INFORMING AGRICULTURAL ADAPTATION POLICY: RISK MANAGEMENT INSIGHTS FROM WINE-GRAPE GROWERS IN THE OKANAGAN VALLEY OF BRITISH COLUMBIA

by

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B.Sc. (Honours), Queen's University, 2001

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE (PLANNING)

in

THE FACULTY OF GRADUATE STUDIES

THE UNIVERSITY OF BRITISH COLUMBIA
July 2006
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ABSTRACT

This study addresses the need for greater understanding of both the process of autonomous adaptation to climate change and the factors that must be considered in the development of agricultural water policy in the Okanagan Basin of British Columbia. It argues that government adaptation policies pursued in the near term should be developed to complement the strategies adopted, or likely to be adopted, by individuals or groups. Previous research from the Okanagan has identified water scarcity as the stimuli to which adaptation may be required and suggested that irrigation water could be used more efficiently.

This research explores the ways in which farmers use water and are likely to respond to future scarcity. To achieve these objectives, this study examines growers’ perceptions of the risk of water scarcity and defines the ways in which growers use water to manage other business risks. It investigates the influence of the political and institutional environment on growers’ perceptions of adaptation trade-offs and their financial capacity to make decisions. The research concludes with an examination of growers’ preferences for policy to complement individual adaptation.

The research results suggest that growers do not perceive the need to use water efficiently for its own sake. However, their adoption of deficit irrigation as an adaptation to market risk leads to low water consumption. While levels of regional knowledge, industry experience and income do affect growers’ willingness and ability to adapt to risks, all of the study participants have the capacity to reduce their exposure to water shortages if they regard it as necessary. Participants’ opposition to water conservation regulations is related to perceptions of inequity and mistrust of government rather than fear of imposed costs. Further research should examine the influence of risk perceptions and government policy on adaptive capacity and water efficiency in other sectors.
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CHAPTER 1: INTRODUCTION

Climate change has been defined by the Intergovernmental Panel on Climate Change as “any change in climate over time,” which is caused either by natural fluctuations or human emissions, and which may have adverse effects on human society (McCarthy et al. 2001). The IPCC asserts that the potential and unknown future impacts of climate change pose a threat to humans and should be addressed by policy development at the international level. Mitigation, which involves efforts to reduce future climate impacts on society through the long-term reduction and limitation of greenhouse gas emissions, has traditionally been an emphasis of most international policy discussions (McCarthy et al. 2001). Evidence suggests that mitigation alone will fall short of its goals to eliminate human vulnerability to climate change.

In 2006, nine years after many industrialized countries committed to reduce their emissions under the Kyoto Protocol, political obstacles still limit the success of mitigation efforts in many countries. In November 2005, Canada hosted delegates from more than one hundred countries to discuss the future of their international commitments. Yet, less than a year later, Canada is itself now on the verge of abandoning its Kyoto targets (deSouza 2006). Political unwillingness to restrict the development of emissions-intensive industry, increased human settlement in hazardous areas and changes in climate unrelated to human activities are conditions which underscore the need for alternative policies to complement mitigation in the reduction of climate change vulnerability (Pielke 1998).

Adaptation is a response to climate change defined as “an adjustment in individual, group or institutional behaviour in order to reduce society’s vulnerabilities to climate” (McCarthy et al. 2001). Adaptation may take a number
of forms including institutional change (Smithers and Smit 1997). Since atmospheric greenhouse gas concentrations are now increasing past the level of historical extremes and forecasts predict that climate will continue to change in the future, adaptation to changing conditions is increasingly necessary to minimize adverse human impacts (McCarthy et al. 2001).

In contrast to mitigation, adaptation does not rely exclusively on public policy to reach stated goals. Because the impacts of climate change are felt at the local level, individuals, families, and organizations are likely to make independent choices to reduce their own vulnerability to these potential impacts. In doing so, they will implement strategies that may vary in both the timing of their implementation and their duration (Smit and Skinner 2002).

Tactical adaptations are short-term, seasonal strategies. In agricultural contexts these strategies may include watering more frequently during drought or turning on windmills for frost protection. Strategic adaptations are those of longer duration, usually lasting between one and five years, which include strategies such as investing in crop insurance or switching crop types. Longer-term, structural adaptations, such as changing governance institutions, are usually implemented at the level of government. As such, government adaptation policy must be developed to complement the strategies adopted, or likely to be adopted, by individuals or groups at a regional level (Smit et al. 2000).

Before policies to affect adaptation are developed, an understanding of the process of unplanned or autonomous response to climate change is essential. Although human systems tend to adapt incrementally to gradual change, both the quality of personal resources and presence of forces external to the climate system will have a significant impact on individuals’ freedom to select adaptation alternatives (Bryant et al. 2000). If public policy-makers understand the process of independent adaptation in a local context, they will be in a stronger position to
assess the limitations of these independent strategies for vulnerability reduction and develop policies that are complementary (Smit et al. 2000). Planned adaptations may reduce human vulnerability through the development of policies that increase the adaptive capacity of individual decision-makers or facilitate the adoption of adaptations that are not already practiced but are deemed by experts as necessary or appropriate (Bryant et al. 2000).

Local Adaptation: the Okanagan case study
This study addresses the need for greater understanding of both the process of autonomous adaptation to climate change and the factors that must be considered in the development of adaptation policy in the Okanagan Valley’s wine-grape sector. Agriculture has historically been the dominant land use in this region of British Columbia. However, recently, economic pressures for land development and crop change have been rapidly altering land ownership and distribution patterns. Although the orchard industry has traditionally been the largest and most significant sector within this agricultural community, vineyard plantings accelerated across the South Okanagan in the 1990s (MAFF 2004). Although vineyards may soon become the most dominant use of agricultural land in the South Okanagan, it is unclear how climate change will affect the wine-grape industry and what types of adaptation policies, if any, should be implemented in this sector.

Although the change in the frequency of extreme weather events in this region is uncertain, regional climate change scenarios forecast that average annual temperatures will increase by 2.5-5 degrees by 2080. Such change would bring forward the spring freshet by six weeks, increase crop water demand in mid-summer and extend the growing season through the autumn (Cohen et al. 2006). Evidence suggests that water scarcity will be the most significant consequence of climate change and the stimuli to which adaptation will be required. Currently, between 70-80% of consumed water in the valley is for
agricultural irrigation and models indicate that within 100 years average water
demand, under present land-use conditions, will be greater than historical
extremes (Cohen et al. 2006). Hence, understanding how irrigation water is
currently managed and could possibly be used more efficiently is critical for
analyzing climate change impacts in the region and developing policies to reduce
vulnerability.

Previous research in the Okanagan has examined agricultural producers’
perceptions of and vulnerability to climate change (Belliveau et al. 2006) and
examined the role of context in four case studies of early adopters of adaptation
strategies (Shepherd et al. 2006). The Canadian agricultural community is
already highly sensitized and accustomed to climatic variability (Bradshaw et al.
2004). Yet, it is unclear whether farmers in this region will perceive changes in
the timing and volume of water supply as part of a systemic change to which
tactical or structural adaptation is required. Climate change is only one of
numerous risks that Canadian farmers confront in their daily operations and its
relative significance in the face of other risks is questionable. In this context,
understanding how actions taken to mitigate diverse agricultural risks affect
farmers’ exposure to climate change risk is important for understanding the
adaptations farmers are likely to undertake.

1.1 Research Goal and Objectives

The goal of this research is to understand how Okanagan vintners use irrigation
water to manage operational risks and determine how personal and contextual
factors affect their decisions. This understanding is critical for developing climate
change adaptation policy that is likely to be workable and implementable in the
Okanagan wine-grape industry.
In order to explore this research question, five objectives have been identified below:

1. Examine the nature of vintners' perceptions of the current and future security of their water resource.
2. Identify the goals and objectives vintners attempt to maximize during business-as-usual decision-making.
3. Analyze the nature of the other risks vintners identify.
4. Define the ways in which vintners' irrigation management is related to risk mitigation and exposure.
5. Investigate vintners' perceptions of and preferences for government policy to increase agricultural water efficiency.

1.2 Thesis Overview

This thesis comprises six chapters. Chapter 2 establishes the conceptual framework for analysis of the research results and is divided into two sections. Section 2.1 describes the process of individual adaptation to risk and argues that the capability and willingness of individuals to make decisions to reduce their exposure to climate change stimuli is a function of their risk perceptions, adaptive capacity and characteristics of their institutional environment. Section 2.2 goes on to argue that adaptation policies must be designed to complement the incremental adaptations made by individuals if they are to be both effective and politically acceptable.

Chapters 3 and 4 are descriptive chapters that detail the historical and legal context of the study and the research methods, respectively. Chapter 3 describes the history of agricultural land-use and the growth of the wine industry in the Okanagan from its establishment to 2006. The chapter then provides background on the region's water supply and systems of provision in the three
larges Okanagan communities in which interviews took place. Chapter 4 describes how the methods employed in this study satisfy its research objectives. It first discusses the study's research design and then defines the process of subject recruitment and the interview protocol. The chapter concludes with an explanation of the process by which the results were analyzed.

Chapters 5 and 6 discuss the empirical results of the research. Chapter 5 reports the interview findings in five parts. Part 5.1 and 5.2 provide a summary of the personal and professional characteristics of the growers in the study population and then profile their water source and management practices. Part 5.3 identifies the goals and objectives producers seek to maximize in their business decision-making and defines the role of water management in risk management. The concluding parts examine the nature of growers' current and future perceptions of water security and define their preferences for government action to improve agricultural water efficiency. Chapter 6 analyzes the study's primary research findings in the context of the adaptation theory discussed in Chapter 2. It is organized in six parts and begins with an analysis of growers' perceptions of the risks they confront and their implications for water management. The chapter goes on to examine growers' policy preferences and the factors that affect growers' adaptive capacity in the present and the uncertainties that may reduce it in the future. It concludes by developing a series of recommendations for the development of near-term adaptation policy.
CHAPTER 2: CONCEPTS FOR UNDERSTANDING ADAPTATION AND POLICY SUPPORT

This chapter establishes the conceptual framework for the analysis presented later in Chapter 6. Sections 2.1 to 2.3 describe the process of autonomous adaptation to risk and argue that individuals operating in an environment characterized by multiple stressors usually make decisions that attempt to balance various objectives. The willingness and ability of individuals to make decisions to minimize their vulnerability to climate change is affected by their perceptions of the risks they confront, the trade-offs they perceive associated with the management of these risks, their use of the personal resources at their disposal and the characteristics of their institutional and political environment.

Section 2.4 argues that an adaptation policy should be politically acceptable to the target group to avoid resistance during the implementation phase. It suggests that the most politically acceptable policies are those which the target group perceives as necessary and which provide individuals with the flexibility to make decisions in their own best interests. Hence, acceptable and effective adaptation policies are those which are developed with an understanding of the process of autonomous adaptation and are both complementary to individual response and regionally appropriate.

2.1 Understanding Autonomous Adaptation

Before any discussion of adaptation policy development can take place, the elements of adaptation within the system in question should be well-clarified. Three principal questions can be asked to inform this discussion: To what condition is adaptation necessary? Who or what is doing the adapting? and How does adaptation occur? (Smit et al. 2000).
Adaptation to what?

Future climatic change is likely to be experienced as an increase in mean annual temperatures, increased climatic variability over temporal scales ranging from months to years, and possibly a change in the incidence of extreme weather events or catastrophes (Smit et al. 2000). In the short term, it is likely that climatic changes and variability will fall within a system's 'coping range'—a range of conditions which are not significantly different from present circumstances and do not cause appreciable harm to human or natural systems. However, a system's ability to buffer variability has limits. Past a certain threshold, human society will suffer negative impacts as a result of these changes. At this point, adaptation to emerging conditions may be necessary (Yohe and Tol 2002).

The most common and observable impacts of climate change will be increases in mean temperatures and shifts in the timing and magnitude of precipitation events (Bryant et al. 2000). The impacts of climate change on water resources in many locations will be significant (Miller et al. 1997). Climate change will affect surface runoff into streams, as well as rates of evaporative loss, crop-water demand and aquifer recharge. In general, transitions to drier regimes are most likely to occur as a gradual increase in the frequency of dry years, interspersed with wet periods, and gradual shifts in the timing of runoff and in the recharge/discharge interactions of groundwater and surface water systems (Miller et al. 1997).

Who or what adapts?

In any discussion of climate change impacts and adaptation it is important to first define the spatial and temporal scale under consideration. Adapting to changes in the magnitude and timing of water availability on a farmer's field over the course of a season is a much different process than adapting to basin-wide shortages over a number of years (Risbey et al. 1999; Smit et al. 2000). Once the scope of the impact is defined, it is then possible to identify stakeholders with an interest in adaptation.
How does adaptation occur?

Previous research indicates that autonomous adaptation tends to be incremental and spontaneous. It can take many forms depending on the social and economic characteristics of the decision-maker’s environment. (Bryant et al. 2000; Smit et al. 2000). The following sections describe the adaptation process and define the importance of risk perception, adaptive capacity and political uncertainty for individuals' selection of adaptation alternatives. Box 1 summarizes the relationships among these aspects of societal response to risk, as discussed in more detail below.

2.1.1 Risk Perception

Signal detection

The first stage in the adaptation process is signal detection. In this stage, a stimuli or 'signal' distinct from normal activity is observed and evaluated by a decision-maker. If the decision-maker observes a signal at her scale of attention and then perceives it as a threat, a process known as risk perception, a decision to adapt to and mitigate the threat typically follows (Risbey et al. 1999; Weber 2005). Although neo-liberal theories of human behaviour assert that individuals will respond to stimuli in a uniform and economically rational way, evidence indicates that the highly subjective nature of defining 'risk' itself affects individuals’ preferences for adaptation options (Risbey et al. 1999).

Expert vs. non-expert risk definition

Risk is traditionally defined by experts as a measure of the degree of probability of an event's occurrence multiplied by the magnitude of its associated consequences (Morgan et al. 2002; Slovic 1985). However, public definitions of
Box 1. The Process of Autonomous Adaptation to Risk

- Socio-cultural factors
- Relative weight of risk
- Risk Experience
  - 'Availability' Heuristic
- Trust
- Expert analysis and communication
- Risk/Signal Perception
- Risk Appraisal
  - Probability
  - Severity
- Optimistic Bias
- Single Action Bias
- Maladaptive Response: denial, wishful thinking etc.
- Adaptation Incentives
- Maladaptive Response: denial, wishful thinking etc.
- Adaptation Appraisal
  - Perceived capacity
  - Adaptation efficacy
  - Consider multiple objectives
- Public education about adaptation options
- Risk and Uncertainty
- Examine the trade-offs
- Brainstorm Adaptation Alternatives
- Adaptation Intention
- Adaptive Capacity
- Education, Business Size & Diversity, Community Social Capital
- Regional/National/International Policies

Source: Adapted from Grothmann and Patt 2005
risk are usually broader than those of experts. In their examination of the
differences between expert and layperson perceptions of risk to ecosystems from
climatic change, Lazo et al. (2000) found that although experts believe the risks
posed by climate change are less certain and less controllable than non-experts,
they are also more accepting of the uncertainty and define the risks as less
threatening. Slovic et al. (2005) argue that experts define risk in statistical
terms, while non-experts usually base their opinions of a risk on not only what
they think about it, but also on how they feel.

This dichotomy between expert and non-expert perceptions of risk can be
partially explained by experts' confidence in rational analysis and greater reliance
on cognitive processing than non-experts (Weber 2005). Although the human
brain uses both the analytical and associative systems to organize and interpret
external stimuli, emotional responses, controlled by the associative system, are
faster, easier and more powerful than the more controlled and considered
responses produced by the analytical system. Since feelings and emotion are
such a powerful factor affecting individuals' perceptions of risk, definitions of risk
are inherently subjective, reflecting the social and cultural perspectives of the
individuals defining it (Weber 2005).

*The socio-cultural basis of risk perception*

The general public is concerned with not only statistical analysis of risk
consequences but also with issues of vulnerability, anxiety, control and security
(Morgan et al. 2002). Non-experts typically feel greater anxiety about risks they
fear, those that they do not understand or over which they have little control
(Kunreuther and Slovic 1996). Factors such as an individual's prior experience
with a risk, her social values and level of trust in the institutions responsible for
risk management can be a much more important determinant of perceived threat
than statistical estimates for non-experts (Bryant 2000; Stedman 2004).
Under conditions of uncertainty, prior experience with a risk is more likely to evoke concern about future risks than statistical information because the affective system takes precedence over the analytical system when the two are in conflict (Weber 2005). Through the subconscious development of a mental shortcut known as the ‘availability heuristic’ individuals establish a link between an image and an experience so that the next time they are exposed to the image they recall the feeling associated with the previous experience. Reliance on intuition to guide behaviour in this way is an efficient means for humans to navigate fast-moving, potentially risky situations. Although many climate change hazards are slow-onset phenomena which do not require quick response, individuals are practiced at making judgments quickly and usually make risk management decisions based on a combination of personal analysis and instinct (Weber 2005).

