Potential of a payments for ecosystem services scheme to improve the quality of water entering the Sydney catchments

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Abstract

Although the Sydney Catchment Authority (SCA) largely controls the quality of water entering the Sydney catchments, it has limited jurisdiction over the majority of activities undertaken on private land, where much of the non-point source pollution originates. The current governance model reflects a traditional ‘command and control’, government-centred philosophy limiting the economic opportunities for landholders. Using six case studies from other jurisdictions we explore the potential for market-based schemes to better enable the SCA to meet its statutory objectives. A contemporary payments for watershed services scheme could better address issues of non-point pollution in more efficient and fairer ways than the present model. Under such a scheme, the SCA would rely more upon negotiated service arrangements pursuing a ‘least cost of supply’ for a defined water quality output, with the costs of these arrangements being reflected in the price of water to consumers. Funds are likely to be applied more strategically to secure water quality outcomes at the least public and private cost while maximizing the value of non-water ecological services from the same lands. These findings are relevant and can be applied to many other drinking water catchments within Australian and other jurisdictions.

Keywords: Ecosystem services; Environmental markets; Payments for ecosystem services (PES); Payments for watershed services (PWS); Sydney

1. Introduction

Empirical evidence indicates that the best quality drinking water is derived from catchments that are predominantly forested (e.g. Barten & Ernst, 2004), but this is not always possible. Data from the USA suggest an inverse relationship between the proportion of a catchment that is forested and the cost of treatment required to meet drinking water standards (Figure 1; Ernst et al., 2004). Compared to a catchment with 10% forest cover, the costs of water treatment are more than 200% higher than for a catchment with 60% forest cover (Ernst, 2004; Postel & Thompson, 2005). This suggests that

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environmental water services are likely to be more economically produced from forested rather than agricultural or industrial lands. However, in terms of economic valuation of land use, agricultural and other uses have a number of values. Economic efficiency lies in the optimization of the mix of values, not in the water services alone, with the aim of delivering the most valuable mix of outputs at the least total cost. In New South Wales (NSW), Australia, the majority of drinking water catchments comprise a mixture of public and private land tenures (Webb, 2012a), with the private lands being generally cleared for agriculture. As a result, achieving optimal value involves a very complex mix of trade-offs and public/private relationships.

Land use impacts on non-point source water pollution. With the exception of land clearing, forestry activities and certain aspects of soil erosion, land uses remain largely unregulated in Australia (Butt, 2009). In drinking water catchments, however, government agencies generally regulate those activities that could adversely impact water quality. The effectiveness of such regulations to achieve the desired water quality outcomes is a matter of debate (Wright et al., 2011). The policy issue to which this paper is directed is whether a command and control mechanism (focused on land use) is likely to be more effective in optimizing all of the costs and values when compared to a market-like mechanism focused on the human services values achieved from those lands.

Specifically, the paper examines the experience of six case studies of water service market approaches to catchment governance, critically examines existing frameworks in the Sydney catchments; and makes recommendations for changes that could be implemented to achieve a higher total value mix from catchment lands and a lower total cost than present arrangements. The objective is to identify achievable and pragmatic changes to legal and institutional frameworks that are simpler, more cost-effective and likely to result in better land management and water quality outcomes, and which will best fit national policy settings.

Within the Australian federal system, a key coordinating mechanism is the Council of Australian Governments (COAG). Among the many functions of this Council is to organize the fiscal relations between the states, and in this context a key priority is the advancement of competitive efficiency in all its forms. Water policy has been a continuing area of policy interest. In 2004, an Intergovernmental Agreement on a National Water Initiative was formed between the states and the national government (COAG, 2004). That agreement concerns (among other things) the cost-effectiveness of urban water infrastructure, reflecting a continuing emphasis upon the adoption of economic natural resource management principles such as a concern for price competition, competitive neutrality between public and
private service providers, and overcoming the problem of the erosion of unpriced or under-priced values in a market system. Economic environmental governance principles were reflected in the COAG Water Reform Framework of 1994 which explicitly required the states to adopt ‘pricing reform based on the principles of consumption-based pricing and full-cost recovery’. Clause 64 of the Intergovernmental Agreement on a National Water Initiative 2004 reflected the continued commitment of all governments to these policy settings.

Thus, the NSW government has committed to the principle that the full costs of water provision are reflected in the consumption price for water to Sydney users. In part this requirement is incorporated in the role of the Independent Water Pricing and Regulatory Tribunal, which sets the maximum prices for services provided by government monopolies. However, that role does not require that they recommend how water provision arrangements might be changed to better reflect COAG principles, which are likely to result in price increases to Sydney water consumers. Under the present regulatory arrangement the use that landholders can make of their lands is restricted by regulation. This means that they may incur opportunity costs for foregone uses of their land without economic compensation, and therefore without these costs being reflected in the price of water, violating concepts of full recovery of all of the costs of provision of the service. It may be that a payments for ecosystem services (PES) model will better reflect the market oriented rationale of national water policy.

2. Material and methods

The purpose of the investigation was to consider alternative approaches to payments for watershed services (PWS) implementation, to explore which aspects of these approaches might best fit the Sydney catchment situation, to identify the potential benefits and disbenefits of these, and then to consider the applicability of a PWS approach to the Sydney catchments. Research techniques included field visits to water supply authorities and to their respective catchments; interviews with academics, water supply managers, catchment managers, and staff of environmental trusts and other non-government organizations; and applied law and policy reform-oriented research aimed at intensively evaluating the adequacy of existing legal and institutional frameworks with a view to recommending changes to any arrangements found wanting.

