Drinking Water Catchment Protection as Disaster Risk Reduction: Modelling Community Support for Restrictive Recreation Policy using the Health Belief Model

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Statement of Originality

I hereby certify that the work embodied in the thesis is my own work, conducted under normal supervision. The thesis contains no material which has been accepted, or is being examined, for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made. I give consent to the final version of my thesis being made available worldwide when deposited in the University's Digital Repository, subject to the provisions of the Copyright Act 1968 and any approved embargo.

Holly Marlin

Badu Niiarrenumba Girru

Water is Life

(Kadang, the traditional language of the Worimi People)

Dedication

To Kathie, for being my confidante, motivator, healer and friend for nearly 30 years.

Requiem æternam.

Acknowledgements

Six weeks ago, I couldn't imagine I'd be sitting here now, reflecting on all that has transpired over the past few years, and preparing to submit this document. It's been a surreal ride.

Spending two years essentially in isolation has been quite a solitary experience. While I wouldn't wish it on anyone, the lockdown provided an incredibly effective circumstance in which to write up a dissertation – it's amazing how motivating it is to focus on a task when there's nowhere to go and nothing else to do! The PhD, in turn, provided a wonderfully safe cocoon, a respite from multiple disasters – fires, drought, floods, more floods, a global pandemic, a war – as well as deaths and illnesses, and all the other incredibly stressful events of the past few years affecting my local and global communities, family and friends. I have emerged supremely grateful to have been spared from the direct effects of so much of the trauma and tragedy that has affected so many others.

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This research was undertaken in the Traditional Countries of the Worimi, Gaewegal, Wonaruah, Awabakal and Darkinjung peoples. I recognise and honour their role as the original, and rightful, custodians of the waterways and their catchments, and pay my respects to their Elders past, present and emerging.

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List of Acronyms

ADWGs	Australian Drinking Water Guidelines
AVE	Average Variance Extracted
CB-SEM	Covariance-based Structural Equation Modelling
CCA	Confirmatory Composite Analysis
CFA	Confirmatory Factor Analysis
DRR	Disaster Risk Reduction
EFA	Exploratory Factor Analysis
HBM	Health Belief Model
HTMT	Heterotrait-Monotrait
LGA	Local Government Area
MGA	Multigroup Analysis
MICOM	Measurement Invariance of Composite Models
NDRRF	National Disaster Risk Reduction Framework
NEP	New Ecological Paradigm
NSW	New South Wales
PLS-MGA	Partial Least Squares Multi-Group Analysis
PLS-SEM	Partial Least Squares Structural Equation Modelling
SEM	Structural Equation Modelling
SCT	Social Cognitive Theory
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
TTM	Trans Theoretical Model
VIF	Variance Inflation Factor

Abstract

While natural and anthropogenic hazards are increasing, Disaster Risk Reduction (DRR) can protect individuals and communities from the adverse effects of disasters associated with those hazards. DRR can be achieved through implementing policies to reduce or remove hazards; such policies, however, are often restrictive and, therefore, contravene personal desires and freedoms. As policies need to be accepted and followed by the community to be effective, it is important to understand the variables influencing community acceptance of those policies. A literature review revealed there was no accepted model of policy support, but that risk perception was likely to be a key influencing factor. A candidate model — the Health Belief Model (HBM) — was identified in the health behaviour field, and tested in the novel context of policy support for its ability to explain support for policies restricting recreational activities in drinking water catchments, which are implemented by metropolitan water managers in Australia to reduce contamination risks to potable water sources. Through Partial Least Squares Structural Equation Modelling, the HBM was found to have good explanatory power for recreation policy support in a sample of the adult population of the lower Hunter Region of New South Wales. Modelling and subsequent analyses determined that risk perception was a key driver of policy support in the sample, and that other important influencing variables in this context included gender and self-interest, particularly in the form of proximity of residence to catchments and personal recreation preferences. The influence of self-interest has important implications for community engagement activities. The HBM can identify factors to which information and education campaigns can be targeted in order to increase community acceptance of risk reduction policies, and has potential application as a general model of risk reduction policy support, particularly in the health and disaster domains. Use of the HBM may assist in the mitigation of disaster risk by helping to increase community acceptance of disaster risk reduction policies.

Chapter 1. Introduction

Chapter 1

1.1. Dissertation Overview

Floods, extreme storms, drought, bushfires, chemical contamination of water — these are just some of the natural and anthropogenic hazards occurring in Australia, which can result in disasters with catastrophic consequences for the community (Binskin et al. 2020). The management of hazards to reduce the risk or consequences of disasters is known as Disaster Risk Reduction (DRR), and policies designed to remove or mitigate hazards are an important method of achieving DRR. This dissertation reports the exploration of variables affecting community acceptance of risk reduction policies designed to mitigate health-related disaster risks. The empirical investigation focused on a case study of a particular anthropogenic hazard posing a threat to potable water quality and, therefore, public health — recreation in drinking water catchments and storages (referred to collectively, herein, as catchments) — in the lower Hunter Region of New South Wales (NSW), Australia. Using techniques from Environmental Psychology, the study explored how community acceptance of risk reduction policies is affected by their perception of risk and other variables, and tested a potential theoretical model of support for a health and DRR policy — The Health Belief Model (HBM). The identification and demonstration of efficacy of a model of policy support is an important contribution in the quest to understand how to increase community acceptance of DRR policies, which is necessary to increase the effectiveness of such policies in reducing the risk of disaster.

This dissertation describes the empirical research undertaken to: explore variables associated with policy support; identify and test a potential explanatory model of policy support; and explore the varying effects of influencing variables on different groups within the community. The implications of the findings for water managers and disaster managers are discussed.

This chapter provides an overview of the research, summarising the context of the study, and describing the research drivers and methodology. The structure of the dissertation is outlined in Table 1.

Table 1: Dissertation Structure

Chapter	Topic	Description
1	Introduction	Sets the context for the study, positioning it within the field of DRR; describes the problem context; and specifies the research question and methods of investigation.
2	Literature Review	Explores current knowledge relevant to the study, including the limited published papers on recreation policy support and related literature, including support for other health- or environmental-related policies. Identifies a range of variables potentially influencing policy support, with risk perception emerging as a potential key variable. Identifies the HBM — a risk-based model — as a candidate model for policy support. Defines the study hypotheses, which were generated from the literature.

Chapter	Topic	Description
3	Methodology	Describes how data were collected for the study, including: questionnaire modification; study population; data collection; and analysis techniques (descriptive, statistical and structural equation modelling) used to explore and assess the data.
4	Model Testing	Details how the HBM was tested as a model of recreation policy support using partial least squares structural equation modelling (PLS-SEM) and the data described in Chapter 3. Compares the model's explanatory power for recreation policy support for two key demographic sub-groupings identified in the Literature Review (Chapter 2) — gender and proximity of residence to catchments. The model verification criteria and process are described extensively, and the results are discussed in relation to the model hypotheses and relevant literature.
5	Additional Analyses	Following the demonstration of the explanatory power of the model for recreation policy support in Chapter 40, this chapter further explores group differences and investigates the influence of two key additional variables on policy support, which are not included in the HBM — personal recreation participation and worldview — as well as the influence of additional demographic variables. The results are discussed in terms of the chapter-specific hypotheses and the context of the study population's policy acceptance.
6	Discussion and Conclusion	Brings together the findings of the two empirical chapters (Chapter 4 and Chapter 5), and discusses the significance and implications of the study and its potential applications to Water Managers and Disaster Managers, including how using the lens of DRR to approach catchment protection may improve water security and resilience.
Appendix A		Study Information Statement and Questionnaire
Appendix B		Study Approval from Human Ethics Committee
Appendix C		Additional Data Analyses

1.2. The Research Problem

1.2.1. Overview

The world is subject to an increasing level of natural and anthropogenic hazards, which can lead to disasters with wide-ranging and significant consequences (National Resilience Taskforce 2018). DRR is needed to protect individuals and communities from the adverse effects of disasters. DRR can be achieved through the development and implementation of policies designed to protect the greater good. As such policies can restrict individuals' activities, they may be challenged or ignored, which can lead to adverse consequences for the community. In order for DRR policies to be effective, acceptance and observance of the policies by the most people possible is required. It would be useful, therefore, to understand how to increase community acceptance of policies to mitigate disaster risk. Further, a theoretical model of policy support would help to identify key areas to which interventions should be targeted in order to increase community acceptance.

Understanding the variables influencing community acceptance of risk reduction policies is required, together with how those variables, and policy acceptance, vary between different segments of the community. While risk perception was identified as a potential key influence on policy support, no accepted model of policy support was identified in the literature. The aim of the study was, therefore, to explore the influence of risk perception and other personal characteristics on support for risk reduction policies, with a key objective to identify and test a theoretical model of policy support.

A candidate model used extensively in the health field — the HBM — was identified, and tested in the novel area of policy support. Recreation policy support was chosen as a case study to explore the variables affecting community acceptance of policy to mitigate disaster risk, as recreation in catchments is a hazard to potable water quality and public health. The HBM was found to be a valid model of recreation policy support in the catchments of the lower Hunter Region of NSW, and may be a useful tool with which to target interventions for changing acceptance of risk reduction policies in this sample population. Future research may demonstrate the usefulness of the model to explain recreation policy support in other locations, and to serve as a model of DRR policy support more broadly.

The key contribution of the research is the innovative application of the HBM. This theoretical contribution is important as the efficacy of the HBM was demonstrated in a novel application, that of policy support. The HBM has traditionally been used to explain behaviour and action under the control of the individual; this study is distinguished from other HBM studies by demonstrating that the HBM can also explain an individual’s support for behaviour to be undertaken on their behalf, or the behalf of the community, by an external agent. In addition, the study filled the gap in the literature by identifying and verifying a model of policy support.

The study context is further described in the following section, which introduces the key aspects of DRR, describes threats to and management of potable water sources in Australia, and demonstrates the relevance of DRR to water management.

1.3. Problem Context

1.3.1. Disaster Risk Reduction

The term 'disaster' often conjures visions of cataclysmic hydrological, meteorological, climatological, or geophysical events, such as floods, cyclones, droughts, bushfires and earthquakes. A disaster, however, can also be anthropogenic in origin. The United Nations (2016, p13) defines a disaster as:

> A serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts.

Of note, hazards lead to disasters when people are exposed to, and are susceptible to the effects of, the hazards (National Resilience Taskforce 2018). Natural hazards cannot be controlled, but disasters can be avoided in many cases by removing or reducing society's exposure or vulnerability to them; examples include avoiding building within known flood plains or high erosion areas, or designing buildings to withstand bushfires or strong wind conditions. In the case of anthropogenic hazards, the hazards are caused by human actions and, therefore, are preventable.

Australia is a signatory to the Sendai Framework for Disaster Risk Reduction 2015 – 2030 (UNDRR 2015), a global agreement for the management of disaster risk, which recognises DRR as a critical component of resilience. Under the Sendai Framework, all levels of society are expected to engage in DRR to reduce disaster risk. Given the greater power and control of Government and Industry, however, the primary onus for action falls on them. Australia's DRR efforts are guided by the National Disaster Risk Reduction Framework, which commits Australia to the Sendai Framework (National Resilience Taskforce 2018).

The Sendai Framework highlights two key requirements of DRR to strengthen resilience: preventing new disasters by reducing exposure and vulnerability[1]; and reducing existing disaster risks. Environmental degradation and human action are highlighted as sources of hazards that must be addressed in order to prevent or mitigate[2] disasters and their effects. Contamination of potable water supplies is an example of such a hazard, as it can result in illness and death, as well as disruption to water supplies.

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[1] susceptibility to the effects of hazards (defined by UNDRR as '*The conditions determined by physical, social, economic and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards*').

[2] reduce the scale and likelihood of impacts

1.3.2. Potable Water

Clean drinking water is essential to sustain life and public health (NHMRC 2011), and is recognised as a basic human right (United Nations General Assembly 2015). In addition to requiring clean water to drink, potable water is an essential need for many societal activities, including health care, sanitation, education and manufacturing (WSAA 2021). Given its essential nature, potable water is the highest and best use of limited and precious freshwater resources.

While potable water supplies are scarce in many areas of the world, Australia faces particular challenges of water security, as it is the driest inhabited continent on earth (Argent 2016). UN Water (2013, p1) defines water security as:

> the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability.

This definition implies that water security requires sustainable management of the whole water cycle in a way that protects against waterborne illness, maintains the resources for future generations, and is affordable.

In Australia, potable water is primarily derived from rainwater, which is collected in the natural and built environment (catchments) and transferred to waterbodies and water storages, which include rivers, dams and groundwater aquifers. The rainfall dependency of the water supply means it is sensitive to climatic changes, and water quality is also affected by the surfaces over which the rainfall travels on its way to the waterbodies and storages. As potable water is susceptible to a range of natural and anthropogenic hazards, it is a key target for DRR action.

1.3.3. Threats to Potable Water Supplies

Potable water sources require protection and management to maintain the security and resilience of the water supply. Water security resilience helps to prevent water supply-related disasters.

As Australian potable water supplies are primarily derived from surface water sources (Hatton 2011), the water supply is threatened by natural hazards. The volume and quantity of freshwater in the environment is affected by a range of natural or environmental processes. Climate change predictions for many areas of Australia indicate that regular rainfall events will decrease, which will lead to a reduction in the amount of potable water regularly available. Further, natural events such as floods, extreme storms and bushfires, are expected to increase (WSAA 2021). These events can all have a negative effect on water quality through introducing large quantities of contaminants such as sediment, ash, and urban pollutants into water bodies. Further, increases in average temperatures will likely increase algal blooms on water bodies, which can generate toxins, and increase the rate of evaporation of water bodies, leading to smaller available water volumes (WSAA 2021), as well as changing biological processes and species distributions within the catchments and waterbodies (van der Linden et al. 2018). All these challenges can adversely affect the natural water purification processes. The risk of cumulative or concurrent large-scale natural hazards occurring is also increasing (National Resilience Taskforce 2018). Water security is also threatened by anthropogenic hazards which, unlike the natural hazards, can be prevented.

Human activity in catchments is also a key hazard to water quality. In addition to development in catchments affecting natural flow regimes of rainwater, development and use of the land can introduce contaminants into the water supply. Such contamination can be introduced through rainwater flowing over surfaces and picking up contamination. Discharges into water bodies from agriculture, industry and landowners are other sources of contamination, as are activities in and on the waterbodies and water storages themselves (Miller et al. 2006).

Contaminants in potable water sources can include pathogens, chemicals, heavy metals and nutrients. The primary risk to human health from potable water is contamination by pathogenic microorganisms (bacteria, protozoa and viruses), particularly those found in human and livestock waste (NHMRC 2011). Pathogens can persist in the environment and can cause illness with very small exposure levels. Importantly, many pathogens are not removed easily or inactivated by conventional water treatment processes, which use chlorine for disinfection. While chlorine can kill bacterial pathogens and reduce the amount of viral and some protozoan pathogens, protozoa such as *Cryptosporidium* are resistant to chlorine and many other disinfection processes. Pathogens, therefore, are the key contaminants of concern for potable water supplies in Australia (NHMRC 2011).

More than 100 different pathogens have been identified in human waste (Cilimburg et al. 2000), and these microorganisms are some of the main causes of acute and chronic illnesses worldwide, such as gastroenteritis, irritable bowel syndrome and autoimmune diseases, some of which can be passed between people through other (non-waterborne) pathways (Leclerc et al. 2002). While waterborne illness can affect all members of the population, those most at risk are the very young, the elderly and those with compromised immune systems (NHMRC 2011).

1.3.4. Failures of the Potable Water Supply System are Disasters

Waterborne illness is a disaster, which can cause significant health[3] and economic[4] costs to the community (Hrudey 2021), as well as to water managers[5] (Stein 2000). Waterborne illness is particularly prevalent in low and middle income countries, where there is a large disease burden that affects life expectancies and results in many fatalities (WHO 2018). In contrast, waterborne illness associated with potable water in higher income countries is considered to be a preventable disaster (Hrudey 2021, Hrudey and Hrudey 2019). Developed nations typically enjoy high quality water that, for most of the population, is distributed directly to their homes and is provided at a low cost. Regardless, contamination of reticulated drinking water supplies remains a key hazard in developed countries, as very large numbers of people can be exposed to the hazard, and illness (both acute and chronic) and death can be caused by small variations in contaminant levels (McKay and Moeller 2001). In addition to the health-related disasters caused by waterborne pathogens, management measures to address contaminated water supplies often include restrictions on the supply of potable water, which can have extensive consequences for society given the interconnectedness and interdependencies of essential services (National Resilience Taskforce 2018), and such restrictions themselves can lead to disaster. As noted by the National Health and Medical Research Council of Australia (NHMRC), therefore, the 'Protection of water sources and treatment are of paramount importance and must never be compromised.' (NHMRC 2011, p1).

Although it is, therefore, clear that waterborne illness transmitted through the potable water supply is a disaster, it does not appear to be considered in such terms by government or water managers in Australia. While major water utilities have many processes in place to ensure the safety of the drinking water supply, including extensive risk management processes, the issue is viewed in terms of public health and supply issues rather than DRR (e.g. Drayton and Seidel 2021).

1.3.5. Potable Water Management in Australia

A core function of water utilities is to protect public health by providing safe drinking water (Krogh et al. 2009). Water utilities supplying potable water to large populations in Australia, therefore, are heavily regulated. The utilities have statutory obligations to meet supply and quality standards

[3] Short-term illness effects include diarrhoea, gastroenteritis, and haemolytic uremic syndrome. Long-term illnesses resulting from waterborne illness include autoimmune diseases (reactive arthritis, Guillain-Barré syndrome), hypertension, irritable bowel syndrome and other digestive disorders.

[4] Conservative cost estimates of outbreaks indicate contamination events cost are in the order of tens of millions of dollars.

[5] The costs to the water utility associated with the 1998 *Giardia* and *Cryptosporidium* contamination incident in Sydney, Australia, included around $33 million in customer rebates, lost revenue, damages, and staff and testing costs during the incident, and that was without any confirmed cases of illness. Costs associated with system and infrastructure improvements were also incurred (Stein, 2000).

for potable water and frequently are subject to heavy oversight by government departments. Urban water utilities in Australia manage their catchments through a risk management process based on identification of the known and likely risks to each area. Factors such as type of storage (surface or groundwater), surrounding land uses, stormwater drainage patterns, and ecological and chemical processes within the water source can affect the type of risk each water supply faces (Miller et al. 2009).

While each water utility in Australia independently manages its water supplies in accordance with their specific challenges, the urban water industry generally follows a precautionary approach to protecting public health, using the Australian Drinking Water Guidelines (ADWGs) (NHMRC 2011) as best practice guidance (and, in some cases, statutory requirements) for their operations. The ADWGs provide a framework of fundamental principles of best practice for managing the safety of public drinking water supplies in Australia. The guidelines have a preventive risk management approach, which incorporates aspects of Australian quality, environmental and risk management standards. A cornerstone of the ADWGs' approach is that of multiple barriers of protection, which include source water protection, water treatment, and monitoring to ensure supplied water is safe to drink. The multiple barrier approach (NHMRC 2011) acknowledges that, while some level of treatment is required for most potable water sources, prevention of contamination is better than treatment, as technology cannot be relied upon to protect human health, and no barrier can be effective against all contaminant types, be effective at all times, or function at a maximum level of efficiency at all times. Source water protection 'to the maximum degree practicable', including protection of the catchments, therefore, is considered the most effective and desirable strategy for avoiding potable water contamination (NHMRC 2011, p2).

Despite a clear need to prevent contamination, Krogh et al. (2009) note there is a common perception that water treatment science has advanced such that all the risks can be engineered out; such views are implicitly and explicitly stated within the water industry, as well as in government planning departments and in the community. The fallibility of treatment processes, however, is well documented (Miller et al. 2006). Waterborne illness outbreaks in locations including New Zealand, Canada, and Europe frequently have been caused by failures of treatment processes, with other contributing factors including the failure to acknowledge and rate the risks and consequences of outbreaks appropriately, which can be significant and long lasting (Hrudey 2021, Hrudey and Hrudey 2019). It is clear, therefore, that treatment processes are not sufficient to mitigate the disaster risk, and that prevention of contamination from entering the water sources is critical. The NHMRC (2011, p2) notes that 'Prevention of contamination provides greater surety than removal of contaminants by treatment', and that prevention of contamination in catchments should be a focus of efforts to ensure safe drinking water supplies. Catchment protection is a critical component of ensuring the safety of the public water supply, as protection and thoughtful management of the catchments can significantly reduce the concentration and number of contaminants in the potable water sources. Catchment protection, therefore, is a key risk reduction measure.

The hierarchy of control of hazards and risks commonly used in the safety industry is based on the understanding that the most effective way to ensure safety is to first eliminate risks where possible, followed by the minimisation of risks, and, finally, to mitigate the effects of any remaining risks (Safe Work Australia 2018). These principles are used frequently within the water industry to manage potable water supplies, and are consistent with the intent of DRR principles. As threats to water security from natural hazards are uncontrollable, actions to manage hazards typically focus on engineering measures, such as source diversification, treatment works, and physical barriers to contamination. In contrast, anthropogenic hazards, which are controllable, can be managed through protective policies. One such threat is that of recreation in the catchments.

Recreation policies for activities in and around the water storages are typically under the control of water managers. While many metropolitan water managers in Australia use a precautionary approach, and prohibit or restrict recreation in and around their catchments and storages (Miller et al. 2006), the demand for access to catchments for recreation is increasing (Billington and Deere 2020, Krogh et al. 2009).

1.3.6. Recreation in Catchments is a Preventable Hazard

Australians are known for their love of sport and outdoor recreation. In 2016, NSW residents aged 15 years and older were estimated to spend 47 million hours in nature-based outdoor recreation activities, with around one third of those hours spent walking, running and cycling (Cheesman and Jones 2020). Outdoor recreation contributed around $11 billion to the Gross Domestic Product of Australia in 2018 (Cheesman et al. 2018), and modelling by Heagney et al. (2019) estimated the value of recreation and tourism in NSW protected areas, such as National Parks, to be around $3.3 billion per annum.

Outdoor recreation has a range of benefits for individuals and communities, including improving mental and physical health (Cheesman et al. 2018). Benefits of exercising in nature include the reduction of anxiety, depression, and illness, and the improvement of cognitive functioning (Sandifer et al. 2015). The estimated avoided healthcare cost of outdoor recreation in NSW in 2016 was $480 million (Cheesman and Jones 2020). Such activities, therefore, are important to the community both in terms of health outcomes and economic benefits.

The question, however, is not whether outdoor recreation is valued by and of benefit to the community, but whether recreation in catchments is of sufficient benefit to overcome the disbenefits associated with increased risk of contamination of water sources and storages. While recreation has known health and mental benefits, these activities do not have to be undertaken in catchments. The benefits of recreation in catchments must be weighed against the threat to public health associated with permitting these activities in these sensitive areas, and the concomitant increased costs of water treatment and recreation management activities. In the case of recreation in catchments, the community is the hazard to water quality.

Recreation is a key contamination hazard for water supplies, as it can introduce pathogens into water bodies; as stated previously, pathogens are the contaminants of greatest risk to health in potable water supplies (NHMRC 2011). Human pathogens such as *Cryptosporidium* can contaminate the water supply through either direct human contact or human waste that is disposed of inappropriately, and public access is a well-known source of pathogens in water storages and catchments (Billington and Deere 2020, Miller et al. 2006). This is particularly true for full body-contact activities in reservoirs (Loganthan et al. 2012); a single infectious person can unknowingly release millions of microbial organisms, such as protozoa and enteric viruses, into waterbodies (Gerba 2000). Recreational activities can also introduce chemicals and nutrients, increase sediment loads, and change the ecology of, and natural processes in, water sources (Miller et al. 2006), as well as adversely affecting the surrounding environment through increasing fire risk, damaging ecosystems and species distribution, and introducing pest species and disease (Krogh et al. 2009). The cumulative effects of recreation are important to consider (Billington and Deere, 2016).

In addition to the threats to water quality associated with increasing recreation access, such action would also increase the costs of the water supply due to increased costs of treatment and management (Krogh et al. 2009), which may threaten the affordability of the water supply. Recreation in catchments, therefore, is an important focus of risk reduction practices and policies by water authorities, particularly in and around surface water storages.

Historically, drinking water in Australia was sourced primarily from protected, forested areas, where high quality water requiring minimal treatment could be found (Krogh et al. 2009). In contrast to water managers in other areas, such as North America and the United Kingdom, metropolitan[6] water managers in Australia traditionally adopted a precautionary approach (Pigram 2007), with recreation generally not permitted on or in permanent dedicated potable water supply reservoirs, although some passive forms of recreation were often allowed in the outer catchments. In many area, these risk-avoidant approaches continue today (Miller et al. 2006).

In many urban areas of Australia, such as in Sydney, Newcastle and Perth, recreation is limited or prohibited in catchments[7]. Direct contact recreation (such as swimming) is typically prohibited on storages primarily used for drinking water, and exclusion zones are frequently found around

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[6] In rural Australian areas, where alternative water-based recreation opportunities are limited, and where water storages typically serve multiple purposes, recreation is frequently permitted (Miller et al. 2006); the lower health risks in these areas associated with smaller populations, however, should be noted.

[7] In contrast, water storages in southeast Queensland were developed with the dual purpose of serving both potable water and recreational functions, so the water utility has a regulatory obligation to provide recreational opportunities in catchments, including boating, fishing and swimming. The cost of managing these recreational activities and limiting their risk to public health is substantial (Veal 2019).

reservoirs where recreation is limited or not permitted, while greater recreational access may be found in outer areas of the catchments (Miller et al. 2006).

With increasing populations and urban sprawl, however, many protected catchments have become closer to residential areas. Concurrently, the reported appeal of, and demand for, recreation in nature is increasing. The pressure to allow or increase recreational access to catchments and storages is well known in the Australian water industry (Bath et al. 2012, Bath et al. 2011, Billington and Deere 2020, Carlsen and Hughes 2010, Krogh et al. 2009, Miller et al. 2006, Petrie and Wrigley 1989, Sharp and Schell 1989). Higher demand is typically associated with storages and catchments located close to higher density residential areas or in locations where fewer alternative recreation locations exist (Fahey 1989, Sharp and Schell 1989). Water managers across Australia are experiencing increasing demand to permit greater access to the catchments for recreation and, in some areas, increasing political pressure to change recreation policies (Billington and Deere 2020, Krogh et al. 2009). It is important to note, however, that, in most areas, it is not known whether increased access is desired by most of the community or just a vocal minority; as such, it is possible that, in many areas, references to 'demand' may more accurately be termed 'interest'.

1.4. Research Question, Aim, Objectives and Hypotheses

DRR is needed to protect individuals and communities from disasters (UNDRR 2015). One important mechanism for achieving DRR is the development and implementation of policies designed to protect the greater good (Sawaneh and Fan 2021). Such policies can restrict activities, which may contravene people's personal wishes and freedoms, leading to the policies being challenged or ignored by individuals. Recent examples of this in Australia include policies to 'protect the right to health and life of people in Australia' (Australian Human Rights Commission 2021, p1) during the COVID-19 pandemic, such as: isolation and lockdown rules; travel restrictions; requirements to 'check in' to premises, maintain physical distance from others and to wear facial masks; and vaccination mandates (Knowlton 2022). Other pertinent examples include flood management, such as permissible development locations (NSW Department of Environment and Planning 2022); and bushfire risk reduction, which include development standards specifying building materials and building design (NSW Rural Fire Service 2019); and fire bans during fire-prone weather conditions (NSW Rural Fire Service n.d.). These laws and policies were designed to protect the health and safety of the community.

Failure of individuals to abide by DRR policies can lead to significant consequences for the community. During the COVID-19 pandemic in Australia, policy breaches by small numbers of people led to multiple disease outbreaks in several locations (Australian Associated Press 2021, Malone 2021, Ward and Carroll 2022), which resulted in significant community restrictions, economic hardships, and illness and death in many people. Acceptance and observance of the policies by the greatest number of people possible is considered, logically, to assist the effectiveness of disaster risk mitigation measures. In order to achieve that, it is necessary to know how to increase community acceptance of policies to mitigate disaster risk. Understanding the factors influencing policy acceptance elucidates areas in which action can be taken to increase policy acceptance. To determine the best course of action, and who to target, it is important to understand the level of acceptance in the community, and how that acceptance varies between different groups within the community.

Recreation in catchments is a water contamination hazard that can be mitigated through restrictive policy. Recreation policy in catchments was used as a case study for understanding community acceptance of disaster risk reduction policy.

The **research question** of this study, therefore, was:

What variables affect community acceptance of risk reduction policies relating to recreation in drinking water catchments?

DRR policy is designed to reduce risk, and risk perception was found to be a key factor influencing policy support in the literature. As such, the **aim** of the study was:

To explore the influence of risk perception and other personal characteristics on support for recreation policies in drinking water catchments.

In order to meet the study aim, the study **objectives** were to:

- Identify potential key variables associated with an individual's attitudes to recreation in the catchments;
- Identify a theoretical model of Policy Support;
- Modify an existing survey instrument to capture data pertaining to identified variables potentially affecting Recreation Policy Support in catchments;
- Conduct a community survey of attitudes to recreation policy in the catchments in the lower Hunter Region of NSW;
- Test the ability of the model to explain Recreation Policy Support using statistical testing (partial least squares structural equation modelling) and the collected survey data; and
- Assess the association of the variables investigated with Recreation Policy Support.

Study hypotheses were developed from the Literature Review (Chapter 2). The eight hypotheses specified below relate to the theoretical model of policy support (The Health Belief Model; HBM), which were tested using structural equation modelling (Chapter 40).

H1 The perceived susceptibility of a person to illness from waterborne disease will be positively associated with the perceived threat of recreation to water quality (recreation risk)

H2 The perceived severity of illness from waterborne disease will be positively associated with the perceived threat of recreation to water quality (recreation risk)

H3 The perceived threat of recreation to water quality (recreation risk) will positively influence support for recreation restriction in the catchments

H4 The perceived benefits of restricting recreation in the catchments will positively influence support for recreation restriction in the catchments

H5 The perceived barriers to restricting recreation in the catchments will negatively influence support for restricting recreation in the catchments

H6 The perceived benefits of restricting recreation will mediate the perceived barriers to restricting recreation in the catchments

H7 The model relationships will differ for the Female and Male samples

H8 The model relationships will differ for people living close to the catchments and those living further away

The following additional six hypotheses related to further group differences and the influence of additional variables of recreation activity types, worldview and personal recreation preferences on Recreation Policy Support; they were tested using non-parametric and descriptive statistics (Chapter 5).

H9 Passive land-based recreation will be more acceptable to the community than water-based recreation activities

H10 Females will be more supportive of recreation restriction than males

H11 People living further away from the catchments will be more supportive of recreation restriction than people living close to the catchments

H12 People will be more supportive of permitting recreation activities in the catchments that match their own recreation practices than people not engaging in those activities

H13 People supporting recreation restrictions will have stronger ecocentric worldviews than people supporting recreation activities in the catchments

H14 Females will have higher perceived recreation risk than males

1.5. Methodology

1.5.1. Research Philosophy

Research questions and methodologies are heavily influenced by the philosophical stance of the researcher (Berryman 2019). There are two key aspects to a research philosophy: the ontology, which defines the fundamental aspects of knowledge and what kinds of questions can be asked and answered; and epistemology, which defines ways we can gain knowledge, including data collection and analysis techniques (research methodology) (Berryman 2019). The research philosophy, therefore, provides guidance and context for the research, as well as creating boundaries for the study in terms of the type of problem that can be investigated, and limits on the inferences that can be made about the outcomes of the study (Moon and Blackman 2017).

Ontological and epistemological positions can be defined in many different ways. One classification system separates ontology into two main branches: realism and relativism (Killam 2013). Realists focus on generalisable truths, which can be discovered through objective measurement, known as an etic or objectivist/positivist epistemology, where the associated research methodology involves the development of *a priori* hypotheses from existing knowledge and logical inference, which are tested in the study (Killam 2013). Etic approaches are common in the basic sciences and psychological research, and the research methods associated with this type of approach can enable efficient and affordable data collection from many participants. They are most defensible and transparent in terms of potential bias from the researcher, and can make use of statistical data techniques that facilitate analysis and permit the exploration of a range of relationships and differences between research groups (Killam 2013). Such approaches are suited to population studies, where information about the collective, rather than the individual, is needed, as well as in circumstances where reliability and external validity (applicability of the results to other contexts) are important (Moon and Blackman 2017).

In contrast, a relativist ontology is focused on individual and context-specific truths, and is associated with an emic or interpretivist epistemology where data are collected from within the system being studied (Killam 2013). Such an approach is common in fields such as anthropology and other social sciences. Hypotheses are developed in response to the information obtained, allowing for the emergence of variables of importance. Emic studies typically collect rich, qualitative data, with both data collection and analysis being very labour intensive, thereby typically constraining such studies to small sample sizes. Critiques of this method include the high potential for researcher bias in the collection, analysis and interpretation of the data due to the subjective nature of the process (Killam 2013).

Both ontological approaches yield useful information. As the study research question focused on understanding variables affecting community acceptance of risk reduction policies, and aimed to identify and test a model of policy support, the study sought to understand and explore attitudes of the collective rather than the individual. This focus was considered most suited to an etic/positivist approach.

1.5.2. Study Approach

While this exploratory study was undertaken in the discipline of Disaster Management, the methodology fits within the field of Environmental Psychology, which investigates how people view, relate to and interact with their environment. The study investigated links between attitudes and perceptions relating to recreation in catchments to behaviour in the form of policy support.

While there is no universally accepted definition of attitudes, they are typically considered to be a cognitive construct; that is, a mental and emotional evaluation of an abstract (e.g. an idea or policy) or concrete (e.g. a person) object (Albarracin and Shavitt 2018). Perceptions, which can be viewed as how people understand, regard and interpret events and concepts, are cognitive psychological processes of synthesis and evaluation, whether undertaken at or below the level of consciousness (Ou 2017).

Cognitive processes can be investigated in various ways. As this study intended to assess the validity of a model in predicting behaviour in a population, it was desirable to collect data from many people in order to account for individual differences occurring within the population. An online self-report survey was considered the most practical and appropriate approach for this study.

As attitudes and perception are cognitive processes, they cannot be observed directly and are, therefore, latent variables; they can be studied, however, through the use of observable behaviours, such as responses to questionnaire items. As attitudes and perceptions are complex and multifaceted, they are not easily captured by responses to a single question. Scales, therefore, are often used to capture data relating to latent variables, with each item in a scale addressing an aspect of the variable being investigated (Hair Jr et al. 2017). In this study, several scales were used to capture data relating to a number of latent factors, which were presented together as an online questionnaire. Further detail regarding the questionnaire is provided in Section 1.5.4 and Chapter 3.

1.5.3. Study Area

The lower Hunter Region, with a population of around 600,000 people, is the seventh largest population centre in Australia. The region is the largest planned growth area in NSW outside of Sydney, and the two townships located adjacent to the main storage dam for the region have been specifically targeted for growth by the State Government (NSW Planning and Environment 2016). As a result, there will be greater pressure on water sources to service the population growth, greater threats on the water sources and storages from contamination, and greater challenges to resilience; these challenges will be exacerbated by a changing climate (DPIE 2022, National Resilience Taskforce 2018, WSAA 2021). Some forms of recreation are currently permitted in the catchments; this includes some activities on the main storage dam due to legacy issues (Hunter Water Corporation 2018). Like other regions of Australia, the water manager (water utility) is under increasing pressure to provide greater recreational access (Stanmore 2018); such demand is likely to grow with increasing population in the catchments. In addition, the Hunter Region is subject to a range of natural and anthropogenic hazards, including bushfires, floods, earthquakes, and industrial development (DECCW 2010), which can adversely affect water quality and security, meaning that DRR will be critical for retaining the resilience of the water supply in the region. Given this, and its broad demographic representation, the region was considered suitable to be used as a case study for testing the model of policy support.

1.5.4. Data Collection

Data for the study were collected through an online community survey of the adult population of the lower Hunter Region of NSW. The survey comprised a questionnaire based on a previously published survey of community attitudes to recreation (Nancarrow and Syme 2010). The questionnaire captured data relating to demographic characteristics, support for a range of different recreation policy options, and a range of latent factors (including the HBM factors of perceived susceptibility, perceived severity, perceived threat [recreation risk], perceived benefits and perceived barriers), and the five-item subscale of the New Ecological Paradigm scale (Dietz et al. 2007).

The questionnaire primarily took the form of closed questions presented with a five-point Likert scale for response options. Where relevant, opportunities for open-ended responses were provided to gain further detail and/or clarification from respondents. The survey instrument is provided in Appendix A. Approval was obtained from the University's Human Ethics Committee (refer to Appendix B), and the survey was piloted, prior to dissemination to the community.

1.5.5. Data Analysis

Assessment of the efficacy of the HBM to explain policy support was undertaken using Partial Least Squares Structural Equation Modelling (PLS-SEM), which assessed the variance in policy support explained by the model factors and differences between groups, specifically gender (Female and Male) and proximity of residence to catchments (Near and Far). Assessment of the influence of other variables (additional demographic variables, recreation participation and worldview) on policy support and further comparison of group differences was undertaken using non-parametric tests of significance (Mann Whitney *U* and Chi-squared tests) and descriptive statistics.

1.5.6. Scope of Research

The study focused on testing the use of the HBM as a model of policy support, and the exploration of other key variables identified in the literature as potentially influencing policy support, specifically worldview and personal recreation preferences. The study was limited to testing the HBM in terms of its ability to explain recreation policy support in the study sample. It was outside the scope of the study, therefore, to test the model in other populations or contexts. The overarching goal of the study was to identify variables that might help increase community acceptance of risk reduction policies, but it was beyond the scope of the study to test the findings of the model in that capacity, or to determine the best ways to undertake interventions and action to change policy support.

Chapter 2. Literature Review

Chapter 2

2.1. Chapter Overview

As described in Chapter 1, waterborne illness associated with contamination of the potable water supply is a disaster. Many urban water utilities in Australia work to reduce the risk of waterborne illness through restricting or prohibiting recreation activities in their catchments as part of a catchment protection strategy, which is consistent with industry best practice guidance (NHMRC 2011) and DRR principles (UNDRR 2015). Water utilities are under increasing pressure, however, to increase recreational access to catchments (Billington and Deere 2020). In order to gain greater community acceptance of risk reduction policies, it is necessary to understand what variables affect policy support, and how those variables differ between different segments of the community. A theoretical model of policy support would help our understanding of how to increase community acceptance of risk reduction policies, and which segments to target.

This chapter reviews the literature relating to recreation policy support. Given the small number of research papers identified, the review included other, related, areas to provide broader insight into factors affecting support for health- and environmental-related risk reduction policies, and to identify potential models of policy support. The review informed the modification of a previously used and published survey instrument (described in Chapter 3), which was subsequently used to capture data for the empirical investigations of the study (Chapter 4 and Chapter 5), as well as the development of the study hypotheses.

A brief introduction to the importance of community acceptance to successful policy implementation is provided below. Literature pertaining to recreation attitudes in catchments is then described, followed by an exploration of research associated with policy support; a key focus is the area of risk perception, which emerged as a potential key influence on policy support from the literature. The chapter then identifies theoretical models of behaviour associated with risk perception, and identifies the Health Belief Model as a potential model of policy support, which is a novel application of this established explanatory behaviour framework.

2.1.1. Background

Safe drinking (potable) water is a fundamental requirement of individual, community and societal health. The importance of this issue is recognised by the United Nations, with one of the 17 sustainable development goals of the 2030 Agenda for Sustainable Development being to 'ensure availability and sustainable management of water…for all' (United Nations General Assembly 2015, p14).

The provision of safe drinking water to the community is a primary function of water utilities (managers) in Australia (Krogh et al. 2009). Drinking water is extracted from a number of different sources, such as rivers, reservoirs and groundwater aquifers. Each natural drinking water source receives water from a catchment (or watershed), which is the area in which rainwater runoff is collected and transported to the water body and storage. Drinking water catchments, water bodies and storages (referred to, collectively, as catchments throughout this dissertation) are complex environmental systems, which host a multitude of environmental processes and organisms and are subject to a range of natural and anthropogenic hazards. Given the necessity of clean water for life and public health, many urban water utilities in Australia adopt a strong precautionary approach to catchment protection (Miller et al., 2006). While the approach is viewed within the water industry as a public health protection measure, the outcome is the mitigation of disaster risk associated with water contamination.

A key component of the precautionary approach is to exclude potentially contaminating activities from the catchment to the greatest feasible extent, which reduces both the risks to public health from the water and the treatment requirements for the water before it is supplied to the community. Protected catchments typically yield high quality water as many types of contaminants are prevented from entering the source waters. Catchment protection is considered the most effective barrier to contamination, recognising that prevention of pollution is better than cure (treatment) (NHMRC 2011, WHO 2011), and can be considered a DRR measure.

There are many types of contamination that can adversely affect water quality, including nutrients, sediment, fuels, pesticides, herbicides, and other chemicals. As noted in Chapter 1, pathogenic microorganisms are the primary hazard to human health associated with potable water (NHMRC 2011), and are a significant cause of disease (WHO 2018). While the incidence of waterborne illness and disease in Australia is much lower than that experienced in many other places in the world, outbreaks of waterborne disease can still result in serious health consequences (widespread infections/illness and even death). Recreation activity is a known source of contamination of water bodies (Miller et al. 2006).

Water managers usually have direct control over the recreation permitted in, on and around water storages. In order to protect public health, many urban water managers minimise the contamination risk by prohibiting or restricting recreational access in catchments (Miller et al. 2006). These restrictions can cause conflict between the water managers and people wishing to recreate in these areas.

Such conflict is not new. A 1930 USA paper notes the issue is of ‘perennial recurrence, seemingly incapable of final solution, at least for certain elements… fishermen are always seeking to have closed lakes opened…’ (Wilson 1930, p357). Developed countries around the world are experiencing an increasing demand for water-based recreation activities (Lawrence 1987), and increasing population density and reductions in natural areas available for recreation are resulting in greater pressure for access to catchments for recreation (Billington and Deere 2020, Carlsen and Hughes 2010, Krogh et al. 2009, Miller et al. 2006, Nancarrow and Syme 2010, Petrie and Wrigley 1989, Sharp and Schell 1989). The benefits of outdoor recreation are well known and are not disputed, and the increasing demand for access to catchments is well understood by many urban water managers. Of note, however, is that ‘we must also consider the wishes of those who do not desire recreational privileges' (Wilson 1930, p358), who would be adversely affected by changes to recreation access. It must also be remembered that while outdoor recreational activities are desirable and beneficial, they do not have to be undertaken in specific forms or locations; that is, recreation activities can be substituted.

In contrast, there is no substitute for clean water, which is fundamental for life and good health. Natural potable water sources are relatively scarce and precious (NHMRC 2011), and the costs associated with developing, accessing and using new sources are extensive. The precautionary principle to catchment management prioritises water protection (for public health protection) over other interests. Increases to catchment access, therefore, would contravene industry guidelines and DRR obligations and would, in many areas, significantly increase the risks and costs associated with the potable water supply (Billington and Deere 2020, Merrett et al. 2014). Further, the role of water managers is to provide safe drinking water and wastewater services to the community, not to provide or manage recreational facilities. Rather than changing policies to increase risks to public health and water security unnecessarily, therefore, it is considered more appropriate to increase community acceptance of the risk reduction policies.

Water quality is an important issue for the community, and research suggests that most people would prioritise clean drinking water over recreation (Mahler et al. 2004). While many authors refer to increasing 'demand', it is important to note that the level of community interest in such access is rarely, if ever, quantified. It is necessary to understand the proportion of the community wishing to recreate in catchments, and what the key drivers for interest in recreation in catchments are. Such understanding can provide guidance to inform the need and targets for intervention strategies in order to increase community acceptance of risk reducing recreation policies.

2.2. Policy Support Research

In order to understand how to increase community acceptance of risk reduction policies, it is necessary to understand the variables influencing policy support. The literature review began with a review of research relating to recreation policy support in catchments, and expanded to other related literature regarding health- and environmental-related risk reduction policy support. In the following sections, the role of risk perception is explored before theoretical models of policy support are identified and discussed.

2.2.1. Importance of Community Attitudes for Effective Policies

The view that community attitudes are important in determining policy is becoming increasingly widespread. Public opinion is recognised as being important for determining acceptable levels of societal risk with their associated trade-offs (Doria 2010, Renn 1998). The influence of public opinion on the range of feasible policy options has also been noted (Rissman et al. 2017), and community preferences can influence the will of government agencies to change their policies, systems and infrastructure (Dean et al. 2016b). Evidence suggests policymakers are reluctant to implement policies lacking support from the public (Drews and van den Bergh 2016, Huber et al. 2020, Kyselá et al. 2019) as attitudes can affect voting decisions (Chapman et al. 2017).

It is worth noting, however, that while some studies suggest that public policy consistently reflects community values and preferences, the representation can be inequitable (Stoutenborough et al. 2015). This is supported by evidence showing that some community segments and special interest groups have greater lobbying capacity. For example, the ability of major sporting groups, such as anglers and power boaters, to have the political lobbying and technical skills required to put their cases convincingly to government for access to water bodies for recreation has been noted, as is the lack of such skills in the smaller interest groups, leading to uneven consideration of access requests (Paterson 1989). Further, the proportion of the community desiring access is typically not reported, suggesting that resultant policy changes may often be made in response to a vocal minority and may not reflect the interests of the broader community.

Stoutenborough et al. (2016) highlighted the importance of community risk perception for policy implementation, noting that the public will demand action on issues of concern, and will question or oppose policies that are not considered to pose a risk or be of sufficient importance. It is critical, therefore, that the community supports risk reduction policies in order for them to be effective.

Unauthorised access to catchment areas is a noted issue for many utilities (Hughes et al. 2008) as it can cause a range of contamination risks, such as waste and vehicle dumping, as well as damage to fencing and other infrastructure, which is costly and time-consuming to repair. Miller et al. (2006) note that demand for recreation access and illegal access are lower in areas where the community values the protection of a closed catchment. It is important, therefore, to understand how the community values protection of their water sources.

Given that catchment protection measures vary between catchments and utilities according to a variety of factors — such as local risks and conditions, historical access provisions, source water quality and the reigning political party — it is expected that community attitudes towards, and support for, catchment management policy will differ according to the particular catchment of interest to them and the particular restrictions imposed in that area. It is expected, therefore, that the overall attitudes of one community cannot be generalised to attitudes of other communities in different catchments, although some commonalities between issues would be expected; further, the key variables influencing those attitudes may be consistent between areas, even if the strength of influence varies by context. The following section describes the limited published research on attitudes to recreation in catchments; the subsequent sections further explore variables potentially affecting support for risk reduction policy.

2.2.2. Recreation Policy Support Research

Discussions with several water utilities across Australia determined that community attitudes to recreation in catchments is a topic of great interest, with many utilities undertaking investigations in their areas of operation, primarily in response to a recent action by the incumbent state government in South Australia to open formerly protected catchments to recreation (Boisvert and Evins 2019, Denholm 2017). Little research on the topic, however, has been published to date. Literature searches identified studies undertaken in: Perth, Western Australia (Bruce 2006, Nancarrow et al. 2010, Syme and Nancarrow 2013); Sydney, NSW (Petrie and Wrigley 1989, Sharp and Schell 1989); and some studies in the USA (Baumann 1969, Bumgardner et al. 1980, Klar Jr. and Ghirin 1983, Steinberg and Clark 1999). Of note, none of these studies were undertaken recently, and most were undertaken on behalf of the water authority as consultancies rather than as academic inquiries. One recent study, however, was identified, which related to recreation policy support in a protected marine area in South Australia (Haensch et al. 2020).

Of the identified studies, only one investigated the factors affecting policy support (Nancarrow et al. 2010, Syme and Nancarrow 2013)[8]. The study, which collected data from residents in the Greater Perth Metropolitan Area, was undertaken in order to provide a methodology for the Australian water industry to develop defensible recreation policies, which incorporated the views of all stakeholders. In this region, recreation is prohibited within two kilometres of water storages, with limited land-based recreation (walking and cycling) permitted in the outer catchment; minimal water treatment processes were required at the time of the survey. The study included community focus groups and an extensive literature review of social psychology and outdoor recreation studies to identify factors likely to affect recreation policy support, with this information used to design a survey instrument. Identified factors assessed in the survey included: risk perception and risk tolerance; recreational preferences; site attachment; actual and perceived knowledge of catchment protection actions; trust in scientists and authorities; precautionary ethics; fairness; and demographic characteristics. Policy support was assessed using a social judgement theory approach, whereby the ‘latitude of acceptance’ or rejection of several policy options was captured, in contrast to a single item capturing a yes or no response. Multivariate analyses in the form of discriminant analyses with stepwise method were undertaken to determine the relative contributions of the identified variables to policy support, and one-way ANOVAs undertaken to determine differences between groups. Data were captured via a telephone survey for two of the groups (general community [N = 604] and ‘serious’ recreators; that is, recreation advocates [N = 66]), while a third group (water industry or water quality professionals [N = 28]) were surveyed using an internet-based questionnaire version of the survey. Stratified sampling was undertaken in terms of gender and proximity of residence to catchments for the community sample.

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[8] Both publications relate to the same study

Key variables accounting for differences in support for the current catchment protection policy were found to be primarily related to perceptions of risk (catchment risk, system risk [likelihood, severity, and control over consequences associated with recreation in the catchments], and trust in the water utility to provide reliable information about catchment protection and drinking water quality), as well as actual and perceived knowledge and precautionary ethics / environmental attitudes. A key difference between the serious recreators and the general community was their perceptions of risk, with community respondents' perceived level of risk greater than that of serious recreators. Overall, support for the current restrictive policy was associated with perceived risks associated with recreation, stronger precautionary ethics, and stronger perceptions of system risk, as well as lower knowledge of actual catchment protection actions. For the other policy options found to be somewhat acceptable, only precautionary ethics and perceptions of system risk were associated with policy support. Risk perception, therefore, was a key driver of recreation policy support, with perceptions of likelihood and severity of consequences also important factors; similarly, precautionary ethics, which included an ecocentric worldview and the need for a precautionary approach to managing risks, was also a strong driver of risk reduction policy support.

Strong support was found within the general community for the existing restrictive catchment protection policy (89%) in contrast to the level of support among serious recreators (24%), and it is noteworthy that the community views were similar to those of the professional group. Gender differences were noted; females were significantly more supportive of the current restrictive policy, and scored more highly on measures of system and catchment risk, catchment protection, and precautionary ethics, suggesting they had greater concern about environmental and sustainability issues than males. Females were also less knowledgeable about the source of their water and protection practices than males. Group differences relating to proximity of residence to catchments were also noted; people living closest to catchments scored significantly lower on catchment risk questions than those living far or very far from catchments. While the authors did not report significant differences in policy support by proximity of residence to catchments, analysis of the raw study data kindly provided by the authors[9] showed respondents living closer to the catchments were less supportive of the current restrictive recreation policy, and more supportive of policies permitting additional types of recreation, than those living further away. In contrast, no clear trend in policy support with other demographic characteristics was identified.

