VALUE AND PRICE: COUNTING ECOSYSTEMS AS URBAN WATER INFRASTRUCTURE

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ABSTRACT

Sustainable management of urban water relies on our ability to integrate knowledge from ecological, social and economic disciplines, and our capacity to examine the functioning of the system as a whole. Three functions of water charges (infrastructure investment, consumption and resource awareness) were investigated using a survey of households in two New Zealand urban communities. Auckland and Christchurch represent opposing endpoints on a continuum relating to charging policies, access to information for consumers, water availability and resource "identification, ownership and pride". A consumer surplus for the maintenance of water related ecosystem goods and services was identified in both communities. Attitudinal and behavioural variables explaining differences in the willingness to pay for water and ecosystem goods and services are discussed. Perceptions of, and expectations for, water management were found to be significantly different between the two communities, displaying an adherence to "identity constructs". Appropriate pricing and water management policies have an inherent potential to drive the required shift towards low impact, sustainable, urban communities. In particular, efforts must be made toward counting ecosystems as an integral part of urban water infrastructure. A transdisciplinary framework for urban water management can help bridge the gap between currently segregated hydrological, bio-physical, social (including cultural) and economic systems of water management.

KEYWORDS

Ecosystem services, ecological identity, sustainability, urban water management, willingness to pay.

1 INTRODUCTION

How resources are managed depends on a society's perception of value. The perception may change with improved understanding of management options and subsequent consequences for the economy, society or the environment. Thus, imperative to sustainability is up to date evaluation of community attitudes to, and expectations for, resource management. By better understanding the multiple realities present in the community, one can design policies that, while deemed acceptable, pull communities' behaviours away from wasteful consumption towards ecologically sustainable resource utilisation and asset investment.

Decisions on how to allocate, price and invest in water are usually made by comparisons between the economic returns on different water demands, and the economic cost of supplying water. The conventional economic paradigm dictates that water be allocated to its highest value use, that investment in water infrastructure should generate the lowest cost and highest profits, and that cost of supply and value of demand is considered when pricing water goods and services. However, ecosystems form important yet frequently ignored components of both supply of and demand on water. Failing to invest in the ecosystems which maintain water quality and quantity, may cause the lifespan and future profits of infrastructure developments to be reduced and running costs of water services to increase substantially (Emerton and Bos, 2004).

Pricing mechanisms for water in New Zealand differ between metropolitan districts, and a variety of fees, rates and volume based charges are currently used. The NZ Parliamentary Commissioner for the Environment (2000) summarised that there are existing pricing deficiencies in water management throughout New Zealand. It is suggested that these are a result of the combination of historic distortions from subsidies, insufficient provision

for renewals, that there is an investment practice of funding debt but not equity, there is little use of economic instruments to modify demand, no customer choice, and that social and political policies are affecting pricing without transparency (Wilson, 1998; PCE, 2000). This, combined with increasing competition for freshwater resources from other sectors such as agriculture and industry, and the increasing pressures on urban natural environments and ecosystem services due to urban growth, compounds the concern that water is both under-valued and under-priced in New Zealand's urban centres (PCE 2002; Aqualink Reseach LTD, 2008; Berry and Hunter 2008). Although the concepts of externalities, demand management and better use of stand-alone infrastructure components frequently features in water managers' internal dialogues, barriers remain to the acceptance of water policy reforms and to the uptake of technologies developed to assist in fit-for-use sourcing, stand alone infrastructure components and demand management.

In Auckland, two councils (Papakura and Auckland City) implemented a full-cost charge on water and wastewater by volume in 1996. This resulted in a marked difference in water usage from the remaining five councils in the region, where some water supply and all wastewater collection and treatment are charged in rates (Craig, 2004). Christchurch residents pay for water services in the general rates, and the city is lacking any mechanism that signals the real value of water for the city (Kerr et al., 2003).

New Zealand's water management districts are unique in terms of stocks and flows of freshwater resources, bio-physical challenges, infrastructure investment procedures, demand management initiatives, pricing policies and public relations. Auckland City and Christchurch City are at the opposite ends of the water resource management spectrum in terms of the physical resources, charging policies and public relations. Also, these cities' "identity constructs" (or slogans) may influence the acceptance of, and expectations for, water management. Auckland- The City of Sails, and Christchurch- The Garden City, project different economic and ecological associations. Subjecting consumers from these cities to the same survey allows for the evaluation of attitudes and perceptions of water service provision, charges and values of water in two very different environments; providing the baseline for a discussion of how current management options inhibit or encourage sustainable pathways, factoring in attitudes to water management, water use, water pricing and sustainable development.

Water management practices can be described as broadly adhering to one of three different resource management paradigms: *free public service; utilitarian;* and the *ecologically sustainable resource management* paradigms. Individual and community attitudes, preferences and expectations related to water management can likewise be classified into typologies of common world views (Nancarrow et al., 2004): *utilitarians*, *conservationists*, *lifestyle* and *not interested*.

