Communicating Scientific and Technical Information about Alternative Water Supply Options: A Review of the Literature

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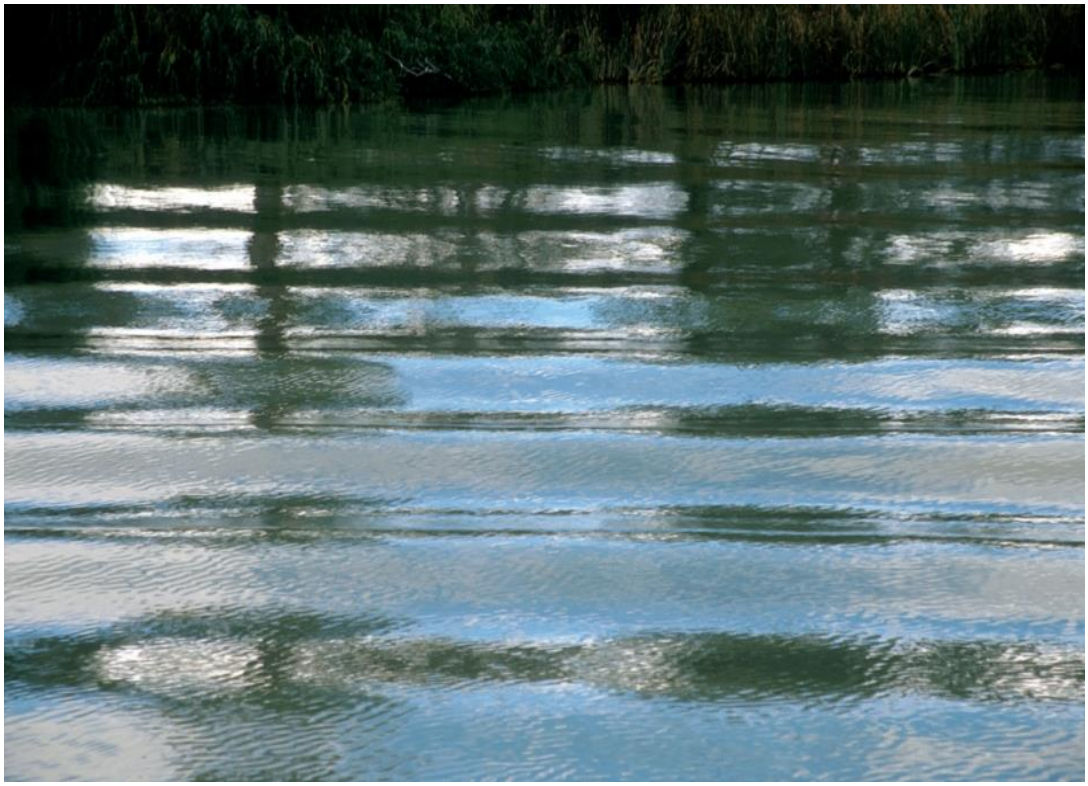

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The Urban Water Security Research Alliance (UWSRA) is a $50 million partnership over five years between the Queensland Government, CSIRO's Water for a Healthy Country Flagship, Griffith University and The University of Queensland. The Alliance has been formed to address South East Queensland's emerging urban water issues with a focus on water security and recycling. The program will bring new research capacity to South East Queensland tailored to tackling existing and anticipated future issues to inform the implementation of the Water Strategy.

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FOREWORD

Water is fundamental to our quality of life, to economic growth and to the environment. With its booming economy and growing population, Australia's South East Queensland (SEQ) region faces increasing pressure on its water resources. These pressures are compounded by the impact of climate variability and accelerating climate change.

The Urban Water Security Research Alliance, through targeted, multidisciplinary research initiatives, has been formed to address the region's emerging urban water issues.

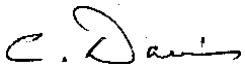
As the largest regionally focused urban water research program in Australia, the Alliance is focused on water security and recycling, but will align research where appropriate with other water research programs such as those of other SEQ water agencies, CSIRO's Water for a Healthy Country National Research Flagship, Water Quality Research Australia, eWater CRC and the Water Services Association of Australia (WSAA).

The Alliance is a partnership between the Queensland Government, CSIRO's Water for a Healthy Country National Research Flagship, The University of Queensland and Griffith University. It brings new research capacity to SEQ, tailored to tackling existing and anticipated future risks, assumptions and uncertainties facing water supply strategy. It is a $50 million partnership over five years.

Alliance research is examining fundamental issues necessary to deliver the region's water needs, including:

- ensuring the reliability and safety of recycled water systems.
- advising on infrastructure and technology for the recycling of wastewater and stormwater.
- building scientific knowledge into the management of health and safety risks in the water supply system.
- increasing community confidence in the future of water supply.

This report is part of a series summarising the output from the Urban Water Security Research Alliance. All reports and additional information about the Alliance can be found at http://www.urbanwateralliance.org.au/about.html.



Chris Davis
Chair, Urban Water Security Research Alliance

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EXECUTIVE SUMMARY

Alternative water supply systems are increasingly being proposed, and implemented, to supplement dwindling traditional water supplies. A crucial component of the success of these schemes is that local communities are informed and involved in all stages of the process, from conception to implementation. This suggests that the role of communication in the water domain is an important one. Here, a review of the literature on the communication of alternative water supply schemes is presented.

According to Moser (2010) there are a number of key elements that must be considered when developing effective communication. These include: goals of the communication, audience, framing, messages, messengers, channels and effect. These elements form the structure of this review and within each are suggested considerations from the literature that can be used when developing communication strategies.

- Determining the goals of the communication endeavour is an important first step. The goals may be to inform and educate a particular audience about a proposed water supply scheme; to engage the community for co-management of a water supply system; to build trust between water authorities and the community; or to try and change particular water use behaviours.
- The intended audience(s) should be indentified and insight gained into their values, attitudes, beliefs, worldviews, social norms and context. It is suggested in the literature that communication efforts can become more salient to audiences when aligned with their set of values and beliefs.
- Communication should be framed in a way that addresses existing issues and concerns or highlights important aspects of identified issues.
- Messages conveyed need to be accessible, consistent, respect diversity and not overwhelm the receiver.
- The messenger plays an important role in the delivery of the message and needs to be trusted; however audiences often differ in their trust of messengers.
- Communication should also be delivered through a variety of channels to appeal to diverse audiences.

Examples from the water management domain are used to further illustrate and examine the above elements. In addition, the review focuses on examining the effectiveness of specific communication methods and efforts. Overall, it is crucial to evaluate the effectiveness of communication activities. This evaluation should be continuous and align closely with goals. It is apparent that community engagement plays a large role in what is perceived to be effective communication. However, the practicality of engaging the community depends on the scale of the water management issue. While "effective communication" is an oft-used phrase in discussions surrounding alternative water supply schemes, what constitutes this is rarely defined or tested in the literature. The appropriateness of certain communication goals is discussed, such as, whether communication should aim to convince people to accept an alternative water supply scheme or to encourage participation in dialogue about the scheme and hence empower communities to participate in decision-making. Future research is required to understand what is meant by effective communication in the water domain and whether holistic communication that connects water with human values is of greater benefit than scheme-specific information in attempting to solve the growing water crisis facing many parts of the world, including Australia.

1. INTRODUCTION

With increasing and competing demands on current water supplies and unreliable rainfall patterns due to a changing climate, one of the greatest global challenges is securing our water future for residential, industrial and agricultural purposes. In particular, securing water supply for growing residential areas has prompted many countries to investigate and invest in alternative water supply schemes, such as recycled water schemes, desalination plants and the utilisation of existing groundwater supplies (Water Services Association of Australia [WSAA], 2005). Successful and unsuccessful attempts to incorporate alternative schemes in diverse places such as Singapore, California, Namibia and Australia, have led to the recognition that the fate of such projects is largely determined by the local communities. Years of research and rigorous science can amount to nothing if the community chooses not to accept (Po, Kaercher and Nancarrow, 2003; Ingram et al, 2006; Hurlimann and Dolnicar, 2010). When trying to conserve current water supplies there is also a need for individual, household and community level behaviour change. The implementation of water restrictions in many parts of Australia has meant that a range of behaviours has begun to change (e.g. turning off taps, reduced garden watering days and so on). Therefore, when considering water security, the community plays a large role in both the implementation of new schemes and conservation of current traditional supplies.