The nature of the recreation activity affected its acceptability. Passive land-based activities were considered more acceptable than off-road activities (trail biking and four-wheel driving) while, notably, policy options permitting water-based activities (including fishing, sailing and swimming) were unacceptable to most respondents. The policy option permitting the greatest variety of

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[9] Thanks are given to the authors, Blair Nancarrow and Geoffrey Syme, and to WaterRA, the funding body for the original research, for access to their study data.

recreational activities, including water-based activities and motorised boats, was unacceptable to nearly all community respondents and the strong majority of serious recreators, and was, overall, the most unacceptable policy option for the sample population. The acceptability of the activities was consistent with their associated risks to water quality, with water managers considering passive land-based activities to pose a lower risk of contamination compared to more active, land-disturbing activities, and direct contact water activities to pose the greatest contamination hazard (Syme and Nancarrow 2013).

It is important to note, however, that respondents were informed that the purpose of the current restrictive policy was to keep contaminants '*such as human bacteria and pathogens, chemicals, and sediment'* out of the drinking water, as well as maintaining the natural treatment processes in the catchments, which enabled the utility to provide high quality water with very little treatment. They were also told that if recreational use was expanded, the risk of contamination would increase greatly, and that water bills would increase by around 15% in order to cover the greater treatment costs and recreational management costs. As such, the responses to this question may have been influenced by the information provided to the respondents. Further, while the analyses involved detailed statistical tests, interactions between the variables were not explored. The authors noted the benefits of further research to understand community attitudes to recreation policies in catchments.

Overall, the results from (Nancarrow and Syme 2010) suggest that risk perception is a key influence on policy support in relation to recreation in catchments. This suggestion is supported by an earlier study of public attitudes in the Perth region (Bruce 2006). The study, which focused on attitudes to a potential change in use of Logue Brook Dam from an irrigation and recreational dam to an irrigation and drinking water dam, was undertaken for the Department of Water using a community survey (1,017 respondents) and a deliberative community forum (i.e. an interactive workshop; [200 participants]) in an attempt to engage broadly and meaningfully with the community and, in the case of the community forum, to gain an understanding of possible attitudes to future changes in addition to existing ones. For the forum, participants were surveyed both prior to an interactive experience and after the interaction to determine whether their views had changed (Bruce 2006). The objectives of the survey were to understand what the community's attitudes were relating to source water protection and recreation in catchments rather than the drivers of those attitudes; as such, no theoretical framework appeared to be used for the development of the survey, although community segmentation was undertaken to identify common characteristics in respondents with similar answers. Stratified sampling was undertaken for the two regions of interest, and participants were recruited via random cold mail-outs to the areas of interest. The survey collected data relating to demographic characteristics, personal use of the dam in question and other water bodies, risk tolerance, appropriate uses and prioritisation of uses of water, and attitudes towards water management measures. Data analysis appeared to consist primarily of descriptive analyses and comparison of group percentages; an exploratory regression analysis was used to determine the key explanatory factor, and significance testing of some form appeared to have been used to compare groups, but no details of these statistics were provided in the report.

Risk tolerance (or risk perception of recreation) was determined to be the most important predictor of policy support. The study found that safeguarding sufficient drinking water supplies was the key issue in the area and the most important use of dams in the region, and ranked well above recreation in terms of importance. As was found by Nancarrow and Syme (2010), the nature of the activity affected its acceptability, although the participants in this study appeared to have greater acceptance of passive land-based activities near drinking water sources than those in the broader greater Perth Metropolitan Area; passive land-based activities were acceptable to most people, while motorised boating in drinking water sources was unacceptable to most respondents, but was slightly more acceptable than general agriculture and industrial activities. The relative acceptability of organic agricultural activities in the catchments, however, indicated the respondents considered chemicals to be the key concern associated with these activities rather than pathogens. Interestingly, motorised activities were less acceptable than non-motorised activities for both land-based and water-based activities, which was also apparent in Nancarrow and Syme (2010).

Differences were found between the general community and recreational users of the dam in question, with the community showing much lower risk tolerance and greater precautionary attitudes than recreators in terms of: the need to avoid contamination rather than relying on treatment to make the water safe to drink; prioritising the safety and protection of drinking water sources above all other uses of the dams; and the need to separate drinking water and recreational water sources. Females were found to be more conservative and risk averse than males. Dam users were more pro-recreation, and considered recreation and tourism to be more important, than people not using the dam for recreation. Further, while there was also strong opposition to the community paying for additional treatment to enable recreation to occur, recreational dam users were more supportive of sharing of costs between all water users.

Bruce (2006) compared the attitudes of the survey respondents to those of the forum attendees, and determined that survey respondents were highly risk averse and protective of water quality; they preferred the separation of potable and recreation sources, and favoured protection over treatment. In contrast, forum participants were willing to accept greater risk; considered water supply, development and drinking water to be compatible uses of water bodies; and preferred to rely on treatment above protection, which were similar attitudes to the recreators. The author concluded the groups had significantly different views about catchment management, and that the forum participants were not representative of the broader community; he noted forum participants clearly favoured the retention of Logue Brook Dam for recreation, and those views did not change in response to the interactive deliberations (Bruce 2006).

Two published studies of community attitudes to recreation in the catchments of Sydney, NSW, were identified (Petrie and Wrigley 1989, Sharp and Schell 1989). The Sydney Water Board reviewed its catchment and storage protection policies for its six water storage dams in 1985 due to ‘significantly increased interest in recreation’ (Petrie and Wrigley 1989, p130). The studies were descriptive reports of community engagement undertaken by a consultant, which again explored what the community attitudes were rather than the drivers of the attitudes. A telephone survey of existing and potential recreational uses of their catchments and storages was undertaken, together with a review of comments made during the public seminar regarding those uses. A media campaign also sought public comment and participation. No further details regarding the questions asked were provided; given the nature of the studies, it is likely there was no theoretical framework underpinning the questions. Further, no details were provided regarding the analysis technique, and only qualitative findings of community views were reported; no details regarding demographic differences or actual levels of support were provided.

The first study included a review of whether the current recreational demands of the community were being met, and whether these and future demands could be met without resulting in adverse effects on water quality or the environment. Shortly thereafter, a review of the catchments and storages in the neighbouring Blue Mountains area was undertaken for the NSW Public Works Department for the Fish River Water Supply (1987), comprising one dam (Lake Oberon) and two primary catchments west of the Blue Mountains. The results of the Sydney study were reported by Petrie and Wrigley (1989), while Sharp and Schell (1989) compared the two studies.

Petrie and Wrigley (1989) found the community had a high level of concern for protecting water quality, and considered water quality must be maintained. The acceptability of activities within the catchments decreased with increasing likelihood of water contamination, particularly in relation to activities involving bodily contact with water. This was generally consistent with the findings of the Western Australian studies (Bruce 2006, Nancarrow and Syme 2010, Syme and Nancarrow 2013), although the Sydney community had a higher acceptance of recreation in catchments than the Perth community. Activities considered acceptable included: passive land-based activities (bushwalking, ranger tours, nature walks, and additional picnic facilities located close to the water but far from offtakes); fishing and camping if undertaken at a ‘safe’ distance from offtake points; and sailing and canoeing activities in safe areas of water, if available. Swimming was considered to conflict with water quality objectives, but a separate swimming pool in picnic areas with an entry fee was considered acceptable. Overall, the authors declared there was strong community support for the current approach of catchment protection via recreation restriction, but that there was also community interest in additional recreation opportunities if they did not adversely affect water quality (Petrie and Wrigley 1989).

The comparison of community attitudes to, and demand for, recreation by Sharp and Schell (1989) identified some interesting similarities and differences between the Sydney metropolitan supply and the Fish River Water Supply. No specific details were provided about the methodology of the Fish River study, or how many community members were consulted. Storages in both areas were developed for the sole purpose of potable water supply, and both water managers had a policy of protecting the water sources to ensure minimal treatment was required. Policies in both areas permitted water-based recreation in locations far from the offtakes for the potable water system, and picnicking at all dam sites, while limited bushwalking and escorted walks were permitted at some locations for a few community groups.

Differences were noted between the two areas in relation to surrounding land use and recreational demand. The Sydney Water Board storages were primarily surrounded by natural bushland, while Lake Oberon was surrounded by managed forests and rural land. The Water Board was 'under pressure from the adjacent dense urban population for increased access and use' (Sharp and Schell 1989, p120), particularly for water-based recreation. This demand primarily came from the expanding metropolitan population of the west and southwest of Sydney, where residences were located much closer to the water storages than to the ocean. The extensive bushland of the catchments was also noted as an opportunity for land-based recreation. In contrast, Lake Oberon and its catchments were not located proximal to many residential areas, but the dam was accessible by adjacent landowners, with sailing and trout fishing permitted on the storage. The authors noted the small adjacent township 'exerts little pressure for increased public use' (Sharp and Schell 1989, p120), and that alternative water-based recreation locations were probably preferred for most activities.

The authors noted significant resources would be required to manage and control additional recreational access, but neither community supported rate increases for either water quality improvements (the water was considered to be already of sufficient quality) or to increase recreational access, which was consistent with Bruce (2006). The lack of demand in the Lake Oberon area indicated additional access was not warranted. For the Sydney storages, additional investigation was recommended for identifying locations and facilities needed to facilitate additional low-risk access, to be permitted with monitoring and management measures (Sharp & Schell, 1989).

Again, these studies showed that the community supported protection of the catchments to protect water quality, and that perceptions of risks associated with recreation activities affected their support of permitting such activities in the catchments, with passive land-based activities considered more acceptable than water-based activities. Further, these studies identified differences in attitudes and demand in different locations and contexts. Such differences have also been found in Queensland, where a dam located close to a popular tourist centre received more than double the annual number of visits compared to the two dams close to major urban centres, and around four times as many visitors compared to the dam located more remotely from major urban centres (Fahey 1989).

A review of attitudes to marine parks in South Australia was undertaken by Haensch et al. (2020), using survey data collected between 2012 and 2019. The data were collected for the People and Parks annual visitor surveys undertaken for the Department of Environment and Water via telephone and online surveys. As such, the study was an opportunistic post-hoc assessment of data collected for another purpose, and was not a theory-based study of policy support. The results showed support for protected areas was greatest for people who associated the parks with conservation protection, were female, aged over 35 years, had higher levels of education, were living in metropolitan areas, or were familiar with marine parks. In contrast, lack of support was found for people who primarily valued recreation in the areas and those adversely affected financially by the protections and their associated activity restrictions, suggesting self-interest and perceived barriers were key negative influences in policy support for a protected area. While this study did not relate to policy support in drinking water catchments, it highlights similar themes to the catchment research.

The self-interest influence on policy support was also apparent in a study of recreation policy in Massachusetts (Steinberg and Clark 1999), which found that residents living adjacent to the reservoir considered recreational access to the dam as an integral part of their life, and were not supportive of policies that were perceived to negatively affect the aspects of the reservoir that they valued, such as installation of tall fences to restrict access in specific areas (due to the adverse effect on the scenic quality of the dam), or having their recreational access removed. As such, the residents maintained a strong self-interest in the reservoir additional to the potable water it provided. Of note, however, was that the reservoir's aesthetic value was rated as more important than the recreational access, although both were very important to the residents.

Differences in acceptability of, and demand for, recreation in catchments were also found in early studies conducted in the USA. Carswell et al. (1969) noted increasing demand for outdoor, water-based activities, with swimming, boating and fishing being some of the most popular recreation activities in the country, leading to increasing consideration of using potable water sources for recreation activities. Baumann (1969) reviewed recreational use of water supply reservoirs in the USA around the same time in order to explore reasons for different recreation policies and usage on and in potable water reservoirs in different areas. Recreation in the surrounding catchments was not explored explicitly, and only qualitative findings relating to community attitudes were reported. The study included mail surveys of communities whose water supply was drawn from reservoirs (with responses received from 256 communities), state health departments to determine access policies and regulations, a literature review, interviews with water managers, and a telephone survey of public opinion in certain areas of the country.

The author found regional differences in permissibility of, and attitudes to, recreation. Recreation was restricted or prohibited in the northeast and far west areas of the country, but was more permissible in other areas. Shoreline fishing was the most permitted activity (~90%), followed by boat fishing (>80%), non-motorised boating (~70%), motorised boating < 10 h.p. (~65%), sail boating (~60%), motor boating > 10 h.p. (~50%), water-skiing (~40%) and, finally, swimming (~30%).

Baumann (1969) noted some trends relating to attitudes to recreation in water managers and the community. First, he considered that the time of development of the storage, particularly whether waterborne illness epidemics had historically occurred in the region, may be the single greatest factor affecting attitudes to recreation. Second, he suggested that recreation activities were dependent on local conditions. Exclusion was preferred in locations with specific characteristics: high quality source water, where the community preferred nature's processes to artificial treatment such as filtration and chlorination ('the people preferred innocence to repentance in a drinking water', p552); in less accessible areas, such as those surrounded by forest rather than cropland; and in areas with many alternative recreation locations. In contrast, areas with turbid source water requiring filtration were more accepting of treatment to protect against disease, and restrictive policies were not developed in areas where alternative water bodies were scarce. Another identified factor was who was responsible for determining the recreation policy — areas where policies were guided by specialist health professionals (the state health department) prohibited recreation, while areas governed by bureaucrats (City Council) permitted it.

Of particular interest was the observation that community attitudes generally reflected the attitudes of the water managers in the region (Baumann 1969), perhaps suggesting that, largely, the community accepted the status quo. This hypothesis, however, does not explain the discrepancy in acceptability of recreation between the studies of Nancarrow and Syme (2010) and Bruce (2006). Inconsistencies were also apparent in studies undertaken in the Massachusetts area, which was an area Bauman found to be supportive of restrictions. For example, Klar Jr. and Ghirin (1983) found water managers in this area were supportive of restrictions, while Bumgardner et al. (1980) found that most residents were supportive of moderate recreational use of reservoirs. As such, while external factors may have some influence over community attitudes to recreation, it is likely that personal factors also have an effect.

2.2.2.1. Summary

Overall, the studies show regional differences in attitudes to catchment protection and the recreation activities that are considered acceptable within catchments and storages, both by water managers and the community. It is notable, however, that lower risk activities, such as passive land-based recreation, are generally considered to be more acceptable to both water managers and the community than higher risk activities, such as direct contact water-based activities like swimming, and motorised water activities.

The age of the identified studies demonstrates that this is a long-standing debate. While their specific findings may no longer be accurate, the studies do show a general trend whereby the type of recreation activity is an important determinant of its acceptability, because of the perceived risk it poses to water quality. The studies also show clear differences in attitudes to recreation in different locations based on a range of factors, including population size, proximity of the catchments to residential areas, and alternative recreation locations, suggesting that self-interest might also be a key factor in recreation policy support.

The lack of explanatory or theoretical models of policy support in which to position the findings of these studies limits the understanding of how and why the variables influence policy support, or how that support might change in different locations or contexts. Support for recreation policy appears to vary depending on a variety of sociological, personal, and situational factors. These include the level of treatment of the potable supply, the views of the water managers (which can be expressed through the level of recreation permitted in a catchment), and the proximity of catchments to one's residence, which can be viewed as a measure of self-interest, primarily relating to familiarity and convenience. Overall, this indicates that policy support, and the level of influence of different factors on that support, may vary depending on the location and context. Perception of risk associated with recreation in catchments, however, appears to be a critical factor in support for recreation policy in catchments. The role of risk perception and other variables in support for other risk reduction policies is explored briefly in the following section.

2.2.3. Variables Influencing Support for other Risk-Reducing Policies

Many policies are designed to reduce the risk of identified hazards from adversely affecting the population. Public risk perception is considered a critical component of acceptance of risk reduction policies (Leiserowitz 2006). In addition to perceived risks, the literature suggests a range of other variables can affect community acceptance of risk reduction policies, many of which are interrelated, and associated with risk perception. Some of this is explored below in the context of climate change, other environmental risks and water policies. It is notable that the identified studies typically investigated the influence of variables identified through previous research and psychological theories, but typically did not explicitly test theoretical models of policy support.

The one identified exception was a study by Shao et al. (2017), which used a conceptual model of risk perception to investigate support for adaptive policies to mitigate risks associated with flooding and hurricanes. The model was developed from literature, while the data used to test the model were obtained from a previously conducted survey of coastal US residents. Multilevel regression analyses indicated that the perception of increasing hazard levels, specifically flood levels and hurricane wind speeds, mediated the influence of contextual risk and consequence on support for flood adaptation policies. Demographic variables such as gender, age, race and political persuasion were also found to influence policy support, with younger people and females more likely to support adaptation policies, although the sample was biased in terms of gender, age and race representation. The study demonstrated the strong influence of risk perception, which mediated the effect of contextual cues on policy support. No other studies investigating this model were identified. Further investigation is required, therefore, to provide a more detailed explanatory theory and model of policy support that is also valid for circumstances where risks are not visible to the community, and that provides guidance for how policy support could be increased.

Literature reviews of climate change policy support have found support is affected by a wide range of factors, many of which are related to, or affected by, risk perception. Such variables include climate change perception (for example, worldview, climate change knowledge, emotions and political ideology), policy perception (including perceived efficacy, cost, and fairness), and contextual factors, including trust, norms, media influence, and geopolitical context (Bateman and O'Connor 2016, Mumpower et al. 2016, van Valkengoed et al. 2022). A recent study also highlighted the importance of place attachment in relation to support for coastal climate change adaptation options (Mallette et al. 2021). Retreat options, which would require relocation and loss of access to valued locations, were strongly opposed; the authors suggested that the results may have reflected the presence of either optimism bias or psychological distancing, which have the effect of reducing the perceived risks (Mallette et al. 2021). Of note is that the relative importance of, and interactions between, the factors influencing climate change policy support have not been determined (Drews and van den Bergh 2016). Challenges in comparing studies and their findings have also been noted, and are associated with different study methodologies, foci and operational definitions, as well as a general lack of theory-driven research to assess policy support (Kyselá et al. 2019).

Research in the environmental health domain has resulted in similar findings to the climate change literature. In addition to risk perception, studies relating to protected areas (Jones et al. 2012, McNeill et al. 2018, Voyer et al. 2015), energy and air quality policy (Hagen and Pijawka 2015, Lou et al. 2017, Stoutenborough et al. 2015, Valeri et al. 2016), vehicle emission reductions (Huber et al. 2020) and earthquake risk (Guo and Li 2016, Perlaviciute et al. 2017) found factors affecting policy preferences included values and worldview, trust, knowledge, the perceived need for the policy, perceived benefits and disbenefits (to self and the community), costs, effectiveness, and a range of self-interest factors, such as direct experience, intrusiveness and fairness. The influence of demographic characteristics varied.

Studies investigating variables affecting support for water-related policies also demonstrate strong associations with risk perception, particularly in relation to environmental concern. Other identified influencing factors include environmental worldview, knowledge, personal relevance, locus of control, and demographic characteristics, particularly age and gender (Baird et al. 2020, Dean et al. 2016b, Rissman et al. 2017, Safford et al. 2014, Salvaggio et al. 2014, Steel et al. 2005, Switzer and Vedlitz 2017a, Switzer and Vedlitz 2017b). Many of these factors appear to be interrelated, and associated with risk perception. Knowledge is expected to be a fundamental foundation of risk perception, both to identify issues of concern, and to affect the level of concern about those issues. While some studies show a strong influence of knowledge on policy support, Dean et al. (2016b) noted that knowledge is typically not consistent, with individuals being highly knowledgeable about some issues and relatively ignorant of others, and self-rated knowledge is not necessarily indicative of actual knowledge (Safford et al. 2014). Knowledge appears to be affected by personal relevance, which itself is related to stronger support for personally relevant policies and a lack of support for policies considered to have negative consequences for self, community, or the environment (Bishop 2013, Dean et al. 2016b, Larson and Lach 2008, Rissman et al. 2017, Safford et al. 2014, Stoutenborough and Vedlitz 2014, Switzer and Vedlitz 2017b); this lack of support may be viewed as perceived barriers to the implementation of protective policies. Local conditions and other personally relevant factors also appear to affect risk perception and knowledge (Bishop 2013, Switzer and Vedlitz 2017b, Switzer and Vedlitz 2017a). Simply measuring the relationship between risk perception and individual variables may not reveal, therefore, the full extent of the interrelationships between a complex set of factors influencing policy support.

Overall, the influence of demographic and other personal characteristics on policy support, knowledge, and risk perception appears to be inconsistent. Females have been shown to be more supportive of enforcement action and activity restrictions compared to males, while no gender differences have been found for support for investment policies (Safford et al. 2014). Females have been found to have higher levels of pro-environmental values, environmental concern and risk perception for drought related conditions compared to males (Bishop 2013, Salvaggio et al. 2014, Switzer and Vedlitz 2017b), although gender was not a significant predictor of support for water conservation policies (Bishop 2013, Salvaggio et al. 2014). A national survey of Australians found males were more supportive of alternative water sources for potable and non-potable uses (Dean et al. 2016b), a finding that possibly reflects the greater risk perception of females. In contrast, males were less supportive of raingarden use for stormwater management (Dean et al. 2016b), and a community segment with the highest number of males was much less willing to pay for waterway protection than other community segments (Dean et al. 2016c), suggesting males may be less supportive of policies that are associated with personal costs.

The effect of age and other demographic characteristics on policy support and risk perception also varies. Increasing age was associated with less support for greater enforcement of environmental regulation, but age was not a factor in support for other policy actions to protect waterways (Safford et al. 2014). Conversely, older age was associated with greater support for: alternative water sources; using raingardens for stormwater treatment; and for drought-mitigating policy (Dean et al. 2016b, Switzer and Vedlitz 2017b); these findings were possibly due to older people have greater experience with water shortages. Consistent with these findings, older people have expressed more concerned about water scarcity (Bishop 2013, Switzer and Vedlitz 2017b), although Switzer and Vedlitz (2017b) found the effect was small. Bishop (2013) found higher incomes and education levels were negatively related to concern for water resources, but people with higher levels of education were more supportive of water use regulation, while Switzer and Vedlitz (2017b) found that income and education were significantly associated with support for drought-mitigating policy but not risk perception. Further, political ideology and affiliation have also been shown to affect support for drought-related policy (Bishop 2013) and use of alternative water sources, as is trust in authorities (Fielding et al. 2015b). Overall, no clear trend is evident for most demographic characteristics.

Many factors, therefore, appear to influence policy support, with different effects potentially associated with different situational contexts. The lack of consistency in findings may be a function of differences in methodology, definitions, or operationalisation of concepts. Additionally, topics of investigation may play a key role, as research has shown that environmental attitudes and behaviours can be quite specific and not generalisable to all environmental issues (Lindsay and Strathman 1997); it is expected that this also applies to policy support. It may, however, be because policy support is a very complex, multi-faceted and context-dependent beast, and that a strong theoretical model of policy support has not been identified. In addition to risk perception, key factors appear to include worldview and perceived benefits and barriers to policies, which are often associated with self-interest. Much of the policy support and preference literature has focused on the role of knowledge, attitudes and demographic differences; Stoutenborough et al. (2015) note that this results from the typically post-hoc nature of the research, comprising secondary analyses of public opinion poll data, which collected only those variables. Studies are increasingly demonstrating, however, that risk perception is a key causal factor of policy preferences, either directly or indirectly, yet has received little focus in research to date (Stoutenborough et al. 2015). Given that risk is a fundamental component of risk reduction policies, the exploration of the effect of risk perception on public support for catchment protection policy is warranted.

2.2.4. Risk Perception

While the literature suggests there is no consistent definition of risk — either in the academic sphere or in public understanding — a common factor is that risk is associated with the possibility of outcomes of actions or events affecting things of value (Renn 1998). In terms of risks affecting health and wellbeing, whether directly or indirectly, risk is usually viewed as the potential for negative consequences to occur. Perception relates to how events and stimuli are interpreted by individuals. For this study, risk perception was, therefore, defined as the possibility of negative consequences to aspects of life that are considered valuable by individuals.

Risk perception in individuals is typically a highly subjective, personalised and emotive process (Slovic 1987). The following sections explore risk perception in terms of its effect on policy support, and differences in risk perception of recreation activities and water quality.

2.2.4.1. Risk Perception and Policy Support

As noted previously, the fundamental influence of risk perception on policy preferences is becoming increasingly apparent (Stoutenborough et al. 2015). Several recent studies have demonstrated the influence of risk perception on policy support, although the influence varies according to the specific risk in question. Stoutenborough et al. (2015) identified that while risk perception was a key determinant of policy support for levee restoration options, there was a hierarchy, or saliency, of risks that became apparent in their choices between different mitigation options; for example, the risk of flooding was higher in importance than the risk of pollution. This idea of hierarchy, or of greater salience of some hazards than others, was also suggested in the findings of a recent paper by Musacchio et al. (2021). They found that prior experience of flooding was not sufficient for people to adopt proactive behaviour to protect their well water, with many people indicating that they considered floods were unlikely to occur. Previous experience with contaminated well water, however, was associated with increased protective behaviours. Stoutenborough et al. (2016) found that the perception of climate change risk in individuals was based on the perceived risks to public health and the economy, and not to other climate change risks, such as environmental changes. In the case of recreation restrictions in catchments, policy support could be affected by perceived risks to drinking water quality, to public health, to the environment, or to the loss of tourism and recreation opportunities.

Evidence also suggests that risk perception and policy support can be modified by other salient factors, which may affect the perceived hierarchy of risks. For example, Flint and Koci (2021) found that risk perceptions of wastewater reuse for irrigation were offset by environmental and economic concerns; they concluded that the barrier to use was negated when water was viewed as a scarce resource. Howell et al. (2019) found that perceptions of risk and benefits were associated with support for gas fracking, and that the effect of perceived knowledge on risk and benefit perceptions varied depending on an individual’s political persuasion. Schuitema et al. (2020) found that strong feelings of control led to reduced risk perception of contamination of drinking water from private wells. This research suggests that risk perceptions can be modified by other factors that influence the salience of a risk, with benefits or costs of actions potentially enhancing or overriding risk concerns.

The nature of the influence of risk perception on policy support is, however, clouded by methodological considerations, particularly in how risk perception and policy support are measured. As noted by Stoutenborough et al. (2015), studies to date have typically investigated global risk perceptions; since risk perception can vary for different, and even related, issues, a sole focus on a global risk perception may mask the specific risk perception drivers that influence policy support. Assessing policy support of aggregated policies can also mask true preferences. For instance, asking people if they support catchment protection policies would not determine whether they were most concerned about public health, environmental conditions, or other factors. Overall, however, the evidence suggests that perceived costs, benefits and level of control can affect perceptions of risk and policy support.

Stoutenborough and Vedlitz (2014, p12) note that ‘Citizen understanding of scientific findings, their assessments of risk, and their personal and political decisions are an important context within which local, state and national decisions and resource allocations on water issues will be made'. If risk perception affects policy support, then people would support policies they perceive reduce risks of concern, and oppose policies they consider increase risks of concern. It is important to note, however, that not all community members are well informed about issues that affect them, including risks to their potable water supplies. For example, a national survey of water literacy in Australia (Dean et al. 2015, Fielding et al. 2015a) found that participant's overall knowledge of water was low, with respondents lacking an understanding of where their drinking water came from, the effects of their activities on water quality, the capacity of waterways to cope with pollutant loads, and treatment processes used for potable water, stormwater, and wastewater. Similarly, Nancarrow and Syme (2010) found their participants had poor knowledge of drinking water sources and measures undertaken to protect those sources from contamination. Further, evidence suggests that many Australians have high confidence in technology to solve current and future environmental problems, have greater concern for the economy than the environment, and believe the country needs economic growth to protect the environment (Chapman et al. 2017). As such, perception of specific risks, such as contamination of water sources, may not be accurate in many community members. The question remains whether people think recreation in catchments poses a risk of concern, or even a risk at all.

2.2.4.2. Recreation Risk Perception

The damage to the environment that can be caused by recreation activities is well documented, as described in Chapter 1. Evidence suggests that many recreators do not notice, or are unaware of, the visible environmental damage caused by recreation (e.g. Manning et al., 2004; Hardiman and Burgin, 2010). When damage is pointed out, however, many recreators indicate a preference to recreate in less damaged and used areas, and support activity restrictions in areas of noticeable degradation or overuse (e.g. Manning et al., 2004; Hardiman and Burgin, 2010). This suggests that attitudes to catchment protection policies may change in response to greater education and awareness of the adverse consequences of recreation. It should be noted, however, that few recreators support complete removal of recreation access (Hardiman and Burgin, 2010), and serious recreators have been found to be less supportive of restrictions than the general community (Hardiman and Burgin 2010, Nancarrow and Syme 2010). Self-interest, therefore, may mitigate the perceived disbenefits of activities. This is a potential key explanation for the differences in risk perception between recreation advocates and the general community noted in Nancarrow and Syme (2010), although differences in perceived and actual knowledge between the groups were also identified.

As noted in the recreation policy research, the acceptability of recreation activities differs. While the previously cited research notes differences in acceptability in terms of risks to water quality, other research indicates that the perceived effects of the activities on the environment also affect their acceptability, and that those perceptions can be influenced by worldview and environmental values. In a study of perceptions of the effect of recreation on the environment (Rossi et al. 2016), environmental values were found to significantly affect perceptions of a range of recreation activities, including motorised (four-wheel driving and trail bike riding) and non-motorised activities (dog walking, picnicking, and hiking). Most respondents considered motorised activities to have the greatest adverse effects on environmental quality (such as damaging plants and frightening wildlife). This finding is consistent with the recreation research described in Section 2.2.2, which showed that motorised activities were less acceptable in catchments than passive land-based activities.

As such, worldview and recreational preferences may affect perceptions of risk regarding recreation. Recreational activities that have visible effects on the environment, such as four-wheel drives and trail bikes, may be perceived to present a greater contamination risk than other types of recreation, such as swimming or hiking. Personal recreation preferences, however, are likely to reduce perceptions of risk associated with those particular activities.

As little literature relating to recreation risk perception was identified, studies pertaining to water quality risk perception were also reviewed. This is discussed further in the following section.

2.2.4.3. Water Quality Risk Perception

Water quality relates to the degree of contamination present in the water, and the quality of water determines its suitability for a particular purpose. Perceptions of water quality can affect if and how people will make use of it, at least in situations where alternatives are present. For example, community perceptions of risk have been a key barrier to the implementation of recycled water schemes, with potable uses considered much less acceptable than other uses (Marks et al. 2008). In terms of public uses of water, drinking water must be of the highest quality as it typically poses the greatest potential risk to health.

Wee and Aris (2019) developed a conceptual model of risk perception as a result of a literature review of research concerning endocrine disrupting compounds in drinking water. The model described risk perception as being affected by five main factors: risk characteristics (likelihood, hazards and severity); affective factors (personal direct and indirect experiences, and positive and negative emotions); cognitive factors (trust, knowledge, attitudes and beliefs); socio-cultural influences (values and worldviews and social norms); and sociodemographic characteristics (gender, age, education and income). Affective, cognitive and socio-cultural factors were found to influence each other and risk perception.

Water contamination has been demonstrated to be a concern for much of the community. Starr et al. (2000) assessed the perception of environmental health risks in Australia via a survey issued to a random sample of households across the country. Respondents were asked to rate 28 hazards to the general population and 12 risks to the individuals' families. Risks found to be of greatest concern were ones that were outside individual control, inescapable, anthropogenic, and with significant health effects (Starr et al. 2000), which are consistent with general risk perception factors. Given that all these factors may apply to drinking water contamination, it is not surprising that water pollution was one of the hazards found to be of greatest concern to respondents. Nearly 80% of respondents considered pollution of reservoir catchment areas to pose a high or moderate risk to the general population. Further, around 40% of respondents considered chemicals or germs in drinking water to pose a high or moderate risk to themselves and/or their families. That study found drinking water quality was an issue of concern for many, if not the majority, of people; differences in perceived risk levels, however, were found in relation to state of residence, gender and age, with females perceiving greater risks than males (Starr et al., 2000).

The fear of water contamination is also evident in community valuations of ecosystem services. There are consistent findings in populations across the world that ecosystem services relating to water quality maintenance and improvement are valued by much of the population. Protecting water quality was found to be the highest rated ecosystem service by several studies (Aguilar et al. 2018, Chaikaew et al. 2017, Lee et al. 2018), while other studies have demonstrated willingness of the community to pay to improve water quality and stream health and to protect waterbodies (Brox et al. 1996, Hunter et al. 2012, Mueller et al. 2017, Ortega-Pacheco et al. 2009, Sheild et al. 2009). In contrast, recreational use is typically considered one of the least important ecosystem services of parks and water bodies (Mahler et al. 2004), suggesting many people would prioritise water quality over recreational access if recreation was considered to pose a risk to water quality, as found in the previously mentioned studies by Nancarrow and Syme (2010) and Bruce (2006). It is expected, therefore, that most community members would choose to protect water quality over permitting recreational use if they considered recreation to pose a risk to water quality.

2.2.4.4. Gender Differences in Risk Perception

Gender differences have been noted by many authors. Davidson and Freudenburg (1996) reported gender differences in environmental risk perceptions, particularly in terms of facilities and technologies posing a risk of contamination. They note that the evidence suggests the differences could be related to concerns about health and safety, and do not result from males' increased knowledge and familiarity of the risks. Gender appears to have an influence on risk perception, with females generally more sensitive to risks than males (Fielding et al. 2016); while females and males may rank different risks in the same order, females may rate the risks as higher health risks compared to males (Starr et al. 2000). The 'white male effect' is well known in risk perception research in the USA, where white males judge risks to be much lower than other groups, which is thought to relate potentially to socio-political differences (Finucane et al. 2000b). Differences in risk perception between the USA and Australia have, however, been noted (Finucane and Maybery 1996), demonstrating that it is important to identify local risk perceptions explicitly rather than relying on those determined for other groups and populations.

2.2.4.5. Summary

Overall, the literature suggests that risk perception is a key influence on policy support, exerting both direct and indirect effects, the latter through modifying perceptions of severity and likelihood of risks. Factors such as self-interest, including perceived barriers of policy implementation, and worldview may also have a substantial influence. Studies regarding the influence of many demographic characteristics are inconclusive, although the weight of evidence suggests females may be more risk averse than males, which may translate to stronger support for risk reduction policies. In terms of recreation policy support, the nature of the recreation activity, gender, and self-interest (in the forms of proximity of residence to catchments and personal recreation habits) appear to influence policy support; importantly, support for restrictive recreation policy is likely to vary in different locations, depending in part upon historical recreation permissibility and the quality of the water source and its required level of treatment.

2.2.5. Policy Support Hypotheses

Based on the literature described in the previous sections, the following hypotheses were generated about policy support and group differences:

- Passive land-based recreation will be more acceptable to the community than water-based recreation activities;
- Females will be more supportive of recreation restriction than males;
- People living further away from the catchments will be more supportive of recreation restriction than people living close to the catchments;
- People will be more supportive of permitting recreation activities in the catchments that match their own recreation practices than people not engaging in those activities;
- People supporting recreation restrictions will have stronger ecocentric worldviews than people supporting recreation activities in the catchments; and
- Females will have higher perceived recreation risk than males.

2.3. Theoretical Models of Policy Support

In order for policy support to be better understood, predicted and increased, a theoretical model of policy support is needed. Given the noted lack of theory-driven research in the policy arena (Kyselá et al., 2019), a key objective of this research was to identify or develop a model of policy support. No accepted models of policy support were identified in the literature.

Risk reduction policies are designed to reduce risks that experts consider are present and pose a sufficient hazard to warrant action. Given the fundamental importance of risk perception to policy implementation, it was considered critical that the perception of the community regarding the risks being addressed be understood. As identified in the policy support research described previously, it is also likely that risk perception is a fundamental influence on their acceptance of the policies. Risk perception, therefore, was considered a critical variable to be included in a model of support for risk reduction policy.

Water contamination poses a health-related disaster risk. Given the extensive use of models in the health domain to explain and predict health-related behaviour that reduces health-related risks, the health behaviour literature was explored in the search to find a candidate model to test in the context of risk reduction policy support.

2.3.1. Models of Health Risk Perception and Behaviour

Some of the most commonly used models to understand and predict behaviour in the health field are Social Cognitive Theory, the Trans Theoretical Model, the Theory of Planned Behaviour, and the Health Belief Model (Glanz et al. 2008, Sulat et al. 2018). These models are described briefly below.

Social Cognitive Theory (SCT) is a model of interpersonal behaviour, which looks at interactions between individuals, their environment, and their behaviour (McAlister et al. 2008). The core concepts of SCT are: reciprocal determinism; outcome expectancies; efficacy of self and the collective; observational learning; incentive motivation; facilitation; self-regulation; and moral disengagement.

SCT emphasises both individual and collective action that can benefit individuals and groups, for example, for broad scale public health benefits. The reciprocal determinism concept allows for the exploration of the influence of, and by, environments on individuals, and can be used in situations such as planned protection and promotion of public health (McAlister et al. 2008). Further, the outcome expectancies concept incorporates beliefs about the consequences and values of behaviours, and the incentive motivation and facilitation concepts cover some barriers to action. While these aspects suggest the model might be suitable for exploring environmental health-related policy support behaviours, the theory does not explicitly include the key variable found to affect policy support — risk perception.

The Transtheoretical Model (TTM) is a model of health behaviour change, and describes six stages of change involved in a behaviour, ranging from pre-contemplation to termination (Prochaska et al. 2008). As it focuses on changes in behaviour, rather than attitudes or perceptions of the need for behaviours, it was not considered appropriate for the exploration of predicting risk-related behaviour.

The Theory of Planned Behaviour (TPB) is an extension of the Theory of Reasoned Action (TRA) (Ajzen 1991). Both theories assume behavioural intentions are driven by both attitudes to a behaviour and perceptions of social norms about the behaviour. The TPB extends the TRA by adding perceived control over the behaviour to the theory. Overall, behavioural intention is considered the best predictor of behaviour under the TPB (Montaño and Kasprzyk 2008). As such, the model focuses on attitudes and beliefs about the behaviours and their outcomes, but does not directly incorporate an individual’s perception of risk. Given that risk perception was expected to be a key influence on policy support, the TPB was not selected for this study.

The Health Belief Model (HBM) (Rosenstock 1974, Rosenstock 1966) is a theoretical model and explanatory framework for predicting health-related behaviours. The HBM posits a person will engage in a behaviour to prevent or treat a condition if they believe they are personally susceptible to the condition, they believe the condition to be sufficiently serious to need avoiding, and that the benefits (and effectiveness) of action to change the potential outcomes outweigh the barriers to undertaking that action (Rosenstock 1974). Variations of the model have also incorporated cues to action, general health beliefs, and self-efficacy to take action, although these variables are less commonly explored (Jones et al. 2015). Demographic and other personal characteristics are considered likely to affect the HBM variables indirectly, but are not explicitly included in the model (Champion and Skinner 2008, Sulat et al. 2018).

While the HBM is promoted as a value-expectancy model of behaviour (Harrison et al. 1992), the model variables match those associated with risk assessments and cost-benefit analyses undertaken by industry and government. In risk management work, including in the water industry, risk assessments commonly rate the level of risk by multiplying the likelihood and consequence of a hazard or event (Miller et al. 2009). This risk rating is equivalent to the perceived threat concept of the HBM formed from the combination of perceived susceptibility (likelihood) and severity (consequence) of a hazard. The perceived benefits and barriers of the HBM, similarly, relate to the concepts of benefits and costs that are used in Cost-Benefit Analyses. The parallels between the HBM and these industry techniques are shown in Figure 1.

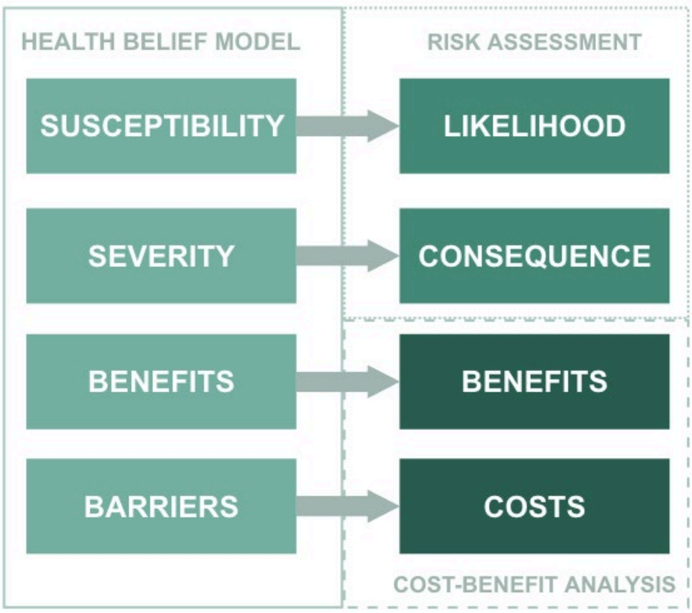

Figure 1: Linkages between HBM and Risk Assessment and Cost-Benefit Analysis

While not officially described in such terms, the HBM, therefore, can be considered to assert that an individual’s actions in relation to health-based hazards are based on a risk assessment of the perceived threat (likelihood and consequence), and a cost-benefit analysis of the potential actions to mitigate that perceived threat (benefits and barriers). Given the strong focus on, and parallels with, risk research and management, the linkages of the model variables with those identified as influencers of policy support in Section 2.2, and the broad acceptance and use of model, the HBM was considered the best candidate model to test in this exploratory study. The application and structure of the HBM are explored further in the following sections.

2.3.2. The Health Belief Model

The Health Belief Model (HBM) was developed in the 1950s and 1960s by social psychologists, and used a cognitive perspective to explain vaccination behaviour, where a person’s behaviour was considered to be driven by their subjective perceptions of the world rather than the objective external environment (Rosenstock, 1974). Specifically, the HBM is a value-expectancy theory, based on the theory that behaviours result from the subjective beliefs about the value of an outcome and the expectation that an action will achieve that outcome (Champion and Skinner 2008); in other words, whether illness is a concern, and whether the benefits of action (avoiding the illness) outweigh the costs. As such, perceived susceptibility, severity and benefits were theorised to have a positive influence, and barriers to have a negative influence, on the likelihood of a preventive or protective behaviour occurring (Rosenstock 1974).

The HBM is one of the most widely used frameworks for exploring and explaining health behaviour (Glanz et al. 2008, Sulat et al. 2018), and has been used to determine personal attitudes and behaviours associated with health-related issues, as well as for guiding behaviour-related interventions (Champion and Skinner 2008). This model has been used extensively to predict a range of health-related behaviours, such as undertaking preventive health measures to protect self — such as influenza and human papillomavirus vaccination, HIV prevention, and mammograms (Champion 1999, Gerend and Shepherd 2012, Mimiaga et al. 2009, Murphy et al. 2013) — and others under one’s care (Toronto and Mullaney 2010), and minimising risks or symptoms for individuals at-risk of, or affected by, illness (such as those caused by smoking or obesity) (Rosenstock 1990). More recently, the HBM has been used to assess protective behaviours during the global COVID-19 pandemic (Al-Sabbagh et al. 2021, Callow et al. 2020, Guidry et al. 2021, Hsing et al. 2021, Shmueli 2021, Wong et al. 2020).

The model is demonstrably useful for predicting attitudes based on perceived risk and the resultant behaviours that people undertake to minimise risk, whether that risk relates to their own health risk or the risk to others. Meta-analyses conducted to assess the effectiveness of the model in predicting health-related behaviours are summarised below. More recently, use of the HBM has extended outside the traditional health field to be used to predict environment-related behaviours and disaster risk reduction and preparedness; an introduction to these studies is provided in Section 2.3.2.2.

2.3.2.1. HBM in the Health Domain

Four key meta-analyses of HBM research in the health domain have been undertaken to date (Harrison et al., 1992; Janz & Becker, 1984; Zimmerman & Vernberg, 1994; Carpenter, 2010). The different methodologies, inclusion criteria and analysis approaches led to different conclusions about the predictive ability of the model and its variables. Importantly, however, the findings demonstrate the usefulness of the model.

The earliest analysis by Janz and Becker (1984) was a critical review of 29 HBM studies undertaken between 1974 and 1984. Analysis comprised counting statistically significant relationships between variables and was not, therefore, a traditional meta-analysis. The authors concluded that the perceived barriers factor was the strongest predictor of behaviour, while perceived severity had the weakest association of all the variables. Susceptibility was more strongly associated with preventive health behaviours (as opposed to behaviours associated with treating a diagnosed condition), while benefits and severity were more salient for treatment rather than prevention behaviours. The authors suggested that the low significance of severity in these studies, particularly, might be due to this variable having less relevance for preventive behaviour, being more relevant to treatment behaviours for people with actual illness or conditions. Similarly, the authors considered perceived benefits to be more relevant to treatment behaviours than preventive behaviours (Janz and Becker 1984). Criticisms of that study focused on the methodological approach, including that it did not sufficiently estimate the variable relationship strengths, and the findings were likely influenced by differences in sample sizes between studies (Carpenter, 2010).

Zimmerman and Vernberg's 1994 meta-analysis of 57 studies using the HBM, TRA and/or the SCT found that, for the HBM studies, the variable with the strongest influence on behaviour was perceived barriers, followed by perceived benefits, perceived susceptibility, and then perceived severity (Sulat et al. 2018). The analysis only reviewed the predictive ability of the model as a whole, however, and did not investigate the predictive ability of each variable on behaviour. Further, the inclusion of additional variables (outside the core four model concepts) in some studies may have compromised the assessment of the effects (Carpenter, 2010). While the authors noted the HBM was the weakest predictor of the three models (HBM, TRA and SCT), no significant difference was found between the models for their predictive ability (Sulat et al. 2018). The conclusion regarding the lower effectiveness of the HBM could have been influenced by the greater number of HBM studies included in the analysis; half of the papers assessed used the HBM, compared to only one quarter each for the other two models.

The meta-analysis of 16 studies investigating the HBM factors and their relationships with health behaviour by Harrison et al. (1992) found all HBM variables were significantly associated with health behaviours, but the effect sizes were all relatively small (Harrison et al. 1992); Carpenter (2010), however, noted that the small effect sizes may have been a methodological artefact. A large degree of heterogeneity was also found for most of the statistically significant effects, indicating that different underlying constructs may have been measured. The barriers factor was found to have the strongest effect size for the preventive and treatment studies reviewed, followed by susceptibility and benefits, with severity having a very small effect. When the preventive studies were reviewed in isolation, however, perceived benefits had the strongest effects. The study did not review the overall predictive ability of the model; the authors noted that the total predictive ability of the model could be reduced if collinearity was present in the variables; alternatively, interactions between variables might result in larger effects (Harrison et al. 1992).

Carpenter's meta-analysis of 18 longitudinal studies published between 1982 and 2007 focused on evaluating the predictive ability of the direct-effects model (Carpenter, 2010) for long-term behaviours; that is, the individual effect of each of the core model variables on behaviour. For preventive behaviours, benefits and barriers had the strongest correlations with behaviour (0.42 and 0.33, respectively), with barriers consistently found to have the largest effects on behaviour; interestingly, barriers were a stronger predictor of preventive behaviour compared to treatment behaviour. Severity was only slightly correlated with behaviour (0.16), while susceptibility had a very weak negative correlation with behaviour (-0.06). Again, the author noted the estimates were heterogenous, which is likely to have influenced the results. Overall, Carpenter's analysis indicated that benefits and barriers were the strongest predictors of behaviour over time, particularly for preventive behaviours. This finding contradicted Janz and Becker's (1984) findings, but was consistent with the initial conceptualisation of the model as a tool for predicting the adoption of preventive behaviours (Rosenstock 1974).

Carpenter (2010) also concluded that unexplored moderating variables were likely influencing the HBM relationships. As Janz and Becker (1984) noted, it is important to remember that the HBM is a psychosocial model, which accounts only for attitudes and beliefs; other factors influence behaviour, such as habits, social pressures, self-interest (like economic or other pressures and preferences) and other situational factors. It is, therefore, very likely that there are other variables influencing behaviour, which are not accounted for in the model; however, this does not detract from the usefulness of the model.

Further, Champion and Skinner (2008) suggested that the influence of one variable may change in response to changes in the other variables; when perceived threat is high, benefits and barriers may be more salient to behaviour compared to when the perceived threat is low, when there may be no need for action. Conversely, when barriers to action are low, the perceived threat may be lowered due to ease of taking action (Champion and Skinner 2008). Such interdependency is important to remember when comparing study findings and drawing conclusions about model efficacy in predicting behaviour, and cannot easily be identified through standard statistical techniques.

Overall, the meta-analyses consistently indicated that the perceived barriers factor was the greatest predictor of behaviour, with perceived benefits also typically showing a strong effect. Perceived severity and perceived susceptibility were typically weak predictors. It is noted, however, that most of the papers' analyses investigated the direct effects model. Janz and Becker (1984) suggested that severity and susceptibility may influence behaviour through perceived threat; Carpenter (2010) concluded that future investigation should focus on the mediated effects of these variables rather than direct effects.

A criticism of the HBM is that the relationships between the variables have not been precisely specified, leading to issues associated with the way the variables are conceived and operationalised (Abraham and Sheeran 2005). This purported weakness can, however, be viewed as a strength — the lack of rigid structure and factor definitions means the model can feasibly be applied to contexts other than that for which it was originally created (that is, the health-behaviour context), making it a potential general model of risk perception and behaviour. While many studies using the HBM have been undertaken in the health field, the model lends itself to multidisciplinary study. Some of these uses are explored in the following sections.

2.3.2.2. HBM in Environment and Disaster Domains

Only a few studies have used the HBM in the field of environmental health to date, although its use has increased in recent years. The model has been used to investigate behaviours in relation to renewable energy use (Bakhtiyari et al. 2017, Yazdanpanah et al. 2021a), conversion to organic farming (Yazdanpanah et al. 2021b), responding to air pollution (Pormosayebi et al. 2018), recycling behaviour (Lindsay and Strathman 1997), health-based waste management behaviour (Sandhu 2014), and on-farm safety behaviour to mitigate risks to consumers associated with microbial contamination (Rezaei and Mianaji 2019). Further, components of the HBM have been used to assess pesticide use (Arcury et al. 2002, Lichtenberg and Zimmerman 1999). As for other HBM research, these studies related to behaviours under the control of individuals and the individuals' associated attitudes.

In addition to routine environmental behaviours, the HBM has been applied to more long-term risks and environmental disasters, such as heat waves and responses to climate change (Akhtar et al. 2018, Akompab et al. 2013, Semenza et al. 2011), drought (Savari et al. 2021, Zobeidi et al. 2021), response to extreme weather events (Andrade et al. 2019), and to predict and increase preparedness for a range of hazards, such as floods (Azmi et al. 2021, Ejeta et al. 2016), earthquakes (Amini et al. 2021, Rostami-Moez et al. 2020), and hurricanes (Lachlan et al. 2021). The HBM has also been used in studies of general disaster preparedness (Inal et al. 2018).

