A theoretical framework for understanding factors that contribute to household adoption of rainwater harvesting in south east Queensland.

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Abstract

This paper examines the experiences of South East Queensland (SEQ) households concerning rainwater harvesting (RH). Although the adoption of household rainwater harvesting is currently booming after extended stagnation at around 8% in SEQ, what actually motivates this adoption is not well understood. A survey of 90 households in Ipswich (one of 18 Local Government Areas in the region) comprising three groups (with an existing RH installation, retrofitted RH installation, and no RH installation) completed a 200+ item written survey spanning household decision making, household behaviour, household beliefs, household RH system characteristics and demographics. A theoretical framework is developed for household adoption of RH systems through an exploratory synthesis of Ecological Modernisation Theory's (EMT) systemic perspective on households as consumers in a market driven by pro-environmental (PE) technologies, together with Everett Rogers' actor-centred theory on the Diffusion of Innovation. The empirical rigour of these two theories is examined by overlaying survey data on core elements of the theories. This paper reports on the pilot study for my thesis, which has the three aims of (a) characterising issues in RH adoption in the aggregated experience of the wider south east Queensland community, and (b) evaluating Ecological Modernisation and Diffusion of Innovation as tools for understanding adoption patterns in household rainwater harvesting to (c) determine a valid, reliable and robust way of describing or predicting the adoption of pro-environmental (PE) technologies. Quantitative and qualitative data are used to conceptually and empirically develop eleven constructs in the synthesis of the two theoretical positions to arrive at a framework that provides theoretical refinement of the household RH adoption phenomena.

Introduction

South East Queensland, midway on the east coast of Australia, continues to suffer from a long "green" drought. A green drought is a period in which it may rain, but rainfall does not replenish water storages (Cordiner, 2006). The one million homes of our urban population in South East Queensland are supplied principally by dams, some operating as low as 20% of capacity. Yet annual rainfall volume to the average home in South East Queensland is sufficient to supply half the household demand for water (Australian Water Association, 2005: 29).

In addition, South East Queensland is one of the fastest growing regions in all Australia, with population expected to increase by 50 000 per year over the next twenty years (Australian Water Association, 2005: i). Urban demand on the reticulated water supply is increasing with population growth in the region. Without further demand management, the projected demand for the 3.7 million south east Queensland residents of 2026 is 630,000 ML per annum. Current treatment capacity is just over 500,000 ML, and supply is 656,774 ML (Australian Water Association, 2005:

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21). The existing resources are barely able to meet current demands. Multiple sources of supply need to be explored, tested and implemented in the immediate future.

With regional rainfall of sustainable volume and good quality, and growing demand on the urban water supply, rainwater harvesting (RH) is increasingly considered as a supplement to the mains supply by resident households and as an urban demand reduction strategy by the 18 Local Government Area Councils and Queensland Government. The "technical" aspects of such supplementation are relatively uncomplicated, and various installation rebates are offered to households by most Councils and by the Queensland Government.

Household RH is distinct from sources such as construction of new dams, water recycling or desalinisation that augment the reticulated supply and is an attractive form of supplementing household supply for several reasons. In addition to reducing demand on mains supply, household rainwater tanks can (a) assure an alternative and independent household supply during mains water restrictions, which is (b) though somewhat dependent on end use and maintenance, usually of acceptable quality for domestic purposes, and which is (c) renewable at acceptable volumes through natural precipitation, despite forecast climate change (Jones, 2005). RH systems produce beneficial externalities, (d) reducing peak stormwater run off and associated processing costs. Finally, they are (e) simple to install and operate, (f) running costs are almost negligible, and (g) it is convenient and economical in the sense that it provides water at the point of consumption.

Current household RH adoption trends

Household adoption of RH systems in south east Queensland is growing, but on recent data, remains limited at 8% in the SEQ region and just 5% in the capital, Brisbane (ABS 4602.0, 2005). While very little is known about why some households adopt RH systems, the ABS report presents a range of factors that inhibit RH adoption from the perspective of non-adopting households that have considered RH systems. The ABS data are unfortunately unclear in defining this sub-population, for example, whether a household *presumption* of issues such as cost, space and time precluded an actual "consideration" by those households. Given the obfuscatory operationalisation, closer exploration of the depth of consideration in non-adopting households is a focus of the present study.

