Journal of Hydrology (NZ) 59 (1): 1-16

Maslow's hierarchy of needs and water management

Paul A. White
GNS Science, Private Bag 2000, Taupo 3352.
Corresponding author: p.white@gns.cri.nz

Abstract

The close bonds between humans and their water supplies follows from the crucial role of water in the societal development of our species. These bonds, which go deeper than our physiological requirements for drinking water and food production, point to the many human needs associated with water.

Maslow's (1954) 'hierarchy of needs', a psychological theory of human motivation, has six drivers of behaviour, arranged by prepotency: physiological, safety, belongingness and love, esteem, self-actualisation, and self-transcendence. Behaviours related to water resources (and corresponding needs) include pursuit of drinking water (physiological); provision of water legislation and water-supply security (safety); community actions to provide water supplies (belongingness and love); economic development (esteem); altruism and education (self-actualisation); and 'big-picture' thinking about the resource (self-transcendence).

The evolution of the New Zealand national water regulatory framework beginning with the Resource Management Act 1991 is demonstrated within the Maslow framework. These policies, regulations and legislation represent advances associated with three needs: safety (e.g., better drinking-water standards), belongingness and love (improved community engagement) and self-transcendence (inclusion of Māori belief systems). However, two needs (esteem and self-actualisation) are not, or are poorly, provided by the regulatory framework.

In contrast, a regional water policy, the Canterbury Water Management Strategy, addressed these two needs. Esteem-need behaviours were demonstrated by inclusion of organisations that promote economic development, e.g., the Canterbury Mayoral Forum and agricultural irrigators. Self-actualisation behaviours were demonstrated by sub-regional water committees (altruism) and the formation of the Waterways Centre for Freshwater Management by Canterbury and Lincoln universities (education).

Future research is recommended to assess deeper psychological understandings of needs and behaviours relevant to water resources and to explore other applications of the Maslow framework to water management policies.

Keywords

Psychology and water use; Maslow's hierarchy of needs; water management; Resource Management Act 1991; Ministry for the Environment (New Zealand); Canterbury Water Management Strategy; Environment Canterbury.

Introduction

The sweep of human history parallels the development of water supplies. Certainly, the pursuit of water supplies has long been a preoccupation of our species. Typical of early civilisation, intricate engineering works

supplied spring water to Bronze Age Jerusalem (Reich and Shukron, 1999) and the first representation of the first pharaoh shows him excavating a canal (Tvedt, 2016). The early Chinese state built a large network of canals; construction of the Grand Emperor's canal commenced in the 5th century BC reaching a length of 1,700 km by approximately the 6th century AD (Tvedt, 2016).

Water supplies have been important to the development of states. The 'hydraulic hypothesis' proposes that states themselves (i.e., autonomous political units with centralised government collecting taxes and enforcing laws) began to form around 4000 BC in response to the development of broad-scale irrigation projects for agricultural production (Carneiro, 1970; Service, 1978; Feder and Park, 2007; Scarre, 2013). Water also had a role in the formation of state financial systems. For example, nilometers (which measured Nile River flood levels) were used by the pharaonic state to set taxes (Friedman, 2016). More recently, during the industrial revolution (late 18th to 19th century) the rise of modern capitalism coincided with the formation of shareholder-owned limited-liability companies that developed canals for waterborne transport in the United States and England (Anon., 1967; Shaw, 1993).

The links between societies and their water supplies have been embodied in water management legislation and practices. In New Zealand, section 5 of the Resource Management Act 1991 (RMA) aims to promote the sustainable management of natural and physical resources, defining sustainable management as "managing the use, development, and protection of natural and physical resources… which enables people and communities to provide for their social, economic, and cultural wellbeing and for their health and safety…" This definition is consistent with the primary definition of sustainable development, i.e., "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987).

Clearly, the social sciences are broadly relevant to analyses of human interaction with their water supplies. Archaeology and anthropology are used to identify prehistoric engineering works and assess the societal conditions that allowed these developments to take place. Resource economics demonstrated that groundwater is a high-value resource, and that financial returns from crops drove changes in water use by agriculture, in the Waimea Plains, Nelson (White *et al.*, 2001; White, 2011).

Psychology is a social science that gives insights into behaviours that are pertinent to water supplies. Glynn *et al.* (2017) observed that behaviours towards natural resources are influenced by biases, beliefs, heuristics and values (BBHV). Furthermore, they proposed the inclusion of BBHV in a cyclic 'science-infused adaptive framework' for management of natural resources, which was demonstrated with the example of the Lake Taupo Protection Project which aims to manage land and water quality (Environment Court of New Zealand, 2011).

Psychology also aims to understand human motivation. A general theory of human motivation included four basic, or 'lower', needs (physiological, safety, belongingness and love, and esteem) and 'higher' needs of self-actualisation and self-transcendence (Maslow, 1943, 1954, 1993; Koltko-Rivera, 2006). Maslow, importantly, ordered his 'hierarchy of needs' by prepotency, from physiological (the most prepotent need) to self-transcendence. Thus, Maslow's hierarchy is also described as a 'pyramid of human needs' (Kenrick *et al.*, 2010). Maslow's hierarchy remains popular today, finding

application in the work place, healthcare, health promotion and an international assessment of well-being (Latham, 2012; Deravin-Malone and Anderson, 2016; World Health Organisation, n.d.; Tay and Diener, 2011).

This paper proposes that Maslow's hierarchy of needs is relevant to water resources management. The hierarchy, and prepotency, is reviewed with relevant examples from water resources in New Zealand. The hierarchy is then used as a framework to classify current national water policies and to provide an institutional analysis of a new regional water policy, the Canterbury Water Management Strategy (CWMS).