Stedman (2004) argues that perceived risk of climate change, in the absence of direct personal experience, is more significantly connected to broad environmental values than an individual’s assessment of its potential impacts. In Stedman’s research, social values, in particular concern about the environment, were the most important factor affecting risk definition. In various studies of risk perception, Flynn et al. (1994) and Slovic et al. (2000) found that white males judge the risks posed by most hazards to be much smaller and more acceptable than women or people of different cultural backgrounds. These results suggest that socio-political factors such as power, societal status and trust in governing institutions have a significant impact on how individuals view hazards. These results are supported in Tucker and Napier’s (2001) study of perceived agricultural chemical risk among Midwestern farmers. In this case, farmers’ perceptions were influenced by their personal experiences, exposure to expert risk assessments and feelings about the trustworthiness of media and other information sources.
Research suggests that one of the most important factors affecting non-experts’ perceptions of risk is their level of trust in the institution or agency responsible for management of that risk (Johnson and Scicchitano 2000; Grobe et al. 1999; Frewer et al. 1996; Kunreuther and Slovic 1996). In his study of acceptance of gene technology, Siegrist (2000) found that trust in institutions responsible for development of the technology had a positive impact on perceived benefit of the technology and a negative influence on its perceived risk. In contrast, both Johnson and Scicchitano (2000) and Kunreuther and Slovic (1996) found that the public may have extreme distrust of the individuals and institutions responsible for risk management. This distrust leads to higher risk perceptions and sometimes political activism to reduce risk exposure. These results are also affirmed by Grobe et al. (1999) who found that uncontrollable risks imposed without associated benefits are politically unpopular and likely to induce outrage among the public.

If individuals do not believe that they are being provided with trustworthy information about a risk, they will rank the threat posed by that hazard as much greater than if they believe the communication is both accurate and complete. Generally, perception of the ‘trustworthiness’ of information is dependent upon perceptions of the information’s source. Wakefield and Elliott (2003) found that although individuals rely upon print media regularly for information, they perceive it as an only ‘somewhat’ trustworthy source. Individuals prefer face-to-face communication with friends, neighbors and known officials to published information because they perceive their personal contacts to be more credible than journalists. In a study of the public health risk posed by foot-and-mouth disease in the UK, Frewer et al. (1996) found that independent experts, public media and consumer organizations are trusted sources of risk information, while private industry and government are not. Trusted sources were defined as institutions possessing expertise in the area of interest and having an interest in or concern for public welfare.
Although a considerable body of literature exists to examine the diverse character of public risk conception, it is presently unclear how well policy-makers understand the nature and relevance of non-expert risk perception. In his 2004 study of planning officers, Snary discovered that many risk management decisions made at the local level do not involve the public in risk definition and as a result do not often address the issues that the public defines as most important.

Risk Appraisal
Psychologists define the next stage of the adaptation process as risk appraisal. Risk appraisal is the process in which an individual evaluates the level of personal threat posed by a risk. It is comprised of two components: perceived probability, the person's expectancy of being exposed to the threat and perceived severity, her appraisal of how harmful the consequences would be to the things she values (Grothmann and Patt 2005). Although this stage is closely related to risk perception and affected by many of the same variables, people generally perceive their personal risk of being harmed as less than average, a phenomenon known as optimistic bias. They are also less threatened by a risk if they have already done something to mitigate it (Grothmann and Patt 2005). Evidence of this single action bias is found in Hansen, Marx and Weber's (2004) study of farmers taking action to mitigate climate change impacts. Their research demonstrated that once an individual has taken one action to reduce her vulnerability or exposure, regardless of its efficacy relative to other alternatives, her feelings of anxiety are alleviated and she is unlikely to do more.

Adaptation Brainstorming & Appraisal
Research indicates that if the personal threat posed by a hazard is high, individuals are more likely to take action (O'Connor et al. 1999). Adaptation brainstorming is the stage in the adaptation process after a threat has been
perceived and in which an individual defines her adaptation alternatives (Grothmann and Patt 2005). This is then followed by Adaptation appraisal, in which an individual estimates the likelihood of successfully reducing her vulnerability or exposure through adoption of an available adaptation option.

2.2 Adaptive Capacity

An individual's choice of adaptation strategy and its ultimate success are influenced by three primary factors: perceived capacity, the individual's perception of her own ability to adapt; perceived efficacy, an individual's evaluation of the effectiveness of adaptation alternatives; and objective or adaptive capacity, a measure of the individual's actual ability to act. These capacities are influenced by both the personal resources she has available to her and the opportunities and constraints offered by the institutional context in which she operates (Grothmann and Patt 2005).

Perceived capacity

A farmer's perception of her own ability to successfully adapt to a threat is one of the most important factors affecting her selection of adaptation alternatives (Grothmann and Patt 2005). If an individual feels empowered to reduce her own vulnerability she will usually do so. However, if she feels powerless to affect change she is likely to enter a stage of denial and adopt a maladaptive response such as non-action (Anthony 2004). Research indicates that farmers generally have confidence in their ability to manage climate risks because they are comfortable with their own skill level and know how to use the technological resources available to them (Bryant et al. 2000). High perceived capacity is very important because it is negatively related to producers' perceptions of their own vulnerability and provides them with the confidence they need to adapt (Anthony 2004; Tucker and Napier 2001).
Perceived efficacy

Research indicates that perceptions of personal capacity are closely related to perceptions of the effectiveness of adaptation strategies (Grothmann and Patt 2005). In her study of agricultural chemical risk to Mexican farm workers in California, Vaughan (1993) found that perceptions of control over experiencing negative health effects of pesticides were related to the adoption of self-protective measures. Those individuals who believed that they did not have alternatives to farm employment regarded the risk as involuntary and uncontrollable and were less than five times as likely to engage in protective behavior as those who believed that they could control the consequences. In this case, individuals who felt powerless to control their exposure demonstrated little confidence in adaptation.

Adaptive capacity

Ultimately, the potential or capability of a farmer to adapt to a threat is determined by the quality of the resources she has to inform her decision, her level of financial security and the political, legal and institutional framework in place to support her (Bryant et al. 2000; Smit et al. 2000). Individual characteristics such as a farmer’s education level, property size and crop diversity are usually positively correlated with a business’ profitability and ability to make investments that buffer risk. Investment in technological tools to increase the efficiency of management practices is usually associated with higher adaptive capacity (Yohe and Tol 2002; Belliveau et al. 2006). In the Okanagan, Belliveau et al. (2006) also identified the availability of affordable farmland and access to credit as important components of adaptive capacity.

Policy and institutional arrangements also have a significant influence on adaptive capacity at the farm level through their impact on business development and profitability. Changes to agricultural trade regulations, for example, have expanded international market access and increased industry
competition and continue to have a significant impact on farm revenues (Belliveau et al. 2006). Burton and Lim (2005) argue that within the framework of international market governance, farmers only have so much power to increase their adaptive capacity. They suggest that reform of national policies and trade institutions is required before Canadian producers will have the ability to make adaptation investments without government assistance. In this context, government incentives such as tax reductions or subsidies may enhance individuals’ ability to adapt through boosting objective capacity (Bryant et al. 2000; Brklacich et al. 1997).

2.2.1 The impact of decision-trade offs on adaptive capacity

In his analysis of agricultural risk management in Italy, Bazzani (2005) found that farmers’ decision-making is driven less by the need to minimize exposure to a single risk than to simultaneously maximize multiple objectives. In his study these objectives are defined as: maximization of income, maximization of leisure, minimization of managerial problems, and minimization of indebtedness. He explains that farm-level decisions are made using these factors as selection criteria but that each management choice typically represents a compromise between conflicting objectives.

In this context, financial security is associated with the ability to make decisions in pursuit of diverse objectives. If an individual has financial flexibility then she usually has greater flexibility to choose an alternative which satisfies multiple preferences because she is less concerned with income maximization. Conversely, the recent decline in profitability of global agriculture brings into question the capacity of farmers to deal with new challenges. Evidence suggests that the willingness and ability of farmers to adapt to climate change stressors are significantly affected by the economic trade-offs associated with these decisions (Bradshaw et al. 2005; Burton and Lim 2005).
Climate

Belliveau et al.'s (2006) study of grape-growers' future vulnerability to climate change in the Okanagan shows that it is too simplistic for agricultural adaptation research to focus solely on decision-making to minimize climate risk. Since farmers are exposed to multiple risks, actions taken to mitigate exposure to one risk impact exposure to others. The grape-growers in her study were more likely to make planting decisions based upon market trends than climate extremes because from their perspective, not being able to sell wine is a greater risk than that of moderate crop damage. As an adaptation to market risk they often plant grape varieties that are popular despite their heightened vulnerability to temperature variability.

Other research indicates that this approach to agricultural risk management is typical in Canada. Traore et al. (1998) found that use of agricultural chemicals by farmers is positively related to health risk but negatively related to crop damage and that there are few options for farmers attempting to mitigate both risks. In their study of prairie agriculture Bradshaw et al. (2004) found that in the 1990s grain farmers were responding clearly to market pressures for crop specialization at the expense of reducing vulnerability to climate extremes through diversification. Similar results were found by Burton and Lim (2005) who argue that agricultural producers are unlikely to take action to mitigate climate change effects unless the adaptations also have economic benefits.

Studies of farmers' perceptions of climate change in Ontario, Alberta and Quebec indicate that although farmers routinely make tactical adaptations to adjust to climate variability they are unlikely to make strategic adaptations to climate unless the adaptations yield an economic benefit or the risk is buffered by an incentive such as crop insurance (Bryant et al. 2000; Chiotti et al. 1997; Brklacich et al. 1997). Bryant et al. 2000 found that because under current climatic conditions farmers regularly suffer annual crop losses, they may be
unwilling to make investments that do not represent clear adaptations to current conditions. Adjustments to economic conditions are often adjustments to climatic conditions which are felt by the farmer in economic terms and take priority over consideration of future risk.

Urban development
Increasing urban-rural conflict in agricultural communities across Canada is also cited as a factor limiting farmers' flexibility to respond to climate stressors. Research indicates that as markets for agricultural products expand and consumers purchase goods produced in more remote locations the connection between rural residents and farmers erodes, resulting in a marked economic and social decoupling of agriculture from the urban community (Smithers et al. 2005). In BC, the breakdown of trust and understanding between farm and non-farm populations has been exacerbated by the immigration of urban retirees to rural areas (Smith 1998). Population growth has created increased demand for housing in both the urban fringe and in rural areas, increasing the interaction between urban and agricultural residents (McCuaig and Manning 1982). More interactions have lead to a steady increase in complaints filed by residents concerned with farm 'nuisances' and greater public pressure for regulation of standard farm practices. Non-farm residents have become frustrated with farm practices that expose them to unwanted noises, smells and conditions which may be seen to decrease their property values. Conversely, urban nuisances such as vandalism, stock harassment and trespassing cause operational and financial strains for farmers (Smith 1998; McCuaig and Manning 1982).

In some communities, producers are restricted rather than protected by local plans and bylaws, which limit their farm's growth or diversification. If the rural non-farm population outnumbers the farm population farmers typically have less power to resist community decisions which impinge upon their freedom to operate normally (Smith 1998). As municipal councils transform to reflect urban
rather than rural values, agricultural producers are increasingly required to absorb extra costs to shield resident neighbors from ‘undesirable’ activities and invest more time and money self-monitoring (Smithers et al. 2005). Transformation of basic infrastructure to support urban rather than rural requirements can also increase time and expense for farmers (McCuaig and Manning 1982).

In the Okanagan, farmers have indicated that they are concerned about the implications of residential development for their future profitability (Shaw et al. 2006). Rapid land development poses a threat to the security of the agricultural land base and growers believe that a growing urban population will command an ever-increasing portion of their water supply in the future. Although farmers are concerned that water shortages will lead to agricultural water pricing most are unwilling to become more efficient now unless it is in their best economic interest to do so (Shaw et al. 2006).

Adoption of more efficient irrigation technology has been advocated as a potential adaptation to future water scarcity in the Okanagan (Cohen et al. 2005). However, evidence indicates that current adoption of these technologies at the farm level may be more powerfully driven by economic concerns than perceptions of resource availability. In their 2003 study of farmers in California, Mendelsohn and Dinar found that sprinkler systems are less popular in hot locations because of high evaporative loss and that drip systems are preferred in their place. However, the researchers determined that this preference was unrelated to perceptions of water availability and was instead motivated by farmers’ desires to minimize pumping costs (Mendelsohn and Dinar 2003).

This phenomenon was also observed by Shaw et al. (2006) in the Okanagan. High electricity costs associated with water pumping were cited by farmers as an incentive for conversion from overhead sprinklers to drip-dominated systems.
Grape-growers also associated drip systems with the ability to strictly control water application to the vines and grow premium quality grapes. For them, investment in efficient technology represents an investment in the profitability of their business. These cases illustrate that risk adaptation occurs within an environment characterized by multiple stressors and that adaptation to one risk can concurrently and inadvertently alter an individual's vulnerability to others.

2.3 Institutional and Political Uncertainty

Institutions establish the ground rules within which individuals make decisions and organizations operate. For water resources, these include basic systems of water law, specific statutes, systems of administration and changing social norms about acceptable water use practices (Miller et al. 1997). Evidence suggests that although hydrological uncertainties associated with climate change may have a big impact on water supply and use in the future, currently political and economic uncertainties associated with the institutional management of water has a more significant impact on users' decisions (Rogers 1994). These findings are supported by research conducted in the Okanagan, which found that the unwillingness of farmers to make investments in efficiency is strongly affected by the policy and legal context in which they make decisions (Shepherd et al. 2006).

In the early 1990s a subsidized agricultural metering program introduced by South East Kelowna Irrigation District (SEKID) and funded by higher levels of government was opposed by local growers. Despite its potential for identifying water wasters and initial focus on education, growers were suspicious of the program because they regarded it as government interference in private rights and the first step towards water pricing. In this region, water provision is based on principles of prior appropriation and beneficial use which have caused individuals to develop feelings of entitlement to their licensed allotments. Growers with historical rights resent government policies which they feel attempt
to undermine their right of precedence in order to redirect water to other, more 'valuable' uses. In this context, growers were unwilling to address government concerns about water efficiency because they perceived the personal trade-offs as highly undesirable.

More recent research in the Okanagan echoes these findings and supports re-examination of the current framework for water allocation in BC. In their 2006 interviews with farmers, Shaw et al. found that some farmers believe that the current water rights system encourages irresponsible water use. These growers argue that the principle of beneficial use promotes a 'use it or lose it' attitude among farmers who worry that if they do not use their entire allotment each year their rights to that water will be taken away. These studies indicate that resistance to implementation of agricultural water conservation measures in the Okanagan is less a function of poor perceived capacity or adaptation efficacy at the farm-level than a product of both farmers' distrust of political decision-makers and a legal framework which does not guarantee farmers that they will have water when they need it most (Shaw et al. 2006).

2.4 Planned Adaptation

One of the biggest hurdles governments must overcome in policy implementation is public opposition to strategies that concentrate costs on unified or vulnerable groups. Although policy-makers often attribute public opposition to lack of understanding, this discontent usually originates from fundamental differences in the relative power of vulnerable publics and the values upon which policies are based. Phidd and Doern (1983) suggest that in liberal democracies such as Canada, governments tend to emphasize the right to individual choice and are more likely to recommend less coercive instruments to achieve policy goals. However, when conflict arises between those who oppose a policy and those
who support it, government is more likely to respond to the concerns of powerful interest groups (Howlett and Ramesh 2003).

In an environment in which urban development consumes an ever greater proportion of regional water supply, farmers confronted with the implementation of an agricultural water conservation policy may have cause to suspect that they are bearing higher costs in order to benefit a more powerful interest group. Hence, strategies that require farmers to use water more efficiently can be highly politically unpopular (Shepherd et al. 2006). If individuals feel that the legal and political structures already in place are unjustifiably costly, they may be willing to accept additional policy only under specific terms. To be both effective and politically acceptable, a policy must be based upon solid understanding of how the target group experiences the threat and an understanding of its preferences for action (Morgan et al. 2002). In this context, an understanding of the factors that affect policy support and the nature of policy instrument alternatives is necessary.

Factors affecting policy support

Public support for environmental policy-making varies widely within the general population, but is most commonly affected by perceived need, or risk of inaction, political attitudes and the technical nature of the issue in question (Gerber and Neeley 2005). Generally, high perceived risk associated with a hazard beyond individual control produces support for government action. As the threat posed by a hazard becomes more serious, public support for government mitigation increases and high risk management costs become more politically acceptable (Halfacre et al. 2000). In the examination of solutions to more familiar hazards, general ideology and political preferences have a large impact on public policy support. Those with more confidence in government generally are more likely to support public risk management policies than those who prefer market-oriented solutions (Gerber and Neeley 2005).
Support for policy development is highest when causal relationships are clearly defined and understood by the general public and risk management polices appear to address these linkages. If scientific uncertainty surrounds the existence of a risk or the actions that can be taken to reduce it, public policy support typically wanes (Johnson and Scicchitano 2000). In situations of scientific or technical uncertainty citizens may be less confident with the effectiveness or suitability of decisions made by elected officials or bureaucrats because the existence of uncertainty requires policy-makers to make value-laden assumptions about cause-and-effect phenomena (Halfacre et al. 2000).

*Policy instrument choice*

The ability of a policy to be realized in practice as it was envisioned by the policy-maker is a function of several forces, most notably the policy instrument chosen to put the policy into effect (Howlett and Ramesh 2003). If the policy to be implemented is unpopular with the target group a more coercive policy instrument is typically required than in a situation in which the group supports policy goals. However, a policy must also be flexible enough to grant individuals the freedom they need to achieve their goals or it will face strong opposition, particularly from unified groups.

The most coercive policy instruments are command and control policies such as regulation. Use of authority-based instruments is advantageous because the government can simply establish a standard and expect widespread compliance. Such instruments may be politically popular in situations in which the public demands a certain level of security about the policy outcome (Hoberg and Harrison 1994) but their inflexible nature makes them less politically popular if they impose concentrated costs on a defined population sector (Yiridoe 2000). Traditionally, policy-makers have recommended taxes and regulatory strategies for controlling agricultural pollution. However, recent difficulties associated with
enforcing command and control policies have motivated a more serious examination of voluntary programs in Canada (Yiridoe 2000).