Critical to the conception and implementation of an alternative water scheme is the role of communication in providing information that may shape individual and community attitudes towards alternative schemes and/or change their water consumption behaviours. While the role of information and communication in creating behaviour change has been well documented in the literature, there remains a lack of clarity about its role with regards to water management. Recently, scientists (and others) have recognised the need to rethink the relationship between science, technology and society (Libutti and Valente, 2006). In particular, a CSIRO study in South East Queensland (SEQ) found that scientists and project leaders involved in implementing a purified recycled water scheme were still uncertain about how to best package information, particularly when trying to reach different audiences and stakeholders (Russell and Green, 2009). In the study, a series of interviews conducted with technical stakeholders identified effective communication as a key remaining challenge. Specifically, communication was said to be necessary to introduce alternative water management options within the community, for the community to make informed decisions and for building trust. Concerns were raised about the need to release communications in a sensitive and timely manner, about how to communicate uncertainty and how current communication strategies could be improved by using a range of tools appropriate for a range of audiences (Russell and Green, 2009).

Communication about water management has historically been situated in the context of developing nations where issues such as access to adequate water supply and water sanitation were, and still are, of primary importance. As noted by Hatfield-Dodds, Syme and Leitch (2006, p.44), "water has been a central focus of culture and social organisation throughout human history". Now, both developing and developed countries are facing water security issues. As a result, and particularly in high density urban areas, the issue of how to best communicate alternative water management options is paramount.

This review details what is known about communication in the water domain. In particular, we discuss the different dimensions of communication, the effectiveness of documented communication examples and where future research efforts are needed. Whilst we draw on the international literature, particular focus, along with recommendations, is given to the Australian context. The purpose of communicating about alternative water supply systems, the role of communication in citizen acceptance of alternative supplies and whether communication and community engagement can lead to effective co-management of traditional supplies are considered. We begin with a brief introduction on the theory of communication and then introduce a framework for discussing the various components of communication in the water domain. To conclude, the gaps in water communication literature will be identified and recommendations for future research highlighted.

2. COMMUNICATION THEORY AND PROCESS

The history of communication theory resides within a variety of disciplines (e.g. sciences, arts, mathematics, literature, biology, business and political science) all of which have influenced its development (Littlejohn and Foss, 2007; Moser, 2010). Although the interdisciplinary focus remains, communication is now considered a stand-alone discipline, where scholars believe that communication is *the* organising element of human life (Littlejohn and Foss, 2007). There have been numerous attempts at defining communication but establishing a single definition has not been possible, or appropriate, given the variety of disciplines in which it is situated (Littlejohn and Foss, 2007). In addition, it has been suggested that the 'real world' application of communication makes it difficult to study in a scientific manner (Craig, 1999; Burns, O'Connor and Stocklmayer, 2003). Therefore, it is argued, communication theories are best understood within historical and cultural contexts and should be seen as reflexive with the ability to reinforce or change everyday thinking and practice (Craig, 1999).

When thinking about communication in relation to water management options, the sub-genre of science communication is an appropriate starting point. Science communication is "a tool to create awareness, enjoyment, interest, opinion forming and understanding" (Burns et al. 2003, p.183). Science communication is a more recent development in communication research that reflects a shift away from one-way information flows where experts were required to inform the 'science illiterate' lay community. Science communication is now seen as a critical means for scientists to communicate their work to society, as well as a way for scientists to be active participants in the process of seeking solutions (Barbour et al., 2008). This current definition also extends to include the community as active participants, rather than passive receivers.

The changing role of science and scientists within our society is complex and raises numerous issues. Treise and Weigold (2002) identify several causes of this complexity:

- journalists are not skilled in science,
- scientists are not skilled in communication,
- scientists say too much, too little, or have restrictions on what they can say,
- the public may not be interested in science, and
- there is disagreement as to what the purpose of science communication really is, e.g., is it to increase science literacy, to inform of new developments, to familiarise people with scientific methods, or a combination of these?

Weigold (2001) states that one of the biggest hurdles facing scientists in communication is language, as they may be capable of translating within their discipline but have difficulty conveying a message to the 'lay' community. Barbour et al. (2008) suggest that it is important for scientists to publish in more general forums if they wish to inform policy or resource management or encourage behaviour change.

Despite the complexity of the communication discipline, attempts have been made at creating generalised models that can describe or be applied across communication contexts. Communication can be conceptualised as a one-way or two-way process (Weigold, 2001). The context of communication is also critical to consider (Wibeck, 2009). The movement of a message from one context to another will always result in alteration of the original meaning. Therefore, while it is interesting to examine the role and apparent success or failure of communication strategies across contexts, the focus needs to be on evaluation of the effectiveness of communication in the specific context under study.

In this review, we go beyond simple models of one-way or two-way processes and adopt a framework proposed by Moser (2010) for understanding the key components of the communication process. Moser (2010) poses a series of questions that highlight specific components important to understanding communication attempts. Although developed originally for climate change communication, the framework has wider applicability to developing and assessing communication processes more generally. The components include:

- Goals: What are the goals (i.e., scope and purpose) of the communication?
- Audience: Who is the audience (individuals, specific sub-populations, particular interest groups or socioeconomic sectors, etc.)?
- Framing: How is the issue framed? What language, metaphors, images, etc. are used?
- Message: What are the messages? What information is conveyed and is it useful and accessible? Content also raises questions about sources of information and their credibility.
- Messenger: Who are the messengers (e.g., politicians, scientists, planners, industry, celebrities and people of different ethnic or socioeconomic background and of different ages).
- Communication Channel: Through which channels does the communication occur?
- Effects: How do we know the communication had the intended effect?

In this literature review, Moser's (2010) framework is used as a guide for reviewing and assessing the literature on communication around alternative water management and supply schemes. It is important to note that this is only one possible framework in which to assess components of the communication process and many examples from the literature actually cross over multiple components, for example the type of communication channel used is strongly related to audience type. By drawing on this framework and using it to assess examples from the alternative water supply literature, we aim to identify what is known about communication in the water domain, whether previous communication attempts have been effective and how water communication can become more effective in the future.

3. CRITICAL COMPONENTS OF COMMUNICATION

3.1. Goals

"People will forgive you for your mistakes; but they won't forgive you for not telling them about them" (Risk Communication Expert, 2001, cited in Hartley, 2003).

Before any communication strategy can begin, the goals and purpose of the activity need to be identified. There are numerous goals that a water communication strategy could set out to achieve, for example: to provide broad-based education on a state-wide initiative or a specific neighbourhood based scheme; to improve community engagement, share views, promote mutual understanding, build trust; and change the attitudes and behaviours of the community. Moser (2010) highlights three goals that are important to consider for all communication: 1) to inform and educate; 2) to achieve some level of social engagement and action; and 3) to bring about changes in social norms and cultural values. It is this third point that is somewhat contentious as it has been commonly cited in the literature (see later section on Audience) that communication needs to fit with community values, attitudes and beliefs, rather than attempting to change them. One important goal for communication is to help practitioners work with the community to decide whether and/or what change is desired (Syme and Hatfield Dodds, 2007). Without this knowledge, it is difficult to assess whether resistance to change has come about as a result of a poor communication and engagement strategy or whether the resistance existed from the beginning (Syme and Hatfield Dodds, 2007).