This paper provides an overview of a larger body of research findings (Creagh, 2010). The research aims to connect the understanding of the management paradigms (reflecting the city identities) with individual preference and typologies. This paper examines the potential for improvements in urban water management through the variety of roles that water charges play in the water consumption system. First, the role of pricing in infrastructure and asset investment is examined. This is followed by a review of the role of pricing in consumption, as a demand management mechanism. Finally the willingness to pay for environmental goods and services in two urban communities is compared and contrasted through an extended contingent valuation. The comparison between the two communities provides the backbone of the discussion about the implications of city identity constructs, including ecological identities, for the acceptance and advancement of sustainable urban water management.

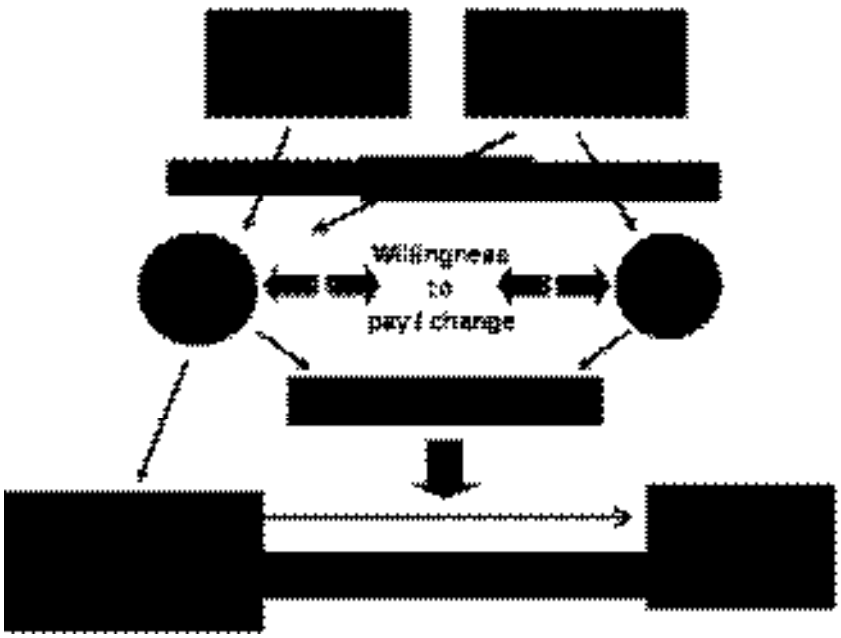
2 FUNCTIONS OF WATER CHARGES

In an effort to curb an ever increasing demand for potable water, many municipalities in OECD countries have since the mid 1990's moved towards more transparent pricing policies for urban water supplies based on the principles of 'user pays' and 'full cost recovery' (OECD, 2000). The concept of 'user pays' expects the consumer to meet the cost they impose on a system (Chapman et al., 2003). In most places however, loss of

ecosystem services and associated values are not included in the pricing equation. Commonly used water pricing structures split the cost between a fixed tax/fee and volume-based charges (Garcia and Reynard, 2004). By having a higher fixed charge, the water utility companies achieve a certain protection against volatility in water consumption, but the practice usually under-prices water, sending economically misleading signals to the consumer. Residential water use under this pricing structure tends to take the characteristics of a luxury service, and to have adverse effects on the environment (Garcia and Reynard, 2004).

Consumption patterns have been learned through past natural resource management paradigms which, in failing to recognise the values of ecosystem services to society and in failing to charge appropriately, severed consumption from any notion of resource availability. Figure 1 illustrates the relationship between values (economic and ecological), price and consumption.

Figure 1: Pathways for water charges and consumption



Currently, natural resource management paradigms are shifting: an ecological awareness is slowly taking hold within resource management institutions and is also increasing in the communities. However, another form of decoupling has surfaced with the most commonly used economic decision aid framework, the neo-classical contingent valuation methods used in cost-benefit analyses (Kumar and Kumar, 2008; Murray, 2009). The economic valuation of ecosystem services has become a positivist-normative process in which people are increasingly de-linked (decoupled) and estranged from the commonsensical and logical ways of thinking, relating and interacting with their natural environment (Kumar and Kumar, 2008). Thus society remains inert to the loss of natural capital. Therefore, rather than continue the trend of decoupling, a systems-value approach that may serve to re-couple previously disjointed concepts of value for individuals was used. With this model, consumption patterns would be expected to change with the influence of ecological values. Uncoupled from ecological values consumption is likely to keep increasing. In contrast, when weights accounting for ecological values, social and personal norms are added, consumption is likely to slow and eventually decline in response to constraints.

Urban water charges thus serve multiple roles; each which can be manipulated to achieve the most ecologically economic efficient outcomes for the urban water system. These are their role in infrastructure asset investments, their role in demand management and finally, in signaling ecosystem conditions back to the community with associated opportunities to reinvest in natural capital. The following sections will describe each function in more detail.

2.1 SUSTAINABLE INFRASTRUCTURE AND ASSET INVESTMENT

To support sustainable development, an infrastructure policy must be concerned with efficiency of resource use to obtain more from less and reduce waste (NZIER, 2004). The Government's Infrastructure Stocktake report (CEDC, 2003) describes the following overarching objective for infrastructure policy: "To enhance infrastructure's net contribution to economic growth and societal wellbeing over time, while reducing the incidence and severity of service failures and adverse effects on the environment."