A systematic review of the application of behavioural theories in research regarding disaster and emergency health preparedness (Ejeta et al. 2015), including the HBM, found that the HBM's four main constructs were found to be associated with preparedness for diverse hazards. As noted by the meta-analyses described for health-related research, however, most of the studies did not define or assess the relationships between model constructs. Further, the authors similarly noted the need to investigate the influence of mediating variables on disaster preparedness. Review of the papers published since then demonstrated that this was still the case; most of the more recent studies using HBM in the environment or disaster domains investigated the direct effects model, although a number did investigate compound variables of perceived threat and/or outcome expectancy (benefits – barriers). The only exception noted was a climate change study, which looked at the mediation of perceived severity on perceived susceptibility; this interpretation of the relationship between these two variables, however, has not been generally adopted; rather, they are more commonly perceived to combine to form the perceived threat construct. Path analysis techniques, such as structural equation modelling, therefore, would be a useful addition to the body of knowledge in this area through enabling the investigation of interrelationships between variables and different pathways of effect.

Overall, these studies provide evidence of the functionality of the HBM outside the traditional health behaviour domain, and illustrate similarities between environmental- and disaster-related behaviours and health behaviours. Using psychological models like the HBM in the disaster domain is important, because they can be used to develop intervention strategies and enhance the resilience of resources and communities (Paton 2019). This is particularly critical for the DRR domain, where some hazards can be removed or reduced, providing additional capacity to tackle uncontrollable hazards when they arise; the lack of use of psychological models in the context of man-made hazards (Ejeta et al. 2015) is an important gap for this discipline.

2.3.2.3. HBM in Water-Related Research

The literature search identified three studies using the HBM in the context of water quality and conservation behaviours. The first paper investigated factors affecting previous and future water quality testing of private wells for contamination (water quality management) in the USA (Straub and Leahy 2014). The four core components of the HBM were investigated in terms of their associated composite variables — perceived threat (susceptibility and severity questions) and outcome expectancy (behavioural evaluation). The latter was conceived, interestingly, as the addition of perceived barriers and benefits rather than the usual subtractive relationship; while the authors noted that ‘responses were reverse scored when needed before summation’ (p1520), it is not clear whether that applied to the barrier questions, essentially reverting the relationship to the conventional one. Other variables investigated were self-efficacy, water quality cues to action, reminder cues to action, and socioeconomic status. The logistic regression found that only outcome expectancy (claimed by the authors to be driven by perceived barriers) and socioeconomic status (income and education) significantly influenced previous well water testing, and only a reminder cue to action was significant for future intentions to test well water. Approximately 70% of the sample was female. Importantly, perhaps, 87% of respondents considered their water was safe to drink; as such, the perceived risks were potentially not sufficient to drive concern or mitigating behaviours. Further, over half the respondents indicated they had concerns about their property values if they identified a water quality problem, which could have led to a perceived barrier to testing their water.

A recent paper reported the use of the HBM to predict farmers' willingness to change their cropping practices to protect water resources in Iran (Boazar et al. 2020). In addition to the core four HBM variables, cues to action and self-efficacy were included in the covariance-based structural equation model. Interestingly, the model had weak predictive ability, only accounting for 28% of the variance in behaviour, and only perceived benefits and cues to action significantly affected behaviour. Notably, all the participants were male.

In another Iranian study, the HBM was used to investigate factors affecting farmers' water conservation behaviours (Tajeri moghadam et al. 2020). The covariance-based structural equation modelling determined that the perceived benefits factor was the strongest predictor of water conservation activities, with perceived susceptibility and cues to action also being significant predictors; together, these three variables accounted for 41% of the variance in water conservation behaviour. Perceived benefits and perceived severity, however, were not significant; nor were self-efficacy or general beliefs. Nearly all the participants (95%) were male.

The two Iranian studies, with essentially all male participants, found perceived benefits of actions to be the strongest predictor of behaviour. As described previously, females generally have higher perceived risks than males (Shepherd et al. 2012, Starr et al. 2000), although the influence of gender is variable — the results may, therefore, have differed if more females were included in the study. Further, it is notable that Iran has suffered extreme water shortages in recent years, with extensive desertification happening across the country. As such, the benefits of action to facilitate their continuing livelihoods is, understandably, likely to be a key driver for action in these contexts. The context of these studies is potentially important when thinking about generalisability to other regions.

Authors who have noted the potential usefulness of the HBM in the field of environmental psychology (Nisbet and Gick 2008, Vining and Ebreo 2002) have focused on the potential for it to be used in the traditional manner; that is, where the model's function is to predict behaviours based on factors under the control of the individuals. This approach is supported by the previously noted environmental and disaster-related studies. It is, however, considered likely that the model would also be useful in assessing people's attitudes towards environmental health risks where the individual would have little or no direct control over the risk factors, such as with the quality of town water supplies. Determination of whether the model can appropriately explain behaviours associated with external rather than personal actions — such as support for health-related policies — is expected, therefore, to be a valid and useful route of inquiry.

2.3.2.4. HBM in Policy Support

At the time of this study, no examples of the application of the HBM in the context of policy support were identified in the literature. As stated previously, however, the HBM has the potential to be a useful model of risk reduction policy support and general risk perception. The use of the HBM in the context of catchment protection policy support is supported by the findings of Nancarrow and

Syme (2010). Their study of attitudes to recreation policies in the greater Perth Metropolitan Region (described in Section 2.2.2) indicated that key variables accounting for differences in catchment protection policy support were catchment risk (perceptions of risks of recreation and the efficacy of treatment measures) and system risk (the likelihood of something going wrong and seriousness of outcomes if something went wrong); these variables show clear parallels with the constructs of the HBM.

Demonstrating the efficacy of the HBM in the context of policy support would create opportunities to expand the use of a model popular in the health arena to a new domain, as well as further support its use in the domains of environmental health and DRR. The information obtained from such application could be used by a variety of utilities and government departments to assist in a range of activities, such as policy development or modification, evaluation of operational changes, and for engaging in community consultation and education activities.

2.3.2.5. Exploration of Group Differences in the HBM

Evidence regarding the influence of the HBM constructs, and of grouping variables such as demographic characteristics, in the HBM framework is inconsistent. The inconsistency may be related to the inclusion of other constructs, such as cues to action, self-efficacy and general beliefs. A key group difference identified in the risk domain was gender, while a key group difference identified in the recreation policy support research was proximity of residence to catchments. The exploration of these variables in the HBM research is described below.

The role of gender has not been investigated frequently with the HBM in environmental and disaster contexts. This may be partly because of the nature of the study; for example, the studies involving farmers in Iran had predominantly male participants. For those studies that did investigate gender differences, females were generally found to have higher concern. For example, females: had higher perceived severity of climate change effects associated with fossil fuel use, and a greater intention to use biofuels (behaviour) (Bakhtiyari et al. 2017); were significantly more likely to take voluntary mitigation action against climate change through reduced energy use (Semenza et al. 2011); and were significantly more prepared for flood (Ejeta et al. 2016) and earthquakes (Rostami-Moez et al. 2020) than males. In contrast, gender was not found to be significantly associated with either risk perception of, or adaptive behaviour during, a heat wave (Akompab et al. 2013), and was also not significantly associated with previous or future testing of private water wells for contaminants (Straub and Leahy 2014). Overall, while females generally appear to have higher perceived risk than males, the influence of gender may vary with context; the influence of gender on risk-related behaviours requires further exploration with the HBM.

The effect of proximity on behaviour has been explored in different ways in previous studies, including physical distance to the site of preventive behaviours and physical distance from the hazard. HBM research indicates that the distance to action — for example, the location of screening facilities or other health care facilities — can be a common barrier to action (Adedeji et al. 2021, King et al. 2017, Pervin et al. 2021, Suwankhong and Liamputtong 2018). Distance can also be treated as a separate predictor. A study by Nadrian et al. (2021) used distance as a demographic predictor in a hierarchical linear regression; the average distance of the health house from the communities was found to be a significant predictor of whether male rural health workers delivered osteoporosis prevention education programs. Trumbo and Harper (2015) looked at the effect of proximity in a modified HBM study, and found greater perceptions of proximity to West Nile Virus (dead birds that might be infected, personal history of infection, and knowledge of people in their household, neighbourhood, and outside their neighbourhood being infected with the virus) to be significantly related to greater perceptions of both affective and ecological risk perception, meaning those participants had greater fear and anxiety relating to the virus and greater perception of the presence of local conditions conducive to mosquito breeding (with mosquitos being the disease vector). Proximity had a significant effect on preventive behaviour when the HBM variables were not included, but its contribution was not significant when the HBM measures were added to the regression. This could have resulted from the way proximity was operationalised in the study; for example, there were clear overlaps with both cues to action and susceptibility.

Overall, the literature suggests that distance, or proximity, can affect behaviour through its influence on the HBM constructs or as a demographic variable. Proximity to catchments was used as a grouping variable in this study to explore the differences in policy support between people living close to catchments and those living at a distance from them.

2.3.2.6. Model Structure

While the HBM is a much-used theory of behaviour, a key criticism of the model is that the relationships between the variables have not been defined clearly (e.g. Jones et al., 2015). The typical conceptualisation and use of the HBM assumes the variables independently affect health behaviour (Abraham and Sheeran 2005), which is known as the direct effects model. As described in the meta-analyses (Section 2.3.2.1), however, such an approach may lead to inaccurate estimates of the contributions of each of the model factors given that two of the variables — susceptibility and severity — have been demonstrated to be weak predictors of behaviour in many contexts (Carpenter 2010). The literature provides conflicting evidence regarding how severity and susceptibility may influence behaviour; susceptibility and severity may indirectly affect behaviour through perceived threat (Champion and Skinner 2008, Janz and Becker 1984), which is consistent with early visual depictions of the HBM framework (Becker et al. 1974). There has been conflict, similarly, regarding the relationship between perceived benefits and perceived barriers. While some studies support the initial model concept of a subtractive effect of one from the other to form an outcome expectancy variable, other authors have argued and demonstrated that the constructs are conceptually distinct, and independently affect behaviour (Skinner et al. 2015).

The exploration of mediation pathways and other variable relationships noted by authors such as Carpenter (2010) may determine how the predictive powers of variables change in relation to values of the other model constructs and provide better intelligence regarding the efficacy of the model to predict behaviour (Champion and Skinner 2008). In an attempt to explore and clarify some of these issues, Jones et al. (2015) investigated some potential relationships between the HBM variables using logistic regression, with the study undertaken in the context of the efficacy of a vaccination campaign. Through an exploration of 24 possible ordering pathways, the authors found only two significant serial mediation pathways, or causal chains: one was from exposure to behaviour mediated by perceived barriers (that is, exposure → barriers → behaviour), and the other was also from exposure to behaviour, mediated by both barriers and perceived benefits (that is, exposure → barriers → benefits → behaviour). Negative associations were found between exposure and barriers and between barriers and benefits, while benefits and behaviour were positively associated. Further exploration of the mediating effects of benefits on barriers was undertaken in this study as described in Chapter 4.

It is noted that many of the previous studies and meta-analyses used first-order statistical methods, such as regression, to assess the model. Such techniques are limited in the relationships they can investigate, and are likely to affect the measured efficacy of the HBM constructs to explain behaviour. It is desirable, therefore, to use techniques that can assess both the importance of individual variables, and the influence of variables on each other, in order to gain a more complete understanding of the influence of each variable. Second order statistics, such as structural equation modelling, offer that ability; further detail is provided in Chapter 3.

2.3.2.7. Summary

The HBM framework specifies that perceived susceptibility, severity and benefits have a positive influence on the likelihood of a protective behaviour occurring, while perceived barriers have a negative influence (Rosenstock 1974). The relationships between the variables, however, have been challenged. Results of meta-analyses suggest that future research should investigate mediation and moderation relationships in the HBM rather than direct effects, and that barriers and benefits are likely to have stronger direct predictive power for behaviour than susceptibility and severity. As described in Chapter 3, structural equation modelling is an ideal technique for the exploration of interdependencies between, and predictive ability of, variables.

Traditional applications of the model include health education programs and health policy. The HBM, however, is increasingly being employed in the environmental health and disaster fields. Most studies using the HBM have investigated circumstances where individuals can take action to minimise a health risk. In the context of the public drinking water supply, however, the water managers and their regulatory systems are responsible for protecting public health. As such, this study proposed a novel use of the HBM, and explored whether the HBM could predict behaviour (policy support) when much of the control was external to the individual.

2.3.3. HBM Hypotheses

The hypotheses relating to the theoretical model of policy support were:

- The perceived susceptibility of a person to illness from waterborne disease will be positively associated with the perceived threat of recreation to water quality (recreation risk);
- The perceived severity of illness from waterborne disease will be positively associated with the perceived threat of recreation to water quality (recreation risk);
- The perceived threat of recreation to water quality (recreation risk) will positively influence support for recreation restriction in the catchments;
- The perceived benefits of restricting recreation in the catchments will positively influence support for recreation restriction in the catchments;
- The perceived barriers to restricting recreation in the catchments will negatively influence support for restricting recreation in the catchments;
- The perceived benefits of restricting recreation will mediate the perceived barriers to restricting recreation in the catchments;
- The model relationships will differ for the Female and Male samples; and
- The model relationships will differ for people living close to the catchments and those living further away.

2.4. Conclusion

Recreation in drinking water catchments poses a potential risk to public health as it can contaminate drinking water sources with pathogens and other pollutants. Many urban water utilities across Australia, therefore, have implemented catchment protection policies that restrict or prohibit recreation in and near water storages and catchments. Urban water utilities, reportedly, are facing increasing pressure from the community to permit greater levels of recreation in catchments, but it is not known what proportion of the community would support such changes in catchment protection policy.

Water pollution is clearly considered a risk to public health by most of the population, and research suggests that most people would prioritise water quality protection over recreational access to catchments if they thought recreation threatened water quality. The perception of risk from recreational activities, therefore, is expected to be an important influence on support for catchment protection policy. Risk perception is a complex process, which appears to be influenced by a range of factors that may differ between individuals and circumstances. Little research to date has explored theoretical models of policy support or risk perception, has been done in a way that can determine the relative contributions of each factor to the outcome behaviour, or determined how the different factors interact.

While risk perception seems to be a key factor in understanding the drivers of policy support, the difference in policy preferences associated with different attitudinal and demographic characteristics is also important to understand, as such intelligence can provide guidance about community segments that are the key supporters of, or objectors to, policies; they can, therefore, identify targets for interventions. This dissertation investigated, therefore, the influence of a range of variables on policy support, determined how they varied between key community subgroups, and explored a model of policy support based on risk perception.

Chapter 3 describes the method used to undertake empirical exploratory research for the dissertation, while Chapters 4 and 5 report on the empirical findings, relating to the efficacy of the HBM to explain policy support using structural equation modelling (Chapter 4) and the influence of other variables on recreation policy support, and determination of which key community groups represent targets for interventions to increase policy support (Chapter 5). The study findings are then discussed in Chapter 6.

Chapter 3. Methodology

Chapter 3

3.1. Chapter Overview

As noted in the previous chapters, the purpose of the study was to explore the influence of risk perception and other personal characteristics on community acceptance of disaster risk reduction policies, with a specific study focus on acceptance of restrictive recreation policies in catchments. This chapter describes the basis of the empirical research undertaken to meet the study objectives to identify key variables associated with policy support and test a theoretical model of policy support.

A community survey was undertaken in the lower Hunter Region of NSW, which investigated recreation practices in the region, levels of support for different recreation policies, and captured data regarding a range of variables identified in the literature as relevant to policy support. The questionnaire was based on a previously published and tested survey. This chapter describes the procedures used to modify, test, disseminate, and analyse the survey data.

3.2. Method

This section reports the method used to explore community attitudes to recreation in the catchments in the lower Hunter Region of NSW. The sample population, survey instrument development, and the methods used to analyse the data are described in the following sections.

3.2.1. Methodological Considerations

A key purpose of the study was to determine community views to recreation in their local catchments. The intent of the study was to obtain representative community views for the study population, which required a large sample size. A sample population survey, therefore, was considered the most efficient and timely method of data collection for the study. Likert scales were used for the collection of attitude and policy support data, as they provide more nuanced response options than simple binary categories and permit the use of a range of statistical tests.

3.2.2. Participants

The study targeted the adult population (aged 18 years or over at the time of sampling) of the Lower Hunter Region of NSW, Australia, where potable water is provided to most of the population by the local water utility, Hunter Water. The utility's area of operations, which was the study survey area, is shown in Figure 2; the figure shows the locations of the catchments and the Local Government Areas (LGAs) (white text).

Figure 2: Study Area

(Source: © Hunter Water Corporation[10]. Reproduced with permission.)

The adult population was estimated to be around 487,000[11] people at the time of the sampling (2019). A minimum sample size of 384 respondents was required to gain sufficient statistical

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[10] https://www.hunterwater.com.au/about-us/our-business/what-we-do; accessed 1 March 2022. Permission to use as per https://www.hunterwater.com.au/copyright-and-disclaimer and confirmed via email.

[11] No clear data enumerating the adult (i.e., aged 18 years and over) population of the lower Hunter Region in Hunter Water's area of operations were available. As such, the population was estimated by subtracting the percentage of people aged under 15 years for Australia (18.9%) [http://www.abs.gov.au/AUSSTATS/abs@.nsf/Latestproducts/3101.0Feature%20Article1Jun%202018?opendocument&tabname=Summary&prodno=3101.0&issue=Jun%202018&num=&view=; accessed 21 Jan 2019; data as at 30 June 2015.] from the population of the lower Hunter (Cessnock, Dungog, Lake

power (confidence level of 95% and a margin of error of 5%)[12] for the significance testing reported in Chapter 5. Data from 454 respondents were used in the analyses reported in this dissertation; demographic characteristics of the sample are detailed in Section 3.2.6.

3.2.3. Materials

This exploratory study investigated the influence of a variety of variables (relating to demographic variables and other personal characteristics) on support for recreation within the catchments using an online survey. The survey instrument (refer to Appendix A) was primarily based on a survey of catchment protection preferences in Western Australia (Nancarrow and Syme 2010). That survey was modified in order to capture data relating to the candidate model of policy support, the HBM, and additional factors identified in the literature review that related to policy support. Further details are provided in the following sections. Not all the data collected in the survey are reported in this dissertation, which primarily focuses on the HBM variables.

3.2.3.1. Item Development

The survey captured data relating to factors likely to affect support for recreation policy in the catchments as identified by the Literature Review. Many of the questions included in the survey pertained to the latent HBM factors (refer to Chapter 2); those factors are described and investigated in relation to recreation policy support in Chapter 4. Questions capturing demographic data and other potentially relevant information for recreation policy support were also included in the survey, and were used in analyses in Chapters 4 and 5.

The questionnaire items were sourced primarily from the survey developed by Nancarrow and Syme (2010). Items were reviewed by the researcher and, where relevant, were allocated to the HBM factors based on their face validity. Questions from that survey not considered relevant to this study were excluded, and items that were relevant but were not easily allocated to a factor under investigation were included in an unallocated group of items (three items).

An extensive literature search was undertaken to determine if any existing HBM questionnaires focused on topics related to this study in order to identify items that had already been used and assessed in research. No suitable scales were found. Some identified scales, however, provided useful guidance about how the HBM factors were conceptualised (item wording), and this knowledge was used with the factor definitions (refer to Chapter 4) to develop additional items for

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Macquarie, Maitland, Newcastle and Port Stephens LGAs [NSW Planning and Environment 2016. Hunter Regional Plan 2036.]; approximately 600,000), resulting in an adult population of approximately 487,000.

[12] https://www.surveymonkey.com/mp/sample-size-calculator/

the survey to ensure that every factor had a minimum of four items to allow for item attrition from the scale validation process undertaken as part of the modelling.

In addition to the HBM constructs, the survey captured data associated with worldview using the five-item subscale of the New Ecological Paradigm (NEP) Scale from Dietz et al. (2007) to determine respondent's general beliefs and attitudes about humans' relationship to the environment. The NEP scale identifies general beliefs about the environment and its ecosystems, and how they are affected by human actions (Stern, Dietz and Guagnano 1995). Higher NEP scores are considered to be associated with stronger pro-environmental attitudes about specific environmental problems (Dietz et al., 2007).

3.2.3.2. Validity

The face validity of the HBM latent factors and their associated survey items was confirmed by two experienced researchers with extensive experience in use of questionnaire design and assessment, who commented on the validity of the items and suggested wording and other changes to enhance comprehension and analysis. Modifications were made to the questionnaire in response to their feedback. All the questions were considered to accurately reflect the factor to which they were allocated. Statistical assessment of the validity and reliability of the factors was undertaken as part of the PLS-SEM analyses reported in Chapter 4. As the NEP subscale measuring worldview was not included in the PLS-SEM, the same statistical testing was not performed for this variable as was undertaken for the HBM variables. The NEP subscale, however, was found to have sufficient internal consistency for statistical testing (Cronbach's alpha value of 0.797).

The purpose of the study was not to develop a questionnaire. Testing of the psychometric properties of the questionnaire, therefore, was not undertaken.

3.2.3.3. Testing

The full survey was piloted with a group of 15 third year environmental science students from the University of Newcastle as part of an in-class activity. Students were asked to complete the survey, to note any issues with comprehension of the items, and to provide feedback on any issues they encountered with the online survey platform. The survey was also tested by a group of 13 employees from the water utility to check for residual issues with question wording/comprehension, response options, or use of the survey platform. Modifications to the survey were made in response to feedback from the two pilot-test groups. The readability of each item was measured using the Flesch–Kincaid Grade Level function in Microsoft Word. The survey was found to have a reading grade level of 9.8 and a reading ease of 51.7, and was considered appropriate for the target audience, given all respondents had completed high school.

3.2.3.4. Questionnaire Format

The final survey instrument is provided in Appendix A. Three eligibility questions were asked at the start of the survey. These forced response (yes/no) questions consisted of consent to complete the survey, age, and location of residence. The survey directed ineligible participants to the end of the survey and thanked them for their time.

The items took a number of different forms, and covered several domains including demographics, recreation activities, attitudes (primarily the HBM factors), and recreation policy support. The survey primarily took the form of closed questions; where relevant, however, opportunities for open-ended responses were provided to gain further detail and/or clarification from respondents. Most of the questions required a response to enable progression through the questionnaire; a 'prefer not to say' option was provided for sensitive demographic questions in order to promote maximum responses while avoiding missing data. The presentation order of the questions was the same for all participants, although some questions were only presented based on previous responses.

Responses to questions relating to the HBM factors were captured using a five-point Likert scale with response options Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4) and Strongly Agree (5). Some items were worded in reverse to control for response bias. The NEP subscale used a five-point Likert scale — Strongly Disagree (1), Disagree (2), Unsure (3), Agree (4) and Strongly Agree (5). In contrast, the policy support questions were presented as a four-point Likert scale, with options of Definitely No (1), Probably No (2), Probably Yes (3) and Definitely Yes (4). No neutral point was provided for those questions in order to force respondents to choose whether to support a policy option (Chyung et al. 2017).

3.2.4. Dissemination Procedure

Approval to conduct the study was provided by the Human Research Ethics Committee of the University of Newcastle (Approval H-2019-0218); a copy of the approval is provided in Appendix B. Data were collected between September and October 2019.

Survey dissemination was undertaken via three key methods. Information was provided on the water utility's community engagement web page, which provides details of the utility's projects. A random selection of people on the utility's email list (people who had previously contacted the utility for an inquiry or complaint) were directly invited to participate in the study via an email from the utility. In addition, the survey was advertised through social media channels, primarily via a water utility employee posting on a social media page dedicated to residents of Medowie, which is one of the closest settlements to the main water storage in the region, and the source of recent enquiries about permissible recreation activities on the storage. Due to the methods of dissemination, a response rate could not be calculated.

Each dissemination method invited interested parties to follow a link to the study Information Statement (provided in Appendix A), which was hosted on the LimeSurvey platform. The Information Statement described that the survey was anonymous, and that, at the completion of the survey, participants had the option to enter a draw to win a prize if they chose. Entry into the prize draw required participants to provide contact details, but participants were advised that the contact details would be collected through a separate survey, and could not be linked to their responses. The prizes consisted of two iPad minis and five $50 electronic gift cards.

While there is conflicting evidence regarding the effectiveness of engagement with online surveys, response rates appear to be increasing over time using this method (Blumenberg and Barros 2018), which is to be expected as the community becomes more familiar with online platforms and the proportion of the community with access to the internet continues to increase. It is noted that a low response rate does not necessarily result in a biased sample (Groves, 2004; cited in Blumenberg and Barros, 2018). Further, concern about participation of online surveys is often associated with under-representation of older age groups; the demographic data of this survey, however, indicated strong representation by older age groups (70 years and above) as shown in Section 3.2.6.

3.2.5. Data Processing

Participants were checked for eligibility prior to analysis, with non-eligible data removed. Eligibility was checked through checking age (18 years and over), postcode of residence (located within the water utility's area of operations), and full completion of the survey (that is, only data from participants who completed the survey were used).

3.2.6. Participant Demographics

A total of 613 people attempted the survey. Of those, 477 participants completed the full questionnaire. Following error checking and removal of people who did not meet the eligibility criteria, the final sample size was 454. This sample size was sufficient for the modelling and descriptive analyses reported in Chapter 4 and Chapter 5.

A summary of the main demographic characteristics of the sample is provided in Table 2. As shown, the sample was skewed towards older age groups, and there were more male (58%) than female (41%) respondents. Nearly all respondents had completed some form of tertiary education, with university graduates comprising nearly half the sample (46%), and trade or TAFE qualifications reported by a further 42% of respondents. A quarter (24%; N = 107) of respondents chose to not specify an income level, but the ones who did were relatively evenly distributed across the income categories.

When separated into the six LGAs within the study area, the greatest number of respondents lived in Lake Macquarie (36%; N = 164) and Port Stephens (21%; N = 95). Respondents living within the LGAs containing the drinking water catchments (Port Stephens and Dungog) formed a quarter (24%; N = 110) of the sample.

Table 2: Demographic Characteristics

Characteristic	N	%	Characteristic	N	%
Gender			**Location of Residence (LGA)**		
Female	186	41	Cessnock	81	18
Male	264	58	Dungog	15	3
Prefer not to say	4	1	Lake Macquarie	164	36
Age (years)			Maitland	13	3
18 - 24	3	1	Newcastle	86	19
25 - 29	9	2	Port Stephens	95	21
30 - 39	60	13	**Length of Residence (years)**		
40 - 49	77	17	< 5	28	6
50 - 59	90	20	5 - 10	57	13
60 - 69	114	25	11 - 20	96	21
70 - 79	85	19	20+	273	60
80+	15	3	**Country/Region of Birth**		
Prefer not to say	1	0.2	Africa	1	0.2
Personal Annual Pre-Tax Income			Asia	7	2
Less than $20,000	35	8	Australia	375	83
$20,001 - $40,000	58	13	Europe	13	3
$40,001 - $70,000	88	19	New Zealand	9	2
$70,001 - $100,000	68	15	North America	4	1
$100,001 - $150,000	72	16	South Africa	3	1
More than $150,000	26	6	South America	2	0.4
Prefer not to say	107	24	United Kingdom	28	6
Highest Education Level			Not specified	12	3
High School	47	10	**Town Water Connection**		
Trade/ apprenticeship	36	8	Yes	443	98
TAFE certificate or diploma	155	34	No	8	2
University undergraduate degree	106	23	Don't Know	3	0.7
University postgraduate degree	103	23			
Prefer not to say	6	1			
Other	1	0.2			

The majority of respondents (81%; N = 369) indicated they had lived in the lower Hunter Region for 11 or more years, with 60% (N = 273) of respondents having lived in the region for 20 or more years. Nearly all respondents were connected to the town water supply (98%; N = 443), and were born in Australia (83%, N = 375); as such, comparison of groups based on those parameters was not feasible. Overall, the sample reflected a diverse group of respondents, representing both genders, different geographic areas in the catchments, and a broad range of demographic groups. It was noted, however, that males and people living inside the LGAs containing the catchments were over-represented. As a result, the survey data were considered sufficient to explore factors affecting policy support, but caution was used in interpreting the results in relation to the types of recreation policies acceptable to the community.

3.2.7. Data Analysis

The two demographic categories assessed for group differences were gender and proximity of residence to catchments. Postcode data were used to identify the locations of participants' residences. As some postcodes cover large geographical areas, participants' proximity to the catchments was determined using the LGA of the postcodes. As noted previously, the catchments are contained within two of the six LGAs within the study area (Port Stephens and Dungog); respondents living in these two LGAs were allocated to the Near group, with the others allocated to the Far group (76%; N = 344).

The Partial Least Squares Structural Equation Modelling (PLS-SEM) reported in Chapter 4 was undertaken using the SmartPLS3 program (Ringle et al. 2015). Statistical significance testing reported in Chapter 5 was performed using JASP 0.12.2. Further details of these analyses are provided in the following sections.

3.2.7.1. Structural Equation Modelling (SEM)

SEM was used to determine whether the HBM could explain the variance in recreation policy support in the sample by analysing relationships between the HBM constructs (the latent variables) and their relationships to the outcome variable, Policy Support. The benefits and processes of SEM are described in the following sections.

Benefits of Structural Equation Modelling

SEM is a second-order, or second generation (2G), statistical technique that is used to describe complex relationships between multiple independent and dependent latent constructs. The benefits of using 2G methods over first-order (1G) statistical methods, such as analysis of variance and regression, include the ability to:

- Assess latent variables measured by multiple indicators (Hair et al., 2017);
- Model multiple dependent and independent variables simultaneously (Lowry and Gaskin 2014);
- Include constructs measured with multiple or single indicators (Hair et al., 2017);
- Work with continuous, ordinal and binary data (Hair et al., 2017);
- Assess the mediating and moderating effects of variables (Lowry and Gaskin 2014);
- Account for measurement error within the variables (Hair et al., 2017);

- Estimate the relationships within causal networks simultaneously and independently, providing a more realistic assessment of the combined, co-dependent relationships between multiple latent variables and across multiple groups (Lowry and Gaskin 2014); and
- Concurrently assess measurement (data) and theory (proposed relationships among variables, represented by the model structure) (Lowry and Gaskin 2014).

It is important to note that 2G techniques do not establish causation, since they cannot establish the temporal precedence and isolation requirements of causation. Such techniques, however, do represent the causal links, or associations (the third requirement for causation) between variables, better than 1G techniques (Lowry and Gaskin 2014).

As described in the Literature Review (Chapter 2), the exploration of causal pathways between the HBM variables is important for understanding the utility of the model for predicting behaviour. The ability of SEM to assess the influence of variables both individually and collectively, and to identify collinearity issues between variables, addresses many of the issues raised in the HBM meta-analyses discussed in the Literature Review.

Types of Structural Equation Modelling

There are two types of SEM, which are undertaken using different software and calculations, and using differing assessment criteria. The most commonly used technique is covariance-based (CB-SEM), which is typically used for confirmatory testing of hypotheses and concepts from well-established empirical research. In contrast, partial least squares SEM (PLS-SEM) is a primarily exploratory technique, which is used to explore or develop theories by identifying trends and patterns in data (Hair Jr et al. 2017), and provides greater flexibility in exploring associations between variables (Lowry and Gaskin 2014). PLS-SEM generally produces model estimates with greater statistical power than CB-SEM and, therefore, is considered better at identifying relationships in population data (Hair Jr et al. 2017). Further, PLS-SEM does not require the data to have a normal distribution (Lowry and Gaskin 2014).

This study investigated the HBM in a previously unexplored context. As the purpose of this study was for theory development and exploration, and the data were not normally distributed, PLS-SEM was considered the more appropriate technique. PLS-SEM was used to identify which, if any, of the constructs examined in this study had explanatory power in relation to policy support, and to explore the interrelationships between the modelled variables (constructs).

Data for the study were collected using the modified, previously published, survey instrument described in Section 3.2.3. Studies involving the creation or modification of questionnaires often include techniques such as Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) to validate the survey instrument; these, however, are not necessary steps in PLS-SEM. Assessment of the measurement model in PLS-SEM includes extensive testing of the validity and reliability of indicators and constructs through a confirmatory composite analysis (CCA), which is analogous to conducting a CFA, although yields different results since PLS-SEM assesses the variables in the context of the model rather than just the factor structure. As such, a separate CFA is not part of the PLS-SEM process, and was not undertaken for this study.

While EFAs are typically used for the assessment of constructs not previously tested to reduce the number of items and/or factors within the data, they are not necessary for PLS-SEM where the constructs are clearly defined[13], and the relationship between the indicator and the construct is determined as part of the measurement model assessment. Further, the CCA process used in PLS-SEM is considered more accurate than the techniques used in regression and EFA techniques (Hair et al. 2020, p108). As such, the PLS-SEM process achieves the same aims of item and factor validation as the EFA and CFA processes, albeit differently, and arguably with better accuracy (depending on the purpose of the study). Finally, separate samples are required for EFA and CFA/PLS-SEM analysis, with split-samples not recommended[3] when the representativeness of the population in the sample is unknown. As the purpose of the study was to investigate the potential use of the HBM to predict policy support rather than the development of a survey instrument, and the undertaking of an EFA would require the collection of a separate sample, an EFA was not undertaken in this study.

Tests of Normality

Much of the data validation required for PLS-SEM is undertaken through review of calculations made by the modelling program. While PLS-SEM is a non-parametric method of statistical analysis and, therefore, does not require data to be normally distributed, data that fall well outside the range of normality may affect the standard errors calculated during the bootstrapping calculation process used to test statistical significance. Such data, subsequently, may increase the risk that significant relationships will be found to be non-significant (Hair Jr et al. 2017). Such a risk can be decreased to an extent through the use of bias-corrected and accelerated (BCa) bootstrapping methods (Hair et al. 2019), which were used in this study. It is prudent, however, to assess the normality of data prior to proceeding to modelling. For PLS-SEM, guidance recommends using skewness and kurtosis values to assess normality rather than tests such as the Kolmogorov-Smirnov and Shapiro-Wilks tests, as the latter are not considered applicable to non-parametric assessments using bootstrapping (Hair Jr et al. 2017).

Skewness is a measure of the symmetry of a variable's data distribution, while kurtosis is a measure of whether there are outliers in the data. Various authors propose different criteria for skewness and kurtosis. The standard guidance indicates that both parameters should fall within the range of -1 to +1 to be considered normal (Hair Jr et al. 2017). For SEM, however, some suggest that skewness values between $\pm$3 and kurtosis values between $\pm$10 are acceptable (Griffin and Steinbrecher 2013). Kim (2013) notes that tests of normality may be unreliable for

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[13] https://forum.smartpls.com/viewtopic.php?p=23360#p23360; accessed 1/10/2019

samples larger than 300 (Kim 2013), and cites guidance from West et al. (1995) which proposes that skewness values outside the range of ±2 and kurtosis values outside the range of ±7 represent non-normal data.

It should be noted that the data used in the model were captured using Likert scales. While the five response options used in the scale for the HBM predictor variables formed a quasi-continuous variable for the purpose of regression-type statistics, the fundamentally discrete and bounded nature of the data means that true normality cannot occur. Further, the lack of a neutral point for the behaviour variable (policy support), which was done in order to force respondents to choose between supporting and not supporting each policy, further affected the continuity of the scale. A more lenient range of acceptability, therefore, was considered appropriate for this study. West et al.'s criteria of ±2 for skewness and ±7 for kurtosis were adopted, therefore, for determining non-normality of the data (West et al. 1995).

Assessment Criteria

Assessment of the data used in SEM is extensive and is a fundamental part of the modelling process. Details of the assessment criteria used for the modelling are provided in Chapter 4 with the modelling results. Table 3 summarises the key assessment parameters used.

Table 3: PLS Structural Equation Modelling Assessment Criteria

Measure	Acceptable Values
Measurement Model	
Indicator loadings	> 0.70; values 0.40 – 0.70 assessed individually
Internal consistency reliability – rho A	0.60 – 0.95
Convergent validity – Average Variance Extracted (AVE)	min. 0.5
Discriminant validity – Heterotrait - Monotrait (HTMT) Ratio	max. 0.9
Structural Model	
Collinearity – Variation Inflation Factor (VIF)	≤ 3
Coefficient of Determination, R^2	≥ 0.4
Predictive Relevance, Q^2	> 0

Interpretation of structural equation models is undertaken in a similar fashion to multiple regression analysis, with path coefficients representing the strength and direction of the relationships between constructs, although the explanatory power of the model is the focus rather than the fit indices (Chin 2010). When model paths are determined to be statistically significant, the null hypothesis is rejected, and the data are considered to indicate support for the theoretical proposition tested by the hypothesis (Lowry and Gaskin, 2014).

3.2.7.2. Descriptive and Significance Statistics

Given the conflicting evidence in the literature regarding the influence of some of the study variables on policy support, the additional analyses in this study were primarily exploratory and descriptive. Quantitative analyses were undertaken to investigate the relationships between demographic and other personal characteristics (such as age, income, gender, education level, location of residence, recreation preferences) and support for recreation policies, with non-parametric statistical testing used to test group differences where feasible and appropriate. Details of the data processing and analyses are provided in the following sections.

Quantitative descriptive analyses were undertaken to investigate the relationships between socio-demographic variables and support for catchment protection policy. These consisted of comparing percentages of responses between groups.

For the recreation policy support questions, responses of Probably Yes and Definitely Yes were taken as support for a policy, and responses of Probably No and Definitely No were classified as opposition to the policy. Majority agreement was classified as 50% or more of a group agreeing with a statement.

Typical statistical testing, such as t-tests, require the data to be normally distributed, and for groups to have relatively equal sizes and variance (Goss-Sampson 2020). The data were not normally distributed as demonstrated by Shapiro Wilks tests[14], and the groups had unequal variance (demonstrated by Levene's tests) in many cases. Further, the group sizes were frequently very different. Significance testing, therefore, was undertaken using non-parametric tests, specifically the Mann Whitney *U* and Chi-squared tests, to determine whether there were significant differences between groups in, respectively, latent factors and policy support. Statistical significance tests were performed using JASP 0.12.2. Further details of the statistical tests are provided in the following sections.

Mann-Whitney *U* test

The Mann-Whitney *U* test was used to determine whether groups differed in response to the latent variables explored in the study, particularly the HBM factors and worldview. The Mann-Whitney *U* is the non-parametric equivalent of an Independent Samples t-Test, and tests whether two groups are different without requiring the data to be normally distributed or have homogeneity of variance. The test compares ranked data for the dependent variable (Brace et al. 2018). This test was used to determine group differences in their latent variable sum scores.

While parametric tests are generally considered to have greater statistical power (that is, greater ability to uncover true statistical differences between samples) than non-parametric tests (Campbell and Swinscow 2011), the Mann-Whitney *U* has more power for skewed distributions (De Winter and Dodou 2010). It is noted that the Mann-Whitney *U* is a more conservative test than the Independent Samples t-test; that is, a t-test would likely yield stronger significance and

[14] Considered appropriate for those analyses, as, unlike the PLS-SEM, the techniques do not use bootstrapping

greater effect sizes when used on the same data. As such, the Mann-Whitney *U* test is expected to have a lower likelihood of indicating a significant difference when one does not exist. While the Mann-Whitney *U* test is not constrained by a minimum sample size, the small number of respondents in some groups suggests that caution should be applied when making inferences about the group differences.

The rank-biserial correlation, r_B, was used as a measure of effect size for the Mann-Whitney *U* tests as per Goss-Sampson (2020). Values less than 0.1 were considered trivial; values between 0.1 and 0.3 corresponded to small effect sizes; values between 0.3 and 0.5 corresponded to medium effect sizes; and values larger than 0.5 were interpreted as large effect sizes.

Chi-squared tests of significance (χ^2)

The chi-squared test compares the expected and observed frequencies of data in mutually exclusive categories. For this study, participants were grouped by gender, proximity of residence to catchments, and worldview. Chi-squared tests were used to determine whether there were significant differences between groups in terms of their support for the different recreation policy options. Tests were undertaken by comparing the number of people in each group who supported a policy (responses of probably/definitely yes) and the number of participants not supporting the policy (responses of probably/definitely no) as previously described.

3.2.8. Summary

A questionnaire from a previously published study was modified to focus on the HBM variables. Following pilot testing, data were collected from the population of the lower Hunter Region of NSW via an online survey. The data analysis consisted of testing the HBM as a model of recreation policy support using PLS-SEM, significance testing of group differences (Mann Whitney *U* and chi-squared tests), and descriptive statistics (percentage comparisons).

Chapter 4 describes the modelling work, including assessment of the measurement and structural models and the findings. The model findings are expanded in Chapter 5, where significance testing and descriptive statistics are used to further elucidate the findings from the PLS-SEM, and add greater insight into the key variables affecting policy support.

Chapter 4. The Health Belief Model as a Model of Recreation Policy Support

Chapter 4

Glossary

A variety of terms are used to label and describe different model components and processes associated with Structural Equation Modelling (SEM). Some of the common terms are described below. A visual depiction of the key components of a model is shown in Figure 3.

Blindfolding: a sample re-use technique involving the systematic removal of data points and subsequent prediction of those data points by the model to estimate the model's ability to predict data not included in the sample.

Bootstrapping: a non-parametric technique used to assess statistical significance. The procedure runs the model repeatedly with varying random sub-samples of the data set to derive confidence intervals and standard errors for the model estimates.

Constructs (latent variables): A variable that is abstract and complex, and cannot be observed or measured directly, but can be inferred through capturing responses to a number of related manifest (observable) variables, such as indicators. Constructs are represented in path models as circles/ovals.

Endogenous variable: In SEM, endogenous variables are constructs with one or more incoming relationships in the structural model (i.e. a path exists from another construct to this construct). They are represented in models as having an arrow from another construct leading to them. Endogenous variables can serve as dependent or independent variables in a structural model (that is; they can be predicted by constructs, and predict other constructs).

Exogenous variable: Constructs that only explain other constructs; that is, they serve as independent variables in a structural model. Exogenous variables are represented in structural models as constructs with arrows only leaving them.

Formative Measures: The indicators form, or cause, the construct; represented by arrows that lead from the indicators to the construct.

Heterogeneity: Condition where groups have different characteristics or values.

Homogeneity: Condition where groups are essentially alike.

Indicators (items): Directly measured, or manifest, variables; e.g. responses to individual survey questions, which represent the constructs. Indicators are represented as rectangles in path models.

Measurement Model: The part of the structural equation model linking indicators and their constructs. Also called the outer model.

MICOM Procedure: Measurement Invariance of Composite Models Assessment; test to assess the invariance of measures across different groups to determine whether the data can be pooled (are homogenous).

Multigroup Analysis (MGA): Test to determine whether model parameters from two groups are significantly different.

Reflective Measures: Indicator measures are caused by, or reflect, the construct being investigated; they reflect the effect of the construct. Represented in SEM by arrows leading from the construct to the item.

Structural Model: The part of the structural equation model showing theoretical or conceptual relationships between constructs. Also called the inner model.

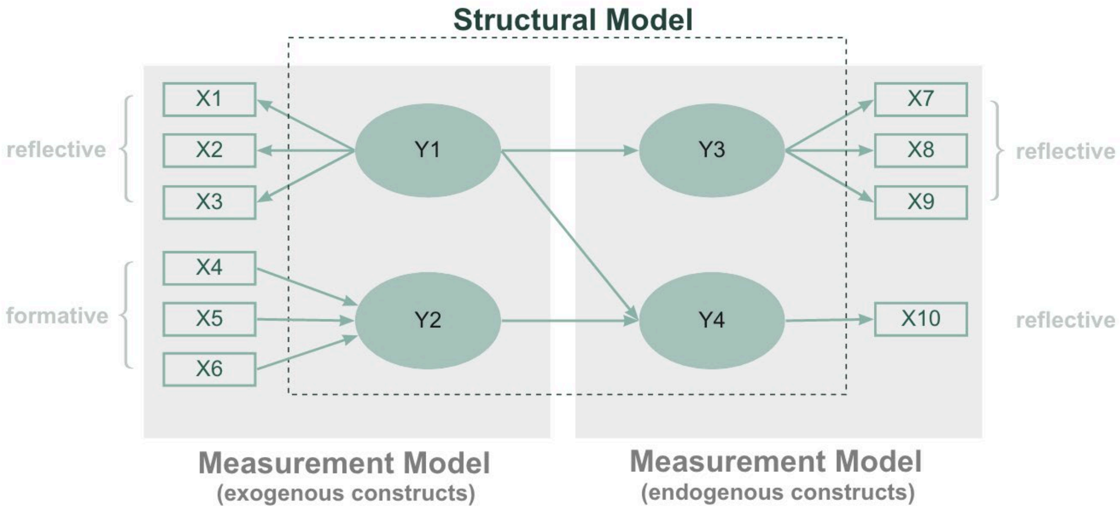

Figure 3: Model Components

(Modified from source: Hair Jr et al., 2017, p12)

4.1. Chapter Overview

Understanding the drivers behind policy support in the community is critical for gaining community support for disaster- and health-risk reduction activities. The purpose of this chapter was to investigate the efficacy of a potential model of policy support in explaining one particular case of policies that reduce both disaster and public health risk — policies relating to recreation in catchments.

Recreation restrictions in catchments implemented by water managers are based on the potential risk of those activities to water quality and, subsequently, to human health. As described in Chapter 2, recreation poses risks to water quality in a number of ways, with the greatest risk being the release of pathogens into waterways. While water treatment processes can improve water quality and reduce the risk of disease, they cannot remove all contaminants or contamination, and are not fully effective at all times, which is why most Australian metropolitan water utilities restrict or prohibit recreation in, on, and/or near their drinking water storages and catchments (Miller et al. 2006). This precautionary approach also serves to mitigate disaster risk and increase community resilience. Given that most metropolitan water managers in Australia with restrictive recreation policies are experiencing increasing pressure to permit or expand access to their catchments for recreation, it is important to gain an understanding of the factors influencing people's policy support, and the segments of the community that do not support restrictive recreation policies, so that interventions might be designed to increase policy acceptance.

The Literature Review (Chapter 2) determined that policy support is a complex phenomenon, influenced by a variety of factors. Risk perception emerged as a key potential influence on policy support, as did certain personal and demographic characteristics. The review identified the Health Belief Model (HBM) as a theoretical framework with the potential to explain policy support; the review also ascertained a potential model structure to explain the relationships between the model's constructs.

This chapter explores the use of the HBM as a model of policy support for the case of recreation policy in catchments through the technique of partial least squares structural equation modelling (PLS-SEM). In the next section, this approach is justified and described, and the study hypotheses are specified. The chapter then describes the modelling method (Section 4.2) and results (Section 4.3), and concludes with a discussion of the findings (Section 4.4).

4.1.1. Study Approach

The Literature Review determined that the HBM is a useful framework for explaining health-related behaviours. Issues identified with much existing research included: the lack of definition or assessment of relationships between model constructs; the potential obfuscating effect of including variables additional to the core HBM constructs; and the lack of research assessing the usefulness of behavioural models in the context of anthropogenic hazards.

This study addressed the first two issues by using a path analysis technique — PLS-SEM — to assess the relationships between the core variables of the HBM (Perceived Susceptibility, Perceived Severity, Perceived Benefits, Perceived Barriers) and the behaviour of interest (Policy Support). Perceived Susceptibility and Perceived Severity were conceptualised as exogenous variables influencing the perceived threat variable of Recreation Risk; this approach has been used previously in the environmental health domain (Akompab et al. 2013, Ejeta et al. 2016, Lindsay and Strathman 1997, Straub and Leahy 2014). Further, the causal pathway of Perceived Barriers to behaviour via Perceived Benefits identified by Jones et al. (2015) was explored using Perceived Benefits both as a mediating variable for Perceived Barriers and an independent predictor of behaviour. The behaviour assessed in the study was support for policies associated with recreation activities in the catchments; as the contamination of waterbodies potentially caused by recreation is an anthropogenic hazard, this addressed the third issue. The theorised relationships between the constructs of the model are shown in Figure 4.

The definitions of the HBM constructs were taken from the literature (Champion and Skinner 2008, Rosenstock 1966, Skinner et al. 2015) and targeted to relevant aspects of the current study, primarily the perceived risks associated with recreation in catchments and the benefits of, and barriers to, mitigating those risks. For the purpose of the study, the constructs were defined as follows:

- **Perceived Susceptibility (PSUS)** — the belief about the personal likelihood of contracting a waterborne illness.
- **Perceived Severity (PSEV)** — the perceived seriousness of contracting a waterborne illness.
- **Recreation Risk (RR)**; that is, perceived threat — the belief that recreation can introduce contaminants into the drinking water supply, which could adversely affect water quality (and, consequently, public health).
- **Perceived Benefits (PBEN)** — positive features or advantages associated with restriction of recreation in the catchments.
- **Perceived Barriers (PBAR)** — perceived obstacles to restricting recreation in the catchments.

As noted previously, the behaviour measured in the study was **Policy Support (POLSUP)**, which measured whether respondents would or would not be likely to support policies permitting various recreation activities in the catchments. Scores on this construct were coded such that high scores corresponded to support for recreation restriction in the catchments (i.e. lack of support for permitting the activities) and low scores represented high support for permitting recreation. For the other constructs, low scores indicated low levels of the construct and high scores indicated high levels of the construct; responses from reverse-worded questions were recoded to reflect this.

4.1.2. Hypotheses

The hypothesised relationships between the variables of the HBM are shown in Figure 4. Each path in the model represents an hypothesis. As noted above, Policy Support was the measured behaviour.

The hypotheses were as follows:

- H1: Perceived susceptibility will be positively associated with the perceived threat of recreation to water quality (recreation risk).
- H2: Perceived severity will be positively associated with recreation risk.
- H3: Recreation risk will positively influence support for recreation restriction in the catchments.
- H4: Perceived benefits will positively influence support for recreation restriction in the catchments.
- H5: Perceived barriers will negatively influence support for restricting recreation in the catchments.
- H6: Perceived benefits will mediate the perceived barriers to restricting recreation in the catchments.

The Literature Review indicated that gender and proximity of residence to catchments were two variables likely to affect recreation policy support. As such, it was hypothesised that the models would differ for those different groups in the strength of the associations between the HBM variables. These hypotheses were specified as follows:

- H7: The model relationships will differ for the Female and Male samples; and
- H8: The model relationships will differ for people living close to the catchments (Near group) and those living further away (Far group).