The CWMS is important to New Zealand because the Canterbury region has the country's largest water allocation (groundwater and surface water) for consumptive uses (Rajanayaka *et al.*, 2010). The region has seen tremendous growth in water allocation (e.g., White and Close, 2016) and a large growth in irrigation (e.g., Central Plains Water Trust, 2018); this growth has been associated with large stresses on the water resource, including political pressure (Mahon, 2006). With this background, "RMA processes were found to be inadequate to manage water resources at sustainability limits" which required the 'paradigm shift' that was the CWMS (Jenkins, 2018).

The discussion considers, in the framework of Maslow's hierarchy, the evolution of current national water legislation, regulations and policies, the gaps in these policies, and the CWMS institutions that occupy these gaps. Potential applications of prepotency to water allocation and to water management are also discussed. Lastly, the paper suggests future directions for research that develops Maslow's hierarchy, and prepotency, to further assess behaviours and water resources.

Maslow's hierarchy of needs and water resources

Maslow's hierarchy of needs, principally described from the substantive work on the subject (Maslow, 1954), is linked to behaviours and water resources. These behaviours reflect the psychological importance of water to individuals (and to society) and build on Maslow's humanist approach by recognising the influence of theistic belief systems. The prepotency of needs is summarised, from Maslow and others, and the relevance to needs and behaviours is outlined.

Physiological

Water and food are two fundamental physiological needs (Maslow, 1954). Physiological needs are the most prepotent of all needs, e.g., "for a man who is extremely and dangerously hungry, no other interests exist but food" (Maslow, 1954). However, physiological needs may be driven by other behaviours; "the person who thinks he is hungry may actually be seeking more for comfort, or dependence." Other physiological needs include sexual desire, sleep, and maternal behaviour; Maslow (1954) commented that "it seems impossible… to make any list of fundamental physiological needs, for they can come to almost any number one might wish."

Survival depends on water. Therefore, the pursuit of drinking water for humans, and their animals, has been a strong preoccupation of our species since the dawn of history and remains so today. No doubt, the development of water supplies demonstrates ingenuity; present generations continue to be impressed by the sophistication of the hydraulic engineering demonstrated by early civilisations.

Collaborative behaviours are required for the development of water supplies, but rivalrous behaviours can occur where water is scarce (e.g., Genesis 26:14-33);

scarcity also makes water a tool of warfare (2 Chronicles 32:3).

The importance of drinking water is recognised by the RMA, section 14(3b), which does not prohibit the taking of water to meet an individual's reasonable domestic needs provided that "the taking or use does not … have an adverse effect on the environment." This permissive access typically translates, under regional council policies, to the classification of drinking water as a 'permitted' activity that does not require a resource consent but typically has provisions; e.g., Tasman District Council (2014; Rule 31.1.2.1) specifies a maximum rate of take of 5 m^3/day for this activity in the Waimea water management zones.

Safety

Safety is a primary motivation for behaviour: "we may then fairly describe the whole organism as a safety-seeking mechanism" (Maslow, 1954). Safety needs are seen in their primal form in children; "the average child in our society generally prefers a safe, orderly, predictable, organized world, which he can count on, and in which unexpected, unmanageable, or other dangerous things do not happen."

Safety needs are manifested in a "very common preference for the familiar rather than unfamiliar things." Neuroses, such as compulsive-obsessive conditions, show a clear 'search for safety' where individuals "try frantically to order and stabilise the world." However, the "normal, fortunate adult in our culture is largely satisfied in his safety needs", feeling "safe enough from wild animals, extremes of temperature, criminal assault, murder, tyranny, etc."

Legislative behaviours are a manifestation of safety needs, i.e., the preference for familiarity and order, that are satisfied by the development of policies for managing water resources. The current national regulatory framework includes legislation, regulations and policies for water resource management, e.g., the RMA and the National Policy Statement for Freshwater Management 2014 (amended 2017) (NPS-FM), and drinking-water quality, i.e., the Health (Drinking Water) Amendment Act 2007 and Ministry of Health (2018). National-level drinking-water quality standards are also relevant to safety needs, e.g., Ministry of Health (2013a, 2013b).

Water users express their determination to obtain highly reliable supplies. This aim commonly leads to engineering works that improve the security of supply, such as the Lee Valley Community Dam (Tasman District Council, 2014) and large-scale irrigation schemes, e.g., the Central Plains scheme irrigating farmland between the Rakaia River and the Waimakariri River, Canterbury (Central Plains Water Trust, 2018).

Water conservation is another response to the maintenance of the supply. For example, an allocation reduction regime operates on groundwater consents in the Waimea Plains at times of environmental stress such as when there is very low flow in the Waimea River (Tasman District Council, 2014; White, 2018). Crisis response is a safety-related behaviour that occurs when water supplies fail, such as during cyclones (White, 1997) and fires.

Belongingness and love

Most individuals desire belongingness and love as we "hunger for affectionate relations with people in general" and "strive with great intensity to achieve this goal" (Maslow, 1954). Love needs involve giving and receiving love and important personal relationships: "the person will feel keenly… the absence of friends, or a sweetheart, or a wife, or children." The absence of love is a common cause of psychological problems: "practically all theorists of psychopathology have stressed thwarting of the love needs as basic in the picture of maladjustment."

Consensus-seeking behaviours, with individuals working towards the common interest, are relevant to this need. Communities are heavily involved with water supply and management in New Zealand; overwhelmingly, they own, fund, and operate drinking-water supply systems. Cross-community collaboration is crucial to the development of irrigation schemes for the common good (Benny, 2014; Body and Cushnie, 2015). Often, inter-generational effort by rural families are at the heart of these developments (e.g., Cameron, 2009). Much of the capital for water infrastructure comes from communities. Many of New Zealand's irrigation schemes were developed with substantial amounts of public money (The Audit Office, 1991) and private capital from approximately 400 scheme shareholders provided funding for the Central Plains irrigation scheme (Central Plains Water Trust, 2018; Central Plains Water Limited, 2019).