The CEDC (2003) identified the following issues as critical to achieve sustainability objectives: sustainable use of scarce resources; demand management through pricing, education and other behaviour changing instruments (which in many instances require alternative modes of service to be available to users); efficiency improvements in supply; and innovative solutions such as use of smaller scale alternatives and alternative supply sources. The report also states that "at the highest level, the Government's … role is to ensure that infrastructure makes its full contribution to sustainable management", and that "poorly developed policies can, on the contrary, result in over-reliance of supply rather that demand management, failure to align sector performance to government objectives, inefficient pricing and deterrence of timely investment in new capacity" (CEDC, 2003). Despite this underlying rhetoric, barriers remain to the uptake of stand-alone infrastructure components.

The phrasing 'reduce adverse effects on the environment' can be interpreted as relegating ecosystems subordinate to the socio-economic water consumption system rather than a fully valued system component (weak sustainability models), let alone that which the rest of the system relies upon (strong sustainability models). The cost of repairing degraded environments and the opportunity costs of losing services, suggests that use charges should be levied in order to sustain nature, rather than the current acceptance that nature can continue to subsidise unsustainable economic activities (Craig, 2004). There are current examples from around the world showing that investing in an ecosystem's capacity to deliver water services is cost-effective and have been preferred over traditional infrastructure solutions (e.g. the "New York Water Management Plan" and the Catskills Ranges (Isakson, 2002) and the Napa River Project (Napa County, 2008)). The development of economic tools and the increased understanding of the roles of ecosystems in both water demand and supply is an important step in starting to count ecosystems as an economic part of water infrastructure (Emerton and Bos, 2004).

2.2 CONSUMPTION

Section 19 of the Local Government Act (2002) allows local government to apply user pays charges for potable water, but does not oblige them to do so. It also prevents user-pays charges for Territorial Local Authority (TLA) provided wastewater services. The application of a user pays approach would imply a full cost recovery of capital as well as operational costs, and the avoidance of cross-subsidisation among user groups (Chapman et al., 2003; Garcia and Reynard, 2004). The pricing structure can encourage conservation further by volume-based charges that include increasing block tariffs (price per unit increases with increasing use (Chapman et al., 2003).

A successful outcome of volume-based charges is determined by factors such as responsiveness to price, which may not be well understood at the time of implementation (MacDonald et al. 2004). If for instance the response to increased charges has been overestimated, a much larger increase in price would be required to reduce the demand required for the desired outcome. In Auckland, responsiveness to price became evident with the leveling off in demand since the implementation of volume-based charges for both potable and waste water services. As there are no volume-based charges in Christchurch there is little current knowledge of price and use elasticity.

Chapman et al. (2003) recommend that externalities should also be taken into account in policy decisions on consumption to ensure that demand management reaches its full potential. Further, evidence is emerging that there is support for demand management to be utilised to its full potential, and that pricing structures/adjustments are favoured over water rationing (Quiggin, 2000; Chapman et al., 2003; Kerr et al., 2003; MfE and MAF, 2003; Watercare Services LTD, 2003; Craig, 2004; Garcia and Reynard, 2004).

2.3 SYSTEMS-BASED WILLINGNESS TO PAY

Community perceptions and the willingness to accept policy change remain poorly understood in most water management districts in New Zealand and overseas. This prohibits the implementation of technological and

policy improvements, affecting asset investment decisions and thus continues to foil attempts to create sustainable, low impact urban communities. Some research suggests however that there are New Zealand communities that accept the benefits of environmental protection. For example, a substantial mean willingness to pay was established for the maintenance of urban stream flows in Christchurch (Kerr et al., 2003).

Contingent valuation (CV) is one of a range of economic methods applied to establish consumer preferences for goods that fall outside traditional markets. CV is a stated preference technique that aims to elicit an individual's willingness to pay (wtp) for increased utility of public goods such as ecosystem services by directly questioning a sample of the population. Survey respondents are presented with hypothetical changes to the environmental amenity along with an associated cost (Carson, 2000). While there are commonly accepted limitations to the applicability of the technique, the dichotomous CV survey procedure is a practicable first step in eliciting information from communities regarding willingness to pay for ecosystem services. By bundling ecosystem services a reasonable estimate of a 'grand total' wtp can be elicited: this may be interpreted as a starting point from which in-depth analysis of various components can be generated, and used for constructing pricing equations based on an extended utility function. An extended utility function takes account of sources of utility outside consumption, for instance the benefit of satisfaction from a socially desirable stated intent.

A priori expectations were that both Auckland City and Christchurch City communities will have a positive willingness to pay for ecosystem services due to an increased awareness of environmental management issues at global and local scales. It was also expected that Christchurch residents are more likely to accept higher hypothetical increases as they currently pay significantly less in relation to total household expenditure than Auckland residents, live with higher water scarcity and have more exposure to urban streams / wetlands and related ecosystem services, thus encouraging an increased sense of identity regarding local freshwater resources. However, the radical policy change required to introduce user-pays pricing structures was expected to moderate the above effects by producing increased rates of 'protest' votes compared to the Auckland residents who have had the structure in place since 1996.