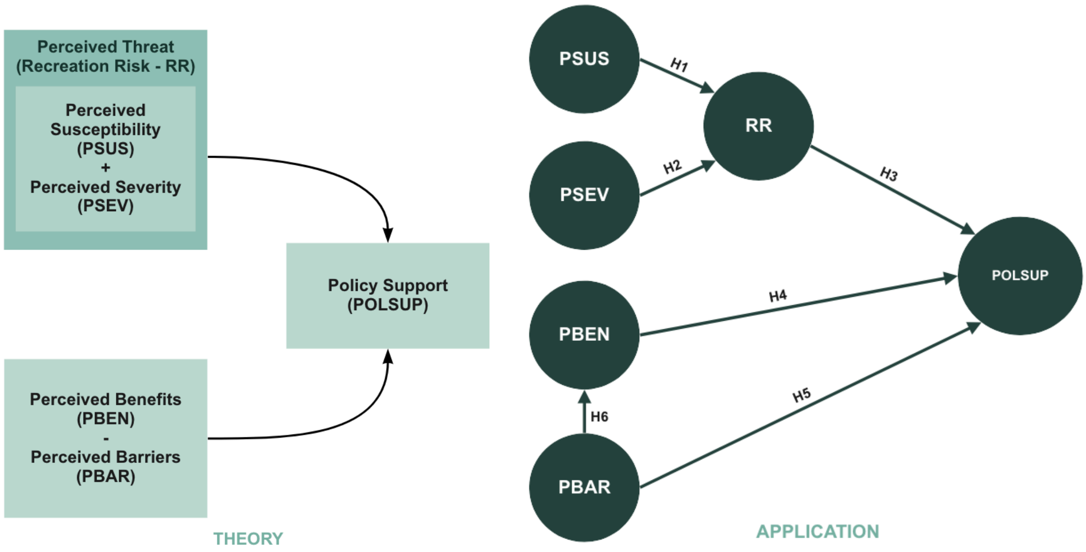

Figure 4: Theory and Application of the Health Belief Model

A description of the data source and assessment criteria for the measurement and structural models is provided in the next section.

4.2. Modelling Method

4.2.1. Data

Data used in the model were collected in the community survey of attitudes to recreation in catchments in the lower Hunter Region of NSW described in Chapter 3. Valid data were obtained from 454 participants; as four people did not specify a gender, and the analyses explored gender differences, data from the 450 participants specifying a gender were used in the modelling. The full questionnaire is provided in Appendix A; the final items retained for the modelling are specified in Section 4.3.2.2.

The HBM construct data were captured on a five-point Likert scale from Strongly Disagree (1) to Strongly Agree (5), while the Policy Support variable was captured on a four-point Likert scale (Definitely No [1], Probably No [2], Probably Yes [3] and Definitely Yes [4]). The lack of a neutral point for the behaviour (policy support) construct was deliberate to force respondents to choose between support and lack of support for each policy. The No Recreation policy option was not included in the modelling as, in contrast to the other policy options, it did not represent a recreation-permitting policy option, and it did not load onto the policy support factor with the other options during the measurement model validation.

4.2.2. Modelling Procedure

A structural equation model comprises two key components: the measurement model, which comprises the data items and the constructs they represent; and the structural model, which describes the theoretical or conceptual relationships between the constructs. Modelling and analyses of the structural and measurement models were undertaken using the SmartPLS3 program (Ringle et al. 2015).

While the SmartPLS3 program calculates parameters for the measurement and structural models simultaneously, the evaluation process is undertaken in two stages. The validity and reliability of the measurement model are first assessed, and modifications are made to indicators associated with constructs if required. Once the measurement model is demonstrated to be acceptable (that is, meets the reliability and validity criteria), the structural model is then assessed to determine whether the theory (the proposed relationships between the constructs) is supported, as evidenced by the strength of the relationships between the constructs (Chin 2010, Hair et al. 2019). The criteria used to assess the measurement and structural models are described in Section 4.2.3.

PLS-SEM is an iterative process, where the measurement model is modified in response to the review of the assessment criteria. Changes can include removal of indicators or constructs from the model, or reallocation of indicators to different constructs.

All constructs in the model were reflective[15], meaning the item responses were considered to be caused by, or to reflect, the construct being investigated. A consequence of the reflective classification is that the definition of the construct does not change when indicators are added or removed, which provides greater flexibility to modify the measurement model in accordance with the findings of the evaluation compared to formative constructs. Once the measurement model was demonstrated to meet the reliability and validity criteria, the face validity of each construct was reviewed by three experienced research professionals to confirm the construct definitions (Section 4.3.2.2) were still appropriate; that is, the constructs and their indicators were reviewed to determine whether they still subjectively seemed to measure what they were intended to measure. The revised constructs were all considered to retain the definitions described in Section 4.1.1. Assessment of the structural model then proceeded, followed by interpretation of the modelling results. The path coefficients represented the strength and direction of the relationships between constructs, while statistically significant model paths indicated support for the hypothesised relationship (Lowry and Gaskin, 2014).

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[15] Verified by James Gaskin, an expert in the field of Structural Equation Modelling, via personal communication

4.2.2.1. Modelling Parameters

All modelling was undertaken using the parameters and settings recommended by Hair et al. (2017). The settings are summarised in Table 4.

Table 4: PLS Algorithm Settings

PLS Algorithm Settings	
Data metric	Mean 0, Var 1
Initial Weights	1.0
Max. number of iterations	300
Stop criterion	7
Use Lohmoeller settings?	No
Weighting scheme	Path
Bootstrapping Settings	
Complexity	Complete Bootstrapping
Confidence interval method	Bias-Corrected and Accelerated (BCa) Bootstrap
Parallel processing	Yes
Samples	5,000
Significance level	0.05
Test type	Two Tailed

4.2.3. Assessment Criteria

As noted previously, the SEM assessment process consists of assessing the measurement model and the structural model. The assessment criteria are described in the following sections.

4.2.3.1. Measurement Model

The measurement, or outer, model in PLS-SEM comprises the indicators (questionnaire items) and their associations with the latent constructs under investigation — that is, the measurement model consists of the questionnaire items grouped into the constructs, and the nature of the relationship between the indicators and their constructs (that is, whether they form the construct or reflect it). In this study, all indicators were reflective, meaning they were caused by the construct rather than forming them. As recommended by Hair et al. (2019), the reflective measurement model was assessed through consideration of indicator loadings, internal consistency reliability, convergent validity and discriminant validity.

Internal consistency reliability and convergent validity assess the overlap in variance between constructs to determine whether the constructs are conceptually distinct (Chin 2010). This is achieved by determining whether the relationship between a construct and its indicators is stronger than the relationship with other constructs and indicators, as indicator loadings should be highest on the construct they are intended to measure. The assessment criteria for the measurement model are described below.

Indicator Loadings

In PLS-SEM, the outer indicator loading represents the contribution of an indicator to the construct to which it is believed to represent, and is known as Indicator Reliability. Technical guidance recommends retaining indicators with loadings greater than or equal to 0.708, which equates to the construct explaining more than half of the variance in an indicator (as the square of the loading represents variance). In practice, a criterion of 0.7 is typically adopted (Hair Jr et al. 2017).

It is noted, however, that weaker outer loadings are often found in studies using newly developed (or modified) scales (Hair et al., 2017), and that removal of all items with lower loadings can adversely affect a construct's content validity (which relates to whether all aspects of the construct are adequately addressed). As such, Hair et al. (2017) recommend that removal of indicators with loadings between 0.4 and 0.7 be considered only if this action leads to an increase in either the Composite Reliability or Average Variance Extracted of the construct above the threshold level (Hair Jr et al. 2017). For this study, all indicators with outer loadings less than 0.4 were automatically removed while indicators with loadings between 0.4 and 0.7 were assessed individually.

Internal Consistency Reliability

Internal Consistency Reliability refers to the level of correlation between different indicators measuring the same construct. Higher values indicate stronger relationships between the indicators and, therefore, greater consistency and reliability.

There are three key statistics for assessing Internal Consistency Reliability — Cronbach's alpha, which is considered the lower bound; composite reliability, which is considered the upper bound; and rho A, which typically falls between the two, and may serve as a good representation of the internal consistency reliability of the construct (Hair et al. 2019). For this study, all three statistics were considered, with rho A serving as the deciding criterion in the case of non-agreement between the three measures. While acceptable values of Internal Consistency Reliability are generally considered to be those falling between 0.7 and 0.95 (Hair et al. 2019), a minimum value of 0.60 is considered acceptable for exploratory research (Hair Jr et al. 2017) like the current study. As such, values of rho A falling between 0.60 and 0.95 were adopted as the ultimate criterion for this study for Internal Consistency Reliability.

Convergent Validity

Convergent Validity assesses the amount of correlation between different items measuring the same construct. As each item in a reflective measure is intended to be a different measure of the same construct, the items should converge; that is, share a high proportion of variance (Hair Jr et al. 2017). Convergent validity for PLS-SEM is assessed through Average Variance Extracted (AVE), which is calculated as the average of the squared loading of each indicator on a construct. The accepted criterion level for AVE is a minimum of 0.50 for all indicators of the construct, which corresponds to the construct explaining at least half the variance of the indicators used to measure it (Hair et al. 2019); this criterion was adopted in this study.

Discriminant Validity

Discriminant Validity refers to the extent to which each construct is truly distinct from other constructs in the model (Hair Jr et al. 2017). The Heterotrait-Monotrait (HTMT) ratio of the correlations is the favoured measure of discriminant validity in SEM (Hair Jr et al. 2017). The HTMT ratio compares mean correlations to the geometric mean of the average correlations for indicators in a construct. For structural models with conceptually similar constructs, a maximum HTMT ratio of 0.9 is recommended, while a maximum value of 0.85 is recommended for models with more distinct concepts. Bootstrapping is also recommended to determine whether the HTMT ratio is significantly different from the maximum value adopted (Hair et al. 2019). A HTMT ratio of 0.9 was adopted for this study as an upper limit to demonstrate Discriminant Validity given the exploratory nature of the study, and that the constructs of the HBM may, in some instances, be conceptually similar (for example, Perceived Susceptibility and Perceived Severity).

Another criterion for Discriminant Validity commonly used is the Fornell-Larcker criterion, which states that the AVE of each construct should be greater than the highest squared correlation of the construct with any other construct (Hair et al. 2011). While this criterion is now considered problematic for discriminant validity assessments (Hair et al. 2019), the Fornell-Larcker values were reported in this study for completeness.

4.2.3.2. Structural Model

Once the measurement model elements have been demonstrated to be reliable and valid, the theory about how those latent variables relate to each other is then tested through investigation of the structural model. The structural, or inner, model of PLS-SEM comprises the theorised relationships between the latent variables, which are represented by the way the variables are linked (Hair Jr et al. 2017), known as the paths. The following sections outline the criteria for assessing the structural model (Hair et al. 2019).

Collinearity — Variance Inflation Factor (VIF)

Collinearity occurs when the different constructs in the model are highly correlated with each other. As the model coefficients are estimated through regression equations in PLS-SEM, high correlation between constructs can result in inflation of the regression coefficients, which can bias the results (Hair et al. 2019). Collinearity, therefore, should be checked before the structural relationships in the model are assessed.

Collinearity is assessed in PLS-SEM through review of the Variance Inflation Factor (VIF), which is calculated through a partial regression process using the latent variable scores of the predictor constructs (Hair et al. 2019). VIF values between 3 and 5 are considered to represent possible collinearity issues, while VIF values greater than 5 represent probable critical collinearity issues

(Hair et al. 2019). As such, VIF values equal to or less than 3 were considered the collinearity criterion for this study. The inner VIF values calculated by the SmartPLS program were used.

Coefficient of Determination (R^2)

The Coefficient of Determination, R^2, measures the variance explained by the predictor constructs for each of the endogenous constructs. As such, R^2 is considered to represent the explanatory power, or in-sample predictive power, of the model (Hair et al. 2019), or how well the model explains the sample data used. R^2 values range between 0 and 1. While higher values indicate greater explanatory power, values of 0.9 or higher may suggest model overfit; that is, that the regression model is reflecting the sample noise rather than the population trend (Hair et al. 2019).

There are no specific criteria for adequate values of R^2 for most disciplines. Values of 0.75, 0.50 and 0.25 are considered, respectively, substantial, moderate and weak in the context of marketing studies (Hair Jr et al. 2017), while values of 0.10 are considered acceptable in some disciplines, such as predicting stock returns (Hair et al. 2019). As R^2 values increase with increasing numbers of predictor constructs included in the model, interpreting R^2 in relation to the results of similar studies with similar model complexity is recommended (Hair et al. 2019).

The published research involving the HBM and SEM in the environmental and disaster fields was reviewed. The most relevant studies had R^2 values ranging from 0.41 to 0.67 (Bakhtiyari et al. 2017, Ejeta et al. 2016, Rezaei and Mianaji 2019, Savari et al. 2021, Tajeri moghadam et al. 2020, Yazdanpanah et al. 2021a, Yazdanpanah et al. 2021b, Zobeidi et al. 2021). As such, R^2 values for policy support in the order of 0.4 and higher were considered to represent a model with appropriate explanatory power for this study.

Predictive relevance (Q^2)

Predictive relevance, Q^2, is a measure of the accuracy of predictions of the path model, and is used to measure the out-of-sample predictive ability of the model (Hair et al. 2019). The statistic is calculated using a blindfolding procedure, which is a sample re-use technique where data points are removed from the data set systematically and, subsequently, are predicted by the model. Bootstrapping is undertaken to run the model a number of times, with different data points removed each time. The omission distance, *D*, indicates the amount of data to be removed, with recommended values between 5 and 1; *D* is selected such that the sample size divided by *D* does not result in an integer to ensure the bootstrapping procedure selects new data every run (Hair Jr et al. 2017). A *D* value of 5 was used in this study, which resulted in 20% of the data being removed each run.

The exogenous constructs are considered to have predictive relevance for the endogenous construct being assessed when Q^2 is greater than zero. Higher values indicate higher predictive accuracy of the model, with values higher than 0, 0.25 and 0.50 generally considered to represent small, medium and large predictive relevance, respectively, of the path model (Hair et al. 2019).

Effect size, f^2

The effect size, f^2, refers to the importance of a predictor for an endogenous construct's R^2 value, and is typically similar to the path coefficient size in predicting importance, unless partial or full mediation is present (Hair et al. 2019). Values of f^2 of 0.02, 0.15 and 0.35 correspond to small, medium and large effect sizes, respectively (Hair et al. 2019).

Indirect and Total Effects

Small path coefficients may be statistically significant, but not necessarily important; assessing the total effects can help identify which relationships are potential targets for action (Hair Jr et al. 2017). Relationships between variables can be direct or indirect (that is, exert an effect through an intervening construct). The total effects analysis assesses the relevance of significant relationships by summing the direct and indirect effects of all variables, and is particularly useful when exploring mediation pathways. The total effect indicates how strongly a construct ultimately influences the target variable. More information regarding mediation is provided later in this section.

Statistical Significance and Relevance of Path Coefficients

The path coefficients of the structural model represent the strength of the relationships between the constructs that are joined by the paths, with larger coefficients representing greater effects on the endogenous latent variable. These coefficients correspond to the standardised beta values calculated in a regression analysis (Hair Jr et al. 2017).

The significance of the path coefficients is assessed using the *p* value (values <.05 are significant), although bootstrapping with a minimum of 5,000 samples is recommended (Hair Jr et al. 2017), where a path coefficient is significant if the 95% confidence intervals do not contain zero. The Bias Corrected method is recommended for determining the significance of skewed bootstrap distributions (Hair et al. 2019). Larger, significant path coefficients represent a larger contribution of the exogenous construct on the endogenous construct and, therefore, more relevant constructs (Hair et al. 2019).

Moderation

A moderating variable affects the strength and direction of a relationship between two constructs. Categorical moderating variables can be used to separate the sample into subgroups for analysis, with the model run separately for each group and the differences tested for significance (Hair Jr et al. 2017). For this study, gender and proximity of residence to catchments were used as grouping variables. Further information regarding how group differences were assessed is provided later in the document.

Mediation

Mediation occurs when the relationship between two constructs is influenced by another construct. In contrast to a moderator, a mediator explains the relationship between the constructs, and how or why the constructs are related, rather the strength and direction of the relationship. Hair Jr et al. (2017) note the need for strong theoretical or conceptual justification for the exploration of mediation within a model. As described in Section 4.1.1, mediation of Perceived Barriers by Perceived Benefits was explored in this study in response to recommendations and guidance resulting from the HBM meta-analyses reported in the Literature Review.

Review of the direct and indirect effects of the mediating construct determines the type of mediating relationship present (Hair Jr et al. 2017). Complementary mediation occurs when the direct and indirect effects are both significant and in the same direction. In contrast, competitive mediation occurs when both effects are significant but in opposite directions, with the mediator acting as a suppressor variable. Full mediation, or indirect-only mediation, occurs when only the indirect effect is significant, meaning the mediation pathway accounts for the full observed relationship between the two constructs. When the indirect effect is not significant, mediation has not been demonstrated.

Hair Jr et al. (2017) recommend use of bootstrapping of the indirect effect for PLS-SEM to demonstrate mediation; this process has higher statistical power and, unlike other tests, does not assume a normal distribution. Mediation should only be assessed for models meeting the measurement and structural model assessment criteria (Hair Jr et al. 2017).

Model Fit

While assessing model fit (for example, through the standardised root mean square residual, or SRMR) is common in covariance-based SEM, the technique has not been evaluated for use with PLS-SEM. As it may be an inappropriate measure, Hair Jr et al. (2017) state that these criteria should not be reported. SRMR was not, therefore, evaluated in this study.

4.2.3.3. Heterogeneity

While PLS-SEM studies typically report on analyses of full data sets, such action requires prior demonstration that the data are homogenous. Hair et al. (2019) recommend testing for unobserved heterogeneity using the measurement invariance of composite models (MICOM) procedure, which determines whether the data may be distorted by the presence of subgroups within the data that respond differently to the variables compared to the general sample. When theory or data indicate the sample may comprise discrete groups, multigroup or moderator analyses are undertaken. For this study, multigroup analysis (MGA) was undertaken for gender and for the Near and Far catchment groups using the processes specified in Hair Jr et al. (2018).

The purpose of the MICOM and MGA is to demonstrate that differences between estimates for groups are due to true differences in the structural relationships between the groups, and are not the result of differences in interpretation of items, or systematic differences in the way the groups respond to questionnaires, such as a tendency to score towards the centres of scales (Hair et al., 2018). The MICOM and MGA procedures are described in the following sections.

MICOM

The MICOM procedure was developed specifically to test for measurement invariance in PLS-SEM (Hair et al., 2018). When measurement invariance is not present, the modelling results can be misleading, as statistical power and precision of the assessment techniques may be affected (Hair Jr et al. 2018). The three-step hierarchical assessment MICOM process consists of:

- Establishment of configural invariance — establishing that the way the constructs and data are treated does not vary between groups. This consists of: ensuring use of the same indicators, on the same constructs; using the same scoring and coding methods for data for all groups; and using the same modelling parameters. This is established by ensuring all items and paths are the same for each group.
- Assessment of compositional invariance — compositional invariance is established when the correlation between the composite scores of the groups is not statistically significant for each of the model constructs. This is undertaken using a permutation procedure, which randomly exchanges observations between the groups; further detail is provided in Hair et al. (2018). Establishment of configural and compositional invariance indicates partial measurement invariance.
- Assessment of the equality of composite mean values and variances — equality is established when there are no significant differences in the mean values and logarithms of variances across the groups. This is again tested through a statistical permutation process.

Demonstration of all three criteria demonstrates full measurement invariance, which means the data can be pooled and assessed as a single group. In contrast, partial measurement invariance means the data should be treated separately; that is, it indicates that there are subgroups within the sample. Where partial measurement invariance is not established, the groups must be assessed separately (Hair Jr et al. 2018).

Multigroup Analysis

If partial measurement invariance has been established, multigroup analysis (MGA) can be undertaken. The purpose of MGA is to determine whether the path coefficients between two groups are significantly different. There are four criteria used to assess multi-group differences, each of which uses bootstrapped results: Bias Corrected Confidence Intervals (if the intervals do not overlap, the path coefficients are significantly different); Partial Least Squares Multi-Group Analysis, which compares the bootstrapped results of the two groups; the Parametric Test, which tests for significant differences between groups assuming equal variances across the groups using a modified t-test; and the Welch-Satterthwaite Test, a non-parametric test of significant differences between groups assuming unequal variances. Hair et al. (2018) recommend use of the PLS-MGA method; all four tests are reported in the chapter, where relevant, for completeness.

4.3. Results

4.3.1. Introduction

An exploration of the potential for Policy Support to be explained by the HBM constructs was undertaken using PLS-SEM. As described in Section 4.1.1, the assessment focused on the core components of the HBM. As noted below, heterogeneity was found in the data, meaning that the full sample data could not be pooled and reported as a single model.

The method used to undertake the modelling, including the assessment criteria adopted for the assessment, is reported in Section 4.2. The model evaluation was undertaken in two-stages, with the validity and reliability of the measurement model first assessed, followed by a review of the structural model to determine whether the theory that Policy Support can be explained by the HBM was supported. Gender and proximity of residence to catchments were found to be potential differentiators of policy support in the Literature Review (Chapter 2), and were explored in this study. The Female and Male samples were found to be heterogenous; models for the two genders, therefore, are reported separately. For the Male sample, a multigroup analysis comparing responses from respondents living inside the catchment LGAs (Near group) and those living outside the catchment LGAs (Far group) is also reported; an insufficient sample size for the Female Near group prevented a similar analysis being undertaken for the Female sample.

The data validation process undertaken prior to modelling is described in the next section (Section 4.3.2). The model for the Female respondents is then reported (Section 4.3.3), consisting of a review of the measurement model parameters, followed by the structural model assessment. The model of the Male respondents is reported in Section 4.3.4, consisting of measurement model review, assessment of the structural model, and assessment of differences between the Near and Far groups. The section concludes with a summary of results (Section 4.3.5). The study findings are discussed in Section 4.4.

4.3.2. Model Data

Data used in the modelling were taken from the survey of lower Hunter residents described in Chapter 3; the demographic characteristics of the data set are provided in that chapter. In summary, data from 450 participants were used in the modelling, consisting of 186 females and 264 males. For the Male model, data from 70 participants formed the Near group and 194 participants formed the Far group. In addition to demographic data, the survey collected data relating to the HBM constructs — Perceived Susceptibility (PSUS), Perceived Severity (PSEV), Perceived Benefits (PBEN), Perceived Barriers (PBAR), Recreation Risk (RR), and Policy Support (POLSUP).

4.3.2.1. Tests of Normality

The data were checked for normality prior to use in the model. While PLS-SEM is not subject to the same constraints of normal data as other methods, extremely non-normal data can pose a risk of Type II error, where significant results are found to be non-significant (Hair Jr et al. 2017). As noted in the Methodology Chapter (Chapter 3), the adopted criteria for skewness (values between $\pm$2) and kurtosis (values between $\pm$7) for this exploratory study were taken from West et al. (1995). The skewness and kurtosis of the items used in the final models reported are presented in Table 5.

Table 5: Skewness and Kurtosis Values of PLS-SEM Indicators

Indicator Code	Skewness	Kurtosis
PSUS2R	0.573	-0.144
PSUS3R	1.41	3.409
PSUS4R	0.005	-0.124
PSEV2	-0.876	1.189
PSEV3	-1.408	2.773
PSEV5N (PSUS1)	-0.407	-0.753
RR1R	-0.371	-0.968
RR2	-0.589	-0.564
RR3	-0.915	0.484
RR4	-0.185	-1.158
PBEN4	-1.244	1.591
PBEN7N (NOTAL1)	-0.729	-0.163
PBEN8N (NOTAL2)	-1.09	0.378
PBAR1	0.529	-0.778
PBAR3	0.227	-0.588
PBAR4	0.194	-1.133
POL2R	-1.204	0.84
POL3R	0.978	0.749
POL4R	0.62	-0.386
POL5R	-0.086	-1.044
POL6R	-0.936	-0.172
POL7R	-1.35	0.998
POL10R	-0.214	-1.387

N.B. Items in parentheses indicate the original indicator names. These names were changed following the initial structural equation modelling assessment, when these indicators were found to fit better with constructs different to those to which they were originally allocated.

The skewness values ranged from 1.41 to -1.408, and, as such, were all within the adopted acceptable range of +2. The kurtosis values were also all within the adopted acceptable range (±7), as they ranged from - 1.387 to 3.409. The data were considered, therefore, to be sufficiently normal for the purpose of this exploratory modelling.

4.3.2.2. Model Constructs and Indicators

The model was run in the configuration shown in Figure 4. As shown, Recreation Risk (perceived threat) was hypothesised to be affected by Perceived Susceptibility and Perceived Severity, and Perceived Benefits was hypothesised to mediate Perceived Barriers.

The model was run with all the relevant indicators allocated to their originally conceived constructs, as well as three indicators that had not been allocated to a construct. The measurement model assessment criteria specified in Section 4.2.3.1 were used to determine whether indicators were retained, removed, or reallocated. One indicator was found to load more strongly onto a different construct from which it was originally allocated (PSUS1) and was, therefore, reallocated; further, two of the previously unallocated indicators (NOTAL1 and NOTAL2) were found to load strongly on the Perceived Benefit construct, and replaced some of the original indicators for this construct.

The final constructs and indicators used in the modelling are presented in Table 6. The face validity of the final constructs was re-assessed by three academics with experience in questionnaire use and design. All agreed that changes to the indicators did not affect the study definitions of the constructs described in Section 4.1.1, and that face validity was retained. Perceived Susceptibility, Perceived Severity, Perceived Benefits and Perceived Barriers were each represented by three items, Recreation Risk by four items, and Policy Support by seven items.

Table 6: Constructs and Indicators used in PLS-SEM

Construct	Indicator Code	Indicator Text
Perceived Susceptibility (PSUS)	PSUS2R	No one gets sick from drinking tap water in this area
	PSUS3R	The local tap water is safe to drink
	PSUS4R	I am less likely to get sick from drinking local tap water than other people in the community
Perceived Severity (PSEV)	PSEV2	Drinking contaminated water would make me very ill
	PSEV3	If something went wrong with the quality of the drinking water, it would be very serious
	PSEV5N PSUS1	If there were contaminants in the local drinking water sources, I would probably get sick
Perceived Benefits (PBEN)	PBEN4	Protecting the drinking water catchments from contamination benefits the community
	PBEN7N *NOTAL1*	I believe Hunter Water should go to any lengths to protect drinking water catchments

Construct	Indicator Code	Indicator Text
	PBEN8N *NOTAL2*	The use of dams for drinking water should always take priority over recreation
Perceived Barriers (PBAR)	PBAR1	There are only a few places people are allowed to go to enjoy their recreational activities
	PBAR3	Recreational activity is being banned in more and more places
	PBAR4	Allowing people to recreate in the restricted catchments is important to me
Recreation Risk (RR)	RR1R	Recreation in drinking water catchments poses very little risk to water quality
	RR2	If recreational access was increased in the restricted drinking water catchments, water quality would probably get worse
	RR33	Recreation in restricted drinking water catchments can contaminate the water supply
	RR4	It is too risky to allow people to recreate close to drinking water dams
Policy Support (POLSUP)	POL2R	All types of recreation
	POL3R	Passive land-based recreation (such as walking and hiking, but not including camping)
	POL4R	Active land-based, non-motorised recreation (such as mountain biking or horse riding)
	POL5R	Camping
	POL6R	Motorised activities on water with no direct water contact (e.g. boating)
	POL7R	Motorised activities on water with direct water contact (e.g. water skiing, wake boarding)
	POL10R	Swimming

*Items ending with R were reverse coded. For the Policy Support construct, low values represented high support for recreation in catchments, and high values represented high support for recreation restriction
Original Indicator Codes are shown in *italics* for items allocated to new constructs

4.3.2.3. Measurement Invariance of Composite Models (MICOM) Procedure

Following assessment of the structural model, the data were checked for heterogeneity using the MICOM procedure described in Section 4.2.3.3. The assessment determined that the composite scores for Female and Male groups were significantly different for Perceived Barriers and Perceived Benefits (refer to Table 7), meaning that compositional invariance was not established; further analyses also resulted in the Male model having one less indicator for the Perceived Susceptibility variable. This meant that the model could not be assessed for the full sample data, and the results of the structural assessment of the full sample model, therefore, are not reported. Further, given the identified heterogeneity, the statistical significance of the gender model differences could not be tested. Separate assessments were undertaken for the Female and Male participant groups separately as described in the following sections.

Table 7: Compositional Invariance – Female and Male Groups

Construct	Correlation *c*	5% quantile of the empirical distribution of *c*	*p* Values	Compositional invariance established?
PBAR	0.996	0.997	.028	No
PBEN	0.998	0.999	.001	No
POLSUP	0.998	0.996	.222	Yes
PSEV	0.994	0.989	.166	Yes
PSUS	0.999	0.978	.722	Yes
RR	1	1	.855	Yes
Data in **bold type** represent significant values				

Heterogeneity between the Near and Far Groups within the Male sample was also assessed. The MICOM procedure determined that partial measurement invariance was established for the Male Near and Far resident groups, enabling comparison of model differences (multigroup analysis) between the subgroups (refer to Section 4.3.4.3). A MICOM analysis could not be run for the Female sample due to the small sample size of the Female Near group; subsequently, multigroup analysis for proximity of residence to catchments was not undertaken for the Female sample.

The assessments of the measurement and structural models for the Female sample are reported in Section 4.3.3. The Male sample assessments are reported in Section 4.3.4.

4.3.3. Females

The Female measurement model was first assessed through examination of the reliability and validity of the constructs and their indicators (Section 4.3.3.1). The assessment of the structural model then proceeded, consisting of evaluation of the theorised relationships between the constructs through assessment of a variety of measures, including collinearity (VIF), the explanatory power of the model (R^2), the predictive relevance (Q^2), effect sizes, and the statistical significance of the path coefficients (Section 4.3.3.2).

4.3.3.1. Measurement Model Assessment

As shown in Table 8, the essential criteria for demonstrating the reliability and validity of a measurement model were all met by the proposed model of policy support (Figure 4) for the Female sample. Three of the loadings fell below the desirable criterion of 0.7: RECPOL2R (All types of recreation), RECPOL3R (Passive land-based recreation) and RECPOL4R (Active land-based, non-motorised recreation). Each recreation option was considered important to retain — All types of recreation generally was not acceptable to the respondents; conversely, both passive land-based and active land-based recreation were both accepted by the majority of respondents. As their loadings were all above the minimum acceptable criterion of 0.4 specified in Section 4.2.3.1, and the explanatory power of the model was greater with their inclusion, they were retained in the study.

The construct reliability was found to be acceptable for all constructs for each of the three assessment measures — Cronbach's alpha, rho A and Composite reliability — with all values falling within the accepted range of 0.6 - 0.95. Convergent validity was also demonstrated for all constructs, with AVE values all greater than 0.5. Discriminant validity of the constructs was demonstrated through the HTMT ratios all being lower than the criterion value of 0.9 (Table 9), and with all values having confidence intervals that did not include 1. Further, all items loaded most strongly onto their assigned construct (Table 10), demonstrating discriminant validity at the indicator level. The Fornell-Larcker criterion was also met for all constructs, with the AVE square roots being larger than the relevant correlations (Table 11). As such, discriminant validity of the constructs and their indicators was established.

The measurement model, consequently, was determined to be valid. The structural model was then assessed as described in the following section.

Table 8: Reliability and Validity Tests – Female Sample

Construct	Indicators	Indicator Reliability	Convergent Validity	Internal Consistency Reliability			Discriminant Validity		
		Outer Loadings	AVE	Cronbach's Alpha	rho A	Composite Reliability	Fornell-Larcker Criterion	Cross Loadings	HTMT
		> 0.70* (0.40 - 0.70 acceptable)	> 0.50	0.60 - 0.95			√AVE > highest correlation	Loading on assigned construct > cross-loadings with other constructs	HTMT confidence interval does not include 1
PBAR	PBAR1	0.85	0.68	0.77	0.80	0.86	Yes	Yes	Yes
	PBAR3	0.78							
	PBAR4	0.85							
PBEN	PBEN4N	0.91	0.77	0.85	0.88	0.91	Yes	Yes	Yes
	PBEN7N	0.81							
	PBEN8N	0.91							
POLSUP	POL10R	0.79	0.53	0.85	0.88	0.89	Yes	Yes	Yes
	POL2R	*0.68*							
	POL3R	*0.52*							
	POL4R	*0.65*							
	POL5R	0.75							
	POL6R	0.84							
	POL7R	0.83							
PSEV	PSEV2N	0.75	0.60	0.67	0.68	0.82	Yes	Yes	Yes
	PSEV3N	0.82							
	PSEV5N	0.76							
PSUS	PSUS2R	0.80	0.57	0.63	0.64	0.80	Yes	Yes	Yes
	PSUS3R	0.73							
	PSUS4R	0.73							
RR	RR1NR	0.89	0.76	0.90	0.90	0.93	Yes	Yes	Yes
	RR2N	0.89							
	RR3N	0.87							
	RR4N	0.84							

Note: Indicators falling outside the normally accepted parameter ranges are *italicised.*
* Recommended

Table 9: Discriminant Validity – HTMT Ratio; Female Sample

	PBAR	PBEN	POLSUP	PSEV	PSUS	RR
PBAR						
PBEN	0.658					
POLSUP	0.630	0.728				
PSEV	0.582	0.786	0.580			
PSUS	0.243	0.256	0.346	0.354		
RR	0.780	0.872	0.752	0.744	0.353	

Table 10: Cross Loadings – Female Sample

Indicators	Constructs					
	PBAR	PBEN	POLSUP	PSEV	PSUS	RR
PBAR1	**0.849**	-0.440	-0.451	-0.296	-0.064	-0.539
PBAR3	**0.776**	-0.333	-0.349	-0.276	-0.031	-0.436
PBAR4	**0.846**	-0.583	-0.523	-0.467	-0.235	-0.638
PBEN4	-0.554	**0.905**	0.637	0.545	0.212	0.734
PBEN7N	-0.358	**0.807**	0.447	0.496	0.164	0.561
PBEN8N	-0.547	**0.910**	0.635	0.544	0.133	0.705
POL10R	-0.511	0.641	**0.791**	0.394	0.217	0.674
POL2R	-0.411	0.511	**0.675**	0.416	0.200	0.485
POL3R	-0.201	0.231	**0.520**	0.162	0.189	0.296
POL4R	-0.310	0.315	**0.653**	0.184	0.269	0.362
POL5R	-0.346	0.410	**0.750**	0.288	0.182	0.402
POL6R	-0.448	0.575	**0.835**	0.433	0.168	0.612
POL7R	-0.455	0.541	**0.831**	0.411	0.119	0.537
PSEV2	-0.346	0.394	0.295	**0.745**	0.211	0.343
PSEV3	-0.308	0.499	0.381	**0.815**	0.079	0.499
PSEV5N	-0.365	0.490	0.404	**0.761**	0.251	0.506
PSUS2R	-0.126	0.178	0.222	0.183	**0.802**	0.234
PSUS3R	0.017	0.091	0.140	0.117	**0.729**	0.142
PSUS4R	-0.186	0.149	0.191	0.198	**0.732**	0.230
RR1R	-0.633	0.699	0.651	0.520	0.209	**0.894**
RR2	-0.545	0.616	0.549	0.567	0.256	**0.886**
RR3	-0.554	0.667	0.568	0.466	0.235	**0.868**
RR4	-0.591	0.704	0.635	0.519	0.270	**0.842**

N.B. Values in **bold** type represent the highest loading of an item on a construct

Table 11: Fornell Larcker Criterion – Female Sample

	PBAR	PBEN	POLSUP	PSEV	PSUS	RR
PBAR	0.824					
PBEN	-0.569	0.875				
POLSUP	-0.548	0.667	0.730			
PSEV	-0.436	0.604	0.473	0.774		
PSUS	-0.152	0.193	0.252	0.228	0.755	
RR	-0.667	0.770	0.690	0.595	0.278	0.873

4.3.3.2. Structural Model Assessment

Assessment of the structural model consisted of review of: collinearity (inner model VIF values); coefficient of determination (R^2); out-of-sample predictive relevance (Q^2); effect sizes (f^2); indirect and total effects; and the statistical significance of the path weights.

Collinearity was assessed through inspection of the inner VIF values. Most VIF values were less than the criterion value of 3 as shown in Table 12; the exception was Recreation Risk on Policy Support, which was slightly higher at 3.038. This value was considered close enough to 3 to indicate that collinearity was not a critical issue in the structural model. Assessment of the structural model, therefore, continued.

Table 12: Collinearity Assessment – Inner VIF Values; Female Sample

	PBAR	PBEN	POLSUP	PSEV	PSUS	RR
PBAR		1.000	1.827			
PBEN			2.492			
POLSUP						
PSEV						1.055
PSUS						1.055
RR			3.038			

The R^2 values, representing the amount of variance explained for each variable, are shown in Table 13. The model explained 53% of the variance in Policy Support (R^2 = 0.530), 38% of the variance in Recreation Risk, and 32% of the variance in Perceived Benefits. The R^2 value of 0.530 for Policy Support was greater than the adopted criterion of 0.4 to represent appropriate explanatory power for behaviour in this study (refer to Section 4.2.3.2).

The accuracy of the path model predictions was then assessed using the Predictive Relevance (Q^2) statistic via a blindfolding procedure with an omission distance (D) of 5. All three endogenous latent variables had Q^2 values between 0.230 and 0.272 (Table 13), which corresponded to a medium level of predictive relevance.

Table 13: Coefficient of Determination (R^2) and Predictive Relevance (Q^2) – Female Sample

	R^2	R^2 Adjusted	Q^2
PBEN	0.324	0.320	0.230
POLSUP	0.530	0.523	0.260
RR	0.375	0.368	0.272

The importance of the endogenous constructs in explaining the variance was assessed through the Effect Size (f^2) statistic (refer to Table 14). As indicated in Section 4.2.3.2, values of f^2 of 0.02, 0.15 and 0.35 correspond to small, medium and large effect sizes (Hair et al. 2019). Large effect sizes were found for Perceived Severity on Recreation Risk (f^2 = 0.476), and Perceived Barriers on Perceived Benefits (f^2 = 0.479). Recreation Risk and Perceived Benefits had small effects on Policy Support, while the effect of Perceived Barriers on Policy Support was not significant. As such, Perceived Severity drove Recreation Risk, and Perceived Barriers strongly influenced Perceived Benefits for the Female sample.

Table 14: Effect Size, f^2 – Female Sample

	PBAR	PBEN	POLSUP	PSEV	PSUS	RR
PBAR		0.479	*0.019*			
PBEN			0.085			
POLSUP						
PSEV						0.476
PSUS						0.034
RR			0.092			

N.B. Values in *italics* represent non-significant results.

The indirect and total effects were reviewed. As shown in Table 15, the indirect effects[16] were all significant, as indicated by the *p* values and confirmed by the confidence intervals achieved using bias corrected bootstrapping.

Table 15: Indirect Effects – Female Sample

Path	Indirect Effect	*t* Values	*p* Values	95% Confidence Intervals (Bias Corrected)	Significant (p<.05)?
PBAR →POLSUP	-0.179	2.785	0.006	[-0.297, -0.05]	Yes
PSEV →POLSUP	0.203	3.497	0.001	[0.104, 0.315]	Yes
PSUS →POLSUP	0.055	2.226	0.026	[0.017, 0.106]	Yes

The total effects (that is, the combined effect of the direct and indirect effects on the endogenous variables) were then assessed (refer to Table 16). Recreation Risk had the strongest total effect on Policy Support (0.363), followed by Perceived Benefits (0.315) and Perceived Barriers

[16] N.B. The Specific Indirect Effects and Total Indirect Effects statistics and confidence intervals were equal.

(- 0.306). Further, Perceived Severity had a very strong influence on Recreation Risk (0.560), which was much greater than the influence of Perceived Susceptibility on Recreation Risk (0.150). Bootstrapping determined that all total effects were significant at the .05 level (Hair Jr et al. 2017).

The mediating effect of Perceived Benefits on the Perceived Barriers construct was then assessed. The indirect effect of Perceived Barriers on Policy Support was significant, indicating that mediation was present. The direct effects of Perceived Barriers and Perceived Benefits on Policy Support were also significant, indicating that partial mediation was established. Perceived Barriers had a negative effect on both Perceived Benefits and Policy Support, while Perceived Benefits had a positive effect on Policy Support. Competitive mediation, therefore, was demonstrated, with Perceived Benefits acting as a suppressor of Perceived Barriers; that is, Perceived Benefits served to reduce the negative association between Perceived Barriers and Policy Support.

Table 16: Total Effects Significance Testing – Female Sample

Path	Total Effect	*t* Values	*p* Values	95% Confidence Intervals (Bias Corrected)	Significant ($p < .05$)?
RR → POLSUP	0.363	3.721	.000	[0.188, 0.549]	Yes
PBEN → POLSUP	0.315	2.617	.009	[0.059, 0.524]	Yes
PBAR → POLSUP	-0.306	3.957	.000	[-0.451, -0.150]	Yes
PSEV → POLSUP	0.203	3.497	.001	[0.104, 0.315]	Yes
PSUS → POLSUP	0.055	2.226	.026	[0.017, 0.106]	Yes
PSEV → RR	0.560	11.86	.000	[0.455, 0.641]	Yes
PSUS → RR	0.150	2.973	.003	[0.045, 0.238]	Yes
PBAR → PBEN	-0.569	10.463	.000	[-0.661, -0.443]	Yes

The statistical significance of the model paths was then assessed using the method specified in Hair Jr. et al. (2017). Most of the path coefficients were significant as shown in Table 17. The significance was confirmed by inspection of the 95% confidence intervals of the bootstrapping confirmed significance (where the intervals did not include 0). The exception was the Perceived Barriers to Policy Support path (p = .063). As such, the hypothesis that Perceived Barriers would have a significant effect on Policy Support was not supported for the Female sample. As the other hypothesised paths were significant, the hypotheses relating to them were supported.

Table 17: Significance of Path Coefficients – Female Sample

Path	Path Coefficient	t Values	*p* Values	95% Confidence Intervals (Bias Corrected)	Hypothesis Supported?
RR → POLSUP	0.363	3.721	.000	[0.188, 0.549]	Yes
PBEN → POLSUP	0.315	2.617	.009	[0.059, 0.524]	Yes
PBAR → POLSUP	-0.126	1.861	.063	[-0.254, 0.007]	No
PSEV → RR	0.56	11.86	.000	[0.455, 0.641]	Yes
PSUS → RR	0.15	2.973	.003	[0.045, 0.238]	Yes
PBAR → PBEN	-0.569	10.463	.000	[-0.661, -0.443]	Yes

4.3.3.3. Summary – HBM for Females

The key model results for the Female sample are shown in Figure 5. All hypothesised paths in the model were significant with the exception of the direct path of Perceived Barriers on Policy Support. While the model had good explanatory power for Policy Support, the effect sizes for Recreation Risk and Perceived Benefits were small in scale. Perceived Benefits significantly mediated the effect of Perceived Barriers on Policy Support. Perceived Severity had much greater influence on Recreation Risk than Perceived Susceptibility.

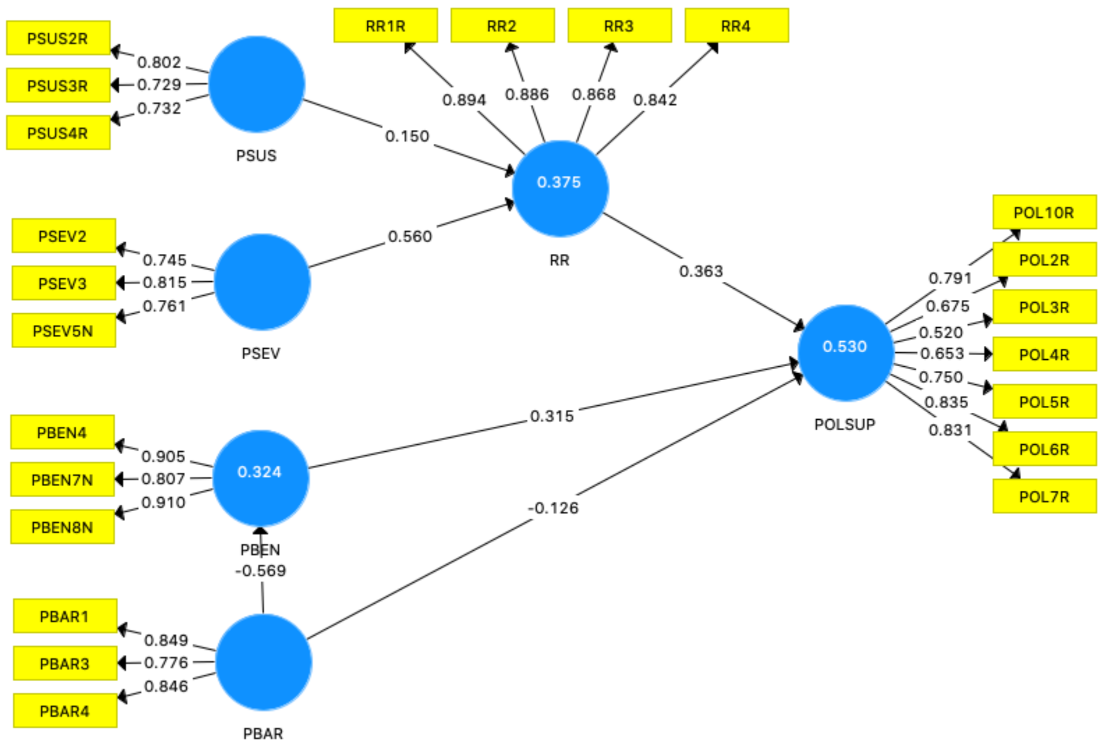

Figure 5: Female Model Summary

R^2 values are shown within the endogenous construct circles. Path coefficients shown for inner (structural) model; indicator loadings shown on outer (measurement) model.

4.3.4. Males

The Male model was assessed using the criteria described in Section 4.2.3. The Literature Review indicated policy support might be influenced by proximity of residence to catchments; this relationship was tested in the model by comparing data for male respondents living inside the LGAs containing the catchments (Near group) to those living outside the catchment areas (Far group). To test for group differences, a MICOM procedure was first undertaken; following the establishment of partial measurement invariance, a multigroup analysis was conducted. Both tests were undertaken using the procedures described in Section 4.2.3.3. MICOM and MGA results are reported after the structural model assessment.

4.3.4.1. Measurement Model

The reliability and validity assessment of the Male sample is shown in Table 18. All indicators and constructs were the same as for the Female model except for the PSUS4 indicator, which only had a loading of 0.375 on the Perceived Susceptibility construct; as this was below the minimum acceptable level of 0.4, this indicator was removed, leaving two indicators representing the Perceived Susceptibility construct for the Male model. As for the Female model, the loadings of RECPOL2R, RECPOL3R and RECPOL4R were below the desirable criterion of 0.7, but were above the minimum acceptable threshold of 0.4, and the explanatory value of the model was greater with their inclusion. These indicators, therefore, were retained. Construct reliability, convergent validity, and discriminant validity were all established as shown in Tables 18 – 21.

Table 18: Reliability and Validity – Male Sample

Constructs	Indicators	Indicator Reliability	Convergent Validity	Internal Consistency Reliability			Discriminant Validity		
		Outer Loadings	AVE	Cronbach's Alpha	rho A	Composite Reliability	Fornell-Larcker Criterion	Cross Loadings	HTMT
		> 0.70* (0.40 - 0.70 acceptable)	> 0.50	0.60 - 0.95 ↔			√AVE > highest correlation	Loading on assigned construct > cross-loadings with other constructs	HTMT confidence interval does not include 1
PBAR	PBAR1	0.85	0.69	0.77	0.77	0.87	Yes	Yes	Yes
	PBAR3	0.84							
	PBAR4	0.81							
PBEN	PBEN4	0.85	0.76	0.84	0.84	0.90	Yes	Yes	Yes
	PBEN7N	0.88							
	PBEN8N	0.89							
POLSUP	POL10R	0.81	0.54	0.86	0.88	0.89	Yes	Yes	Yes
	POL2R	*0.68*							
	POL3R	*0.52*							
	POL4R	*0.68*							
	POL5R	0.80							
	POL6R	0.83							
	POL7R	0.79							
PSEV	PSEV2	0.73	0.58	0.67	0.70	0.81	Yes	Yes	Yes
	PSEV3	0.74							
	PSEV5N	0.82							
PSUS	PSUS2R	0.93	0.78	0.72	0.78	0.87	Yes	Yes	Yes
	PSUS3R	0.84							
RR	RR1R	0.90	0.80	0.92	0.92	0.94	Yes	Yes	Yes
	RR2	0.93							
	RR3	0.86							
	RR4	0.89							

Note: Indicators falling outside the normally accepted parameter ranges are *italicised*
* Recommended

Table 19: Discriminant Validity – HTMT Ratio; Male Sample

	PBAR	PBEN	POLSUP	PSEV	PSUS	RR
PBAR						
PBEN	0.783					
POLSUP	0.734	0.787				
PSEV	0.465	0.799	0.609			
PSUS	0.146	0.179	0.183	0.181		
RR	0.762	0.900	0.809	0.738	0.305	

Table 20: Cross Loadings – Male Sample

Indicators	Constructs					
	PBAR	PBEN	POLSUP	PSEV	PSUS	RR
PBAR1	**0.845**	-0.505	-0.504	-0.265	-0.086	-0.534
PBAR3	**0.836**	-0.537	-0.476	-0.283	-0.111	-0.476
PBAR4	**0.804**	-0.524	-0.534	-0.309	-0.043	-0.584
PBEN4	-0.535	**0.846**	0.596	0.535	0.060	0.682
PBEN7N	-0.564	**0.880**	0.578	0.538	0.178	0.681
PBEN8N	-0.548	**0.886**	0.615	0.539	0.135	0.701
POL10R	-0.589	0.649	**0.807**	0.415	0.122	0.697
POL2R	-0.416	0.534	**0.684**	0.409	0.052	0.494
POL3R	-0.238	0.238	**0.518**	0.239	0.106	0.377
POL4R	-0.399	0.422	**0.675**	0.316	0.154	0.524
POL5R	-0.504	0.472	**0.802**	0.280	0.091	0.504
POL6R	-0.467	0.580	**0.828**	0.395	0.136	0.595
POL7R	-0.448	0.524	**0.794**	0.359	0.071	0.486
PSEV2	-0.183	0.372	0.296	**0.727**	0.081	0.315
PSEV3	-0.305	0.494	0.376	**0.741**	0.025	0.413
PSEV5N	-0.285	0.520	0.398	**0.820**	0.183	0.610
PSUS2R	-0.128	0.145	0.154	0.128	**0.923**	0.257
PSUS3R	-0.024	0.102	0.086	0.123	**0.838**	0.182
RR1R	-0.598	0.696	0.683	0.558	0.222	**0.902**
RR2	-0.603	0.720	0.650	0.593	0.247	**0.932**
RR3	-0.542	0.675	0.608	0.529	0.191	**0.856**
RR4	-0.558	0.741	0.661	0.542	0.250	**0.893**

N.B. Values in **bold** type represent the highest loading of an item on a construct

Table 21: Fornell Larcker Criterion – Male Sample

	PBAR	PBEN	POLSUP	PSEV	PSUS	RR
PBAR	0.829					
PBEN	-0.630	0.871				
POLSUP	-0.610	0.685	0.737			
PSEV	-0.346	0.617	0.475	0.764		
PSUS	-0.096	0.143	0.142	0.142	0.881	
RR	-0.642	0.790	0.727	0.620	0.255	0.896

4.3.4.2. Structural Model Assessment – Full Male Sample

All the Inner VIF values were less than 3.0 (Table 22), indicating that collinearity was not an issue for the Male sample.

