76.6 (targeted)	Torrumbarry Irrigation Area, Victoria	Cost Benefit Analysis	Crossman et al 2009.
LAND	LAND USE /LAND COVER	Water purification (change of salinity)	Change in land use for reallocation of 31 GL of water from irrigation to environment. Valuation of avoided cost of remove salt from water. Targeted and non targeted water acquisition. (time horizon of 30 years)	PV ($AUD 2009/ML) = from $0 to $ 4.823	PV ($m AUD2009) = from $11.3 to $23 (non targeted)/from $27 to $53.5 (targeted).	Torrumbarry Irrigation Area, Victoria	Cost Benefit Analysis	Crossman et al 2009.

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Asset	Attribute	Ecosystem services	Scenarios/study	Marginal value	Total financial value or aggregation value	Site	Method	Authors
LAND	LAND USE /LAND COVER	Recreational activities (land based)	Change in land use (**reforestation**) for reallocation of **61 GL of water** from irrigation to the environment. Targeted and non targeted water acquisition. (time horizon of 30 years)	PV ($AUD 2009/ha) = from $96 to $ 642	PV ($m AUD2009) = $0 (non targeted)/from $1.5 to $10.2 (targeted)	Torrumbarry Irrigation Area, Victoria	Cost Benefit Analysis	Crossman et al 2009.
LAND	LAND USE /LAND COVER	Carbon sequestration	scenarios					Polagse, Paul, Hawkins, Siggins 2008
LAND	LAND USE /LAND COVER	Food production						Bryan, Marnavek, 2004
LAND	CROP AND LIVESTOCK	Food production	Gross value of non irrigated food production and irrigated food production		Non irrigated gross value in 2005/2006 = 10 351 millions $ (and 9308 m$ in 2000/01) Irrigated gross value in 2005/06 = 3779 m$ (and 3480 m$ in 2000/01)	MDB	Market prices	ABS, 2008
LAND	CROP AND LIVESTOCK	Fibre production	Non irrigated value of total **cotton** production and irrigated cotton production		Non irrigated gross value in 2005/2006 = 64 millions $ (and 79 m$ in 2000/01) Irrigated gross value in 2005/06 = 797 m$ (and 1105 m$ in 2000/01)	MDB	Market prices	ABS, 2008
BIOTA	HARVESTED FISHES	AQUACULTURE	Silver Perch (gross value production)		$m AUD 2008 = $2.3	New South Wales	Market prices	ABARE, 2009
BIOTA	HARVESTED FISHES	AQUACULTURE	Silver Perch (gross value production)		$m AUD 2008 = $0.7	Queensland	Market prices	ABARE, 2009
BIOTA	HARVESTED FISHES	AQUACULTURE	Yabby (production)		$m AUD 2008 = $0.3	New South Wales	Market prices	ABARE, 2009

Asset	Attribute	Ecosystem services	Scenarios/study	Marginal value	Total financial value or aggregation value	Site	Method	Authors
BIOTA	HARVESTED FISHES	AQUACULTURE	Impact on fishing industry and local economy of the cessation in pumping water from Lake Alexandrina to Lake Albert		Landed harvest value of fish in the area + $7.5m/annum total value-added contribution to the local economy = $22m/annum	Lake Albert and Lake Alexandrina	Market prices	Coorong District Council 2009
BIOTA	NATIVE VEGETATION	Sense of place for non aboriginal people	Community values of forests	$8.90/visitor/year by the TCM and 22$/person/year by the CVM	Aggregation by the TCM = $950 000/year	South East Forests of Australia (New South Wales and Victoria) listed on the register of national estate	TCM and CV	Carter 1992
BIOTA	NATIVE VEGETATION	Sense of place for non aboriginal people	WTP to improve management of remnant vegetation (one-off payment)	$43 (AUD 1998)/household	$36 M (AUD 1998)	North-East Victoria (1 880 056 ha)	CM	Lockwood, Carberry 1998
BIOTA	NATIVE VEGETATION	Sense of place for non Aboriginal people	WTP to improve management of remnant vegetation (one-off payment)	$52 (AUD 1998)/household	$53 M (AUD1998)	Murray Catchment, New South Wales (3 643 686 ha)	CM	Lockwood, Carberry 1998
BIOTA	NATIVE VEGETATION	Sense of place for non aboriginal people	Survey to know how much household would be willing to pay to improve river side vegetation	$AUD 2004/% of river covered with healthy vegetation = between $1.5 and $2.5		Bega River (New South Wales)	CM	Morrison and Bennett 2004
				$AUD 2004/% of river covered with healthy vegetation = $2		Clarence River (New South Wales)		
				$AUD 2004/% of river covered with healthy vegetation = $1.5		Georges River (New South Wales)		
				$AUD 2004/% of river covered with healthy vegetation = from $1.5 to $2		Gwydir River (New South Wales)		
				$AUD 2004/% of river covered with healthy vegetation = from $1.4 to $2		Murrumbidgee (New South Wales)		