If behaviour change is the goal of communication then it is important to understand the extent to which information can promote behaviour change. The provision of information helps to raise awareness of issues, provide citizens with additional knowledge and empowers them to make a critical assessment of the proposed scheme or management plan (Lorenzoni and Hulme, 2009; O'Toole et al., 2009). Often there is a misperception that if people are not acting or changing in the way experts expect then the answer must be to provide them with new and improved information, and lots of it

(Russell and Hampton, 2006). Holden (2002) notes that in the United Kingdom there was a formal announcement to change the original term 'Public Understanding of Science' to 'Public Engagement with Science and Technology'. Despite the emergence of a more empowering term, there remains an underlying belief that the public possesses a knowledge deficit (Libutti and Valente, 2006), particularly in regard to water management, along with the belief that greater technical information will lead to public acceptance (Russell, Lux and Hampton, 2009) and less controversy (Nisbet and Mooney, 2007).

Hartley (2001) believes that the goal of communication is more than transmitting scientific or technical information; it must relate to people's views, ensure fair decision-making, and help build trust between community and practitioners. In a review of eight potable reuse case studies, Marks (2006) highlights a lack of transparency at the early planning stages; she argues that the emphasis was placed on marketing the proposals rather than keeping the public informed and including them in deliberative consultation. The outcome was that one of the eight schemes was implemented; a result that Marks (2006) argues highlights the importance of including community engagement in the goals from the beginning of any water communication activity. Examining such historical back-flips has led to a call to include new forms of knowledge (e.g. from different disciplines) and expertise (e.g. public knowledge) when considering water management options (Head, Wallington and Robinson, 2010). Whether these recommendations are adhered to in the future is yet to be determined. In sum, it appears that, while information provision is an important goal of communication, community engagement is critical. Therefore, the goals of communication need to be determined by all with a vested interest.

3.2. Messages

"There are too many unanswered questions. We need a bit more assurance" (Anonymous participant, community workshops on the acceptance of PRW, cited in Alexander et al. 2008).

Messages are about how we convey information and whether it is useful and accessible (Moser, 2010). Hartley (2003) suggests that information should be compatible with human cognitive processes. This means presenting information in small instalments to avoid overwhelming the receiver, using common vocabulary rather than jargon, presenting information in familiar settings, as well as making sure a variety of media and mediums are used to present the information. Messages are more than words or information; they are accompanied by imagery, tone, emotions, pictures and colour and it is by using a combination of these that messages are able to reach a wide range of audiences and keep their attention (Hartley, 2003; Moser, 2010). It is important to keep the message consistent (Moser, 2010). In addition, messages must be positive and respect diversity (Nisbet and Mooney, 2007) and everyone must have equal access to the information (Hartley, 2003).

Uncertainty is an important challenge faced by communicators and can create issues for establishing clear messages. Wibeck (2009) notes that failure to address issues around uncertainty when communicating can be detrimental in the design and implementation of alternative water supply schemes. There are two main models for communicating uncertainty: the separation model where experts inform policy; and the integration model where experts, policy makers and citizens discuss the uncertainties together (Wibeck, 2009). Wibeck (2009) suggests that both models have positive and negative aspects but, overall, the integration model appears to be better at increasing trust between stakeholders (Wibeck, 2009). The integrative approach can also be used to "encourage reflection and learning within and across sectors" (Wibeck, 2009, p.99) and create a sense of shared responsibility to create achievable outcomes.

Specific case studies of communication in water management (Marks and Zadoroznyj, 2005; Trumbo and O'Keefe, 2005; and Khan and Gerrard, 2006) suggest that information is a powerful tool for raising awareness and changing behaviour if conveyed correctly. Careful consideration is needed to develop appropriate messages, as people require more than just the facts and figures (Russell and Lux, 2009). Marks and Zadoroznyj (2005) investigated various water reuse sites and found that those sites with extensive formal water communication strategies (e.g. websites, newsletters, invited public attendance/input at board meetings) had higher awareness amongst residents regarding the regulations

and rules surrounding the reuse systems. In addition, accountability was clearer and residents had less need for more information. Khan and Gerrard (2006) argue that there are ten messages that need to be communicated about water reuse schemes, with the main focus of the messages on highlighting the benefits of a scheme to encourage community acceptance. Although the authors speak about engaging stakeholders in the decision making process and encouraging two-way communication, this is not evident in their messages which fail to provide opportunities for community engagement or input. In relation to information about water conservation, Trumbo and O'Keefe (2005) found that those with pro-environmental values and behaviour are more likely to seek out information on water conservation and that information is a predictor of water conservation behaviour. On the basis of this finding they suggest that water conservation promoters should not dismiss the power of information.

Although these case studies highlight the potential importance of information and messages about water management, there are several ways in which the intended meaning of messages can be misinterpreted. For instance, different audiences may interpret the same message in different ways according to their values, a phenomenon termed *polyseme* (Fiske, 1986). Audiences may reach a shared understanding of a message but place different value on its meaning: *polyvalence* (Conduit, 1989). Contradictory values or statements contained within a message can be reconciled in different ways by audiences seeking to alleviate cognitive dissonance: *multivalence* (Stroud, 2002). To overcome misinterpretations, Moser (2010) notes that messages must be tested prior to fully fledged outreach campaigns if campaigns are to be effective. Moreover, Hurlimann and McKay (2004) suggest that providing information alone will not improve trust in an agency or supplier of a water scheme and instead, timely and effective communication is what is needed. What is meant by 'effective communication' will be discussed later.

3.3. Framing

"Scientists aren't good at communicating how risk assessments are done in a way that people can understand. But they are very technical and hard to understand even for technical people" (Anonymous participant, CSIRO risk interviews 2008).

The way an issue or activity is framed is one of the major considerations for effective communication (Moser, 2010). Here, we draw on the water management literature, risk communication literature and the persuasion literature to provide insight about the importance of framing for effective communication. The major premise of framing is that an issue can be viewed from a variety of perspectives and therefore can have multiple implications (Chong and Druckman, 2007). Framing can also refer to the process by which people conceptualise an issue or reorient their thinking about an issue based on their interests and concerns (Chong and Druckman, 2007; Isendahl, Pahl-Wostl and Dewulf, 2010). People draw their opinions from a set of beliefs that are already stored in their memory, of which only some beliefs are applicable at that time. Framing works by creating new beliefs or making certain beliefs 'strong' or available (Chong and Druckman, 2007). Nisbet and Mooney (2007) reflect on the framing of science and suggest that scientists need to accept that their scientific facts will always be misapplied and therefore they should avoid emphasising the technical details of their science when trying to defend it.

Moser (2010, p.39) suggests that "frames construct a problem, provide a perspective from which to interpret it, even help us perceive some aspects of it, while disregarding or overlooking others, and deeply influence how persuasive we find the information being communicated". Further, frames are triggered by words, imagery, symbols, messengers, music, tone of voice and gestures which resonate with some audiences, and mobilise them into action (Moser, 2010). There is rarely a single frame that can communicate complex and uncertain issues such as alternative water management schemes. Isendahl et al. (2009; 2010b) investigate the concept of framing by asking water managers from three European river basins to participate in "uncertainty dialogues" to identify uncertainties in water management as part of their New Approaches to Adaptive Water Management (NeWater) Project. The responses were qualitatively analysed via a discourse analysis and from the discussions they were able to develop a set of framing parameters that can be applied to help raise awareness about various uncertainties. They note that by questioning and contrasting the different frames used and by making

them explicit, it is possible to scope out uncertainty in the proposed water management strategies and therefore where to focus the most attention.

Perhaps the best examples of framing in the water management literature come from recycled water case studies (Hartley, 2006, Menegaki et al., 2009; Miller and Buys, 2008). Hartley (2006) demonstrates how frames created by the media can be influential on particular groups in society. In his example, a San Diego newspaper published a cartoon of a man and a dog both drinking from the toilet, with the caption "toilet to tap" attached to it (Hartley, 2006). This phrase instantly appealed to those opposing the proposed recycled water scheme and from then on was widely used in a variety of contexts by those opposed to the project. Menegaki et al. (2009) investigated whether different terminology changes the acceptance of recycled water. They found that the term "recycled water" resulted in greater acceptance of recycled water use for both farmers and consumers than when the term "treated wastewater" was used. Miller and Buys (2008) found gender differences in the acceptance of recycled water: different aspects of the arguments for and against recycled water resonated with each gender. For example, men were more likely than women to say they understood the recycled water process. From their findings, Miller and Buys (2008) suggest that current communication strategies for recycled water do not always reach women. This finding suggests the importance of framing messages in different ways to reach a wider audience.