Table 22: Collinearity Assessment – Inner VIF Values; Male Sample

	PBAR	PBEN	POLSUP	PSEV	PSUS	RR
PBAR		1.000	1.828			
PBEN			2.857			
POLSUP						
PSEV						1.021
PSUS						1.021
RR			2.932			

The R^2 values, representing the amount of variance explained for each variable, are shown in Table 23. The model explained 58% of the variance in Policy Support (R^2 = 0.582), 41% of the variance in Recreation Risk, and 40% of the variance in Perceived Benefits. As for the Female model, the Male model was considered to have appropriate explanatory power for Policy Support. Table 23 also demonstrates that the model had good predictive relevance, with Q^2 values between 0.297 and 0.325.

Table 23: Coefficient of Determination (R^2) and Predictive Relevance (Q^2) – Male Sample

	R^2 Square	R^2 Adjusted	Q^2
PBEN	0.398	0.395	0.297
POLSUP	0.582	0.577	0.300
RR	0.413	0.409	0.325

The importance of the predictors for the endogenous constructs was assessed through the Effect Size (f^2) statistic (refer to Table 24). As specified in Section 4.2.3.2, values of f^2 of 0.02, 0.15 and 0.35 correspond to small, medium and large effect sizes (Hair et al. 2019). Recreation Risk had a medium effect on Policy Support (f^2 = 0.143), while the effects of Perceived Benefits and Perceived Barriers on Policy Support were small. Very large effect sizes were found for Perceived

Severity on Recreation Risk (f^2 = 0.594), and Perceived Barriers on Perceived Benefits (f^2 = 0.660).

Table 24: Effect Size, f^2 – Male Sample

	PBAR	PBEN	POLSUP	PSEV	PSUS	RR
PBAR		0.660	0.050			
PBEN			0.045			
POLSUP						
PSEV						0.594
PSUS						0.048
RR			0.143			

The indirect and total effects were reviewed. As shown in Table 25, the indirect effects[17] were all significant as indicated by the *p* values and confirmed via bias corrected bootstrapping.

Table 25: Indirect Effects – Male Sample

Path	Indirect Effect	*t* Values	*p* Values	95% Confidence Intervals (Bias Corrected)	Significant (p<.05)?
PSEV →POLSUP	0.250	5.167	0.000	[0.158, 0.349]	Yes
PBAR →POLSUP	-0.145	3.395	0.001	[-0.228, -0.069]	Yes
PSUS →POLSUP	0.071	3.283	0.001	[0.031, 0.114]	Yes

The total effects were then assessed (Table 26). Recreation Risk had the strongest total effect on Policy Support (0.418), followed by Perceived Barriers (-0.342). Further, Perceived Severity had a very strong influence on Recreation Risk (0.595). All total effects were significant at the .05 level (Table 26) and confirmed through bootstrapping (Hair Jr et al. 2017). Competitive mediation for the Male sample was found (as it was for the Female sample), with Perceived Benefits acting as a suppressor of Perceived Barriers.

[17] N.B. The Specific Indirect Effects and Total Indirect Effects statistics and confidence intervals were equal.

Table 26: Total Effects Significance Testing – Male Sample

Path	Total Effect	*t* Values	*p* Values	95% Confidence Intervals (Bias Corrected)	Significant (p<.05)?
RR → POLSUP	0.418	5.667	0.000	[0.278, 0.554]	Yes
PBAR → POLSUP	-0.342	5.562	0.000	[-0.456, -0.225]	Yes
PSEV → POLSUP	0.250	5.167	0.000	[0.158, 0.465]	Yes
PBEN → POLSUP	0.231	3.412	0.001	[0.107, 0.366]	Yes
PSUS → POLSUP	0.071	3.283	0.001	[0.031, 0.114]	Yes
PSEV → RR	0.596	16.353	0.000	[0.524, 0.659]	Yes
PSUS →RR	0.170	4.348	0.000	[0.087, 0.243]	Yes
PBAR → PBEN	-0.630	17.192	0.000	[-0.704, -0.557]	Yes

The significance of the path coefficients was then assessed. As shown in Table 27, all the paths of the Male model were highly significant, representing large contributions of these variables on their associated constructs. The significance was confirmed through bootstrapping (results not shown).

Table 27: Significance of Path Coefficients – Male Sample

Path	Path Coefficient	t Values	*p* Values	Significant (p<.05)?	Hypothesis Supported?
RR → POLSUP	0.418	5.667	0.000	Yes	Yes
PBEN → POLSUP	0.231	3.412	0.001	Yes	Yes
PBAR → POLSUP	-0.196	3.909	0.000	Yes	Yes
PSEV → RR	0.596	16.353	0.000	Yes	Yes
PSUS → RR	0.170	4.348	0.000	Yes	Yes
PBAR → PBEN	-0.630	17.192	0.000	Yes	Yes

4.3.4.3. Measurement Invariance of Composite Models (MICOM) Procedure

As the measurement and structural models for the Male sample were determined to be valid, a MICOM analysis was undertaken to determine if multigroup analysis could be conducted for the Near and Far groups. The three-step MICOM procedure specified in Hair Jr. et al. (2018) and outlined in Section 4.2.3.3 was followed. Configurational invariance was established by ensuring that the path models for both groups were identical, with no changes to items, variables or paths between the groups. Compositional invariance was then established (Table 28) by determining that the correlations between the composite scores for each group were not significantly different (as the *p* values for all constructs were greater than 0.05).

Table 28: Compositional Invariance

Construct	Correlation, *c*	5% quantile of the empirical distribution of *c*	*p* Values	Compositional invariance established?
PBAR	0.999	0.993	0.724	Yes
PBEN	1	0.998	0.923	Yes
POLSUP	0.998	0.99	0.559	Yes
PSEV	0.993	0.969	0.420	Yes
PSUS	0.995	0.917	0.548	Yes
RR	1	0.999	0.211	Yes

The third step of the MICOM — assessment of mean and variance equality between the groups — was then undertaken. As shown in Table 29, full measurement invariance was not established, as equal means and variances were not found for all latent variables across the groups. Since configurational and compositional invariance were established, partial measurement invariance was demonstrated, meaning that meaningful multigroup analysis to test for differences between the Near and Far groups could be undertaken.

Table 29: Full Measurement Invariance Test – Equality of Composite Mean Values and Variances

Construct	Difference of the composite mean value (=0)	95% Confidence Interval	p-Values	Equal mean values?
PBAR	0.774	[-0.271; 0.270]		
PBEN	-0.489	[-0.273; 0.265]	0.000*	No
POLSUP	-0.361	[-0.283; 0.284]	0.010*	No
PSEV	-0.228	[-0.277; 0.278]	0.112	Yes
PSUS	-0.019	[-0.267; 0.286]	0.894	Yes
RR	-0.538	[-0.269; 0.274]	0.000*	No
Construct	**Logarithm of the composite variances ratio (=0)**	**95% Confidence Interval**	**p-Values**	**Equal variances?**
PBAR	0.283	[-0.342; 0.294]	0.084	Yes
PBEN	0.372	[-0.429; 0.358]	0.066	Yes
POLSUP	0.367	[-0.371; 0.313]	0.035*	No
PSEV	-0.003	[-0.387; 0.346]	0.987	Yes
PSUS	-0.025	[-0.517; 0.484]	0.927	Yes
RR	0.371	[-0.345; 0.276]	0.021*	No

* Indicates significant difference

4.3.4.4. Multigroup Analysis – Near v Far

Multigroup analysis was undertaken to determine whether the Near and Far groups were significantly different. As described in Section 4.2.3.3, there are four methods of assessing multigroup differences. The results of the Partial Least Squares MGA (PLS-MGA) recommended by Hair et al. (2018) are reported below, together with the alternative methods of assessing multigroup differences (Permutation, Parametric, and Welch-Satterthwaite Tests). The PLS-MGA was undertaken using the complete bootstrapping option with 5,000 samples, and the percentile bootstrapping option for confidence interval calculation (Hair Jr et al. 2018). The Permutation test also used 5,000 samples.

As shown in Table 30, the only significant difference found between the group path coefficients was for the PBAR → PBEN path, with the Near group coefficient (-0.703) significantly larger than that of the Far group (-0.560) (refer to Table 31). A significant difference was found for these path coefficients by the recommended PLS-MGA test and the non-parametric Welch-Satterthwaite Test but not the other two MGA tests. As such, the results were cautiously taken to demonstrate a significant difference between the groups for the PBAR → PBEN path, with the mediation path stronger for the Near group than the Far group.

Table 30: Multi-Group Analysis

Path	Path Coefficient Difference	Multi-Group Analysis Tests			
		PLS-MGA	Permutation Test	Parametric Test	Welch-Satterthwaite Test
RR → POLSUP	-0.108	0.517	0.516	0.503	0.509
PBAR → POLSUP	-0.093	0.484	0.447	0.436	0.479
PBEN → POLSUP	0.086	0.550	0.595	0.592	0.553
PSUS → RR	-0.085	0.378	0.357	0.356	0.377
PSEV → RR	0.078	0.315	0.372	0.350	0.318
PBAR → PBEN	-0.143	0.046*	0.079	0.106	0.045*

*Significant difference

The significance of the path coefficients within each group was then explored. As shown in Table 31, except for PSUS → RR for the Near group, all model paths were significant for both groups. Further, the path coefficients for the Near group were stronger for four of the six model paths; the exceptions were the PSUS → RR and RR → POLSUP paths.

Table 31: Multi-Group Path Coefficient Significance

Path	Near Group				Far Group			
	Path Coeff.	*t* Value	*p* Value	Hypothesis Supported	Path Coeff.	*t* Value	*p* Value	Hypothesis Supported
RR → POLSUP	0.339	2.389	0.017	Yes	0.448	5.396	0.000	Yes
PBAR → POLSUP	-0.280	2.365	0.018	Yes	-0.186	3.205	0.001	Yes
PBEN → POLSUP	0.276	2.374	0.018	Yes	0.190	2.187	0.029	Yes
PSEV → RR	0.658	10.313	0.000	Yes	0.580	13.115	0.000	Yes
PSUS → RR	0.113	1.342	0.180	No	0.197	4.275	0.000	Yes
PBAR → PBEN	-0.703	13.942	0.000	Yes	-0.560	11.22	0.000	Yes

A comparison of the R^2 values of the two groups and the full Male sample is provided in Table 32. While the variance explained for each of the three endogenous variables by the HBM was higher for the Near group compared to the Far group, the HBM was considered to have good explanatory power for both groups and for the full Male sample.

Table 32: R^2 Comparison (Bootstrapping Results)

Construct	Near Group	Far Group	Full Male Sample
POLSUP	0.667	0.535	0.582
RR	0.481	0.400	0.413
PBEN	0.494	0.313	0.398

4.3.4.5. Summary – HBM – Male Sample

All hypothesised paths in the model for the full Male sample were significant. Policy Support was most strongly influenced by Recreation Risk, while the effects from Perceived Benefits and Barriers were significant but small. Perceived Benefits strongly mediated the effect of Perceived Barriers on Policy Support, and Perceived Severity had much greater influence on Recreation Risk than Perceived Susceptibility. The model had good explanatory power for Policy Support, explaining 58% of the variance in that construct. The key model results for the full Male sample model are shown in Figure 6.

All hypotheses were supported for the Far Group. For the Near Group, Perceived Susceptibility was not a significant predictor of Recreation Risk, but all other hypothesised paths were significant. The model had good explanatory power for the Near and Far groups, but explained more of the variance for the Near group. The groups differed significantly only in relation to the Perceived Barriers → Perceived Benefits path, where the relationship was significantly stronger for the Near group. Overall, the HBM was a stronger model for predicting Policy Support, Recreation Risk and Perceived Benefits for the Near group, explaining more of the variance of these endogenous variables compared to the Far group. The key model results for the Near and Far Male groups are shown, respectively, in Figure 7 and Figure 8.

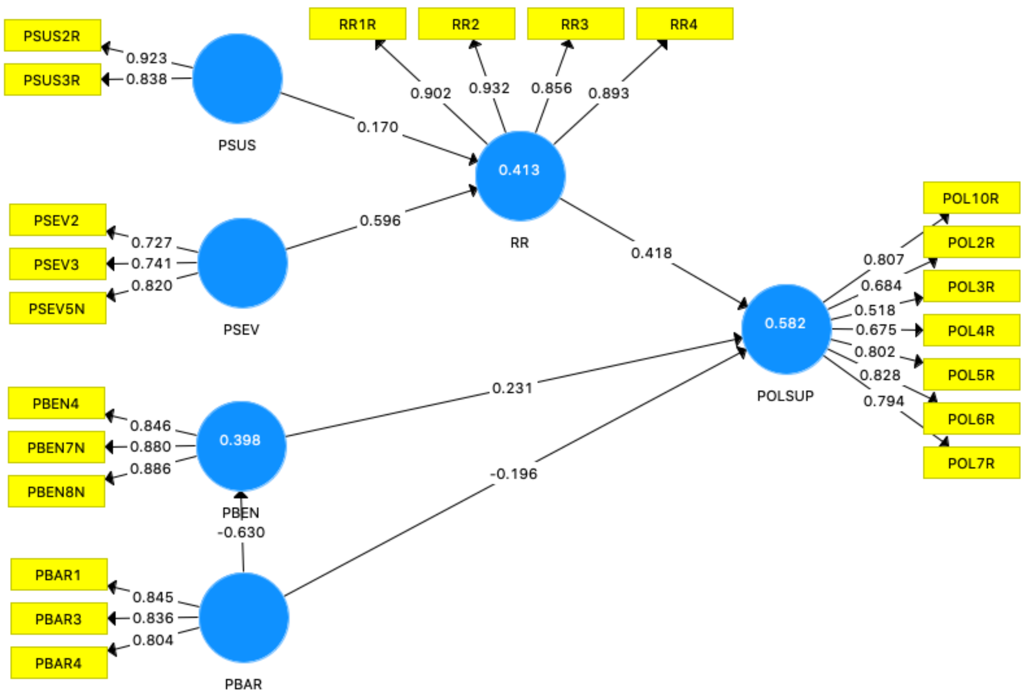

Figure 6: Male Model Summary – Complete Sample

R^2 values are shown within the endogenous construct circles. Path coefficients shown for inner (structural) model; indicator loadings shown on outer (measurement) model.

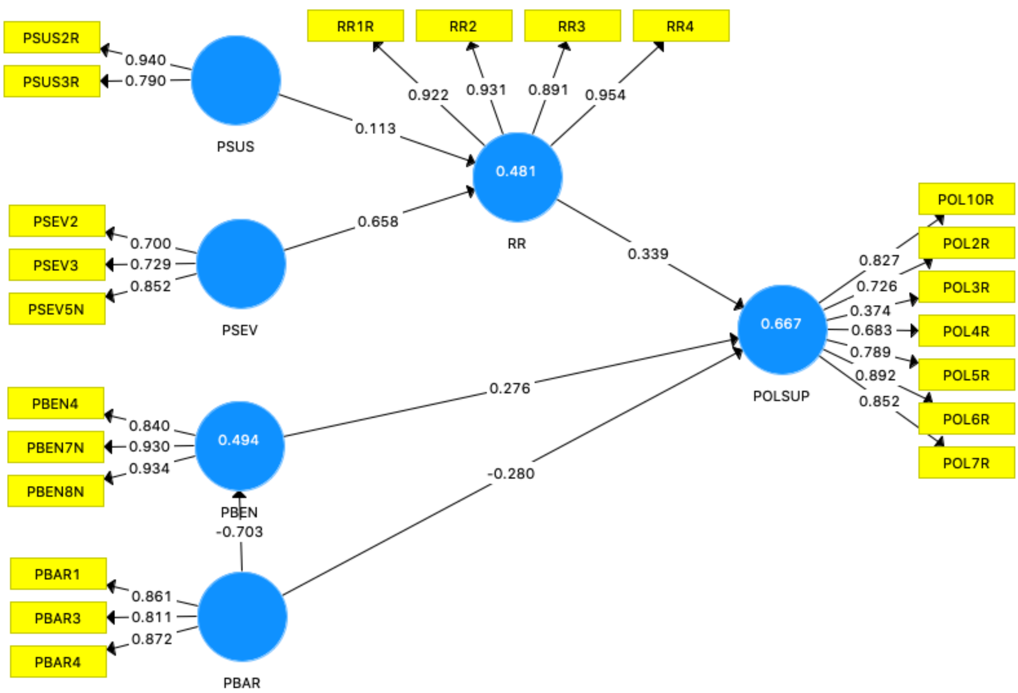

Figure 7: Near Male Group Summary

R^2 values are shown within the endogenous construct circles. Path coefficients shown for inner (structural) model; indicator loadings shown on outer (measurement) model

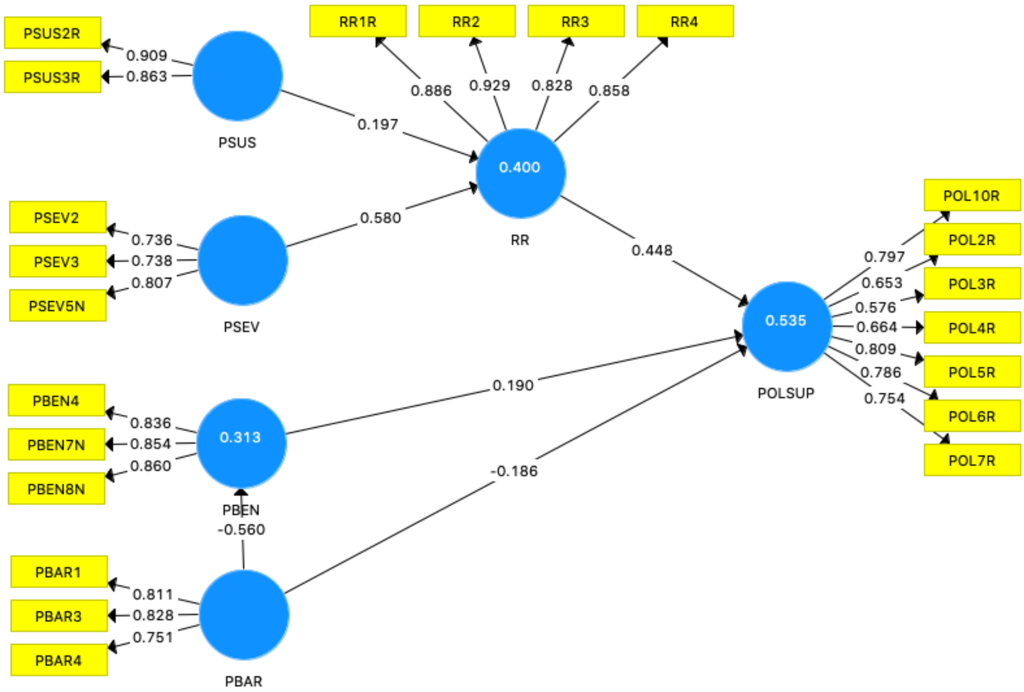

Figure 8: Far Male Group Summary

R^2 values are shown within the endogenous construct circles. Path coefficients shown for inner (structural) model; indicator loadings shown on outer (measurement) model

4.3.5. Modelling Summary

The HBM was found to be a valid explanatory model for both gender samples in this study. The differences between those samples could not be compared statistically because the gender groups were heterogenous and the Male model had one less indicator for the Perceived Susceptibility construct.

The model had greater explanatory power for males living close to the catchments compared to males living further away. Recreation Risk was the strongest influence on Policy Support for all groups. Similarly, Perceived Benefits strongly mediated the effect of Perceived Barriers on Policy Support for all groups. With two exceptions, all paths were significant for all groups; Perceived Barriers did not significantly affect Policy Support for the Female sample, and Perceived Susceptibility did not significantly influence Recreation Risk for the Near Male Group.

The next section discusses the findings and compares them to literature. Further discussion is also provided regarding the application of the findings and the study strengths and limitations.

4.4. Discussion

The objectives of this study were to test the ability of a candidate model of policy support in the context of support for recreation policy in catchments using data collected from a sample of the lower Hunter Region community. Based on the Literature Review (Chapter 2), the HBM was selected as the candidate model to assess. The literature also provided guidance about a potential model structure to explore and hypotheses relating to the model relationships, which were tested in this study as described in the previous section. This section reviews the findings, compares them to literature, and discusses the strengths and limitations of the study, before describing further work to be reported in the subsequent chapter.

4.4.1. Findings

Eight hypotheses were evaluated, which related to the relationships between the HBM constructs and policy support; the results of the assessment are summarised in Table 33.

Table 33: Hypothesis Support

Hypotheses		Supported?			
		Females	Males		
No.	Description		Full Sample	Near	Far
H1	The perceived susceptibility of a person to illness from waterborne disease will be positively associated with the perceived threat of recreation to water quality (recreation risk)	Yes	Yes	No	Yes
H2	The perceived severity of illness from waterborne disease will be positively associated with the perceived threat of recreation to water quality (recreation risk)	Yes	Yes	Yes	Yes
H3	The perceived threat of recreation to water quality (recreation risk) will positively influence support for recreation restriction in the catchments	Yes	Yes	Yes	Yes
H4	The perceived benefits of restricting recreation in the catchments will positively influence support for recreation restriction in the catchments	Yes	Yes	Yes	Yes
H5	The perceived barriers to restricting recreation in the catchments will negatively influence support for restricting recreation in the catchments	No	Yes	Yes	Yes
H6	The perceived benefits of restricting recreation will mediate the perceived barriers to restricting recreation in the catchments	Yes	Yes	Yes	Yes
		Females		Males	
H7	The model relationships will differ for the Female and Male samples	Yes		N/A	
H8	The model relationships will differ for people living close to the catchments (Near group) and those living further away (Far group)	N/A		Partial Support	

As most of the hypotheses were supported, the HBM was considered a viable model of policy support relating to recreation in drinking water catchments for this sample. The model was found to have sufficient explanatory power for the Female and Male samples, and for both the Near and Far resident groups within the Male sample.

The hypothesis that the model relationships would differ for the Female and Male samples could not be tested through significance testing due to heterogeneity between the groups in relation to the Perceived Benefits and Perceived Barriers constructs. The presence of heterogeneity, however, suggests differences in the way the groups responded to the questions. Further, the results suggested that the strength of the relationships between the HBM constructs differed for the Female and Male groups. The HBM explained more of the variance in behaviour for the Male sample, and most of the path weights were stronger in the Male samples than the Female sample; the only path stronger for the Female group was the influence of Perceived Benefits on Policy Support. Further, Perceived Barriers significantly influenced Policy Support for the Male groups, but not the Female sample. The results were considered to provide partial support for the hypothesis.

The hypothesis that the model relationships would differ for people living close to the catchments (Near group) and those living further away (Far group) could only be tested for the Male sample; the hypothesis was only supported for the meditating relationship between Perceived Barriers and Perceived Benefits, which was significantly higher for the Near group. The HBM explained more of the variance of all endogenous constructs in the model for the Near group compared to the Far group, particularly for Policy Support. Recreation Risk was a stronger predictor of behaviour for the Far group, but not significantly so. Another difference between the Near and Far groups related to the effect of Perceived Susceptibility on Recreation Risk; this pathway was not significant for the Near group, but was for the Far group. The difference in strength of the relationships between these constructs for the two groups, however, was not significant.

The HBM proved to be a useful explanatory model of policy support behaviour. The findings supported the use of Perceived Threat (Recreation Risk) as a predictor of Policy Support influenced by Perceived Susceptibility and Perceived Severity, and the use of Perceived Benefits as a mediator of Perceived Barriers. The Literature Review provided evidence to indicate that risk perception was likely to be a key driver of policy support. This study explored whether a risk-based model — the HBM — could explain support for recreation policy in the lower Hunter Region. The model was found to explain a good proportion of the variance in policy support in all groups tested. Further, Recreation Risk was the strongest influence on Policy Support in all groups tested. The study demonstrated, therefore, that risk perception (Perceived Threat) was a key driver of policy preferences, and the HBM was a viable model of policy support, in the study context.

4.4.2. Comparison to Literature

4.4.2.1. Model Variables

The variance in policy support behaviour explained by the model for the groups investigated in this study ranged from 53% to 67%. This was at the higher end of the range of variance found for other studies of the HBM in the environmental and disaster domains, which ranged from 28% to 67% (Bakhtiyari et al. 2017, Boazar et al. 2020, Ejeta et al. 2016, Rezaei and Mianaji 2019, Savari et al. 2021, Tajeri moghadam et al. 2020, Yazdanpanah et al. 2021a, Yazdanpanah et al. 2021b, Zobeidi et al. 2021).

Of note, the findings of this study indicated that recreation risk perception (perceived threat) was the strongest predictor of policy support behaviour. This finding was consistent with the literature regarding flood risk preparedness and recycling behaviour (Ejeta et al. 2016, Lindsay and Strathman 1997) — although the influence of perceived threat in this study was much greater — and with a recent study of actions to protect private wells from flooding (Musacchio et al. 2021). The findings contrasted, therefore, with those finding no significant effect of perceived threat on adaptive behaviours during a heat wave (Akompab et al. 2013) and previous or future testing of drinking water wells for contamination (Straub and Leahy 2014). Perceived susceptibility was a relatively weak, but significant, predictor of both perceived threat and of policy support for all groups except the Near Male group, for which susceptibility was not a significant predictor of perceived threat; this was generally consistent with the meta-analyses of health effects HBM studies described in the Literature Review (Chapter 2).

The meta-analyses of use of the HBM in the health field primarily related to use of the direct effects model and, as such, are not directly comparable to this study. Those analyses, however, consistently indicated that barriers were generally a stronger predictor of behaviour than benefits, which was not the case for this study. In this study, benefits had a stronger influence on behaviour than barriers for three of the four groups explored, and perceived barriers did not significantly influence behaviour directly for the Female sample. These findings were more consistent with the HBM studies in the environmental and disaster domains (Bakhtiyari et al. 2017, Boazar et al. 2020, Rezaei and Mianaji 2019, Savari et al. 2021, Tajeri moghadam et al. 2020, Yazdanpanah et al. 2021b), where benefits were found to be a significant predictor of behaviour in most of the reviewed studies. It is also noteworthy that the environment and disaster studies used structural equation modelling while the earlier health-related studies tended to use first order statistics, which do not have the same capacity to assess relationships between variables.

The benefits construct was found to mediate (suppress) significantly the relationship between barriers and behaviour for all groups assessed. This finding was consistent with the suggestion by Janz and Becker (1984) and the findings of Jones et al. (2015) that there was a causal pathway of perceived barriers to behaviour via perceived benefits.

Overall, the analysis suggests that when the direct effects of the HBM variables are assessed, barriers and benefits have the greatest influence on behaviour, but the effects of susceptibility and severity increase when they are assessed in the context of perceived threat. The differing influences of the individual variables may result from methodological differences (the use of first order versus second order statistics), but also may indicate that the influence of the HBM variables may vary with different threats and behaviours. As noted in the Literature Review (Chapter 2), environmental attitudes and behaviours can be quite specific and not generalisable to all environmental issues (Lindsay and Strathman 1997); similarly, risk perception has been found to vary depending on the risk in question (e.g. Stoutenborough 2015), and the same is likely to be the case for a variety of health- and disaster-related issues. Further research may help clarify whether the differences in findings relate to methodological differences or subject matter.

When the study was conducted, there were no examples of the application of the HBM in the context of policy support in the literature. Since then, a single study including a policy support component was identified (Suess et al. 2022). That study, undertaken in the context of travellers' support for mandated vaccination requirements for travellers for COVID-19, found that the perceived benefits of vaccination influenced personal willingness to be vaccinated and the belief that others should be vaccinated prior to travel; these latter constructs themselves were significantly associated with support for pre-travel vaccination policy. Perceived benefits were influenced by perceived susceptibility to, and severity of, COVID-19. Frequency of travel was found to be a moderating variable — more frequent travellers were significantly more supportive of pre-travel vaccination policy than less frequent travellers (Suess et al. 2022). Those results may suggest the influence of self-interest on policy support, as was found for this study. This idea is explored further in the Discussion Chapter (Chapter 6).

4.4.2.2. Gender

The HBM had greater explanatory power for the Male sample compared to the Female sample, suggesting that more variables additional to the HBM constructs may influence policy support for females. While the differences in model performance could not be compared statistically due to heterogeneity, the results suggested some gender differences in the influences of the HBM constructs on policy support, particularly in relation to the direct effect of perceived barriers on policy support. The results also suggested a potentially stronger influence of perceived threat on policy support for males, a stronger mediating effect of benefits on barriers for males, and a stronger influence of benefits on policy support for females.

As noted in the Literature Review, few HBM studies have investigated gender differences, and, to date, no clear pattern of gender influence has been identified. Females were found to have higher perceived severity of climate change effects and a greater intention to use biofuels (Bakhtiyari et al. 2017); be more likely to reduce energy use voluntarily to mitigate climate change (Semenza et al. 2011); and be more prepared for flood and earthquake hazards (Ejeta et al. 2016, Rostami-Moez et al. 2020) than males, while no gender differences were found for risk perception or preparedness for heat waves (Akompab et al. 2013) or testing of private drinking wells for contaminants (Straub and Leahy 2014). The Literature Review concluded that the influence of gender in the HBM required further investigation, but might vary with context. This study indicated that gender might affect recreation policy support and risk perception; further explorations of gender differences in this sample are reported in Chapter 5.

4.4.2.3. Proximity to Catchments

As noted previously, the model had stronger predictive ability for the Near Male group than the Far Male group, although the only significant difference between the groups was in relation to the mediating relationship of benefits on barriers, which was stronger in the Near group than the Far group. It is notable that the influence of barriers on policy support was also strongest for the Near group. Of interest, susceptibility did not significantly influence perceived threat in the Near group while it did for the Far group, although the group differences in explanatory power for this variable were not significant. Together these results suggest that the Near group had lower perceptions of the risk of recreation to water quality and their health, and had greater self interest in permitting recreation. The influence of proximity on the Female sample could not be tested due to the small sample size of the Near Female group; this exploration would be interesting to undertake in future research.

The Literature Review identified proximity as an important contributor to behaviour and risk perception in health-related HBM studies through proximity to resources to facilitate preventive behaviours (such as location of a health care facility). Several studies found that health care facilities located far from communities or individuals were a barrier to action (Adedeji et al. 2021, King et al. 2017, Pervin et al. 2021, Suwankhong and Liamputtong 2018), suggesting that the greater the distance of a service from a person's residence, the less likely it is to be used. The findings of this study are consistent with this, in that the relationship between barriers and benefits varied between the two proximity groups in the Male sample. The influence of proximity on policy support is explored further in Chapter 5.

4.4.3. Study Strengths and Limitations

4.4.3.1. Strengths

The research addressed three key issues identified in HBM research. First, the lack of definition or assessment of relationships between model constructs was addressed through the use of the PLS-SEM technique, which is the key strength of the study. SEM is a powerful statistical technique, with rigorous tests of data validity, which is can model multiple independent and dependent variables, observed and latent variables, mediating and moderating effects, and direct and indirect variable effects at the same time, while also explicitly assessing measurement error. This enables the technique to provide a better understanding of the interactions and associations between variables, and enables assessment of the efficacy of a model as a whole rather than as individual coefficients. The assessment determined that the HBM was a viable model of recreation policy support for the Hunter sample. Second, the potential obscuring effect of variables additional to the core HBM constructs was addressed by including only the core HBM variables in the model. Third, the lack of research assessing the usefulness of behavioural models in the context of anthropogenic hazards was addressed by using the HBM in the context of recreation in catchments, which is an anthropogenic water contamination hazard.

4.4.3.2. Limitations

The purpose of the modelling was to assess the potential applicability of the HBM as a model of policy support, specifically for policies relating to recreation in the drinking water catchments. It was outside the scope of the study to develop a survey instrument recommended for future research. While the items and constructs used in the modelling were determined to have construct, statistical and internal validity, the test-retest reliability of the measure was not assessed, which would determine the stability/reproducibility of the scores over time (Morling 2018). Further, not all items loaded onto the expected constructs; while the final items were checked independently for face validity, only a small pool of items was used. Testing a broader pool of items, and different wording, might identify items that better represent the constructs. Further testing and refinement of the questionnaire, therefore, is recommended. It should also be noted that not all the recreation policy options were included in the final model; specifically, the No recreation, Non-motorised water activity with no direct water contact (like kayaking or sailing), and Non-motorised water activity with direct water contact (e.g. wind surfing and kite surfing) policy options were removed during the measurement model validation process. The model's predictive ability for recreation policy support, therefore, may not extend to those recreation categories.

Additional to this, the PLS-SEM technique is designed to work with metric or quasi-metric scales (that is, those with equidistant data points) (Hair Jr et al. 2017). In this study, a deliberate decision was made to exclude a neutral middle point in the policy support variable in order to force a choice for support or not support of a policy while still retaining multiple response options. While the data for this variable generated a relatively continuous scale, further testing of the model should be undertaken to determine whether the format of the response options influenced the results.

A related issue is that the assessment of the measurement model for the Male sample resulted in one of the Perceived Susceptibility indicators being dropped. As a consequence, the measurement models for the Female and Male samples were different, meaning they could not have been compared even if the samples were not heterogenous. Use of a broader pool of indicators as described above would assist with this issue in future research. Further exploration of the heterogeneity of the gender samples is also required, to determine whether they are different enough to warrant different measurement and structural models.

While most of the relationships in the model were determined to be significant and the variance explained in Policy Support by the HBM constructs relatively high, the effect size of the HBM constructs was not. For the Female sample, the effect sizes for Recreation Risk and Perceived Benefits on Policy Support were small, and the effect of Perceived Barriers on Policy Support was not significant. In contrast, Recreation Risk had a slightly stronger effect for the Male sample (medium effect size), while Perceived Benefits and Perceived Barriers had small effect sizes on Policy Support. Effect size is a measure of importance; small effect sizes suggest that the relationships between the variables may not be that strong. Further investigation is required to determine whether the significance of the constructs was an artefact of the relatively large sample size, or if the effect sizes can be increased through modifications to the item indicators. In addition, the collected sample was not demonstrated to be representative of the population, and the effect of sampling bias on the modelling results should be explored through further research. A discussion of more representative sampling regimes is provided in Section 5.3.3.

4.4.4. Conclusion

The modelling resulted in two key findings. First, the HBM served as a viable model of recreation policy support for the lower Hunter Region. Second, risk perception, or perceived threat, was a strong driver of recreation policy support. The model explained a substantial proportion of the variance in policy support, with risk perception being a key influence. Unlike typical assessments using first order statistical techniques (such as regression) to identify factors, the structural equation modelling used in this study was able to assess variable interrelationships and significance of contribution concurrently, thereby providing a more powerful understanding of the effects of different variables on policy support. The perceived severity of outcomes had a strong influence on risk perception, and the perceived barriers mediated the effect of the perceived benefits on policy support.

Other factors are likely to influence policy support, which are not included in the HBM. Some of these variables are explored further in Chapter 5, together with further analysis of group differences in relation to gender and proximity of residence to catchments, as well as other variables identified in the literature.

This study provides evidence to support a structure of the model whereby perceived susceptibility and severity have an indirect influence on behaviour, benefits and barriers have direct effects on behaviour, and benefits serve as a mediator between barriers and behaviour. Further, the study demonstrates the utility of the model in addressing anthropogenic hazards, and its potential greater application within the field of DRR.

The predictive ability of the model for other populations remains to be tested. Further refinement and testing of the questionnaire items is also warranted. The results, however, are promising, and suggest the value of the HBM could extend outside its traditional realms. The HBM is a candidate for a general model of risk reduction policy support.

Chapter 5. Recreation Policy Support in the Lower Hunter Region

Chapter 5

5.1. Chapter Overview

The Literature Review noted that many urban water utilities restrict or prohibit recreation in their catchments and/or storages to protect water quality and, subsequently, public health, but that many water managers are experiencing pressure to increase recreational access to catchments. Given the importance of catchment protection to water security and DRR, it is important to understand the variables affecting support for risk reduction policies in order to determine how to increase acceptance of those policies within the community.

The previous chapter successfully validated the use of the HBM as a model of recreation policy support, and identified differences in factors affecting policy support between females and males, and between people who live close to catchments and those living further away, in the study sample. As such, the chapter identified how the model factors affected the groups differently, which provides useful information for explaining, and potentially changing, people's support for risk reduction policies. The modelling, however, did not determine which groups supported which policies, or whether the community supported restrictive recreation policies. Further, the model did not explain all the variance in policy support, indicating additional variables were likely exerting an influence. The purpose of this chapter, therefore, was to explore recreation policy support further in this sample, with the goal of gaining a greater understanding of group differences in order to expand the understanding of the variables affecting policy support and how policy support might be increased.

The chapter first describes the approach and hypotheses, as well as providing context for recreation activities in the local catchments. The Results section (Section 5.2) explores the influence of different variables on policy support, and further investigates differences in policy support and perceived recreation risk for the gender and proximity groups explored in the previous chapter. The chapter concludes with a discussion of the findings and a summary of the empirical research undertaken for the dissertation; the Discussion Chapter (Chapter 6) examines the broader implications of the study findings and conclusions.

The data explored in this chapter were obtained from the same community survey of the lower Hunter Region used in the modelling (Chapter 4) and described in the Methodology Chapter (Chapter 3). The survey included questions regarding personal recreation practices, levels of support for different recreation policies, and different personal characteristics.

5.1.1. Approach

Chapter 4 demonstrated the utility of the HBM as a model of recreation policy support, and identified differences in policy support between genders, and between people living close to catchments (Near group) and those living further away (Far group), in the study sample. Further exploration was undertaken in this chapter to determine which types of activity (if any) the community considered acceptable in the catchments, and which groups might desire greater recreational access. The chapter also explores some additional variables identified in the literature as potentially affecting policy support that were not included in the modelling, including personal recreation preferences, worldview, and demographic characteristics; further differences between the gender and proximity groups tested in the modelling were also explored. Given the importance of perceived recreation risk to policy support identified in Chapter 4, the level of perceived recreation risk in the community and in the groups explored in the modelling were further explored in this chapter. While the previous chapter noted heterogeneity between the female and male samples in this study, the differences were found only for the barrier and benefit variables of the HBM; pooling of the data into a full Hunter sample was, therefore, considered acceptable for policy support, perceived recreation risk and personal recreation preferences.

It should be noted that the model investigated in Chapter 4 did not include all the policy options captured by the survey, as they were excluded through the model verification process. The policy options not included were: No recreation, Non-motorised water activity with no direct water contact (like kayaking or sailing); and Non-motorised water activity with direct water contact (e.g. wind surfing and kite surfing). These policy options were assessed in this chapter for completeness.

The explorations were undertaken using a combination of descriptive and statistical analyses. Non-parametric tests were used to test group differences and relationships between variables; as described in Chapter 3, these consisted of Mann-Whitney *U* and chi-squared tests and their associated tests of importance. Some purely descriptive analyses were also undertaken, where supporters and non-supporters of different policies were compared through percentages. Policy support was indicated through a response of probably or definitely yes, while responses of probably or definitely no were taken as lack of support. Majority support was defined as 50% or more of a group supporting a policy.

As reported in Chapter 3 (Methodology), proximity to catchments was determined through the LGA of the participants' residences. People living inside the LGAs containing the catchments were allocated to the Near group, while other participants were allocated to the Far group.

It should be noted that stratified sampling was not undertaken, and that the sample was biased towards males (59% of the sample). Further, residents of the LGAs in which the catchments are located were over-represented in the sample (24%); while this enabled inter-group comparisons, it suggests that the policy support results may not be truly representative of community attitudes in this area. The results should provide an indication of the types of recreation activities more acceptable than others, however, and the intergroup comparisons are expected to yield important information.

5.1.2. Hypotheses

In addition to the eight hypotheses explored in Chapter 4, six hypotheses were explored in this chapter. The hypotheses, which were derived from the Literature Review (Chapter 2), related to policy support and to gender and proximity group differences as follows:

H9 Passive land-based recreation will be more acceptable to the community than water-based recreation activities.

H10 Females will be more supportive of recreation restriction than males.

H11 People living further away from the catchments will be more supportive of recreation restriction than people living close to the catchments.

H12 People will be more supportive of permitting recreation activities in the catchments that match their own recreation practices than people not engaging in those activities.

H13 People supporting recreation restrictions will have stronger ecocentric worldviews than people supporting recreation activities in the catchments.

H14 Females will have higher perceived recreation risk than males.

Differences in policy support by other demographic characteristics (age, income, and education level) were also explored, but no hypotheses were made regarding the relationship between those variables and policy support as there were no clear trends evident in the literature.

5.1.3. Catchments of the Lower Hunter Region – Background

The lower Hunter Region is located on the mid-north coast of NSW, and encompasses metropolitan, peri-urban and rural areas. The population is concentrated along the coast, with three of the most populated LGAs of the region (Newcastle, Lake Macquarie and Port Stephens) located on the coastline. The Lake Macquarie LGA is named after the largest coastal saltwater lake in the country, which falls within its boundaries, and is a popular location for motorised and non-motorised water-based recreation activities. The drinking water catchments of the region are within the Port Stephens and Dungog LGAs. The local water utility, Hunter Water, provides water and wastewater services to approximately 600,000 customers; the population of the region is, however, expected to increase by 20% by the year 2036, including a 25% increase in the population of the Port Stephens LGA (NSW Planning and Environment 2016).

The water supply system of the lower Hunter Region comprises two surface water storages (Grahamstown and Chichester Dams), three main rivers (Chichester, Wangat and Williams)[18] and two groundwater aquifers (the Tomago and Tomaree Sandbeds). The management of river and aquifer water resources and water security is undertaken by the NSW State Government, while the surface water storages are owned and managed by the water utility, which is a State-Owned Corporation. The water utility's operating licence mandates that drinking water must be managed in accordance with the ADWGs, which require a multiple-barrier approach to ensuring safe drinking water is supplied to customers, including catchment protection to the maximum extent practicable (NHMRC 2011), and that oversight of the utility's operations is to be provided by the state health department (IPART 2017). In addition, under legislation[19], the water utility is required to conduct its operations in compliance with the principles of ecologically sustainable development, including use of the precautionary principle to prevent environmental damage and protection of biological diversity and ecological integrity.

The community enjoys high quality drinking water. No widespread incidents of waterborne illness have occurred, and no boil water alerts or 'do not drink' advisories have been issued by the water utility during the past twenty years or more (O'Donoghue 2021). In contrast, other areas of NSW, including the Upper Hunter and areas such as Grafton, Kempsey, Scone, Jindabyne and Bega, experience extensive contamination incidents. A 2017 report on water quality contamination (Miskelly 2017) indicated boil water alerts had been issued to over 100,000 people in rural NSW between 2006 and 2017; 10 boil water alerts were issued in the Grafton area, which were associated with *Cryptosporidium* (a protozoan parasite) contamination from cattle and swimmers in the catchment.

The catchment areas of the lower Hunter Region are gazetted as Special Areas in state legislation, with restrictions on the types of development and activities permitted within the catchments in order to reduce water contamination; these areas are identified in Council development plans. A large township is located adjacent to, and within the catchment of, the main storage reservoir. Large areas of some of the catchments are covered by National Park; other areas, covered by State Conservation Areas, or owned by the water utility, are protected from development and public access.

Recreational access to the catchments is controlled by several agencies. The water utility controls access to the surface water storages and to areas within its landholdings, which includes land surrounding the reservoirs. Access to the National Parks and State Forests within

[18] Two additional rivers – the Paterson and Allyn Rivers – provide water to a very small population, and are not formally gazetted as drinking water catchments under the Hunter Water Regulation 2015 and, as such, were not a focus of this study.

[19] *State Owned Corporations Act 1989 and Protection of the Environment Administration Act 1991*

the catchments is controlled by National Parks and Wildlife, while access to the rivers is controlled by the state transport authority.

Some recreation is permitted on and adjacent to the reservoirs. Picnic facilities are provided at both reservoirs, but dogs, horses and other pets are prohibited within these areas. The water utility states that no public access to the dam or water's edge is permitted at either surface water storage (Hunter Water Corporation 2018); at the time of the survey, however, sailing, kayaking/canoeing and shore-based fishing were permitted in a portion of Grahamstown Dam when the Sailability Port Stephens club was operating. Sailability, which leases its sailing club and facilities from Port Stephens Council (who leases it from Hunter Water), is a club facilitating sailing activities for disabled people. The arrangement with the Sailability Club is long-standing, and is seen as a valuable community service. Recreation in the forested areas of the Tomago Sandbeds is prohibited to protect the quality of the groundwater and the water extraction infrastructure, and to avoid public access to the Department of Defence lands in the area.

Some recreational access is permitted in the National Park overlying the Tomaree groundwater aquifer (walking/running and some designated public vehicle access trails), and motorised boating activity is permitted in the river from which most of the water for the main reservoir is extracted. Recreation paths around Grahamstown Dam are limited to a cycleway linking the townships of Medowie and Raymond Terrace, which runs along the southern edge of the dam, adjacent to the public road. There are no specific walking trails around Chichester Dam, but there are substantial trails available in the proximal Barrington Tops National Park. Very little recreational activity occurs in the Wangat River catchment or around the dam itself due to its steep terrain and limited access. The Chichester River catchment, however, is home to a range of agricultural activities and holiday accommodation, with associated recreational use of the river by private properties.

While there are no restrictions on recreation in the Chichester and Wangat Rivers, restrictions on boating activity are in place for the Williams River (TfNSW 2021); a key area of contention is the Seaham Weir Pool, located between the towns of Clarence Town and Seaham, from which water is extracted for pumping into Grahamstown Dam. Motorised boating activities, including waterskiing and wakeboarding, are permitted by the transport authority in some areas of the weir pool. These activities have been identified as a key contributor to declining water quality and riverbank condition in the weir pool, and there is heated debate in the community about whether the boats should be removed (Bevan 2021, Bevan 2020a, Bevan 2020b, Kelly 2016, Portelli 2020, Sharpe 2016). Tubes, jetskiis and other personal watercraft are prohibited in the section of the Williams River within the drinking water catchment (Roads and Maritime Service N.D.).

The recreational access arrangements to the catchments are problematic. There is confusion in the community about what is permitted and why, and high levels of unauthorised access have occurred over many years. The unauthorised access particularly relates to fishing activities and motorised vehicle access in areas of the dam adjacent to residential areas and the Medowie State Conservation Area (an area of protected land managed by National Parks and Wildlife) and in the groundwater catchments (Stanmore 2018).

Grahamstown Dam is located between the townships of Medowie and Raymond Terrace, and is proximal to residential areas. A key focus of inquiries to the water utility regarding recreational access relate to access for kayaking and fishing on Grahamstown Dam (Stanmore 2018). In 2018, a question was asked on a social media page for the Medowie community regarding whether kayaking was allowed on the dam. The subsequent responses from the local community led to the local Council putting a motion to the water utility to request additional recreational access to the dam (Norris 2018). The water utility's response at the time was that: recreation posed a risk; they were undertaking additional risk assessments; and that the Department of Health did not support additional access — no change to the existing arrangements was, therefore, planned (Stanmore 2018). Since then, however, the water utility has rescinded access to the dam for kayaking and fishing; only sailing by the Sailability Club is now permitted. In response to the Council motion and recent events within the water industry (notably the paradigm shift in South Australia resulting from the Government decree to open previously protected catchments to recreation in 2018), the utility embarked upon a number of studies to assess the risk of recreation on the reservoir to water quality. This dissertation was conceived in response to the question regarding whether the interest in recreation from the township represented the views of the broader customer base.

5.2. Results

This section describes the results of the analyses undertaken for the survey data to investigate community attitudes to recreation in the catchments and to explore which demographic and personal characteristics were associated with recreation policy support. A summary of the participant demographics is provided in the Methodology Chapter (Chapter 3). Unlike the modelling chapter, which excluded data from four participants not indicating a gender, the data reported in this chapter relate to the full sample (N = 454) except in the case of the gender group comparisons. Statistical testing of group differences was undertaken using non-parametric tests (Mann-Whitney *U* and chi-squared tests) as described in the Methodology Chapter.

Section 5.2.1 reports on policy support for the full sample and differences in that support between the gender and proximity groups explored in the previous chapter. The influence of other variables identified in the literature (demographic characteristics — age, income and education level); personal recreation preferences; and worldview), but not included in the HBM, are then explored. A brief exploration of the reasons nominated for policy support in the survey is then provided before differences in perceived recreation risk between the gender and proximity groups are further explored, as this was the key influence on policy support identified in Chapter 4. The section concludes with a summary of the findings, determining the key demographic and personal characteristics associated with recreation policy preferences for catchments in the lower Hunter Region. Discussion of the implications of the findings for DRR practices and enhancing community resilience is provided in Section 5.3.

5.2.1. Recreation Policy Support

The recreation policy preference questions in the survey related to different categories of activity, which were:

- **No recreation**.
- **All types of recreation**.
- **Passive land-based recreation**: walking; bushwalking or hiking; running; orienteering or rogaining; picnicking; climbing or rock climbing; birdwatching; and photography.
- **Active land-based, non-motorised recreation**: cycling, mountain-biking and horse riding.
- **Camping**.
- **Motorised water activity with no direct water contact**: fishing in a motorised boat, motorised boating and jetskiing.
- **Motorised water activity with direct water contact**: waterskiing and wakeboarding.
- **Non-motorised water activities with no direct water contact**: canoeing, kayaking, rowing, sailing, and fishing from land/non-motorised boat.
- **Non-motorised water activity with direct water contact**: wind surfing and kite surfing[20].
- **Swimming**: for the purpose of the categorisation exercise, this referred to swimming in oceans, lakes or rivers.

Respondents were asked to indicate their level of support for each of the ten policy options, which equated to their support to permit a category of recreation activity in the catchments, using a four-point Likert scale of Definitely No (1), Probably No (2), Probably Yes (3) and Definitely Yes (4). In the following analyses, percentage support represents the percentage of respondents indicating definite or probable support for a recreation policy (that is, summed responses of probably or definitely yes). Majority support was classified as 50% or more of a group indicating support for a policy option.

[20] N.B. surfing and bodyboarding were not included as these are ocean-based activities, and are not undertaken in lakes or rivers

5.2.1.1. Which Recreation Policies were Supported?

Responses for the full sample, and for the gender and proximity groups used in the modelling, are described below. Based on the literature, it was hypothesised that passive land-based recreation activities would be more acceptable to the community than water-based recreation activities. As shown in Figure 9, Passive land-based recreation was the most supported recreation activity in the sample, with 86% of respondents indicating support for this category of recreation activity in the catchment. The second most acceptable policy option was that of Active land-based, non-motorised recreation (73%). In contrast, the water-based activities received less support, with motorised water-based activities being the least supported forms of recreation by the sample. The hypothesis that passive land-based activities would be more acceptable to the community than water-based recreation activities was, therefore, supported.

Three recreation policies were considered acceptable to the majority of respondents in the full sample (N = 454): Passive land-based recreation (86%); Active land-based, non-motorised recreation (73%); and Non-motorised water activities with no direct contact (60%). It is noteworthy that a No recreation policy (41%) and, conversely, two direct water contact activities (Non-motorised water-based activities with direct water contact and Swimming), were supported by many respondents (respectively, 49% and 44%). The least supported policy options were the two motorised boating options (22% and 14%) and the All types of recreation policy (13%). Review of the comments provided by participants in the open-ended questions showed clear opposition to motorised recreation activities, with fuel and noise concerns explicitly noted (refer to Appendix C).