3 METHODS

A full description of methods and the survey instrument can be found in Creagh (2010). The survey was conducted August-October 2008. The questionnaire was distributed to 750 households each in Auckland City and Christchurch City, selected from local body electoral rolls using standard random-lists selection procedures (Whitehead, 2006). Respondents were given four weeks to complete the questionnaire. All respondents who returned a questionnaire and detached contact details were entered into a draw of two prices in each city of NZ$300. The questionnaire consisted of a participant information sheet, and introduction, five sections of questions, and a self addressed prepaid return envelope.

The questions covered the areas of perceptions regarding what's included in current charge; a valuation section including proposed new charging structure; attitudes toward water pricing, management and domestic water use; perceptions of the condition of local freshwater resources; preferences regarding management options; perceived household water use; and finally socio-economic variables.

The dichotomous choice contingent valuation section was designed following the National Oceanic and Atmospheric Administration (Arrow et al., 1993) guidelines and J. Whitehead's (2006) "A practitioner's primer on contingent valuation". It departed from the guidelines by bundling the environmental benefits. The proposed change in water-charge scenario described how water and ecosystems are related and asked if respondents were willing to pay more if the charges included protection and restoration of the ecosystems in the watershed, with a' water authority' collecting and managing the funds. The increases in charges to be accepted were fixed amounts of $10, $40, $100, $200 and $400 per annum, with equal numbers of each amount in the sample.

The responses were analysed using the SPSS 16.0 and R software packages. Presented is this paper are some of the main results from the binomial logistic regression.

4 RESULTS

The response rate was 25.7 % from the combined valid sample of 1370, with 171 valid responses from Auckland and 179 valid responses from Christchurch. In Auckland 63% of respondents were female, in Christchurch female respondents accounted for 52%. The mean age was 49.6 with a standard deviation of 15.8. The sample had an adequate spread of income categories in both cities, and although it was biased towards higher representation from New Zealand Europeans, Professionals and Managers there was representation from all major ethnic communities (Maori represented 10% in Auckland and 5% in Christchurch) and occupational categories. The average time for completing the survey was 24.5 minutes with a standard deviation of 12.2 minutes. The valuation question achieved a 100% response rate in Auckland, and a 97% response rate in Christchurch. Open-ended questions achieved the lowest response and Likert scale questions an average of 93% (lowest 89%, highest at 98%).

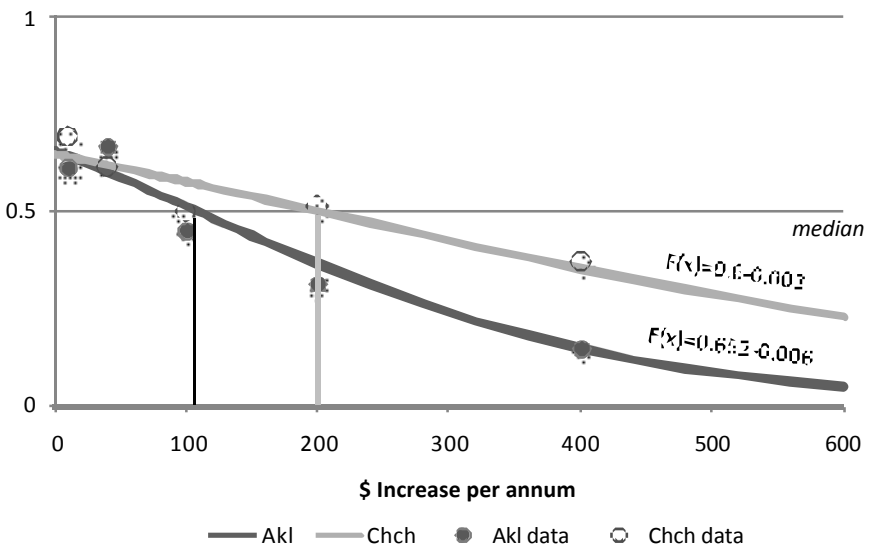
4.1 WILLINGNESS TO PAY

A positive willingness to pay for ecosystem services was found in both Auckland and Christchurch. Figure 2 shows the resulting logistic distribution of the probability of respondents in Auckland and Christchurch accepting the increase in water charges as proposed in the valuation question. At the lowest bid of a $10 increase, 67% accepted in Auckland and 69% accepted in Christchurch.

The mean wtp estimate for Auckland from the logistic regression counting all negatives as zero was $179, for Christchurch the mean wtp was $346. Aggregated by numbers of households in each city the Auckland community consumer surplus for water related ecosystem goods and services was $24.3 million, for Christchurch $51.9 million (for further statistical analysis see Creagh, 2010).

The median (the 50% acceptance threshold) for Auckland was found at $109 increase per annum, for Christchurch at $200 increase per annum. The lower bound majority threshold willingness to pay estimate for water related ecosystem services in Auckland was $12 million per annum (NZD 2008), and in Christchurch $25 million per annum.