Communities can also be at the centre of water management; Waimea Plains water zone committees are an early New Zealand example of such involvement (Nelson Catchment and Regional Water Board, 1981; Fenemor, 1988). Currently, elected water zone committees are the interface for water management by Environment Canterbury (Jenkins, 2018; Eppel, 2015), see later.

Tribalism, that is, the behaviour and attitudes that stem from strong loyalty to one's own tribe or social group (*Oxford English Dictionary*, n.d.), is probably an outcome of belongingness and security. Threats can enhance this behaviour and result in political action, e.g., in opposition to Canterbury irrigation development (Mahon, 2006).

Esteem

"All people in our society (with a few pathological exceptions) have a need or desire for a stable, firmly based, usually high evaluation of themselves, for self-respect, or self-esteem, and for the esteem of others" (Maslow, 1954). Esteem needs were identified by Maslow (1954) as (1) strength, achievement, adequacy and confidence, and (2) prestige, status dominance, recognition, attention, importance, and appreciation. "Satisfaction of the self-esteem need leads to feelings of self-confidence, worth, strength and adequacy", but "thwarting of these needs produces feelings of inferiority, of weakness, and of helplessness."

Esteem needs are associated with behaviours that seek social status, respect and recognition (Maslow, 1954; Rowan, 1998). Humanity has a general preference for economic growth as societies and individuals seek to improve their status and well-being. Wealth growth has had wide implications for society, such as improvements of social indicators (freedom from hunger, mortality rates, child labour, education, access to safe water, and life expectancy; Goklany, 2002). For many industries, economic growth is linked to water use.

Individual recognition can transcend financial status because of the many ways that effort is acknowledged and respected. Industry leaders in the water sector receive accolades in the form of awards from their peers (e.g., New Zealand Hydrological Society, 2017; Irrigation NZ, 2017). In addition, the media commonly recognises individuals for their achievement and their personal characteristics such as determination, social motivation and longevity.

Self-actualisation

Self-actualisation is described as "man's desire for self-fulfilment, namely, to the tendency for him to become actualized in what he is potentially" or the "desire to become everything that one is capable of becoming" (Maslow, 1954). In addition, "self-actualising people are, without one single exception, involved in a cause outside their own skin, in something outside of themselves" and

"They are working at something which fate has called them to somehow and which they work at and which they love, so that the work-joy dichotomy in them disappears" (Maslow, 1993).

Self-fulfilment (i.e., the fulfilment of one's hopes and ambitions, *Oxford English Dictionary*, n.d; see also Gewirth, 1998) is related to this need. Self-fulfilment behaviours related to water resources could include development of skills, education (receiving and providing), and attraction to water-related causes such as environmental protection.

Altruism, perhaps the most demonstrable self-actualising behaviour, sees individuals and groups donating their time for the betterment of society and the environment.

The New Zealand Diploma in Field Hydrology is such an example (New Zealand Qualifications Authority, 2014). Field hydrologists gave their time freely to develop this qualification after recognising that their training requirements were not met by ad hoc courses and that demand for staff was growing (M. Ede, pers. comm., 14 December 2017; White, 2003). To date, this qualification has been available for three years and has been completed by approximately 21 hydrologists.

Altruism is also exhibited by community groups that aim to unite society behind sustainable management of water resources. The Canterbury-based Water Rights Trust was formed in 2002 and has aimed to encourage restoration, maintenance, protection, and enhancement of rivers, wetlands, and aquifers. The trust, using voluntary labour, has tried to effect these aims by affiliation with other like-minded entities and communicating with government, politicians and the public. Successes have not been measured in tangible projects but rather in drawing attention to the flaws in water management and highlighting the changes required (J. Sanders, pers. comm., 5 January 2018). Similarly, Taupō's Lakes and Waterways Action Group comprises volunteers who have given much of their time to the Lake Taupō Protection Project (Environment Court of New Zealand, 2011). The Lakes and Waterways Action Group has led more than 220 community meetings, typically at monthly intervals from the mid-1990s to the current day, informing the community on water science and land management related to the Lake Taupō Protection Project.

Self-transcendence

Maslow (1993) described self-transcendence as "the very highest and most inclusive or holistic levels of human consciousness, behaving and relating, as ends rather than means, to oneself, to significant others, to human beings in general, to other species, to nature, and to the cosmos." Related behaviours are the "loss of self-consciousness and of self-awareness" resulting from "concentration on something outside one's own psyche."

Self-transcendence behaviours ("beyond the merely human"; Maslow, 1993) include thought and discourse possibly without regard to solutions, i.e., as ends rather than means (Maslow, 1993). Examples of these behaviours include 'big-picture' thinking such as the concept of sustainability in the RMA and the Gaia hypothesis that life on Earth is maintained by a system of interactions between ecosystems and their inorganic surroundings (Lovelock, 1972).

Maslow, described as a humanist psychologist by Leontiev (2008), puts self-transcendence behaviours within a humanist framework. However, theism is relevant to water resources. In Christianity, water has played roles as a manifestation of God that are utilitarian and metaphorical, from creation to baptism, resurrection and apocalypse; e.g., "I am Alpha and Omega, the beginning and the end. I will give unto him that is

athirst of the fountain of the water of life freely" (Revelation 21:6). For Māori, the banks of rivers were used for ceremonies, such as burials; water has a life force ('mauri') and Māori describe the 'metaphysical' harm that comes to them when water is polluted or mixed (Waitangi Tribunal, 2012).

Prepotency

Maslow (1943, 1954) suggested that needs may be arranged in a hierarchy of 'prepotency' where the satisfaction of 'higher' needs depends, to some extent, on the prior satisfaction of 'lower' needs with "decreasing percentages of satisfaction as we go up the hierarchy" Maslow (1943). For example, the prepotency of safety is clear: "practically everything looks less important than safety… even sometimes the physiological needs."