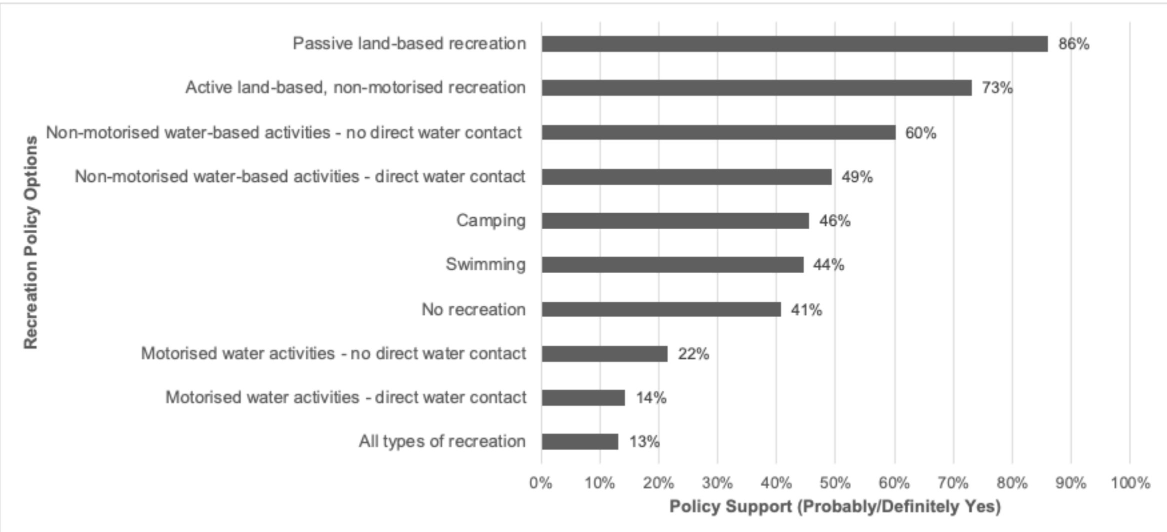

Figure 9: Ranked Policy Support – Full Sample

Given the gender and proximity differences identified in the modelling (Chapter 4) and the Literature Review (Chapter 2), policy support preferences were explored in relation to gender and proximity. It was hypothesised that females would be more supportive of recreation restriction than males. The difference in policy support between the genders is shown in Table 34. The female group was less supportive of permitting each category of recreation, and more supportive of a No recreation policy, than males; chi-squared tests demonstrated the differences between the gender groups were significant at the .05 level for seven of the ten policy options. The policies for which significant gender differences were not found were the All types of recreation policy, which was one of the lowest supported policy options overall, and the two most supported policy options — Passive land-based recreation and Active land-based, non-motorised recreation. The latter policies were the only two policies supported by the majority of females in the sample. In contrast, males had majority support for permitting six of the ten categories of recreation in the catchments, including Non-motorised water activities, Swimming and Camping. Notably, nearly half of all female respondents were supportive of a No recreation policy (48%) compared to only 36% of males. The hypothesis that females would be more supportive of recreation restriction than males, therefore, was considered supported.

Table 34: Policy Support by Gender

Policy Options	Percentage Support (Probably/Definitely Yes)		Chi-squared test (df = 1; N = 450)	
	Females N = 186	**Males** N = 264	χ^2	***p***
No recreation	48	36	**7.34**	**.007**
All types of recreation	10	16	3.28	.070
Passive land-based recreation	***85***	***87***	0.25	.617
Active land-based, non-motorised recreation	***70***	***75***	1.37	.242
Camping	39	***50***	**5.99**	**.014**
Motorised water activities, no direct water contact	15	27	**9.81**	**.002**
Motorised water activities, direct water contact	8	19	**10.44**	**.001**
Non-motorised water activities, no direct water contact	47	***70***	**23.94**	**<.001**
Non-motorised water activities, direct water contact	37	***58***	**18.99**	**<.001**
Swimming	33	***53***	**17.11**	**<.001**

Percentages reported in ***bold italic*** type indicate majority (i.e. $\geq$ 50%) support for the policy option
Chi-squared test results reported in **bold type** represent a statistically significant difference between the groups

The differences between policy support in the two proximity groups (Near and Far) was then explored. Based on the literature, people living further away from the catchments (the Far group) were hypothesised to be more supportive of recreation restrictions than people living close to the catchments.

Policy support for the two proximity groups is shown in Table 35. Significant differences between support for each group were found for eight of the ten policy options, all of which — except for the No recreation option — were more highly supported by the Near group than the Far group. No differences were found between the groups for the Passive land-based recreation option, which was highly supported by both groups, and Camping, which received majority support from the Near group but not from the Far group, although this difference was not significant.

Only three recreation policy types were supported by respondents in the Far group, which were the same as those supported by the full sample (Passive land-based recreation; Active land-based, non-motorised recreation; and Non-motorised water activities with no direct contact). In addition to these three activities, respondents in the Near group supported three more types of recreation policy — Non-motorised water activities with direct water contact, Swimming and Camping. The four recreation policy types that were not supported by a majority of respondents in either group were the motorised water activities (with and without direct water contact), All types of recreation, and No recreation, although 44% of the Far group indicated support for a No recreation policy.

The Far group had significantly higher support for the No recreation policy option, and the percentage of supporters of all the recreation-permitting policy options was lower for the Far group than the Near group, with most of those differences being significant. The hypothesis that people living further from the catchments would be more supportive of restrictive recreation policies, therefore, was considered to be supported.

Table 35: Policy Support by Proximity of Residence to Catchments

Policy Options	**Percentage Support** (Probably/Definitely Yes)		**Chi-squared test** (df = 1; N = 454)	
	Near Group N = 110	**Far Group** N = 344	χ^2	***p***
No recreation	31	44	**5.82**	**.016**
All types of recreation	20	11	**5.83**	**.016**
Passive land-based recreation	***90***	***85***	1.83	.177
Active land-based, non-motorised recreation	***82***	***70***	**5.58**	**.018**
Camping	***54***	43	3.79	.052
Motorised water activities, no direct water contact	34	18	**12.46**	**<.001**
Motorised water activities, direct water contact	25	11	**12.38**	**<.001**
Non-motorised water activities, no direct water contact	***74***	***56***	**11.04**	**<.001**
Non-motorised water activities, direct water contact	***61***	46	**7.775**	**.005**
Swimming	***56***	41	**8.283**	**.004**

Percentages reported in ***bold italic*** type indicate majority (i.e. > 50%) support for the policy option
Chi-squared test results reported in **bold** type represent a statistically significant difference between the groups

5.2.1.2. Effect of Demographic Characteristics, Personal Recreation Participation and Worldview on Policy Support

Chapter 4 demonstrated how the HBM variables influenced policy support. Perceived recreation risk was a key driver of policy support, with higher risk perception associated with higher support for restrictive policies; perceived severity of illness was a strong driver of recreation risk perception, while perceived susceptibility to illness was a significant, but not strong, influence on risk perception for most of the groups investigated. Perceived benefits also positively influenced support for restrictive policies, while perceived barriers negatively influenced support for restrictive policies.

Further, the model analyses indicated that there were gender differences in policy support, as well as differences between proximity groups. The influence of other variables on policy support identified in the literature is explored in this section, consisting of other demographic characteristics, personal recreation preferences, and worldview.

Demographic Characteristics

Gender and proximity of residence to catchments were identified as key differentiating demographic differences in the Chapter 4 and the Literature Review. The influence of other demographic characteristics on policy support was also explored, specifically in relation to age, income, and highest level of education; results are summarised here, while tables reporting policy support percentages for the demographic groups described in this section are provided in Appendix C. As noted previously, a No recreation policy was supported by 41% of the full sample. Greater support for this policy was found for: people with annual incomes less than $20,000 per year (54%), $20,001 - 40,000 per year (53%) and $70,001 – 100,000 (43%); University postgraduates (50%); and people aged 70 -79 (48%), 30 - 39 (45%) and 60 - 69 (42%). These groups typically did not support recreation-permitting policies other than Passive land-based recreation and Active land-based, non-motorised recreation, which was consistent with the support from the female sample reported in Section 5.2.1.1.

In contrast, greater support for more recreation activities was found for people aged 18 – 29, trade/apprenticeship and TAFE graduates, and people with annual incomes of $100,000 and above. These groups typically had higher support for each recreation-permitting policy, and supported more policies by majority, than the other groups.

It is worth noting that the only demographic group supporting the two motorised water-based policies was the 18 - 29 year age group. Given the small sample size of this group (N = 12), this result was not considered to be representative of community views of this age group. Overall, the results indicated that motorised boating was not supported by any demographic groups.

Personal Recreation Preferences

The personal recreation activities of respondents were explored. Recreation participation was grouped to match the categorisation of the recreation policy support questions (Section 5.2.1). The All types of recreation policy option was not assessed for these groups as no participants engaged in all the listed categories of recreation. Participation rates (percentages) for the recreation categories are provided in Table 36; uncategorised recreation participation data for the full sample are provided in Appendix C.

Nearly all respondents (N = 422; 93%) indicated that they participated in some form of outdoor recreation. Most respondents engaged in Passive land-based recreation (N = 396; 87%), while Swimming (63%) and Camping (46%) were also popular. Water sport participation was higher for Males than Females, and higher for the Near group than the Far group. Direct water contact activities (excluding swimming) were extremely uncommon across all the groups, being only undertaken by a very small minority of the sample.

Table 36: Recreation Participation Percentages by Full Sample, Gender and Proximity of Residence to Catchments

Recreation Categories	Participation (%)				
	Full Sample N = 454	Gender		Proximity	
		Females N = 186	Males N = 264	Near N = 110	Far N = 344
Outdoor recreation	**93**	**94**	**92**	**98**	**91**
Passive land-based recreation	**87**	**90**	**86**	**88**	**87**
Active land-based, non-motorised recreation	33	30	35	39	31
Camping	46	48	45	**66**	40
Motorised water activity, no direct water contact	28	18	34	46	22
Motorised water activity, direct water contact	7	4	9	15	5
Non-motorised water activity, no direct water contact	48	40	**53**	**70**	41
Non-motorised water activity, direct water contact	3	2	4	5	3
Swimming	**63**	**68**	**59**	**65**	**62**

Bold type indicates majority participation (i.e. 50% of sample or greater)

Recreation policy support was compared based on whether people engaged in a particular category of activity or not. Respondents who indicated that they did not engage in outdoor recreation did not answer the questions relating to participation in the specific types of recreation. Policy preferences for these respondents were grouped with those of respondents who indicated that they did not undertake a specific activity type. For example, people who did not engage in outdoor recreation were included in the non-camper group, the non-swimmer group, and so on; each of these groups was termed the Non-recreator group, while the group participating in the activity was termed the Recreator group in the following descriptions. Given this definition, it was hypothesised that Recreators would be more supportive of policies than Non-recreators. Results are shown in Table 37.

Chi-squared tests indicated that significant differences in policy support between the Recreator and No-recreator groups were found at the .001 level for the motorised and non-motorised water-based activities (for both no direct and direct water contact) and for Camping, where the people engaging in these activities were significantly more supportive of permitting them in the catchments than the people who did not engage in those activities. Of note is that people engaging in Motorised water activities with direct water contact, Non-motorised water activities with no direct water contact and Non-motorised water activities with direct water contact had majority support for those activities, which were not supported by the Non-recreators. The Recreators and Non-recreators did not differ significantly in their support for the No recreation, Passive land-based recreation, Active land-based non-motorised recreation and Swimming policies.

Table 37: Policy Support (% Probably/Definitely Yes) by Recreation Participation

Policy Option	Policy Support (% Probably/Definitely Yes)		Chi-squared test (df = 1; N = 454)	
	Recreators	**Non-recreators**	χ^2	***p***
No recreation	40 (N = 422)	***53*** (N = 32)	2.18	.139
Passive land-based recreation	***86*** (N = 396)	***88*** (N = 58)	0.18	.67
Active land-based, non-motorised recreation	***78*** (N = 148)	***71*** (N = 306)	3.08	.07
Camping	***58*** (N = 211)	35 (N = 243)	**23.75**	**<.001**
Motorised water activities, no direct water contact	41 (N = 127)	14 (N = 327)	**39.04**	**<.001**
Motorised water activities, direct water contact	***62*** (N = 34)	10 (N = 420)	**67.45**	**<.001**
Non-motorised water activities, no direct water contact	***72*** (N = 218)	49 (N = 236)	**24.72**	**<.001**
Non-motorised water activities, direct water contact	***93*** (N = 14)	48 (N = 440)	**10.95**	**<.001**
Swimming	46 (N = 285)	43 (N = 169)	0.389	.53

Percentages reported in ***bold italic*** type indicate majority (i.e. > 50%) support for the policy option
Chi-squared test results reported in **bold** type represent a statistically significant difference between the groups

Worldview

As explained in Chapter 3, worldview was measured using the five item subscale of the New Ecological Paradigm (NEP) instrument (Dietz et al. 2007). The scale includes two reverse-worded items; responses to these items were recoded prior to summing the response scores for this variable for each participant. The resultant sum scores ranged from 5 to 25, where scores of $\leq$ 10 (equivalent to responses of strongly disagree or mildly disagree to each of the five items) corresponded to highly anthropocentric worldviews and scores of $\geq$ 20 corresponded to highly ecocentric worldviews (equivalent to responding mildly or strongly agree to each of the five subscale items). Nearly half the sample (46%; N = 208) had highly ecocentric worldviews; in contrast, only 3% (N = 13) of the sample demonstrated a strong anthropocentric worldview.

Differences between worldview for Supporters (probably/definitely yes responses) and Non-supporters (probably/definitely no) of the different recreation policy options were explored for the full sample. It was hypothesised that supporters of recreation restriction (that is, Supporters of a No recreation policy and Non-supporters of the recreation-permitting policy options) would have stronger ecocentric worldviews (higher NEP sum scores) than people supporting recreation in the catchments. Mann-Whitney *U* tests were performed on the sum scores to determine if there were significant differences in NEP scores between the groups; results are shown in Table 38.

Table 38: Effect of Worldview on Policy Support

Policy Options	NEP Score (Mdn)		Mann-Whitney *U* Test		
	Non-supporters	Supporters	*U*	*p*	r_B
No recreation	18.0 (N = 269)	21.0 (N = 185)	**17,896.5**	**<.001**	**-0.281**
All types of recreation	19.0 (N = 394)	16.0 (N = 60)	**16,939.5**	**<.001**	**0.433**
Passive land-based recreation	20.0 (N = 63)	19.0 (N = 391)	12,641.5	.368	0.026
Active land-based, non-motorised recreation	20.5 (N = 122)	19.0 (N = 332)	**24,090.5**	**<.001**	**0.190**
Camping	20.0 (N = 247)	18.0 (N = 207)	**32,114.0**	**<.001**	**0.256**
Motorised water activities, no direct water contact	20.0 (N = 356)	16.0 (N = 98)	**25,675.0**	**<.001**	**0.472**
Motorised water activities, direct water contact	20.0 (N = 389)	15.0 (N = 65)	**18,958.0**	**<.001**	**0.500**
Non-motorised water activities, no direct water contact	22.0 (N = 181)	18.0 (N = 273)	**32,265.0**	**<.001**	**0.306**
Non-motorised water activities, direct water contact	21.0 (N = 230)	18.0 (N = 224)	**32,626.0**	**<.001**	**0.267**
Swimming	20.0 (N = 252)	18.0 (N = 202)	**32,098.0**	**<.001**	**0.261**

Mann-Whitney *U* test results reported in **bold type** represent a statistically significant difference between the groups
N.B. All hypotheses were that Group 1 > Group 2 except for the No recreation policy, where Group 2> Group 1

Significant group differences were found at the .001 level between Supporters and Non-supporters for each policy option with the exception of Passive land-based recreation, where no significant difference was found; this policy option had a high level of support in the community. Further, for each policy option, the median NEP score for people supporting recreation restriction was higher than the scores of people supporting recreation permission. The hypothesis, therefore, was considered supported. The effect sizes for the group differences ranged from small to medium, with the strongest effect sizes found for the motorised water activities with and without direct water contact and the All types of recreation policies (r_B = 0.5, 0.47, and 0.43, respectively); supporters of these policy options had the lowest median NEP scores (15 and 16) of all the groups, indicating stronger anthropocentric views.

As significant differences were found for Supporters and Non-supporters of policy in worldview, differences in worldview scores between the gender and proximity groups were explored to determine the potential differentiating effect of this variable on the groups. The Female group (Mdn = 21.0) had significantly higher NEP scores than the Male group (Mdn = 18.0) at the .001 level, with a medium effect size (U = 31,759.0; $p<.001$; r_B = 0.294). Similarly, the Far group (Mdn = 20.0) had significantly higher NEP scores than the Near group at the .001 level, with a small effect size (U = 13,735.5; $p<.001$; r_B = - 0.274). As such, females and people living outside the catchments generally had stronger ecocentric worldviews than males and people living in the catchments.

5.2.2. Perceived Recreation Risk

Risk perception was identified in the Literature Review as a factor associated with policy support, and was found to be the main driver of policy support in the modelling reported in Chapter 4, with higher recreation risk scores associated with stronger support for restrictive policies. The modelling indicated that risk perception had a stronger influence on the Near Male group than the Far Male group, and appeared to have a potentially stronger influence on Males than Females; given the Near Male and full sample Male groups were found to be the least supportive of recreation restrictions in Section 5.2.1.1, risk perception was considered a key potential target for interventions, and worthy of further investigation.

While the perceived risk of recreation activities in the drinking water catchments was assessed through five questions in the survey, only four met the criteria for inclusion in the modelling in Chapter 4; the results reported relate to the four items used in the modelling[21].

Recreation risk sum scores were calculated for all participants. As responses were captured on a five-point Likert scale from Strongly Disagree (1) to Strongly Agree (5), the sum scores had a possible range of 4 to 20, with higher scores indicating higher perceived risk. The median recreation risk sum score for the full Hunter sample was 15.0; a score of 16 would equate to responding ‘Agree’ to each of the four questions. The community, therefore, was considered to have a relatively high level of perceived recreation risk.

Differences in perceived recreation risk were then explored between the gender and proximity groups using Mann-Whitney U tests. Based on the literature, it was hypothesised that Females

[21] N.B. The item *Allowing recreation on or in drinking water dams is too risky* was not used in the modelling.

would have higher recreation risk scores than Males. This hypothesis was supported, as Females (Mdn = 16.0) had significantly higher recreation risk scores than Males (Mdn = 14.0) at the .001 level, with a small effect size (U = 29,831.5; $p<.001$; r_B = 0.215).

As the Near group had stronger support for recreation activities in the catchments, and stronger policy support was associated with lower recreation risk scores in the model, the difference between the two groups was tested. A Mann-Whitney U test demonstrated there was a significant difference at the .001 level for the proximity groups, with the Far group (Mdn = 16.0) having higher scores than the Near group (Mdn = 12.0) with a medium effect size (U = 13,270.5; $p < .001$; r_B = -0.299).

5.2.3. Reasons for Policy Support

In order to understand the sample's support for recreation policies further, survey respondents were asked to nominate the reasons for their policy support. The list of responses was derived from Nancarrow and Syme (2010); an 'other' category was also provided to allow respondents to nominate their own reasons. Results are shown in ranked order in Table 39.

Table 39: Policy Support Reasons

Reason	N	%
We need safe water to drink	373	82
Drinking water must be protected	365	80
We need to stop water pollution	303	67
Prevention of pollution is better than treatment	302	67
Recreation is healthy	247	54
There are other places to go for recreation	239	53
People are irresponsible	231	51
I don't want my water bills to increase	179	39
Most people behave responsibly	139	31
Recreation damages the environment	87	19
There are not enough places to go for recreation	71	16
I don't think recreation pollutes water	61	13
Other	23	5
People should be able to recreate wherever they want	22	5

The most common responses from the Hunter sample were We need safe water to drink (82%) and Drinking water must be protected (80%), which were nominated by the strong majority of the sample. Other responses nominated by the majority of the sample were: We need to stop water pollution (67%); Prevention of pollution is better than treatment (67%); Recreation is healthy (54%) — the only pro-recreation reason nominated by the majority of respondents; There are other places to go for recreation (53%); and People are irresponsible (51%). Only

13% of respondents indicated that they didn't think recreation pollutes water. The least selected option was that people should be able to recreate wherever they want (5%).

In addition to the policy support reasons, responses to questions relating to views on catchment protection were reviewed (refer to Table 40). The data indicated the community understood the importance of high quality drinking water, that recreation restrictions for activities on the dams reduce the contamination risk, and that treatment (technology) is not sufficient to produce safe drinking water. Further, the strong majority (81%) considered that drinking water should always be prioritised over recreation. Together, the data indicated strong community support for catchment protection, and the need to prioritise drinking water safety over recreation. The results demonstrated the high level of concern from the community to protect the water sources from contamination.

Table 40: Community Views on Catchment Protection and Recreation (Percentage Agree/Strongly Agree)

Statements	% Full Sample
If something went wrong with the quality of the drinking water, it would be very serious	89
The use of dams for drinking water should always take priority over recreation	81
Protecting our drinking water now is protecting our children's future	80
Restricting recreation on the dams reduces the risk of contamination of the water supply	74
I believe Hunter Water should go to any lengths to protect drinking water catchments	68
Restricting community recreation in the catchments helps protect me from water-borne illness	63
More and more people are coming to people's favourite places for recreation	60
Greater community recreation in the catchments would increase my water bill due to the increased costs of treatment and management	52
Technology can provide whatever treatment is needed to produce safe drinking water	41
It is safer to drink water from a natural, clean environment than to rely on artificial treatment	37
Recreational activity is being banned in more and more places	31
Allowing people to recreate in the restricted catchments is important to me	30
Recreation poses very little risk to drinking water quality	29
There are only a few places people are allowed to go to enjoy their recreational activities	26
I insist on people being able to do their recreational activities anywhere they choose	7

5.2.4. Summary

Variables found to affect policy support were gender, proximity to catchments, and worldview, with females, people living outside the catchment LGAs (Far group), and people with stronger ecocentric worldviews more supportive of recreation restrictions. Personal recreation participation was also related to policy support, with people supporting restrictions of activities in which they did not engage. No clear trends in policy support by age, income or education level were found. The previous chapter demonstrated the strong role of risk perception in policy support; this chapter determined that females and people living outside the catchment LGAs (Far group) had higher perceived recreation risk than males and people living close to the catchments (Near group).

The analyses indicated there was strong community support for restriction of many, but not all, recreation activities in the catchments of the lower Hunter Region. There was very high support in the community for prohibiting motorised water-based recreation activities in the catchments, with only people engaging in these forms of activities supportive of permitting them in the catchments. In contrast, the majority of the community supported allowing two categories of recreation in the catchments — Passive land-based recreation (walking; bushwalking or hiking; running; orienteering or rogaining; picnicking; climbing or rock climbing; birdwatching; and photography) and Active land-based, non-motorised recreation (cycling, mountain-biking and horse riding). A third category — Non-motorised water activities with no direct water contact (canoeing, kayaking, rowing, sailing, and fishing from land/non-motorised boat) was supported by some groups within the sample, and received majority support from the full sample analysis, but this appeared to have been influenced by the over-representation of males in the sample, as this policy was not supported by the majority of females.

A No recreation policy was supported by 41% of the full sample. Greater support for this policy was found for people with low to medium incomes, older age groups, females, and people living outside the catchment LGAs. These groups typically did not support recreation-permitting policies other than land-based recreation, with some also supporting non-motorised water activities with no direct water contact. In contrast, greater support for more recreation activities was found for males, people living closest to the catchments, people aged 18 – 29 (but note the small sample size), trade/apprenticeship and TAFE graduates, and people with annual incomes of $100,000 and above. These groups typically had higher support for each recreation-permitting policy, and supported more recreation-permitting policies by majority, than the other groups.

These findings are discussed in relation to the hypotheses and literature in Section 5.3. Broader implications of the study findings are explored in Chapter 6.

5.3. Discussion

Understanding the factors affecting community support for restrictive policies is critical for gaining community support for disaster- and health-risk reduction policies. Chapter 4 demonstrated that the HBM was a viable model of recreation policy support in the lower Hunter sample, with risk perception being a key driver. Further, differences in the influence of the HBM variables on different population subgroups, specifically gender and proximity to residence groups, were identified. The modelling, however, did not elucidate the level of support in the community for restrictive policies. Further, the modelling determined that variables other than the HBM constructs were likely exerting some influence on policy support. The purpose of this chapter was, therefore, to explore recreation policy support further in this sample, with the objective of gaining further understanding of variables affecting policy support. Group differences were also explored further to determine how those might differ between key groups. This section reviews the findings of the statistical and descriptive analyses undertaken, compares them to literature, and discusses the strengths and limitations of the study. Discussion of the broader implications of the findings is provided in Chapter 6, together with the study conclusions.

5.3.1. Findings

In addition to the HBM constructs, gender, and proximity of residence to catchments, which were identified in Chapter 4, recreation type, personal recreation preferences and worldview were found to influence recreation policy support. Overall, females and people living further away from the catchments were found to be the most supportive of recreation restrictions; these groups also had stronger ecocentric worldviews and higher recreation risk perception than the groups found to be most supportive of permitting recreation in the catchments, which were males and people living close to the catchments. Self-interest emerged as a key variable affecting recreation policy support, with people living close to the catchments being the most supportive of permitting recreation activities in those areas; in addition, personal recreation participation also affected policy support, with people more supportive of permitting activities in which they personally engaged. Further, the type of recreation activity played an important role in acceptance, with land-based activities being more acceptable than water-based activities, particularly motorised water activities. Overall, however, the results demonstrated that the majority of the community supported restriction of most categories of recreation in the catchments. This suggests that the reported ‘demand’ for recreation in this region’s catchments is more accurately described as interest from minority groups.

The six hypotheses tested in this chapter were derived from the Literature Review. As shown in Table 41, all the hypotheses were generally found to be supported. For the hypotheses relating to policy support, significant group differences were not found for each of the policy options explored, but were found for the majority of the policy options, and the general trends predicted in the hypotheses were found to be present; these results, therefore, were taken as support for the hypotheses. Significant differences were not found for any groups for the land-based recreation policies, which were supported by the full sample and all subgroups investigated. In contrast, consistent group differences were found in support for the motorised and non-motorised water-based activities (with and without direct water contact), indicating these forms of recreation activities were more contentious in this sample.

Table 41: Hypothesis Support

Hypotheses		Supported?
No.	**Description**	
H9	Passive land-based recreation will be more acceptable to the community than water-based recreation activities	Yes^
H10	Females will be more supportive of recreation restriction than males	Yes*
H11	People living further away from the catchments will be more supportive of recreation restriction than people living close to the catchments	Yes*
H12	People will be more supportive of permitting recreation activities in the catchments that match their own recreation practices than people not engaging in those activities	Yes*
H13	People supporting recreation restrictions will have stronger ecocentric worldviews than people supporting recreation activities in the catchments	Yes
H14	Females will have higher perceived recreation risk than males	Yes

^ Significance testing not undertaken

* Hypothesis found to be true for the majority of the policy options, and general hypothesised trend demonstrated.

5.3.2. Comparison to Literature

5.3.2.1. Influence of Different Variables on Policy Support

The findings that passive land-based activities were more acceptable than water-based activities was consistent with previous studies in Western Australia and Sydney (Bruce 2006, Nancarrow and Syme 2010, Petrie and Wrigley 1989, Sharp and Schell 1989); those studies also indicated that motorised water-based activities were less acceptable than non-motorised water-based activities, as was found in this investigation. The Hunter community appeared to be more accepting of recreation than those from the greater Perth Metropolitan Region by Nancarrow and Syme (2010), but were similar to Bruce (2006). It is feasible that the acceptability of recreation activities is influenced not only by perceptions of contamination, but by perceived environmental damage or disturbance (Rossi et al. 2016, Sharp and Schell 1989); this is supported by the high level of ecocentric concern found in supporters of recreation restrictions, as well as the general community, in the Hunter sample.

The finding that ecocentric worldviews were associated with support for restrictive policies was consistent with the literature (Nancarrow and Syme 2010, Salvaggio et al. 2014, Switzer and Vedlitz 2017a, Switzer and Vedlitz 2017b). Females, who had stronger ecocentric views and were more supportive of restrictive policies in this study, have been consistently demonstrated to have greater environmental concern (Haensch et al. 2020) and stronger pro-environmental views than males (Nancarrow and Syme 2010, Salvaggio et al. 2014), as well as greater recognition of ecosystem services (Flotemersch et al. 2019). This may be a result of their making stronger connections between environmental conditions and consequences for themselves, others, and other living things (Stern et al. 1993), which is also likely to be associated with greater risk perception. People living further away from the catchments also demonstrated stronger ecocentric worldviews and greater support for recreation restriction in the catchments, which is consistent with the findings of Flotemersch et al. (2019) that greater physical distance from ecosystems is associated with greater value placed on the provisioning services of the ecosystem rather than the recreational value.

While the Literature Review indicated that the influence of gender might vary with context, the modelling results in Chapter 40 suggested there might be gender differences in recreation policy support and risk perception. This was confirmed by the analyses in this chapter, which found females were more supportive of restrictive recreation policies, and had higher perceived recreation risk, than males.

The finding that females were more supportive of restrictive recreation policies than males was consistent with the literature showing females had greater support for restrictive policies in drinking water catchments (Nancarrow and Syme 2010) and marine parks (Haensch et al. 2020), and greater support for activity restrictions (Safford et al. 2014). The greater risk perception of females was also supported by literature; while the influence of gender on risk perception appears to vary with context, the general risk perception literature indicates that females are generally more sensitive to risk than males (Fielding et al. 2016). Starr et al. (2000) noted that the genders ranked hazards in the same order, but that females considered the level of the hazards to be higher than males. This might be explained by the findings of Davidson and Freudenburg (1996), who suggested gender differences in environmental risk perceptions, particularly in relation to contamination risks, resulted from females' greater level of concern about health and safety rather than lack of knowledge or familiarity with the risk.

The results are also generally consistent with the literature in the disaster and environmental field discussed in the Literature Review (Chapter 2) and the modelling study (Chapter 4), where females were found to have greater concern about, and greater behavioural action to address or prepare for, issues such as climate change and natural hazards (Bakhtiyari et al. 2017, Ejeta et al. 2016, Rostami-Moez et al. 2020, Semenza et al. 2011). Overall, the findings of this study suggest that females are more likely to be supportive of policies protecting human health and reducing disaster risk.

The study found differences in policy support by proximity of residence to catchments, with people living close to the catchments being less supportive of recreation restrictions in those areas. This finding is consistent with the analysis of data from Nancarrow and Syme (2010), which indicated that support for restrictive recreation policies was stronger with increasing residential distance from the catchments, and other studies showing that people perceive greater value in recreation locations closer to home (Brown et al. 2002, Ives et al. 2018, Raymond and Curtis 2013). The literature indicated that the likelihood of regular recreation visits to coasts, lakes and rivers decreased exponentially with increasing distance to one's residence, and that people were more willing to travel larger distances to visit the coast compared to lakes or rivers (Elliott et al. 2020), implying that the people living closest to the catchments are the ones most likely to recreate there. It is not unexpected, therefore, that these were the people who were most supportive of permitting recreation in these areas. Further, this study found people were more supportive of restricting recreation activities that they did not personally undertake; this was consistent with the findings of: Rissman et al. (2017), who found people were less supportive of policies that restricted their personal activities; Haensch et al. (2020), who found that people who valued recreation in marine parks were less supportive of implementing protected areas; and Bruce (2006), who found that recreational users of a dam were less willing to accept removal of recreation activities than those not using the dam.

The evidence, therefore, suggests that support for recreation in the catchments is greatest in the people who would be the most likely to obtain a personal benefit from that recreation. This interpretation is supported by the recent requests for greater recreational access to the Hunter catchments, which were received from people living adjacent to the main storage dam (Norris 2018), and requests from special interest recreation groups, such as kayakers and anglers (Stanmore 2018). Further, evidence suggests that people living close to, and who visit catchments frequently, attribute special values to them (Steinberg and Clark 1999).

Bruce (2006) found people supporting the separation of recreation and potable water storages considered water quality safety and protection above all other concerns, were highly risk averse and protective of water quality, and favoured protection over treatment. Supporters of recreation on potable water storages, in contrast, were willing to accept greater risk; considered water supply, development and drinking water to be compatible uses of water bodies; and preferred to rely on treatment above protection. This study found similar results. This clearly indicates different approaches would be required to change attitudes for the different groups and, therefore, highlights the importance of identifying different community segments, and of targeting actions to suit those segments, to increase the effectiveness of community engagement activities (Dean et al. 2016a). In this sample, efforts to increase community acceptance of restrictive recreation policies would be best targeted to people living close to the catchments and males, and to focus on recreation risk.

Comparison – Hunter v Perth

The survey used in the study was based on one developed by Nancarrow and Syme (2010) and used to capture data in the greater Metropolitan Region of Perth in 2010. A comparison of the findings of the two studies, therefore, is warranted. This study demonstrated that the community was supportive of permitting two categories of recreation in the catchments, which both related to land-based, non-motorised recreation. In contrast, the Perth study indicated that community was more supportive of recreation restriction than the Hunter sample, with strong majority support for retaining the existing restrictive policy, which prohibited human contact with the water and public access within two kilometres of the storages, and all off-road driving and water-based activities within the catchments; passive land-based activities were, however, permitted outside the restricted zone. It is noted, however, that the Perth study stressed that the risk of contamination would greatly increase if the policy was changed and more recreation was allowed closer to or in the water. They were also told that very little treatment of water was currently needed, and that increased recreation would mean increased costs for 'high level water treatment' and recreational management of about $600 million, with an associated increase in water bills of approximately 15%. This information could have affected respondents' perception of the risks associated with recreation, and the adverse cost implications to them as customers. Differences in water scarcity between the two regions is also noted; Perth has suffered significant reductions in its annual average rainfall since the 1970s and has implemented extensive water restrictions for many years (World Bank 2018); in contrast, the Hunter Region enjoyed relative water security for many years, avoiding the effects of the Millennium Drought that affected many areas of the state and country as a whole. Prior to the survey, the last drought affecting the Hunter region, which resulted in restrictions on water use, occurred in the 1980s. The scarcity of the water resources, and greater general awareness of the value of water in the community, may have contributed to the more conservative views in that community.

Some similarities were found, however, between the two studies — females were more supportive of restrictions than males; support for restrictions was greater for people living further away from the catchments; and motorised water-based activities were the least supported types of recreation activity in the catchments. Further, passive land-based activities were the most supported type of recreation activity in both studies. In addition, both samples indicated strong support for catchment protection and prioritisation of drinking water quality over recreation, with 80% or more of each region indicating that the use of dams should always take priority over recreation and that protecting our drinking water now is protecting our children's future.

The results indicate that regional differences exist in community attitudes; while studies in one region can provide guidance on potential community attitudes and concerns, consultation with the communities in question will always be required to understand their unique perspective. This is particularly important for DRR, as, in addition to the differences in recreation preferences, water utilities, and catchment management strategies, differences in surrounding land-uses and in climate and other natural hazards will also exist. The unique circumstances facing each community, and the communities' priorities, should be well understood for DRR decision-making, to determine which risks they consider acceptable, and what trade-offs they consider are justified. This is particularly true if greater risk exposure is being considered, such as is the case for increasing recreation access to catchments.

The results of the comparison showed that, in both regions, males and people living closer to catchments were more supportive of increasing recreation in the catchments. Campaigns to change minority views to match the views of the general community, therefore, should start by targeting these groups. Provision of information regarding the risks and consequences of the actions may sway their opinions; additional research is required, however, to determine the key factors influencing their attitudes.

Both studies suggested that pressure to open catchments was from minority special interest groups and, as such, did not represent the views of the broader community. Principles of DRR (UNDRR 2015) and the ADWGs (NHMRC 2011) indicate that this is not sufficient justification to increase risk to the whole community.

5.3.3. Study Limitations

The purpose of the study was to explore factors affecting policy support. Random sampling was undertaken to engage with a broad cross-section of the community, and to obtain a sufficient sample size to permit the analyses undertaken. While the method and size of the sample was appropriate for the study, and included a broad range of demographic groups, males and people living in the LGAs containing the catchments were over-represented in the sample. The sample was also skewed towards older age groups, with very low representation from people aged 18 – 29 years. Further consultation is required to understand community support for recreation in the catchments in this area more fully, with a particular need to gain better insight from females and young people, and to improve the level of understanding and awareness of the issues under investigation. While collection of a representative sample was beyond the scope of this project due to the research question and budgetary and time constraints, future research intending to be used to justify policy changes based on community attitudes should aim to ensure a random and representative sample is collected, such as through proactive and systematic polling methods. Undertaking deliberative research in the target population would also be beneficial. Specifically, representative participatory engagement activities such as citizen juries, which are carefully selected to be representative of the target population, would provide an evidence-based, transparent decision-making process for determining which risks are acceptable to the informed community (Smith and Wales 2000).

As stated previously, the model investigated in Chapter 4 excluded the No recreation, Non-motorised water activity with no direct water contact (like kayaking or sailing), and Non-motorised water activity with direct water contact (e.g. wind surfing and kite surfing) policy options. All recreation policy options were included in the analyses in this chapter for completeness; no consistent differences in policy support factors were noted for the categories of recreation excluded from the model.

The recreation policy options did not include an option for motorised land-based recreation, such as four-wheel driving and trail biking. Given the very low number of respondents engaging in these activities, and the comments about the noise generated by motorised boating activities, it is not expected that there would be strong community support for these activities to occur in sensitive locations. It is noted, however, that much of the unauthorised access occurring in the catchments relates to four-wheel driving and trail bike access, particularly in the sandbeds and around the edge of Grahamstown Dam (Stanmore 2018).

As noted in Chapter 4, the applicability of the study findings to other locations and contexts has not been demonstrated. Further research is required to determine if the variables identified in this study exert a similar influence in other populations and for different risk reduction policies.

5.3.4. Summary

In addition to the variables explored in the previous chapter, recreation type, personal recreation participation and worldview were found to affect recreation policy support. Females, people living outside the LGAs containing the catchments, and people with strong ecocentric worldviews were most supportive of restrictive recreation policies, while males and people living close to the catchments were more supportive of permitting recreation in the catchments. In addition, people supported recreation policies that would permit them to engage in their preferred forms of recreation in the catchments. Passive land-based recreation was supported by all groups investigated in the study; in contrast, water-based activities were less supported overall, with motorised water-based activities only supported by people undertaking those forms of recreation. Together, these results suggest that, in addition to the HBM variables explored in Chapter 4, gender, worldview, self-interest and recreation type are key factors affecting recreation policy support.

The role of risk perception in policy support was explored further. As determined in Chapter 4, higher perceived recreation risk was associated with greater support for restrictive policies. This chapter confirmed that females and people living further from the catchments perceived recreation to pose a bigger risk to drinking water than males and people living close to the catchments, who were more supportive of recreation; the former subgroups also had stronger ecocentric worldviews. People living inside the catchments are a key target for intervention in this region to increase support of catchment protection policies.

The strong influence of self-interest is noteworthy. While permitting recreation in the catchments would benefit the people who want to recreate there, the increased risks and costs associated with such action would be shared by the whole community. In contrast, catchment restrictions benefit the whole community of reticulated water users. As noted by Wilson (1930): ‘In the discharge of any public trust it is often necessary to limit the privileges of a few for the benefit of the many…’ (p358). To put it more simply, ‘Logic clearly dictates that the needs of the many outweigh the needs of the few’ (Meyer 1982).

Overall, however, the community indicated support for permitting only two categories of recreation — passive and active non-motorised land-based recreation. These forms of recreation pose the lowest risk of contamination of water sources, particularly in relation to pathogens, which, as previously noted, are the key contaminants of concern for potable water supplies. In contrast, there was very strong community opposition to motorised water-based activities, which are not only significant sources of contamination but also cause significant environmental degradation and disturbance in an area of the catchment located close to where the main water supply is extracted. This has important implications for the future of these activities in the catchments. Of note, however, was the relatively strong support for swimming and other non-motorised, direct contact water-based activities. Given the potential of these activities to introduce pathogens into the water sources, broad community education regarding pathogenic risk is warranted.

Given the strong support in the community for drinking water protection and prioritisation of drinking water above recreation needs, and the lack of support for permitting most categories of recreation in the catchments, the study suggests there is strong support in the community for restrictive recreation policies. This finding supports the current precautionary approach to catchment protection in the lower Hunter, which serves to reduce both health and disaster risks to the community's water supplies.

This study provided information regarding the factors affecting policy support, as well as differences in policy support between different subgroups of the community. A discussion of the broader implications of this research is provided in Chapter 6, which explores the importance, contribution, significance and application of the research findings.

Chapter 6. Discussion and Conclusion

Chapter 6

6.1. Chapter Overview

This dissertation investigated the variables affecting community acceptance of policies to mitigate health-related disaster risk by exploring the influence of several personal characteristics on support for restrictive recreation policies in drinking water catchments. Protection of drinking water sources and their catchments is a fundamental role of water managers in Australia, and is undertaken primarily to protect public health, but also serves to benefit the community through reduced treatment costs, environmental protection, and increased resilience of the water supply, thereby increasing community resilience and reducing disaster risk.

The Literature Review (Chapter 2) identified potential variables influencing policy support, with risk perception emerging as a key contributing factor; the lack of an accepted theoretical model of policy support was also discovered. A potential candidate model (the HBM) was identified in the health behaviour field. Testing of the model's efficacy to explain policy support was undertaken using the powerful second order statistical technique of PLS-SEM, which both validates the survey items and assesses the relationships between, and importance of, the model variables in explaining the outcome variable, policy support (Chapter 4). Data used in the modelling assessment were collected from a community survey of the lower Hunter Region of NSW, Australia, using a previously published instrument, which was modified to capture the HBM variables and other key factors identified in the Literature Review (Chapter 3). Additional analyses were undertaken to explore policy support further in the study sample; gender and self-interest (proximity of residence to catchments and personal recreation preferences) were found to be key differentiating characteristics in the Hunter sample (Chapter 5). Together, the analyses verified the HBM as a viable and useful model of recreation policy support, and identified key community subgroups in the sample to which interventions could be targeted to enhance their support of restrictive recreation policies.

As the two empirical chapters (Chapters 4 and 5) discuss literature relevant to their specific findings, this chapter focuses on the broader context of the findings. The principal findings of the empirical studies and their overall importance and significance are described, as well as the contribution of the study to the existing body of knowledge (Section 6.2). The implications and applications of the study for water managers are discussed, followed by an outline of directions for future research. The conclusion completes the dissertation (Section 6.3).

6.2. Discussion

The overarching goal of this study was to understand how to increase community acceptance of DRR policies. The study research question focused on investigating the variables affecting community acceptance of risk reduction policies in the context of support for policies restricting recreation in drinking water catchments. Risk perception was demonstrated to be a key influence, with stronger perceptions of the risk of recreation to water quality associated with stronger support for recreation restrictions. Risk perception was itself positively influenced by the perceived severity of waterborne illness and, to a lesser extent, perceived susceptibility to waterborne illness. Perceived benefits of recreation restriction also had a positive effect on support for recreation restrictions and served to mediate the negative effects of perceived barriers to recreation restrictions on policy support. The type of activity proposed also strongly affected whether its restriction was supported, with restrictions on motorised water-based activities supported by the strong majority of the community in the sample in contrast to passive land-based activities, which were considered acceptable to most people. Of note, respondents were generally less supportive of restricting activities in which they personally engaged. Two demographic variables demonstrated clear differentiations in policy support — gender and proximity of residence to catchments. Females and people living further away from the catchments were more supportive of restrictive policies, and had stronger recreation risk perception and ecocentric worldviews, than males and people living close to the catchments. The key target group identified for intervention in this study sample was males living close to the catchments. The four key findings emerging from the study are discussed and explored in the following sections.

6.2.1. Principal Findings

6.2.1.1. The Health Belief Model was a Viable Model of Policy Support

While no accepted model of policy support was identified in the Literature Review, risk perception emerged as a key influencing variable. The HBM is a model of health behaviour used extensively in behavioural health research, and is, essentially, a risk assessment and cost-benefit model, based on the theory that perceived susceptibility (likelihood), severity (consequences), barriers (costs) and benefits explain behaviour as shown in Figure 10. The HBM was selected as a candidate model for exploration in this study to explain support for policies restricting recreation in catchments, which serve to reduce health and disaster risks. The HBM's efficacy in explaining recreation policy support was tested through the use of PLS-SEM, a powerful statistical technique with the capacity to assess individual influences of factors and their interrelationships.

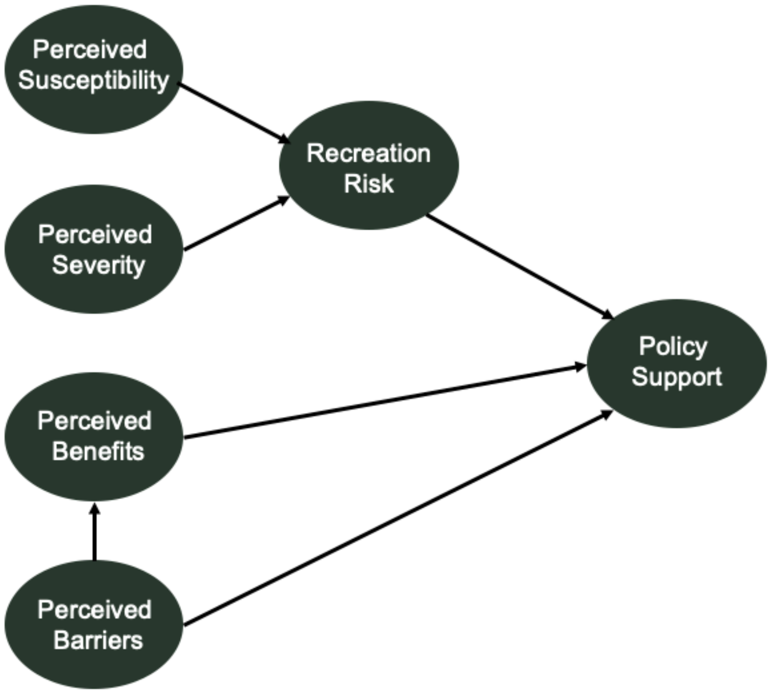

Figure 10: Health Belief Model of Recreation Policy Support

The HBM was found to be a valid model of recreation policy support for the lower Hunter population sample, explaining between 53 and 67% of the variance in policy support in the different demographic groups assessed (females, males, and two male subgroups — those living close to catchments and those living at a distance from catchments). Perceived susceptibility and perceived severity exerted indirect influences on recreation policy support through the recreation risk (perceived threat) variable, which was itself most influenced by perceived severity, while perceived benefits mediated the effect of perceived barriers on recreation policy support. The model had the greatest predictive ability for the group least supportive of recreation restrictions (males living inside the catchments) in this sample, which was identified as the key target group for intervention.

This study supports the application of the HBM in the fields of environmental psychology and DRR. As described in the Literature Review, the HBM has been used successfully to explore phenomena such as renewable energy use, organic farming practices, recycling behaviour, as well as responses to long-term risks and disasters such as climate change, drought, and flood and general disaster preparedness (Bakhtiyari et al. 2017, Boazar et al. 2020, Ejeta et al. 2016, Rezaei and Mianaji 2019, Savari et al. 2021, Tajeri moghadam et al. 2020, Yazdanpanah et al. 2021a, Yazdanpanah et al. 2021b, Zobeidi et al. 2021). It is notable that, unlike this study, most studies identified in the literature did not define or assess the relationships between the model constructs; the definition of the variable relationships in different contexts may provide useful information upon which interventions may be based.

This study also explored the use of the HBM in a novel context of policy support. Previous research was limited to the use of the HBM to predict behaviour under an individual's control; in contrast, policy support can be thought of as behaviour supporting a third party to take action, and this study found the HBM to have predictive power in this context. A recently published study supports the use of the HBM in this manner; Suess et al. (2022) successfully applied the HBM in the context of exploring travellers' support for policies requiring travellers to be vaccinated against the COVID-19 coronavirus. That study did not assess the core HBM variables, with additional variables included in their model, and the perceived barriers variable was excluded; further, the model structure was conceptualised in quite a different manner than in this study. Regardless, the HBM was found to be robust: perceived susceptibility, perceived severity and perceived benefits were all found to influence policy support for mandatory vaccination, albeit indirectly, with the model explaining between 41% and 70% of the variance in policy support for the different groups explored. The model was found to have the greatest explanatory power for the more frequent travellers (those with greater self-interest); that finding was similar to this study's finding that the model had the greatest predictive power for the group most supportive of recreation activity, who arguably had the greatest self-interest in recreation being permitted. These results indicate the HBM may serve to be a useful model of policy support for a variety of different health and disaster-related policies.

6.2.1.2. Recreation Risk Perception was a Key Driver of Recreation Policy Support

Recreation risk perception was the strongest driver of recreation policy support in all the groups assessed in this study, with high risk perception associated with higher support for recreation restriction (lower support for permitting recreation activities). Risk perception was found to vary among different segments of the community, and appeared to be influenced by gender (with females having higher risk perception than males) and proximity of residence to catchments (with people living outside the catchments having higher risk perception than those living inside the catchments). Within the model, the perceived severity of consequences of water contamination had a stronger influence on recreation risk perception than the perceived susceptibility of an individual to waterborne illness, although both factors significantly contributed to recreation risk perception for most community subgroups. Risk perception appears to be a key target, therefore, for intervention to increase community acceptance of DRR policies.

The gender differences in risk perception found in the studies were consistent with the wide body of evidence indicating that females often have higher risk perception of specific risks, as well greater general sensitivity to risks, than males (e.g. Fielding et al. 2016, Fielding et al. 2015b, Finucane et al. 2000a, Starr et al. 2000). It must be noted, however, that while females often demonstrate greater concern or risk perception (e.g. Bakhtiyari et al. 2017, Nancarrow and Syme 2010), gender differences in risk perception are not always noted (e.g. Akompab et al. 2013, Straub and Leahy 2014).

This dissertation adds to the growing evidence supporting the fundamental influence of risk perception on policy support (Stoutenborough et al. 2015), although it is noted that the hierarchy, or salience, of risks differs for individuals and contexts (Stoutenborough 2015). Risk perception is known to be individual and affected by emotion (Slovic 1987), and this dissertation provides evidence to suggest that self-interest may be a key factor affecting those emotions; the role of self-interest is described further in the next section. The risk perception of those supporting recreation in the catchments may have been diminished or outweighed by the perceived personal benefits to be attained that were not related to waterborne illness, such as the perceived enhanced property values for locations close to reservoirs, the convenience of recreation locations closer to home, or the addition of new locations in which to engage in their favourite pastimes. Non-personal benefits, such as an expected increase in tourism and associated economic benefit to the community, might also have been a factor, as found by authors such as Flint and Koci (2021). In the case of people supporting recreation restrictions, the perceived health risks associated with recreation may have been a dominating factor, and may be related to the perceived risk to their own health or the health of their families or communities, or the risk to the health of the environment and its myriad inhabitants, as suggested by the modelling and additional analyses relating to worldview. Further exploration of these potential influences on policy support would be useful.