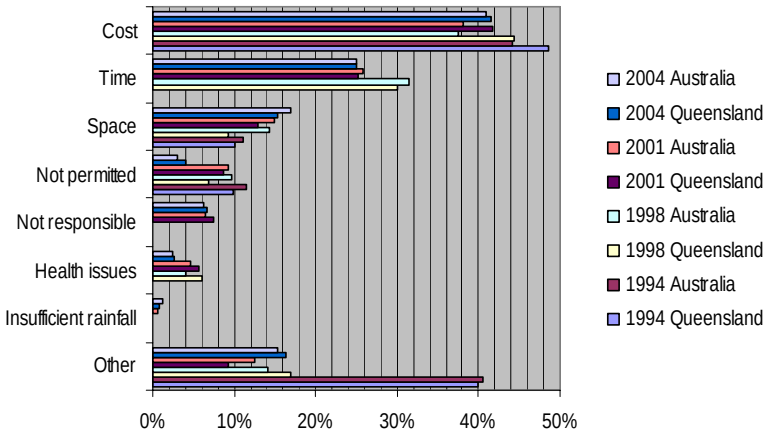

FIGURE 1: Reasons for not installing a rainwater tank
Source: (Australian Bureau of Statistics, 4602.0 (2005: 33)

Figure 1 shows that of those households in south east Queensland that had considered installing a tank, cost (42%), lack of time (25%) and lack of space (15%) were reported as the greatest inhibitors. It is of some interest that 15% of households cited (collectively unspecified) other reasons for not installing a rainwater tank. 4% of Queensland households reported they were not allowed to install a tank in their area (historically accurate), down from 8% in 2001, and just over 2% of Queensland households cited potential health issues as a deterrent. These are not significantly

different from the national data and appear reasonably stable over time, suggesting inhibitor validity and reliability.

Clarification of issues associated with household reticence to adopt RH technologies may be useful in developing means of facilitating wider household adoption, and so ameliorate the growing burden of demand on reticulated water resources. This problem poses a number of broad research questions, each of which concerns a cluster of more fine-grained issues. The broad questions are:

- What are the dominant influences on household decision-making and behaviour associated with adoption of household RH systems?
- What are the experiences of south east Queensland households in connection with establishing, using and maintaining household RH systems?

Theoretical framework

In the style of Thomas Kuhn (1922), Michael Burawoy and colleagues suggest "to lay out as coherently as possible what we expect find in our site before entry" in the "Extended Case Method" as a pathway to provide fine-grained refinements to existing theory in its "theoretical gaps and silences" (Burawoy 1991:10). This paper considers a synthesis of Ecological Modernisation (EM) and Diffusion of Innovation (DI). The theories are completely compatible in operating from a shared paradigm of structural functionalism, they are logical and positive and experiential; a highly effective way of organising structural and cultural elements in their effects on consumption.

However, while these are both emergent and popular theories, there is no shortage of critics who suggest that "theory" somewhat overstates the rigour of both, and operationalisation weaknesses persevere. Nevertheless, the combined frameworks of EM and DI are interesting because they respectively offer (a) a systemic perspective on society with (b) an actor-based approach that articulates the perspective of the adopter. Together, they are the spider *and* the web. Two further questions are raised concerning the explanatory power of the structures of EMT and DI under philosophical and scientific scrutiny:

- How effective is Ecological Modernisation Theory (EMT) in explaining the interaction of variables like household consumption decisions, product innovation and governance in support of household adoption of RH systems?
- How effective is Diffusion of Innovation Theory (DI) in explaining the interaction of variables like relative advantage, system complexity and communication in support of household adoption of RH systems?

Interrogation of the theoretical framework in this context yields an understanding of the suitability of EMT and DI as a lens on household adoption of RH systems, as well as other PE technologies.

Ecological Modernisation and Diffusion of Innovation

EMT provides a useful framework for studying adoption of PE technologies because it theoretically inverts previously assumed connections between the environment and development, decoupling economic development from environmental degradation (eg Christoff, 1996; Huber, 1985). EMT contends that private sector innovation, governance and consumption reforms mutually influence each other and that all of these can exert a positive influence on the environment. The household purchase of a rainwater harvesting system appears idiomatic.