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Asset	Attribute	Ecosystem services	Scenarios/study	Marginal value	Total financial value or aggregation value	Site	Method	Authors
BIOTA	NATIVE VEGETATION	Sense of place for non aboriginal people	Survey to know how much household would be willing to pay to improve river side vegetation	$AUD 2008/household/1% increase in river length with healthy vegetation = between $3.5 and $5.5		Goulburn river (Victoria) ,	CM	Bennett, Dumsday, Gillespie 2008
				$AUD 2008/household/1% increase in river length with healthy vegetation = $5.5		Moorabool River (Victoria)		
				$AUD 2008/household/1% increase in river length with healthy vegetation = $3		Gellibrand (Victoria)		
BIOTA	NATIVE VEGETATION	Sense of place for non aboriginal people	1% improvement healthy vegetation	$2.35 AUD 2005/household/yr in 15 yr time	no	Murray Darling Basin (Queensland, Toowoomba)	CM	Windle and Rolfe, 2006
BIOTA	NATIVE VEGETATION	Aquatic and terrestrial habitat for biodiversity/sense of place for non aboriginal people/sites of high aesthetical values	WTP for increase of 1000 ha of healthy RRGs (for 20 year)	from around $1.45 to $3.29 (/yr/household) (AUD 2008)	No	Red gum forests along the River Murray in Victoria	CM	Bennet, Dumsday, Gillepsie 2008
BIOTA	NATIVE VEGETATION	Aquatic and terrestrial habitat for biodiversity/sense of place for non aboriginal people/sites of high aesthetical values	Implicit prices estimates for improving uncleared land (scrublands and grassy woodlands) for habitat	$0.72/household/1000 ha/year for 5 year for the **Scrubland** and $1.06/household/1000 ha/year for 5 year for the **grassy woodlands** (AUD 2005)	Aggregated values across the south Australian population : $866/1000 ha for the **Scrubland** and $1266 /1000 ha for the **grassy woodlands** (AUD 2005)	Upper South-East of South Australia	CM	Hatton MacDonald, Morisson, 2005
BIOTA	NATIVE VEGETATION	Aquatic and terrestrial habitat for biodiversity/sense of place for non aboriginal people/sites of high aesthetical values	1% increase in the area of healthy vegetation	$3.01 to $5.70 per year for 10 years	No	River Murray	CM (conditional logit model and error component model)	Hatton MacDonald, Morisson, 2009
BIOTA	ICONIC SPECIES	Aquatic and terrestrial habitat for biodiversity/sense of place for non aboriginal people/sites of high aesthetical values	Increase the frequency of waterbird breeding by a year	$12.80 and $20.08 per year for ten years		River Murray		
			1% increase native fish population	$2.22 and $3.62 per year for ten years				

Asset	Attribute	Ecosystem services	Scenarios/study	Marginal value	Total financial value or aggregation value	Site	Method	Authors
			Improving the waterbird habitat quality from poor quality to high quality	$134 and $242 per year for ten years		Coorong		
BIOTA	ICONIC SPECIES	Aquatic and terrestrial habitat for biodiversity/sense of place for non aboriginal people/ sites of high aesthetical values	WTP to increase of 100 breeding pairs of regent and superb parrots (for 20 year)	From around $4 to $8.40 (yr/household) (AUD 2008)	No	Red gum forests along the River Murray in Victoria	CM	Bennet, Dumsday and Gillespie 2008
BIOTA	ICONIC SPECIES	Aquatic and terrestrial habitat for biodiversity/sense of place for non aboriginal people/sites of high aesthetical values	WTP for 1% increase of native fish (cods) (for 20 year)	From about $1 to $1.40 (yr/household) (AUD 2008)	No	Red gum forests along the River Murray in Victoria	CM	Bennet, Dumsday and Gillespie 2008
BIOTA	ICONIC SPECIES	Sense of place for non aboriginal people	Survey to know how much people would be willing to pay to improve population species	$AUD 2004/species = between $1 and $7.5		Bega river (New South Wales)	CM	Morrison and Bennett 2004
				$AUD 2004/species = $2		Clarence River (New South Wales)		
				$AUD 2004/species = between $1.7 and $3.5		Gwydir River (New South Wales)		
				$AUD 2004/species = between $1.7 and $4		Murrumbidgee (New South Wales)		
BIOTA	ICONIC SPECIES (water birds)	Sense of place for non aboriginal people	Survey to know how much people would be willing to pay to improve population species	$AUD 2008/household/species = from $3 to $4		Goulburn river (Victoria) ,	CM	Bennett Dumsday and Gillespie 2008
				$AUD 2008/household/species = from $18 to $23		Moorabool River (Victoria)		
				$AUD 2008/household/species = $17		Gellibrand (Victoria)		
BIOTA	ICONIC SPECIES (fish population)	Sense of place for non aboriginal people	Survey to know how much people would be willing to pay to improve percentage of	$AUD 2008/household/1% increase in population = from $4.4 to $5.5		Goulburn river (Victoria) ,	CM	Bennett Dumsday and Gillespie 2008