The importance of message framing suggests that it is imperative to understand the alternative views, knowledge and arguments of stakeholders involved in water management options. This can be achieved through participatory processes (Chong and Druckman, 2007; Isendahl et al., 2009) that also take into account the views and knowledge of water managers and practitioners. The views of these latter stakeholders play a large role in developing effective and relevant management options and should therefore be included to avoid filtering of information based on their own frames or worldviews (O'Toole et al., 2009). Of course, making water management more inclusive of all forms of knowledge and extending the idea of participation to be more inclusive is a huge task.

3.3.1. Persuasion

The persuasion literature provides important insights to inform the framing of messages. The main theoretical model guiding persuasion research, the Elaboration Likelihood Model (Petty and Cacioppo, 1986), was developed as a framework for organising and understanding the basic processes underlying the effectiveness of persuasive communications. The model posits two main ways or routes through which people process messages: the central route and the peripheral route. When people process messages through the central route they pay close attention to the information and they engage in effortful processing of the messages. To engage in this type of information processing, however, people need to be motivated and to have the capacity, for example the time and ability to understand the information. When people do not have the motivation or capacity they process messages through the peripheral route, using peripheral cues to process messages, such as whether the person delivering the message is an expert, or whether the communicator is attractive (Petty and Cacioppo, 1984).

According to the persuasion literature, people will think about an issue either cognitively (logical-content based) or affectively (emotion-content based). Shavitt (1990) found that the most persuasive way to promote something was to match the content of the message to the way the majority of people *thought* about what was being promoted. Shavitt (1990) showed that basing communication on the object's cognitive or affective attitude base increased the amount of favourable thoughts about an object. According to this approach, communicators should first ascertain *how* people think about the issue. Hence, in the case of recycled water, we need to know whether people think emotionally about it - "if we don't recycle water now, we may have no clean water to drink soon!"; or cognitively about it - "if we don't augment our water supply with recycled sources, the price of water will inevitably increase", and what segments of the community are more likely to base their attitudes on cognitive or affective appraisals. Once this is established, communication messages can be tailored to reflect cognitive or affective appeals depending on the audience and how they think about the issue.

Despite the effectiveness of persuasive communication in some spheres (e.g. alcohol related road-deaths, cigarette smoking and so on), evidence suggests that one-way persuasive communication is less effective for garnering acceptance of recycled water, than community engagement techniques (Po et el., 2004). Despite this, persuasive communication does occur in water management situations. Often in water reuse programs, when the proponents are eager for implementation, there is a tendency to try and persuade the community, under the guise of community engagement, to accept the scheme (Russell and Hampton, 2006; Russell, Lux and Hampton, 2009). Often it is assumed that because the technical information is sound and the risks minimal, the stumbling block is that the community need to overcome their emotions in order to accept the scheme. Therefore marketing professionals are given the task of consultation work to encourage, or persuade, acceptance (Russell et al., 2009).

3.3.2. Visual Persuasion

Visual communications can be used to both inform (e.g. via science communication) and persuade (e.g. advertising) (McCoy, 2000). McCoy (2000) argues that information and persuasion are inter-related as purely factual messages without promotional content must still motivate or persuade the viewer. An audience perceived as 'needing' information must also desire this information for communication to be effective. In the context of communicating risk or environmental conservation, this distinction is even more tenuous as factual information is often intended to affect behavioural change despite not knowing whether the need for this information is there. Visual images in advertising function as 'cues' that link a product with personal experiences or emotional states: a symbolic form of communication central to metaphors (Proctor et al., 2005). In a meta-review of the persuasive effects of metaphor, Sopory and Price-Dillard (2002) conclude that effectiveness is maximised when the metaphor is novel, used at the beginning of the message, simple, singular and focused on a familiar target. Metaphors used at the start of the message are effective because they frame subsequent information and direct audience attention in a selective manner to intended meaning. The Superior Organisation persuasion theory (derived from Gentner, 1989) best explained the data: metaphors evoke more semantic associations than literal language and better organise the argument through increased connections and ease of interpretation. Metaphors highlight relationships between arguments, thereby enhancing message coherence, saliency and persuasiveness. This mobilises cognitive resources, generates affect and influences motivational processes in the audience who attribute greater credibility to the source of the message. An example of effective use of visual metaphors in water communication is British Columbia's Water Plan "Living Water Smart" (see: http://livingwatersmart.ca/book/). The picture-book style water plan was developed by the government in collaboration the community and its appealing images resulted in support and action across the spectrum of stakeholders (Caddie, 2010).

3.3.3. Risk Communication

One large body of literature that fits neatly under a discussion on framing is risk communication. Risk communication is important from a societal perspective as it aims to communicate information about potential threats to people's health, safety or well-being (Gurabardhi, Gutteling and Kuttschreuter, 2004). When we apply risk communication to the water domain it is important to consider whether all water management options are perceived or framed as risky, or whether they actually are risky. The Water Services Association of Australia (2005) suggests that all alternative measures and management strategies aimed at securing long term water supply have some degree of uncertainty or risk, particularly because Australians take the reliable supply of safe water for granted. Further, they note that understanding these risks is key to the long term future of Australian communities and hence communication around these options is crucial (Water Services Association of Australia, 2005). Yet, Dingfelder (2004) suggests that Singapore's New Water scheme was successful as it was framed as being beneficial in reducing Singapore's reliance on Malaysia and thus the benefits were highlighted as outweighing the health risk concerns.

Risk communication is complex. Messages about risky options are rarely spoken with one voice, therefore conflict can arise (Stern, 1991). The deficit model of lay public understanding assumes that the public does not understand science and therefore is deficient (Sturgis and Allum, 2004). This deficit model is often apparent when conveying environmental risks as it is assumed that controversy surrounding risk can be resolved with the provision of more accurate and technical information to the lay public. Numerous studies have demonstrated that risky issues will not be resolved by the provision of more accurate information because risk perceptions are not just about technical information (Lorenzoni, Pidgeon and O'Connor, 2005; Russell and Hampton, 2006). Risk perceptions are also based on social norms, values, beliefs, trust, and past actions of the agencies and therefore they cannot be isolated from the broader social and cultural context in which they occur. Hence, it is argued that the traditional deficit model of risk communication needs to be revised (Vaughan, 1995; Sturgis and Allum, 2004; Russell and Hampton, 2006; Hurlimann, 2007). Hurlimann (2007) states that this need is particularly true for recycled water where the technological feasibility has been proven but the social aspects have not been properly explored. Risk perception responses develop over a course of interaction and discussion and education on technologies and their implications (Russell and Hampton, 2006). If proper engagement strategies are employed and the perceived risk outweighs the benefits, then another solution to water management may be necessary (Hurlimann 2007). Another important consideration for risk communication is the inclusion of minority communities as they often have a higher exposure to risks but are the least engaged (Vaughan, 1995).

A study by Browne et al. (2008) highlights the importance of understanding how risk is perceived by the community. Browne et al. (2008) investigated community and technical perceptions of risk associated with purified recycled water in SEQ. As well as offering their own views, technical participants were asked to represent risk perceptions from the perspective of a 'typical community member'. The findings show that technical participants (e.g., water managers, policy makers, researchers, etc) perceived the community as non-accepting, emotionally driven, health concerned and lacking in trust and confidence, whereas the community participants expressed quite diverse and complex attitudes towards risks and recycled water. The outcomes of this research suggested that there is a real need for ongoing dialogue between technical experts and community members to break down assumptions about community concerns, so experts can address actual rather than perceived community concerns (Brown et al., 2008).