3. Payments for watershed services

3.1. Introduction

‘Ecosystem services’ are goods and services provided by ecosystems for the benefit of humans (Daily, 1997; MEA, 2005; Salzman, 2006; Kroeger & Casey, 2007). A PES scheme is a ‘transparent system for the additional provision of ecosystem services through conditional payments to voluntary providers’ (Tacconi, 2012). These can include ‘catchment’ or ‘watershed’ services (Stanton et al., 2010) or ‘hydrologic services’ (Brauman et al., 2007) such as water for domestic, agricultural, commercial, industrial, and hydro-electric power generation; the supply of fish and other freshwater products; reduction of flood damage; prevention of soil erosion and sedimentation of waterways and reservoirs; and recreation and aesthetic values (Brauman et al., 2007). Catchment lands also provide
complementary services including primary production, housing, biodiversity, cultural and economic values and, in some instances, industrial uses. The central goal of an environmental services model is that payments are intended to be for a delivered outcome, rather than for an input activity, though in practice the line between payment for an input and payment for an output becomes blurred because of practical problems of traceability and measurement of outcome at the level of the individual landholding or landholder activity units.

A PWS is ‘a payment or exchange of credits between a buyer and a seller to effect some improvement of a watershed service’ (Stanton et al., 2010). There are many types of PWS schemes including ‘Government PWS’, ‘Private PWS’, and ‘Water Quality Trading’ (WQT) schemes. Government PWS schemes involve a government agency as the buyer of watershed services from landowners. Payments take forms including economic incentives to change land use practices, subsidies, cost-sharing arrangements, tax relief, land purchase deals, and the purchase of conservation easements or restrictive covenants (Butt, 2009). Private PWS schemes involve payments by a private entity to landowners to protect a watershed service, such as the Vittel PES scheme in France (Wunder et al., 2008), for either business reasons or philanthropic interests. Some, but far from all, PWS schemes allow for trading of pollution or perhaps use rights between landholders. WQT schemes involve a framework whereby a cap on pollution loads is set by regulation and the regulated entities purchase and trade in offset credits to meet their obligations (Shortle & Horan, 2001).

The number of PWS schemes, and the area of land protected, is expanding worldwide. In the USA alone in 2008 PWS transactions exceeded US$1.3 billion and operated across 16.4 million ha of land (Stanton et al., 2010). There are many different forms of PWS, but typically the drivers of the underlying demand are regulatory and/or economic (Webb, 2012b).

3.2. Case studies

The diversity of approaches to implementation of PWS concepts is reflected in the case studies described below, with an analysis of their key components.

3.2.1. Boston, Massachusetts. Quabbin Reservoir is the largest catchment for the city of Boston, managed by the Division of Water Supply Protection (DWSP) of the Massachusetts Department of Conservation and Recreation (DCR). The catchment area is 38,400 ha and 66% of this land is owned and controlled by the DCR (DCR, 2007). The following information was compiled from available literature and interviews with the Director, Regional Director, Assistant Regional Director, Environmental Analyst, and Chief Forester from the DWSP, DCR.

Under the US Safe Drinking Water Act (Pub L 93–523 (1974)) the US Environment Protection Authority (EPA) introduced the Surface Water Treatment Rule (SWTR) of 1989. This requires the use of water filtration unless a water authority can prove that its water is of a sufficient standard to be issued with a Filtration Avoidance Determination (FAD). Water quality in the Quabbin Reservoir is high and the DCR does not filter the water supply (Kyker-Snowman, 2000). The Quabbin/Wachusett systems are one of few serving large cities in the USA that have been granted a FAD since 1989. The cost of building a filtration plant for the Boston water supply should this be required has been estimated at US$200 million with significant on-going costs. This creates an economic incentive for the DCR to manage its forests for water supply protection (Webb, 2012b).
The PWS scheme at Quabbin/Wachusett is largely driven by the SWTR and FAD incentive to avoid the cost of filtration. Water users’ rates cover the cost of watershed management for water quality protection. Approximately US$30 million per year is raised through the scheme, which equates to approximately US$780 per hectare. The PWS scheme coupled with approximately US$200 million of Commonwealth environmental bond money has been used to purchase land parcels and conservation easements prioritized on the basis of watershed services. The DCR has invested in wastewater treatment plant upgrades within the catchment. A comprehensive active land management plan (DCR, 2007) involves investing in forest management and best management practices to cost-effectively maintain high water quality and continue to avoid the need for Boston to filter its water supply.

3.2.2. New York City. New York City (NYC)’s water is largely supplied from the Catskill/Delaware catchments which cover an area, excluding the reservoirs, of 409,400 ha. Information collated here was sourced from available literature and interviews with the Assistant Commissioner of the NYC Department of Environmental Protection (DEP), the Director of the Yale University Center for Business and Environment, and staff from the Forests, Watershed Lands and Community Planning, and Natural Resources programs of DEP.

Faced with potentially declining water quality in its catchments (Daily & Ellison, 2002; Postel & Thompson, 2005), under the SWTR the NYC DEP was on the brink of having to invest in a filtration plant at a cost (in the early 1990s) exceeding US$6 billion and on-going maintenance costs of approximately US$300 million per year (Salzman, 2011). The alternative was to protect the catchments and improve water quality (Chichilnisky & Heal, 1998; Heal, 2000). To date some US$1.5 billion has been invested via the PWS scheme for water provision to 10 million New Yorkers (Salzman, 2011). The PWS scheme is based on a Memorandum of Agreement (MOA) between the city; the state; the EPA; environmental groups; and representatives of the counties, towns and residents of the catchment in upstate New York (NYC DEP, 2011).

