AN ECONOMIC ANALYSIS OF SURFACE IRRIGATION WATER RIGHTS TRANSFERS IN SELECTED AREAS OF SOUTH AFRICA

RM Armitage

WRC Report No 870/1/99

Water Research Commission

EXECUTIVE SUMMARY

South Africa has since the early 1980's exhibited a mature water economy characterised by extreme competition between users, high and growing demand, and increasing social costs. Water scarcity has traditionally been tackled by the exploitation of new water supplies by water management institutions concerned with the construction of large scale storage and conveyance facilities. However, most of the country's available water sources have been fully appropriated given current technologies, and the remaining marginal sources are becoming increasingly expensive to exploit. As a result emphasis has now turned to the optimal allocation of water resources.

The agricultural sector, which consumes the most water in South Africa, is regarded as the primary source to meet demand through water savings. Despite this rationalisation of water use in agriculture, irrigated agriculture will have to maintain and improve productivity to meet growing food demand in future. This will require an enabling environment that allocates irrigation water optimally. Water marketing is one such mechanism that can allocate water to its highest valued use in an efficient and flexible manner.

The aims of this research are to evaluate the policy scenario of market allocation of irrigation water to identify the criteria for a well functioning market, and the efficiency advantages of market allocation of water. Procedural requirements for a water market will be identified by looking at water markets in a number of countries. In addition, the study aims to deal with the issue of how to quantify water use rights in the establishment of a water market. The study researches demand side responses to water allocation in two irrigation districts in South Africa,

by investigating how water markets can lead to more efficient water allocation and use. The research endeavours to highlight the benefits from, and institutional arrangements facilitating, market trading of water rights along the Lower Orange River, as well as the potential for, and institutional changes necessary, to facilitate the operation of a market along the uMhlatuze River. In each catchment area, a survey of irrigation farmers was carried out. Finally, the study attempts to ascertain sample farmers' responses to the new Water Act, and briefly evaluate the new Water Law principles and their possible effects on water markets and irrigation farmers.

In a water economy, the institutional framework determines the feasibility of water market transactions. The ability of the property institution to foster desired behaviour depends on how exclusively property rights are defined and how effectively it reduces transaction costs. Deliberate institutional change towards transferable water rights will result from demand by individuals users to alter the existing institutional framework. The new institution will be implemented if the resulting returns exceed the marginal cost of mobilising the resources needed to introduce the innovation. However, individuals do not always act in the interests of the group, therefore institutional change may not be forthcoming owing to problems of collective action or political resistance. This depends on the power balances among vested interest groups and their ability to act collectively to express their lobby. If individuals agree to institutional changes, and trade is voluntary, then the new institutional framework can be considered more efficient than the old.

Allocation of water through a market offers a number of potential advantages. Firstly, it promotes efficiency in allocation by placing water in the most highly valued uses in a flexible manner. Water users are empowered by requiring their consent to any reallocation of water and

compensation for transferred water. Decentralised information is brought to bear on water management decisions and flexibility is established in response to changes in crop prices and water values. Individual users are forced to consider the full opportunity cost of their water use, as well as some external costs related to their water use or transfer. Finally, a water market requires well defined and enforceable water rights, providing for secure tenure of water and in turn stimulating investment in water-saving technology.

An efficient water market requires water rights that are well defined in the unit of measurement and reliability of the right, enforceable, transferable and ideally separate from land use, and an efficient administrative system that prevents against abuses of the system and maintains proper chain of title over the water rights. A number of potential problems with water markets have also been identified. High transaction costs can limit the scope of trading. The variable nature of water may make it difficult to achieve the necessary certainty for transferable water rights. Finally, externalities may be imposed on third-parties and important societal public good values ignored during water trades between individual users.

Informal water markets have developed in Pakistan and Northern India among farmers along canals and surface watercourses, despite the illegality of such trades. These trades exhibit high transaction costs owing to the high level of coordination required between farmers. In Valencia, Spain, water is auctioned every Sunday morning. Buyers bid for particular irrigation times from the canals. Water trading occurs extensively in the Western US. Rights of use and transfer are controlled by a complex and highly developed set of rules. Restrictions are imposed on transfers which are governed by the no-injury rule. Return flows are protected by specifying water rights as the consumptive portion of the right. These policies that protect third-parties increase the costs

of achieving transfers and constrain trading. Chile has taken active steps to promote active water markets. Water allocation within and between sectors is achieved through the market. All users are organised into Water User Associations that own and manage the infrastructure, monitor allocation, and approve water transfers. Third-party rights to return flows are eliminated, thereby reducing transaction costs and promoting active water markets. Mexican Water Law establishes water use rights for 5 to 50 years in length on a volumetric basis separate from land use. Individual users are organised into Water User Associations. Farmers are empowered to sell their concessions to other users within the same Water User Association and receive the proceeds of the sale. Water sales outside the district require a majority vote of the Water User Association and government approval. All such proceeds go to the district. Water use rights are defined as consumptive rights. Downstream users are granted the rights to the return flows, reducing return flow third-party effects.