Hurlimann (2007) summarises that satisfaction, trust, information, communication and knowledge are all factors that relate to the perception of risk. Research by Hurlimann (2007) investigating risk perceptions about recycled water found that 33% of participants thought there was a risk involved with using recycled water and this was mostly to do with concerns about danger to children. Risks also increased the more personal the use of recycled water. By identifying specific concerns, such as risk to children and animals, risk communication strategies can target these concerns. This view is supported by Po et al. (2003) who note that there is a need to understand different risk perceptions so that effective risk communication strategies can be developed that cater for different sectors of the community.

3.4. Messengers

"A (communication) process may also require basic character strengths of patience, empathy, respect, wisdom, sincerity, and humour. The ability to apply these characteristics comes from stamina and experience" (Water Environment Federation Report 1998, p.231, cited in Hartley, 2003, p.1-1).

The role of the messenger, or communicator, is crucial to the framing and delivery of a message, as it brings a unique set of characteristics and resources to the situation (Littlejohn and Foss, 2007; Moser, 2010). The role of the scientist as a messenger has been evolving with rising expectations of the social obligation of scientists to communicate their work to society and to interact with the public and be participants themselves in a process of seeking solutions to issues (Barbour et al., 2008; Libutti and Valente, 2006). The notion of the scientist or practitioner being part of the process is supported by Wolfe (2009) who recommends that, for effective water management, it is important to look at not only consumers' attitudes, values, beliefs and knowledge but also to include and understand

practitioners' attitudes, values and beliefs as this helps to clarify the environment in which they transmit their data, information and knowledge. Davies (2008) makes the interesting point that the term science communication is not correct as it is not science as a whole that will confront society; instead it is individuals or a small group of experts that will frame and shape the communication process.

One of the major aims of communication is to improve trust. This is particularly true for water management when relationships between the community and the proponents of a water supply system (e.g. government, scientists, planners etc) are often strained, particularly when considering recycled water schemes. Numerous studies have demonstrated that engaging in proper participatory processes helps to build trust and therefore minimise risk perceptions and resistance to change (Attwater and Derry, 2005; Syme and Hatfield-Dodds, 2007; Miller and Buys, 2008). Hartley (2003) notes that often people trust the science and technology but they do not always trust the sources of information (e.g. government or media). Hurlimann's (2007) research shows that trust in water authorities was found to be positively related to having good integrity and the authority's ability to communicate. According to Moser (2010), while communication improves trust, having a trustworthy messenger is critical in establishing the credibility of the information conveyed and can improve the effectiveness of communication. Further, Moser (2010) highlights the importance of having the right messenger to give a "seal of approval" to information that may otherwise be deemed untrustworthy. Therefore, when thinking about trust it is important to recognise that although trust is usually built through effective communication and dialogue, having trust (e.g., in the form of a trustworthy communicator) to begin with also promotes effective communication (Hartley, 2003).

An important consideration is the context dependent nature of trust in messengers (Moser, 2010). The same messenger will not always produce the same reactions. Po et al. (2003) summarise that successful reuse programs in the past were often implemented at a time when trust in government and experts was high and therefore communities believed in the former's ability to make the right decision. The changing nature of our society also factors into our understandings of trust. The development of alternative water sources, such as recycled water, is challenging the basic trust that communities have in authorities to deliver traditional and safe household water (Marks and Zadoroznyj, 2005). As well as having the appropriate messenger, building trust takes time and communication and information exchange may take may years to develop (Hurlimann and McKay, 2004; Water Services Association of Australia, 2006).

When examining the effectiveness of the messenger, most case studies in the literature refer to recycled water. According to Khan and Gerrard (2006), the success of the recycled water scheme in Singapore could be a result of the government delivering information about the scheme as the population had high levels of belief and trust in the government to make the right decisions. In a less successful example of an attempt to implement a recycled water project in Toowoomba, Australia, Hurlimann and Dolnicar (2010) emphasise the important role that the interest group Citizens Against Drinking Sewerage (CADS) had in getting a negative message about recycled water out to the community first. While the proposed Water Futures Initiative in Toowoomba was not entirely a water recycling plan, CADS took the 'first mover advantage' and their messages against recycled water became the benchmark by which the community would judge all other information (Hurlimann and Dolnicar, 2010). Therefore, the ability of the CADS group to utilise its role as a messenger by communicating in a timely manner made it extremely difficult for any subsequent positive messages to break through, no matter how much the messenger was trusted. In the same context, a study of supporters and opponents in the Toowoomba referendum about recycled water demonstrates that messengers are not viewed uniformly by the community (Price, Fielding and Leviston, 2010). Supporters' and opponents' worldviews influenced their trust in key messengers (e.g., local government and local business figures) of the campaign. In a study of the factors influencing respondents' decisions to drink recycled water, Dolnicar and Hurlimann (2009) conclude that scientists and experts were the best sources for gaining confidence about the proposed scheme. Interestingly, friends and family were seen as influential in raising doubts. This is important to consider when thinking about the role of the messenger in achieving effective communication.

3.5. Audience

"Widespread information (is needed) so people can feel empowered" (Anonymous participant, community workshops on the acceptance PRW, cited in Alexander et al. 2008).

As the various components of the proposed communication framework are detailed, it becomes apparent that many of the components are closely interconnected. When thinking about audience, it is paramount that the purpose/goals of the communication endeavour and audience choice be closely linked (Moser, 2010). This means having an understanding of audience or community values, attitudes, beliefs, worldviews and any social norms that may be operating to influence how the communication is interpreted, as well as an understanding of the context and the information sought by the audience (Zehr, 2000). The science communication literature emphasises the importance of incorporating local knowledge and culture into translations of science (Manzini, 2003; Sturgis and Allum, 2004). Zehr (2000) poses a question about what is the preferred mix of expert and lay knowledge in science communication. While there is no single best answer to this question, this section details the importance of audience in communication.

3.5.1. Audience Attitudes, Values, Beliefs

As noted in the section on risk communication, audiences filter information through the lens of their value and belief systems and cultural experiences and norms, which may vary amongst diverse communities (Vaughan, 1995). This presents an important challenge for practitioners and agencies when trying to communicate about water management options as it may not be possible to gain insight into all possible responses. In a survey conducted by Dolnicar and Schafer (2009), three "strong accepter" groups emerged (e.g. general strong accepters, desalination strong accepters and recycled water accepters). The authors suggested that different communication strategies are required for each segment. Additional results from Dolnicar and Schafer (2009) indicate that participants believed tap water currently contained more chemicals than recycled water. The authors suggest that this presents an opportunity for marketers to position alternative water sources as having a competitive advantage over current supplies and that the beneficial aspects of water supply systems that appeal to people's attitudes, such as the creation of new jobs at a water recycling plant, should be highlighted (Dolnicar and Schafer, 2009). Dingfelder (2004) notes that understanding attitudes of disgust towards recycled water may benefit from research that examines how humans get by in a world where everything has been potentially contaminated. This approach has implications for framing techniques, for example, promoting the use of natural features, such as having recycled water run through a stream before drinking, can make a scheme more appealing. One of the issues in investigating attitudes towards alternative water management is that reported attitudes towards water conservation, for example, can be high but when a plan is implemented the behaviours do not match (De Oliver, 1999).

While targeting communication to suit audiences is an agreed upon strategy in the literature, having an overall goal to increase the community acceptance of recycled water when other options are available has been debated. Miller and Buys (2008) report from their study that participants were extremely aware of the water crisis in the region, and were generally understanding and supportive of decision to implement water recycling without a referendum, but other options were preferred. Similar beliefs have been reported by Dolnicar and Hurlimann (2009) as respondents in their study held more positive beliefs about desalinated water than recycled water, and the authors suggest that this may be because the health risks associated with desalinated water are less controversial. Further, it has been suggested that rather than seeking to change behaviours to suit a particular scheme, practitioners should challenge assumptions and provoke questioning and reflection around attitudes, values and beliefs (Russell and Lux, 2009). Russell, Lux and Hampton (2009) suggest that much of the promotion of recycled water is based on predetermined ideas of community behaviours, without consultation with members of the community about what they are already doing and what they may want to know and change. While appropriate community consultation and engagement efforts are suggested in the literature as a way to understand acceptability of alternative water supply options, the task of achieving this is enormous. Therefore some interesting questions remain about how to communicate in

a way that appeals to a variety of community values, particularly if the proposed alternative water supply scheme is to be implemented on a city wide (or larger) scale.