In 1997 NYC owned just 3.5% of the catchment lands, whilst 21.1% of the area was owned by other public agencies or land trusts so that in 1997 some 24.6% of the catchment was afforded a strong level of public protection. Using the PWS scheme the city has secured further land by purchase or through conservation easements (NYC DEP, 2011), increasing the lands under the city’s control by 319%. The city now manages 14.55% of the catchment. Much of the effort has prioritized purchase of riparian buffers within the catchment. The city, state, and land trusts now collectively control 32.7% of the riparian buffers (NYC DEP, 2011).

Investment has also been funded in forest and land management works to reduce streambed and bank erosion; full channel restoration works including sewage treatment upgrades; streambank stabilization; riparian vegetation rehabilitation; and stormwater management works. Arguably water quality in the Catskills/Delaware systems has always been high, but monitoring by the DEP shows that loads of many pollutants such as phosphorus have declined through the PWS scheme (NYC DEP, 2011).

3.2.3. Seattle, Washington. Seattle Public Utilities (SPU) owns and operates the water supply system that delivers drinking water to approximately 1.4 million people. The following information was sourced from available literature and interviews with SPU staff including the Supervisor of the Fish and Wildlife Unit, and the Aquatic and Riparian Ecologist. Water is sourced from the Cedar River (70%) and South Fork Tolt River catchments (30%). The Cedar River catchment supply is unfiltered but has a FAD waiver. A PWS scheme has been in operation since 1992. The total catchment area is 36,230 ha; it is mostly forested and 99.9% owned and managed by SPU (City of Seattle, 2000). Previously the
US Forest Service (USFS), Weyerhaeuser and the Milwaukee Railway Company owned proportions of
the catchment but in 1962 it was agreed that all land would be transferred to the City. The aim was to
better control logging and fires and to prevent unsupervised public access to the catchment. The final
transfer occurred in 1996.
With 99.9% ownership of the catchment, SPU had largely guaranteed that it could continue operating
the Cedar River water supply with few concerns about water quality. However, system operation poten-
tially threatened a number of fish and other wildlife species listed under the Endangered Species Act
(Pub L 93–205, 1973). SPU was required to formulate a Habitat Conservation Plan (HCP) for the vari-
ous species and their habitat and was granted an Incidental Take Permit that allowed these impacts of
the operations to be offset by protection measures and restoration works in the catchment. The HCP was
signed in April 2000 with a duration of 50 years. The HCP and related works are funded by a levy on
water rates through the PWS scheme which focuses on managing fish passage, maintaining water qual-
ity and regulating streamflows (City of Seattle, 2000).

3.2.4. Santa Fe, New Mexico. Santa Fe, New Mexico has a population of 75,000. It has a cool semi-
arid climate and wildfires are not uncommon (Steelman & Kunkel, 2004; Gutzler & Van Alst, 2010).
Information on the city’s water supply was sourced from available literature and complemented by inter-
views with the US Department of Agriculture (USDA) Forest Service District Ranger and the Executive
Director of the Santa Fe Watershed Association. The Santa Fe municipal catchment supplies up to 50% of
the water used by Santa Fe residents and businesses; the remainder coming from groundwater wells.
The catchment is 6,954 ha in area. The City owns and manages around 400 ha near the upper and lower
dams and riparian zones. The remainder comprises the Santa Fe National Forest and Pecos Wilderness
Area. This created a problem for management of the catchments for water quality protection as the City
had little control over how forests were managed by the USFS (Webb, 2012c).
For more than 100 years the Santa Fe catchment forests have been managed using complete fire sup-
pression. This led to stands becoming overstocked, vulnerable to pest or insect attack, and prone to
intense fires with drastic consequences for soil erosion and contamination of the water supply (Santa
Fe, 2009). Having witnessed the effects of intense fires on the water supplies of Los Alamos and
Denver, Colorado (Moody & Martin, 2001; Reneau et al., 2007; Robichaud et al., 2008), a consensus
was reached that Santa Fe needed to act. Discussions began around 2007 and culminated in the pro-
duction of a 20-year plan. The plan is unique in that it “seeks to fund forest restoration activities
using the Payments for Ecosystem Services model as an insurance policy against future threats, particu-
larly of catastrophic fire, to the municipal water supply”.

The major signatories to the Plan are the USFS, Santa Fe Watershed Association, the Nature Conser-
vancy, City of Santa Fe Water Division and the City of Santa Fe Fire Department. The cost of the Plan is
estimated to be US$4.3 million over 20 years. It will leverage US$0.65 per month from water users in
the city from water charges to pay for fuel reduction burning and forest thinning. This investment in the
catchment is expected to avoid a repair bill of US$22 million if 2,800 ha of the catchment were to burn.
Without hazard reduction, the likelihood of such a fire was estimated to be one in five in any given year
(Santa Fe, 2009). Underpinning promotion of the scheme is a public education and outreach program
conducted by the Santa Fe Watershed Association.

3.2.5. Denver, Colorado. Denver water is a non-profit public utility that supplies drinking water to
around 1.3 million people. Its catchments total 1 million ha in area across four river basins which deliver
water to 15 major reservoirs. Much of the land in the catchments is forested public land managed by the USFS (Webb, 2012b). Information on the water supply was sourced from available literature as well as interviews with the Manager of Water Resource Planning at Denver Water, and several USFS staff including the Regional Forester, the Water Partnerships Coordinator, Water Program Manager, Regional Soil Scientist, Partnership Liaison Officer, and Water Quality Hydrologist.

The PWS scheme originated in response to large wildfires in the catchments in recent decades (Moody & Martin, 2001; Robichaud et al., 2008). One fire caused US$38 million in property damage, cost US$42 million to suppress, and US$48 million to remediate. There was an acknowledgement from Denver Water and the USFS that management of National Forest land was impacting in an adverse way on Denver Water’s business. Denver Water had no jurisdiction to ensure the USFS undertake appropriate management. The USFS was aware of Denver Water’s requirements but could not afford to undertake the required management due to limited funds (Webb, 2012b).