This study found that a market for "outer land" water rights emerged along the Lower Orange River in 1994 and was driven by the desire of large-scale table grape producers to expand their operations. "Outer land" water rights sold for an average price of R3378.89/15000m^3/ha. The market was however not fully developed since no inter-sectoral trading was permitted, nor had market transfers of canal water or conserved water developed. A possible reason for this is that farmers prefer to retain conserved water for water supply security. No temporary water transfers had taken place, which may be explained by the high fixed costs involved in transporting the water to the "outer land" and developing this land, and the high fixed transaction cost of hiring a lawyer in the transfer process.

Trading emerged despite a significant extent of bureaucratic regulation imparted on the water

market. A number of institutional arrangements facilitated the development of the market. Many farmers with "outer land" water rights found it uneconomic to develop this land for irrigation purposes, generating a bank of unused water rights that expedited the subsequent reallocation of this water through the market. "Outer land" water rights were completely specified in the unit of measurement and had a high-implied reliability. Irrigation rights also enjoyed high priority. This created certainty in what was being traded and predictability in the outcome of the reallocation process. "Outer land" water rights were transferable between irrigation properties, and legally sanctioned by government from May 1989. However, before individual transfers could proceed, a number of bureaucratically determined conditions had to be satisfied. As a result, water transfers were not simple voluntary trades between two parties, but rather negotiated transfers between the two parties and bureaucratic authorities. The controlled allocation environment in which water rights were allocated ensured that water rights were wholly enforceable and secure. The administrative function performed by the regional Department of Water Affairs and Forestry office was central in the successful establishment and functioning of the market. The transfer process specified by the Department of Water Affairs and Forestry was clearly defined and well understood. It was however guided heavily by bureaucratic regulation, and farmers had to prove any land for which an application had been filed to purchase water rights, was suitable to irrigation. Transaction costs arising from these elaborate bureaucratic conditions imposed on transfers may have been unnecessarily high. The supervising and recording function of the Department of Water Affairs and Forestry was important in maintaining the correct chain of command over water rights. In addition the Department of Water Affairs and Forestry performed an important role as provider of market information. Finally, since no return flow had been calculated and implemented for water rights, transfers were achieved without otherwise necessary adjudication processes.

Results of discriminant analyses between Buyers and Sellers, and Buyers and Non-Buyers of water rights along the Lower Orange River support the argument that tradable water rights will lead to improvements in the efficiency of water allocation and use. "Outer land" water rights moved from lower valued users with the potential to grow wine grapes, raisin grapes, and field crops to higher valued users with the potential to grow table grapes. These farmers had the highest estimated return per unit of water applied showing that water rights gravitated to the most efficient users of water. As a direct result of the transfers, previously undeveloped high potential arable land was brought into production. This in turn will lead to an associated increase in investment and employment opportunities, as well as an increase in agricultural productivity.

A number of institutional responses to the *status quo* regarding water trading could strengthen the market: Transaction costs and bureaucracy would be reduced by eliminating the need for farmers to obtain a cultivation certificate to develop land, and by delegating authority to the regional Department of Water Affairs and Forestry to authorise trades. The continued administrative function of the regional Department of Water Affairs and Forestry office in recording and monitoring water transfers, and extension of this support to market trading of canal and conserved water when the demand arose, will promote market efficiency.

Within the Nkwaleni Valley water allocation is highly regulated and well controlled. Farmers place a weekly order for water and all pump meters are calibrated and monitored monthly. Irrigation water rights on the uMhlatuze River have a low implied-reliability resulting from the variability in river flows, and frequent restrictions on irrigation water extraction. No water market activity had occurred in the Nkwaleni Valley. Forty-one percent of sample farmers stated that they would like to purchase water rights at present, while no survey farmers stated that they

would like to sell or rent out any water rights at the present time. The majority of respondents believed sufficient demand for water exists in the Nkwaleni Valley to facilitate a water market. However, 41 percent of respondents believed a water market could not function successfully because no tradable margin of water would exist. Fifty percent of respondents believed market trading of water rights could take place because most properties required water to develop uncultivated land, and following a switch to more efficient irrigation technology in response to continually increasing water charges, conserved water could be sold or rented out.

Demonstrated demand by farmers in the Nkwaleni Valley to establish a water market seems unlikely. Potential market development is founded on a significant number of potential Buyers and high and rapidly increasing demand for water by downstream urban uses. However, market potential appears to be constrained by the lack of any willing sellers. A number of reasons may explain this. Crops produced by potential Buyers in the Nkwaleni Valley are not vastly more profitable than crops produced by Non-Buyers. Transaction costs may exceed the difference in value of water to the potential buyer and seller. Farmers may wish to retain surplus water for security against drought. Finally, farmers appear to be using all their water and may be unwilling to sell water rights for land they have already developed, as this would involve sacrificing the development cost of the land. Farmers in the Nkwaleni Valley pay a pro rata levy for each cubic metre of water used up to their maximum water allocation, and any unused water is temporarily reallocated to industry. Political resistance to the development of a water market may develop from industrial users who are currently reallocated unused agricultural water without having to compensate the farmer.