3.5.2. Worldview

Worldview, or an individual's perspective on the world, can influence the way information is communicated and interpreted. Worldviews are sets of beliefs and assumptions that describe reality or an individual's outlook on life (Koltko-Rivera, 2004). Isendahl et al. (2009) note that a person's personal, educational and cultural background can influence their view on the world and this can lead them to selectively focus on communication aspects that are most relevant. It is a difficult task to ensure that a communication endeavour appeals to multiple worldviews. In an attempt to do this, Levy et al. (2003) propose four broad worldviews that communicators could consider in the context of water resource management:

- The nature constant perspective views water resources as a set of environmental goods valued according to their economic worth. Manifests in large scale construction such as dams.
- The nature ephemeral perspective sees intrinsic value in water and that water resource systems cannot safely tolerate human activities. It emphasises that governments are often reluctant to recognise ecological distress and that consensus on an issue between scientists is seldom achieved.
- The nature resilient perspective views the environment as forgiving of most shocks and that severe perturbations such as floods and droughts are to test the resilience of the system or ability to absorb change.
- The nature random perspective sees environmental phenomena as highly variable and that future events are independent of the past.

No one worldview is correct, rather, Levy et al. (2003) emphasises the need to acknowledge and understand that community members differ in their worldviews, an understanding that can help to overcome difficulties in communicating complex problems like water resource management. Hartley (2001) states that it is important for those wishing to communicate about alternative water management to engage in high quality public dialogue in order to understand different perspectives. An understanding of different worldviews allows communication to be tailored to suit particular groups under the premise that people will often only respond to information that is salient to their own beliefs and assumptions. Levy et al. (2003) note that information that confirms existing water resource beliefs is readily accepted and other information may be rejected, ignored or reinterpreted. However, tailoring communication to reflect only a few broad worldviews presents some challenges, including: the possibility of opposing perspectives both having appeal; the difficulty of fitting such people into defined groups; and the ability for people's worldviews to become more apparent or change depending on the context. Given that the context in which alternative water supply schemes are proposed and implemented is often changing, communication about alternative water management needs to reflect this.

3.6. Channels

"*The most useful info was the Water Futures pamphlet; it went through everything and wasn't biased"* (Anonymous participant, cited in Price, Fielding and Leviston 2010, article in review).

When considering the ways in which communication can occur, it is important to distinguish between one-way and two-way communication channels or communication techniques. One-way communication occurs when a message is transferred, either in a written, verbal or non-verbal form, yet there is no dialogical interaction between the messenger and the audience. In risk communication, this tends to be experts informing a target audience and if the audience rejects the notion then it is usually interpreted as a lack of understanding (Fisher, 1991). Alternatively, two-way communication focuses on dialogue, engagement and learning, and allows for a variety of perspectives to be shared. Both one-way and two-way communication techniques are necessary and can occur simultaneously depending on the situation and the type of audience (e.g. a conversation between two individuals or a

small group workshop) (Moser, 2010). Overall, it is thought that two-way communication is more effective as it is an empowering process and should be promoted as an ongoing activity (Fisher, 1991; Khan and Gerrard, 2006; Moser, 2010). It has been suggested by Miller and Buys (2008) that there needs to be new ways to disseminate information via non-traditional means, so that all citizens feel comfortable and confident enough to fully engage with and debate the issue. However, in some circumstances it may be difficult to have a two-way process and engagement with all citizens, such as when communicating to large and diverse audiences.

3.6.1. Specific Techniques for Communicating

Information and persuasive messages can be delivered to the public through text, spoken word and visual imagery. The International Association for Public Participation (IAP2, 2006) has a toolbox of techniques including: techniques to share information (e.g. emails, conferences, newspapers); techniques to compile and provide feedback (e.g. surveys, comment forms); and techniques to bring people together (e.g. citizen juries, advisory groups, town meetings). The sizeable number of techniques presented by the IAP2 (2006) demonstrates the breadth of the options available when thinking about how to convey information.

Numerous techniques were used in the successful awareness raising campaign of Singapore's Water Reclamation Scheme, such as documentaries, media releases, internet websites, school visits and a visitor's centre (Po et al. 2003). When choosing a communication pathway, Hartley (2003, p.3-4) suggests that communicators should "not overwhelm the receiver, use common vocabulary and present information in familiar settings…go to the people, and use visual representations".

Visual representations have been utilised in water management communication as they can make information easier to understand and can increase a shared understanding of issues, focus on particular issues and explore approaches to risk mitigation (Larson and Edsall, 2010; Severtson and Henriques, 2009). The Queensland Water Commission (QWC) demonstrates the use of visual communication on its website home page, where updates of dam levels are given alongside a clear graph of residential consumption (QWC, 2010).

Nicholson-Cole (2005) highlights other advantages of conveying information in a visual manner, including the capacity to: convey strong messages; improve message recall; condense complex information and communicate new content; provide the basis for personal thoughts and conversations, contributing to people's memory and issue-awareness; and communicate ideas in an instant using many different media and contexts. Therefore, visual representations have an ability to appeal to people's values, attitudes and beliefs (Foss, 2004). Visual communication appeals to peoples' 'experiential' processing system, which is emotional and holistic, relying on images, metaphors and narratives to interpret risk and guide behaviour (Epstein, 1994).

In contrast, linguistic communication appeals to the 'rational' processing system, which is analytic and deliberative, relying on words and numbers (Epstein 1994). By activating multiple associations and generating emotion, visual communication enhances information processing (Lang and Friestad, 1993 for review). Indeed, visual communication can be superior to linguistic communication as it conveys extended concepts (DeLuca, 1999), is more persuasive (see Bulmer and Buchanan-Oliver, 2006 for review) and improves audience recall (see Brosius, 1993 for review). These benefits derive from the *implicit* nature of visual imagery which prompts the audience to draw on their prior knowledge in order to infer meaning (Messaris, 1997). As such, individuals' unique experiences can be more readily associated with visual messages which often have open-ended meaning.

3.6.2. Methods to Achieve Behaviour Change

If the end point of communication about water management options is to create behaviour change, then social marketing is worth noting as a channel to achieve such change. In their definition of social learning, Lefebvre and Flora (1988) note that it is based on traditional marketing techniques but with a focus on ideas, attitudes and lifestyle changes, which are suitable for translating complex educational

messages and behaviour change initiatives into concepts and products that are appealing to large segments of the population. Overall, the goal of social marketing is to benefit the target audience not the marketer (Dolnicar and Saunders, 2006; Jesperson, 2005, McKenzie-Mohr, 2000). McKenzie-Mohr (2000) notes that most programs aimed at fostering sustainable behaviour are information intensive, with the assumption that enhanced knowledge will lead to attitude and behaviour change. McKenzie-Mohr (2000), believes that high levels of public participation are needed to achieve desired sustainability goals, for example, reduced water consumption or acceptance of alternative water supply schemes. Additionally, McKenzie-Mohr (2000) notes that the failure of mass media campaigns can be attributed to an inadequate design of the message, which is also noted by Moser (2010) as one of the key concepts to successful communication. An alternative perspective is provided by Dolnicar, Hurlimann and Nghiem (2010) as their recent survey results (n=1000) demonstrate that the use of relevant visual stimuli results in a significant increase in participants' stated likelihood of use of recycled and desalinated water. These discrepancies between whether the provision of information increases acceptance or leads to actual behaviour change, rather than stated, need to be further investigated.