Following much negotiation, on 29 July 2010 Denver Water and the USFS signed a 5-year Memorandum of Understanding (MOU) titled ‘Restoring forest and watershed health to protect the City and County of Denver’s municipal water supplies and infrastructure’. Denver Water and the USFS will each contribute US$16.5 million toward restoring catchments. Hazard reduction activities such as forest thinning and rehabilitation of previously burnt areas will occur. The PWS scheme will be funded in part by payments of US$27 per household in total over 5 years by Denver Water’s customers (Webb, 2012b).

3.2.6. Tualatin River basin, Oregon. The Tualatin River WQT scheme was developed by a partnership including Clean Water Services (CWS), a water utility, and the Willamette Partnership and The Freshwater Trust, both non-profit organizations (Webb, 2012b). In addition to reviewing available literature, interviews were held with an Environmental Market Specialist at Willamette Partnership, and the Director of the Institute for Water and Watersheds at Oregon State University. The Tualatin River basin in northwestern Oregon to the west of Portland has an area of 1,844 km² and flows easterly from the Coast Range to the Willamette plains. Approximately one-third of the catchment is used for agriculture. Much of the riparian vegetation has been cleared. The lower catchment is largely urbanized (Cochran & Logue, 2011).

The ‘pollutant’ that the environmental market aims to address is water ‘temperature’. Specifically, this relates to the temperature of water released into tributaries from the Durham and Rock Creek wastewater treatment facilities operated by CWS (Cochran & Logue, 2011). While these plants release clean water, it is warm. This is neither beneficial for aquatic life, including endangered coldwater salmonids, nor compliant with the US EPA’s Total Maximum Daily Load (TMDL) requirements regulated by the Oregon Department of Environmental Quality (DEQ, 2001). Under section 303(d) of the Clean Water Act (Pub L 92–500, 1972), territories and certain tribes must develop lists of ‘impaired waters’. These are waters that are highly degraded or polluted. The EPA mandates that the relevant state or similar authority develops a TMDL for each impaired system. The TMDL reflects the maximum level of a given pollutant that can safely be discharged into receiving waters to meet water quality standards. In the Tualatin, to meet the TMDL’s thermal waste load allocation, the wastewater treatment plants would need to reduce thermal loads by 95%; reducing effluent temperature from 22 to 17 °C (DEQ, 2009). One option was to install cooling structures to reduce treated water temperature before its release into waterways at a prohibitive construction cost of US$60–150 million (Cochran & Logue, 2011).
The WQT scheme was triggered by the realization that approximately 40% of the thermal input into the basin is solar energy reaching the streams due to altered land use (Cochran & Logue, 2011). Under the WQT scheme tree planting along stream sides allows wastewater treatment plants to offset their temperature pollution. Shading lowers stream temperature to reduce the overall temperature to offset the thermal pollution of the treatment plants. Modelling of shade impacts was undertaken using the ‘Shade-a-Lator’ tool to determine the benefits of tree planting in riparian zones, based on the Heat-Source model (DEQ, 2009). To comply with the TMDL each wastewater facility is required to offset its temperature emissions at a ratio of 2:1 (Clean Water Services, 2009). Under the WQT scheme CWS funds tree planting by using revenue raised from rate payers. CWS either enters into 20 year leases with farmers or purchases conservation easements. Farmers who participate are paid a sign-in bonus for the lease or easement and an annual payment to maintain the riparian zone. CWS undertakes the planting or pays a contractor to do so. Over 1.6 million trees and shrubs have been planted along 50 km of stream-front in the basin at a total cost of US$4.5 million (Cochran & Logue, 2011). Riparian shading has generated 295 million kilocalories per day of credits. When augmented by cold water releases from upstream reservoirs, this has meant CWS has generated more credits than it needs for compliance. The scheme is accruing other benefits for water quality and aquatic ecology that exceed the program’s original objectives (Cochran & Logue, 2011).

3.3. Analysis

The case studies highlight the diversity of PWS options to address issues of water quality within water supply catchments. They illustrate the flexibility of market instruments to respond to differing landscapes within varying legal frameworks. For example, PWS schemes operate on a mixture of public and private land in New York and Boston, yet solely on public land in Seattle, Santa Fe, and Denver. In each of the PWS schemes investigated water users are the buyers of watershed services and the schemes are largely instituted by government agencies but collaboratively with public land trusts, watershed associations, and non-governmental organizations.

The WQT scheme in Oregon is different in that it involves trading in pollution credits between point sources and non-point sources, often referred to as point–non-point trading (Horan et al., 2002a, 2002b). It is representative of a very large number of WQT examples from throughout the world, which can be operated in conjunction with a PWS or otherwise. The effectiveness of these schemes is variable, but there are a sufficient number of successes to demonstrate the potential of WQT (Martin & Shortle, 2010).

Some key requirements for successful trading in watershed services can be elucidated, as highlighted by interviews with staff at the USDA Office of Environmental Markets. These include:

(i) Demand – where is it? Mostly a regulatory driver will be needed, so it is important to work with agencies such as the EPA to develop appropriate rules.
(ii) Supply – the main issue here is encouraging landowners to be involved in the program. It is essential to develop a strategy for certainty.
(iii) Infrastructure – to make market instruments work there needs to be solid supporting infrastructure. This includes regulatory development, metrics (i.e. what is the unit of exchange?), protocols, education services, environmental assurance programs, advisory boards, registries, and the like.
Regarding demand, in each case there is a driver that makes improving water quality imperative. In Boston, New York, and Seattle PWS schemes are driven largely by the desire to comply with the SWTR and to maintain FAD status. This incentivises investment in catchments to avoid the costs of purchasing and maintaining filtration plants. The Oregon WQT scheme similarly is driven by the need to meet TMDL requirements and to avoid the construction of expensive cooling structures. In the Santa Fe and Denver examples the regulatory driver is absent; however, PWS investment is an insurance against the risk of future wildfires and associated costly remediation measures (Webb, 2012c). These economic and regulatory drivers create willing buyers of watershed services, ultimately being the consumers of the water.