The direct effect of pro-environmental technological innovation, according to EM principles, is adoption. The theory-in-action is complicated because rainwater harvesting is not a new technology (although innovations in accompanying equipment have burgeoned). Nevertheless, calls to "rationalise" lifestyle or to reduce consumption are generally received reluctantly by the community and with the ongoing drought, community use of water is increasingly rationed. The advantage and

significance of installing a rainwater tank is that it actually "expands the limits" [cf Meadows et al., 1974] to household consumption.

EMT secondarily recognises that the social, political, economic and environmental return on pro-environmental governance and policy has had a significant impact on adoption of PE technologies (eg Hajer, 1995; Janicke, 1991).

In South East Queensland, Queensland and local governments facilitate community adoption of rainwater harvesting systems through a combination New Environmental Policy Initiatives (NEPIs) like mandating RH systems in new housing approvals and cash rebates offered to households for retrofitting RH systems. EMT contends these governance incentives encourage adoption by reducing the direct cost of installation to households. In South East Queensland, these so-called "indirect" impacts created a substantial household RH rebate system that produced unprecedented demand and a waiting list of four to six months for manufacture of rainwater tanks. The culture of RH adoption provides an interesting longitudinal contrast to ABS data predating the rebate system in South East Queensland.

The third tine and most recent development in EMT is its expansion from command and production to incorporate a focus on consumption (Mol and Sonnenfeld, 2000; Spaargaren and van Vliet, 2000). It provides a consumer marketplace in which social dimensions include chreseology, communication and satisfaction. Households as social and economic units must overcome inertia in the context of an available, high quality mains water supply; transcend the inhibitiors such as cost, space and time reported in the ABS study; maintain a commitment to the decision throughout the process of selecting technologies that enable desired end usage, finding qualified installation professionals; and accommodate changes to their lifestyles and routines that ownership necessitates.

EMT holds the implicit assumption that the community will "go green", given the choice and incentive. It provides six constructs as (systemic) structural moderators of household adoption of rainwater harvesting systems: Consumption and Lifestyle, Economic Influence, Environmental Influence, Governance and Regulation, Societal Influence and Technology and Innovation.

A shortfall in the EM perspective arises at the construct of Consumption and Lifestyle, in which the heterogeneity of adopters is somewhat over-theorised as "lifestyle choice." While the system is adequately operationalised by EMT, the reality of RH adoption by individual households is evidently not step-wise. More fine-grained understanding of the diffuse reality of household adoption is required. Synthesis of EMT with Diffusion of Innovation theory allows a more fine-grained analysis by empirically collaborating a further five moderators of adoption.

Diffusion of Innovation theory, taken as the body of work pioneered by Everett Rogers (1983), encompasses adoption of new technologies, but also new ways of knowing or ideas. DI asserts that adoption is facilitated by criteria centred on the *actor*. Diffusion is defined as "the process by which an innovation is communicated through certain channels over time among the members of a social system" (Rogers 1983:5). Rogers recognised adoption spreads through populations in the shape of the S curve, though the shape varies with saturation, differing rates of adoption and that each innovation follows its own paths of diffusion along the curve (Figure 2), the S curve is a distinct commonality, replotting a bell curve in the adopting population.

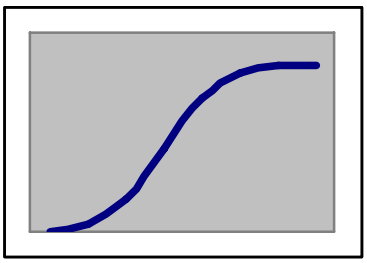

FIGURE 2: Standard adoption curve, where X = proportion of population ddopting and Y = time
Source: Rogers (2003)

Rogers argues that across a range of DI research, five dimensions, the constructs of relative advantage, compatibility, complexity, trialability and observability are identified as factors influencing adoption. As such, DI offers to provide the 'household experience' through its actor-based methodology. Rogers argues these five moderators have been "widely used for the past twenty years" (1983: 211). In a meta-analysis of studies using Rogers' model, Rogers argues "49% to 87% of the variance" in adoption of innovations was variously explained by combinations of the five characteristics of innovations.