McKenzie-Mohr (2000) suggests that advertising creates awareness amongst communities but that it is social marketing that helps to create behaviour change. Further, he notes that social marketing is comprised of four steps:

1. uncovering barriers to behaviours and then, based upon this information, select which behaviours to promote;
2. design a program to overcome the barriers to the selected behaviour;
3. pilot the program; and
4. evaluate the program once it has been broadly implemented.

This general approach to behaviour change is consistent with other literature focused on achieving positive environmental behaviour change (Steg and Vlek, 2009). Bates (2010) notes that the term social marketing can be misleading, given traditional notions of marketing. Hartley (2003) warns of the issues associated with the term 'marketing' and that anything that suggests manipulation of the public and not taking their concerns seriously is risky, can damage credibility and therefore jeopardise trust in an organisation. The end purpose is to create behaviour change by incorporating the values, attitudes and beliefs of the audience into the communication strategy, but a social marketing campaign can still not guarantee positive social change (Bates, 2010).

3.6.3. Education

Educational campaigns are an important channel for communicating about alternative water management options. In Australia, education campaigns have been used for many years, for example the school-based WaterWatch and WaterWise programs (Swinton, 2004). This bottom-up process involves water authorities working with schools to teach children (and inadvertently parents) about ways to reduce their water consumption. Moreover, numerous advertisements have appeared on television highlighting how people can save water throughout their day (McDonald and Maloney, 2010). Recently the Healthy Waterways Partnership has taken the lead to reinvigorate the SEQ Schools' Water and Catchment Education Steering Committee (SUCCESS) network, a group formed to improve the delivery of water and catchment education in schools. One of the goals of the group is to collate a contact list and matrix of who is doing what in the area of water education and communication, providing a valuable tool for water educators and communication specialists. The Australian Water Association (AWA) also has a strong educational focus and professionals within the AWA agree that there is a need for increased community awareness about water and that education is required for this to occur (Deere et al., 2004). Further, education was seen as the foundation for other tools to build on and that people needed to be educated first in order to contribute to water management debates and planning. However, gaining funding for educational activities is problematic as it is difficult to attribute on-ground outcomes to education alone (Deere et al, 2004). This issue has also been raised in regard to SEQ residents' reduction in water consumption and questions remain as to whether the reduction was due to the extensive educational campaign initiated by QWC or due to

other factors such as financial incentives and crisis points reached (McDonald and Maloney, 2010). Despite numerous programs across Australia, many people are not changing their water related behaviours, suggesting that more research is needed in exploring the role of Australian values and culture in relation to water (Swinton, 2004).

3.6.4. Community Engagement

Much of the discussion surrounding the communication of alternative water supply schemes and water management has tended to focus on participants' knowledge, their access to information and often willingness to accept certain schemes. Yet there is little evidence that increased knowledge of the system leads to acceptance, although knowledge is good for building trust between the community and the providers (Nancarrow et al., 2009). It is increasingly recognised in the literature that communication needs to engage the community and understand peoples' attitudes, values and beliefs, not just provide one-way information. Singapore's Water Authority, PUB, states that part of the reason the Singaporean public have been accepting of the NEWater scheme is that the water authority decided to change the pre-existing communication paradigm to one where creative communication methods, such as street-style magazines and creative ideas for people to engage with water recreationally, were used to encourage Singaporeans to take ownership over their water supply (PUB, 2008b). In California, the Redwood City recycled water case study has also been documented as a successful engagement exercise (Ingram et al., 2006). Here, the community members that opposed the scheme were given the opportunity to form a task force where they could provide feedback to the council on how to proceed (Ingram et al., 2006). It was through this group that a mutual appreciation for the water supply problem evolved through ongoing dialogue, helping to build trust (Ingram et al., 2006).

Australia has a poor history of community consultation and engagement in relation to water management across a variety of contexts. This is thought to be because the key principles, such as transparency, openness and the provision of credible information are not adhered to (Hatfield Dodds et al., 2006; Russell and Hampton, 2006; Russell, Lux and Hampton, 2009). Many researchers recognise the need to focus on process and dialogue, so participants can develop their views and fully engage in issues to achieve a sustainable outcome, rather than just accepting a proponent's preferred scheme or trying to express views via a snapshot survey (Attwater and Derry, 2005; Hatfield Dodds et al., 2006; Hartley, 2006; Marks, 2006; Russell and Lux, 2009; Russell et al., 2009). Russell and Hampton (2006, p. 221) neatly sum up the benefits of community engagement in the water sector, which include:

- generate consensus on the benefits of a project;
- create a sense of involvement and control;
- avoid objections at the time of implementation;
- educate on required practices and precautions;
- increase the value of water;
- spread the message;
- reassure that the developer is open and accountable;
- incorporate local operating conditions; and
- alert developers to any unknown safety issues.

In addition, Syme (2008) states that "thirty years of experience with community-based research have led to an observation that, given a facilitative environment, the community is often prepared to make choices which are decidedly more innovative than those currently being made on their behalf" (p.104). Further, Marks (2006) also highlights the importance of public involvement as an expectation and requirement for the introduction of innovative solutions to water management. Therefore, the call to include multiple forms of knowledge and include communities in the decision making process to create ownership over water options is paramount. However, such sentiments may not be appropriate in certain situations, for example in a water crisis situation where ongoing drought means that action needs to be taken quickly, rather than after consultation and deliberation.

Many have trialled dialogical engagement processes with multiple stakeholders and have had successful results in co-management of water resources (Spehr and Curnow, 2007; Russell et al., 2009). There are also specific engagement and behaviour change frameworks for the water domain which are available for all practitioners to access (Hartley, 2003; Spehr and Curnow, 2007). The use of participatory modelling has also been trialled in regards to creating different water management scenarios. In the examples reported by Stave (2003), it was noted that participant interaction and trialling of the models led to the stimulation of discussion and identification of ways to better frame water management options. Social learning is another process where effective engagement can lead to sustainable outcomes. In the water domain, social learning theory has been recently applied in natural resource management, integrated catchment management and adaptive water management (see Ison, Roling and Watson, 2007; Pahl-Wostl et al., 2007) and has been identified as useful to apply to the design, development and implementation of water recycling schemes (Russell and Hampton, 2006) and to encourage water conservation behaviour. Taking a social learning approach can help to ensure public concerns are addressed by using terminology that the public is familiar with and ensuring access to information and environmental and health performances, but providers need to be mindful of not imposing their judgements (Russell and Hampton, 2006). By involving participants from the beginning and creating 'communities of practice' where different forms of knowledge are incorporated through social learning, it is possible for innovative management to occur. This approach also allows a more comprehensive approach to dealing with uncertainties (Attwater and Derry, 2005; Isendahl et al., 2010). As demonstrated by Pearson et al. (2010), achieving an end point is not the goal; it is more about a strategic process of creating scenarios of the future and operationally achieving these through social learning.

While engagement tends to be at the forefront of recommendations for effective communication, there are also issues associated with the process. Owens (2000) notes that engagement often assumes that citizens are informed and have the capacity to contribute to the decision making process. Further, Owens (2000) notes that when considering engagement for behaviour change, there is no escaping the contextual constraints, such as the size of community or the nature of the issue, which may influence effective action. When reflecting on the effective presentation of information, Russell et al. (2009) suggest that it comes down to experimenting and adjusting to get it right for the right group of people. This can result in an expensive and time consuming process, making the approach less viable. There are also suggestions that it may be better to avoid public consultation, particularly when introducing alternative water supply schemes (Dolnicar and Hurlimann, 2009). In their qualitative study on the acceptability of drinking desalinated and recycled water in eight Australian locations, participants noted that when faced with the scenario of a worsening drought, the majority of respondents stated that they would have no choice but to drink recycled water and were willing to accept both recycled and desalinated water in such conditions. Therefore, deciding not to give citizens a choice during a water crisis may be deemed by citizens to be the best decision given the circumstances. In the past, the "Decide, Announce, Defend" mantras have not been successful as they have not considered social, cultural, environmental and political implications (Dolnicar and Hurlimann, 2009). But Dolnicar and Hurlimann (2009) also note that the parameters of community involvement have also not been researched and question whether public participation in lieu of a formal vote would satisfy the public and ensure adequate sustainable solutions to water supply issues. These are interesting considerations for the future of Australia's water supply.