Regarding supply, the key requirement is willing sellers of watershed services. This is supported by the availability of appropriate legal and institutional mechanisms to enable trade to occur. In Boston and New York watershed services are bought from private landholders using instruments such as land purchase, conservation easements, and contracts. The conservation easements, akin to restrictive covenants, may be purchased by water management agencies directly or through public land trusts. Such easements frequently help conserve private forests that landholders could otherwise log. In the northeast USA conservation easements are increasingly used to generate income to offset rising land values and property taxes (D’Amato et al., 2010).

In Seattle, Santa Fe, and Denver the PWS schemes rely upon MOU between government agencies as both buyers and sellers of watershed services. These MOUs range from 5 to 50 years and specify where and how management activities are to be undertaken. Finally, the Oregon WQT scheme utilizes conservation easements and leases with private landowners who are paid for maintaining riparian vegetation or for its restoration. Regardless of the watershed services, participation by landholders, public or private, is voluntary and secured by payments and legal instruments. A key feature is that the full costs of provision of the environmental service are met from the market, rather than requiring a forced subsidy by the provider of water services to the consumer. Thus the water price comes to better approximate an economically efficient level that incorporates the private cost and at least a reasonable estimate of more of the environmental costs than would be otherwise reflected.

It is not obvious from the case study descriptions what the ‘infrastructure’ requirements are to enable trade. Without adequate institutional arrangements and supporting structures, such as audit, compliance, and monitoring, markets are liable to fail. Furthermore, as explained by a Professor of Agricultural and Environmental Economics at Penn State University, it is a myth that ‘if we create a market, people will come’ (Martin & Shortle, 2010). Many examples of market failure exist but WQT schemes seem to be more likely to succeed when they use existing mechanisms and relationships (Horan & Shortle, 2011). Sociology and focus group research suggest that, in general, farmers prefer to deal with agencies and persons with whom they are familiar and trust (Braden et al., 2009; O’Grady, 2011).

4. Managing Sydney’s drinking water catchments

4.1. Introduction

The Sydney metropolitan drinking water supply is sourced primarily from a catchment area of approximately 16,000 km² located to the west and southwest of the city (Figure 2). Water drains into eleven major reservoirs from five large catchments, the Warragamba, Shoalhaven, Woronora, Upper...
Nepean, and Blue Mountains catchments (SCA, 2010). The largest reservoir is Lake Burragorang behind the Warragamba Dam with a catchment area of 9,051 km². The Warragamba catchment supplies approximately 80% of the metropolitan area’s water. More than 70% of its area is privately used for agriculture on soils that are prone to gully erosion, with negative impacts on water quality (Armstrong & Mackenzie, 2002).

4.2. Legal and institutional frameworks

_Cryptosporidium_ and _Giardia_, two major causes of gastrointestinal illness (Ng _et al._, 2011), were detected in Warragamba Dam and throughout the Sydney Water Corporation’s supply system between July and September 1998 (Stein, 2000). Given the potential seriousness for public health (Mackenzie _et al._, 1994; Hoxie _et al._, 1997), the NSW government commissioned a comprehensive inquiry into the management of Sydney’s water supply (McClellan, 1998). The inquiry identified significant sources of pathogenic contamination within the ‘inner’ and ‘outer’ catchment including cattle, residential...
development, native, and feral animals. It also highlighted the potential pollution of waters with contaminants from sewage treatment plants, sewer overflows, coal mines, base metal and sand mining activities, poultry farms, chicken hatcheries, piggeries, dairies, saleyards, abattoirs, stormwater runoff, sheep, and cattle grazing. These issues were exacerbated by land clearing including the removal of riparian vegetation buffers (Stein, 2000). The Commissioner concluded that there was a serious risk to the safety of Sydney’s water supply posed by the state of the catchment and its management (McClellan, 1998).

The Sydney Catchment Authority (SCA) was promptly established as a statutory body representing the Crown under the Sydney Water Catchment Management Act 1998 (NSW). The role of the SCA is three-fold: to manage and protect Sydney’s catchment areas and infrastructure works; to supply raw water to Sydney Water and other water authorities; and to regulate certain activities within or affecting the ‘inner’ or ‘outer’ catchment. The SCA should ensure that it promotes water quality, protects public health, safety, and the environment, supplies water that meets appropriate quality standards, and that its operations are consistent with the principles of ecologically sustainable development.

The SCA is principally responsible for managing the ‘special areas’ adjacent to the reservoirs and mostly comprising native bushland or forest. The special areas cover 20% of the catchments; 65% in reserves under the National Parks and Wildlife Act 1974 (NSW), 18% is SCA freehold, and 13% is private freehold or leasehold (SCA, 2007). Reserves are managed subject to a MOU and a plan of management between the SCA and the NSW Office of Environment and Heritage (OEH). With the exception of private land, the SCA has the power to prohibit certain activities in special areas. The SCA has the same power as the EPA across the entire catchment area to investigate matters, serve environment protection notices and undertake proceedings for offences under the Protection of the Environment Operations Act 1997 (NSW).