Maslow's theory is commonly represented in the literature by a 'pyramid' of needs (e.g., Kenrick *et al.*, 2010; Neher, 1991; Schaller *et al.*, 2010). However, Rowan (1998) opined that needs should be represented by "something like a ladder", because a pyramid suggests that "there is an end point to personal growth" and because Maslow himself did not use a pyramid to represent his hierarchy. The pyramid can also infer that full satisfaction of a need is a prerequisite to the fulfilment of higher needs, which is counter to Maslow's description of prepotency.

Prepotency has relevance to water resources, with drinking water as the most important, i.e. physiological, need. The relative importance of needs is probably conditional on circumstances, e.g., the need for drinking water will overpower all other needs when drinking water is very scarce. Similarly, 'safety' and 'community' behaviours become more prominent during times of high stress on societies (e.g., economic, warfare and environmental emergencies) that force communities to work together.

Current New Zealand water legislation, regulations and policies contain very few examples of prepotency, e.g., drinking water supply can be a permitted activity under the RMA and most regional water resource plans have a permitted use policy, such as Policy 18 of the Waikato Regional Plan (Waikato Regional Council, 2012).

Maslow's critics

Critiques of Maslow's hierarchy ('the theory') by psychologists have included Neher (1991) who noted that many 'lower' needs are largely altruistic in nature, as demonstrated in sociological research, and that "'Maslow's tendency to emphasise the role of our innate needs in directing the course of healthy psychological development… leads to a view of human development that is one-sided". Rowan (1998) proposed that the hierarchy should have two esteem needs: respect from others, social status, recognition; and goals founded on self-evaluated standards and self-confidence where "we are not just magistrates, we are legislators." Rowan (1998) identified a 'competence' need, i.e., "we all have this need to do something well …just for the sake of the pleasure in being able to do it" that is "about mastery and control, and it is first noticeable in the very early days of life."

Other psychological critiques also consider prepotency, e.g., Maslow's higher needs "differ qualitatively from the lower needs… in that they motivate us in the absence of a sense of deficiency." (Neher, 1991). The theory has been criticised as an apparent focus on the self, e.g., Maslow saw needs other than self-actualisation as 'unworthy', partly because they were "basically selfish in nature" (Neher,1991); Hanley and Abell (2002) discussed the "apparent selfishness implicit in Maslow's model".

Hanley and Abell (2002) noted that environmental relatedness was "absent from Maslow's process of self-actualisation". They also stated that the theory is 'male-based hierarchy' but "women operate under a different set of values than men"; e.g., "in

feminist theory primary status is placed on the importance of relationships for personal development" (Trigg, 2008).

Reconstructions of Maslow's hierarchy use the theory as a base. Heylighen (1992) defined basic needs (homeostasis, safety, protection, feedback and exploration). Hanley and Abell (2002) produced an 'interpersonal model of self-actualisation', which merged the theory with 'global' drivers (e.g., parenting and family, natural environment, and spiritual relationships).

Together, these critiques build on the theory, rather than reject it. Therefore, they take little from the relevance of the 'extraordinarily useful' Maslow theory (Rowan, 1998) and add complexity to the theory, which could be considered in future research on behaviour and water resources.

Maslow's hierarchy and current national water management policies

The framework of Maslow's hierarchy (in regard to water resources) is used to classify current New Zealand national water management legislation, regulations and policies beginning with the RMA (Table 1).

Physiological (drinking-water) needs were referenced by the RMA and safety needs, as related to water quality, have been a focus of subsequent legislation, regulations and policies. A 1993 assessment of public infrastructure for drinking water found "a large number of small supplies about which little or nothing was known" and that some standards for municipal supplies "were not as good as could be desired" (Ministry of Health, 2013a). Since then, new drinking-water legislation has increased regulatory requirements on community water suppliers and set better standards of drinking-water quality.

The NPS-FM considers safety needs, with an objective relating to human health and contact recreation. NPS-FM objectives and policies follow the RMA by developing community engagement processes (i.e., the belongingness and love need) with community input to the development of objectives for freshwater management units (Policy CA2) and restate the RMA's importance of economic wellbeing (the esteem need). Self-transcendence needs were also developed in the NPS-FM with the inclusion of sustainability and Māori belief systems, i.e., Te Mana o te Wai (the integrated and holistic well-being of a freshwater body) "must inform the setting of freshwater objectives and limits" (NPS-FM, Objective AA1).

Institutional analysis of the Canterbury Water Management Strategy using Maslow's hierarchy

Institutional analyses provide a way of assessing how organisations behave and interact and the effect of these organisations on the wider community (Davis and North, 1971). For example, institutional analyses identified the challenge of environmental administration in the immediate-post RMA period (Memon, 1993) and identified possible bias in the CWMS, i.e., "collaborative governance arrangements risk becoming captured by powerful interest groups." (Kirk, 2015).

An institutional analysis used the framework of Maslow's hierarchy (in relation to water resources) to assess human needs associated with the CWMS development. The CWMS had 33 organisations involved in its development (particularly, as identified in Chapter 3 of Jenkins, 2018). Of these, 12 are defined here as 'CWMS institutions' with 21 CWMS-related committees and groups under their umbrella (Table 2). Note that CWMS institutions can work at multiple levels in the hierarchy.

The drinking-water need was not represented by institutions in the CWMS development, probably because drinking water was removed from the regional priority list (Jenkins, 2018). However, drinking water is one of the ten target areas of the CWMS to be achieved by 2040 (Jenkins, 2018).

Table 1 – Maslow's needs and current New Zealand national water management legislation, regulations and policies.