3.7. Effect

"People would like to know more about recycled water schemes that exist overseas, including first hand experiences of the people, or Australians, who have lived there." (Anonymous participant comment during community workshops on the acceptance PRW, cited in Alexander et al. 2009).

Different studies have resulted in more specific indicators of effectiveness or different ideas altogether about what constitutes effective communication. For ease of interpretation, these have been summarised in Table 1.

Table 1: Characteristics of Effective Communication Techniques of Relevance to the Water Sector.

Effectiveness of Participatory and Collaborative Methods	Source
Journalists need training in science; they need to focus on understanding audience needs and to work more closely with sources.	Weigold, 2001
Effective communication needs to be flexible and take audiences' diverse backgrounds into consideration. Receivers will always approach topics with their own ideas, attitudes and beliefs.	Barker, 2006
Public dialogue; fair and sound decision making process; trust.	Hartley, 2006
Communication needs to be an ongoing process. Success is determined by regional circumstances and context.	Khan and Gerrard, 2006
A two-way model of exchange between researchers and the public.	Libutti and Valente, 2006
Healthy collaboration between providers and end users is required to achieve long term, beneficial outcomes.	Marks, 2006
Effective water resource management requires community engagement to build support and to enhance outcomes.	Syme and Hatfield Dodds, 2007
A science-society dialogue instead of a one-way deficit model of communication.	Davies, 2008
Effective communication comes from truly participatory processes, especially if lay people and developers/authorities/experts can intersect and overcome framing and language barriers.	Russell et al., 2009
Social learning and engagement are necessary to achieve a sustainable decision; however effective communication needs to occur before engagement.	Pearson et al, 2010
Mode, channel and setting of the communication determine what can be said, how it can be said, how it can be conveyed, in how much time and space, by what means, and whether or not there is opportunity for dialogue, reflection and social learning – all of which affect the ultimate impact of a communication.	Moser, 2010
Effectiveness of Information and Messages	
At the very least, the audience needs to understand the message. Asking people what message they took from the communication is one way of verifying this.	Weinstein and Sandman, 1992
Diverse types of information, given that all people learn and communicate differently. Having individual motivation and organisational commitment to the communication effort.	Hartley, 2006
Scientists and experts are best sources of information for the public to listen to in order to gain confidence about proposed scheme.	Dolnicar and Hurlimann, 2009
Tapping into the mental models that people use to make sense of the world makes certain messages effective.	Moser, 2010
Effective communication is about practice, experience and reflection.	Barker, 2006
The effectiveness of visual communication is determined by the formal properties of the image, visual literacy of the audience and cultural variations in meaning.	Kostelnick, 1995 Trumbo, 1999
Specific Tools	
Visitors to NEWater in Singapore are invited to watch videos of Californian residents speak about the benefits of the California Water 21 reuse scheme.	Khan and Gerrard, 2006
Paradigm shift in PUB's water communication: Water Wally mascot, a magazine style annual report, a street style magazine revolving around water aimed at youth, use of glamorous celebrities in promotion, attractive packaging for NEWater bottles and an open, honest and timely approach in all media releases.	PUB, 2008
Alternative communication tools need to be used in conjunction with web based instruments as websites may not be pertinent to all members of a community. The existence of a communication tool does not necessarily mean that people will automatically communicate using it.	O'Toole et al., 2009

Throughout this review, the effectiveness of communication has been referred to and, although many authors highlight the need for effective communication, few detail what this entails and even fewer empirically test effectiveness. Here, we outline what is known about the effectiveness of communication in the water sector. An important consideration for the measure of effectiveness in communication is that all the components of the process (e.g. goals, messages, framing, audience, channels and messenger) are thought about in advance, including the evaluation measures (Weinstein and Sandman, 1992; Syme, Nancarrow and Seligman, 2000). Moser (2010) notes that communication efforts need to be responsive to the changing needs of audiences via monitoring, testing, evaluating and updating communication efforts. Others agree that by keeping communities engaged via fair processes there will be reduced perceptions of risk, improved fairness and less adverse effects on those involved (Khan and Gerrard, 2006; Syme and Hatfield Dodds, 2007).

When examining the characteristics of effective communication in Table 1, it is apparent that community engagement and participatory processes are noted in the literature as the most effective. This has been supported by Thomas et al (2006) where they report that the Healthy Waterways Partnership in SEQ has been an effective communication case study effort due to having an integrated and adaptive management approach whereby scientific research, community participation and strategic development occur simultaneously; resulting in achievement of the goal of cost savings in water quality management by stakeholders.

An important consideration for assessing effectiveness is whether the communication effort led to behaviour change or improved acceptance of a particular scheme, or whether other factors contributed to observed changes. The effectiveness of communication has been investigated in SEQ where it is unknown whether water consumption levels lowered (and remain low) due to extensive education campaigns by the QWC or because community attitudes towards water changed due to financial incentives, or due to prohibitions on use, or because drought crisis point was reached (McDonald and Maloney, 2010). This behavioural change is currently being investigated by numerous researchers but, given the contextual circumstances it may be difficult to pinpoint the exact cause of the change.

4. FUTURE RESEARCH

While much of the literature on communication about alternative water supply options highlights the importance of effective communication, few studies have provided empirical or evaluative evidence of what exactly this constitutes. There is an obvious need to define, through empirical evidence based on a systematic program of research, what is meant by effective communication in regard to water management. Presented below are several research priorities.

As we have demonstrated, context is an important consideration for effective communication. Whether communicating a scheme in the context of the whole water cycle is more efficient than focusing on one particular component (e.g. recycled water scheme) is yet to be tested empirically. Contextualised scenarios that investigate how different states of water supply security can influence community perceptions of risk would also prove useful.

An overarching criterion stressed throughout the literature is that communication should link in with local community values. While in theory this is sound advice, in practice it may be quite difficult. Therefore, further research is required to discern whether different communication for different groups, in line with specific cultural discourses, overcomes barriers and increases awareness, acceptance or behaviour change.

The specific influence of particular communication channels in the water domain should also be pursued in an experimental setting. For example, how do different media (e.g. visual, verbal, written) or sources with the same message influence community perceptions and actions? Given the importance of visual and alternative methods of communicating, there is benefit in exploring the impacts of the use of different visual or interactive communication tools around water resource management and exploring whether this is effective with a diverse set of stakeholders.

Finally, there is a need for more qualitative exploration of participant perceptions on water use and alternative supplies (Russell and Hampton, 2006; Russell, 2009). Further research applying a discourse analysis on community dialogue around water issues would provide further insight into people's values about water.

5. CONCLUSION

Communication specialists and scientists have a huge task ahead of them as much of the literature suggests that information and activities should be aimed at individual and community attitudes, beliefs, values and worldviews. Making use of different types of information and channels to convey the message is likely to appeal to a range of people as they can tune into information that fits best with

their established views of the world. Key to achieving communication goals is engaging the community so that issues, questions, and goals can be worked out via a co-management approach. Creating an ongoing dialogue with the community is preferred, and having a clear communication message is critical. However, a co-management approach may not be appropriate in certain contexts, particularly if water availability has reached crisis point. All of the components of the process (e.g. goals, messages, framing, audience, channels, messenger) need to be thought about in advance, including the evaluation measures, to ensure effective communication. While numerous case studies in the literature outline the various components for successful communication, there is little empirical evidence evaluating the impacts of different methods on different groups within the community. As well as this, there is little evaluative information on communication efforts in the sphere of alternative water supply options. Future research can help to ascertain whether holistic communication connecting human values to water is of greater benefit in the transfer of knowledge and for optimal understanding than traditional scheme specific techniques.

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