Another of the SCA’s functions is to supervise concurrence in relation to environmental planning within the catchments. All development or activity proposed within the catchments must comply with the SCA’s recommended practices and standards (SCA, 2011a), and must have the consent of the SCA Chief Executive. Development within the catchments should have a ‘neutral or beneficial effect’ on water quality before the SCA will grant concurrent approval. The 15 councils in the catchments must obtain SCA concurrent approval for development (SCA, 2011a).

Notwithstanding these roles of the SCA important activities are beyond its scope as they are managed or regulated by other agencies, if at all. The SCA is not permitted to regulate any ‘scheduled’ activities under the Protection of the Environment Operations Act 1997 (NSW), nor any ‘non-scheduled’ activities that have been granted an environment protection licence under that Act. The SCA can, however, refer pollution matters to the EPA. Scheduled activities are typically point sources of pollution including ‘livestock intensive activities’ such as piggeries, commercial poultry farms and dairy farms; ‘mining for coal’; ‘road construction’; ‘sewage treatment’; and ‘waste disposal’. These activities are regulated by the NSW EPA through a licensing system. Further point sources of pollution within the catchments include septic tanks and urban stormwater, which are regulated by local councils.

Non-point source pollution is a significant issue for the quality of water entering the reservoir system. These sources include grazing activities (Erskine et al., 2002), forest management (Croke & Hairsine, 2006), road maintenance and the effects of wildfires (Smith et al., 2011). The majority of these non-point source activities are regulated or managed by other agencies such as the Soil Conservation Service, Forestry Corporation of NSW, the NSW Fire Brigade, National Parks and Wildlife Division of the OEH, the Rural Fire Service, and local councils (Webb, 2012c).
Improvements to catchment condition can reduce non-point source pollution risk through such activities as soil conservation and the rehabilitation of riparian zones (Webb & Erskine, 2003). To that end the SCA has developed a decision support system to identify the greatest risks to pollution within the catchments (SCA, 2009a). The decision support system guides catchment actions to improve water quality (SCA, 2009b). During the 2010–2011 financial year the SCA spent AUS$20.45 million on its ‘Healthy Catchments’ program with tasks including fencing stock out of riparian zones, the rehabilitation of derelict mines and repairing streambank and gully erosion (SCA, 2011b).

Until recently, in addition to the SCA and other agencies, three Catchment Management Authorities (CMAs) had a role in catchment activities within Sydney’s drinking water catchments. Each of these CMAs used catchment action plans as a basis for assistance to landholders through grants, loans, subsidies, education, and training courses.

4.3. Issues identified with the present system

Despite the intention of the Sydney Water Catchment Management Act 1998 (NSW) for the SCA to provide overall management of Sydney catchments for water quality, the SCA lacks jurisdiction over all activities in the catchments. Even in catchment management, up until January 2014 it shared this role with the three CMAs. From January 2014 a new institutional structure involving three Local Land Services has been in place. As yet it is unclear how this structure will interact with the SCA. A lack of jurisdiction over catchment activities is not unusual in Australian drinking water catchments. For example, in NSW there are 112 water utilities, the majority having little or no jurisdiction over the catchment lands supplying their water (Webb, 2012c).

The concurrent approval role of the SCA in assessing the water quality effects of developments across the catchments is essential to ensure consistency between local councils. In the three financial years from 2007 to 2010 the SCA withheld concurrent approval in three of 1,254 development applications assessed (SCA, 2010). This suggests either that the SCA uses its powers conservatively, or that councils and developers comply with the SCA’s recommended practices and standards (SCA, 2007).

The SCA has significant control over the special areas but limited control on private land. It can maintain forest in special areas but has limited capacity to promote afforestation for water quality on private land. In conjunction with the CMAs the SCA has been involved in educating landowners and providing grants, subsidies and direct investment for works to reduce non-point source pollution. The SCA invests more than AUS$20 million annually in ‘Healthy Catchments’ initiatives (SCA, 2009b). However, compared to the NYC and Boston schemes that invest approximately US$500 and US$780 per hectare each year, respectively (Stanton et al., 2010), the SCA investment of approximately AUS$13 per hectare per year is small. There is sufficient evidence to indicate that much more could be done to improve the quality of water entering reservoirs such as Warragamba Dam (Kristiana et al., 2011), and an investment system based upon achieved standards of environmental services would seem to have the potential to deliver more than this level of investment.

The lack of a clear water quality standard for waters entering supply reservoirs is a weakness of the current arrangement, as it is in all Australian jurisdictions. This omission is surprising given the risk to public health from contamination, highlighted by the 1998 crisis (Stein, 2000). The Sydney public does not have a choice in water provider. Acceptance of the risks of contamination is therefore involuntary (McKay & Moeller, 2001). The lack of an overall standard or target for water quality, and an independent funding mechanism to support achievement of these standards, makes management of pollution...
sources problematic. As we have discussed above, a politicized catchment funding mechanism increases the likelihood that the price of water will not adequately reflect the full cost to private landholders (or government agencies) in delivering this service. This has implications for the reliability of the market in controlling overconsumption of water, and for the equity of treatment of landholders who are obliged to subsidize this consumption. Environment protection licence provisions may cap the pollution that can emanate from one source but this does not automatically take into account the cumulative impact of multiple sources. Polluters are usually not required to offset their impacts on water quality elsewhere in the catchment (Wright et al., 2011).