Relative advantage, the most significant predictor in Rogers' work, is multidimensional as it constitutes the household's perception of any advantages conferred by adoption, including, for example, economic, environmental, social prestige, convenience and satisfaction influences and outcomes. The relationship is positive: the greater the relative advantage perceived in a RH system, the more likely is adoption (Rogers, 2003). The present study argues the broad influences constituting this factor obscure more fine-grained understanding and that many of these influences are better explained in the synthesis with EM theory.

The other factors are decreasingly significant in their impact on adoption. 'Compatibility' is the consistency with existing values, past experiences and needs so that compatible, rather than alien technologies and values are typically easier to accommodate and more likely to be adopted. Is the RH technology compatible with the values, beliefs and expectations of the household – and not, therefore, so grand as a new value system or a choice among competing lifestyles (Rogers, 2003).

Complexity'is the extent to which an innovation is perceived as difficult to understand and use. Innovations tend to adopt more slowly if they are perceived as too complex. RH is elementary in concept and practice. Chreseology, that is consideration of the actual mental, behavioural or other impact that adoption places on the household is important in estimating impact of complexity (Rogers, 2003). 'Trialability' has also been shown to influence adoption, where the innovation may be trialled or experimented with on a partial basis (Rogers, 2003).

Observability concerns diffusion of the innovation, whether the innovation is visible to others. Rogers (1979) found that installations of solar panels on a house were shown to peers and may be found in spatial clusters. Diffusion is defined as "the process by which an innovation is communicated through certain channels over time among the members of a social system" (Rogers, 2003; Rogers, 1979).

Despite a claim they are conceptually distinct, Rogers concedes the moderators are not discrete: "Each of these [moderators of adoption] is somewhat empirically interrelated with the other four." (1983: 211). The uncertain factor structure is recognised. Rogers observes (1983: 234) "As yet, there has been very little diffusion research designed to determine the relative contributions of each of the five types of variables." There is clear opportunity for refinement of moderators that—at least for the synthesis of the two theories herein—are 'better explained' elsewhere. For example, the issue of government incentives for adoption of PE technologies, Rogers includes in the catch-all Relative Advantage, whilst EMT would recognise it as PE governance.

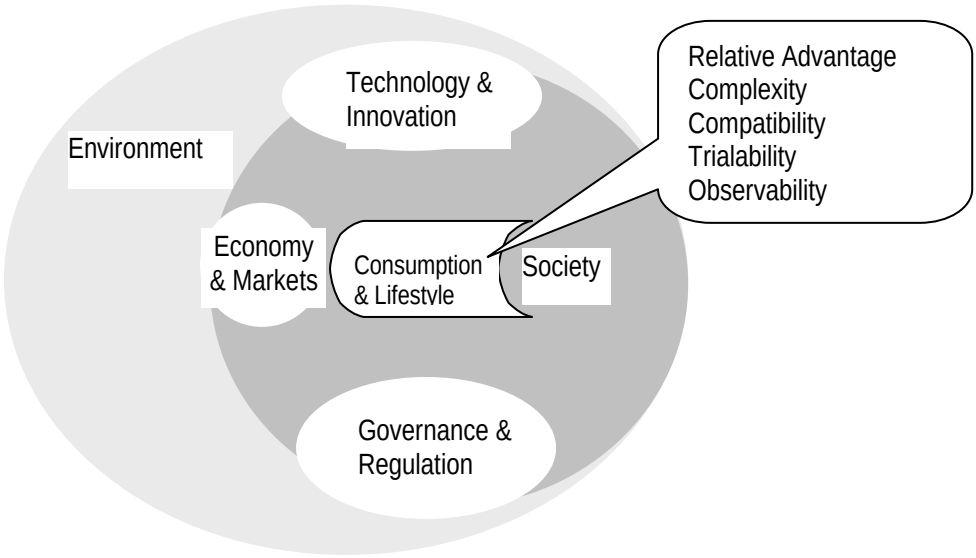

FIGURE 3: Graphic Depiction of the Integration of Diffusion of Innovation with Ecological Modernisation

FIGURE 3 presents a graphic summarising the synthesis of theories proposed in this pilot. It is consistent with the view of Ecological Economics, in that the social subsystems operate within the confines of a closed (and therefore finite) ecological system.

The synthesis attempted in this pilot study provides eleven moderators of adoption. The fresh empirical and inductive exploration of household RH adoption decision-making may yield data sufficiently sophisticated to confirm the basis of these eleven moderators.