Voluntary programs are a less coercive means to achieve policy goals than regulation. They are usually based on agreements between industry and government which outline a set of practices or code of conduct to which the industry commits but is not legally bound to follow. Although voluntary agreements are based only upon expectations of compliance, they are often underlain by the threat of regulation so it is usually in the best interests of industry to participate (Harrison 2001).

Information-based programs are less coercive and generally less effective than voluntary programs at meeting policy objectives. They can be divided into two categories: information dissemination and information regulation. Information dissemination is a passive approach in which the government expects people's behaviour to change if they have the appropriate information. Since there is no requirement for individuals to act once they are provided with information, most individuals will only change their behaviour if they come to realize that there is a personal incentive to do so (Hoberg and Harrison 1994).

If it is truly in the best interests of the targeted group to alter its practices, information dissemination is an extremely cost-effective approach to achieve widespread compliance. However, information provision usually needs to be complemented by an approach which directly exposes the decision-makers to the benefits being publicized. Both Traore et al. (1998) and Baerenklau (2005) found that awareness of the benefits of using a new soil conservation technology is positively correlated with its adoption. Baerenklau's research with Wisconsin dairy farmers demonstrates that although farmers exhibit aversion to income risk they are comfortable adopting new technology to improve management results as long as they or someone they trust has shown it to be effective. In this case,
personal observation of a technology’s benefits was a significant factor leading to its adoption. This research indicates that education is a valuable first step in any policy directive which also benefits the targeted group. Financial incentives have a significant impact on individuals’ willingness to experiment with new technology, but they may not have to be particularly large or distributed for long time periods if the long-term benefits of its adoption are clear.

Information regulation is an approach which requires targeted actors to publicize information for comparison with other businesses. An information development approach includes the generation and retrieval of information by government with the goal of providing political actors with more reliable and detailed information upon which to base their decisions. It is also intended to motivate image-conscious businesses to improve their standards so that they compare favourably with others (Howlett and Ramesh 2003).

Selection criteria
In their analysis of options for climate change adaptation in the Canadian water sector, deLoe et al. (2001) argue that adaptation strategies adopted within the next ten years will be introduced into an environment in which the impacts of climate change are uncertain and unpredictable. As such, adaptations adopted in the near-term should not be costly or drastic adjustments to anticipated future conditions. Instead, they should be no regrets strategies which also have immediate, present-day benefits. Adaptations should be reversible, so that they can be adjusted if they are found to be maladaptive in the future, and minimize environmental damage, so that they do not unnecessarily stress ecosystems which are already under pressure from changing climatic conditions. Other selection criteria identified by deLoe include: cost-effectiveness; equity; feasibility; and effectiveness.
Conclusion

This chapter argues that support for policy to mitigate risk vulnerability is a function of both the public’s perception of the need for such a policy and the instrument used to implement it. If individuals believe that a policy is necessary and implemented in a way that is both fair and flexible, they are unlikely to reject it. However, a policy also needs to be powerful enough to accomplish stated goals. In the context of adaptation to climate change risk, the most effective and acceptable public policies are likely to be those which are based on an understanding of how producers make decisions within a multiple risk context and provide them with the flexibility to respond to policies without compromising their financial and personal security.
CHAPTER 3: OKANAGAN BASIN: GEOGRAPHICAL, HISTORICAL AND INSTITUTIONAL BACKGROUND

This chapter provides an understanding of the geographical, historical and institutional context shaping this research. Such an understanding is crucial to analysis of the research results because individuals' values, perceptions and experiences are shaped by characteristics of their external environment and have a significant impact on their capacity to make decisions. The chapter is structured in three parts. Part 3.1 is an introduction to the basic geography and climate of the Okanagan region. Part 3.2 outlines the history of agricultural development and settlement in the region and discusses the challenges posed by urban growth to the security of the agricultural land base. It then goes on to detail the rapid emergence of a quality wine industry in response to trade liberalization pressures beginning in the late 1980s. The third and final part of this chapter defines the institutional structure for water management in the region and contrasts the current water management systems in the three largest study communities: Penticton; Summerland and Oliver.

3.1 Geography and Climate

The Okanagan Valley is located in the southern interior of British Columbia, and stretches approximately 200km across three regional districts from the town of Enderby in the north to Osoyoos on the Washington State border in the south. Average elevation at the valley bottom is approximately 1100 m while mountains to the east and west reach heights of almost 2000m.
The valley's lakes and rivers drain an area of 8200 square kilometers and carry runoff southward into the United States. Although the valley has six large main-stem lakes (of which the largest, Okanagan Lake, is 350 square kilometers in area), this region is one of the driest in southern Canada. The valley has dry, mild winters and hot, dry summers with temperatures that can reach in excess of 40 degrees Celsius. Mean annual precipitation ranges from 700mm in the mountains to 300mm at the valley bottom, most of which falls as rain and snow in the winter months.

The Okanagan Basin comprises three regional districts: North Okanagan Regional District, which is centered on Vernon; Central Okanagan Regional District, which includes Kelowna; and South Okanagan-Similkameen Regional District, which encompasses southern Okanagan communities such as Penticton and Osoyoos, and Keremeos in the Similkameen Valley. Population growth has proceeded rapidly in the Okanagan Valley from the 1970s to the present. Between 1971 and 2001 the valley's population doubled to a size of almost 300 000 (Cohen et al. 2005). Although much of the growth has occurred in the three largest communities: Vernon, Kelowna and Penticton, growth is also progressing rapidly in a number of smaller municipalities. The South Okanagan-Similkameen Regional District has traditionally been the most sparsely populated part of the valley (Kerr et al. 1985). However, it is now home to more than 81 000 people and is expected to grow to 114 000 by 2026, an increase of 46% from 1996 (RDOS 2006).

3.2 History of the Wine Industry

*Early History*

The mild climate and fertile soil of the Okanagan have made it a desirable location for horticulture ever since Europeans first settled the area in the late nineteenth century. The province's first commercial orchards were planted in the
central and northern parts of the valley beginning in the 1890s in response to demands from resident miners and with the support of a Canadian government eager to expand settlement in its remote western territories (Kerr et al. 1985).

The development of a quality wine industry in this area initially lagged because field experiments conducted in the early twentieth century indicated that European grape varieties of the species *vitis vinifera* were unsuitable for the Okanagan’s climate (CVA 2005). Since *viniferas* could not survive the long, cold winters of the central or northern parts of the valley and irrigation systems were not yet developed in the milder south, Okanagan vintners at first grew hardy, native hybrid grapes. Unfortunately, the quality of the wine produced by these grapes was poor. Despite advances yielded by irrigation and technological development, social movements such as prohibition reduced the incentive for innovation and growth until the 1960s. Experimental trials to consider whether European varieties could be grown successfully in the Okanagan were not widely undertaken until the province’s moratorium on the issuance of new winery licenses imposed during prohibition was lifted in 1979 (CVA 2005).

After locally-specific techniques for irrigation and cultivation of *vinifera* grapes were developed for the Okanagan, the South Okanagan-Similkameen Regional District became the most desirable location for vineyard and winery development in the region. Although grapevines naturally increase their hardiness in winter, historic kills in the Okanagan have typically been associated with short periods of intense cold caused by the south-eastern flow of arctic air through the region’s mountain valleys (Caprio and Quamme 2002). By the 1960s frost kills had limited soft-fruit plantings and promoted apples and other temperature resistant grain crops north of Summerland. Vineyard development, which had previously predominated in the Central Okanagan, moved southwards throughout the 1960s and 1970s (Kerr et al. 1985).
Land pressures

Rapid population growth and economic diversification were concurrent with the development of the agriculture industry throughout the valley in the mid twentieth century. Government programs to encourage regional development after the 1950s focused on the expansion of tourism and light industrial sectors often at the expense of agriculture. Development to support a growing population became the priority use of land, and until 1972 agricultural land was consumed at an accelerating rate to accommodate urban infrastructure (Manning and Eddy 1978). Substantial areas were consumed for the development of transportation networks and most new communities were settled on flat, low-lying land suitable for agriculture (Manning and Eddy 1978).

To combat the rapid conversion of agricultural land to other uses, the provincial government of the time passed the Environment and Land Use Act on July 1, 1971 to freeze development on all land with soil suitable for agriculture (Kerr 1985). The BC Land Commission (now Agricultural Land Commission) created the Agricultural Land Reserve (ALR) in 1973, excluding sufficient land for 5 years of development in those areas where non-agricultural land was not immediately available. The Agricultural Land Commission Act applies to all land in the province with the exception of land under federal jurisdiction and takes precedence over other provincial legislation and local zoning (Smith 1998).

Although the existence of the Agricultural Land Reserve has alleviated pressure for conversion of agricultural land it has not eliminated it (Smith 1998). Subdivision and exclusion of land is permitted through an appeals process administered by the ALC and this has lead to land speculation and soaring land values across the region. Consequently, it is more difficult for farming families to acquire agricultural land in the region without accepting unprecedented levels of debt. The growing trend towards planting specialty, high-value crops in the
region can be partially attributed to the high investment costs now required for start-up or expansion of farm businesses (Farmer 1 pers. comm. 2005).

*Trade liberalization*

The increasing inter-dependence of global economic systems since the late 1980s has increased both opportunities and challenges for agricultural producers in the Okanagan and also had a significant impact on their planting decisions (Farmer 2 pers. comm. 2005; Farmer 1 2005). Obligations under free trade agreements such as NAFTA and the WTO have integrated agricultural markets and intensified competition for Canadian products and forced producers to specialize and occupy niche markets or expand in order to survive (Skogstad 1996). With the establishment of the Canada-US Free Trade Agreement in 1988, BC produced hybrid wines were exposed to competition from higher quality imports and the industry was forced to transform in order to remain profitable (CVA 2005). A government-sponsored tear-out program of all hybrid grapes was initiated in 1988 and continued throughout the early 1990s. Growers were paid to clear their land of hybrids and then re-plant with *vinifera* varietals in order to establish a new BC industry based on high quality wine (Farmer 2 2005).

In 1990 the BC Wine Act established the BC Wine Institute (BCWI) a government-administered standard setting body for BC wine (BCWI 2005). The BCWI was founded upon a mandate to establish standards for 100% BC wine, to certify compliance with these standards and to provide support programs for the development of the industry. It adopted the Vintners’ Quality Alliance seal as a mark of quality production and within ten years had established itself as a recognized brand in the eyes of BC wine consumers (BCWI 2005; MAFF 2004).

As of 2006 the BC wine industry is thriving, expanding its markets and experimenting with new varieties. In 1989 there were 1 100 acres planted to wine grapes. Now there are almost 6 000 acres. BC generated $240 million in
domestic wine sales in 2003 and an additional $33.2 million in exports, primarily to the US, Japan and the European Union (MAFF 2004). In mid-2006 the newly formed BC Wine Authority will position itself as the new wine quality standards organization for BC and the BC Wine Institute will be repositioned to focus on marketing of BC wines (MAFF 2004). This new authority is set to be an improvement on the current system because its independent nature and transparent quality assessment process should command consumer confidence and encourage industry growth (Farmer 3 pers. comm. 2006).

As of March 2004 there were 90 wineries, 229 independent vineyards and 139 winery owned vineyards in BC (MAFF 2004). Eighty-nine percent of the wine grapes grown in BC are grown in the Okanagan Valley and approximately 60 of the 90 wineries listed by the Ministry of Agriculture in 2004 are also located there. Most of the large, estate wineries in the Central Okanagan and almost all the Lower Mainland and Vancouver Island wineries purchase grapes from independent growers in the Okanagan (Farmer 3 2006). In the Okanagan Valley portion of South-Okanagan Similkameen Regional District there were 35 listed wineries in 2004. However, at the time of this research in January 2006 at least 40 wineries were established in this area.

Although winery establishment looks set to continue in the next few years evidence suggests that there will be fewer opportunities for newcomers to establish vineyards in the near future (MAFF 2004). The expense of investing in properties currently for sale is prohibitive for individuals without a second source of income and subdivision of agricultural land has reduced most available land parcels to sizes below the 5 acres recommended for independent vineyard establishment (MAFF 2004). Currently, close to 50% of the vineyards owned by wineries are less than 10 acres in size and over 80% of the independent vineyards are less than 10 acres in size (MAFF 2004). For individuals farming ever-smaller vineyards, wine production is a logical means to increase personal
income without further land purchasing. In the future, farmers predict that most of the older orchard land that comes up for sale will be bought by only the largest wineries because they are the only ones who will be able to afford the rising prices of land and crop conversion (Farmer 3 2006; Farmer 1 2005).

Despite the rapid growth and expansion of the BC wine industry over the past 15 years established grape-growers in the region stress the importance of maintaining a high standard of quality for their product. Despite the presence of measures to support wine industry growth, alcohol production and distribution is heavily regulated in BC and this has a significant impact on the income of wineries throughout the province (Farmer 1 2005; Farmer 2 2005).

The Liquor Control and Licensing & Liquor Distribution Branches of the BC Government issue licenses for the production and sale of liquor and possess the exclusive right to purchase and distribute beverage alcohol in BC (BCLiquor 2005) The Liquor Distribution Branch (LDB) operates government liquor stores and distribution centres that provide alcohol to private sector retail establishments such as cold beer & wine stores and duty free stores. Their regulations stipulate that direct sales from alcohol manufacturers such as wineries can only occur from on-site retail stores. As such, sales from breweries and wineries currently account for only 10% of all the liquor sold in BC (MAFF 2004).

Many small Okanagan wineries are reluctant to sell their products through government liquor stores because they receive a lower proportion of the profits than if they sell directly to consumers. Small wineries also often have difficulty meeting the minimum supply requirements of the LDB and are forced to sell on-site or through private VQA stores (Farmer 3 2006). For these small-volume producers quality is very important because they rely upon repeat customers and word of mouth instead of in-store visibility to maintain wine sales. However,
quality is also very important for large Okanagan producers who need high-volume sales in liquor stores but cannot afford to compete in price with inexpensive imports from other ‘new world’ wine regions such as California and Australia (Farmer 1 2005; Farmer 2 2005).

3.3 Institutional Control of Water Resources

Irrigation water is critical to the growth and survival of almost all crops during the Okanagan’s hot and dry growing season from April to October. However, water management and policy development in this region is complicated by the presence of multiple interests in water use and consumption regulated by various government agencies (Shepherd et al. 2006). These interests include, among others, demands for municipal servicing, maintenance of in-stream flow for fisheries protection and recreation in addition to irrigation requirements.

Two main principles guide the system of water governance in BC – the prior appropriation and beneficial use principles. The prior appropriation principle states that priority for use in times of shortage is allocated to the holder of earliest issued license. The beneficial use principle is discretionary in nature and is controlled by the province. It states that if the holder of the license does not demonstrate beneficial use of her allocation (usually by consuming it in its entirety) then she forfeits her right to it (Scott 1991).

*History of jurisdictional control*

In the first half of the twentieth century, development of water systems for irrigation, flood control, domestic water supply and power generation was the primary consideration of water resource planners and engineers in BC. By the late 1960s, public awareness of the unintended environmental and social consequences of large infrastructure developments was growing and Canadians had become dissatisfied with the disproportionate emphasis on economic criteria
in project evaluation and planning (O'Riordan 1972). This unrest lead to the passage of the Canada Water Act in 1970, which clarified government responsibilities defined by the Constitution Act of 1867 and laid the foundation for federal and provincial collaboration to improve resource management and planning across Canada.

Currently, the BC government has control of all surface and groundwater in the province, with the exception of those water bodies supporting commercial fish stocks and those on First Nations’ or other federally owned land. These waters are regulated by the federal departments of Fisheries and Oceans and Indian and Northern Affairs Canada respectively. In the Okanagan, the federal government is also responsible for Osoyoos Lake, which lies on the national border between British Columbia and Washington, and is managed under the International River Improvements Act.

Generally, the federal government is responsible for doing research and managing waters of national economic importance while provincial ministries handle day-to-day management of water quality and quantity. The most important provincial ministries with responsibilities for water management are the: Ministry of Environment; Health; Agriculture and Lands; Forest & Range; and Energy, Mines & Petroleum Resources. Although the surface water system in the Okanagan has been reasonably well studied, there are still significant gaps in knowledge of the region's groundwater system (Natural Resources Canada 2006). Although the Ministry of Environment lists almost 5000 wells in the Okanagan Basin, withdrawals from these wells are not licensed or monitored and the long-term impacts of these activities on water supply are poorly understood (Ministry of Environment 2006).
Regional planning and management

In BC, water resources are managed locally by municipal governments in incorporated areas and by regional districts, improvement districts, irrigation districts or water user communities in unincorporated areas. The BC Local Government Act, administered by the BC Ministry of Community Services, defines the structure and responsibilities of these institutions. Municipal governments are usually responsible for domestic and agricultural servicing within urban boundaries, while improvement districts are usually responsible for providing a variety of basic services to rural communities. Irrigation districts and water user communities are bodies responsible for the provision of irrigation and/or domestic water to a small number of users. Depending on their size, they may be managed by a regional board of directors. Since a water user community is defined as a system with a minimum of two connections, it may be small in size and less formally managed. Regional districts are government bodies responsible for a number of planning and development issues such as growth management and may encompass numerous municipalities and scattered settlements. Regional districts are usually only responsible for providing water to small or unincorporated communities within their jurisdiction.