Initiating institutional change towards market trading of water rights in the Nkwaleni Valley will

require that a number of issues be considered. Water rights are well defined but have low reliability, potentially driving down market prices and constraining transfers. Continued monitoring of water extraction by the Nkwaleni Irrigation Board and the Department of Water Affairs and Forestry will be important to ensure the enforceability of water allocations, while the guarantee of authorisation to water allocations and purchased water allocations under the new Water Act will provide for secure rights. In any event, the emergence of a market will depend on how well transaction costs are minimised by the administrative function performed by the Nkwaleni Irrigation Board and the Department of Water Affairs and Forestry, in defining a transparent transfer process, supervising and recording trades, and resolving conflicts among members.

The new South African Water Act provides the framework for water markets in South Africa. Two important points can be drawn from the new National Water Act. Firstly, for the first time in South African Water Legislation statements regarding water trading are included as a policy option for water allocation. However, preference is still given to administrative price setting for water resources. Secondly, while the National Water Act mentions water markets as a possible option in water allocation, the effected legislation makes very unclear provision for legal transfers of water use licenses. On balance, the new National Water Act will not facilitate market trades of water use licenses. Legislation regarding water trading is vague, creating much uncertainty about legal water trades, and the extent of bureaucratic control and regulation of water trading in the new water legislation creates highly restrictive conditions for voluntary transfers between willing transactors.

The new Water Act in South Africa provides for continued centralist intervention in water

management. There will be no private ownership of water, only authorisation for a use right that will be held for a temporary predetermined period. Existing water rights will only be recognized to the extent that they are "beneficially used in the public interest". Water licenses will not give a guarantee of the assurance of supply or quality of the water, and water use licenses may by notice be temporarily controlled, limited or prohibited. Government will be exclusively responsible for water allocation, and public interest advocated above private interest in the evaluation of efficiency, equity and sustainability objectives. However, there are no clear cut criteria on which decisions regarding the "optimal use" of water can be based, and any decisions taken in the public interest will be subject to political bias.

The Water Act has important implications for irrigation farmers. The collateral value of irrigation properties will be reduced and farmers' incentives to make more productive and sustainable use of water distorted. The new Water Law proposes a time limited water use allocation, without compensation or recognition that water rights were paid for by the owner in the capitalised land value. Increased centralist intervention may place irrigation farmers under increased financial pressure, and land values could decline in the long term as a result of excessive taxation of water usage and restricted scope for increased profitability. As a result of the proposed legislation, irrigators may not hold water use licences with complete assurance, possibly constraining long-term investment and resource conservation. Farmers will not have sufficient incentives to invest in water-saving technology and other production inputs if tenure over water is short and there is uncertainty about water ownership.

The overwhelming majority of survey respondents in the Lower Orange Region believed that the proposed new Water Act had created widespread uncertainty about water trading, would lead to

fewer water market transactions, and would reduce their incentives to invest in irrigation technology. In both study areas, most respondents believed that any sale of some of their water use licence would negatively influence the success of their reregistration for water use rights. As a result, little support for a water market may emerge under the institutional arrangements specified by the new Water Act.

Market trading of water could be introduced in an incremental manner. The first step would be to permit market trading of irrigation water use rights among irrigators within a Water User Association control area. The second step would be to permit trading between irrigators and urban users within the Water User Association area, and the final step would be to encourage trading of water rights between users belonging to different Water User Associations, and ultimately inter-catchment transfers. Permitting inter-sectoral trades would enable farmers to sell water to higher valued urban uses and receive effective compensation, while at the same time generating irrigation water savings. Establishing tradable water use rights requires a number of institutional and organisational contributions, including procedures for formalising water licenses and resolving water disputes. The quantification of water use licenses of individual irrigators will be necessary. Basic determination of the volume of water available in each catchment for allocation to individual farmers will be needed, after allocations to the Reserve, international requirements, and other use sectors have been satisfied. Individual licenses should be quantified as the estimated volume of water available 85 percent of the time, with proportional sharing of shortages among all irrigators.

The specification of the consumptive portion of the water use licence is the favoured approach in dealing with return flows. In well watered areas where return flows are not significant, and in

existing state water schemes where irrigators are allocated precise water volumes from impounded water, the consumptive portion of the water use licence could be specified as 100 percent of the water use licence. This would effectively eliminate transaction costs associated with negative return flow impacts, and improve the efficiency of the market.

Addressing equity objectives by improving access to water for previously disadvantaged groups will have to be tackled by government intervention. However, in so doing it is important that existing and potential future water markets for irrigation water are not constrained. In river catchments where water is scarce, the establishment of water markets along with local water user participation in water management through the organisation of Water User Associations, would improve the efficiency of water allocation over existing bureaucratic allocations by a centralised agency. Government agencies have an important role in such water markets by designing appropriate laws and regulations governing water trading, and strengthening private and public institutions to administer these rules.