Figure 2: Logistic fit of willingness to pay responses



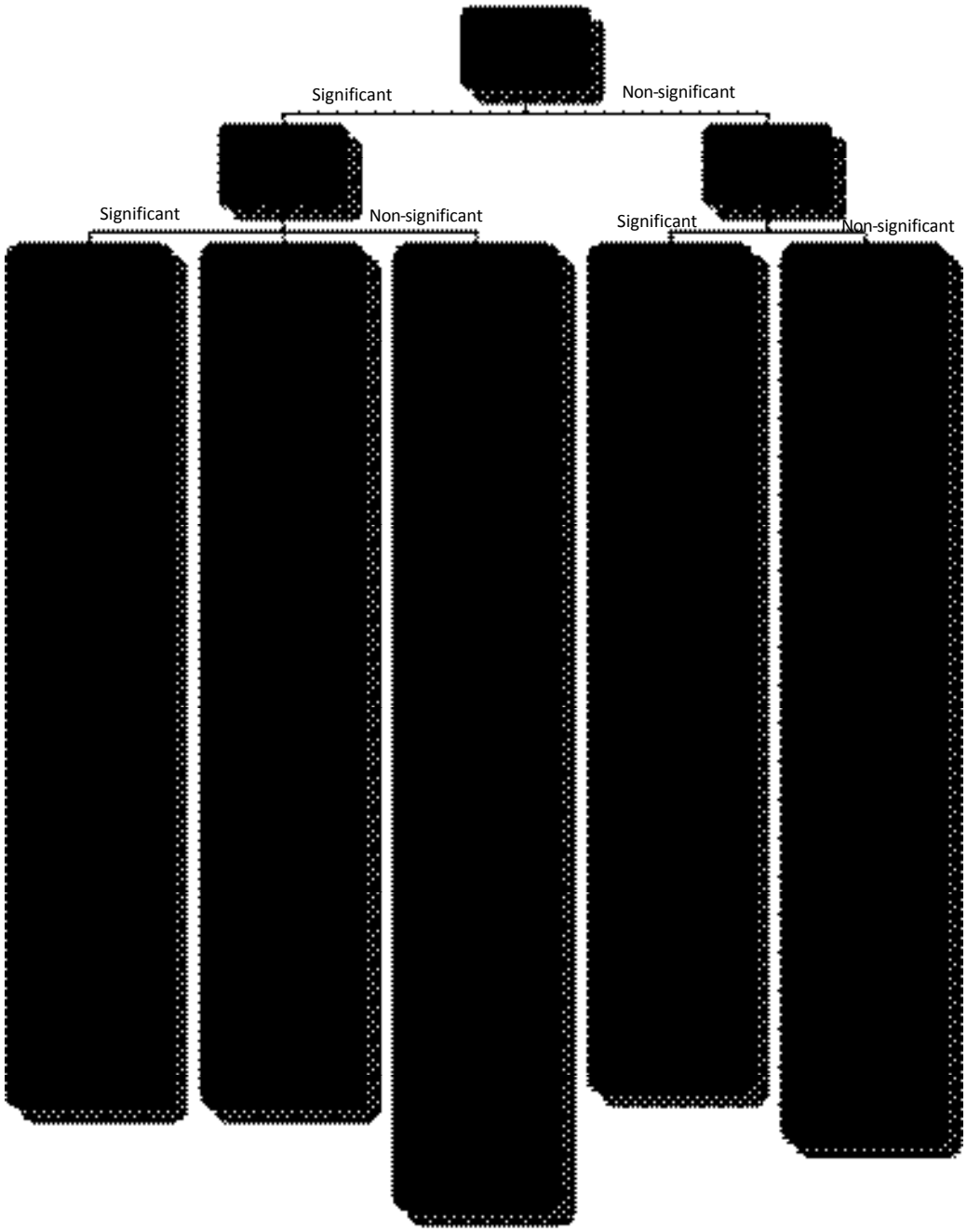
Auckland: median=$ 108.7; mean= $178.6; aggregated mean = $24.3 million
Christchurch: median=$ 200.0; mean = $345.8; aggregated mean = $51.9 million

4.2 ATTITUDES

The research characterised two contrasting communities in terms of attitudes, perceptions, water use behaviour and management preferences. It was found that the two communities exhibited very different characteristics regarding awareness of, and attitudes to, current management and pricing structures. There was a similar heightened awareness of environmental issues related to water, but that water issues are understood in isolation rather than as one whole system; and that the current 'city identities' associate strongly with both attitudinal and behavioural characteristics. It was found that people in Auckland were more aligned to a *utilitarian* water management paradigm; and that people in Christchurch were more polarised, and aligned both with the *free public service* and the *conservationist paradigms.*

Figure 3 presents a summary of the findings from binomial logistic regressions of both the attitudinal and contingent questions; each variable has been placed into a box according to whether or not it was found to significantly predict place of residence, acceptance of the proposed price; and whether it affected acceptance differently in the two communities.

Figure 3: Results from the logistic regression with variables from the household survey as predictors for (1) place of residence, (2) acceptance of proposed increase in charges, and (3) acceptance of increase with a city interaction term.