Research Agenda

Asset	Attribute	Ecosystem services	Scenarios/study	Marginal value	Total financial value or aggregation value	Site	Method	Authors
			pre-settlement species	$AUD 2008/household/1% increase in population = $5		Moorabool River (Victoria)		
				$AUD 2008/household/1% increase in population = $2		Gellibrand (Victoria)		
BIOTA	WILDLIFE HUNTED	Recreational activities (river-based)	Values generated by duck hunting	Estimation of the consumer surplus = from $42 to $52/hunter to (AUD 2000)	Aggregated values for hunter for a year = from $12500 to $18200	Upper South-East of South Australia	Travel Cost survey	Whitten, and Bennett, 2001b
BIOTA	WILDLIFE FISHED	Recreational activities (river based)	Benefits from fishing (94 respondents)	Average expenditure on a trip = $43/angler and average yearly benefit (from saving cost to do elsewhere) = $972/angler (AUD 1988)	No	Ovens and King Basin	WTP	Sinden, 1988
BIOTA	WILDLIFE FISHED	Commercial value of fishing			1.1 millions $A 1997	Lower River Murray	Market prices	Baker, Pierce 1997
BIOTA	WILDLIFE FISHED	Recreational value (of fishing)	One-off payment		9.6 millions $A 1997	Lower River Murray	CVM	Baker, Pierce 1997
BIOTA	WILDLIFE FISHED	Sense of place for non aboriginal people	One-off payment		45.2 millions $A 1997	Lower River Murray	CVM	Baker, Pierce, 97
AIR	Climate change	Food production	Valuation of impact in irrigation profit over 25 years/scenario of climate change and different water allocation due to climate change		For a decrease in water availability from 11% (mild climate change) to 65% (severe climate change), Decrease in irrigation profit from 9% to 52% (which means from $m 35 to $m 200/year) (AUD 2007)	MDB Victoria	?	Qureshi, Connor, Kirby and Mainuddin, 2007

Asset	Attribute	Ecosystem services	Scenarios/study	Marginal value	Total financial value or aggregation value	Site	Method	Authors
		Food production	Valuation of impact in irrigation profit over 25 years/scenario of climate change and different water allocation due to climate change		For a decrease in water availability from 11% (mild climate change) to 65% (severe climate change), Decrease in irrigation profit from 22% to 87% (which means from $m66 and $m260/year) (AUD 2007)	MDB South Australia	?	
		Fresh water for irrigation	Valuation of impact on water prices for irrigation over 25 years/scenario of climate change and different water allocation due to climate change	For a decrease in water availability from 11% (mild climate change) to 65% (severe climate change), the prices rises from $110to $300 /ML/year (AUD 2007)		Lower Murray Darling Basin	?	
AIR	Climate change	Prevention of damage due to environmental disturbances	Impacts of the increase in the frequency of drought the social value of water (including drinking water for Adelaide, water for irrigation and environmental flows) /comparison of 2 scenarios: first in the case where decrease of inflows is proportional an		Social cost of environmental disturbance : with a similar reduction of inflow of 15%, the social value declines by about$ 500 million in the case of the proportional reductions and by about $1 billion in the case of the probability change approach (drought)	MDB + Adelaide	?	Adamson et al. 2009.