Under the new Water Act, overcoming institutional and legal barriers for market performance will require that water use allocations to irrigators be specified as perpetual, or at least as very long term, with a minimum duration of 40 years. Water use rights must be inherently secure and water trading must also be unequivocally authorised through the relevant legislatures. Government must be willing to surrender control over water trades to Water User Associations and focus on oversight responsibilities. Market based improvements in water use at the district and sector level could be achieved while at the same time allowing government to maintain a role in water management, if markets were permitted to operate freely within the Water User Association, and trades between members of different Water User Associations required

Catchment Management Agency approval.

This research entails a detailed evaluation of the policy scenario of water market allocation and identifies the general criteria for a well functioning market, efficiency advantages of market allocation, and potential constraints to market establishment and operation. A literature review of water markets in a number of countries identifies the procedural requirements for a water markets in each situation. The research also highlights the facilitating institutional arrangements and benefits from market trades of "outer land" water rights along the Lower Orange River, as well as the potential for and necessary institutional changes to facilitate tradable water rights along the uMhlatuze River. The new Water Law principles are briefly evaluated and their possible effect on irrigation farmers theorised. Finally, the study attempts to deal with the issue of how water use licenses will be quantified, however, further hydrological research into this topic in each river catchment is necessary to identify the method in which the water allocation to irrigated agriculture and individual irrigators will be determined.

ACKNOWLEDGEMENTS

The research in this report emanated from a project funded by the Water Research Commission and entitled:

"THE PRICING OF WATER RESOURCES IN SOUTH AFRICA, WITH SPECIFIC REFERENCE TO RIPARIAN SURFACE WATER"

The Steering Committee responsible for this project, consisted of the following persons:

Dr. G. R. Backeberg	Water Research Commission (Chairman)
Mr. H. Maaren	Water Research Commission
Prof. W. Nieuwoudt	University of Natal
Prof. J. Groenewald	University of Pretoria
Mr. N. Lecler	University of Natal
Prof. M. Lyne	University of Natal
Dr. R. Rutherford	Loxton, Venn and Associates
Mr. J. van Rooyen	Department of Water Affairs and Forestry
Mr. J. van Zyl	Agrimodel

The financing of this project by the Water Research Commission and the contribution of the members of the Steering Committee is acknowledged gratefully.

This project was only possible with the co-operation of many individuals and institutions. The author would like to record his thanks to the following:

Messrs W. J. J. Burger and W. Brook for their assistance in completing the surveys along the Lower Orange and uMhlatuze Rivers respectively.

The farmers along the Lower Orange and uMhlatuze Rivers who participated in the survey.

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INTRODUCTION

The South African water economy has, since the early 1980's, exhibited increasing competition between users, inelastic supply of water, high and increasing demand for water, and increasing social costs (Backeberg, 1994). Demand on water supplies continues to increase owing to population and economic growth, industrialisation and urbanisation, the need to address the inequity in water allocation, and environmental demands. Compounding growing water demand are the factors of climatic variability, skewed regional distribution of water resources with respect to areas experiencing economic growth, and deteriorating water quality. In the light of this increasing pressure on water resources it is essential that available water be put to its best use. The allocation of rights to available water resources requires immediate consideration (Backeberg, 1994).

Fifty-one percent of all water consumption in South Africa occurs in irrigated agriculture, prompting the observation that this sector is considered to be the primary contributor to satisfying demand through potential water savings (Water Research Commission, 1996). Irrigation water has generally been supplied at highly subsidised rates, encouraging production activities that would not necessarily be competitive if water were supplied at full cost (Walmsley, 1995). Past practices of the State in South Africa to write off loans to irrigation farmers and irrigation boards, and later to subsidise water tariffs, resulted in these benefits being capitalised into irrigation land, and gave false market signals that water was abundant and irrigation land was scarce (Groenewald, 1995). As a result water has been under-priced as an economic resource and users have not treated water as a scarce commodity (Winpenny, 1994). Increasing food demand in the future, arising out of population growth, higher standards of living and increased per capita

consumption will mean that irrigated agriculture will have to meet the challenge of producing more food for consumption under increasing water scarcity, as government objectives change to bring about a rationalisation of water use in agriculture. Mitigating the reduction in irrigation water for farmers will require an enabling environment through institutional reform that allocates water in an efficient and flexible manner (Backeberg, 1997).

Water scarcity in South Africa has historically been resolved with the exploitation of new water sources through water management institutions concerned primarily with the construction of storage and conveyance facilities, with the aid of significant public subsidies (Walmsley, 1995). However, since many water sources have been fully appropriated given current technologies, and the remaining water sources are becoming more expensive to exploit, these supply side responses to water scarcity are becoming increasingly inadequate (Conley, 1993; Backeberg, 1994). Thus, existing institutions that have evolved for water management are no longer ideal. Emphasis has now turned to the optimal allocation of the existing water supplies, requiring management institutions that reflect the ultimate economic scarcity of water, and allocate limited water supplies among various competing demands in a flexible manner. The reassessment of the existing Water Law to result in a new Water Act is a reflection of the need for new water management institutions and allocation systems better suited to the needs of the country.