5. An ecosystem services approach

From the alternative methods or frameworks for managing catchments described in the case studies in section 3, two options for the Sydney Catchment to address the concerns we have discussed are PWS and WQT schemes targeting non-point- and point-source pollution. These schemes should complement existing regulatory and institutional frameworks (Daily et al., 2009), minimize transaction costs to prevent market failure (Martin et al., 2008), and ideally involve simple design and implementation (Greenwalt & McGrath, 2009). In Sydney’s catchments any changes would require complementary changes to regulatory and institutional regimes. We have highlighted some of the risks with the existing policy settings and for the sake of objective comparison we highlight some of the policy risks of our proposals (Martin & Williams, 2010). A discussion of each main opportunity and associated risks surrounding its adoption is presented in the following sections.

5.1. Payments for watershed services

A PWS scheme controlled by the SCA could use funds from the sale of raw water to principally mitigate non-point source pollution. The SCA invests more than AU$20 million per year via the ‘Healthy Catchments’ initiatives (SCA, 2009b). A PWS scheme could leverage further funds from SCA’s customers to maximize water quality protection by purchasing watershed services on private or public land. With a population exceeding 4 million there is a large rateable base for PWS levies, roughly comparable with the NYC and Boston case studies that yield far larger investment in catchment protection.

The SCA has identified priorities to improve catchment health (SCA, 2009b). One option is contracts with landowners to carry out rehabilitation works that target improvements in water quality such as the fencing of stock out of riparian zones, remediation of erosion gullies, or recycling of effluent from dairy farms. All such actions are key deliverables identified by the SCA (SCA, 2009b) and a PWS scheme could generate the funds to implement these over the catchments.

Reflecting the Boston and New York case studies, the SCA may also purchase restrictive covenants on land important for water quality. Landholders would be paid for restrictions on use of their land, obviating the problems of unfunded opportunity costs. In biodiversity banking, incentives such as rate and tax relief for covenants have proven to be effective incentives for land conservation (Cowell & Williams, 2006) that are relevant to the Sydney catchments. Alternatively the SCA could lease hydrologically sensitive land from private landowners.

Given that much of the special areas in the ‘inner’ catchment are on public land where public funds are under increasing pressure, a PWS scheme could pay for activities to reduce the risk of wildfires, such
as occurred in 2001 (Chafer et al., 2004). Following the Santa Fe and Denver examples, the SCA could enter MOAs with government agencies responsible for forest management, including OEH and the Forestry Corporation, to undertake hazard reduction activities. Such activities could include fuel reduction burning or forest thinning (Webb, 2012c), as appropriate, and would be at least partially funded by the SCA through the scheme. The aim would be to prevent large scale wildfires such as the 2003 Canberra fires that had deleterious impacts on water quality (White et al., 2006). With climate change, fire risk will increase (Bradstock et al., 2009) and better funded control within the public catchments has relevance to the protection of adjacent private interests as well as to water quality.

5.1.1. Legal and institutional risks. Implementation of a PWS scheme requires addressing legal and institutional barriers. The first issue concerns the potential use of restrictive covenants under a PWS scheme. In the USA ‘conservation easements’ recorded on the land title bind the landowner’s ‘successors and assigns’ (Serkin, 2010). In NSW, despite section 70A(1) of the Conveyancing Act 1919 (NSW), a mere covenant does not bind successors in title (Butt, 2009). In the light of changing management priorities and the emergence of new challenges such as climate change (Owley, 2011a, 2011b), it may be sensible for policy reasons to limit the duration and scope of restrictions and payment commitments, and so a limited duration legal arrangement may not be a problem.

However, were it is necessary to have a more enduring legal instrument to achieve water quality benefits from private land a land lease, or special forms of easement with management conditions, may be needed. A lease creates a proprietary interest that would allow the SCA to have exclusive possession for a term. Greater certainty can be achieved by registering the lease against the land title (Butt, 2009).

There will be many contractual issues with a payment for services approach. It is possible that as the SCA’s ‘Healthy Catchments’ program is established, arrangements could be achieved by extending existing contractual processes. The most substantial impediment or risk to a PWS initiative will be implementing the mechanisms needed to charge the SCA’s water utility customers and ultimately the consumers through a water rate increase. As discussed above, water pricing structure is controlled by the Independent Pricing and Review Tribunal (IPART). Applications can be lengthy and time-consuming, and IPART (correctly) takes an independent stance in its determinations. However, the terms of reference under which it operates are set by government and a proposal for a water market approach to comply with the COAG policy commitments of the NSW Government would seem to be a valid matter for IPART consideration.

5.2. Water quality trading

A second option for the SCA is a WQT scheme as a means for more efficiently pursuing catchment-wide total water quality targets. We envisage a point–non-point WQT scheme to supplement the regulation of point sources under environment protection licences. A point–non-point WQT scheme could help to offset the impacts of point sources such as sewage treatment plants, piggeries, dairies, and poultry farms. This would involve trading in water quality credits between the point sources (buyers) and those able to help to offset these emissions (sellers). For example, nitrogen and phosphorus released from sewage treatment plants might be offset by various activities on farming land (SCA, 2009b). Relevant actions include tree planting, reduced use of fertilizers on farmland, or construction of artificial wetlands in urban environments (Greenway, 2010).
5.2.1. Legal and institutional risks. Changing from a system of point source pollution management based on environment protection licences to a point–non-point WQT scheme faces legal and institutional barriers. The first is the lack of defined standards for water quality entering drinking water reservoirs (McKay & Moeller, 2001). A WQT scheme is less likely to operate successfully without a specific cap on the total loads of pollutants entering the catchments. The cap provides the constraint on supply that is essential for a viable market to emerge. Creating the cap requires reforms to enable the SCA, perhaps in collaboration with the EPA, to set binding standards for water quality entering into reservoirs. The US EPA TMDL regulations for individual catchments are a useful model to consider. A new provision in the Sydney Water Catchment Management Act 1998 (NSW) would enable the SCA to set the standards to be mandated under a modified version of the Sydney Water Catchment Management Regulation 2008 (NSW). We suggest that similar changes should be made to the Protection of the Environment Operations Act 1997 (NSW) to facilitate WQT schemes in other regions of the state. McKay & Moeller (2001) suggest that caps on pollutant levels would be best determined based on a uniform Australian standard for water quality entering reservoirs.