Maslow's needs, ordered by prepotency	RMA: objectives and sections 1991	Human drinking-water legislation and regulations[1,2,3]	NPS-FM policies and objectives 2017
Self-transcendence	Sustainability (s 5). Culture generally (s 5); Māori culture (s 6(e), 7(a), 8, 140h and 199(2)(c)).	Nil	Sustainability: water quantity (B1) and water quality (A1). Culture generally, iwi/hapū cultural values (Preamble); Māori belief systems (Policy AA1).
Self-actualisation	Nil	Nil	Nil
Esteem	Economic wellbeing in the definition of sustainability (s 5).	Nil	Enable communities to provide for their economic well-being (Objective A4, Policy B8).
Belongingness and love (community)	Community wellbeing in the definition of sustainability (s 5).	Protect the health and safety of communities (69A)[1]; defines the register of community drinking-water suppliers (69J)[1]; defines compliance criteria for 'networked' and 'small' drinking-water supplies (s 1.3) [3]	Community (including tangata whenua) engagement (policies AA1, Policy CA2, CA2f); involvement of iwi and hapū (Objective D1).
Safety	Legislation itself: the RMA.	Legislation itself: protect the health and safety of people (69A)[1]; reduce the risk of contamination of drinking-water sources (Explanatory note)[2]; and new drinking-water quality standards[3].	Policies themselves: the NPS-FM including human health, contact with fresh water (Objective A1) and recreation (Appendix 1).
Physiological (drinking water)	Drinking water and stock water (s 14(3)(b)).	Ensure that an adequate supply of drinking water is provided (69S)[1].	Nil

[1] Health (Drinking Water) Amendment Act 2007
[2] Resource Management (National Environmental Standards for Sources of Human Drinking Water) Regulations 2007
[3] Ministry of Health (2018)

Table 2 – Maslow's hierarchy: an institutional analysis of the CWMS. Consultants noted by Jenkins (2018; Chapter 3), who have typically provided technical advice, are excluded from this analysis.

Maslow's Hierarchy of Needs, ordered by prepotency	**CWMS Institutions (Jenkins, 2018; Chapter 3)**
Self-transcendence	Environment Canterbury[1]
	Ngai Tahu[1]
Self-actualisation	Environment Canterbury[2]
Esteem	Canterbury Mayoral Forum[1]
	Ngai Tahu[2]
	Mayfield Hinds Irrigation
	Waimakariri Irrigation Ltd
	Central Plains Water Limited
Belongingness and love (community)	Community Panel
	Multi-stakeholder groups
	Nitrogen Allocation Reference Group
Safety	High Court
	Environment Court
	Environment Canterbury[3]
Physiological (drinking water)	Nil

Environment Canterbury[1]: CWMS committees, i.e., Regional Water Zone Committee; Strategy and Programmes Group; Water Executive; Planning Group; and Resource Management Group.
Environment Canterbury[2]: ten Canterbury zone committees.
Environment Canterbury[3]: Hearing commissioners and hearing panels.
Ngai Tahu[1]: Ngai Tahu role as kaitiaki.
Ngai Tahu[2]: Ngai Tahu role as developer.
Canterbury Mayoral Forum[1]: with CWMS committees, i.e., Regional Reference Group, CSWS Mayoral Steering Group, Officials Group, and city and district councils.

The legal system provided safety needs with the High Court considering a challenge to the Canterbury Land and Water Regional Plan (Jenkins, 2018). Environment Canterbury hearing commissioners and hearing panels had 'safety' roles in policy development, e.g., the draft of this Plan was considered by a hearing panel (Jenkins, 2018).

Environment Canterbury has contributed to the belongingness and love (community) need through a strong desire to take communities along with the CWMS project with, particularly, the innovation of zone committees (see below). Several community groups worked with the CWMS. The Community Panel developed a sustainability framework for evaluating water storage options and multi-stakeholder groups assessed these options. The Nitrogen Allocation Reference Group, which addressed nitrogen allocation options, comprised farming interests, rūnanga representatives and the general community.

The Canterbury Mayoral Forum, which oversaw the CWMS, fulfilled an esteem need with its development focus; "Since 2015, the Mayoral Forum has led the Canterbury Regional Economic Development Strategy … to build a strong regional economy with resilient, connected communities and a better quality of life for all." (Canterbury Mayoral Forum, 2019). Developers were relevant to esteem needs. Irrigation companies or trusts irrigate, or plan to irrigate, large areas of the Canterbury Plains: Mayfield Hinds Irrigation (Body and Cushnie, 2015), Waimakariri Irrigation Limited (2019), Central Plains Water Limited (2019), and Central Plains Water Trust (2018). Ngāi Tahu plan to establish 7000 ha of irrigated land for dairying (Jenkins, 2018).

Altruism (a self-actualisation behaviour) was demonstrated by the members of Environment Canterbury's sub-regional zone committees. These committees were established by the CWMS to develop actions

and tactics that deliver on the ten targets of the CWMS (Environment Canterbury, n.d.). Committee members are sourced from the community (appointed by the three CWMS partners – regional and local councils and rūnanga), rūnanga (members appointed by their rūnanga) and councils (elected officials from Environment Canterbury, city councils and district councils) (L. Woudberg, pers. comm., 30 March 2020).

Michael Blackwell, the Waimakariri Water Zone Committee chair, describes his altruistic motivations to be involved with the committee: "…we have to move forward as a community to help resolve this historical environmental damage. I want to see my grandchildren be able to safely enjoy these river systems within the next two decades." (Environment Canterbury, 2020). For Blackwell, "water goes to the core of who we are as country", but "since my youth I've seen local ecosystems degrade so that now they are on the brink of collapse" (M. Blackwell, pers. comm., 31 March 2020). He volunteered for the zone committee in 2016/17 aiming to make a difference to water quantity and water quality in the Waimakariri area. Members receive an honorarium of $4000/year to attend no less than eight zone committee meetings (L. Woudberg, pers. comm., 30 March 2020). However, they commonly spend more time than they are paid for – "it is voluntary, it is hard work, but you do it because you care" (M. Blackwell, pers. comm., 31 March 2020).

Education, another self-actualisation behaviour, was not mentioned by Jenkins (2018). The Waterways Centre for Freshwater Management was established in 2009 as a joint partnership between Canterbury and Lincoln universities with Jenkins as an inaugural professorial fellow (University of Canterbury, 2010). Since then, the centre has graduated 53 students with a Postgraduate Diploma in Water Resource Management, 50 with a Master of Water Resource Management, and six students with a PhD (S. Knopick, pers. comm., 10 December 2019).