Water marketing has been advocated as the most effective means of reallocating scarce water supplies in South Africa (Backeberg, 1994). Markets are the classical economic institution for allocating scarce resources efficiently and flexibly, (Griffin and Boadu, 1992), and evidence from a number of countries including Chile, Mexico, Australia, United States (US), and Pakistan has shown that water markets are an effective mechanism for improving irrigation water allocation

and its use (Easter, 1996). Allocation of water through a market offers a number of potential advantages: It promotes efficiency in allocation by placing water in the most highly valued uses in a flexible manner. Property rights to water empower water users by requiring their consent to any reallocation of water and compensation for transferred water. Decentralised information is brought to bear on water management decisions by enabling individual users to apply first hand knowledge in determining how much water to apply and which crops to produce. The market process establishes flexibility in response to changes in crop prices and water values, as demand patterns and comparative advantage change and crop diversification proceeds. Within a water market, individual users are forced to consider the full opportunity cost of their water use, as well as some external costs related to their water use or transfer. Finally, a water market requires well defined and enforceable water rights, providing for secure tenure of water and in turn stimulating investment in water-saving technology (Cummings and Nercissiantz, 1992; Howe et al, 1986; Anderson and Leal, 1989; Pingali and Rosegrant, 1995).

However, a number of potential problems with water markets have also been identified. High transaction costs can limit the scope of trading. The variable nature of water supply may make it difficult to achieve the necessary certainty in transferable water rights, and finally, externalities may be imposed on third-parties (Schleyer and Rosegrant, 1996). Colby (1990), argues that policy induced transaction costs arising from transfer restrictions, act as a Pigouvian tax, and limit water trading among individuals. This is desirable as third-party effects are not always taken into account in the transfer process.

While market trading of water use licenses will be permitted in limited areas under the new National Water Act, these markets will have to operate within a significant set of institutional

constraints owing to government's commitment to manage water resources in the public interest. This will limit the ultimate size and efficiency of the water markets. Improving equity in access to water resources for previously disadvantaged individuals in South Africa is an important objective that must be addressed by government. However, it is not necessary that in so doing, emerging water markets be unnecessarily constrained or existing water markets destroyed. Market allocation of irrigation water allotments could have important benefits in improving the efficiency in water use and allocation within individual river catchments.

The aims of this research are to evaluate the policy scenario of the establishment of water markets for the allocation of irrigation water, to identify the criteria for a well functioning market, and the efficiency advantages of allocating water through the market system. Evidence from a number of countries that have implemented tradable water rights with varying degrees of success will be presented in an attempt to identify the procedural requirements for a water market. The study will research demand side responses to water allocation in two irrigation districts in South Africa, by investigating how water markets can lead to more efficient water allocation and use. In the first study area, the Lower Orange River, where water is a scarce resource and production is entirely dependent on irrigation water, market trading of water rights has occurred. In the second study area, the Nkwaleni Valley, water is similarly a scarce resource with production wholly dependant on irrigation, but no trading of water rights has occurred. This research endeavours to highlight the benefits from, and institutional arrangements facilitating, market trading of water rights along the Lower Orange River, as well as the potential for, and institutional changes necessary, to facilitate the operation of a water market along the uMhlatuze River in the Nkwaleni Valley. In addition, the study will attempt to ascertain sample farmers' responses to the new Water Act, and briefly evaluate the new Water Law principles laid out in

the White Paper on Water Policy as well as the relevant parts of the National Water Act and their possible effects on water markets and irrigation farmers.

CHAPTER 1

INSTITUTIONS AND ECONOMIC PERFORMANCE

1.1) Institutions, institutional change and property rights

Over the past several decades there has been increased interest in the role institutions play in the operation of economic systems (Furubotn and Richter, 1991: 1). Institutional economics focuses on the structure and operation of dynamic human relations pertaining to the creation and disposal of scarce goods and services, by individuals and groups in realising both private and public aims (Gruchy, 1947 cited by Kapp, 1968).

1.1.1) Institutions defined

Commons (1931: 648) defines an institution as "collective action in control, liberation and expansion of individual action." He asserts that scarcity gives rise to the implementation of property rights and to conflicts of individual interest. Collective action is imperative to resolve these conflicts and instill order for cooperation (Mitchell, 1935).

Central to institutional economics is the institution of property, and the rules governing the transfer of property rights (Furubotn and Richter, 1991: 2). A transaction involves the alienation and acquisition of rights of property and liberty that are created by society, and that must be negotiated between parties before production, exchange, and consumption can occur (Randall, 1978). The institutional framework determines the feasibility of transactions. Appropriate institutions reduce uncertainty by providing a structure to human relations in the exchange process, and affect economic performance through their impression on costs of exchange and production (North, 1990: 6). Institutions play an important role in shaping individual's

expectations about their rights to resource use in economic activity, and the division of the income stream resulting from that activity (Hayami and Ruttan, 1985: 95). Institutions can promote exchange of property rights through market forces by securing future return on investment through predictable rule of law (Beghin and Fafchamps, 1994). Together with technology employed, institutions affect economic performance by determining transaction costs and production costs (North, 1994), and in doing so they may have the effect of either facilitating or retarding economic growth (Hayami and Ruttan, 1985: 95). Thus, the ability of a property institution to foster desired behaviour depends on how exclusively property rights are defined and how effectively transaction costs have been reduced (Nieuwoudt, 1990).