Consumption and Lifestyle: operationalised as the extent of mastery that households seek over their own consumption preferences (whether consuming or conserving) and the effort they invest to achieve this.

Economic Influences: operationalised as net effects of installation and maintenance costs offsetting available installation rebates and expected reductions in water bills.

Environmental Influences: operationalised as the effect of ongoing drought, climate change and diminished reservoir holdings on household Rh adoption and use.

Governance and Regulation: operationalised as the effects of NEPIs (New Environmental Policy Initiatives) that mandate and regulate RH installations, as well as incentives provided for RH adoption.

Societal Influences: operationalised as the effects of community and shared community responsibility.

Technology and Innovation: operationalised as the role that existing and emergent technologies play in household RH adoption through their impact on the functionality of RH installations.

Relative Advantage: operationalised as the extent to which RH installations advantage the adopting household on those factors that have particular significance for that household, and differentiated from Rogers' operationalisation as also that they are not better accounted for elsewhere.

Complexity: operationalised as the degree to which the functionality of household RH systems are conceptually understood and technically of good practice, providing water quality appropriate to household uses.

Compatibility: operationalised as the extent to which RH adoptions are compatible with household lifestyle (experiences and values), and integrated with household structures like plumbing and yard space.

Trialability: operationalised as the extent to which households require additional familiarisation with RH systems before adoption.

Observability: operationalised as the extent to which households passively display or actively share awareness of their RH adoption with others.

Methodology

Sampling: Households are used as the units of analysis because they are a discrete, well-operationalised socio-economic unit. A stratified multi-stage cross-sectional sampling procedure was used to obtain N=30 in each of three RH conditions (an existing RH installation, RH installation for or on behalf of the household, and no RH installation) for the single Local Government Area (the City of Ipswich) used in the pilot study.

Privacy legislation prevented the researcher obtaining RH adopter identities from rainwater tank suppliers or Councils. So, households in each of the LGAs were randomly sampled from the street directory. These households were approached in person by the researcher and if they consented to participate in the research they were given the 'Adopters' Survey". Respondents indicated whether the RH system was fitted before purchase or by the current occupant to distinguish respondents between the RH system conditions. Subsequently, another household in the same street (but without RH) was similarly approached and invited to complete the 'Non-Adopters' Survey'. This method of data collection provided the best synthesis of random sampling, and so also generalisability of the data, with constraints of sampling convenience for the stratified conditions.

Instruments: A written survey format was selected primarily to allow respondent anonymity and also because a number of the survey items require reflexive responses which may not be easily forthcoming to respondents in an oral interview format.

Two pen-and-paper surveys (adopters and non-adopters) were developed from a review of the 2005 Cooperative Research Centre for Water Quality and Treatment Draft Manual for Good Practice in Household Rainwater Harvesting, current technologies in RH systems, operationalisation of the theoretical constructs in the theoretical positions of EM and DI, items following the ABS document 4602.0 (2005) Environmental Issues: People's Views and Practices, and items reflecting current governance, experience, communication and household judgment in South East Queensland.

The two instruments incorporate a cover letter to the research with contact details and instructions, and approximately two hundred data points across eighty items in a combination of formats ranging from multiple choice to short answer. The survey format is structured into five sections - (a) household RH systems and applications, (b) household decision making, (c) household behaviour, (d) household beliefs and values (e) demographics. Draft surveys were iteratively trialled in pre-testing with consequent correction of unforeseen issues in the clarity and ease of use of the survey instruments. The aim of the pilot survey is to allow data collection suitable to support development of scales and factor structures contributing to my PhD thesis.

Research Process: A pilot survey was made of the 90 Ipswich households, with 30 in each RH condition. A systematic follow-up communication regime was used (Dillman, 2000), comprising a 'thank you letter' and provision of duplicate surveys to non-respondents to assure optimal response rates. A codebook formalised and preserved the integrity of categorisation of responses during data collation.

Planned Analyses: Analysis of responses provides depth and structure to the operationalisation of proposed factors. Since this is a relatively exploratory search for the 'meanings' and behaviours associated with household RH, quantitative methods will be informed and complemented by collated qualitative content analyses in accordance with criteria developed in the thesis codebook.