The strongest predictors for accepting the proposed price increase, disregarding place of residence, were (1) preferring to increase the cost when and if needed, (2) agreeing that ecosystem restoration should be included in the water charge and (3) the belief that the majority would accept the proposed price increase. Also increasing the likelihood for accepting the proposal was a stronger belief that *good quality water from the tap is a privilege*(...) , and that *water charges should be separate and by volume*.

The strongest predictors for not accepting the proposed increase was to consider oneself to be *using water carefully*, a stronger belief that *households should not pay at all*, and that the *charges should be combined in the rates* (Figure 3).

One of the interesting results from the logistic regression was that people in Auckland who did know the service provider's name were willing to pay less than those that did not know the name. This could reflect a lingering sentiment and concerns that Metrowater is run as a business, and as such, is believed to be maximising profit that is not necessarily reinvested in water management. In addition, a portion of Auckland residents still believe that

Metrowater is privately owned. It could however, also reflect skepticism towards water utilities' capability of ecosystem management.

In the analyses of water consumption patterns, Christchurch residents were again typically less informed and used more water per household per day than they recorded. There was a lower uptake of water conservation devices such as rainwater tanks and low flow shower heads, and less use of dual flush toilets. The reason most stated for not saving water by such devices was a lack of information, and secondly, the cost of investment.

It is important to recognise that the backbone of an individual's 'water identity' (for instance consumption behaviour, production of stormwater and appreciation for natural water bodies), is intrinsically linked to access to information of both the economic and ecological water systems; and that willingness to pay will be influenced by both. The findings presented have demonstrated that there is a certain level of acceptance in the community to take account of both systems, positing thus that information concerning the system as a whole should be considered in management and communicated to consumers.

5 DISCUSSION

5.1 EXTENDED CHARGING STRUCTURE

In New Zealand, many TLA's have accepted, albeit not implemented, the rationale behind cost-recovery for water services (White et al., 2006; Water New Zealand, 2009b). Also, local government and resource management institutions have accepted the notion of triple bottom line accounting (e.g. Water New Zealand, 2009a), and the idea that externalities should be accounted for by those that benefit from the transactions. So far however, the ecosystems supporting life in our cities have been provisionally maintained by rates, with no accountability for excess use, wear and tear, degradation and depletion. There is an urgent need for the urban communities to be given an explicit link to the ecosystems that sustain them. Water is consumed by everyone. Hence, an opportunity exists through water charges to deliver a pathway for residents to participate in creating a sustainable future into every household, by making consumption of water ecologically relevant, and eventually, closing the circle by reinvesting in natural capital.

Scherzer and Sinner (2006) maintain that externalities are a cost factor even though they are often unpriced and/or not accounted for, and should ideally be explicitly priced at their opportunity cost (e.g. the amount needed to compensate for say pollution or the loss of habitat). Thus, cost-recovery and externality pricing are aimed at recovering costs, whereas resource rent collection is aimed at collecting any surplus value. Collecting resource rent helps to protect against inefficient allocation of the resource, as the resource should be allocated to those uses that create the most value (including monetary, non-monetary, tangible and intangible).The rent is at any point in time contingent on market conditions, technology, and the system of property rights used to govern access and management (Scherzer and Sinner, 2006; Sharp, 2003).

An extended pricing equation is suggested below. The appropriate charging structure for ecologically sustainable water management should include a fixed term for operations o, a cost recovery term v_{c+e} (where c = cost of supply, e = externalities/eco-costs), and a range of weighted values w such as r for rent (consumer surplus for ecosystem services), a scarcity term s, and a precautionary investment term u (for uncertainty):

$$\text{Price of water} = o + v_{c+e} + w_1 r + w_2 s + w_3 u \qquad (1)$$

Pricing specifications will differ according to individual regions' cultural, environmental and economic constraints, and should be determined around the concept of 'peak ecological water' (Palaniappan and Gleick, 2008).

In conclusion, it is argued that the interpretation of a 'grand total wtp' as illustrated here helps to establish the acceptance of the inclusion of an eco-component in the pricing of water, suggest the level to which this is likely

to be accepted by the majority, and provide information on household preferences to policy analysts and decision-makers.

5.2 COMPARING AUCKLAND AND CHRISTCHURCH PREFERENCES

A major constriction in the development of sustainable, low impact urban communities relates to the inherent reluctance of governing politicians to regulate, or pass directives that upset sections of their voter base, even in situations where they possess a greater understanding of management outcomes (Boven, 2003; Chapman et al., 2003). Therefore, it is imperative to understand the underlying drivers of attitudes and preferences, to be able to devise analytical tools, and further, to design strategies that can effectively drive the required shifts. Attitudes toward environmental management are created by contextual, social and individual factors (Stern, 2000), including for example pricing, income, education (contextual); dominant world view and social expectations (social); and crisis events and progressive adaptation to lower environmental quality (psychological) (see Creagh, 2010, Chapter 3).