Assuming a cap on particular pollutants, the next barrier is the creation of a form of property rights in water quality – or more accurately, property in a permit to discharge specified units of particular pollutants. A key to success of a point–non-point WQT scheme is the capacity to ‘unbundle’ property rights that are identifiable, alienable and that can be assumed by third parties (Martin et al., 2010). Creating statutory rights in water quality as profits à prendre has occurred with carbon (Butt, 2009), and could be accommodated by amendments to the Conveyancing Act 1919 (NSW). The carbon example illustrates that once water quality rights are defined by statute as profits, various instrumental approaches can be used to provide a basis for trading and registration of interests (Butt, 2009).

Given the research of Braden et al. (2009), it would seem that a WQT scheme would be most likely to succeed if administered by a body with which landowners are familiar. The SCA is the obvious choice as it has been operating in the catchments since 1998. However, for the SCA to operate effectively in this new context it will require new systems and skills, and the difficulties of changing from one ‘game’ to another should not be under-estimated. Cultures and systems tend to be persistent and early failures and difficulties must be anticipated.

It is important that incentives are provided to landowners to prevent perverse outcomes. Perverse outcomes can include over-payment for activities, and rewarding of harm-doing. Questions of additionality (ensuring that payments are for new outcomes) and avoiding windfall gains to landowners who have degraded their land are both difficult policy problems that will require sophisticated institutional design (Horan & Shortle, 2005).

For WQT it is essential that verifiable units of exchange are determined as well as appropriate trading ratios (Shortle & Horan, 2006). Assuming that scientists can model water quality and develop units of exchange between point and non-point sources of pollution, appropriate trading ratios are largely a question of economics (Shortle & Horan, 2008). For example in the Tualatin River case the trading ratio is set at 2:1 on the basis that this is likely to double the benefits of trade. However, there is an argument that such a ratio can work in a perverse way by actually diminishing overall trade in the market because it increases uncertainty (Shortle, 2013). We suggest that to maximize trade and increase certainty of transactions the SCA should consider offsetting point source pollution with proportional non-point source remediation.
6. Conclusions

Management of Sydney’s drinking water supply catchments underwent significant change in 1998. Today water quality entering the reservoirs is largely controlled by the SCA, using a combination of direct land management for lands under their legal control, and (for private lands) zone-based regulation of land use, controls over specific potentially polluting activities, and government grants and subsidies. The governance model reflects a traditional ‘command and control’, government-centred philosophy that is evident in most Australian drinking water catchments.

There are deficiencies in the present system. The SCA has limited jurisdiction over the majority of activities undertaken on private land, much of which is cleared, which can be the source of non-point source pollution. The mechanisms for managing such activities are ‘command and control’ regulation. This limits the economic opportunities for landholders. The capacity of the SCA to provide economic support or incentives for landholders is limited by the willingness of government to use taxation funds for this purpose, and so the economic interests of private landholders in managing their own lands is to some degree ‘hostage’ to politics. Furthermore, the approach is based on land use (input) controls rather than water quality (output standards), limiting the potential for flexibility and innovation in achieving defined goals. Using case studies from other jurisdictions we explore the potential for PWS and WQT schemes to better enable the SCA to meet its statutory objectives. We argue on the basis of these examples that a contemporary PWS scheme that reflects the experience of other jurisdictions does have the potential to better address issues of non-point pollution in ways that are likely to be more efficient and fairer than the present model. Under such a model, the SCA would rely more upon negotiated service arrangements pursuing a ‘least cost of supply’ for a defined water quality output, with the costs of these arrangements being reflected in the price of water to consumers. This would require changes to the mode of operation of the SCA and the approval of the IPART to enable a change in the pricing regime. The international experiences we have documented suggest that under a PWS scheme funds are likely to be applied more strategically than under present command and control mechanisms, to secure water quality outcomes at the least public and private cost while maximizing the value of non-water ecological services from the same lands.

The approach proposed better reflects national competition and water governance policy commitments under Clause 64 of the Intergovernmental Agreement on a National Water Initiative 2004, which incorporates the COAG’s Water Reform Framework of 1994 with its explicit adoption of ‘pricing reform based on the principles of consumption-based pricing and full-cost recovery’. The states agreed to ensure that the full costs of water provision are reflected in the consumption price for water, but the present arrangement means that some landholders incur opportunity costs for foregone uses of their land without economic compensation, and therefore without these costs being reflected in the price of water.

Underpinning the PWS scheme we suggest are defined standards for the quality of water entering the reservoirs, implemented through a cap on the total loads of various pollutants emanating from point and non-point sources in the catchments. Market-like arrangements for purchasing services to reduce pollutants would provide the mechanism for achieving these goals at least cost. In effect a WQT approach creates property rights in water quality as profits à prendre. This unbundling would be achieved by statutory amendment. We suggest that SCA be the administering agency, supported by advisory boards and rigorous protocols, to preserve institutional familiarity with landholders, corporate knowledge of the catchment and to reduce the transaction costs of change. However, we appreciate that a significant change in approach requires new skills and attitudes and that making such a transition may in itself
introduce risks and costs that will need to be managed. These findings are of relevance to many drinking water catchments in Australia and beyond in situations where authorities have little jurisdiction over catchment lands and where governance models reflect traditional ‘command and control’, government-centred philosophies that limit economic opportunities for landholders.

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