The only entity currently responsible for regional management of water resources is the Okanagan Basin Water Board which was created to address issues of water quality, most particularly Eurasian Milfoil, in Okanagan Lake in 1968. A basin-wide authority for water management does not currently exist, although an unsuccessful attempt was made to establish one in response to the 1974 recommendations of the Okanagan Basin Study.

The Canada-BC Okanagan Basin Agreement was signed in 1969 with the goal to develop a framework plan for the planning and management of water in the Okanagan Basin (O’Riordan 1972). A number of studies were completed to provide background on the physical, social and biological features of the basin.
and three futures scenarios for the region were also developed and considered, each incorporating different rates of economic and population growth and levels of environmental protection to the year 2020.

The principal recommendation of the Consultative Board's Main Report, released in March 1974, was that a single authority be established to co-ordinate the implementation of the framework plan. The board suggested that the Okanagan Basin Water Board be reformed to undertake this responsibility and administer all future regional water resource management functions. Ultimately this regional water management authority was never established.

Critics of the Basin Agreement attribute the plan's failure to lack of political support. Although there was widespread popular support for the project, politicians were only minimally involved in the public involvement program and felt threatened by the participatory nature of the planning process (Janamaat 2005). For this reason, the resistance of regional politicians to cede power to a new authority was not identified during the planning stages and emerged only after the Board's recommendations were presented (Janamaat 2005). Although the Okanagan system is facing unprecedented demands on its water resources and public awareness of quantity issues is growing, it is unclear if the creation of a new regional governance body would be any more politically acceptable in 2006 than it was 30 years ago.

South Okanagan case studies
In the three largest communities in this study area, irrigation water is supplied and regulated by an urban purveyor. However, agricultural users do not pay for their water based upon what they consume; they are charged a flat rate per irrigated acre. In each case the consumer's peak flow is restricted by a valve on the main line but there is no annual limit to consumption.
**Penticton**

The City of Penticton is a community of 31 000 located at the southern end of Okanagan Lake south-east of Summerland and south-west of Naramata (RDOS 2006). Domestic water supplied by the City of Penticton is drawn from two sources: Penticton Creek and Okanagan Lake. Although the city pumps directly from Okanagan Lake, the Penticton Creek system is gravity-fed and originates at Greyback Mountain Lake and Dam, approximately 10km east of Penticton at 1649m. The City also maintains a well as a backup supply. Most of the irrigation demand within city limits comes from the Naramata Bench on the city's north-eastern perimeter. Greyback Dam, constructed under an Agriculture and Regional Development Act (ARDA) program in 1967, services this agricultural demand. Untreated water is diverted from Penticton Creek below the dam at the Campbell Diversion. The undiverted flow in Penticton Creek continues downstream and is treated for domestic consumption at the Penticton Water Treatment Plant (City of Penticton 2006). Currently agricultural users are charged for their water on a flat-rate per irrigated acre charge. There are not any water conservation bylaws that apply to agriculture at this time, although the city is considering the implementation of an inclining block rate structure for all metered domestic connections.

**Summerland**

The District of Summerland is located on the west shore of Okanagan Lake and has a population of 10, 713 people (DOS 2006). Almost all residential and agricultural properties, including 3 520 irrigated acres of farmland, are serviced by the district system (Facet Decision Systems Inc. 2005). Developed storage on Trout Creek, including a system of 9 dams, provides about 90% of water consumed in the district. The remaining 10% is supplied by Eneas Creek System. Approximately 80% of the total supply is consumed for irrigation (UMA Group Ltd. 2004).
Summerland’s dependence on its upland sources for water supply and associated vulnerability to changes in seasonal precipitation were exposed when the community suffered a severe water shortage in the summer of 2003. This shortage can primarily be attributed to lower than average snowfall during the winter of 2002-2003 and the failure of Summerland Council to impose water restrictions on domestic and agricultural users early in the season (Shaw et al. 2006). Although Andrew Reeder, the water manager for the district, observed low snowpack levels in March and warned council of imminent drought, action was not taken rapidly enough to forestall conflict between agricultural users, Fisheries & Oceans Canada and local officials the following August (Shaw et al. 2006).

As of 2006, Summerland actively promotes water conservation in both the agricultural and domestic sectors and is pursuing a number of investments to improve management of its water system. Currently, agricultural and domestic water systems are connected and it is very difficult to determine how water is being used. Summerland is now pursuing separation of its irrigation and domestic water systems over a 25 year period and has already begun meter installation on all agricultural connections within its jurisdiction (Shaw et al. 2006). A five-stage system of domestic water restrictions has also been developed which links reservoir levels on a trigger graph with restriction levels. Agricultural users are currently exempt from restriction bylaws although they also have conservation targets they are encouraged to meet (Shaw et al. 2006). A stakeholder-developed action plan, created in response to the 2003 drought, now also exists to define water allocation priorities during periods of severe drought.

Oliver

The town of Oliver has a population of 4350, with an additional 4500 people living in the surrounding area, all of whom are serviced by the town of Oliver.
water system (Town of Oliver 2006). Although agricultural and domestic water are formally separated in this system, both are drawn from sources that drain Okanagan Lake. The urban residential system withdraws water from Okanagan River while agricultural water is supplied through an irrigation canal that begins at Vaseux Lake and runs parallel to Okanagan River for most of its course. Although the canal initially parallels the east side of the river it crosses the river south of MacIntyre Bluff and flows south through the town of Oliver on the western side of Highway 97. Some residences on the west side of the community are also serviced by the irrigation canal while others pump wells for domestic use.

During the summer of 2003 the Town of Oliver did not experience any water shortages and no water restrictions were put in place (Shaw et al. 2006). Although rural water demand comprises approximately 85% of the community’s total demand, the community as a whole consumes only a quarter of its licensed allotment (Dobson Engineering Ltd. 2005). In 2006 Oliver has recently completed a draft Water Demand Analysis and Conservation Plan as the foundation for discussion with council about demand-side management. Although the public does not perceive water conservation as currently necessary, water managers believe that improving understanding of the community’s water budget is an important element of effective water management (Shaw et al. 2006). The conservation plan recommends metering to provide better management of information and encourage water conservation. The plan is expected to garner opposition from local farmers who feel threatened by conservation policies.

Conclusions

Government policies over the last 50 years have had a significant impact on local land-use and development patterns in the Okanagan. Trade economics and
regulatory policies have affected the size of individual properties, crop choices and business profitability in the agriculture industry. Changes in these factors have lead to both agricultural intensification and land-use conversion throughout the region. The impact of these land-use decisions on water consumption should not be underestimated. To understand how adaptation to water scarcity occurs and should be planned, it is important to first understand how different population groups use water and then consider how future land-use shifts may affect consumption patterns. Contextual factors fundamentally shape individuals’ and organizations’ perceptions of risk and patterns of consumption. Hence, their influence on the effectiveness and acceptability of water conservation policies in all consumption sectors is significant.
CHAPTER 4: METHODS

The main objectives of this research are to understand how wine-grape growers in the South Okanagan use water to manage the multiple risks that threaten their profitability, examine how growers' choice of management practices is influenced by perceptions of water security, and identify key elements of a water conservation policy growers would be likely to support. The purpose of this chapter is to describe the methods employed in this research to satisfy these objectives. The chapter is organized into three sections and begins with a description of the research approach and design of the survey instrument. The following sections outline the process of subject recruitment, describe the interview structure and define the methods of data analysis.

4.1 Research Design

Survey Selection

The first step in the design of this study was to choose a survey instrument that would achieve the objectives of this research. Two principal research approaches were considered: focus groups and interviews.

A focus group is a focused group dialogue in which the researcher acts as a facilitator, and participants present and discuss their opinions (Finch and Lewis 2003). Focus groups differ significantly from group interviews, in part because they may foster shared learning. Participants can reflect upon their own views and then refine them in light of the views of others. Although focus groups are a useful means to understand interactions among people, focus groups are less useful for understanding individuals' perspectives in detail (Finch and Lewis 2003)
In contrast to focus groups, interviews are one-on-one discussions between the researcher and study participants. There are two main types of interview formats: unstructured and semi-structured. Unstructured interviews are exploratory in nature and are broadly designed to give participants the flexibility to choose which elements of a topic they want to discuss. The significant difference between semi-structured and unstructured interviews is that in semi-structured interviews the researcher asks the same questions in the same way each time. Although the interviewer may probe for more detail in response to some questions, she has a clearer idea of the range of expected responses and exploration of new ideas and topics is limited (Arthur and Nazroo 2003).

Since a critical component of this research is defining the relationship between individuals’ risk perceptions and their associated actions and policy preferences, I chose to meet with participants one-on-one rather than in a group setting. Although a focus group approach might have been a useful means to initiate discussion between individuals, I also felt that the sensitive nature of some of the material was better addressed privately. I designed a semi-structured questionnaire with a mix of open and closed questions, designed to both facilitate comparison between responses and provide growers with the flexibility to answer unpredictably. Since I had not previously met most of the participants I chose to conduct the interviews in person, rather than over the telephone, because I felt that the quality of responses would be higher if the participants developed a rapport with the researcher. In-person interviews were preferred to mail-out questionnaires because I wanted to ensure that I received a minimum number of complete responses.

Questionnaire design
The questionnaire, approved by the University of British Columbia Office of Research Services, was designed to order data in a logical, natural way, with introductory and background questions at the beginning, moving to more serious
and in-depth questions in the middle (Arthur and Nazoo 2003). It is divided by theme into seven parts. Parts I and II include short answer and multiple choice questions about the personal and professional attributes of sampled growers. Part III investigates the characteristics of growers' water source and irrigation management systems. It poses questions that differentiate growers' primary and secondary water sources, their systems of water provision and the rationale behind their choice of irrigation technology. Responses in this section are primarily closed, short answers.

In Part IV, respondents are asked about their perceptions of the current and future security of their irrigation supply. They are asked to comment on their satisfaction with their current system of water provision, their perceptions of the security of their future supply, and the trade-offs associated with making investments to increase their water-efficiency. In this section, questions are framed as statements to which respondents must indicate their level of agreement on a 5 point scale. Respondents are then asked to explain their choices more fully. The following two parts, V and VI, examine the role of water as a risk management tool. Questions in these sections are less structured and designed to identify producers' business goals, define the risks that present a threat to attainment of these goals, and understand how water is managed to reduce risk exposure.

Part VII, the final section of the survey, uses a combination of multiple choice, short-answer and open-ended questions to develop an understanding of growers' preferences for a hypothetical agricultural water conservation policy. In this section growers are asked to identify existing policies that encourage water efficiency in agriculture, make recommendations about the types of research needed to guide policy development, and explain why they would or would not support policy development and/or implementation by a particular level of government. They are also asked to identify the pros and cons of different policy
instruments and give their own opinion of agricultural water metering, a politically controversial practice in this region.

The goal of this section is not only to examine the nature of growers' perceptions of the need for a water conservation policy, but also to identify the elements of a policy development process they would consider effective and credible. Opinions of current policy are critical to the development of new policy because they provide analysts with more information about why current efforts have or have not been successful. Growers' preferences for research reflect their personal values and provide insight into the interests they would like a new policy to address. Support for control of policy at different jurisdictional levels speaks volumes about the degree of competence and trust growers associate with each level of government.

4.2 Interview Protocol

Subject recruitment
The selection of participants in this thesis was driven by the research need to understand in detail the attitudes and management practices of a defined study population. Previous research (Belliveau et al. 2006) has indicated that wine-grape growers in the South Okanagan are more vulnerable to climate change and more dependent on water to manage risk than those in the central or northern parts of the Okanagan Basin. Since a driver of this research is the need to understand the process of climate change adaptation and it is unclear if growers in the central and northern areas confront and manage risks in the same way as their southern counterparts, I chose a purposive approach to subject recruitment.
Purposive sampling is a type of non-probability sampling in which individuals are selected for inclusion in a study because they share common features or characteristics that are of interest to the researcher (Ritchie et al. 2003). In this case a homogenous, non-probability sample is more appropriate than a probability sample because the goal of the research is not to examine the prevalence of certain views or behaviours within the local population as a whole but rather develop a rich understanding of issues specific to a unique group of people.

Growers were selected based upon 3 primary criteria:

1. They reside and work in communities in South Okanagan-Similkameen Regional District
2. They understand both the practices of vineyard and business management
3. They hold professional positions which give them the power and flexibility to take action to mitigate these risks.

Based upon these criteria and my own understanding of the industry, I decided that winery owners and independent vineyard owner/operators were the best interview candidates. I compiled a complete list of the wineries in the region using membership directories available on the BC Wine Institute and Association of BC Winegrowers websites, contact information for wineries provided by BC Liquor Stores and a BC VQA store in Vancouver and recommendations from researchers who had previously worked in the region. I initially identified forty-one wineries in this region, six more than the thirty-five listed by the Ministry of Agriculture in December 2004 (MAFF 2004). However, after investigation I realized that several of the wineries were owned and managed by the same person or couple. To avoid duplication, I sent letters to these individuals only at the winery they had established first. I identified thirty-six different winery owners. Four independent growers, one now retired, who had been involved
with prior research in the region and met the selection criteria were also
included.

At this stage I contacted each business by phone to confirm the name of the
owner and the winery’s address before sending a letter of introduction inviting
the individuals to participate in the study. Forty letters were sent and a second
round of telephone calls was made 10 days later to answer growers’ questions
and arrange a time for an interview. Thirty-four individuals were reached by
telephone during the recruitment process and nineteen interviews were set up.
Recruitment was more successful in Summerland, Oliver and Okanagan Falls
than Penticton or Naramata (Table 1). However, in general, interest in the study
was high. Most of the individuals who were contacted expressed enthusiasm
about being interviewed. Only three individuals admitted that lack of interest was
responsible for their refusal to participate.

Table 1. Interview recruitment success rates in each of the study communities

<table>
<thead>
<tr>
<th>Wineries Contacted</th>
<th># of Interviews</th>
<th>Success Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naramata</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Summerland</td>
<td>5 (1)*</td>
<td>3 (1)</td>
</tr>
<tr>
<td>Penticton</td>
<td>7 (1)</td>
<td>0 (1)</td>
</tr>
<tr>
<td>OK Falls</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Oliver/Osoyoos</td>
<td>12 (2)</td>
<td>6 (2)</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>36 (40)</strong></td>
<td><strong>15 (19)</strong></td>
</tr>
</tbody>
</table>

*The number in brackets refers to the number of independent or retired growers
unaffiliated with a winery.

*Interview Structure*

Between January 23 and 27, 2006, nineteen interviews were conducted in the
Okanagan communities of Okanagan Falls, Oliver, Naramata, Summerland and
Penticton. The interviews ranged from one to two hours in length and were held
either at the interviewee’s home or place of work. At the outset, producers were
asked to sign a consent form assuring them that the study subscribes to an ethical code of conduct defined by the university and that their responses would remain anonymous. None of the interviews were recorded because I believed that I would receive more honest answers to controversial questions if participants felt that they were truly speaking 'off the record'. I also felt that it was not necessary. The questionnaire was designed to elicit very specific information that I could note easily.

4.3 Analytical Approach

The interviews in this thesis were analyzed using content analysis, a process in which important themes are identified by examining the context in which comments are made and the words chosen to discuss them (Ryan and Russell 2000). In content analysis, the frequency of occurrence of words and phrases is considered an indicator of an item's salience relative to other variables. Once transcript analysis has identified themes of research importance, these can then be linked to outside variables such as the demographic characteristics of participants (Spencer et al. 2003).

The first stage of data analysis was to organize the responses, participant by participant, and enter them into a spreadsheet for the summary of raw data. The data was categorized question in a format similar to the questionnaire structure. Multiple choice responses were entered as numeric codes that could be easily compared across participants. Short answer responses to each question were examined for common themes. Similar responses were assigned the same code, usually a concise phrase, to convey the meaning of the response, and then entered into the spreadsheet. In-depth responses to open-ended questions, important quotations and stories were compiled and sorted by grower in a separate word processor file so that explanations and important information were not lost in the tabulation and could be more easily retrieved.
Once the raw data were compiled, summary tables, diagrams and graphs were created to convey the information. Bar graphs were selected as the most effective means to communicate information from individual questions and tables were chosen for data with more complex patterns that could not be effectively conveyed by a figure. Diagrams were created to illustrate the relationship or direction of flow between ideas for easier conceptual understanding. These figures, tables and diagrams are presented and interpreted in the results chapter. Analysis of these results in the context of the theory discussed in chapter 2 and the policy context defined in chapter 3 occurs in the final chapter of this thesis.
CHAPTER 5: BALANCING MULTIPLE RISKS: THE IMPLICATIONS OF GROWERS' EXPERIENCE AND PERCEPTIONS FOR IRRIGATION CHOICES AND POLICY SUPPORT

The purpose of this chapter is to present the most important research findings from the surveys and interviews completed with 19 wine-grape growers in January 2006. The following six sections divide, summarize and discuss the primary themes and results of the interviews. Section 5.1 surveys the demographic and professional attributes of the individuals within the sample and Section 5.2 outlines the characteristics of their water supply and management systems. Section 5.3 defines the producers' personal goals and emphasizes their connection to water management and individuals' risk management decision-making. The final two sections focus more specifically on perceptions and policy preferences for mitigating potential water shortages in the future. Section 5.4 investigates in more detail the nature of producers' perceptions of risk and Section 5.5 defines a process to improve water-use efficiency and discusses the characteristics of a conservation policy that growers would be likely to support.