Lower recreation risk perception may also be associated with greater comfort with treatment processes and greater confidence in treatment technologies and processes to keep the water safe to drink. This interpretation is supported by the findings of Nancarrow and Syme (2010), who found that people more supportive of recreation in the catchments thought there was a higher level of control for drinking water contamination compared to those who were supportive of recreation restrictions. Further exploration of the influence of these variables, and the interactions with other factors affecting risk perception, is required.

Given that only a few categories of recreation activity were supported by the majority of respondents, the study suggests that the population is concerned about the risks recreation poses to water quality. This is consistent with the research by Starr et al. (2000), who found that nearly 80% of respondents in an Australian survey considered pollution of drinking water reservoirs to be a high or moderate risk to the general population. That study also found that, while risks to drinking water were not the highest rated risks when compared to other general or environmental risks, drinking water quality was an issue of concern for many, if not the majority, of people.

6.2.1.3. Self-interest is a Key Factor Influencing Policy Support

Two key self-interest factors were associated with policy support — proximity of residence to catchments and personal recreation preferences. People living close to the catchments were most supportive of permitting recreation in the catchments, while people living further from the catchments were more supportive of excluding all recreation activities and of restricting specific types of recreation activities; this was also found by Nancarrow and Syme (2010). Personal recreation preferences also had a significant effect on some recreation policies; as reported in Chapter 5, the majority of people not engaging in outdoor recreation supported excluding all recreation activities from the catchments, while people engaging in specific types of recreation activities were significantly less supportive of restricting those types of activities in the catchments. This finding is consistent with the literature — few recreators support complete removal of recreation access, and serious recreators have been found to be less supportive of restrictions than the general community (Hardiman and Burgin 2010, Nancarrow and Syme 2010). Further, as previously noted, Suess et al. (2022) found self-interest (in the form of frequency of travel) influenced the explanatory power of the HBM in explaining COVID vaccination policy support.

Evidence suggests that self-interest is more likely to influence policy support when respondents have been primed to consider their personal benefits and barriers to the policy (Chong et al. 2001), such as occurred with this study. Of note, the modelling indicated that the group most opposed to recreation restrictions had the strongest perceived barriers to recreation restrictions as well as the lowest recreation risk perception; these variables appear, therefore, to have been influenced by self-interest. People living near catchments attribute special values to them (Steinberg and Clark 1999). Place attachment and opposition to policies affecting valued uses of a site have been associated with optimism bias and psychological distancing, which reduce the perceived risks associated with hazards (Mallette et al. 2021) and likely increase the perceived barriers of actions. If such factors are found to be at play, measures to reduce them may be successful in increasing perceived risks and benefits of risk reduction actions. It is also noted that values have a greater influence on policy support when people have a lower level of self-interest in the policy (Chong et al. 2001). Previous studies demonstrated that support for protection and restoration policies was reduced when the policies were considered to have negative consequences for not only the self and one's personal activities, but also for the community or the environment (Rissman et al. 2017, Safford et al. 2014, Stoutenborough and Vedlitz 2014). Further exploration of the extent of the influence of self-interest and values on risk perception, perceived barriers and policy support would be useful.

The influence on self-interest on risk perception and policy support has important implications for the level and nature of community engagement undertaken to develop or communicate protective policies. There is an increasing trend in government to have significant stakeholder involvement in policy development. This is seen to be important not only because community support is necessary for effective implementation (and for re-election of political parties), but because policy should reflect community values (Stoutenborough et al. 2015). It is important to note, however, that policy in a democratic country such as Australia (and, arguably, all countries) should act to benefit the community as a whole, for the common good rather than for the benefit of only a vocal or powerful minority. This is particularly true of policies relating to the mitigation of public health and disaster risks. DRR policies are intended to mitigate risks for the benefit of the community as a whole and, as described previously, may result in restrictions that conflict with individuals' goals and wants. It is likely, therefore, that there will always be some opposition to such policies, which may be primarily driven by self-interest.

The role of self-interest in policy support is an important consideration for policy development and consultation. The detrimental consequences of self-interest were conceptualised by Hardin (1968) in his metaphor of the 'tragedy of the commons'. In theory, co-operational and fair use of shared resources should provide benefits for all; in practice, however, many people seek to serve their individual interests above those of the collective, resulting in degradation and overuse of the shared resources to the detriment of all, unless self-interest is constrained through some form of regulation. The manifestation of the tragedy of the commons has been demonstrated in many contexts, including overfishing, degradation of national parks, carbon pollution, air pollution, water pollution (Hardin 1968) and, more recently, toilet paper shortages during the initial stages of the coronavirus pandemic.

The metaphor applies to the use of potable water storages and catchments. As noted in the Literature Review, proponents of recreation in the catchments argue that catchments and storages are public resources; that is, they are 'commons' (Hughes et al. 2013, Hughes et al. 2008). While they serve to generate and store public water resources, viewing the potable water storages and catchments as commons for other activities leads to the erosion of their aspects that create value, such as clean water, and is likely to result in the overuse and degradation of a resource that provides an essential service to the community.

Not only does the tragedy of the commons explain the role and consequences of self-interest in relation to physical actions, it also applies to policy support. If individuals are driven by self-interest, then they will support policies that serve that self-interest, and that may lead to negative consequences for others, such as the inequitable use of resources and unfair distribution of burdens for the resultant negative consequences. In terms of essential resources, such as clean drinking water, it is crucial for both equity and community resilience that these resources are allocated and used fairly (Syme et al. 1999). In terms of recreational use of potable water sources and storages, the fairness criterion is not met if the demand is driven by the self-interest of a small segment of the population. In the case of recreation in catchments in the lower Hunter Region, this study suggests that requests for greater recreation access represent the wishes of some people living closest to the catchments and special interest groups, who arguably would obtain the most benefit from policies permitting recreation in these locations.

There are two key facets of these benefits worth noting: their inequity, and the long-term adverse consequences. The benefits of permitting recreation in the catchments would likely be of greatest benefit to those living closest to the catchments, as their proximity makes the catchments more visible (and desirable) and more accessible, and there are many alternative locations in the region in which people living further away are potentially more likely to make use of. Further, those living close to the catchments may benefit from increased property values associated with proximity to a more desirable location. The costs, however, would be shared by everyone supplied with water by the regional water utility. Such costs may be financial, such as through additional treatment, management and insurance costs associated with the recreation activities, but also relate to the increased risks to health and resilience of the water supply recreation (Billington and Deere 2020, Miller et al. 2006). In addition to the inequitable distribution of benefits, the costs would also inequitably affect the community; the costs would be greater for the more vulnerable members of the community, such as the elderly and the immunocompromised, who are more at risk of bad outcomes from waterborne illness, and those with low incomes, who may struggle to afford the essential service of potable water if costs increase to accommodate greater treatment.

The long-term adverse consequences of the actions are also important. Not only will the financial costs to customers be ongoing if additional treatment plants are required to manage the created contamination risks, but the degradation of the catchments and their associated environments could have long-term adverse effects on water quality, and have broad-ranging consequences for system resilience (Krogh et al. 2009, Miller et al. 2006). In contrast, catchment protection policies have long-term, broad-scale benefits.

As Wilson so eloquently wrote, ‘The demand to open our lakes does not proceed from a real necessity which must be satisfied — it is rather a luxury, to be indulged as becomes a luxury, certainly not at the expense of others.’ (Wilson 1930, p358). This is particularly relevant in areas where alternative recreation locations exist, such as in the study area. Regulation is required, therefore, to mitigate the effects of self-interest (Hardin 1968); in the case of water quality, this can be achieved through catchment protection policies, including restrictions on recreation.

Having established the need for catchment protection policies and that policy support is affected by self-interest, it is important that the role of self-interest in policy support be recognised and appropriately addressed. Stakeholders are likely to present views and support actions that support their own interests, indicating that the views of single individuals or small groups of individuals are not likely to reflect all the views or interests of the wider community. The need for broad consultation to represent as many community views as feasible is evident.

Further, it is critical that engagement activities and subsequent policies are based on input that is not only representative, but that is informed. As demonstrated in the Literature Review, the community generally has a low level of water literacy, which means they cannot fully appreciate the risks to the water supply system associated with different actions. Key aspects of engagement activities and responses to community attitudes to protective policies requiring attention are the level of awareness and understanding within the community of the risks and implications of failure to implement a protective policy, and gaining an understanding of the objectionable aspects of the policy. Many people are likely to have biased views that do not necessarily account for all the critical factors that should be considered in decision-making. In terms of catchment protection, such factors include increases in health risks, decreased system resilience, and additional costs to customers for their water supply.

Syme et al. (1999) found that fairness can mitigate self-interest in the area of water use allocation; efforts targeted at illustrating fairness principles may, therefore, serve to modify pro-recreationists views of recreation and catchment protection. Given the results of this study suggested a strong influence of self-interest on recreation policy support, the effect of fairness on self-interest in relation to recreation policy support would be a useful avenue of exploration, and may enhance efforts to increase the perceived risk, and reduce the perceived barriers to restrictions, previously mentioned. The influence of self-interest is likely to be an important determinant of the success of efforts to increase community acceptance of risk reduction policies, and warrants further investigation.

6.2.1.4. The Type of Recreation Activity Significantly Affects its Acceptability to the Community

This study's findings that land-based activities were more acceptable than water-based activities, and motorised activities were less acceptable than non-motorised activities, was consistent with the early literature from Western Australia and Sydney (Bruce 2006, Nancarrow et al. 2010, Petrie and Wrigley 1989, Sharp and Schell 1989, Syme and Nancarrow 2013). It appears, therefore, that the types of recreation activities in catchments desired by most of the community in different areas may be of a relatively low risk to water quality. Activities presenting a low risk to water quality may be considered by water managers if there is sufficient community interest, an appropriate commitment to and funding for management of the activities, and sufficient treatment available to manage the risks. It must be noted, however, that the cumulative effects of different hazards to catchments and water quality must be assessed (Billington and Deere 2020), including consideration of how permitting some activities in the catchments may lead to greater expectations in the community for additional activities.

The acceptability of many of the activities in this study was generally consistent with the level of risk posed to water quality as judged by water managers (Syme and Nancarrow 2013); a key exception, however, was the relatively high level of support for swimming in the Hunter community, and for non-motorised direct water contact activities. Direct water contact activities in reservoirs and catchments would be a key source of pathogenic contamination, which is the contamination type posing the greatest threat to public health (NHMRC 2011). Broad community education in this community regarding pathogen risks is, therefore, recommended.

Of particular note is the strong community support for restriction of motorised water-based activities in the catchments. Such activities are currently permitted in a very sensitive location of the region's main surface water supply (the weir pool, from which water is extracted for pumping into the main surface reservoir), and have been demonstrated to be associated with significant erosion and damage to the riverbanks (Glamore et al. 2015, Healthy Rivers

Commission of New South Wales 1996), and significant pollution loads to the drinking water source. Articles regarding the associated deteriorating water quality, erosion issues, and the future of motorised boating are published regularly in local newspapers and media, which suggests that there is extensive community debate about the issue (Bevan 2021, Bevan 2020a, Bevan 2020b, Kelly 2016, Portelli 2020, Sharpe 2016). In this sample, these activities were only considered acceptable to participants personally engaging in these activities. This contrasts with the findings of the Williams River Inquiry (Healthy Rivers Commission of New South Wales 1996), for which more community submissions were received in support of retention of boating on the weir pool as opposed to those supporting removal of the boats. It is notable, however, that most pro-boating submissions in that study were via a form letter and, critically, that the consultation focused on residents and businesses in the Williams River catchment; that is, people who were more likely to use the river for these activities. It is also notable that this section of the community receives potable water from a different catchment, which is not affected by the boating activities. While some submissions were received from people living outside the catchment, it is argued that the views of the broader community, including those whose water supply would be most affected by the boating activities, were not necessarily captured. In contrast, the current study surveyed a broader section of the community. Overall, the results suggest that motorised boating in the weir pool has only localised benefits, that supporters of these activities are a vocal minority group, and that their activities are not supported by the broad community.

The water utility has a legislative requirement[22] to conduct its operations in compliance with the principles of ecologically sustainable development, including use of the precautionary principle to prevent environmental damage and protection of biological diversity and ecological integrity. The decision regarding whether to allow motorised boating on the weir pool is under the control of a different government agency. While the water utility may not have authority over activities occurring in the weir pool, it has a responsibility to advocate for the removal of motorised boating from the area in order to protect water quality and reduce disaster risk. This study provides evidence of strong community support for such action, indicating that these activities are generally only desired and considered acceptable by the people who directly benefit from them.

6.2.2. Research Importance

DRR is a critical part of community resilience. While disasters may only explicitly affect a proportion of the community, the adverse effects are typically felt more broadly, with consequences that can cause both tangible and intangible damage and losses on different spatial and temporal scales (Walia et al. 2021). As such, it is in communities' best interests to

[22] *State Owned Corporations Act 1989 and Protection of the Environment Administration Act 1991*

mitigate disaster risk wherever possible. Under the Sendai Framework (UNDRR 2015) and National Disaster Risk Reduction Framework (NDRRF) (National Resilience Taskforce 2018), every level of society has a responsibility to minimise existing risks, and prevent new disaster risks, that are within their control.

Measures to mitigate disaster may conflict, however, with the preferences and wants of individual community members. For example, people may desire to live in floodplain areas, as they are located close to services or amenities, while others desire a 'tree-change', wanting to live in bushland areas; development in such areas is associated, respectively, with flood and bushfire risks. Restrictions on the type and location of dwellings people can build can cause aggravation and opposition, as well as challenges to policy and pressure on governments to ignore disaster risks. In the case of recreation in drinking water catchments, some community members may feel that the catchments are public resources (Hughes et al. 2013, Hughes et al. 2008) and, as such, should be accessible to the public to engage in activities that they enjoy, such as swimming, boating and camping. As these types of activities contaminate the water sources, however, they increase public health and water supply risks (Krogh et al. 2009, Miller et al. 2006), thereby making public access the hazard from which the community needs protection in order to prevent potentially avoidable disasters.

While it is acknowledged that it is unlikely, or even impossible, to please all the people all the time, it is desirable to have policies that are acceptable to as many people as possible in order to maximise the number of people abiding by them and to minimise the number of people challenging them (Stoutenborough et al. 2016). It is important, therefore, to understand how to increase community acceptance of risk reduction policies, particularly in those individuals who feel their freedoms and desires are being restricted. This requires an understanding of variables affecting acceptance and which groups require targeting for intervention or other action. This research helped to achieve this goal by identifying and verifying a model of policy support, which enabled the identification of target groups and variables for increasing acceptance of risk reduction policies in the context of recreation in catchments. Application of the model in other contexts may help to understand and guide actions for increasing community acceptance of policies that protect the community against other disaster risks.

6.2.3. Research Contribution

The key contribution of this study relates to the novel application of the HBM. This theoretical contribution is important for two reasons. First, the study demonstrated the efficacy of the HBM in a novel application. The HBM has traditionally been used to explain behaviour and action under the control of the individual; in contrast, this study found that the HBM can be used to explain an individual's support for behaviour to be undertaken on their behalf, or the behalf of the community, by an external agent. Second, the study filled the gap in the literature by demonstrating that the HBM has utility as a theoretical model of policy support.

Lack of support for risk reduction policies can lead to non-compliance with policy requirements, as well as lobbying by interested parties to change policies that are not seen to be fair, reasonable or just, or even simply not consistent with personal or group preferences. A stark example of this was recently seen during the COVID-19 pandemic, which is arguably a period where public freedom in Australia faced its greatest challenge, and the government exerted the greatest control over the activities of a free society. The community was divided along public health and personal freedom lines, with non-supporters of the policies disobeying laws and guidelines for acceptable activities, travel restrictions, and physical distancing and mask wearing mandates, as well as participating in large-scale protests (Australian Associated Press 2021, Malone 2021, Ward and Carroll 2022, Convery 2021). It is important to note that, as the government began prioritising the economy over public health, and bowed to perceived public pressure to ease restrictions and even the most basic of protective measures, Australia's infection rate soared to become the highest in the world (Lu 2022).

While recreation in catchments has not generated the same level of passion as COVID-19 to date, parallels between the two circumstances are evident. Where a policy is inconsistent with one's personal desires, one is not likely to adhere to its requirements. One key factor in increasing community acceptance, therefore, may be making the policy more salient or relevant to non-conformists, in order to change their attitudes towards it.

This study provides guidance to meet this goal, by demonstrating that the HBM variables had explanatory power for policy support — in this case, policies relating to recreation activities in catchments. The model was only tested in this particular case, and in a particular location — the lower Hunter Region of NSW. While the data pertained to these particular circumstances, the implications of the study have broader reaching consequences. As each catchment or region is subject to its individual risks and hazards, management measures and policies for catchments vary (Miller et al. 2006). Further, individuals vary in their level of compliance with authority declarations, as well as in their personal interests. Given similarities noted between attitudes in the Hunter and the greater Perth and Sydney regions reported in this dissertation, however, it is feasible that the model will have explanatory power in other catchments. The influence of the individual constructs may vary with circumstance and location, while the model structure itself may prove robust to changes or may need refinement in different contexts.

While this study specifically investigated support for a health-related policy, the HBM is, at its core, a risk assessment model. Previous research has demonstrated the usefulness of the model in the disaster domain, and the model has the potential to explain support for other DRR policies. Further, given that many, if not all, policies are arguably developed to address a risk of some nature, the HBM might serve as a more general explanatory model of policy support. Research is needed to explore the efficacy of the HBM to explain policy support in other locations and contexts.

6.2.4. Study Implications and Applications for Water Managers

The study identified and validated a model for understanding community support for risk reduction policies, which provides insight into the key variables affecting policy support and how those variables differ between different groups, providing guidance for where actions could be targeted in order to increase policy support. The use of the HBM offers two key benefits — it can identify which groups have views that are inconsistent with the rest of the community, and can also offer important intelligence for identifying which factors may be more salient for those groups, thereby providing targets for effective interventions.

The study findings concurred with the observation by Harrington et al. (2008) that a community typically comprises multiple groups and individuals with a variety of conflicting values, attitudes and priorities, rather than being homogenous. It is also known that identifying, and addressing, group differences can lead to more effective engagement activities (Dean et al. 2016a). This study provides a mechanism for understanding group differences in policy support and using that knowledge to develop more effective community engagement. The study findings have important applications and implications for water managers.

Potable water is a scarce resource, and is becoming more vulnerable with climate change (WSAA 2021). Water security is one of the biggest challenges to future societies. The water industry protects water security by having multiple water sources where possible, but, given changing climatic conditions and increasing development pressure on catchments, the risk of the utilities' capabilities being overwhelmed is also increasing (National Resilience Taskforce 2018, WSAA 2021). Mitigating hazards, such as recreation, where possible and gaining broader acceptance of risk reduction policies from all stakeholders (including government decision-makers and the community) is becoming more critical. Further, appropriate management of water security risks is part of the water managers' due diligence obligations and risk management obligations. The implications of this study for water managers are discussed in the following sections.

6.2.4.1. Due Diligence

The water industry in Australia is experiencing continual challenges associated with climate change and increasing development in sensitive catchment areas, which, inevitably, increase the risk to the potable supply (WSAA 2021). Increasing development in catchment areas leads to greater pressure on Australian metropolitan water utilities to allow greater recreation access, an action that would further increase hazards to the potable water supply (Krogh et al. 2009, Miller et al. 2006). Increasing recreation access in catchments could result in significant changes to risk profiles, current operating practices, treatment processes and management activities, as well as potentially significant extra costs to the community (Billington and Deere 2020, Miller et al. 2006), in addition to representing a failure to meet DRR responsibilities

(National Resilience Taskforce 2018). Such an action may also represent a failure of due diligence.

Water utilities in Australia are tasked with providing not only safe drinking water, but providing a secure and affordable essential service to the community, and are required to demonstrate due diligence in managing the risks associated with their operations. One key requirement of due diligence is to demonstrate that foreseeable risks to consumers have been appropriately assessed and addressed (Davison and Deere 2005). In this sense, due diligence requirements are consistent with DRR principles. In the case of recreation, it is important to note that the community is the hazard, and recreation, while accepted as important for health and wellbeing, is not essential — particularly compared to the need for safe drinking water — and does not need to be undertaken in a specific form or location. Recreation, therefore, is a key target for hazard reduction by water authorities.

Restrictive recreation policies meet due diligence requirements in a number of ways. First, the negative effects of recreation on water quality have been clearly demonstrated (Miller et al. 2006); as such, restricting recreation access reduces the risk of waterborne illness. Further, industry best practice mandates that source water protection is of the utmost importance and must never be compromised, and that health protection must be prioritised over any other objectives for potable water sources (Billington and Deere 2020, NHMRC 2011). Third, recreation restriction avoids the additional financial costs associated with the management of increased recreational access and additional or enhanced treatment processes required, as well as the additional risks associated with those treatment processes (such as chemical by-products, which can negatively affect health), and the risk of failure. These costs would inequitably affect the most vulnerable community members, such as the immunocompromised, the elderly, and those struggling financially.

Recreation restrictions are consistent with the precautionary approach of the ADWGs (NHMRC 2011), to which many water managers are required to adhere; this approach has even greater importance given the previously noted increasing risks to water quality and security associated with climate change. Recreation restrictions are also consistent with DRR responsibilities, which include prevention of foreseeable new hazards and reducing existing hazards (UNDRR 2015). As such, restrictive recreation policies are considered fundamental to the demonstration of due diligence by water managers. The implications for increasing community acceptance of restrictive recreation policies are discussed in the following section.

6.2.4.2. Increasing Support for Catchment Protection

Management of disaster (and other) risks requires the implementation of effective risk reduction policies, which requires support from stakeholders. This study serves to help water managers understand the factors affecting policy support and identify ways to increase that support, both in people affected by the policies (the community) and other stakeholders who can override those policies or implement other policies that contravene the intent of the water managers' risk reduction policies (the government).

Community

The key focus of this study was to understand community attitudes with the eventual aim of understanding how to increase community acceptance of risk reduction policies. This study provides a means for water managers to understand, and potentially influence, community attitudes to recreation, by identifying target variables and groups for interventions, in order to reduce disaster risk and increase the resilience of the water supply.

The HBM was validated as a model of support for policies restricting recreation in the catchments of the lower Hunter Region of NSW, and the findings can be applied to this population, where males living close to catchments would be the key target group for intervention. Catchment protection measures vary between catchments and utilities, however, so it is likely that community attitudes towards, and support for, catchment management policy will differ according to the particular catchment of interest to them and the particular restrictions imposed in that area, as was found when comparing the study findings to those of Nancarrow and Syme (2010). This has implications for policy development and implementation, as the attitudes of one community cannot be generalised to attitudes of other communities in different catchments, although some similarities are to be expected. It is critical, therefore, to understand the local context and local views, and to target policies and campaigns to address local issues, concerns, and values.

This study indicates that the HBM can be used by the water industry to understand community attitudes. In order to make the most informed decisions, the model should be run in each area of interest to confirm the factors of greatest importance in any particular population, and to determine subgroups that are key targets for intervention or attitude change campaigns.

As noted previously, risk perception was a key influence on policy support. Risk perception is considered to be influenced and modified by information (Stoutenborough et al. 2015), and evidence indicates that providing information regarding the reasons for risk reduction policy can change attitudes to, and increase support for, those policies (e.g. Gramann 1999). This was demonstrated by Manning et al. (2004) and Hardiman and Burgin (2010), who found that recreators supported activity restrictions in areas where degradation was apparent, or in areas they were informed were degrading. Education campaigns focusing on recreation risks may have the greatest influence on support for catchment protection policies involving recreation restrictions; campaigns focusing on risks may also apply to other DRR policies. It is important to note, however, that information campaigns are not always successful in changing behaviour or attitudes.

While much risk communication research has focused on the information deficit model, which posits that providing more information changes attitudes and behaviour, evidence suggests that a range of other factors, such as a lack of trust or confidence in authorities, ambiguous messages, and risk perception, may negatively affect this approach (Abunyewah et al. 2018). Further, people are likely to filter out information that doesn't fit with their worldview and preferences. For example, studies have found that information that is consistent with one's existing beliefs leads to greater action, while information that is incongruent or challenges existing beliefs is less effective at creating change, and can lead to greater polarisation of views (Switzer and Vedlitz 2017a); this can lead to the inhibition of 'collective welfare rationality by blocking citizens from converging on the best available scientific evidence on how to secure their common interests in health, safety, and prosperity.' (Kahan et al. 2011, p.15). Effective strategies require methods, therefore, to motivate and persuade people to take action, particularly those likely to fail to act to mitigate the hazard (Abunyewah et al. 2018). Interventions with factual information tailored to the salient concerns, values, and knowledge of the target groups are likely to be more successful than interventions designed for a more generic audience (Dean et al. 2019, Dean et al. 2016a, Dean et al. 2015, Nilsson et al. 2016).

The results of this study showed that the community valued water quality over recreation, and that they did not support damaging or polluting recreation activities in the catchments. More recent consultation with the community undertaken by the water utility (Hunter Water Corporation 2021) demonstrated strong community support for catchment protection. Water quality was found to be the most important factor to the community; water supply reliability and environmental protection were other key community values. The value of catchment protection was emphasised by the community's indication that they were willing to pay more to enable the utility to invest in catchment management and protection. The importance of water conservation, and avoiding the risk of the need for emergency responses, was apparent. This clearly signals that the community expects and supports the utility to protect the catchments. Further, unlike the consultation undertaken in 2014 (Metropolitan Water Directorate 2014), the 2021 liaison did not identify recreation as a community value, possibly as a reaction to the drought and subsequent water restrictions occurring in 2019; given this happened after the survey the study was conducted, policy preferences in the community may have swayed even more towards catchment protection and recreation restrictions compared to those reported in this study. This evidence provides strong support for maintaining recreation restrictions in catchments in the study area.

Government

A further motivation for water managers to understand community attitudes is that it provides evidence to challenge, or potentially avoid, policy changes imposed by government. Such a case occurred in South Australia in 2018, where the opposing political party ran on a platform of increased recreation access in catchments with the goal of increasing tourism, which contrasted with the sitting political party's public health protection approach (Denholm 2017).

Following the election, the recreation policies in most of the state's catchments and reservoirs were changed significantly; interestingly, there is now public backlash against the change due to perceived health concerns (Peddie 2022). While water managers may not have the power to change government policy, a proactive approach to exploring community attitudes, and communicating how their policies reflect community attitudes (as well as their obligations to protect public health and mitigate disaster risk), may deter political parties from thinking they can win votes and elections by targeting recreation in catchments in their political platforms. Further, such advocacy and education actions are responsibilities of water managers under the DRR Frameworks (National Resilience Taskforce 2018, UNDRR 2015).

For DRR to be effective, all sectors must understand the vulnerability of the system to risks and the capacity of the system to address them. As stated in the NDRRF (National Resilience Taskforce 2018, p12):

> It is our collective responsibility to efficiently equip decision-makers in all sectors with the information and capabilities they need to make decisions that reduce disaster risk. Change will come from improved access to reliable information… and through greater public awareness of direct and indirect disaster risks and impacts.

There is a strong onus on the water industry to explain clearly the risks to water sources associated with different natural and anthropogenic hazards in order to inform better decision-making in other sectors. This applies equally to recreation restrictions as to other anthropogenic hazards in catchment areas, such as land-use planning.

6.2.4.3. Water Source Protection as Disaster Risk Reduction

While the methods of this study were drawn primarily from the environmental psychology and health fields, the overarching lens for the study was that of DRR. This lens has important applications and implications for protecting water sources; some of these are discussed below.

The definition of disaster risk in the National Disaster Risk Reduction Framework is: 'the potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society or a community' (National Resilience Taskforce 2018, p22). The purpose of DRR is to minimise the loss and suffering caused by disasters. Water contamination, which can result in the loss of life or injury, and causes damage to the water source (an asset) is a significant public health and disaster risk. It is argued, however, that the government, water authorities and the community do not currently view water contamination associated with land use and public access as a disaster.

As noted previously, the water industry has a duty both to protect public health and maintain an affordable and essential service; in order to achieve this, it also has a duty to inform and educate other stakeholders (particularly government decision-makers and the community) about the risks to water sources and the rationale behind protective actions. The use of the

DRR lens to view water protection may be beneficial in aligning stakeholders to a common understanding, concern for, and willingness to act.

The essential nature of clean potable water is irrefutable. Clean drinking water is an essential need for all of society, and a basic human right (United Nations General Assembly 2015). The water supply industry, however, is subject to extreme constraints given the limited availability of natural potable sources, the significant threats to those sources associated with changing climatic conditions, and the high costs and environmental impacts associated with developing alternative water sources. In contrast, residential and other forms of development have more flexibility in where they can be placed. While the alternative locations may not be as ideal from a convenience or other perspective, these limitations must not take precedence over protection of potable water supplies. There is an apparent lack of understanding, however, in the community and government about risks to water security and the fallibility of treatment processes; this is evident in community actions that challenge water protections (such as seeking additional recreation access to catchments, unauthorised catchment access, and applications for rezoning and increased development density within catchment areas) and government decisions, which permit development to encroach upon catchments and water storages and, in some cases, even mandate it (e.g. NSW Planning and Environment 2016). Protection of drinking water sources and storages should be given the highest priority for DRR in order to protect society and public health, and these areas should be protected to the fullest extent possible; the best way to prevent water contamination hazards from affecting the water supply is to prevent contamination from entering the source waters (NHMRC 2011). This includes prohibiting recreation on and in water storages and other sensitive catchment areas.

In addition to issues with waterborne illness and supply restrictions, essential services, such as water and energy, are interconnected and interdependent; failures of the water supply system, therefore, could result in problems in a wide range of sectors, adversely affecting communities and broader society in a range of ways, including burdens on the health system, and disruptions to energy and food production. Further, disasters result in significant community costs, both tangible and intangible, and these costs are increasing over time, and will be further magnified by a changing climate (National Resilience Taskforce 2018).

Recreation in sensitive drinking water catchment areas, such as water storages, increases disaster risk rather than reducing it. The adverse consequences of permitting recreation in catchments affect all water customers through increased treatment costs for their water supply, an increased risk of illness, increased disaster risk, and reduced resilience of their water supply. The water contamination hazards posed by recreation cannot be mitigated by reliance on treatment processes alone (NHMRC 2011). The fact that the current treatment practices have, to date, protected the community from public health disasters is not evidence that they can continue to do so in the face of continual challenges associated with climate change and extensive development in sensitive catchment areas, and the inherent fallibility of treatment processes (Hrudey 2021). The hazards, however, can be minimised and prevented through appropriate policies, including prohibition or restriction of recreation in drinking water catchments.

In order to protect the water sources from contamination, the water industry needs to educate and advocate for greater catchment protection. The use of the DRR lens to promote catchment protection may facilitate that advocacy through increasing the salience and significance of the threat in the minds of the community and decision-makers.

Context

While water managers do not currently think about catchment protection in terms of DRR, the link between DRR practices and catchment protection is clearly apparent. The use of DRR as a lens through which to view, discuss, and promote catchment protection is an important proposition.

The water supply, and its high quality, is arguably taken for granted in many locations in Australia, particularly in metropolitan areas where clean water is always on tap, and waterborne illness rates are low (Ruprecht 2009). As described previously, however, cumulative challenges to water quality arise from many directions, including climate change and development encroachment. Source water contamination is the proverbial elephant in the room, or a grey rhino — a 'highly probable, high impact yet neglected threat' — a problem that is obvious to anyone who cares to look, but that is being ignored by government (Wucker 2016).

Wicked Problem

One possible reason for the failure to address source water protection properly is that source water contamination, and water resource management in general, are viewed as wicked problems (Lach et al. 2005, Markowska et al. 2020, Patterson et al. 2013, Smith and Porter 2010). The concept of wicked problems emerged in the 1970s as a result of recognition of the existence of problems that are complex and difficult to address, defying typical rational and linear solutions, and involving many parties (Rittel and Webber 1973).

Not only are water sources complex ecological systems, but they are affected by a range of factors, all of which typically are managed by different government or other agencies, often with competing agendas and multiple layers of bureaucracy. In the face of such complexity, the response has been for each agency to adopt a somewhat blinkered focus, targeting a small area to control without appropriate attention to the broader system and context.

A key problem for water managers is that they hold the responsibility, but not always the power, for protecting water quality and public health associated with potable water. Further, they themselves are encouraged to adopt — or have imposed upon them — competing agendas. While the prime directive for water utilities is to provide safe, high quality drinking water to the community to protect public health (NHMRC 2011), they are increasingly being told that they need to be more community focused, supporting liveability goals as well as facilitating development (WSAA 2014), and some utilities, such as the utility in South Australia, are having recreation planning and management functions thrust upon them, functions that are well outside their core duties (Billington and Deere 2020).

While water resource management as a whole may be a wicked problem, difficult or impossible to solve, it is argued that some aspects of the problem have the potential to be mitigated. While the occurrence of natural hazards cannot be controlled, there is some level of control over whether they result in disasters. With anthropogenic hazards, however, there is a higher level of control over them, with hazards such as waterborne illness considered preventable (Hrudey and Hrudey 2019, NHMRC 2011). The type and location of development is also controllable, as is recreational access to catchments. In addition to preventing disasters associated with the anthropogenic hazards, the prudent management of resources to protect them from controllable hazards provides greater resilience to avoid or mitigate disasters associated with the uncontrollable hazards (UNDRR 2015). In order for this to occur, risks to water sources need to be understood, acknowledged, and incorporated appropriately into planning decisions. It is argued that DRR provides a vehicle for increasing the visibility of source water risks and for gaining widespread support for catchment protection measures.

Path Forward

Key controllable hazards for water sources and storages are land use planning and recreation access. Given clean drinking water is a fundamental need for all members of society, recognising the vulnerability and critical importance of the water supply to society is an essential requirement for making good planning decisions. While planning authorities note the presence of drinking water catchments and storages in their strategic plans, adequate consideration of the vulnerability of these areas to contamination does not always occur; an implicit assumption appears to be that modern treatment processes are sufficient to protect public health. As the ADWGs (NHMRC 2011) state clearly, however, multiple barriers to contamination are required to protect public health, with avoidance of contamination the most important, and most effective, barrier. Treatment processes are fallible, subject to human and technological error, and cannot remove all the contamination, or all types of contaminants. Further, greater treatment typically involves greater costs to customers, including costs associated with the purchase, running and maintenance of specialised treatment equipment, energy and chemical use, and disposal of the waste generated by the treatment (Billington and Deere 2020). Catchment protection, including recreation restrictions, is an important measure to reduce the risk of disaster to, and maintaining the affordability of, potable water supplies.

As noted previously, Australia is a signatory to the Sendai Framework for Disaster Risk Reduction 2015 - 2030 (UNDRR 2015) — a global agreement for the management of disaster risk, which recognises DRR as a critical component of resilience. The Sendai Framework highlights two key avenues of DRR to strengthen resilience: preventing new disasters by reducing exposure and vulnerability (susceptibility to the effects of hazards), and reducing existing disaster risks. Environmental degradation and human action are both highlighted as sources of hazards that must be addressed in order to prevent or mitigate disasters and their effects. Under the Sendai Framework, all levels of government and society are expected to engage in DRR to reduce disaster risk within their control, particularly government organisations and utilities. Anthropogenic source water contamination hazards, such as land use and recreation policies, are controllable by government bodies, and must be addressed in order to meet DRR obligations to reduce disaster risk.

Benefits of the DRR Lens for Catchment Management

Using DRR as a lens through which to engage with government departments and decision-makers may elevate the importance of the water supply and its protection. Positioning catchment protection as a DRR strategy may promote its importance to other stakeholders. The term ‘disaster’ arguably confers a greater sense of importance, urgency and scale than ‘health risk’, and the global community has committed to addressing disaster risks. While awareness of DRR in Australia still appears to be in its infancy, the increasing occurrence of natural hazards such as storms, fires and floods, and the ever-growing awareness of the consequences of climate change suggest that DRR will increase in salience and importance to society.

In addition to drinking and sanitation services, the water sector is an essential service to every other major sector, including health services, energy production, manufacturing, schools, government agencies, businesses, telecommunications, and fire suppression; service disruption, therefore, can have significant consequences for the community and the economy. As noted by the Water Services Association of Australia (2021), the US National Infrastructure Advisory Council considers the water sector to be a ‘critical lifeline sector’. Without a safe water supply, society cannot function. This critical role is not well understood or appropriately supported, however, with its essential functions not prioritised during disaster planning and prevention, its services undervalued and taken for granted, and insufficient investment made to support resilience. A similar situation is present in Australia (WSAA 2021).

The focus of the Australian water industry has been on public health protection and supply continuity rather than DRR. The industry currently engages in extensive risk assessment and management processes and measures, many of which are arguably similar or complementary to those that would be undertaken for DRR purposes. The industry uses the ADWGs (NHMRC 2011) to steer risk management activities, and the principles of those guidelines align well with principles of DRR. As such, the lens of DRR does not necessarily require extensive changes to existing practices, rather serves as a new perspective through which the problem can be viewed, explored, communicated and, hopefully, addressed. Changing the focus (or simply communication) of risk management from public health protection to DRR arguably elevates the importance of the actions, and makes the risks more salient and comparable to others not in the industry. Promoting risk management measures in terms of disaster, particularly for catchment management actions, may result in better outcomes for catchment and source protection, particularly in relation to decisions made outside the water sector that affect the catchments and water storages, such as land use planning activities and political pushes for greater access to catchments and storages for recreation. Adopting a DRR focus for catchment protection may raise the profile of the issue and provide additional justification for protecting water resources.

DRR requires an integrative approach to catchment planning, which addresses all the controllable risks. Putting water contamination into the context of DRR highlights the role of different sectors of society in risk reduction, and the need for every stakeholder to play their part to remove or reduce risks under their control (UNDRR 2015). In addition to water managers, key stakeholders are: government planning departments and councils, who control land-use planning in catchments; community members, whose personal actions can increase or reduce the hazards by protecting or endangering the water; and elected government parties, who can override decisions by the water managers, and set the direction for state planning departments and councils for land use planning decisions.

DRR provides a mechanism for justifying catchment protection policy to both the community and all levels of government to achieve better consideration of implications for water quality in decision-making and greater support for risk reduction policies. Communicating DRR principles in submissions to planning strategies should highlight the responsibilities of decision makers to mitigate disaster risks; such submissions should also clearly outline the risks and consequences of contamination, which would fulfil some of the responsibilities of water managers to provide clear information about hazards to inform better decision-making (National Resilience Taskforce 2018). In a similar manner, reporting recreation policies and responding to requests for additional recreation access to catchments in terms of mitigating disaster risks may enhance the salience of risk reduction policies in the minds of the community. Such communications should also explain clearly the fallibility of treatment processes and the consequences of failure of the water managers to provide water of appropriate quality, topics that are frequently misunderstood by recreation proponents (for example, Hughes et al. 2013, Hughes et al. 2008). Coupling greater communication about hazards to, and limitations of, the water supply system with DRR principles and responsibilities may result in planning decisions that do not encroach on catchments and do not allow inappropriate development in, and access to, sensitive areas.

While wicked problems are considered to have no definitive solutions (Rittel and Webber 1973), that does not mean they do not require action, or that action will be ineffective. Development of measures to address a wicked problem is dependent on the way the problem is defined (Lach et al., 2005). If the water supply task is conceived of being simply an engineering problem, issues of supply, demand and quality will be conceptualised as being 'solved' through engineering processes such as chemical and mechanical treatment, which are, for all intents and purposes, controllable, understandable, and quantifiable. Such a problem definition, however, fails to recognise the fallibility of treatment systems as discussed previously, but also the context of water sources.

While reservoirs initially may be constructed to hold water for ultimate human consumption, they become natural ecosystems and home to myriad life forms, as are the rivers providing water to them. As Smith and Porter (2010) note, while treatment of contamination may serve as a method of protecting potable water quality, it does nothing to protect the quality of the sources and storage and their associated ecosystems. Further, technological solutions tend to be associated with additional energy consumption (which, unless offset, comes with increased carbon emissions), additional chemical use, and greater waste generation, all of which directly or indirectly cost the community and the environment (NHMRC 2011).

In contrast to the engineering lens, catchment protection measures are less controllable, understandable and quantifiable, given catchments and water bodies are complex systems. The uncertainty inherent in catchment protection action means it is often overlooked in preference for the controllable solution. While catchment management — particularly improvement — is a less familiar route to water quality protection for water utilities, it often has multiple benefits in addition to source water quality improvement, which starkly contrasts with the typical additional costs associated with technological solutions. Catchment management for water quality purposes can result in ecosystem benefits through greater protection, enhancement and coverage of flora, which can improve habitat for fauna and increase biodiversity. Other benefits include: carbon sequestration; improved bank stability (which prevents loss of property); improved soil condition; reduced erosion, improved aesthetics, and improved water security (Billington and Deere 2020, Environment Australia 1999). Given the importance of healthy ecosystems for the resilience of local, national and global health and wellbeing, and the community expectation of, and support for, their protection, treatment cannot be the primary mechanism for ensuring water quality. Defining the wicked water supply task in terms of DRR may help to steer the agenda for solutions away from the typical anthropocentric treatment-based focus and towards more ecocentric catchment protection.

6.2.5. Future Research

Directions for future investigation are described in the following sections in terms of recreation policy support, the broader use of the HBM, and avenues for increasing community acceptance of risk reduction policies.

6.2.5.1. Recreation Policy Support

As expected, the HBM did not fully account for all the variance in behaviour; as described in the Literature Review, the model only accounts for attitudes, while policy support is a complex and multi-faceted beast, likely to be influenced by a range of demographic and other characteristics to different degrees, with the influence likely to vary depending on the policy in question. This study intentionally focused on the influence of the core HBM variables — perceived susceptibility, perceived severity, perceived threat (risk perception), perceived benefits and perceived barriers — and explored the influence of two key demographic variables; gender and proximity to catchments. Other variables identified in the additional analyses and the Literature Review provide useful routes of inquiry for future studies with the model, and may lead to the description of a more complete model of recreation policy support. Given the importance of self-interest, salience is a key area to study.

Further investigation is also required to explore whether the explained variance and effect sizes of the HBM constructs can be increased through modification of the questionnaire items, and whether different model structures for different population subgroups would have greater explanatory power. Subgroups of interest should be identified prior to data collection (such as gender and proximity to catchments), and targeted surveying should be done to ensure sufficient sample sizes are achieved to enable multigroup comparisons. If results are to be used to inform policy decisions, a representative sample should be collected.

The model requires testing in other populations. It would be useful to compare the findings from populations with similar recreation policies and catchment protection perspectives to the Hunter, such as Perth, and those with very different policies, such as Southeast Queensland, where water reservoirs were developed to have a dual purpose of drinking water storage and recreation. Comparing the HBM construct influences and relationships in different populations to those of the Hunter is necessary for demonstrating the generalisability of the model in the context of support for catchment recreation policy.

In addition to identifying targets for interventions and education campaigns, the model may have utility in assessing the effectiveness of those actions. Such an exploration could be undertaken through the use of an additional variable — cues to action, which is commonly included in much HBM research — or through comparison of pre- and post-intervention scores.

6.2.5.2. The HBM as a Model of Other Policy Support

A key contribution of this study is the demonstration of the usefulness of the HBM in a novel area of policy support. This area of application differs in that, traditionally, the HBM has only been applied in contexts where the outcomes are under the control of the individual. In contrast, this study found the HBM also applied in a context where the behaviour investigated related to support for actions to be undertaken by a third party, for the benefit of the broader community.

This finding opens up a range of new avenues for testing the HBM. Of particular relevance, based on this study and the Literature Review, is the investigation of the ability of the HBM to explain support for other health, environmental and DRR policies. For water managers, the HBM has potential utility for exploring community support for other catchment protection and water security measures, such as development restrictions and the use of alternative water sources for the public drinking supply where perceived risks are present, such as purified recycled wastewater. For other users, the model's utility as a general model of policy support, and of risk perception and behaviour, is also worthy of exploration.

As noted in the Literature Review, few HBM studies have investigated gender differences. In this study, gender differences in the model could not be tested statistically due to heterogeneity between the female and male samples in terms of the perceived barriers and perceived benefits variables. This itself suggests a gender difference, if only in terms of how the genders interpreted the question. As few studies report testing for heterogeneity, there may be issues associated with pooling data from the two genders, which could lead to erroneous conclusions about the model relationships and significance; this is an important area to address. In addition to the need to test for gender differences to demonstrate model validity with pooled data, gender differences themselves warrant further investigation, as patterns of differences in behaviour may emerge with greater attention given to the issue.

6.2.5.3. Attitude Change

It was beyond the scope of this study to investigate the most effective ways to change attitudes or policy support. Much research exists regarding the design of effective consultation and behaviour change strategies; as noted previously, effective strategies include those providing factual information, and that are tailored to the target group in terms of information, existing knowledge, values and concerns (Dean et al. 2016a, Dean et al. 2015, Dean et al. 2019, Nilsson et al. 2016). Additional research is required to determine the most effective ways to increase community acceptance of risk reduction policies.

6.2.6. Summary

This dissertation determined that recreation risk perception was a key driver of support for restrictive recreation policies in the drinking water catchments of the lower Hunter Region of NSW. The HBM was demonstrated to be a valid model of recreation policy support for this sample. Importantly, the dissertation demonstrated the efficacy of the HBM in a new context, specifically showing its ability to explain support for actions undertaken by external parties rather than under an individual's control; this finding has important implications for the usefulness of the model in a much broader context than has been explored to date. Of note is the usefulness of the model to explain risk-based policy support, and its potential to be used as a model of policy support generally.

Other important findings included the demonstration of heterogeneity in community policy support for recreation in catchments, particularly the role of self-interest in influencing policy support, which has important implications for how community views are considered and incorporated into the development and modification of policies. The study also identified key factors to target for community education, awareness and other interventions for the study population. Further research is needed to explore the effectiveness of the model to explain support by other communities and for other types of policy.

Importantly, the potential benefits of exploring, communicating, and promoting catchment protection through the lens of DRR were highlighted. The water industry is in the unenviable position of being responsible for protecting public health with very limited power to control or develop policies to protect water quality and security, having to rely primarily on influencing decision-makers. DRR is proposed as a means by which the critical importance of protecting water sources is recognised by other agencies and the community, and a potential mechanism for gaining widespread support for catchment protective policies and investments.

Water utilities do not currently think of their recreation policies in terms of DRR. Positioning catchment protection and recreation restrictions as DRR is considered a critical component to mitigate these challenges to catchment protections. If the government is to fail in its duty under the National Disaster Risk Reduction Framework and the Sendai Framework to remove existing risks and prevent new ones from emerging, it is even more important for other policymakers to remove and prevent risks within their control. It is vital, therefore, that the water managers continually challenge attempts to increase hazards to their water sources and catchments in order to maintain the resilience of the water supply system. Further, they must enforce recreation restrictions within the catchments under their control when it is in the best interest of the majority of the community.

Effective DRR requires the acceptance and support of DRR policy by the community. This research provides an important tool for understanding community acceptance, and direction for increasing acceptance, of DRR policy. In addition to increasing community acceptance of DRR policies, efforts must be made to educate government and other policymakers with power over the catchments that catchment protection is a critical and essential component of maintaining a secure water supply and protecting public health, and that treatment processes do not remove all contamination challenges. The lack of public health outbreaks and supply failures in the past is not an indication of the ability of the system to continue to perform as well under repeated and consistent challenges. Removing the controllable hazards, such as recreation and poor land use planning, can prevent controllable disasters and build resilience of the system to cope with the inevitable and increasing natural hazards.

6.3. Conclusion

The world is subject to an increasing number and intensity of natural and anthropogenic hazards. DRR is needed to protect individuals and communities from the adverse effects of disaster, which can have wide-ranging and significant consequences on communities and individuals. In 2018, Australia committed to managing disaster risk through the reduction of existing risks and prevention of the creation of new risks, when it became a signatory to the Sendai Framework for Disaster Risk Reduction, a global disaster risk reduction strategy. The National Disaster Risk Reduction Framework (NDRRF), which was prepared by the National Resilience Taskforce in 2018, guides Australia's efforts to meet its obligations under the Sendai Agreement to proactively reduce disaster risk by 2030. Under these Frameworks, all sectors of society are accountable for reducing disaster risks within their control, with the greatest onus placed on Government, given its greater power of influence.

One important method of DRR is through the development and implementation of policies which result in the removal or reduction of exposure, or vulnerability, to hazards. Such policies can restrict individual and community activities, which can contravene people's personal wishes and freedoms. Examples of such restrictions include: restrictions on permissible development locations to mitigate flood risk; requirements for development design and materials to mitigate bushfire risks; and the extensive restrictions implemented in Australia during the COVID-19 pandemic, including isolation and lockdown measures, and requirements to wear face masks, receive vaccinations, and maintain physical distancing.

If not considered acceptable by those to whom the policy applies, DRR policies can be challenged (for example, by exerting pressure on elected representatives to change policy) or ignored. The COVID-19 pandemic is a clear illustration of both of these, with challenges seen in community protests, and individuals choosing their personal freedom over the DRR restrictions, resulting in the spread of disease to previously unaffected, and in many cases vulnerable, communities. In this instance, the actions of people ignoring the policies resulted in widespread illness, death, restrictions and economic and financial consequences for millions of people. This extreme example clearly demonstrates the need for acceptance and observance of DRR policies by the most people possible in order for the policies to be effective.

Given the importance of community acceptance of DRR policies, it is important to know how to increase community acceptance of these policies, which was the overarching goal of this research. In order to achieve that, it was essential to understand what variables influence their acceptance of risk reduction policies; focusing on the case of recreation policies in drinking water catchments, this was the research question for the study. To determine the best ways to influence policy acceptance, and which segments of the community to target, it is important to understand how those variables vary between different community segments.

Clean drinking water is a fundamental requirement of the health and resilience of communities, and is essential for all of society; the provision of safe drinking water is, therefore, an essential service and a basic human right. Failures of the water supply system could result in wide-ranging societal impacts, adversely affecting individuals, communities, business, economies and governments. The water industry has a critical role in protecting public health by ensuring that water supplied to the community is safe to drink; this requires the water to be essentially free of contaminants. Additionally, under the NDRRF, water utilities are accountable for reducing disaster risk associated with their activities, including provision of potable water to the community and the management of their landholdings and operations; their policies, therefore, are key mechanisms to reduce disaster risk in their sphere of influence.

The potable water supply in Australia is subject to extreme constraints — natural potable water sources are scarce and exceptionally vulnerable to changes in climate, and alternative water sources can have high supply costs and can adversely affect the environment. The vulnerability of water sources is increasing due to climate change. Further, ever-increasing development pressures in catchments remove natural treatment processes within the catchments and increase contaminant loads to water sources and storages. The cumulative effects of anthropogenic hazards reduce the resilience of the system to cope with natural hazards, and threaten the ability of the water sector's mitigation measures to maintain a safe and consistent supply of potable water. Removal of hazards, therefore, is particularly important in this sector.