Quantitative data in the pilot study will be analysed using the SPSS package in connection with the extraction of factors influencing adoption identified in this document. A descriptive analysis of all items in the surveys (range, means and deviations) is a starting point for deeper covariation analyses. Several large items on the surveys were designed with scale development in mind, for example Question 4.1 incorporates 37 attitudinal items covering constructs in the adoption theories. Since this research taps pluralistic social issues, it is assumed that most interactions will be multidimensional and ultimately, principal factors analyses are planned to establish power of explanatory factors.

Results and Discussion

At the time the paper was due to be submitted the large number of factors proposed for the analysis obfuscated effective statistical analyses. Where possible, summary data are presented here, with the fuller quantitative analysis to be presented at the conference. Consistent qualitative responses allow confidence in reporting on these data.

The systemic influences on household adoption were considered in terms of six constructs derived from EM theory: Consumption and Lifestyle, Economic Influences, Environmental Influences, Governance and Regulation, Societal Influences and Technology and Innovation.

Consumption and Lifestyle: The primary reasons cited for installing an RH system was freedom from current water restrictions, typically for garden watering (62%). Households also installed RH systems to obtain better quality drinking water (25%), to reduce household consumption of mains water (25%) and because they felt the Government had failed to act on the water crisis (13%). Although frequency and descriptive data suggest this was a significant motivator, scale development ($\alpha = 0.65$) suggests the need for further refinement of piloted items.

It is noted that the concept of mastery over consumption does not necessarily translate to reduced consumption – indeed one of the 'advantages' afforded by RH adoption is that it 'expands the limits' of available water to a household. This was particularly evident in the frequency of respondents citing overcoming water restrictions for outdoor use. Other comments include:

- *We grew up with rainwater and prefer the taste to mains water, plus we keep animals, poultry and like our own vegetables and a green environment*
- *To keep the desired level in the pool*
- *An alternative source of water, water without chlorine*

The vast majority (81%) of households reported no additional impact of the RH installation in their daily routine, which both theories argue is important in encouraging adoption, while a small number reported minimal disturbance effecting system maintenance:

- *Very little—only to clean the filter and first flush after the rains which takes an hour*

Economic Influences: ABS data suggest economic influences (typically the upfront cost of installation) are the primary inhibitor of household RH adoption. On average, adopting households spent $2400 on RH installation after rebates (approximately 3% of annual income) for a modal 5000L tank. Non-adopting households reported they were prepared to spend an average of $1400 after rebates, again for a modal 5000L tank and a similar percentage of household income. Scale development ($\alpha = 0.80$) does suggests a moderately strong relationship. With an item relating to saving on future water bills removed, the psychometric integrity of this scale improved ($\alpha = 0.84$) at the expense of conceptual integrity, so the item was retained because the topic was reported by several respondents in their written answers, for example:.

- *Because we are on acreage and pay enough in water rates as it is*

- *[Households installing tanks should have] less red tape & charges for permits & inspections, rebates on water bills*

Environmental Influences: Scale development of environmental influences - the impact of the environment in household decision making - suggest a moderately strong relationship ($\alpha = 0.81$). In Australia the recognition of climate change has recently gained more popular acceptance, for example the conservative Federal Government finally recognising the validity of IPCC and other reports. Combined with the ongoing drought in South East Queensland, which has seen reservoirs drop to below 20% capacity, the water crisis is a daily issue in the media and the SEQ community. 96% of respondents reported household conservation of water, while over two thirds of respondents reported that installing a tank were essential, given the drought. 86% were motivated by ensuring household access to water during mains restrictions and just over half reported that their values on the environment had been a bigger incentive than the rebate offered for installation. Three quarters of households extended the influence of the environment over their decision making on other household purchases.

- *Yes, we are running out of water*
- *Yes, to ensure that this commodity is available for future generations*
- *Yes, because of current and likely future drought conditions*
- *Yes, we can no longer rely on normal rainfall*
- *Use of water that is otherwise wasted*

Governance and Regulation: The Councils that govern the eighteen Local Government Areas of South East Queensland evolved separately, with historically each responsible for the management of water supplies to their community. Since the ABS (2005) survey, and particularly as the burden of water supply has transformed the historical cash cow of water charges raised from the community, Councils and the Queensland Government have each implemented NEPIs to address household RH as a form of water demand management. Rebates for tank installations range from $200 to $700 and are cumulative with a $1000 Queensland Government rebate. These rebates are conditional on RH installations satisfying various requirements eg tank capacity, integration with household plumbing, siting conditions and so on. Undoubtedly, these rebates have given incentive to many households for RH adoption. Yet one compelling finding of this research has been the reluctance of households (19%) to seek the rebates despite installing tanks.