This study attempted to bridge the chasm between the social science and economics' discourses on environmental behaviour and willingness-to-pay, by coupling attitudinal understanding to individual preference valuation. The findings confirmed that ecological sustainability has registered as a desired development objective amongst a cross-section of the general public, but also a lack of understanding of what that entails, and how a community may go about achieving it. This was demonstrated for example by the lack of support for water to be scarcity linked, as well as the lack of importance placed on the notion that water should be sourced locally. Such reluctance could be due to people's lingering uncertainty towards electricity prices being linked to availability. In Auckland, people may readily remember the previous drought and the effects that had on the economy; thus reflecting the current situation where security of supply overrides other concerns, and the acceptance that price links directly to the economic system, but is absent from the ecological water system. As was expected, people in Christchurch were more accepting of the idea of linking price to scarcity, and those in support were much more likely to accept the proposed price increase. People in Christchurch also placed stronger importance on sourcing water locally. This finding sustains the argument of the importance of identification with the resource. A further example is provided by the general support for user-pays policies, but for the proportion of respondents who gave that as a reason for not accepting the proposed increase indicating a lack of understanding of what it entails. Likewise, the higher the agreement to the statement *I am careful with the water I use* the less likely the respondent was to accept the price increase.

Another important note concerns the perception of most respondents that the majority of households would not accept the price increase. On one hand, this answer provided reassurance or justification for those that did not accept. For those that did accept, one can argue that 'warm glow' (the good feeling achieved by agreeing to pay for a service without actually paying for it) and hence social and personal norms is demonstrated as a genuine source of utility, and/or the lack of faith in the community's current attitudes towards the environment.

Further, there was a strong preference in both communities for the water service provider to give discounts for reduced use in the event of a supply constraint, e.g. the willingness to save may be greater than the willingness to pay. This sentiment was more strongly expressed in Christchurch than in Auckland. This can also be explained by the lack of pricing signals in Christchurch, whereas incentive to save via pricing already exist in Auckland creating less use elasticity in the system. In general, attitudes and motivational variables were as expected stronger predictors of acceptance than the actual price in Christchurch, whereas the Auckland community had a more utilitarian (conforming to economic theory) response to the proposed price increase.

It was also particularly surprising that neither community recognised water as having cultural and spiritual importance, contradicting the importance placed on the locally sourced ground water in Christchurch and the cultural identification with gardening. Likewise, in Auckland the cultural importance placed on good water quality in the harbours remains decoupled from urban water management for most people. One explanation to this may be that the word 'spiritual' has strong religious connotations and could be perceived as meaning to give water some religious value, making respondents uncomfortable with that label.

Sustainable management of urban water relies on our ability to integrate knowledge from social, ecological and economic disciplines, and our capacity to examine the functioning of the water system as a whole. Improved

understanding of systems must encompass understanding the underlying values of a community. People expressed a clear wish to be better informed about water management, and an appreciation of being asked to participate in the study. The opportunities inherent in such expressions are significant, and managers and decision-makers should capitalise on this by facilitating a dialogue with the public about water management options. It is also supporting the argument for community participation and adaptive management structures for local water authorities.

Overall, the findings from this research highlighted an increased awareness about sustainable management, but at the same time, the continuing lack of understanding and buy-in from the community to move towards sustainable resource management. The empirical findings support the argument that consumption is not the only source of utility for urban residents, and that a different pricing equation may be acceptable to both the communities targeted in this survey. The analysis of the responses can be used to tailor-make information campaigns about the merits of the available options, and can also inform infrastructure investment decisions. One of the more surprising findings from the survey was the lack of sense of the cultural importance of water, given the fact that water obviously carries significant value to the cultures of both cities. Possibly the statement was put wrongly; or, perhaps many uses of water (as are most ecosystem services) are so strongly embedded into our psyche that it is no longer recognised by urban residents as a valuable socio-cultural good.

5.3 ECOLOGICALLY SUSTAINABLE URBAN WATER MANAGEMENT

If sustainability is a goal for society, then ecosystem services must be included in the balance-sheets of water infrastructure. The willingness to pay to maintain ecosystem services in a water-shed should be understood and be available for decision-makers when making choices between alternative uses of land, water and investment funds. Pricing specifications will differ according to individual regions' cultural, environmental and economic constraints, and should be determined around the concept of 'peak ecological water' and 'soft path' investment strategies (Gleick, 2006; Gleick and Palaniappan, 2010). It is argued that the current adherence to conventional cost-benefit analyses and the prioritisation of infrastructure investments to part-solutions, continues to slow progress towards sustainable urban societies. Moreover, without transdisciplinary understanding, infrastructure policy and fiscal decisions will continue to be made in isolation, without regard to the ecological and social sub-systems of water management.

The neo-classical economics' assumption of 'rationality' should continue to be challenged; 'warm glow' should be accepted as a legitimate motivation in wtp estimates, which accordingly should be understood as a social attribute, a societal 'intention'. As such, system-value estimates (or grand total willingness to pay) can be interpreted as gauges of attitudes or the value of intent, and be used as a measure of the level of acceptance of introducing different components to the charges of water to make up some of the deficit in the current water service equation. The estimates' relative strengths and positions say a lot about the community that produced that estimate. Thus, even rough numbers are useful in informing policy-makers. In this research, the communities did express that on top of current charges, and on top of whatever else is spent on environmental management, they would like to see that appropriate (socially fair, economically efficient) charges are in place to ensure the sustainability of the resource, through the protection and restoration of water related ecosystem services. The confirmation of consumer surpluses for maintaining ecosystem services should encourage decision-makers to develop pricing structures that provide feedback signals between water consumption, ecological and built infrastructure components; and to establish and facilitate programmes that restore and protect both option and existence values intrinsic to the local ecological 'capacity'.