Legend: Non-market techniques include WTP = Willingness to pay; CV = Contingent valuation; CM = Choice modelling; TCM = Travel cost method

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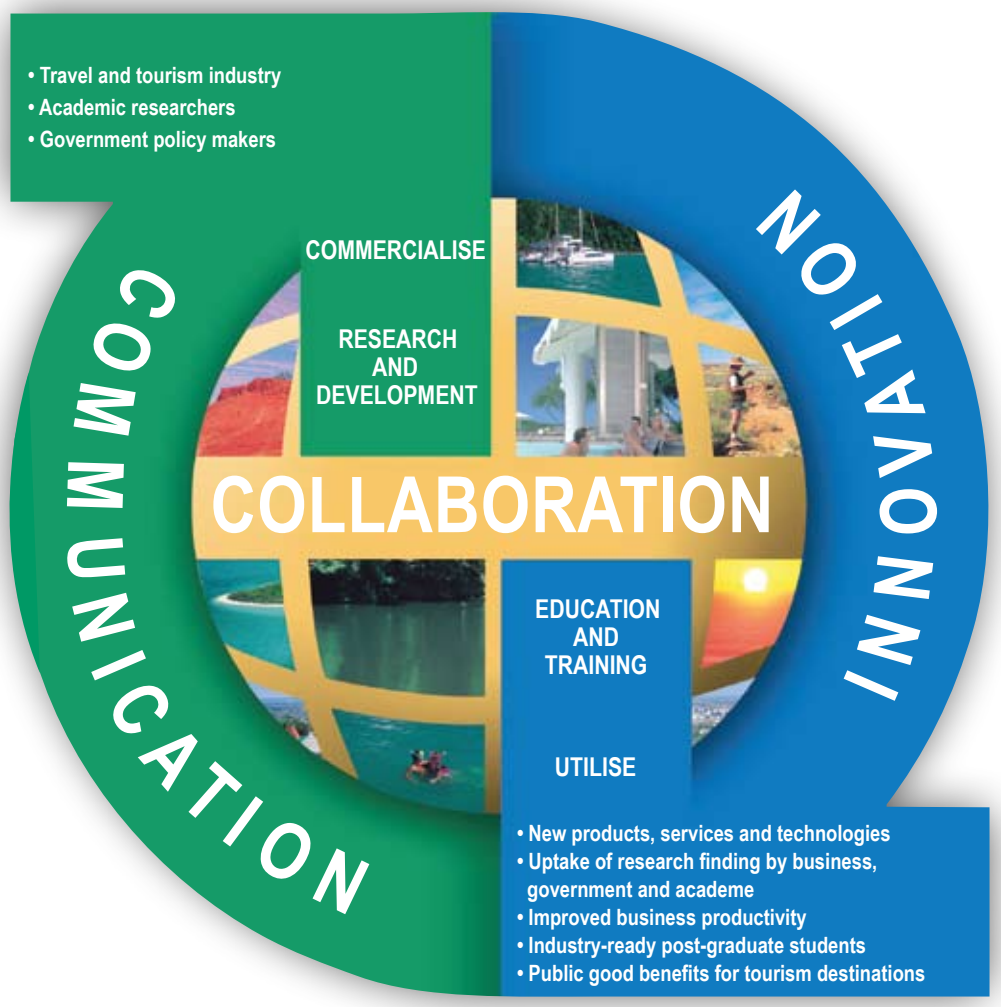

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EC3, a wholly-owned subsidiary company, takes the outcomes from the relevant STCRC research; develops them for market; and delivers them to industry as products and services. EC3 delivers significant benefits to the STCRC through the provision of a wide range of business services both nationally and internationally.

An Australian Government Initiative

Green Globe

KEY EC3 PRODUCTS

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SUSTAINABLE
TOURISM
CRC

Sustainable Tourism Cooperative Research Centre (STCRC) is established under the Australian Government's Cooperative Research Centres Program.

STCRC is the world's leading scientific institution delivering research to support the sustainability of travel and tourism—one of the world's largest and fastest growing industries.

Introduction

STCRC has grown to be the largest dedicated tourism research organisation in the world, with $187 million invested in tourism research programs, commercialisation and education since 1997.

STCRC was established in July 2003 under the Commonwealth Government's CRC program and is an extension of the previous Tourism CRC, which operated from 1997 to 2003.

Role and responsibilities

The Commonwealth CRC program aims to turn research outcomes into successful new products, services and technologies. This enables Australian industries to be more efficient, productive and competitive.

The program emphasises collaboration between businesses and researchers to maximise the benefits of research through utilisation, commercialisation and technology transfer.

An education component focuses on producing graduates with skills relevant to industry needs.

STCRC's objectives are to enhance:

- the contribution of long-term scientific and technological research and innovation to Australia's sustainable economic and social development;
- the transfer of research outputs into outcomes of economic, environmental or social benefit to Australia;
- the value of graduate researchers to Australia;
- collaboration among researchers, between searchers and industry or other users; and
- efficiency in the use of intellectual and other research outcomes.