- *We refused to involve the council or Beattie [Queensland Premier] because they're a bloody pain*
- *We knew we wouldn't get the rebate because of where we put the tank, but we wanted it anyway.*
- *Any involvement of any of these departments would be disastrous*
- *In 2001 when we purchased our first tank there was a low demand for tanks; no government subsidies were available. We've put another one in since but it's too much trouble [pursuing the rebate].*

In addition to the rebate carrot, the Queensland Government also introduced legislation mandating RH installations for newly built homes and renovations. Although this legislation wasn't effective until January 1, 2007, Councils may impose their own regulations and many introduced this earlier. In the pilot study I visited several new estates, searching for such homes, but was disappointed to find that larger scale developments had not provided RH installations. This has been attributed to uncertainty as to whether the developer or home owner is eligible for the rebate, with the developer losing out. A small number of newly built households sampled may not reflect the views of the wider community:

- *It's part of the long term sustainable design we wanted in our home, the whole house runs on rainwater with automatic switching to mains back up.*

However, almost three quarters of the pilot sample clearly supported this mandate and some felt Councils and Government had not gone far enough.

- *Rainwater tanks should be a standard inclusion for anyone renovating or building a house in this day and age - no thought required.*
- *Increase the minimum tank size and require that a minimum of the roof area is used to make tanks more effective.*
- *help low income families, compulsory for landlords to install tanks*
- *Make tanks mandatory and provide income-rated rebates and full rebates for those who can't afford them*
- *Make the rebate and inspections systems they have actually work*
- *Mandate for new buildings for toilet flushing, laundry and garden use*
- *Subsidise Council installation to create jobs for apprentices*

Although this factor provided an interesting range of written feedback, scale development for the Governance and Regulation construct requires further development at this stage. The most valued sources of information used by households (rated for quality and completeness of information) were system retailers (%), Council (%), and Queensland Government (%). Most respondents reported obtaining this information through internet or telephone contact.

Societal Influences: The role of individual household consumption in the context of community consumption has been developed through the Tragedy of the Commons problem (Hardin, 1968). While earlier sections show that households seek to buffer themselves from community water restrictions, one third additionally reported that it was unfair that some households went to the trouble of installing tanks to reduce consumption when other households didn't (56% rejected this assertion). Three quarters of households reported that more adequate centralised supply (eg dams) were more appropriate

- *Can't believe that government was stupid enough to think it could meet demand in the first place. People need to be more responsible and contribute where they can.*
- *Changing lifestyle and increased water use was and is foreseeable, why do governments consistently fail to see this until now*

Scale development was exceptionally weak for the proposed Societal Influences items, despite the apparent consistency across individual items.

Technology and Innovation: The central tine in EM theory is the white knight of emergent PE technologies that decouple environmental impact from consumption and development. Indeed, household RH systems clearly satisfy this in part, by augmenting the water available to households, both temporally and in terms of volume. Yet no one could argue that technologies central to RH are new. New technologies do exist, however, in the form of automated 'topping up' of tanks and of automated switching between rainwater and mains supply. The $1000 Queensland Government rebate is conditional on the latter technology, from experience recognised by one respondent.

- *Rainwater tanks are not a complete solution and may be detrimental where automatic mains top up is provided (as is the case for Pimpana-Coomera integrated water cycle management scheme. With automatic top up, people will be unaware as to when they are using mains water for garden purposes.*

In the Machiavellian age we live, it is also of interest that the *concept*, as well as the technical device for switching between mains water and the rainwater supply has been patented (Ennor, 2006), which may have implications for diffusion based on the considerable cost of the marketed device (≈$800), which essentially requires only a solenoid and floats, but inhibits cheaper competitors, maintaining a financial barrier to more complex RH system adoption.