Institutional forms are informal codes of behaviour and conventions, and formal going concerns governed by law (Randall, 1978). Institutions can be classified into three basic categories: The **constitutional order** specifies the basic rules about societal organisation; **Institutional arrangements** are created within these constitutional rules, and include laws, regulations, associations, contracts, and property rights; **Normative behavioural codes** embody the cultural values that coerce behaviour and authenticate the institutional arrangements (Feder and Feeny, 1993: 241).

Within the context of a water economy, institutions are defined as a set of values, customary rules, water rights, water markets and water legislation. Together these form the "rules of the game", with respect to water use and exchange (Backeberg, 1995: 2). The institutional arrangements determine the basis for administrative or market control over water. They are capable of creating order and certainty for users to facilitate the achievement of economic and social goals, while on the other hand they can create impediments to efficient resource use,

requiring that individuals expend a significant amount of resources to compensate for their obsolete design (Livingston, 1995). This study focuses on institutional arrangements that facilitate the operation of markets in tradable water rights.

1.1.2) Institutional change

North (1990: 6) asserts that men live in a world of apparent rapidity in institutional change, with all levels of institutional organisation continually evolving and altering the choices available to individuals. Improvements in agricultural productivity are often attributed solely to changes in technology. However, economic growth results from both technological and institutional innovation. Economic development can be explained as economic growth in conjunction with efficient institutional change, where institutional change is driven by the attainment of an organisational structure that will effect the realignment of property and other rights and reduce transaction costs (Nabli and Nugent, 1989: 22).

North (1994) contends that individual decision makers are the agents of institutional change. It is the subjective perceptions of individuals which determine the choices they make. Thus sources of institutional change are the opportunities perceived and acted on by individuals. These opportunities present themselves through external changes in the environment or the acquisition of information and skills by the individual. Competition, which results from the continuous interaction between institutions and individuals within organisations in the economic setting of scarcity, is the key to institutional change. Competition forces organisations to continually invest in knowledge to survive, and the institutional framework dictates the kind of knowledge perceived to have the greatest pay-off (North, 1990: 78).

Deliberate institutional change will result from the demand by individuals to alter the institutional framework, when the perceived cost of altering that framework is less than the cost of recontracting within the existing institutional framework (North 1994). Hayami and Ruttan (1985: 107-110) hypothesize that a new institutional solution will be supplied if the returns from implementing the innovation exceed the marginal cost of mobilising the resources needed to introduce the innovation. Individuals do not always act in the interests of the group, (Popkin, 1979: 252), therefore institutional change may not be forthcoming owing to problems of collective action or political resistance. This depends on the power balance amongst vested interest groups in a society and their ability to act collectively in order to express their lobby (Olsen, 1971; Stiglitz, 1989: 26).

The path of institutional change that determines the evolution of an economy is shaped by constraints derived from the past and the innumerable incremental choices of individuals which continually modify these constraints (North, 1989). Institutions tend to change incrementally rather than discontinuously as a result of the imbeddedness of informal constraints in society. Formal rules may change overnight as a result of legislative changes to either the statute, judicial rules, regulatory rules and constitutional rules. Changes in informal rules have the same originating sources of change, but they occur gradually and sometimes subconsciously as individuals evolve different patterns of behaviour, consistent with their new perception of benefits and costs (North 1994). Stiglitz (1989: 26) argues that the adoption of new institutions may be impaired by uncertainty, since imperfect information about new institutions typically biases individual's choices in favour of institutions and conventions by which they have lived.

In an economy which fulfils the gains from trade through the establishment of efficient

institutions, it is the private objectives of individuals with the bargaining strength to alter institutions that produce socially efficient institutional arrangements, under certain circumstances. These circumstances are determined by the subjective perceptions of individuals, the ability of the institutions to reduce transaction costs, and the malleability of the institutions in responding to changing preferences and relative prices (North, 1990: 16).

1.1.3) Property rights defined

Property applies to everything with respect to which one person is entitled to a right and the same person is also subject to a duty. In this way all persons are subject to a duty to respect the rights of others. Property is in the nature of things either corporeal or real, such as land, or incorporeal or artificial, such as a right of action (Maasdorp, 1976: 1). Runge (1984) states that property rights are the characteristics of property institutions, being a subset of all institutions. Economic agents do not operate independently of one another, and face uncertainty as to how the actions of others will affect the manner in which their own decisions affect their reception of economic benefits. Property rights are thus an instrument of society that reduce uncertainty by allowing individuals to form stable expectations that they hold in their dealings with others. These expectations become expressed in the laws and customs of society (Demsetz, 1967).