5.1 Demographic and Professional Profile of Producers

Table 2. Participant distribution by business type and location

<table>
<thead>
<tr>
<th>Community</th>
<th>Winery</th>
<th>Independent</th>
<th>Retired</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naramata</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Summerland</td>
<td>3 (1)*</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Penticton</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Okanagan Falls</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Oliver</td>
<td>6 (2)*</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>15</strong></td>
<td><strong>3</strong></td>
<td><strong>1</strong></td>
</tr>
</tbody>
</table>

* the number in brackets is the number of sampled wineries that is corporately owned, not owned by the respondent.
The respondents surveyed in this research are all Caucasian, English-speaking, adult male residents of five communities in the South Okanagan. With the exception of one respondent from Summerland, all of the participants are residents of the communities in which they farm and the vineyard of interest is geographically close to, if not on the same property as the associated winery (Table 2). In Summerland, the respondent is the business manager and son of the owner of a large winery whose grapes are farmed by a farm-labour contractor in Oliver. The farm-labour contractor was later interviewed with reference to the management of the Summerland-owned property in addition to his own personal vineyard, also located close to Oliver. The business manager’s responses with reference to risk perception have been attributed to Summerland, because he has grown up in that area. The retired grower, now a viticulture consultant and educator in Summerland, was surveyed with regard to his opinions on government programs and policy alternatives only. His opinions on those topics are included in the final part of this results section. He did not complete other sections of the survey.
Half of the participants interviewed have family roots in the Okanagan and have been involved in farming in the region for greater than 20 years (Figure 1). One individual holds a family property dating back as far as the 1930s while 5 individuals are newcomers to the area and have worked in farming for less than 10 years. Six of the participants said that they were born or have lived in the Okanagan for almost all of their lives, 9 are from BC or other parts of Canada and the remaining four represent Holland, Australia, Switzerland and England.

Figure 2. Location and Date of Establishment of Vineyards

**Vineyard development**

Two of the first vineyards to be established in the South Okanagan are also two of the largest (Figure 2). Both are several hundred acres in size and owned today by large wineries. They are located close to each other on Black Sage Bench on the east side of Okanagan River close to Oliver. In the 1980s and 90s, rapid growth of the BC wine industry led to the development of seven more of the sample vineyards in the Oliver area, with the largest establishing on the bench. Until 2004, 1300 acres on Black Sage Bench were owned by a few large wineries
and managed uniformly by a farm labour-contractor in Oliver. In 2005, the two partners in the company collectively manage over 600 acres. They were both interviewed in this survey. All four of the Okanagan Falls vineyards were developed in the 1970s and 1980s. None of the vineyards in Summerland, Naramata or Penticton were developed before 1980.

Table 3. Land-use before establishment of the current sample vineyard

<table>
<thead>
<tr>
<th>Previous Use</th>
<th>Number</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orchard</td>
<td>7</td>
<td>In Oliver, 0 vineyards were previously orchard</td>
</tr>
<tr>
<td>Vineyard</td>
<td>2</td>
<td>Vacant land after the hybrid tear-out in Oliver</td>
</tr>
<tr>
<td>Virgin/Grazing</td>
<td>7</td>
<td>Six Oliver vineyards were previously unfarmed</td>
</tr>
<tr>
<td>Mix</td>
<td>2</td>
<td>One was a hybrid/virgin mix (Oliver). The other was a vineyard/orchard mix in Naramata</td>
</tr>
</tbody>
</table>

After the 1980s sponsored tear-out of hybrid grape varieties and the subsequent vinifera replant program, land-ownership in the South Okanagan changed rapidly (Table 3). Many people that had previously farmed hybrid grapes left the region and sold to newcomers. In Oliver, two of the current vineyards were left vacant and sold after the hybrids were taken out and six of the current vineyards were still virgin shrub-steppe and used only for grazing. One was a mix of both. The current vineyards that were previously orchards are located in the Okanagan Falls area and further north.

This sample represents vineyards across a range of size classes distributed across a number of locations (Figure 3). The smallest three properties are between 5-10 acres and the five largest, all located on Black Sage Bench, are well over 100 acres.

Referred to as 'the natural progression of grape-growing' by one participant, winery establishment followed vineyard development in 13 of the cases. The most common time to establish a winery is as the first harvest of grapes.
approach, four years after the first planting. Two wineries were established before they developed vineyards, and one winery was established forty years after the first grapes were planted on the property. The three independent growers interviewed were not personally interested in the extra work associated with establishing a winery because each had been farming for more than 20 years and said they were approaching the end of their careers. Two mentioned it as a possibility for their children.

![Figure 3. Number of vineyard properties in each size class](image)

Most winery respondents commented that they prefer to supply their own needs with their own grapes because they have more control over their quality than if they contract purchase. However, 12 of the 15 winery respondents did indicate that they either: lease land to supply their volume needs; purchase grapes from independent growers or sell grapes to other wineries. These activities were identified as adaptations to the disparity between supply and demand for different grape varieties across the region and the availability and distribution of land for lease and purchase. Across the region the average number of grape varieties in a participant’s vineyard was 9, with a conservative vineyard choosing
to focus only on its 5 best and two of the largest operators farming 20 each across several hundred acres.

5.2 Water Source & Management Profile

Although the types of systems which provide these vineyards with agricultural water are diverse, the options available to each property are often limited. Only 5 of the 18 vineyards have a secondary system in place as a back up, although many commented that well-drilling is a possibility if they need it. The five primary methods of supplying irrigation needs are: pumping from the Okanagan River mainstem; groundwater pumping from personal wells; agreements with urban purveyors and irrigation districts and distribution by a water user community.

In Naramata the Regional District of Okanagan-Similkameen draws water from Okanagan Lake and an upland reservoir to meet the needs of its urban and
agricultural residents. Although both Naramata operators mentioned that the town’s water quality is damaged by the turbidity in the upland source they are happy with the volume of flow they currently receive and don’t expect it to change when the agricultural and domestic systems are separated in the future. In Penticton and Summerland the easiest supply option for agriculture is also the urban system. Both operators in Summerland mentioned that although they are right next to the lake, they don’t think they would be able to get a license to pump directly. One suggested that he would drill a well as a secondary source if necessary.

In Okanagan Falls, the four vineyards are located on the eastern slopes of the valley, above the community itself, and are serviced by independently developed systems. Two vineyards have an agreement with Sun Valley, an irrigation district pumping a communally owned well with servicing for 28 agricultural properties. Another belongs to a water user community with three other families which have built their own dam to trap snowmelt on a nearby creek. The fourth, located further north is able to draw principally from Skaha Lake with a license part of the year on a proximal creek.

In Oliver, 9 of the vineyards are at the same elevation as the town and use water drawn from Okanagan River while the small operator overlooking the valley pumps from his own well and storage pond. On Black Sage Bench, the two large properties located north of town pump directly out of the irrigation canal, at that location running parallel and to the east of the river itself. South of town, the urban system provides pressurized water from the canal to the two properties on the west side of the valley. On the Bench south of Oliver, two of the properties have their water provided by the management company, which has a system of river pumping designed and built to provide water for hundreds of acres. Two properties on the Bench pump wells.
Irrigation patterns

The operators sampled make irrigation decisions using a variety of methods. Fourteen individuals cited qualitative methods such as looking at and touching the vines, feeling the soil and digging holes as an important determinant of their decision to irrigate. Of the 14, eight use only qualitative techniques to make their decisions, four use soil probes to measure soil moisture and others use ET rates from PARC and pressure bombs to measure leaf pressure. Four vineyards over several hundred acres each use a combination of management methods: soil probes, pressure bombs, photosynthetic guns and ET rates.

Consumption patterns

When questioned about the changes in their irrigation consumption patterns, 16 respondents said that they use either the same amount of water or less per acre than they did in 1996 (Table 4). They most commonly attribute this pattern to the stage of vine growth on their property. The five individuals who had replanted vinifera grapes throughout their vineyard before the early 90s had mature grapes with a constant annual water demand by 1996. Seven of the respondents were in the process of replanting their vineyards in the 1990s and said that they use less in 2006 than in 1996 because the plants’ demand for water has dropped. Only four individuals cited management decisions as an explanation for consumption changes. Two individuals do not know if their consumption has changed.

Table 4. Summary of water consumption trends (per acre) since 1996

<table>
<thead>
<tr>
<th>Use</th>
<th># Resp.</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Same</td>
<td>5</td>
<td>Mature grapes in 96; water management the same</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>High demand from young grapes; better scheduling</td>
</tr>
<tr>
<td>Decrease</td>
<td>7</td>
<td>Grapes have matured so now need less water</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>More aware of diminishing water supply – use less</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Changed irrigation technology</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Improved scheduling</td>
</tr>
</tbody>
</table>

58
Irrigation technology choices

Examination of operators' choice of irrigation technology indicates that there is a preference for irrigation systems which allow the grower to strictly control water application to the vines (Table 5). Of the 10 individuals with drip as the lead technology in their system, only 1 said that he had drip 'because it was here'. The other 9 specifically chose to make the investment, either when they bought the property, or as their business income increased. Three growers are currently in the process of installing drip as part of a dual system with the overhead they currently have in place. In contrast, 4 of the 8 individuals with overhead as their principal technology said that they have it 'because it was here' when they bought the property and two of the three with exclusively overhead indicated that they have no plans to change their irrigation system in the future. Although 10 individuals mentioned that drip in combination with a more disperse system of watering is best, the three growers with only drip indicated that they have no plans to put in a dual system. Two individuals that are switching to a drip-overhead system explained that at the time their vineyards were established, overhead was the standard technology to use but that they wouldn't put it in now as their first choice.

Table 5. Types of irrigation systems in place

<table>
<thead>
<tr>
<th>Irrigation Technology</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Only Drip</td>
<td>3</td>
</tr>
<tr>
<td>Dual: Drip-Overhead</td>
<td>5</td>
</tr>
<tr>
<td>Dual: Drip-Spinners</td>
<td>2</td>
</tr>
<tr>
<td>Only Overhead</td>
<td>3</td>
</tr>
<tr>
<td>Dual: Overhead-Spinners</td>
<td>2</td>
</tr>
<tr>
<td>Dual: Drip-Overhead from</td>
<td>3</td>
</tr>
<tr>
<td>Overhead I.P.</td>
<td></td>
</tr>
</tbody>
</table>

Individuals with experience using overhead irrigation systems were able to identify numerous benefits and costs associated with its use (Figures 5 & 6). Its benefits include the ability to regulate micro-climate through cooling, frost
protection and saturation of the root zone in preparation for winter. It is also considered a valuable tool in coarse soils, where overhead irrigation diffuses water across the surface and leads to the establishment of ground cover crops. This growth reduces erosion and permits harvesting tools to move between the rows without sinking.

![Diagram of pros of overhead irrigation](image)

**Figure 5.** Pros of overhead irrigation identified by its practitioners

Despite these benefits, overhead irrigation is generally perceived to be less water efficient than other technologies. High evaporation rates in heat and in wind are associated with poor quality control; operators are unable to precisely regulate the flow of water to individual vines and find it difficult to decide how much and for how long to water each block during periods of peak demand. Although under-watering is typically associated with high quality wine grapes, timing deficit irrigation using overhead technology is challenging and over-watering can lead to problems such as excess growth and humidity-related disease. It is also
economically inefficient if the operator is paying to pump water that he does not effectively utilize.

In contrast to overhead technology, trickle-drip irrigation systems have much higher perceived benefits than costs (Figure 7). They use a low volume of water because water is applied directly to individual plants, significantly reducing evaporative loss, lowering pumping costs, and effectively eliminating the threat of humidity-related disease. The most widely perceived benefit of using a drip system is the ability to grow a very high quality grape. Deficit irrigation is easy to practice because the system is highly controlled. Critics of drip maintain that since it does not produce a cover crop, organic matter in the soil is depleted, reducing soil structure and health in the long term. If used alone, it also lacks the climate-control benefits offered by overhead. Although only one individual with drip irrigation mentioned its expense, others who do not currently have it mentioned cost as the single most limiting factor affecting their decision to install it.
When respondents were asked to identify the most significant trade-off they confront when contemplating an investment to increase water efficiency, twelve of 18 respondents asserted that a trade-off does not exist (Figure 8). Grape quality is directly connected the grower's ability to control the volume of water provided to the vine and as such, the financial benefits of producing premium grapes greatly outweigh short-term investment costs. The grower who has never considered the trade-offs disagrees that drip irrigation is required to grow premium grapes and says that as he has a secure surface source that he co-operatively manages he has no incentive to change his technology.

Three growers mentioned that they come from countries where they have seen water crises in the past and say that water is always a good investment regardless of quality issues if you have the money. Two of the three individuals who identified money as the largest trade-off are either already on, or converting to drip technology because they believe that in the long term the investment is
worth it. The third individual has been farming for less than 10 years and said that at this time he needs to focus on more immediate, high-return investments, such as expanding his winery before making technological investments in water efficiency. The individual who fears that an investment to increase his water efficiency today may result in pressure to conserve even more in the future has been farming in the Oliver area for over 20 years and associates agricultural water conservation with expanding urban development.

Seventeen individuals said that irrigation scheduling is either critical or important as a management strategy in their vineyard, although most mentioned that they monitor a system of indicators that they have developed personally through experience and education (Table 6). There was general consensus among those for whom scheduling is 'critical' that traditional scheduling, as defined by the Ministry of Agriculture, is not appropriate for growers practicing deficit irrigation. All of the individuals use drip or are in the process of putting it in as their
primary technology. A number of respondents mentioned that there is very low level of knowledge about Best Management Practices for grape-growing within government, leading to confusion of growers who are new to the industry and particularly those who come from the tree-fruit industry. One individual, who has been growing grapes for less than 10 years said that during the first few years he over-watered but that as a result of talking with his neighbors he is now "learning how to do things better and we don't just have the sprinklers on max all the time now."

Five of 18 individuals said that irrigation system design is 'important' instead of critical; of those, four are growers using overhead technology. One operator who relies exclusively on overhead said that he doesn't have a problem practicing deficit irrigation because "If you know how to schedule for your own land, technology isn't so important." In general, the participants seemed to feel that technology to monitor soil (probes) etc. are a valuable tool, but not necessary on small-medium sized farms where more qualitative assessment of irrigation is sufficient. A number of people made comments such as: "If you know your land you notice problems and learn how to deal with them so technology isn't crucial" and "Technology is more important if you don't know your soil" and "you only need it if your property is really big and hard to keep track of."

Table 6. Responses ranking importance of different water management strategies for achieving grape quality

<table>
<thead>
<tr>
<th></th>
<th>Irrigation Scheduling</th>
<th>System Design</th>
<th>Technology Choice</th>
<th>Soil Moisture Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td>Important</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Neutral</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Unfamiliar with it</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
5.3 Balancing Multiple Risks in Pursuit of Profitability

The producers in this sample all identify a relatively common goal that motivates them: they strive towards the development of a business which thrives or remains profitable throughout their lifetime, enables them to provide for a family and maintain a way of life. Nine of 18 respondents mentioned in passing that at least 2 generations of their family currently work in the business and 4 others mentioned that they are working hard with the business so that they can pass it on to their children if they want it. Six individuals mentioned that they are happy that the industry is young and growing, and compared it as a positive alternative to tree-fruit which they view as a struggling industry in decline.

In this context, the risks and uncertainties that concern growers most are those that pose a threat to the survival and prosperity of their business (Box 3).

**Box 3. Risks That Affect Growers’ Profitability**

<table>
<thead>
<tr>
<th>Growers’ Fundamental Goal:</th>
<th>Maintain the profitability of the business for myself and my children</th>
</tr>
</thead>
</table>

**Factors that threaten goal attainment**

- **Urban Development**
  - Insecurity about the future of agriculture in the Okanagan
- **Climate Risk**
  - Land values are high and limit vineyard expansion
  - Climate extremes and variability can damage crops
- **Market Demand**
  - Unpredictability of future market demand for grape varieties
  - Competition from cheap imports and cheap labour
- **Government Policy**
  - Recession affecting tourism and sales
  - Unwarranted government policy can increase costs for growers

*Source: Interviews*
The most commonly stated challenge to farming grapes in the Okanagan is the price of agricultural land. Sixteen of 18 individuals commented that land and skilled labour costs in the Okanagan are too high for grapes to be produced at the economy of scale which allows for production of inexpensive, bulk wine. Consequently, with the exception of the (largest) land-holders who have the financial flexibility to purchase land at over $100 000/acre, most farmers are trying to increase their profit margin with the land that they have.