Self-transcendence needs were represented by Environment Canterbury and its committees (Table 2) with aims that are compatible with, and extend on, sustainability. These needs are also represented by Ngāi Tahu with their responsibility as kaitiaki (cultural guardians) for safeguarding the mauri (life force) of water (Jenkins 2018).

Discussion

Water policy trends over time

National water legislation, regulation and policy development beginning with the RMA (1991) focused on basic needs (Table 1) which probably have, as predicted by prepotency, a relatively high priority for society. Currently, two Maslow needs (esteem and self-actualisation) are not, or are poorly, provided by national legislation. Therefore, national water policies do little to recognise the drivers of economic uses of water (the esteem need) and self-actualising behaviours such as education and altruism.

Maybe gaps in the national legislation (Table 1) partly drove the need for a paradigm shift in Canterbury water management. The CWMS populates all Maslow's needs in regard to water resource management (Table 2), with one notable exception: drinking water was not a priority for the CWMS in the period described by Jenkins (2018).

Economic development (the esteem need) is the focus of a relatively large number of CWMS institutions, which is perhaps the reason for Kirk's (2015) identification of the risk of institutional bias in the CWMS (see above). However, the self-interest of development-focused institutions is tempered by the wide range of needs and behaviours that are represented in the CWMS. In particular, the Canterbury zone committees, CWMS-mandated com-

munity members at the 'coal face' of water management decision-making, aim to develop sustainability actions at the local level (Environment Canterbury, n.d.).

CWMS institutions do not represent all altruistic organisations with interests in water resources. Two organisations (Water Rights Trust and Fish and Game New Zealand) were not part of the CWMS development, according to Jenkins (2018). He described these organisations as 'adversarial groups' that withdrew "from participation in zone committees and reverted to adversarial approaches" noting the "unwillingness of Environment Canterbury Commissioners to meet" with them.

Prepotency and water policies

Potentially, prepotency in national water legislation could result in a level of policy sophistication that goes beyond current policies. Prepotency of basic needs could mean a water allocation regime where drinking water has priority over the economic uses of water (esteem). Potentially, safety (security of supply) could have a higher priority than esteem needs which may lead to the establishment of secure water supplies before water is allocated for economic uses.

Hurdles to the implementation of prepotency in legislation are significant. Such policy would be more complex than the RMA alone, partly because Maslow's hierarchy covers a myriad of behavioural issues that may be too numerous to address in the law. In addition, prepotency is probably conditional on circumstances, e.g., productive uses of water could be more important during difficult economic times.

Future research directions

Future research could obtain a deeper psychological understanding of behaviour relating to water resources and water resource management e.g., by assessing BBVH and motivation (Glynn *et al.*, 2017; Maslow, 1943, 1954, 1993). In particular, this research could assess the relation between needs and prepotency, aiming to understand how these vary over time. On the policy level, further research could aim to assess the potential for Maslow's needs and prepotency as a water-legislation framework (i.e., 'human-based' water management) thus providing a useful adjunct to sustainable management as defined by the RMA.

Conclusions

Humans have a very close affinity with their water supplies. This has been demonstrated by the development of water supply schemes, large and small, and of states themselves, dating back to dawn of civilisation (Carneiro, *1970;* Tvedt, 2016; Reich and Shukron, 1999). Therefore, the science of psychology has much to offer to the understanding of the relationships between human behaviours and water resources.

Human behaviours related to water resources were categorised by Maslow's 'hierarchy of needs', a psychological theory of motivation (Maslow, 1954). Prepotency of these needs means that satisfaction of 'higher' needs depends, to some extent, on the prior satisfaction of 'lower' needs.

An assessment of the New Zealand national water legislation, regulations and policies against Maslow's hierarchy showed how these have evolved since the RMA, which was passed in 1991. The NPS-FM and human drinking-water legislation (e.g., Ministry of Health, 2018), represent advances in national water management associated with three needs: safety, belongingness and love (community) and self-transcendence. In contrast, esteem needs and self-actualisation needs are not, or are poorly, provided by these policies.

Esteem and self-actualising behaviours were demonstrated by an organisational analysis of the Canterbury Water Management

Strategy (CWMS) using Maslow's hierarchy. For example, the esteem need was expressed by organisations that promote economic development (e.g., Canterbury Mayoral Forum) and irrigators. Sub-regional water committees fill an altruism need with committee members typically spending more time in their roles than they are paid for.

Maslow's hierarchy may provide a framework for future 'human-based' water management that considers the prepotency of needs. Therefore, future research could aim to assess deeper psychological understandings of behaviours towards water resources and investigate applications that supplement sustainable water management legislation.

Acknowledgements

I would like to express my gratitude to Mike Ede, Marlborough District Council for comments on industry training in hydrology, and to John Sanders, for his summary of Water Rights Trust activities since 2002. Canterbury citizens are thanked for their contributions to the paper: Mark Pizey for his comments on the Central Plains Water Trust; and Lesley Woudberg and Michael Blackwell for their comments on Environment Canterbury zone committees,

Reviewers (anonymous Journal of Hydrology and Lydia White) are thanked for their useful comments on drafts of this paper.

References

Anonymous. 1967: Early History of the Locks and Canals Corporation. *Towpath Topics 5(3)*: 3. Middlesex Canal Association, Billerica, Massachusetts.

Benny, T. 2014: *Water Gives Life. The story of Morven Glenavy Ikawai Irrigation Scheme*. Morven Glenavy Ikawai Irrigation Company, Canterbury.

Body, A.; Cushnie, A. 2015: *Water, Farming and Families: the Mayfield Hinds Irrigation Scheme*. Mayfield Hinds Irrigation Limited, Ashburton.

Cameron, B. 2009: *Liquid Gold*. Brian Cameron, Ashburton, New Zealand.