Property rights designate the behavioural norms regarding economic goods that individuals must comply with in their dealings with others, or face the penalty of non-compliance (Pejovich, 1990: 27). A property right is a right to a benefit stream that is only as secure as the duty of all others to respect the conditions protecting that stream (Bromley, 1989). Such a right empowers in an individual the capacity to call on the coercive power of the state to enforce their interests in a particular outcome. The protection derived from a property right is the implied duties that fall

on those who would otherwise seek to interfere with the interests of the property right holder (Bromley, 1995). From this it follows that the economic value of property rights must be protected and enforced in a way that is recognised by society, since the structure of property rights influences the allocation of resources in an economy (Furubotn and Richter, 1991: 6).

A systematic relationship exists between property rights and economic choices, since property rights define the rights of individuals to the use, income and transferability of resources (Furubotn and Pejovich, 1972; De Alessi, 1991: 47). The way in which the prevailing property rights assignments in an economy affects the allocation of resources is exchange. An individual cannot transfer to others more rights than he owns, and thus the extent of trade and the terms of trade are influenced by the property rights structure in society (Furubotn and Richter, 1991: 6).

Along with the market, property rights reduce the real resource losses faced by individuals as a result of imperfect information. These losses can be grouped together as transaction costs, and broadly they include the costs associated with (a) the creation or change of an institution; and (b) the use of the institution (Furubotn and Richter, 1991: 8).

1.2) The exchange of property rights in economic theory

Over the past few decades there has been growing recognition that standard neoclassical economics is excessively abstract and incapable of dealing with current real world problems. In particular, the issues of efficiency and equity have been contentious topics, with institutionalists refuting the neoclassic claim that they can be measured objectively (Pasour, 1981).

1.2.1) The neoclassical approach

Neoclassical economics is concerned primarily with the allocation of resources through the forces of demand and supply in a market economy, without considering fully the complex institutions on which contracts in actual markets crucially depend (Bardhan, 1989: 3). The existence of political, legal, monetary, and other systems is acknowledged by neoclassical economics. However, these systems are either regarded as having neutral effect on economic processes, or are taken as given and specified in such a way as to suggest that institutional influence is of minimal importance, thereby setting aside institutional change as a subject for economic analysis (Furubotn and Richter, 1991: 11; Fusfeld, 1977).

Neoclassical economics uses the Walrasian general equilibrium model as an instrument of analysis in its study of small segments of isolated systems (Kapp, 1968). Prices and quantities are determined in a market by equating demand and supply, while imperfect information and uncertainty are not considered (Pasour, 1990: 12). Furubotn and Richter (1991: 11) note that for a competitive economic system, in the context of the general equilibrium model, to achieve a first best Pareto optimal configuration, it must be a system in which: (a) transaction costs are zero and individuals operate with unbounded rationality (ie, a decision maker can obtain and process any desired information at zero cost); (b) firms and individuals are both rational and profit maximisers; and (c) institutional arrangements play no role in determining equilibrium solutions.

According to neoclassical theory, the three classic marginal equivalences needed for Pareto optimality are satisfied at market equilibrium. These are (a) the marginal rates of substitution are the same for all consumers; (b) the marginal rate of substitution between any pair of inputs is the same for all producers; and (c) the marginal cost of production is the same for all firms, and is

equal to the product price.

The First Theorem of Welfare Economics states that each competitive equilibrium is Pareto efficient (Arrow, 1985). A social state is Pareto efficient if no individuals position can be improved without causing a worsening in the position of another individual. Taking the assumption of zero transaction costs, then the initial allocation of property rights is irrelevant in terms of efficiency because these rights can be costlessly and voluntarily traded to achieve the new Pareto efficient rights allocation. Consequently the concepts of efficiency and equity become separable under the neoclassical assumptions (Bardhan, 1989: 5).

Any disturbance in the Walrasian model results in the instantaneous attainment of a new equilibrium because, with no transaction costs, the costs of adjustment are zero. Thus, no effort is required in the exchange process, prices will allocate resources to their highest valued use, and economic efficiency is ensured (Barzel, 1989: 9). As a result, prices are taken as exclusive indices of individual and social welfare, and as criteria of the efficiency of allocation and the optimality of decision making (Kapp, 1968).

1.2.2) Shortcomings of the neoclassical approach

An understanding of general equilibrium theory is important in understanding production and exchange within the market, however, the role of institutions cannot be ignored (North, 1990: 17).