There is a division of strategies for increasing profitability (Table 7). Bigger producers that need to sell a large volume of wine generally focus on following market trends and planting varieties in relation to their popularity. They typically plant many varieties and are willing to take self-acknowledged 'moderate' or 'big' risks with their planting their decisions in relation to climate, because they believe that the market payoff of harvesting a successful crop is worth it. Medium-sized wineries tend to plant a fewer number of varieties and are more likely to focus on those that they can do really well. Three people commented that they cannot compete globally with red wines from other places and that the risk of a big freeze for reds is just too great. They prefer to be more conservative in their planting decisions because they believe that there will always be a market for world class whites. Since they do not have to sell thousands of cases of wine they are not worried about occupying a niche market. Fifteen individuals representing both large and small wineries commented that the most effective way to increase their profit margin is to focus on grape quality through *deficit irrigation*. In this context, deficit irrigation is defined as a process in which vines are given less water than they actually demand during the berry set stage of growth. Grapes are left to shrivel slightly in order to concentrate the fruit sugars and bring out their flavour.
Table 7. Decisions growers can make to mitigate the impact of these risks

<table>
<thead>
<tr>
<th>Market Demand</th>
<th>Business development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focus on grape quality</td>
<td>Plant more marketable varieties</td>
</tr>
<tr>
<td>• Maintain quality through good irrigation scheduling</td>
<td>• Focus on what is done best</td>
</tr>
<tr>
<td>• Invest in better irrigation technology to increase control</td>
<td>• Expand vineyard on your property or expand on other land</td>
</tr>
<tr>
<td>• Increase quality through personal control of grape production</td>
<td>• Expand winery</td>
</tr>
<tr>
<td>•</td>
<td>• Stay up to date with research &amp; technology developments</td>
</tr>
<tr>
<td>•</td>
<td>• Expand product marketing</td>
</tr>
<tr>
<td>•</td>
<td>• Increase off-farm income to decrease vulnerability</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Climate Risk</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Plant varieties based on regional and site-specific climate</td>
<td></td>
</tr>
<tr>
<td>• Use resources such as PARC to assist you with challenges</td>
<td></td>
</tr>
<tr>
<td>• Use irrigation for cooling and frost protection</td>
<td></td>
</tr>
<tr>
<td>• Research your site before you buy it</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Urban Development</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Invest in land with business partners</td>
<td></td>
</tr>
<tr>
<td>• Develop relationships with other producers so that you can unite and defend your interests</td>
<td></td>
</tr>
<tr>
<td>• Become active in planning and politics in your community</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Government Policy</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Not really anything you can do about federal or provincial policy</td>
<td></td>
</tr>
</tbody>
</table>

Source: Interviews

Other risks identified by producers include policy decision-making by local, provincial and federal governments which threaten their land and water resources and impose paperwork and extra costs (Box 3). These challenges range from struggling to make money while selling through the liquor distribution branch, increasing regulation of wineries, escalating urban-rural conflict that is poorly mitigated by weak provincial policies such as 'right to farm, and local land development planning in Summerland and Oliver. Seven individuals mentioned
climate extremes and variability as a big risk they face. These risks are associated with extreme cold, mild weather that increases vulnerability to spring and fall frost, excess moisture and pests. Two people mentioned ‘global warming’ as a source of potential extremes and unpredictability in the future that concerns them. Only two individuals mentioned that the threat of a water shortage is a risk that concerns them today. One of these individuals attributed the water shortage risk to land development planning rather than climatic change.

5.4 Perceptions of Water Shortage Risk

Experience with water shortages
Although almost half of the growers surveyed in this study have been farming in the Okanagan for over 20 years, few of them have ever confronted a situation in which they did not have more than enough water to meet their irrigation demands. The widely publicized drought of 2003 did not significantly impact any of the growers surveyed. Four individuals from Summerland and Naramata mentioned that watering restrictions had been placed on them in 2003, but that they had not been personally impacted because they have low irrigation requirements in mid-summer. Since they believe that their vines are resilient to drought and that their irrigation purveyor is required to maintain at least minimal flows to their properties, these growers are confident that they will have sufficient water to meet their needs during future droughts.

Two individuals with more than 20 years’ experience in the Oliver area recalled a summer in which the level of Okanagan River dropped to an unprecedented low. At that time, the individual who pumps directly out of the river said that his pump had almost come out of the river and almost rendered it impossible to irrigate. He said that this, combined with his general philosophy on the need for responsible water management, has led him to invest a lot of money in setting up a sophisticated pumping system and drilling a backup well to protect himself.
The grower on the Oliver town system remembered that his water had been shut off for a short period because the government had required the purveyor to maintain a minimum flow level in the river at the expense of irrigation needs. Although the impacts of the system shut-down were minimal for this individual he says that he is nervous about such an event occurring in the future when Oliver is servicing a much larger residential population.

Monitoring water consumption
In general, the growers are complacent about measuring or monitoring their water consumption. Only 3 of 17 individuals, including 2 of the largest users, said that they keep records about their water use, which is measured by a pump (2 cases) or calculated based on valve pressure and flow rates. The other 14 individuals said they are able to calculate use in this way but do not regularly do so. Most growers commented that water consumption is poorly regulated. Since purveyors charge for water on a flat rate per irrigated acre system which does not consider use or crop type, growers are unconcerned about understanding what proportion of their annual or peak flow they actually consume. Two individuals with large licenses from Okanagan River in Oliver said that they choose to monitor their own water consumption although it is not strictly necessary. They both have grandfathered licenses and know that they use much less than their licensed amount. One of the individuals said that he now uses less than half of his annual allotment, and 25-30% of the volume that he consumed in the 1980s, as a result of vinifera's low water demand.

Perceptions of current supply: personal
Growers' relaxed attitude towards measurement and monitoring extends to an overwhelming satisfaction with their water sources and systems of provision generally (Figure 9). When asked to comment on the flexibility and volume delivery of their systems, only two individuals do not 'agree' or 'strongly agree' that their systems satisfy their demands. The individual that feels his system
does not deliver adequate flows during peak times pumps directly out of surface water on his own property and attributes the deficiency to declining snowpack. The individual that believes his system is not flexible enough is concerned about his legal entitlement to water from his purveyor after September 30. Water purveyors, concerned about early freezes damaging pipes, often turn off their systems for winter before grape harvest in October, leaving grape-growers without water to soak vine roots before winter. Although numerous individuals mentioned this as a drawback to being supplied by a purveyor, several respondents mentioned that it is not usually a problem because they have a good relationship with the purveyor and can pay a fee to extend water service into October.

![Figure 9. Responses to the question: Through my current system of water provision I have enough water to irrigate during peak times and whenever I need it during the growing season.](image)

**Perceptions of the future: basin system and personal source**

Although growers’ perceptions of their current supply are fairly uniform, their predictions about the future of their personal source and that of the basin
system are widely variable (Figure 10). Notably, individuals' perceptions of changes to the hydrological system are almost completely unrelated to their predictions of personal supply.

Although five individuals do not have an opinion about basin supply in the future, many people commented that snowpack has decreased steadily in the last ten to fifteen years and climate is warmer, more variable, and prone to extremes. Individuals with less than ten years experience in the valley were less likely to comment on changes in climate or snowpack than those with longer residency.Growers voiced mixed opinions about the implications of climate variability for basin supply. Four individuals suggested that climate patterns are cyclical and that today's warming trend will have cooled somewhat by 2031. In this scenario, water supply will remain the same in the future. Others believe that a diminished snowpack is indicative of climate warming, either on a short-term or a long-term scale, and will probably reduce basin supply further by 2031.
Perceptions of personal supply in the future are less related to philosophies about hydrologic changes than to individuals' level of control over their water source. Four individuals believe that their rights to draw from their current source will remain the same in the future. One of these individuals pumps directly out of a mainstem lake and two others are isolated from the mainstem on systems where the majority of the users are agricultural. The fourth, pumping out of Okanagan River north of Oliver, is confident that as long as Canadians have to provide water downstream to the U.S. there will be enough water flowing past his door for his needs.

Eleven of the 13 individuals who think their right to draw from their current source will decrease 'somewhat' or 'a lot' mentioned the fact that agriculture is not considered a priority in the Okangan and that urban development will consume a lot more water in the future. Five of 8 respondents in Oliver were concerned about urban development in the region and all 8 said that the volume they have a right to consume will decrease in the future.

Figure 11. Responses to the question: I think that in 25 years I will have enough water if I don't change the way I manage it on my property
When questioned further about source access in the future, growers expressed mixed feelings about their ability to maintain production without changing their water management practices (Figure 11). Eight of 18 individuals 'strongly agree' or 'agree' that they will have enough water for their irrigation needs without making any changes, regardless of changes to source access. Of these, five attribute this security to the fact that they use drip and are already very efficient.

The remaining ten individuals are doubtful about the broader, systemic impact of their personal choices. Three individuals disagree that they will have sufficient water in the future, despite their current reliance on drip. These growers are concerned that residential growth will consume a lot of water in the future and do not believe that personal efficiency reduces their vulnerability to water shortages. The other seven growers, five from Oliver, said that they didn’t know or they were neutral about whether they would have to change their management practices in the future in response to water scarcity. They remain optimistic.

5.5 Growers’ recommendations for the policy process

*Current incentives for water conservation*

Examination of growers’ perceptions of current policy indicates that external incentives for responsible water use in agriculture are poorly advertised, if at all (Figure 12). Fifteen growers are confident that policies to encourage responsible water use do not exist at this time. Three others cited the Environmental Farm Plan (EFP) program as a source of partial funding for conversion to drip irrigation systems. However, none of these individuals are actually pursuing funding through the program. In two of the cases the participants had completed the conversion before the EFP program was established and they mentioned that funding is not available retroactively. The third, a large operator, said that the
money he would be granted is not worth the time it would take him to complete the required paperwork.

Although unaware of its application to water conservation, several other individuals mentioned the Environmental Farm Plan program as a funding source for small infrastructure such as fencing. No-one seemed to feel that being ‘environmentally friendly’ was a marketing tool, although one small operator said that he is going to go through the EFP process because he believes in supporting the program itself. One respondent believes that there is a political disincentive that discourages him from conserving water. He commented that “If [farmers] use less, people say we can make do with even less. When does it stop? I know how much I need – no-one has to tell me.”

![Bar chart]

Figure 12. Distribution of responses to the question: Are there any external/policy incentives for you to conserve water on your property?

Research to support policy development

Underlying growers’ views on the development of a water conservation policy for agriculture is the dominant philosophy that agriculture’s access to water should
be protected from urban demand. Many growers mentioned that associated with the decline of agricultural profitability in the 1990s has been the ongoing subdivision of agricultural land and its conversion to hobby farms or release from the ALR. This change in land-use and ownership, typically from farm families to retired urbanites, has exposed growers to more competition for land and water resources and increased urban-rural conflict.

The respondents recognize that urban development and population growth are inevitable in the Okanagan. However, they emphasize that thought needs to be given to sustainable urban planning before development occurs. They perceive urban water use as the most rapidly growing demand sector within the basin and are concerned that domestic servicing will be given priority in the future. Growers are concerned that their interests are not represented by municipal politicians who are more concerned with attracting investment from wealthy land developers than maintaining agricultural viability in Okanagan communities.

In this context, the respondents would like to see research determine current patterns of urban and agricultural water supply and demand across the Basin and scenario projections for the future. This information could then be used to develop a regional growth strategy to guide the distribution and timing of further development and guarantee access for agriculture.

Jurisdictional control of policy development and implementation
Different growers perceive many advantages and disadvantages of policy development and/or implementation by each level of government (Figure 13). With the exception of two individuals who have never considered the issue, the respondents voiced strong opinions on this topic. One grower commented that after thirty five years in the Okanagan he is convinced that no government department is competent enough to develop such an important policy. Instead, a
private consultant should be hired to make policy recommendations to the Ministry of Agriculture & Lands.

![Chart showing distribution of respondents' preferences for agency or partnership to lead development and implementation of agricultural water conservation policy.]

Figure 13. Distribution of respondents' preferences for the agency or partnership they most strongly support to lead development and implementation of an agricultural water conservation policy.

Two individuals support the federal government to lead this initiative because they believe that water conservation is an issue of national importance. One grower commented that imposing the costs of agricultural water conservation on individuals is not feasible with the current system of international trade regulations in place. Only when Canadian agriculture can survive without government subsidies can growers can be expected to make investments and pay the full cost of the water they use. Until then, the federal government should be obliged to bear the costs on behalf of growers.

Although local government is perceived to have the most locally-specific knowledge and relevant water-management experience, only two growers believe that local bureaucrats have the expertise to develop policy. Politicians at the local level are also generally perceived as less trustworthy than those from
higher levels of government because they rely upon their established alliances with local land developers to ensure their re-election.

Eleven growers support provincial involvement, via the Ministry of Agriculture & Lands, in policy development and implementation at some level. The Ministry of Agriculture is perceived to possess the necessary expertise to develop policy, and also, more significantly, has the authority to enforce co-operation between municipalities and regional districts. Six individuals mentioned that the biggest problem with developing a water conservation policy would be conflict between local jurisdictions.

Policy instrument preferences
In the latter part of the survey, participants were asked to define elements of an effective policy that would inspire their support. This elicitation process exposed a distinction between those individuals that identify themselves as independent businesspeople or members of the wine industry and those that are concerned with protecting the interests of Okanagan agriculture in general. Since the producers generally perceive their personal water demand to be low, few feel financially threatened by a potential reform of pricing structures. If they consider only their own personal interest or the interests of the industry they are likely to support policy changes that make the resource less expensive for them and more expensive for others. In contrast, those individuals that consider the interests of agriculture more broadly are less likely to support measures that impose concentrated costs on any agricultural sector. Growers' opinions on the role of voluntary, regulatory and economic-based policy instruments are discussed here in the context of the policy development process.

i. Education, Best Management Practices & Regional Institutions
Six growers mentioned that deficit irrigation could be considered a best management practice for the wine-grape industry in BC but that many new
growers are ignorant of the connection between grape quality and water management. These individuals believe that the first step of any policy program should be effective grower education. They are convinced that most growers will independently choose to invest their time and money in innovative irrigation, monitoring and scheduling practices if they are aware of the financial rewards. Site visits and consulting by experienced vintners were recommended as effective means to educate new producers.

Four individuals mentioned that hard data on volumes and flows should be a key input in the development of any policy to increase efficiency. Once water managers understand where, when and how much water is being used they will be better prepared to target education strategies at irresponsible consumption sectors. Three growers recommended meters as the most effective tool to measure flow rates, consumption and distribution. One individual said that he advocates the introduction of meters as the first step in a program of education and regulation similar to that done by SEKID.

Support for the management of education programs was divided between those who feel that irrigation districts should be in control and those who think that the wine-grape industry itself should take more initiative. Several growers new to the industry commented on their isolation from other growers in their area and the lack of assistance they received from industry organizations when they were trying to establish their business. Those with more experience in the region commented that although growers now belong to any one of three different organizations, everyone will be united by free membership in the new BC Wine-grape growers’ council to be formed in 2006. This organization will focus on education, research & development for the benefit of all growers.
ii. Economic incentives

Although all of the growers believe that they should have secure and guaranteed rights to minimum flow rates, eight individuals mentioned the need to improve agricultural water-efficiency through the use of economic incentives. Suggestions include rewarding individuals who use less than their allotment through providing tax breaks or making meters tax deductible. One individual recommended the set up of an incentive program for individuals that put in meters themselves and submit flow information to their irrigation purveyor. Another said that he thinks a market for selling water rights between growers within each agricultural sector could increase efficiency.

iii. Regulation

There was general consensus among the respondents that metering water consumption is a necessary precursor to regulation. However, only half of the respondents (9/18) support agricultural metering. Three are ambivalent about its introduction and 6 others believe that it is not necessary in the Okanagan.

Examination of the relationship between growers’ personal characteristics and support for metering indicates that those with less than 10 years experience in the region are unlikely to oppose metering outright. Although farmers with more than 10 years experience in the region diverge in their opinions, both of the respondents with less than 6 years in the valley were ‘neutral’ in their support for agricultural metering and those with between six and ten years all supported it. Presence and absence of support appears to be most related to growers’ perceptions of their personal ability to adapt and personal philosophies about environmental stewardship and agricultural water rights.

In contrast to growers’ mixed views about agricultural metering, fifteen people commented that they support domestic/commercial metering. Water metering is viewed by respondents as an effective way to understand the movement of flows
throughout the system and set targets for use. Although metering can be an effective tool to ensure equitable access, its critics argue that prices for agricultural water should be based upon the social value of food, not just actual consumption (Table 8).

Table 8. Pros and cons of water metering as identified by producers

<table>
<thead>
<tr>
<th>PROS</th>
<th>CONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>• It allows you to target conservation policies at the wasters</td>
<td>• Agricultural use will drop and there will be more water for development</td>
</tr>
<tr>
<td>• It is fair to pay for what you use</td>
<td>• May lose our rights and be regulated to a new 100% based on only a couple of years’ data</td>
</tr>
<tr>
<td>• It allows you to compare the water consumption of different management practices</td>
<td>• More paperwork and no personal benefit</td>
</tr>
<tr>
<td>• It is valuable to know how much water is flowing through your system to different locations to track water flow</td>
<td>• It’s not fair to charge agriculture based on use because the market value of the crop is not linearly related to how much water it uses</td>
</tr>
<tr>
<td>• It makes people think more about the value of the resource if they have to pay for it</td>
<td>Source: Interviews</td>
</tr>
<tr>
<td>• Water consumption will decrease</td>
<td></td>
</tr>
</tbody>
</table>

All of the individuals that support or are neutral about metering in agriculture also support metering in other sectors as an equitable solution to reduce waste. The majority of the growers see urban servicing as the most rapidly expanding demand sector and associate future water supply shortages with population growth rather than agricultural consumption. Numerous growers commented that agriculture has been labeled as a waster by the public as a consequence of the irresponsibility of a small proportion of growers primarily in the tree-fruit sector.
Those in support of agricultural metering believe that meters should be used in conjunction with educational programs first and that billing for water should be delayed until users understand their own consumption patterns. After meters are well established then they can be used to impose penalties on abusers or regulate industries to BMP standards. One grower cautioned that high billing rates for agriculture may lead to more well drilling and significant groundwater withdrawals if regulation of surface and groundwater is not integrated.
CHAPTER 6: ANALYSIS AND CONCLUSIONS

The sixth and final chapter of this thesis considers the study's primary research findings in the context of concepts discussed in Chapter 2. To do this, it defines the way in which producers perceive their own vulnerability to water scarcity and the need to make decisions to reduce it. It then explores the nature of other risks farmers confront and examines how the management of water to mitigate these risks affects farmers' vulnerability to climate change and willingness and ability to adapt to it. The chapter concludes with an examination of growers' preferences for government intervention and the implications of this analysis for near-term adaptation policy. Recommendations for future research are also identified.