Having this knowledge creates significant opportunities for local governments. Ecosystem services can be bundled to achieve the desired relative increases in supply via changes in land use demand, and demand for integrated ecological-economic-social approaches to manage ecosystem assets may be created (Costanza, 2000b). Taking account of the uncertainties related to ecological thresholds, support is mounting for the conservation of critical natural capital to be price determining rather than price determined (Daly, 2007 in Farley, 2008), and for municipalities to establish value-chains that benefit the society and ecosystems (Emerton and Bos, 2004). Water is consumed by everyone. Hence, an opportunity exists through water charges to deliver a way to participate in creating a sustainable future into every household, by making consumption of water ecologically relevant, and closing the circle by reinvesting in natural capital.

5.4 CITY IDENTITY CONSTRUCTS

The current cultural–ecological city identity constructs were identified as likely barriers to the uptake of sustainable technologies, and to influence the acceptance of full-cost user-pays water charges in both communities. The corollary suggests that revised city identities have the potential to become significant community drivers toward sustainable management of water resources. From these findings, it is argued that urban water management has strong inherent potential to further a community's expectations for an ecologically sustainable future, and a latent potential to become the mechanism for achieving that goal.

It is imperative for sustainable development that urban populations reconnect with the ecosystems on which they depend. Here we contend that water, being ubiquitous in humans' life experience, has the potential to bring together the economic and ecological systems for urban residents; and the potential to forge a stronger ecological identity (sense-of-place) needed to drive progress towards ecological sustainability. At present, association with nature is largely removed due at least in part to the reticulation of water infrastructure. Only through duress- droughts, floods, or pollution events- are urban residents reminded of the origins and destination of freshwater. An explicit connection between the ecological systems and economic systems of water management, and the real values of ecosystem services (for water and by water) remain vague concepts for most people in most cities of the world. The potential inherent in the Māori world view (e.g. Sharples, 2009); the mauri of water, the damage caused by loss of mauri and expectations of reciprocal relationship between humans and nature, provides a unique platform and carries significant potential for shaping new visions for catchment based urban water management.

5.5 SUMMARY

The link between water and the environment has rarely been perceived beyond pollution and quality concerns; ecosystem services in particular are omitted from water infrastructure equations. Explicit formulation of ecosystem values, if integrated into existing economic arrangements, may offer a pathway to a new field of incentives, investments and value chains (Emerton and Bos, 2004). For asset investment decisions to be made according to sustainability criteria the total value of water in a catchment must be established. By making the ecosystem's role in the supply chain explicit, and by incorporating ecosystem goods and services in the pricing equation, the failure to meet infrastructure sustainability objectives becomes economically inefficient. By removing the subsidiaries of 'free gift' and 'free disposal' from the water supply chain, economically efficient infrastructure investment will converge towards ecological efficient supply alternatives. By relating the pricing structure of water to 1) the condition of the ecosystems, 2) the non-use value of water in the catchment (resource rent) and 3) the availability of water, pricing signals would serve to inform the community about the system's conditions at any given time and encourage response by decision-makers, water managers and consumers to converge towards ecologically efficient consumption.

5.6 FUTURE RESEARCH

This paper has outlined some of the important attitudinal differences in two urban communities, and attitudinal variables that may serve to enhance the rate of policy reform. Influencing opinion leaders in government, industry and communities is likely to have a wider and faster effect than regulation on pricing alone (Boven, 2003). These relationships could be further explored with scenario modeling techniques involving a wide range of stakeholders. Concurrently with this improved knowledge, water pricing must be developed that allows convergence of responses across community sectors- including decision-makers, professionals and consumers. Mediated system dynamics modeling with focus groups involving stakeholders from across all community sectors could identify system blocks, explore the strength of feedback loops and evaluate system conditions for water management districts and be used to enable learning through creation of 'what-if' scenarios (Constanza and Ruth 2001; van den Belt, 2004; Meadows, 2008).

6 CONCLUSIONS

Current water management practices in New Zealand fail to meet several of the overarching sustainable development objectives as stipulated under current resource management legislation.

If sustainability is a goal for urban water management a transdisciplinary approach and a systems perspective is required.

Although there seems to be an increasing awareness amongst the water services industry and the general community about sustainability, there is a lack of understanding regarding how a community may achieve ecological sustainability.

Consumption behaviours learned through past resource management paradigms shape communities attitudes, perceptions and expectations around water management; thus a paradigm shift is needed to significantly change people's consumption behaviour and expectations.

A positive willingness to pay for ecosystem services was found in two New Zealand urban communities currently with very different management and charging policies in place.

The lower bound majority threshold willingness to pay for ecosystem services in Christchurch was NZD$25 million per annum.

The lower bound majority threshold willingness to pay estimate for water related ecosystem services in Auckland was NZD$12 million per annum.

The development of cultural-ecological identity constructs related to water management could aid urban communities in creating expectations of sustainable water management.

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