Carneiro, R.L. *1970:* A Theory of the Origin of the State. *Science 169(3947): 733–738*. https://doi.org/10.1126%2Fscience.169.3947.733.

Canterbury Mayoral Forum 2019: https://www.canterburymayors.org.nz/. Accessed 1/12/2019.

Central Plains Water Limited 2019: Central Plains Water Limited: Sustainable Development of Central Canterbury's water resource. Retrieved 1 December 2019 from https://www.cpwl.co.nz/.

Central Plains Water Trust. 2018: Central Plains Water Trust. Retrieved 10 July 2018 from http://cpw.org.nz/

Davis, L.E. and North, D.C. 1971: Institutional Change and American Economic Growth. Cambridge: Cambridge University Press. https://doi.org/10.1017/CBO9780511561078.

Deravin-Malone, L.; Anderson, J. 2016: Chronic Care Nursing: A Framework for Practice. Cambridge University Press. DOI: 10.1017/CBO9781316544341.

Environment Canterbury. n.d.: About the water zone committees. Retrieved 29 March 2020, from https://ecan.govt.nz/your-region/your-environment/water/whats-happening-in-my-water-zone/about-the-water-zone-committees/.

Environment Canterbury. 2020: Wetlands a passion for Waimakariri chair. Retrieved 29 March 2020, from https://ecan.govt.nz/get-involved/news-and-events/zone-news/waimakariri/wetlands-a-passion-for-waimakariri-water-zone-committee-chair/.

Environment Court of New Zealand. 2011: Decision No. NZEnvC 163 in regards of Proposed Waikato Regional Plan Variation 5 – Lake Taupo catchment. 48 p.

Eppel, E. 2015: Canterbury Water Management Strategy: 'a better way'? *Policy Quarterly 11(4): 49–57*.

Feder, K.L.; Park, M.A. 2007: *Human Antiquity: An Introduction to Physical Anthropology and Archaeology*. Fifth Edition. McGraw-Hill, Boston.

Fenemor, A.D. 1988: *A three-dimensional model for management of the Waimea Plains aquifers, Nelson*. Publication No. 18 of the Hydrology Centre, Department of Scientific and Industrial Research, Christchurch.

Friedman, Z. 2016: Nilometer. *In*: Selin, H. (Ed.) *Encyclopaedia of the History of Science, Technology and Medicine in Non-Western Cultures*. Third Edition. Springer, Netherlands.

Gewirth, A. 1998: *Self-Fulfillment*. Princeton University Press, New Jersey.

Goklany, I.M. 2002: *The globalisation of human well-being*. Policy Analysis 44. Cato Institute, Washington, D.C.

Glynn, P.D.; Voinov, A.A.; Shapiro, C.D.; White, P.A. 2017: From data to decisions: Processing information, biases, and beliefs for improved management of natural resources and environments. *Earth's Future 5*: 356–378. DOI: 10.1002/2016EF000487.

Hanley, S.J.; Abell, S.C. 2002: Maslow and relatedness: creating an interpersonal model of self-actualisation. *Journal of Humanistic Psychology 42(4)*: 37–57.

Heylighen, F. 1992: A cognitive-systematic reconstruction of Maslow's theory of self-actualisation. *Behavioral Science 37(1)*: 39–57.

Irrigation NZ. 2017: *Honorary Members*. Retrieved 8 December 2017 from https://www.irrigationnz.co.nz/EventsAndTraining/Awards/HonoraryMembers.

Jenkins, B. 2018: *Water management in New Zealand's Canterbury Region. A Sustainability Framework*. Global Issues in Water Policy 19. Springer, Netherlands.

Kenrick, D.T.; Griskevicius, V.; Neuberg, S.L.; Schaller, M. 2010: Renovating the pyramid of needs: contemporary extensions built upon ancient foundations. *Perspectives on Psychological Science 5(3)*: 292–314. DOI: 10.1177/1745691610369469.

Kirk, N.A. 2015: *Local government authority and autonomy in Canterbury's freshwater politics between 1989 and 2010*. A thesis submitted in partial fulfilment of the requirements for the Degree of Doctor of Philosophy at Lincoln University. Lincoln University, Canterbury.

Koltko-Rivera, M.E. 2006: Rediscovering the Later Version of Maslow's Hierarchy of Needs: Self-Transcendence and Opportunities for Theory, Research, and Unification. *Review of General Psychology 10(4)*: 302–317. DOI: 10.1037/1089-2680.10.4.302.

Latham, G.P. 2012: *Work motivation: History, Theory, Research, and Practice*. Second Edition. Sage Publications, Los Angeles.

Leontiev, D.A. 2008: Maslow Yesterday, Today, and Tomorrow. *Journal of Humanistic Psychology 48(4)*: 451–453. DOI: 10.1177/0022167808320536.

Lovelock, J.E. 1972: Gaia as seen through the atmosphere. *Atmospheric Environment 6(8)*: 579–580. DOI:10.1016/0004-6981(72)90076-5.

Mahon, S. 2006: *The Water Thieves*. Longacre Press, New Zealand. 192p.

Maslow, A.H. 1943: A theory of human motivation. *Psychological Review 50(4)*: 370–396. DOI:10.1037/h0054346.

Maslow, A.H. 1954: *Motivation and personality*. Harper, New York.

Maslow, A.H. 1993: *The Farther Reaches of Human Nature*. Penguin Compass.

Memon, P.A. 1993: *Keeping New Zealand Green*. Otago University Press, Dunedin. 173 p.

Ministry for the Environment. 2009: *Draft Users' Guide: National Environmental Standard for Sources of Human Drinking Water*. Ministry for the Environment, Wellington.

Ministry for the Environment. 2015: Description of the National Environmental Standard for Human Drinking Water. Retrieved on 12 March 2015 from http://mfe.govt.nz/laws/standards/drinking-water-source-standard.html.