6.1 Risk Perception: implications for adaptation

In briefest terms, this research suggests that growers are unlikely to autonomously make decisions to adapt to water scarcity in the near future because they do not perceive a need to do so. They believe that they are already efficient enough to buffer the impacts of future scarcity. Moreover, they do not think that their consumption is significant enough to have an impact on the basin system.

Although most of the growers surveyed in this study assume that in the future agriculture in the Okanagan Basin will not have the same consumption rights as it does now, few are personally concerned about the impact of access restrictions. At present, most growers recognize that they have more than enough water to irrigate during periods of peak demand and few keep records of their water consumption, although they acknowledge that it would be relatively straightforward to do so. Only five of 18 individuals have bothered to spread the
risk of shortage by making use of two provision systems; the other thirteen do not regard this step as necessary.

Complacency about monitoring current water use can be attributed to growers’ perceptions that their irrigation requirements are much lower per acre than those of other agricultural crops in the Okanagan. They also believe that their historic rights prevent them from facing restrictions beyond a threshold that they would define as threatening. Several growers in the Naramata and Penticton area commented that they are not concerned with measuring consumption because they use so little water. They can go without watering their vines for weeks at a time in mid-summer because their soils retain moisture so well. Two individuals who have been farming grapes in the Okanagan for more than twenty years said that they are less concerned with their water use now than in the past because *vinifera* grapes have a much lower irrigation demand than hybrids. They feel secure with their legal rights to water, because their water licenses are grandfathered and their allotment is based upon the demand of hybrid grapes, not *vinifera*.

Factors affecting risk perception

The individuals most concerned with restricted water access are those who have lived in places where they were either personally affected by water shortages or knew people that were affected. The individual who pumps out of a surface source fed by snowmelt in Oliver said that he is increasingly aware of his vulnerability and the need to use water responsibly because he has observed the level of his irrigation pond drop consistently in the last five years. Another individual who pumps directly out of the river in Oliver echoes this sentiment. He remembers a year when Okanagan River was so low his pump was almost out of the water. Both of these individuals, in addition to others with similar experiences, have readily made investments in water efficiency.
Heightened risk perception regarding water supply is also associated with lack of individual control over water access and absence of trust in the water purveyor. In Okanagan Falls, for example, the growers all feel comfortable with their supply because they either personally control it or it is controlled by a small, agricultural purveyor. The growers in this area have not suffered shortages in the past and associate access with consistent snowpack and precipitation. Growers close to Okanagan River in the Oliver area perceive their supply to be plentiful and are not driven to conserve water as a result of scarcity concerns.

On the other hand, distrust of the priorities of government officials in Oliver is linked to higher risk perception regardless of water supply. An individual on the town system in Oliver commented that he remembers a time when his water system was shut off for a short period to retain instream flow levels in the river. Although his operation was not adversely affected on that occasion, it made him aware of agriculture’s low political priority and his operations’ vulnerability to similar events in the future. Eleven of the thirteen individuals from across the region who think that their right to draw from their current source will decrease ‘somewhat’ or ‘a lot’ in the future also attribute this to the fact that agriculture is not a priority of local governments and urban development will have greater demands in the future.

While growers in Summerland and Naramata faced water restrictions during the summer of 2003, these individuals feel secure about their water access because they believe that agriculture is a priority to the local government and feel assured of minimum flow provision during drought. This is not the case in Oliver, where a few individuals reliant on the town system believe that agriculture is not a priority and water will eventually be re-directed to other uses. All eight respondents in Oliver said that they thought that their rights could decrease in the future.
Individuals who have resided in the Okanagan for more than ten years suggested that basin supply will be negatively affected in the future by reduced precipitation. A number of people commented that snowpack has decreased steadily in the last 10-15 years and climate is more variable. Although some people think that snowpack levels will continue to decline in the future, others are more optimistic and suggest that the trend will have reversed itself within another 25 years. Although several individuals mentioned that some kind of climate change may be occurring they believe that there is so much uncertainty regarding its impacts that it is not worth worrying about.

Since water scarcity is not a concern for most growers in the present, the majority have not considered the need to reduce their operation's vulnerability to future shortages. Only a few individuals mentioned that they had made investments to increase their water efficiency partly because of supply concerns. The three individuals who use overhead irrigation technology exclusively stated that they are not planning to put in a drip system because the costs are not worth the benefits. Although their comments imply that they could make the investment if they wanted to, in general, water efficiency is not considered an agricultural investment priority for its own sake. Almost all the growers are quite confident that they would be only minimally affected by supply reductions in the future because they do not use much water as it is. Individuals that have put in drip have typically made the decision based upon consideration of other drivers.

It is unclear how much of growers' disinterest in their agricultural water consumption is a function of growers' feelings of isolation from other users. Since grape-growers operate independently, without strong ties to an industry organization, they may not feel a strong sense of responsibility towards other users in the basin. Most grape farmers mentioned that water consumption is poorly regulated by their local purveyor and are aware that their consumption is not monitored or compared against that of others. Since efficiency is not a
priority of the local regulator they do not make it a personal priority themselves. Growers also remain unconvinced of the systemic impact of their personal choices. Seven people commented that their management practices do not have much of an impact on water supply for others in their area while three individuals using drip systems believe that they will not have enough water in the future, despite their current efficiency.

**Limitations of this research**
Since the perceptions of almost half of the winery-owners in the South Okanagan are documented in this study it is likely that the diversity of opinions present in the population as a whole is represented by these research results. Nevertheless, there is uncertainty regarding the extent to which these perceptions are shared by others, including independent grape-growers or farmers in other agricultural sectors. All of the sampled individuals are adult males of European descent and since evidence suggests that white males, on average, have higher incomes and lower risk perceptions, it is possible that these results are not representative of all farmers in the region. Although all of the winery-owners contacted for inclusion in this study were men, the demographic characteristics of independent grape-growers in the Okanagan are undocumented. Anecdotal evidence also suggests that other agricultural sectors are more culturally diverse than the wine industry. Tree-fruit, for example, has traditionally been dominated by visible minority groups from homogenous cultural backgrounds. It is uncertain how ethnicity affects perceptions or awareness of local issues and preferences for water management in this context.

**6.2 Managing Multiple Risks**

In the discussion of adaptive capacity in Chapter 2, financial capacity was identified as an important component of an individual's ability to make investments in response to business threats. Belliveau et al. (2006) define...
financial capacity as a function of a farmer's access to credit, income and assets. She argues that the desire to strengthen financial capacity is a major driver of farmers' management choices. Although discussion of credit access and insurance is beyond the scope of this study, understanding the ways in which producers are vulnerable to income loss and make decisions to minimize such loss is relevant to the examination of water consumption in this sector. Water scarcity is not a pressing concern for most growers in 2006. On the other hand, they do face a number of other risks which represent a threat to the profitability of their businesses: government policy; urban growth, market demand; and climate. The nature of these risks is discussed in the following section and the interaction between them is highlighted in Box 4.

i. **Government policy**

Policies at the international and national level affect growers through their impact on market access and demand. Trade liberalization has both exposed the Canadian wine industry to greater competition and increased its access to international markets. Government assistance during the hybrid tear-out program made it possible for an industry based on quality wine to expand and the subsequent development of the Vintners' Quality Alliance certification standard expanded consumer confidence and had a positive effect on sales, particularly in British Columbia. However, the high price of BC wine makes it a luxury good and vulnerable to changes in economic trends which affect tourism and sales.

ii. **Urban growth**

Government policies on land-use at the provincial and local level have an impact on growers because they do not sufficiently alleviate pressure for conversion of agricultural land to other 'higher value' uses. Subdivision and sale of agricultural land and the subsequent petition for its removal from the Agricultural Land
Box 4. The Interactions of Producer-Identified Risks and their Implications for Water Demand

Reserve frequently leads to its purchase by land speculators and wealthy hobby farmers. This has decreased the availability and increased the cost of agricultural land for use by full-time farmers. At present it is difficult for new farmers to get into the business because they either cannot afford the start-up costs or cannot find large enough properties to buy. Many growers commented that they would be unable to enter the business now because skyrocketing land values in the last five years have restricted purchase opportunities. They believe that only the largest wineries and wealthy urban migrants now possess the capital to purchase the vineyard patches that come up for sale around the region.
iii. Market Demand

Economic forces associated with product competition and escalating land values have lead growers to focus on both product quality and marketing to increase revenue without further land purchasing. Since land parcels are generally too small and expensive to focus on production of cheap, bulk wine, growers concentrate on the production of quality wine which can be sold at a higher mark-up. In this context, fifteen individuals representing both large and small wineries said that the most effective way to increase their profit margin is to focus on grape quality through deficit irrigation. They also emphasized the need to make grape variety choices based on a combination of consumer preference trends and site suitability criteria.

Big wineries tend to place more emphasis on a variety's popularity than smaller wineries because they need to move larger quantities of their products through the liquor stores. Yet, larger wineries are also better positioned to cater to consumer preference than small wineries. Large properties possess diverse site characteristics and give growers the flexibility to shift varieties around the vineyard. Big wineries may also have the financial capital to buy or lease additional land to grow the grapes they need or the means to purchase them from independent growers. Contract purchasing is a useful adaptation to rapid shifts in public preference because it can shorten or eliminate the time lag between vine planting and harvest, usually a period of 4-5 years. Although smaller wineries may have a more limited capacity to cater to consumer preference, they survive by occupying a somewhat different market niche. They tend to be more restricted in the types of grapes they can plant so they often place more emphasis on doing what they can do best and build a reputation for themselves by winning awards and maintaining product consistency.
iv. Climate

The smaller wineries that choose to focus on the varieties they do best usually choose to grow varieties that are well-suited to the Okanagan's climate. These varieties tend to be less sensitive or difficult to manage than varieties at the limit of their geographic range. The Okanagan is a cool-climate wine region with a short growing season and fewer growing degree days than wine regions in Australia, California and Southern Europe. As a result, many varieties of red grapes are unsuited to the Okanagan's climate because they do not receive enough heat during the growing season to ripen in time for fall harvest. Delaying grape harvest is risky because entire crops can be wiped out by unpredictable autumn frosts. White grape varieties have lower heat requirements than red varieties so can usually be harvested before the weather turns cold. However, white varieties are sensitive to high temperatures and do not photosynthesize or build fruit at hot sites at mid-day.

Consumer preference in Canada and overseas currently favours the production of red wine. As a result, many of the largest Okanagan wineries invest a lot of resources growing and managing red grape varieties that are difficult to ripen in time for harvest. However, regardless of winery size, every participant surveyed in this study was growing at least one red variety because they knew that if they could ripen it, they could sell it. One individual from a well-established small winery cautioned that although it is possible to grow red grapes in the Okanagan, only the best vineyard managers will be able to do it well enough to win awards, so from a quality perspective it is better to focus on growing and producing world-class whites. Three others from small wineries agreed with this statement. They added that they are wary of planting red grapes because Okanagan reds cannot compete globally with reds from warmer regions and the freeze risk is just too great.
Leasing land to supply volume needs, purchasing grapes from independent
growers and selling grapes to other wineries is a way to address the disparity
between supply and demand for different grape varieties across the region. It is
also a means to mitigate climate and market risk. Wineries in northern or more
climatically extreme locations can purchase red grapes from vineyards in the
Oliver and Osoyoos area to meet their needs while avoiding the risk of crop
failure. Although many small wineries are wary of quality concerns associated
with purchasing grapes they themselves haven’t grown, this tends to be less of a
priority for large wineries.

Implications for water management and vulnerability
Examination of the forces driving farmers’ decision-making reveals that although
farmers do not currently regard water as a scarce resource, most are cognizant
of its value and are motivated to use it in a responsible manner. Wineries of all
sizes are concerned with producing quality grapes and regard careful water
management as critical to this process. Despite its high price, twelve of the
eighteen sampled growers have already or are about to install drip irrigation
systems at their own expense because they are convinced of its benefits. Of
these, only one uses it ‘because he has it.’ Almost all of the growers interviewed
in this study acknowledge that it is easier to consistently produce good quality
grapes with drip irrigation because the technology makes it possible to cater to
the needs of individual plants instead of larger vineyard blocks. For individuals
that are responsible for pumping their own water, drip is also considered an
investment in the long-term reduction of hydro costs because reduced pumping
requirements lead to lower electrical demand.

Although they are not as water efficient as drip systems, overhead systems also
have many acknowledged benefits, particularly to do with the reduction of
climate risk. Overhead sprinklers can be used to soak the soil profile after
harvest to protect vine roots from freezing during the winter and are also useful
for overhead cooling during hot periods and warming to alleviate frost risk. Most of the individuals that rely on overhead systems appreciate their benefits but also use them because it was either the standard technology when they established the property or it was there when the purchased the land. Overhead sprinklers are considered by many to be an outdated technology and those that seek its benefits are more likely to put in ground-level spinners than overhead sprinklers. Two individuals with drip systems have put in spinners to grow ground cover and two others that use overhead chose spinners as their technology when they expanded their vineyard because it was cheaper than a drip system. In these cases, decisions that are good climate change adaptations are concurrently preferred economic adaptations to market and climate risk.

6.3 Adaptive Capacity

In their (2006) analysis of Okanagan grape-growers’ vulnerability Belliveau et al. argue that growers’ reliance on water for frost protection and overhead cooling increases their vulnerability to climate change induced shortages, particularly in the Oliver area where supply reductions are expected to be most pronounced. However, this analysis ignores the fact that autonomous adaptation to climate change stimuli is likely to occur over time. Nor does she recognize that the differential ability of individuals to adapt may be a more powerful determinant of their vulnerability than location. The results of this research suggest that individuals’ knowledge of the area, farming experience and business size all affect their adaptive capacity, and thus their future behaviour in response to climate change.

*Knowledge and Experience*

The participants in this study are characterized by the diversity of their professional backgrounds and places of origin. Nine of the 18 individuals surveyed have family roots in the Okanagan and have been involved in farming
for more than 20 years. Of these, six said that they were born or have lived in the Okanagan for almost all of their lives. These individuals can be characterized by their high level of knowledge about: the issues facing the Okanagan region, agriculture in general, and best management practices for grape-growing. With the exception of one established grower in Penticton who formerly farmed tree-fruit, the growers with the most experience and knowledge tend to be located in Oliver and Okanagan Falls, areas with the longest history of grape growing.

In this context, established grape-growers have an adaptive advantage because they possess the knowledge and experience to make water management choices based on qualitative indicators such as sight and touch. They also have a better understanding of the unique nature of their own property and the irrigation requirements of vines on different soil types etc. In contrast, new growers have a lower level of knowledge about irrigation practices and are prone to use water wastefully unless they have done research about grape growing prior to vineyard establishment.

Greater experience may also be associated with higher income, because experienced grape-growers and wine-makers can usually produce wine of consistently high quality and command high sale prices. The largest Okanagan wineries (which are also some of the oldest) tend to use water more efficiently because they use more sophisticated (expensive) soil monitoring technology to develop irrigation schedules. Other less expensive resources for assisting growers with their irrigation choices include nitrogen 'bomb' cylinders for measuring leaf pressure and published Evapo-transpiration rates from the Pacific Agri-Food Research Station (PARC) in Summerland. However, soil probes are generally regarded as the most effective and desirable monitoring technology.

Although many long-established grape growers are converting to dual irrigation systems which allow them to combine the benefits of overhead and drip systems,
two individuals with more than twenty years of grape-growing experience are reliant upon overhead systems alone. These individuals argue that experience is more valuable than technology and they use water very efficiently to grow grapes of high quality using careful scheduling and qualitative monitoring.

Business Scale
Willingness and ability to adapt is not only associated with farmers' personal characteristics but also with the type and size of their business. This research suggests that business owners who hold large properties and produce wine have greater flexibility to make adaptation decisions than owners of small, independent vineyards, because they are more profitable. Wine-making was described as 'the natural progression of grape-growing' by one respondent because the profit margin on wine production is much greater than on fresh grapes alone.

Property size may also be an important determinant of adaptive capacity because management activities tend to be more economically efficient and represent a lower proportion of total business costs if they are practiced on a large rather than small geographic scale. The two farm-labour contractors in Oliver who manage hundreds of acres on Black Sage Bench are able to do so very efficiently because the high revenue from wine sales provides them with the capital to make costly investments. As a result, they are in the process of building a sophisticated tri-pump system on Okanagan River and contracting an irrigation design consultant to help them lower their water consumption and energy pumping costs.

Synthesis
Examination of growers’ perceptions of water scarcity indicates that farmers are not currently motivated to use water efficiently for its own sake. However, the emphasis on deficit irrigation as a best management practice for premium grape production nevertheless leads to efficient water use by most growers. In this context, the individuals in the strongest position to adapt are those who hold the largest properties and produce the most wine because they have high profits to re-invest in their business to decrease vulnerability to risk. However, even small farmers, many of whom feel threatened by the high costs associated with urban development and government regulation, have demonstrated that they can afford to design and install an efficient irrigation system and monitor their soil moisture to achieve a high quality product. These results indicate that if individuals perceive a threat, in this case market competition, they are willing to address it if they are confident that they have the necessary resources for adaptation.