Again, scale development was exceptionally weak for technological innovation items. A key event in the role and diffusion of RH technologies, however, was the policy of Councils through the 1970s to ban household RH, ostensibly under the auspices of health concerns, but what was widely recognised in the community as a desire to augment consumption of the reticulated mains water for revenue purposes.

EM theory sidestepped the problem of stepwise adoption with a given set of systemic conditions by arguing for household idiosyncrasies on the basis of lifestyle. Although 65% of adopting households felt their adoption decision was a lifestyle choice, the thesis attempted in this research finds this position somewhat superficial in its insensitivity to household heterogeneity. Instead, the idiosyncratic influences on household adoption are considered in terms of five constructs derived from Rogers' actor-based DI theory, which advantages the problem through segregation of the 'lifestyle' construct into more specific aspects. Rogers provides five: Relative Advantage, Complexity, Compatibility, Trialability and Observability.

Relative Advantage: The most significant of Rogers' factors in explaining adoption, Relative Advantage is problematised by colluding *every* advantage and incentive conferred by adoption. Since many of these are better explained elsewhere, particularly through the factors offered by EM theory, one function of this pilot was to seek to establish specific instances of this occurrence. In terms of results, the majority of households reported multiple specific advantages in adoption. On the face of the data presented, it appears that virtually all of the 'advantages' households realise through RH adoption can be siphoned off to more specific factors enabled through the synthesis with EM theory. A decision is yet to be made whether this factor should be retained in the final account, although for the purpose of empirically validating the synthesis of theories, it is valuable to demonstrate that this appears to be the case.

Complexity: Comprising both conceptual and technical complexity of RH installation, 100% of household across both adopter and non-adopter conditions 'Strongly Agreed' or 'Agreed' that "The concept of harvesting rain for use by my household is simple and appealing". While most households are doing simple RH installations to facilitate garden watering, 12% of respondent households have integrated the rainwater supply with the mains supply to internal fixtures (eg laundry, toilet flushing) in the household. The additional costs of this supplementation added an average $3000 to the installation costs relative to RH installations for non-household use, and must be completed by a licensed plumber and signed off by Council inspectors. Where these more complex installations allow rainwater to supply as much as 90% of household water needs, households must be strongly motivated to transcend reliance on the mains supply.

- *No need, we've always used mains*
- *Water is used in every part of the home, except for the kitchen sink, which Council wouldn't allow*

Others thought there was a role to be played by Council in helping to assure integrity of maintenance.

- *Councils should check filter screens on tanks*
- *The rebates are good, but advice about maintenance is needed*

Compatibility: The ABS report suggests the only inhibitor to have an increasing impact is available yard space, as lot sizes decrease. 88% of adopting households indicated space was not an issue, compared with 57% of nonadopters. 27% of adopters said the RH installation was troublesome to integrate with the existing household plumbing, while 73% indicated it was compatible with household values and lifestyle. Scale development requires further work.

Trialability: Neither adopters nor non-adopting households indicated a need to trial RH systems before installation. This result was expected because of the low complexity already recognised, whereas it emerged DI literature because of the unfamiliarity of many innovations for potential adopters.

Observability: Rogers' development of the Observability construct was based on findings that the visibility of photovoltaic panels for solar hot water led to localised clusters of adoption (Rogers). While 56% felt it was important that their household conserve water as an example to others, only 25% displayed (required) signage that rainwater was in use. Fewer than 25% of households felt a sense of pride in contributing to water conservation through tank installation. Although 78% reported that showing guests the water tank precipitated discussion of the water crisis, only 25% of households were influenced to adopt RH on the advice of friends and more than half were reluctant to give any advice to others on RH installations.

Conclusions

Although it is still too early to establish any meaningful quantitative assessment of the factor structure in household adoption of RH systems (and other PE technologies), the data obtained in this pilot survey confirm the roles of each of the proposed factors in moderating adoption, with the exception of Trialability, which was not expected to play a significant role.

Since this survey was undertaken as a pilot study of the concepts provided by the two theoretical perspectives, refinement of items and scales will reduce the likelihood that these data will be totally compatible with consequent research. Nevertheless, the results provide some confidence that the more nebulous issues problematising the theorising of both EM and DI perspectives, respectively of Consumption and Lifestyle and of Relative Advantage can proceed to be more meaningfully explored through the synthesis of these perspectives.

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