Ministry for the Environment. 2017: National Policy Statement for Freshwater Management 2014 updated August 2017 to incorporate amendments from the National Policy Statement for Freshwater Amendment Order 2017. 47 p.

Ministry of Health. 2000: Secure groundwater: bores and wells for safe household water. Pamphlet A5, Ministry of Health, Wellington.

Ministry of Health. 2013a: *Guidelines for Drinking-water Quality Management for New Zealand 2013*. Third edition. Ministry of Health, Wellington.

Ministry of Health 2013b*: Household water supplies. The selection, operation and maintenance of individual household water supplies*. Ministry of Health, Wellington.

Ministry of Health. 2018: *Drinking-water Standards for New Zealand 2005 (revised 2018)*. Ministry of Health, Wellington.

Neher, A. 1991: Maslow's theory of motivation: a critique. *Journal of Humanistic Psychology 31(3)*: 89-112.

Nelson Catchment and Regional Water Board. 1981: Waimea Basin Water Management Plan. 20p + map.

New Zealand Hydrological Society. 2017: *Outstanding Achievement Awards*. Retrieved on 8 December 2017 from http://www.hydrologynz.org.nz/index.php/nzhs-awards/nzhs-recipients.

New Zealand Qualifications Authority. 2014: *New Zealand Diploma in Field Hydrology*. Qualification Reference 234. New Zealand Qualifications Authority, Wellington.

Rajanayaka, C.; Donaggio, J.; McEwan, H. 2010: *Update of Water Allocation Data and Estimate of Actual Water Use of Consented Takes 2009–10*. Aqualinc Research Ltd report H10002/3 for Ministry for the Environment. 118p.

Reich, R.; Shukron, E. 1999: Light at the End of the Tunnel: Warren's Shaft Theory of David's Conquests Shattered. *Biblical Archaeology Review 25(1)*: 22–33, 72.

Rowan, J. 1998: Maslow amended. *Journal of Humanistic Psychology 38(1*): 81-92.

Scarre, C. 2013: *The Human Past, World Prehistory and the Development of Human Society*. Thames and Hudson. 784p.

Schaller, M.; Neuberg, S.L.; Griskevicius, V.; Kenrick, D.T. 2010: Pyramid power: a reply to commentaries. *Perspectives on Psychological Science 5*: 335–337. DOI: 10.1177/1745691610369474.

Self-fulfilment. n.d.: *Oxford English Dictionary*. Retrieved 24 November 2019 from https://en.oxforddictionaries.com.

Service, E.R. *1*978: Classical and modern theories on the origins of government. *In:* Cohen, R.; Service, E.R. (Eds.) *Origins of the State: The Anthropology of Political Evolution.* Institute for the Study of Human Issues, Philadelphia.

Shaw, R.E. 1993: Canals for a Nation: The canal era in the United States 1790-1860. University Press of Kentucky.

Tasman District Council. 2014: Tasman Resource Management Plan. Volume 1: Text. including amendments to 8th March 2014.

Tay, L.; Diener, D. 2011: Needs and subjective well-being around the world. *Journal of Personality and Social Psychology 101(2)*: 354–365. DOI: 10.1037/a0023779.

The Audit Office. 1991: The process for disposal of Crown-funded irrigation schemes. The Audit Office, Wellington.

Tribalism. n.d: *Oxford English Dictionary*. Retrieved 24 November 2019 from https://en.oxforddictionaries.com.

Trigg, A.B. 2008: Deriving the Engel Curve: Pierre Boudieu and the social critique of Maslow's hierarchy of needs. *In*: Dolfsma, W. (Ed.) *Consuming Symbolic Goods. Identity and Commitment, Values and Economics.* Routledge, Oxon.

Tvedt, T. 2016: *Water and Society. Changing Perceptions of Societal and Historical Development.* I.B. Tauris, London.

University of Canterbury 2010: *University of Canterbury Chronicle 45(17)*.

Waikato Regional Council. 2012: Proposed Waikato Regional Plan Variation No.6 – Water Allocation Operative (10 April 2012). Waikato Regional Council document number 2141102, 80 p.

Waimakariri Irrigation Limited. 2019: Waimakariri Irrigation Limited. Retrieved 1 December 2019 from https://www.wil.co.nz/.

Waitangi Tribunal. 2012: The interim report on the national fresh water and geothermal resources claim. WAI 2358. 296 p.

White, P.A. 1997: Hydrological extremes and the groundwater system. *In*: Mosley, M.P; Pearson, C.P. (Eds.) *Floods and Droughts: The New Zealand experience*. New Zealand Hydrological Society, Wellington.

White, P.A. 2003: President's column: Future labour needs in hydrology. *New Zealand Hydrological Society Newsletter No. 22*: 1–4.

White, P.A. 2011: Economic drivers of land use and groundwater use by irrigators, Waimea Plains Nelson, New Zealand. *New Zealand Journal of Marine and Freshwater Research 45(3)*: 513-524.

White, P.A. 2018: Efficiency measures and water management. *Journal of Hydrology (NZ) 57(2)*: 95-105.

White, P.A.; Close, M. 2016: Groundwater systems. *In*: Jellyman, P.G.; Davie, T.J.A.; Pearson C.P.; Harding, J.S. (Eds.) *Waters of New Zealand (2nd edition)*. New Zealand Hydrological Society and New Zealand Limnological Society, Wellington.

White, P.A.; Sharp, B.M.H.; Kerr, G.N., 2001: Economic valuation of the Waimea Plains groundwater system. *Journal of Hydrology (NZ) 40(1)*: 59-76.

World Commission on Environment and Development. 1987: *Our common future.* Oxford University Press, New York.

World Health Organisation. n.d.: The Ottawa Charter for Health Promotion. First International Conference on Health Promotion, Ottawa, 21 November 1986. Retrieved on 15 October 2017 from http://www.who.int/healthpromotion/conferences/previous/ottawa/en/index1.html.

Manuscript received 30 May 2019; accepted for publication 26 May 2020