While the water industry does not think about its water protection measures as DRR actions, the DRR perspective is consistent with Australian water industry practices, which are typically guided by the National Health and Medical Research Council's ADWGs (NHMRC 2011); these guidelines emphasise the need to protect catchments and to avoid contamination entering the source waters. Most metropolitan water supply systems, such as that of the lower Hunter Region, have multiple barriers to managing contamination in order to comply with these guidelines. While the current systems generally have protected the community from public health and supply disasters to date, treatment systems are not fallible, and past performance is not indicative of future performance; further, continual challenges associated with climate change and increasing development and public access in sensitive catchment areas inevitably will increase the risks to the potable supply. The anthropogenic hazards can be minimised through protection of drinking water catchments through appropriate land use planning and public access policies, which are DRR measures.

Recreation in catchments is a hazard to potable water quality, public health, and the continuity of the potable water supply. It is recognised that recreation in catchments may be desirable for some community members, particularly those living close to them. It must be understood, however, that these areas are very sensitive, and increasing public access or development in sensitive catchment areas increases the risk of disaster for the community, and poses a threat to the resilience of social and economic systems in those regions. As noted by Wilson (1930, p359), ‘Is it wise to wilfully and knowingly run the chance of adding pollution of the most dangerous type to our water just because we think we can take it out?’.

In order to meet the ADWGs and reduce contamination hazards, many metropolitan water utilities in Australia prohibit or restrict recreation in their drinking water catchments and storages. It is acknowledged that some water managers in Australia and overseas permit recreation in and on their catchments and storage reservoirs; it could be argued, therefore, that it must be safe to do so. DRR principles require, however, that new hazards not be introduced, and existing hazards be managed. In the context of recreation policy, this means that catchments with no recreation access should retain that status, and catchments where recreation is permitted must carefully manage that access to reduce the associated risks, which may include removal of previously permitted activities where warranted. The fallibility of treatment systems to remove contamination must be noted, as must the costs of treatment (which are passed on to the community), which means that adding treatment processes to manage recreation risks may not pass the due diligence test for water utilities. Catchment protection is recognised, however, as industry best practice, and its application in the form of restrictive recreation policy in the catchments is consistent with DRR principles. The use of the DRR lens for considering catchment protection is likely to have benefit for aligning stakeholders, such as the community and government, in their goals and actions to reduce disaster risks.

Recreation policy in drinking water catchments was used as a case study for understanding community acceptance of risk reduction policy in this dissertation. Given that DRR policies are designed to reduce risk, and that the Literature Review found risk perception to be a key factor influencing policy support in the literature, the aim was to explore the influence of risk perception and other personal characteristics on support for recreation policies in catchments, through the identification and testing of a potential model of recreation policy support based on health-based risk perception — the HBM.

The model was tested using a modified survey, which assessed the HBM and other personal characteristics in an adult sample of the population of the lower Hunter Region of NSW. Use of an advanced statistical technique, PLS-SEM, enabled the concurrent investigation of the individual effects of variables and the relationships between the variables. Additional analyses were also undertaken using first order statistics to further explore group differences.

Risk perception was found to be a key driver of policy support in all groups assessed, and was influenced by the perceived susceptibility to the hazard, and the perceived severity of the hazard. Perceived benefits of restriction measures were also found to influence policy support strongly, and to mediate the perceived barriers to implementing restrictions. Gender, proximity of residence to catchments and personal recreation preferences were also found to be important characteristics influencing policy support. Overall, females and people living outside the catchments were more supportive of recreation restrictions than males and people living inside the catchments, while people engaging in particular types of recreation activity were less likely to support restrictions of those activities in the catchments in the lower Hunter sample.

The study demonstrated the utility of the HBM as a model of recreation policy support in catchments, and identified target groups and factors for intervention to increase community acceptance of restrictive recreation policy in the lower Hunter Region sample. The HBM also has the potential to be applied to policy support research more generally and, consequently, has great potential to further explore community support for DRR policies and ways to increase acceptance and compliance with such policies.

Additional research is needed to quantify the influence of other variables in recreation policy support in this sample and to test the explanatory power of the model for recreation policy support in other locations, as well as the applicability of the HBM to other policy support contexts. It was also beyond the scope of this study to explore the most effective type of intervention or to test the effectiveness of interventions at changing policy support, which requires further investigation. While the relative importance of each of the HBM variables would be expected to change in different locations and contexts, the literature suggests the model is likely to be viable in the broader policy support and DRR contexts.

The HBM can identify factors to which information and education campaigns can be targeted in order to increase community acceptance of risk reduction policies, and has potential application as a general model of risk reduction policy support, particularly in the health and disaster domains. The HBM is, therefore, considered an important tool for increasing community acceptance of DRR policies and actions.

FIN

Appendix A.

Study Information Statement and Questionnaire

Associate Professor Graham Brewer
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University of Newcastle, Callaghan, NSW 2308
tel +612 4921 5794 | fax +612 4921 6913
graham.brewer@newcastle.edu.au

THE UNIVERSITY OF NEWCASTLE AUSTRALIA

Information Statement for the Research Project:
Community Attitudes to Drinking Water Catchment Protection

You are invited to participate in the research project identified above. The study is being conducted by a PhD Candidate at the University of Newcastle, in collaboration with Hunter Water, and is supervised by Associate Professors Graham Brewer and Thayaparan Gajendran from the School of Architecture and Built Environment.

Why is the research being done?
The purpose of the research is to understand how the community of the lower Hunter Region views protection of the drinking water catchments, specifically in relation to recreational activities in and around water sources and storages, and what factors affect those views. The study will also be used to determine how much general community support there is for existing catchment protection policy and what, if any, changes to policy would be acceptable to the community.

Who can participate in the research?
We are seeking people aged 18 years and over who live in the lower Hunter Region of NSW to participate in this research.

What would you be asked to do?
If you agree to participate, you will be asked to complete a short online questionnaire. Questions will ask about your attitudes to different types of recreational activities and other issues that may affect your attitudes, as well as details about you. There are no other commitments associated with participation.

What choice do you have?
Participation in this research is entirely your choice. Only those people who give their informed consent and complete the questionnaire will be included in the project. Please note that you may exit the questionnaire at any time.

How much time will it take?
We estimate the questionnaire will take around 15 minutes to complete. You will only need to complete the survey once.

What are the risks and benefits of participating?
Your participation in the study may benefit the lower Hunter Region by providing feedback on your attitudes to recreation in the areas where your drinking water is taken from. The information gained may be used by Hunter Water to review or revise catchment protection policies and operational procedures, or to develop future educational campaigns.

Participating in the research is not anticipated to cause you any disadvantage or discomfort. We cannot promise you any personal benefit from participating in this research. If you choose to participate in the study, you will be given the option to go into a draw to win one of two iPad minis or one of five $50 eftpos gift vouchers at the end of the questionnaire. Entrants to the prize draw will be allocated a unique number, and the winners will be selected using a random number generator. Prizes will be drawn on 30 November, with winners notified by email.

If you indicate you would like to enter the prize draw, you will be directed to a separate website, and will be asked to provide details of how we can contact you. Please note your contact details would not be linked to your responses to this questionnaire in any way.

How will your privacy be protected?
The questionnaire is anonymous, and it will not be possible to identify you from your answers. The questionnaire is hosted on the Lime Survey website via a secure encrypted connection, and the software will not record your location. The privacy policy of the survey host can be found here: https://www.limesurvey.org/policies/privacy-policy. Data will be stored for at least five years on the University of Newcastle's secure server.

How will the collected information be used?
The information collected will be presented in a dissertation to be submitted for the candidate's PhD degree, and data summaries may be presented in papers published in scientific journals and/or in conference presentations. Summary data will also be provided to Hunter Water. Individual participants will not be identified in any reports arising from the project. Non-identifiable data may be also be shared with other parties to encourage scientific scrutiny, and to contribute to further research and public knowledge, or as required by law.

If you would like a copy of the study summary, please email Associate Professor Graham Brewer (graham.brewer@newcastle.edu.au) or visit Hunter Water's website (https://yourvoice.hunterwater.com.au/) after May 2021.

Project Funding
The project has been funded by Hunter Water through a scholarship for the PhD Candidate. Please note that the student is a contract employee at Hunter Water, and that the research is being undertaken as part of their studies and not as part of their employment.

What do you need to do to participate?
Please read this Information Statement and be sure you understand its contents before you consent to participate. If there is anything you do not understand, or you have questions, contact one of the researchers.

Further information
If you would like further information, please contact Associate Professor Graham Brewer via email (graham.brewer@newcastle.edu.au) or by phone (4921 5794).

Thank you for considering this invitation.

[Signature]
Dr Graham Brewer
Associate Professor School of Architecture and Built Environment

Community Attitudes to Drinking Water Catchment Protection Survey

[Eligibility Questions]

These questions will determine whether you are eligible to complete the survey.

Do you agree to complete the survey? *

◯ Yes

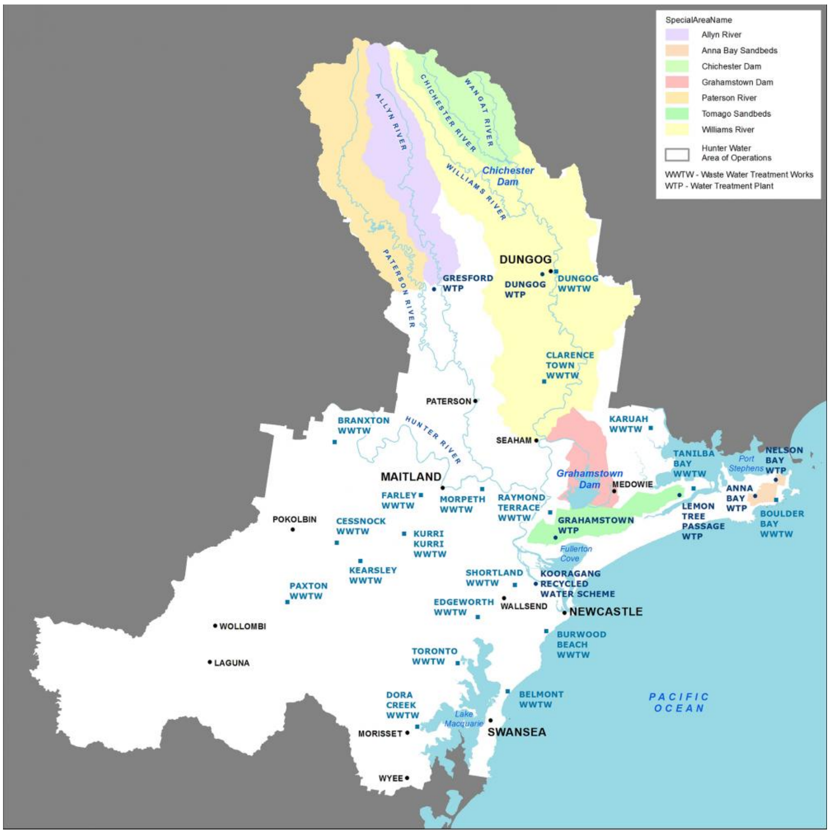
◯ No

Are you 18 years of age or older? *

◯ Yes

◯ No

With this survey, we are looking to understand the views of people who live in the lower Hunter Region of NSW. This area is shown in the following map.



Do you live in the lower Hunter Region? *

◯ Yes

◯ No

[Recreation Preferences]

The next few questions ask about the type/s of recreation you do and where you do it.

Do you participate in any form of outdoor recreation (for example: running, walking, picnicking, cycling, fishing, sailing and so on)?

○ Yes

○ No

Please select all the types of outdoor recreation you do from the following list. [Only answer this question if the following conditions are met:
Answer was 'Yes' to "Do you participate in any form of outdoor recreation (for example: running, walking, picnicking, cycling, fishing, sailing and so on)? "]

☐ Walking, bush walking or hiking

☐ Running

☐ Orienteering or rogaining

☐ Cycling

☐ Mountain biking

☐ Picnicking

☐ Camping

☐ Climbing or rock/mountain climbing

☐ Bird watching

☐ Horse riding

☐ Photography

☐ Trail biking

☐ Four wheel driving

☐ Hunting/shooting

☐ Team or court-based sports (e.g. basketball, netball, football, cricket, tennis, lawn bowls etc.)

☐ Swimming in the ocean, lakes or rivers

☐ Swimming in pools

☐ Fishing from land or non-motorised boat

☐ Fishing from motorised boat

☐ Canoeing, kayaking or rowing

☐ Wind or kite surfing

☐ Surfing or body boarding

☐ Motorised boating

☐ Water skiing or wake boarding

☐ Jet skiing

☐ Other - please specify:

Where do you mainly participate in these activities? Please select all that apply: [Only answer this question if the following conditions are met: Answer was 'Yes' to “Do you participate in any form of outdoor recreation (for example: running, walking, picnicking, cycling, fishing, sailing and so on)?”]

☐ Urban, city or town area

☐ Rural or bushland area

☐ Oceans or estuaries

☐ Rivers

☐ Lakes or dams

Other:

Do you belong to any organised recreation group?

☐ Yes

☐ No

If yes: Please tell us the names of the organised recreational group/s you belong to (optional):

[Information Text]

Hunter Water extracts water from dams and groundwater aquifers (sandbeds) for use as drinking water. The water in these dams and aquifers comes from rain that runs off a large area of land that is called a drinking water catchment. Water for the lower Hunter Region is extracted from Grahamstown Dam, Chichester Dam, the Tomago and Tomaree Sandbeds, and the Allyn and Paterson Rivers. The water is treated before being added to the public water supply.

Grahamstown Dam is an off-river storage dam. Water is extracted from the Williams River at the Seaham Weir Pool, and is pumped into the dam. Grahamstown Dam provides drinking water for Newcastle and Lake Macquarie, as well as parts of Port Stephens such as Medowie, Raymond Terrace, and Fullerton Cove.

Chichester Dam receives water from the Chichester and Wangat Rivers, and primarily provides water for the areas around Dungog, Clarence Town, Paterson, Vacy and Seaham, as well as the Coalfields around Cessnock.

The Tomaree Sandbeds supply much of the water for the Tomaree Peninsula (including Anna Bay, Nelson Bay, Fingal Bay, Salamander Bay etc.), while the Tomago Sandbeds play an important strategic function as a drought reserve, with water from the eastern end of the sandbeds supplying water for Lemon Tree Passage.

Water from the Paterson and Allyn Rivers is supplied to Gresford.

To your knowledge, have you ever visited or recreated in a drinking water dam or catchment in the lower Hunter Region?

☐ Yes

☐ No

☐ I don't know

If yes: Please specify which catchments you have or think you might have visited or recreated in.

Please choose all that apply:

☐ Grahamstown Dam

☐ Seaham Weir Poor

☐ Chichester Dam

☐ Tomago Sandbeds

☐ Tomaree Sandbeds

☐ Other:

In the past two years, how often have you visited the dams or catchments? [Only answer this question if the following conditions are met: Answer was 'Yes' to “To your knowledge, have you ever visited or recreated in a drinking water dam or catchment in the lower Hunter Region?”]

☐ Once or twice

☐ A few times

☐ Many times

☐ I am not sure

[Information Text]

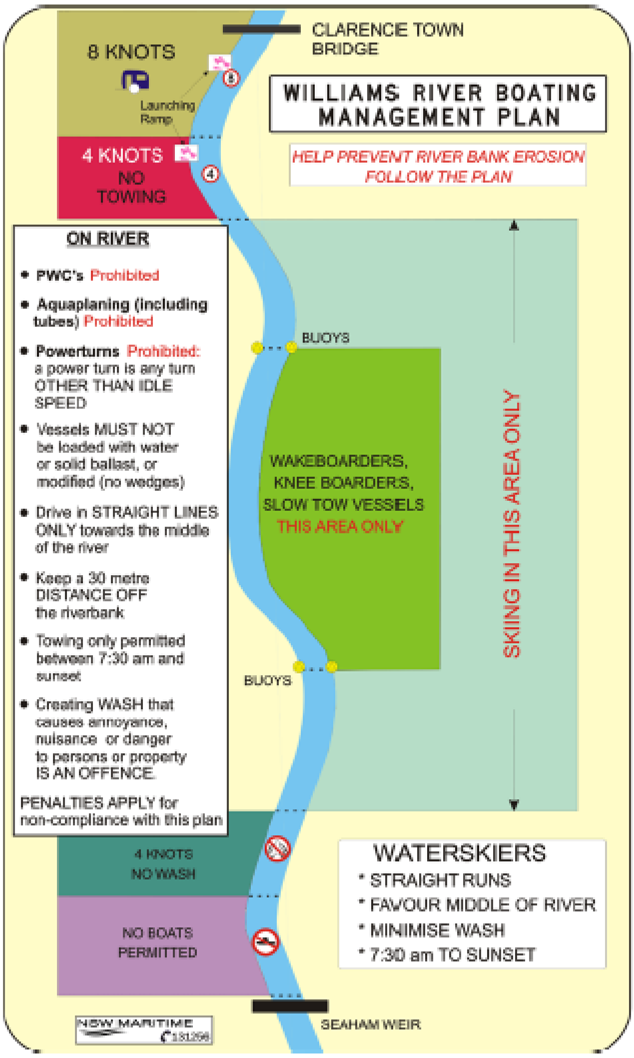
The Government currently restricts recreation in the drinking water dams and some catchment areas in the lower Hunter Region in order to protect the quality of the source drinking water. Recreation is a known source of contaminants as it can introduce human pathogens, chemicals and sediment into water sources, and disrupt the natural environmental processes that help to purify the water. The National Health and Medical Research Council considers pathogens transferred through human bodily waste to be the greatest threat to public health.

The restrictions that apply to the Hunter Water catchments are described below.

Storage Dams

Both Grahamstown Dam and Chichester Dam have parks with public picnic facilities. Other activities are restricted to protect drinking water quality. The restrictions are:

- No public access to the dams or the water's edge;
- No swimming or entering the waters;
- No boating or fishing (with the exception of from the shore within the grounds of the Grahamstown Aquatic Centre or from non-motorised boats within the Grahamstown Aquatic Centre sailing area with approval from Sailability Port Stephens); and
- No dogs, horses or other pets within the picnic areas.
- Seaham Weir Pool/Williams River
- The following restrictions on motorised boating activities are enforced by NSW Maritime:
- No boats permitted immediately upstream of Seaham Weir (restricted zone);
- 4 knot speed limit upstream of the restricted zone (no wash zone);
- Water skiing allowed from the start of the 4 knot zone south of Clarence Town to the start of the 4 knot zone north of Seaham;
- Wake boarding and other slow tow activities may only take place in the middle of the Seaham Weir Pool;
- 4 knot speed limit downstream of the 8 knot zone; and
- 8 knot speed limit at Clarence Town.



Groundwater Catchments

The majority of the Tomago Sandbeds catchment is covered by the Tilligerry State Conservation Area (SCA) and Hunter Water-owned land. These areas are closed to the public in order to protect groundwater quality and water extraction infrastructure.

The Tomaree Sandbeds are almost completely covered by Tomaree National Park and managed by NSW National Parks and Wildlife Service in consultation with Hunter Water. Access is permissible in some areas. Horse riding and vehicle access off designated public vehicle trails are not permitted.

[Information Text]

The following questions ask about your attitudes and beliefs about recreation in the drinking water catchments where public access is currently restricted or prohibited. The questions ask you to indicate how much you agree or disagree with each statement. The questions also include a 'neutral' option, which should be used when you don't agree or disagree with, or don't know how you feel about, a statement.

For the purpose of these questions, the term 'contamination' relates to impurities or pollution in the water. Contaminants can include things like bacteria, chemicals, pesticides, and soil/sediment.

[Perceived Susceptibility]

Please rate how much you agree or disagree with the following statements. (Response options Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree)

- If there were contaminants in the local drinking water sources, I would probably get sick
- No one gets sick from drinking tap water in this area
- The local tap water is safe to drink
- I am less likely to get sick from drinking local tap water than other people in the community

[History]

Have you ever been sick from drinking contaminated water before? Please choose all that apply:

☐ Yes, from drinking water at home

☐ Yes, from drinking water somewhere else in Australia

☐ Yes, from drinking water overseas

☐ No, I have never been sick from drinking contaminated water

☐ I don't know

[Recreation Risks]

Please rate how much you agree or disagree with the following statements. (Response options Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree)

- Recreation in drinking water catchments poses very little risk to water quality
- If recreational access was increased in the restricted drinking water catchments, water quality would probably get worse
- Recreation in restricted drinking water catchments can contaminate the water supply
- It is too risky to allow people to recreate close to drinking water dams
- Allowing recreation on or in drinking water dams is too risky

[Perceived Severity]

Please rate how much you agree or disagree with the following statements. (Response options Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree)

- People who are sick from drinking contaminated water do not need to see a doctor
- Drinking contaminated water would make me very ill
- If something went wrong with the quality of the drinking water, it would be very serious
- Getting sick from drinking contaminated water would not have major effects on my life

[Perceived Benefits]

Please rate how much you agree or disagree with the following statements. (Response options Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree)

- It is safer to drink water from a natural, clean environment than to rely on artificial treatment
- Restricting community recreation in the catchments helps protect me from water-borne illness

- Greater community recreation in the catchments would increase my water bill due to the increased costs of treatment and management
- Protecting the drinking water catchments from contamination benefits the community
- Restricting recreation on the dams reduces the risk of contamination of the water supply
- Protecting our drinking water now is protecting our children's future

[Perceived Barriers]

Please rate how much you agree or disagree with the following statements. (Response options Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree)

- There are only a few places people are allowed to go to enjoy their recreational activities
- More and more people are coming to people's favourite places for recreation
- Recreational activity is being banned in more and more places
- Allowing people to recreate in the restricted catchments is important to me
- I insist on people being able to do their recreational activities anywhere they choose
- It would be cheaper and easier for people to recreate in the restricted catchments

[Trust in Authorities]

Please indicate how much you agree or disagree with the following statements. (Response options Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree)

- I do not trust Hunter Water to manage our water responsibly
- I have complete trust in Hunter Water to provide me with safe tap water to drink
- I do not trust Hunter Water to keep up with the latest water treatment science
- Hunter Water has many controls in place to stop something going wrong with the quality of the drinking water
- I feel confident that Hunter Water can treat the drinking water to prevent me from getting sick
- I am not confident in Hunter Water's ability to stop people from recreating in the restricted drinking water catchments

[Not allocated]

Please rate how much you agree or disagree with the following statements. (Response options Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree)

- I believe Hunter Water should go to any lengths to protect drinking water catchments
- The use of dams for drinking water should always take priority over recreation
- Technology can provide whatever treatment is needed to produce safe drinking water

Before today, how much had you thought about the management of drinking water catchments to protect drinking water quality?

☐ Not at all

☐ A little

☐ A moderate amount

☐ A lot

☐ A great deal

[Policy Support]

What recreation policy do you most strongly support in your local drinking water catchments? *

☐ Allowing no recreation

☐ Allowing all types of recreation

☐ Allowing certain types of recreation

☐ Allowing recreation for organised groups only

☐ Allowing recreation in certain catchments only

☐ Other - please specify:

Which types of recreation would you support in the lower Hunter Region drinking water catchments? * [Only answer this question if the following conditions are met: Answer was 'Allowing certain types of recreation' at question "What recreation policy do you most strongly support in your local drinking water catchments?"]

Please write your answer here:

Which catchments would you allow recreation in? * [Only answer this question if the following conditions are met: Answer was 'Allowing recreation in certain catchments only' at question "What recreation policy do you most strongly support in your local drinking water catchments?"]

Please choose all that apply:

☐ Catchments in urban areas or with lots of surrounding development (e.g. Grahamstown Dam)

☐ Forested catchments with little development (e.g. Chichester Dam)

☐ Groundwater catchments (like Tomago or Tomaree Sandbeds)

☐ Other:

Please indicate whether you support each of the following policy options. * (Response options: Definitely No; Probably No; Probably Yes; Definitely Yes)

- No recreation
- All types of recreation
- Passive land-based recreation (such as walking and hiking, but not including camping)
- Active land-based, non-motorised recreation (such as mountain biking or horse riding)
- Camping
- Motorised activities on water with no direct water contact (e.g. boating)
- Motorised activities on water with direct water contact (e.g. water skiing, wake boarding)
- Non-motorised water-based activities with no direct water contact, like kayaking or sailing
- Non-motorised water-based activities with direct water contact, like kite-surfing or wind-surfing
- Swimming
- Recreation by organised groups only
- Recreation only in highly disturbed and urban catchment (such as Grahamstown Dam)
- Recreation only in forested catchments (like Chichester Dam)
- Recreation only in groundwater catchments (like Tomago and Tomaree Sandbeds)

Please indicate the reasons for your policy support preferences. Select all that apply.

☐ Drinking water must be protected

☐ We need to stop water pollution

☐ We need safe water to drink

☐ I don't want my water bills to increase

☐ There are other places to go for recreation

☐ People are irresponsible

☐ Prevention of pollution is better than treatment

☐ Recreation is healthy

☐ There are not enough places to go for recreation

☐ Recreation damages the environment

☐ People should be able to recreate wherever they want

☐ I don't think recreation pollutes water

☐ Most people behave responsibly

☐ Other – please specify:

[Willingness to Pay]

Hunter Water's water treatment plants were designed to treat the likely types of contaminants found in the drinking water catchments. If greater recreational access was permitted in the restricted catchment areas, the risk of contamination of the water sources would increase. This higher level of risk may mean that additional water treatment processes would be required. The recreational activities would also need to be managed. As Hunter Water is a public utility, the costs of these changes would mean greater costs to water customers.

If the current policy was to be changed to allow greater recreational access to the drinking water catchments, who do you think should pay for the additional treatment and management that would be required? Please select all that apply.

☐ Recreators

☐ Drinking water customers

☐ Everyone

☐ Government

☐ Other - please specify

[New Ecological Paradigm Scale]

Listed below are statements about the relationship between humans and the environment. Please indicate how much you agree/disagree with each statement. (Response options: Strongly Disagree; Disagree; Unsure; Mildly Agree; Strongly Agree)

- The so-called "ecological crisis" facing humankind has been greatly exaggerated
- The earth is like a spaceship with very limited room and resources
- If things continue on their present course, we will soon experience a major ecological catastrophe
- The balance of nature is strong enough to cope with the impacts of modern industrial nations
- Humans are severely abusing the environment

[Demographics]

The following questions are intended to find out more about you. Please remember that the survey is anonymous, and you will not be personally identifiable from your responses.

Please select the category that best describes your age. *

☐ Less than 18 years

☐ 18 - 24 years

☐ 25 - 29 years

☐ 30 - 39 years

☐ 40 - 49 years

☐ 50 - 59 years

☐ 60 - 69 years

☐ 70 - 79 years

☐ 80 years or over

☐ Prefer not to say

Do you have any school-aged children?

☐ Yes

☐ No

☐ Prefer not to say

Which country were you born in?

Please write your answer here:

Which country/countries have you spent most of your life in? *

Please write your answer here:

What is your postcode? *

How long have you lived in the lower Hunter Region?

☐ Less than 5 years

☐ 5 to 10 years

☐ 11 to 20 years

☐ More than 20 years

☐ I don't live in the lower Hunter Region

What is your gender? *

☐ Female

☐ Male

☐ Other

☐ Prefer not to say

Are you currently studying?

○ Yes

○ No

What type of study are you currently doing?

Only answer this question if the following conditions are met:

Answer was 'Yes' at question “Are you currently studying?”

☐ High school

☐ TAFE

☐ University

☐ Other:

What is the highest level of education you have completed?

☐ Primary school

☐ High school

☐ Trade/apprenticeship

☐ TAFE certificate or diploma

☐ University undergraduate degree

☐ University postgraduate degree

☐ Prefer not to say

☐ Other:

What is your annual personal income before tax?

☐ Less than $20,000

☐ $20,001 - $40,000

☐ $40,001 - $70,000

☐ $70,001 - $100,000

☐ $100,001 - $150,000

☐ More than $150,000

☐ Prefer not to say

Have you ever worked for a water utility?

◯ Yes

◯ No

[Feedback]

We are interested in understanding any other thoughts or concerns you may have about catchment protection. These include anything relating to recreation or catchment protection in general. If you have any comments you would like to make, please enter them below.

[Prize Draw]

Participants are invited to enter a draw to win one of two iPad minis or one of five $50 eftpos cards. Entry will require you to provide details so you can be contacted if you win. These details will be entered into a separate website, and will not be linked to your questionnaire responses.

Would you like to enter the prize draw?

◯ Yes

◯ No

If yes is selected:

Thank you for participating in this study. Please click the link below to submit your responses, and to be taken to a site where you can enter your contact details if you wish to enter the prize draw.

Submit your survey.

Thank you for completing this survey

Community Attitudes to Recreation in Drinking Water Catchments - Prize Draw Entry

Thank you for participating in our study of community attitudes to recreation in drinking water catchments. You have been directed to this site as you indicated that you wished to enter the draw to win one of two iPad minis or one of five $50 eftpos gift cards.

Please provide details of how we might contact you in the event of you winning a prize.

Please enter your name. *****

Please enter your email address and/or preferred telephone number. *****

Please enter your mailing address. *****

Thank you for your entry. Prizes will be drawn on 2 December 2019, with winners notified that day.

Submit your survey.

[N.B. Questions marked with an asterisk were mandatory.]

Appendix B.

Ethics Approval

HUMAN RESEARCH ETHICS COMMITTEE

Notification of Expedited Approval

To Chief Investigator or Project Supervisor:	**Associate Professor Graham Brewer**
Cc Co-investigators / Research Students:	**Ms Holly Marlin** **Associate Professor Thayaparan Gajendran**
Re Protocol:	**Water resilience**
Date:	**25-Jul-2019**
Reference No:	**H-2019-0218**

Thank you for your **Response to Conditional Approval (minor amendments)** submission to the Human Research Ethics Committee (HREC) seeking approval in relation to the above protocol.

Your submission was considered under **Expedited** review by the Ethics Administrator.

We are pleased to advise that the decision on your submission is **Approved** effective **25-Jul-2019**.

In approving this protocol, the Human Research Ethics Committee (HREC) is of the opinion that the project complies with the provisions contained in the National Statement on Ethical Conduct in Human Research, 2007, and the requirements within this University relating to human research.

Approval will remain valid subject to the submission, and satisfactory assessment, of annual progress reports. *If the approval of an External HREC has been "noted" the approval period is as determined by that HREC.*

The full Committee will be asked to ratify this decision at its next scheduled meeting. A formal *Certificate of Approval* will be available upon request. Your approval number is **H-2019-0218**.

If the research requires the use of an Information Statement, ensure this number is inserted at the relevant point in the Complaints paragraph prior to distribution to potential participants You may then proceed with the research.

Conditions of Approval

This approval has been granted subject to you complying with the requirements for *Monitoring of Progress*, *Reporting of Adverse Events*, and *Variations to the Approved Protocol* as detailed below.

PLEASE NOTE:
In the case where the HREC has "noted" the approval of an External HREC, progress reports and reports of adverse events are to be submitted to the External HREC only. In the case of Variations to the approved protocol, or a Renewal of approval, you will apply to the External HREC for approval in the first instance and then Register that approval with the University's HREC.

- ***Monitoring of Progress***

Other than above, the University is obliged to monitor the progress of research projects involving human participants to ensure that they are conducted according to the protocol as approved by the HREC. A progress report is required on an annual basis. Continuation of your HREC approval for this project is conditional upon receipt, and satisfactory assessment, of annual progress reports. You will be advised when a report is due.

- ***Reporting of Adverse Events***

1. It is the responsibility of the person **first named on this Approval Advice** to report adverse events.
2. Adverse events, however minor, must be recorded by the investigator as observed by the investigator or as volunteered by a participant in the research. Full details are to be documented, whether or not the investigator, or his/her deputies, consider the event to be related to the research substance or procedure.
3. Serious or unforeseen adverse events that occur during the research or within six (6) months of completion of the research, must be reported by the person first named on the Approval Advice to the (HREC) by way of the Adverse Event Report form (via RIMS at https://rims.newcastle.edu.au/login.asp) within 72 hours of the occurrence of the event or the investigator receiving advice of the event.
4. Serious adverse events are defined as:
   - Causing death, life threatening or serious disability.
   - Causing or prolonging hospitalisation.
   - Overdoses, cancers, congenital abnormalities, tissue damage, whether or not they are judged to be caused by the investigational agent or procedure.
   - Causing psycho-social and/or financial harm. This covers everything from perceived invasion of privacy, breach of confidentiality, or the diminution of social reputation, to the creation of psychological fears and trauma.
   - Any other event which might affect the continued ethical acceptability of the project.

5. Reports of adverse events must include:
   - Participant's study identification number;
   - date of birth;
   - date of entry into the study;
   - treatment arm (if applicable);
   - date of event;
   - details of event;
   - the investigator's opinion as to whether the event is related to the research procedures; and
   - action taken in response to the event.

6. Adverse events which do not fall within the definition of serious or unexpected, including those reported from other sites involved in the research, are to be reported in detail at the time of the annual progress report to the HREC.

- ***Variations to approved protocol***

If you wish to change, or deviate from, the approved protocol, you will need to submit an *Application for Variation to Approved Human Research* (via RIMS at https://rims.newcastle.edu.au/login.asp). Variations may include, but are not limited to, changes or additions to investigators, study design, study population, number of participants, methods of recruitment, or participant information/consent documentation. **Variations must be approved by the (HREC) before they are implemented** except when Registering an approval of a variation from an external HREC which has been designated the lead HREC, in which case you may proceed as soon as you receive an acknowledgement of your Registration.

Linkage of ethics approval to a new Grant

HREC approvals cannot be assigned to a new grant or award (ie those that were not identified on the application for ethics approval) without confirmation of the approval from the Human Research Ethics Officer on behalf of the HREC.

Best wishes for a successful project.

Human Research Ethics Committee

For communications and enquiries:
Human Research Ethics Administration

Research & Innovation Services
Research Integrity Unit
The University of Newcastle
Callaghan NSW 2308
T +61 2 492 17894
Human-Ethics@newcastle.edu.au

RIMS website - https://RIMS.newcastle.edu.au/login.asp

Linked University of Newcastle administered funding:

Funding body	Funding project title	First named investigator	Grant Ref
Hunter Water Corporation/50/50 Scholarship(**)	Realising resilience at Hunter Water	Brewer, Graham	G1701093

Appendix C.

Additional Data Analyses

Overview

This appendix provides details of additional data analyses undertaken for Chapter 5.

Recreation Participation

Reported recreation participation is summarised in the table below. Nearly all respondents (93%; N = 422) indicated that they took part in some form of outdoor recreation. Walking, bushwalking or hiking (80%; N = 361) was the most popular activity, followed by swimming in ocean, lakes or rivers (63%; N = 285) and picnicking (51%; N = 231). The least popular activities were horse-riding, jet-skiing, wind/kite surfing, orienteering/rogaining; climbing, trail biking and waterskiing/wakeboarding, where 7% or less of the sample reported participation.

Recreation Activities and Participation Summary

Activity	N	%	Activity	N	%
Outdoor recreation participation	422	93	Orienteering/rogaining	13	3
Birdwatching	62	14	Photography	113	25
Camping	211	46	Picnicking	231	51
Canoeing, kayaking or rowing	140	31	Running	84	19
Climbing (rock/mountain)	16	4	Sailing	10	2
Cycling	120	26	Surfing or bodyboarding	71	16
Fishing (land or non-motorised boat)	155	34	Swimming (ocean/lakes/rivers)	285	63
Fishing (motorised boat)	109	24	Swimming (pools)	203	45
Four-wheel driving	86	19	Team or court sports	66	15
Horse-riding	11	2	Trail biking	21	5
Hunting/ shooting	23	5	Walking, bushwalking or hiking	361	80
Jetskiing	12	3	Waterskiing or wakeboarding	34	7
Motorised boating	74	16	Wind or kite surfing	14	3
Mountain biking	61	13	Other	30	7

Recreation Policy Support

Most Strongly Supported Policy

Respondents were asked to nominate the recreation policy that they most strongly supported in their drinking water catchments via the following question:

What recreation policy do you most strongly support in your local drinking water catchments?

- *Allowing no recreation*
- *Allowing all types of recreation*

— *Allowing certain types of recreation*

— *Allowing recreation for organised groups only*

— *Allowing recreation in certain catchments only*

— *Other - please specify*

Half of respondents (52%; N = 258) selected *Allowing certain types of recreation*, which potentially reflects the current recreational policy in the region. The second most supported option was *Allowing no recreation*, with 28% (N = 126) of respondents choosing this option. Allowing recreation in certain catchments only was chosen by 13% of respondents (N = 60). Allowing all recreation and allowing recreation for organised groups only had similar levels of support, at 3% each (N = 13 and N = 14 respectively). Only 3 people (1%) chose 'other'.

The greater importance of recreation in the catchments for those living in the catchments was noted. Two-thirds (64%; N = 70) of respondents living in the two LGAs containing the catchments supported certain types of recreation being permitted, compared to 49% (N = 168) of respondents living in LGAs outside the catchments. Conversely, a No recreation policy was supported by nearly a third (31%; N = 106) of respondents living outside the catchment LGAs compared to only 18% (N = 20) of respondents living within the catchment LGAs.

Differences were also seen in policy preferences by gender. A No recreation policy was more strongly supported by females than males (37% v 22%, respectively), while recreation in certain catchments only was more supported by males compared to females (17% v 7% respectively).

Allowing Certain Types of Recreation

For the 238 respondents who chose Allowing certain types of recreation as their most strongly supported policy, an open-ended question was provided to nominate the type of recreation they would allow:

Which types of recreation would you support in the lower Hunter Region drinking water catchments?

As the question was open-ended with no examples or guidance provided, it is expected that responses related to recreation activities of particular interest to individuals (those they particularly wanted or did not want) rather than all activities they would consider acceptable. Not all respondents specified the type/s of recreation they would allow — five respondents did not provide an answer, one said 'unsure' and another said 'unknown'.

There was a tendency for most respondents to specify non-contaminating activities. For example:

- *Ones that would not pose a risk and / or contaminate the drinking catchments water supply*

- *Recreation should be allowed in most catchments however it needs to be restricted such that only those types of recreation that are unlikely to form a risk of contaminating catchments are allowed*

- *Recreation that does not entail risk of spills of fuel or any other hazardous substances in the water*

- *No swimming, boating etc. which can directly contaminate water. Activities confined to areas controlled by Hunter Water eg picnic areas which are usually downstream of the catchment at a dam anyway are acceptable. No activities to pollute in the catchment itself*

What individuals considered to be contaminating, however, appeared to vary. For example:

- *Ones where people are not in the water and are only using boats propelled by humans, wind or electric motors eg rowing, kayaking, sailing. If the rowing kayaking and sailing involve competitions then the supervising boats need to be powered by electric motors. We don't want contamination from fuel or fuel waste products.*

- *I believe the following should be allowed - swimming, fishing from land, fishing from a row boat and sailing. This would stop all petrol and other chemicals getting into the dams and catchment areas and therefore stop contamination.*

- *Grahamstown Dam is my main interest so would like to see Un-restricted use of the Dam for: Craft that are non polluting (Sail and Electric); Allocated swimming areas (with Beach) near Raymond Terrace and Medowie; Non-Bait (Lure) Fishing should also be allowed.*

Comments such as this suggested that respondents were concerned about fuel/oil contamination associated with boat engines, and some didn't recognise/agree that body contact was a source of contamination (or the risk of other activities in the catchments). Other comments indicated that motorised craft may also be undesirable due to the noise or other disturbance associated with engines:

- *Recreation that does not impact the natural environment in the catchment areas and surroundings, including impact from engines noise*

- *'passive' type recreation eg picnics, bar-b-ques beside the dam. Definitely no motorised vehicles (ESPECIALLY JET SKIS) on the water*

Overall, a trend was noted for non-motorised recreation to be preferred. A number of people specified 'non-motorised recreation' would be supported; for example:

- *I would only support non powered recreation only*

- *Enjoying the area without use of any motors or other possible source of contaminants*

A further number specifically mentioned that motorised recreation should not be permitted; for example:

- *Picnics, non motorised water craft, fishing, possibly swimming. Definitely NO motors*

- *sailing ONLY; NO motorised activity*

- *Recreation that does not involve engines or bodily waste or chemicals*

- *no motorized craft*

Conversely, one respondent thought that motorised craft could improve the environment:

- *I think the use of motor boats on catchments would improve water quality and ability to carry more biodiversity through aeration of the water*

The most common responses related to passive land-based activities, such as walking, bushwalking/hiking, picnicking. A number of respondents specified that activities on or in the dam should not be permitted.

- *Walking and hiking anything that didn't involve you entering water*

- *Camping and picnicking but no on or in water activities*

- *Non water*

- *Nothing on or in the water. In areas around the water I would support walking, running, cycling, picnics (as long as adequate facilities available such as toilets with treatment and rubbish disposal bins). No boating even unpowered boats as the hulls can bring in contaminants, no windsurfing or other similar activities as people fall into the water*

Passive/non-motorised water activities were also commonly mentioned, with sailing and kayaking/canoeing popular (e.g. 'Canoeing kayaking paddle boarding'; 'Stand up paddle boarding, swimming, sailing, kayaking, canoeing'; 'All water recreation types that are not motorised, ie sailing, swimming, canoeing, fishing, wind surfing'). Fishing was also popular — some respondents specified a location (such as shore-based fishing, or fishing from non-motorised boats), while others simply stated 'fishing'. Swimming was mentioned by a number of respondents, but less frequently than the activities noted above. It was noted that swimming and fishing were explicitly not supported by a few respondents.

Camping and active land-based activities, such as cycling/mountain biking were less frequently nominated. Motorised land activities were not popular, with only two respondents mentioning this type of activity (both stating they would support four-wheel driving).

Recreation in Specific Catchments Only

The 60 respondents who answered the most strongly supported policy with Allowing recreation in certain catchments only were asked to nominate the types of catchments they would allow recreation in, with the following options presented (they were asked to select all that apply):

- *Catchments in urban areas or with lots of surrounding development (e.g. Grahamstown Dam);*
- *Forested catchments with little development (e.g. Chichester Dam);*
- *Groundwater catchments (like Tomago or Tomaree Sandbeds); or*
- *Other*

The most common response was Forested catchments with little development (60%; N = 36), followed by Catchments in urban areas or with lots of surrounding development (33%; N = 20) and then Groundwater catchments (22%; N = 13). These responses may reflect the example locations provided, as Grahamstown and Chichester Dams may be viewed as having more recreation variety and, are, therefore, more desirable to recreate in, than the groundwater catchments.

For the six people who answered 'other', the responses provided were:

- *Catchments that don't directly impact a dam (e.g. Williams Valley);*
- *As it currently stands;*
- *Ones where it is sustainable and safe;*
- *Don't know;*
- *None; and*
- *Not sure.*

Association of Personal Characteristics with Recreation Policy Support

Age

Recreation policy support by age group is summarised in the table below. One person did not provide an age group, and was not included in the analysis. Further, due to small sample sizes, the 18 – 24 and 25 – 29 years age groups were pooled; the resultant group still had a relatively small sample size of 12.

Policy Support by Age Group

Policy Options	**Percentage Support (Probably/Definitely Yes)**						
	Age (years)						
	18 - 29	**30 - 39**	**40 - 49**	**50 - 59**	**60 - 69**	**70 - 79**	**80+**
	N = 12	N = 60	N = 77	N = 90	N = 114	N = 85	N = 15
No recreation	17	45	35	39	42	48	33
All types of recreation	33	18	19	10	11	6	27
Passive land-based recreation	**92**	**85**	**90**	**87**	**85**	**84**	**87**
Active land-based, non-motorised recreation	**75**	**82**	**79**	**82**	**73**	**54**	**60**
Camping	**58**	48	49	48	**50**	31	47
Motorised water activities, no direct contact	**58**	33	34	17	16	12	13
Motorised water activities, direct contact	**50**	30	25	7	9	6	7
Non-motorised water activities, no direct contact	**75**	**55**	**66**	**57**	**61**	**56**	**67**
Non-motorised water activities, direct contact	**58**	45	**60**	**50**	**50**	41	40
Swimming	**58**	45	**57**	43	47	31	33
Percentages reported in **bold** type indicate majority (i.e. > 50%) support for the policy option							

The age analysis was consistent with the results of the full sample, with only three policy options supported by the majority of all age groups — passive land-based activity, active land based, non-motorised recreation, and non-motorised water-based activities with no direct water contact.

Overall, the youngest age group (18 – 29) was the most supportive of recreation activities in the catchments, and the 70 – 79 years group was the least supportive. The youngest age group supported the greatest number of recreation-permitting policy options, with the 18 – 29 group supporting all policy options with the exception of All types of recreation and No recreation options. This was the only age group to support motorised water activities. The small sample size of this group should, however, be noted. In contrast, the oldest age groups (70 years and above) supported the fewest recreation policies, only supporting the activities supported by the full sample. Further, nearly half of the 70 - 79 years (48%) and 30 - 39 years (45%) groups supported a No recreation policy. No clear trend of recreation policy support was found for the intermediate age groups.

Income

Variations from the full sample policy support were found for the analysis by income group (refer to the table below). The lowest income earners ($40,000 per year or less) were the least supportive of recreation activities in the catchments and supported a No recreation policy. This group supported Passive, land-based recreation and Active, land-based non-motorised recreation but, in contrast to the full sample and the rest of the income groups, did not support non-motorised, non-contact water activities.

Conversely, respondents in the highest income groups supported the greatest number of recreation activities, including camping and swimming, and had the highest level of support for motorised water-based activities of all the income groups. Of interest, Non-motorised water activities with direct water contact were supported by the majority of respondents in the middle- and high-income groups, but not the low-income earners or the group that did not disclose an income.

Policy Support by Income

Policy Options	Percentage Support (Probably/Definitely Yes)						
	Annual Personal Income ($)						
	< 20,000	20,001 – 40,000	40,001 – 70,000	70,001 – 100,000	100,001 – 150,000	150,000+	PNTS*
	N = 35	N = 58	N = 88	N = 68	N = 72	N = 26	N = 107
No recreation	**54**	**53**	40	43	31	23	40
All types of recreation	6	12	10	15	25	15	9
Passive land-based recreation	**86**	**84**	**90**	**88**	**83**	**92**	**83**
Active land-based, non-motorised recreation	**69**	**67**	**75**	**71**	**82**	**81**	**70**
Camping	31	47	48	31	**57**	**69**	44
Motorised water activities, no direct contact	6	9	22	29	32	38	18
Motorised water activities on water, direct contact	6	5	14	19	24	31	9
Non-motorised water activities, no direct contact	43	48	**67**	**60**	**71**	**81**	**54**
Non-motorised water activities, direct contact	31	33	**55**	**50**	**63**	**62**	48
Swimming	43	34	45	44	**57**	**54**	39

Percentages reported in **bold** type indicate majority (i.e. > 50%) support for the policy option
* PNTS = prefer not to say

Overall, higher income earners were more supportive of recreation in the catchments, including activities requiring special equipment, like boats, kayaks, and camping equipment, while low-income earners were least supportive of recreation, and more supportive of a No recreation policy. It is noteworthy that 80% of the respondents in the higher income groups ($100,0001 and above) were male; as such, part of the difference in attitudes for those groups may be associated with the gender differences reported in Chapter 5.

Education

A summary of recreation policy support (percentage of respondents selecting probably or definitely yes) by highest education level is provided in the following table; the data exclude the six participants who selected the Prefer not to say option for this question and one respondent who selected the Other category.

Policy Support by Highest Education Level

Policy Options	Percentage Support (Probably/Definitely Yes)				
	Highest Education Level				
	High School	Trade/ apprenticeship	TAFE certificate or diploma	University undergraduate degree	University postgraduate degree
	N = 47	N = 36	N = 155	N = 106	N = 103
No recreation	43	39	36	39	50
All types of recreation	13	22	14	8	15
Passive land-based recreation	**87**	**86**	**88**	**81**	**88**
Active land-based, non-motorised recreation	**68**	**69**	**79**	**70**	**71**
Camping	38	**53**	**50**	37	47
Motorised water activities, no direct contact	15	33	28	16	16
Motorised water activities, direct contact	9	22	20	11	10
Non-motorised water activities, no direct contact	**55**	**58**	**64**	**58**	**59**
Non-motorised water activities, direct contact	47	50	52	47	47
Swimming	45	47	48	38	44

Percentages reported in **bold** type indicate majority (i.e. > 50%) support for the policy option

All five categories of education level showed majority support for the activities acceptable to the whole sample (that is, Passive land recreation, Active non-motorised land recreation and Non-motorised water activity with no direct water contact). The University postgraduates had 50% support for a No recreation policy. The trade/apprenticeship and TAFE graduates additionally supported Camping and Non-motorised, direct contact water sports in the catchments. Swimming and motorised boating activities were not supported by the majority of any group, but most education groups had over 40% agreement for swimming activity in the catchments (the exception being University graduates). Overall, university graduates and high school graduates were the least supportive of recreation in the catchments, while trades and TAFE graduates were the most supportive.

Gender did not play a clear role in education level — there were high numbers of both females and males in the two university groups and the TAFE graduates, but males dominated the Trade/apprenticeship group (86%) and the high school group (62%). Similarly, no clear pattern was found for education level by age, although high school graduates were more likely to be aged between 60 and 80, a group found to be more conservative in the age analysis.

Appendix D.

Copyright Permission

From: Lisa Warren
Sent: Monday, 11 July 2022 11:17 PM
To: Sam Sneddon; Clare Hogue; Holly Marlin
Subject: Re: Request for permission to use HWC figures in my PhD

All ok from my end.

Cheers
Lisa

Get Outlook for iOS

From: Sam Sneddon
Sent: Monday, July 11, 2022 3:56:31 PM
To: Clare Hogue; Holly Marlin; Lisa Warren
Subject: RE: Request for permission to use HWC figures in my PhD

Hi Holly
Permission granted to use the Area of Operations map from the website. Just confirm with Lisa on the use of the image from the RAP (for any cultural reasons).

Sam

From: Clare Hogue
Sent: Monday, 11 July 2022 12:39 PM
To: Holly Marlin; Lisa Warren; Sam Sneddon
Subject: RE: Request for permission to use HWC figures in my PhD

Hi Sam,
Are you able to provide any guidance to Holly or point her in the right direction?

Cheers,
Clare

From: Holly Marlin
Sent: Monday, 11 July 2022 9:45 AM
To: Lisa Warren; Clare Hogue
Subject: Request for permission to use HWC figures in my PhD
Importance: High

Hello fonts of knowledge!
I am hoping to use one or two Hunter Water graphics in my PhD (see below), and was wondering who to ask for permission? The source/s would be fully credited.
I'd be grateful for any guidance.

Many thanks,
Holly.

https://www.hunterwater.com.au/about-us/our-business/what-we-do and the RAP

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