6.4 Considerations for Policy Development

Research into the potential impacts of climate change has suggested that the resilience of Okanagan communities to future water scarcity may be weak as a result of the comparatively high and irresponsible consumption of water by agricultural irrigators. In this context, the development and implementation of an agricultural water conservation strategy has been identified as an appropriate means to encourage water efficiency and reduce agricultural consumption. This study was undertaken to inform the development of such a policy in the wine-grape industry. One of the primary assumptions underlying this research goal is that water is currently managed poorly by farmers in the Okanagan and that research may uncover a method for convincing them that they need to change their practices. Previous attempts to regulate agricultural water consumption in this area have been politically unpopular and there has been speculation that
farmers may be using more water than they need in order to protect their water rights from being expropriated and transferred to new urban developments.

In spite of these claims, the irresponsible consumption of water as a tool to protect agricultural water rights and restrict urban growth has not been observed or documented in this study. All of the surveyed growers mentioned their respect for the Okanagan’s environment and expressed their desire to use soil and water carefully in order to preserve the resources for their farm and their family in the future. Half of the individuals surveyed had two or more generations of their family working the property and four others expressly voiced the desire to pass along the farm to their children. Because almost all of the individuals believe that they are using their water resources efficiently at the moment, many resent interference from government (at any level) in their water or farm management practices. Only one individual, in Oliver, mentioned that he is wary of using water more efficiently because he is afraid of losing his rights. This individual believes that he uses water as efficiently as he can to achieve the quality results he seeks. He argues that site characteristics have a significant impact on vines’ water demand and as a result he is wary of government guidelines informing him of how and how frequently he should be irrigating.

Perceptions of water metering
Previous research has revealed that agricultural irrigation is currently responsible for almost two-thirds of all water consumed in the Okanagan Basin and discussion of the opportunities for climate change adaptation at a basin level has recently begun to focus on the need for an agricultural water conservation policy in the near term. In this context, the results of this research challenge the stereotype that growers are uniformly opposed to water metering and regulation because they are unwilling to cede their private property rights or pay for what they use. In fact, this study found that growers’ mixed opinions on water metering are not associated with fears of volume-based pricing. On the contrary,
many growers support metering because they believe that if they were metered they would actually pay less and it would be more fair that the current flat-rate per acre system. Those that object to metering do so because of equity issues and mistrust of government regulation.

Lack of support for water metering is an expression of growers’ unease with the politics of power and the low value of agriculture to the government and population in general. Although most grape-growers are confident that they could cope with the costs associated with meter installation and water pricing, they do not think that it is reasonable to impose extra costs on agricultural sectors such as tree-fruit growers, who have more intensive water demands but yet are already unprofitable. The rapid expansion of golf courses, single family homes and swimming pools across the region indicates to farmers that urban and land-development interests are a political priority and protection of agricultural resources is not. While agriculture is expected to incur costs associated with efficiency, there are few incentives for domestic water conservation.

Opposition to government regulation of water consumption is also a function of growers’ lack of confidence and trust in government programs generally. Government policies are perceived by interviewees to be poorly developed and bureaucratically managed and create additional paperwork and costs for growers at little individual or community benefit. Although growers commented that they are more supportive of policy implementation at the local level, because local officials understand how to tailor programs to the needs of the community, they do not trust pro-development councils to act in their interest or effectively address controversial regional issues with other local governments.
Policy Recommendations

Although most wine-grape growers are already committed to efficient water use because of their emphasis on quality grape production, individuals new to the industry and the Okanagan would benefit from greater guidance in vineyard management. Newcomers indicated that in their first few years of operation they did not have the necessary expertise to make good vineyard management decisions. In this context, education programs would be a highly effective means to encourage efficient water use. Established growers are confident that the financial rewards associated with deficit irrigation are such that growers would be willing to make voluntary investments if they were aware of the long-term benefits.

Growers’ lack of familiarity with current government education and incentives programs such as the Environmental Farm Planning Program suggests that the provincial government has not been particularly effective at marketing its services to individuals in this industry. Established growers commented in interviews that irrigation ‘scheduling’ as defined by the Ministry of Agriculture is inappropriate for grape irrigation and that many services are targeted at the tree-fruit industry because it is more familiar to and better understood by government. Education services such as site visits and consulting would be better conducted by established vintners from an inclusive industry organization.

Although the BC Wine Institute (BCWI) has been a valuable resource for its members since its establishment in 1990, it does not represent all growers and vintners are currently divided in membership between three different industry organizations. Industry insiders commented that the new BC Wine-Grape Growers’ Council which will be formed in 2006 will fill this need because it will have free membership and focus on research and development for the benefit of the industry. Definition of Best Management Practices (BMPs) and development of education programs will be a priority of this new organization.
programs and policies should be designed in consultation with this organization in order to complement instead of replicate or replace its activities.

Institutional Change

The biggest barriers to implementation of water metering programs in the wine-grape industry are political and institutional. Unlike other industries where additional costs may threaten farmers’ profitability, grape-growers would be likely to support metering in their own industry if they felt that it would not compromise their access to water in the future. Some growers are concerned that their water consumption rates may change in the future if temperatures are more variable and precipitation patterns change. They are wary of metering consumption for ‘education’ purposes by government because the maximum demand rates observed during the study period may not accurately reflect the magnitude and timing of future crop-water demand. If the government regulates growers’ consumption to a new maximum, based upon flow data from the monitoring period, growers are legitimately worried that their additional rights may be removed, increasing their vulnerability to future scarcity.

Previous Okanagan research has suggested that agriculture should reduce its water consumption so that water managers can calculate the stock of unallocated water acting as a buffer against future drought (Cohen et al. 2006). The interviewees hold the view that this is unrealistic. In a pro-development environment such as the Okanagan, it is unlikely that any water will remain unallocated. Producers may be correct to assume that increasing their water efficiency will be associated with increased personal vulnerability if it means they will have reduced access to water in the future. From an environmental perspective, efficient water use should still be encouraged provided that it does not compromise the resilience of growers to future scarcity. However, a barrier to this goal is the ‘use it or lose it’ philosophy institutionalized by the beneficial use principle. In contrast to this policy, in which growers only have a right to the
amount of water they actually use, growers support a system of drought water allocation similar to that developed for Trout Creek in Summerland, in which stakeholders themselves negotiated the plan and agriculture was guaranteed minimum flow rates.

6.5 Future Uncertainty

One of the greatest uncertainties associated with future water consumption in the Okanagan surrounds its use to mitigate climate risk for cooling and frost protection. Changing consumer preferences, warming temperatures and shifts in precipitation patterns may have unpredictable consequences for grape planting decisions and agricultural water consumption in the future. At present, grape-growers in the Oliver/Osoyoos area are growing equal volumes of red and white grapes and use overhead irrigation to diffuse excess heat for whites and the risk of frost for reds. The proportion of white grapes being grown slowly increases towards Summerland and Naramata, although even there the proportion of red grapes may be close to forty percent of the total acreage. As climate warms it is unclear whether the frost risk for both varieties will increase as climatic variability increases or decrease as red grapes are ready for harvest earlier and the first frost is pushed back towards November.

The uncertainties associated with climate change and market demand for future water consumption in the grape industry are compounded by likely changes in land-use patterns and levels of agricultural adaptive capacity in the future. Anecdotal evidence from the tree-fruit industry suggests that apple and cherry growers would be unable to afford more efficient irrigation technology, even if they had an interest in using it. Intense competition from U.S. and overseas imports has made apple-growing particularly unprofitable in the Okanagan and farm incomes in this sector are very low. The implications of such a trend for adaptive capacity in the wine industry are difficult to predict.
Three individuals who have been farming in the Okanagan since the 1970s said that they feel nervous about the future of the wine industry in the Okanagan because they believe that it has grown to an unsustainable size. All three said that although there are 6000 acres planted to grapes in the Okanagan Valley today, a much lower number will persist in the future due to site and climate unsuitability in the long-term. In the opinion of one of the independent growers land values in the Okanagan are currently so high that new growers are forced to charge unreasonably high prices for wine produced with grapes grown on poor quality land. Although consumer confidence in the industry is currently high, it is bound to enter a bust cycle during which many people will lose money and those who are not committed to farming for the long-term will sell out. The future use of land that is unprofitable to farm is uncertain.

*Need for a cautionary approach*

Adaptation policies developed for the near term (ie. within the next ten years) should not compromise the flexibility of future generations to adapt to climate change stimuli in an environment characterized by different physical, political and economic variables. Near-term policies should be cautionary in nature and represent adaptations to existing conditions, be flexible and reversible enough to respond to changing impacts and reduce adverse effects on natural systems as much as possible. In this context, it is the author's personal opinion that one of the most important goals for near-term policy in the Okanagan should be the retention of land and water resources for agriculture so that Canadians do not lose the ability to grow fresh food. Although food security is an issue that has not been explicitly addressed in this thesis, because wine-grapes are not a food product per-se, the preservation of land for food production is imperative as human societies confront the possibility that climate change may increase global desertification and further the loss of arable land.
A present reality is that regardless of climate change, population growth and urban development will continue in the Okanagan for at least the near future. In this context, adaptation policies should address the need for efficient use of water and land resources in both agricultural and urban sectors. Based upon the results of the interviews and the author's understanding of the challenges facing the basin, numerous recommendations for action in the near term have been identified and are summarized here.

1. The capacity of the Agricultural Land Commission should be strengthened so that it has the power to overturn illegitimate applications for exclusion of land from Agricultural Land Reserve.

2. Land-use planning should be more heavily regulated in Okanagan communities and should focus on compact development and residential densification. The Smart Growth programs initiated in Oliver and in discussion in Naramata are excellent models of this type of development.

3. Regional districts and municipalities should be required to develop growth management plans which accommodate growth on non-agricultural land and submit them for external review.

4. There should be greater regulation of urban water consumption. Demand-side management strategies should be implemented to reduce outdoor water use in particular.

5. Groundwater wells should be licensed.

Further research should also be undertaken to investigate regional water consumption rates by sector and the temporal and geographic distribution of these stocks and flows. Detailed studies of crop-water demand across the region are already in progress by the Ministry of Agriculture and Lands and several government agencies are examining the interactions between surface and groundwater sources in the Okanagan Basin. Further social science research should focus on understanding how water consumption is related to risk
mitigation in other agricultural sectors and what types of incentive or education programs would effectively reduce water waste. The possibilities for recycled wine-making water or other grey-water for irrigation should also be investigated.

Ultimately, this new research should inform the development and establishment of a regional board with authority from the province to review growth management plans and ensure that north-south development plans in the basin are equitable and compatible. Although the creation of such a regional body would probably be as contentious today as it was in the 1970s, the unprecedented pressures on the region's land and water resources make its establishment necessary for adaptation co-ordination.

Conclusions

Through examination of the process of farm-level risk perception and management, this study informs adaptation policy development by providing decision-makers with an understanding of the ways in which water is used by grape-growers to manage market, climate and urban development risks. This study reveals that although growers do not perceive the need to use water efficiently for its own sake, their adoption of deficit irrigation as an adaptation to market risk leads to low water consumption. Although growers' levels of regional knowledge, industry experience and income do affect their willingness and ability to adapt, all of the growers surveyed in this study have the capacity to reduce their exposure to water shortage if they regard it as necessary.

Hence, these research results suggest that metering water consumption may well be unnecessary to improve agricultural irrigation efficiency in this sector. The financial gains associated with the use of drip irrigation for premium grape production are so significant that education programs may be the most
appropriate means to encourage water efficiency amongst grape-growers. Although some growers support water metering and volume-based pricing because they believe that it would reduce their operating costs, growers who are concerned more broadly about the viability of agriculture in the region tend to oppose it. Even growers who are highly efficient with water have an interest in concealing their actual consumption from government regulators because they are wary of expropriation of their water rights, re-allocation of those rights, and increased vulnerability to water shortages in the future. The interview results suggest that growers would be willing to support metering for educational purposes if domestic and commercial metering programs were implemented concurrently and the current system of water allocation was reformed to guarantee them water access when they need it in the future.

Given the uncertainty surrounding future land-use and water consumption patterns in the Okanagan, adaptation policies pursued in the near term should address current problems, be reversible and flexible to changing future conditions and minimize environmental damage to the region. In this context, policies should foster the efficient use of water and land resources by both agricultural producers and land developers and must be informed by further research into water consumption and hydrologic system dynamics in the basin.


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# APPENDIX 1: RESEARCH QUESTIONNAIRE

## I. Personal Information

1. What community do you live in?

2. What is your position in this vineyard/winery? (circle response)
   - Owner/operator
   - Vineyard manager
   - Other (specify):

3. How long have you farmed here? (circle response)
   - Less than 5 years
   - 6-10 yrs
   - 11-20 yrs
   - More than 21 years

4. Where are you from originally? (circle response)
   - Okanagan
   - BC (other)
   - Canada (other)
   - Europe
   - Australia
   - Other country (specify):

## II. Business Profile

5. When was this vineyard established?

6. When was the winery established?

7. What was the use of this land under the previous owners? (circle all that apply)
   - Vineyard
   - Orchard
   - Virgin land
   - Other (specify):

8. How many acres of vineyard do you own?
   - 0-3
   - 3.01-5
   - 5.01-10
   - 10.01-20
   - 20.01-40
   - 40+
9. How many acres of grapes do you contract from independent growers?

10. How many acres do you lease and/or manage for others?

11. How many varieties do you farm now?

III. Agricultural Water Management

12. a. What is your primary water source?

- Okanagan River
- Skaha Lake
- Osoyoos Lake
- Creek draining mountain reservoir
- Personal Well(s)
- Oliver Irrigation Canal
- Okanagan Lake
- Other (specify):

b. Why did you choose this source?

13. a. Do you use a secondary water source? (yes/no)

b. If so, what is it?

- Okanagan River
- Skaha Lake
- Osoyoos Lake
- Creek draining mountain reservoir
- Personal Well(s)
- Oliver Irrigation Canal
- Okanagan Lake
- Other (specify):

14. Do you have an irrigation purveyor? If so, who?

15. Under what agreement/legal arrangements do you have a right to this water?
16. Do you know what your allotment is?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>Maybe</th>
<th>No Response</th>
</tr>
</thead>
</table>

17. How do you measure the volume of water you use?

18. Has the volume of water applied per acre on your property increased or decreased in the last 10 years? Why or why not?

19. a. What is your primary irrigation technology?

b. Why did you choose this technology?

20. What are its advantages/drawbacks (pros & cons)?

21. a. Do you have a secondary irrigation technology now?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>No Response</th>
</tr>
</thead>
</table>

b. If yes, why did you choose this technology and what are the benefits?

c. If no, are you planning to install one in the future? Why or why not?

22. How do you decide how much to irrigate?
IV. Perceptions of Water Availability

23. How do you define "water shortage"? Have you ever experienced a water shortage before (y/n)? What did you do? What was the outcome? What did you learn from the experience?

Choose the response that best fits your reaction to the following statement

24. My current system of water provision supplies me with more than enough water to irrigate during peak times

Strongly Agree
Agree
Neutral
Disagree
Strongly Disagree
Unknown

Comments

25. My current system of water provision is flexible enough to give me water whenever I need it during the growing season

Strongly Agree
Agree
Neutral
Disagree
Strongly Disagree
Unknown

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26. I think that in the next 25 years the volume of water cycling through the Okanagan Basin system will: (circle response)

- Increase a lot
- Increase somewhat
- Remain the same
- Decrease somewhat
- Decrease a lot
- Don't know
- No response

Comments

________________________________________________________________________

________________________________________________________________________

27. I think that in the next 25 years my personal supply of water for irrigation will:

- Increase a lot
- Increase somewhat
- Remain the same
- Decrease somewhat
- Decrease a lot
- Don't know
- No response

Comments

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
28. I think that in 25 years I will have enough water to meet my needs if I don’t change the way I manage water on my property.

Strongly Agree
Agree
Neutral
Disagree
Strongly Disagree
Unknown

Comments


29. I think that improving my water efficiency has more costs than benefits in the short term (next 10 years)

Strongly Agree
Agree
Neutral
Disagree
Strongly Disagree
Unknown

Comments


30. I think that improving my water efficiency has more costs than benefits in the medium and long term (more than 10 years)

Strongly Agree
Agree
Neutral
Disagree
Strongly Disagree
Unknown
V. Risk Management

31. What are your long and short-term goals for your business?

32. What are the biggest risks or challenges that you face in trying to attain these goals?

33. What actions can you take to reduce the impacts of these risks and uncertainties?

34. How does taking action to manage water more efficiently affect how you can manage the other risks you face?

35. Please rank the importance of the following water management strategies for achieving grape quality:

   a. Irrigation scheduling
      critical important neutral unimportant unfamiliar
      with it
   b. Irrigation design
c. **Soil moisture monitoring**

- critical
- important
- neutral
- unimportant
- unfamiliar

with it

d. **Irrigation technology**

- critical
- important
- neutral
- unimportant
- unfamiliar

with it

VI. **Government programs**

36. What incentives are currently in place to encourage you to use water more efficiently?

37. What level(s) of government do you believe is most qualified to develop and/or manage such a program in your best interest? (choose as many as you like)

a) Local/municipal (ie. City of Penticton)
b) Regional (ie. District of Okanagan-Similkameen)
c) Provincial (ie. Ministry of Environment or Ministry of Agriculture)
d) Federal
e) Other
f) None of the above

Why?

38. What topics should be researched before this type of a policy is developed?
39. If a policy to increase water-efficiency in agriculture was going to be implemented, would you be more likely to support (choose as many as you like):

a) A voluntary program (ie. a water certification standard)
b) Universal regulation (ie. irrigation metering)
c) A system of economic incentives (ie. tax breaks/insurance/subsidies)
d) Other
e) None of the above

Why? From your perspective, what are the pros and cons of these approaches?

40. What is your personal opinion of agricultural water metering?