1.2.2.1) Transaction costs

While the fundamental neoclassical assumption of scarcity and hence competition has proved to

be robust, the assumption of a frictionless exchange process has not (North, 1994). The neoclassical ideology will only attain its predictive results under zero transaction costs (Coase, 1960). Under real world conditions, every trade agreement involves a contract that must be defined and enforced. Transaction costs are the costs of specifying and enforcing the contracts that underlie exchange. Dahlman (1979) states that transaction costs include search and information costs, bargaining and decision making costs, and policing and enforcement costs, as well as risk and uncertainty associated with transfer of rights due to imperfect information. They can be divided into *ex ante* and *ex post* costs. Drafting, negotiating and safeguarding an agreement are *ex ante* costs. The problem of moral hazard, cheating and shirking lead to *ex post* costs, which include contract enforcement and risk (Datta and Nugent, 1989: 37). Transaction costs are likely to increase as the number of individual agents involved increases, when the level and sophistication of technology increases, or when a degeneration in social conventions, that reduce risks, occurs (Datta and Nugent, 1989: 42).

The criteria for organising transactions is one of cost minimising. The object is to minimise the sum of production and transaction costs (Williamson, 1979). If these costs exceed the revenue gained, then the contract will not be entered into (Cheung, 1970). With transaction costs arising from defining and enforcing property rights and from imperfect information, the attributes of the asset to be transferred in the exchange process will not be known fully by both parties. As a result the exchange may not take place, and prices alone will not ensure the optimum allocation of resources (Coase, 1988: 12; Furubotn and Richter, 1991: 6).

The initial distribution of property rights influences the distribution of wealth and income in society by determining who benefits from income flows generated by the use of resources. When

transaction costs are positive, the allocation of property rights becomes critical. A primary pillar of neoclassical economics is the separability of equity and efficiency. This breaks down under this situation, because the terms of contracts in various transactions, which directly affect efficiency of resource allocation, now depend crucially on ownership structures and property relations (Bardhan, 1989: 5).

1.2.3) The institutional approach

Institutionalists have recognised that economic processes cannot be adequately explained as self contained and self sustaining systems, isolated from a social and physical environment of which the economic system is a part, from which it receives inputs, and with which it is related through numerous complementary interdependencies. Rather, institutionalists view an economy as an open system in perpetual dynamic interaction with a complex social, political and physical environment. Economic processes receive important organising impulses from this environment and in turn exert their own influences on it (Kapp, 1976).

Samuels (1988: 3) describes institutional economics as an understanding of the structure of institutions which constitute the market, and the structure of property rights that determine which individual's interests shape demand and supply in the market. Institutions must therefore be included as endogenous variables in an economic system. Institutionalists view transaction costs, and the institutions that evolve to minimise them as the key to the performance of economies (Bardhan, 1989: 3). The level of transaction costs determines: (a) the degree to which individuals can profitably exchange property rights for mutual benefit, and (b) the existence of conditions whereby the cost of bringing the associated harmful or beneficial effects to bear on the decisions of one or more of the interacting individuals is too high to make it worthwhile (Nieuwoudt *et al*,

1997).

While economic efficiency is described by the concept of Pareto optimality within the neoclassical paradigm, Buchanan (1986: 94-95) notes that the only way in which the outcome of the exchange process can be evaluated is through the revealed choice behaviour of individuals to potential exchanges. Each individual will have different perceptions attached to a potential exchange of rights, and there is no way for an external observer to determine whether or not the observed level of exchanges falls short of some idealized norm. Efficiency of resource use within an institutional setting is thus ensured, as long as exchange is voluntary to market participants. This implies that resource allocation is shaped by institutional arrangements, and efficiency is comparable only between institutions and not within an institution.

The ultimate test of efficiency can be seen as agreement on the changes of rules governing market exchanges. If individuals agree to institutional changes, and trade is voluntary, then the new institutional arrangements can be considered more efficient than the old arrangements. Agreement signals that individuals perceive the old rules to be inferior. Since individuals are driven by self interest, the institution that evolves as a result of the change will allocate resources in a more efficient manner. Artificial restraints placed on exchange between parties via a political agency, precludes an observation of the true test of efficiency - the agreement between parties. As a result the resource allocation arising under such a situation can only be presumed inefficient (Buchanan, 1986: 98).

CHAPTER 2

TRADABLE WATER RIGHTS

Over the past two decades, there has been growing evidence that markets in tradable water rights can be effective mechanisms for allocating scarce water resources. In areas with limited water supplies or inefficient water allocation, markets have applicability as an alternative mechanism for improving water allocation and its use (Easter, 1996; Chang and Griffin, 1992).

Economically efficient patterns of resource use are obtained under conditions where (at the margin) the value earned by the resource in any given use equals its scarcity value or opportunity cost. In theory, these conditions result from one of two resource allocation institutions. In a decentralised institution, the resource is obtained by all users within a competitive market. Competitive forces generate a market price which reflects the resources' relative scarcity. In a centralised institution, the resource is controlled by a central authority. The authority must know the scarcity value of the resource, and either directly allocate water so as to equate value-marginal-product and the scarcity value, or make water available at a price equal to its scarcity value (Cummings and Nercissiantz, 1992).

2.1) Shortcomings of public water allocation

Commonly, water has been considered too essential a resource or too insensitive to price for its use to be left to the impersonal forces of free markets (Frederick, 1986). The traditional approach to water allocation has been to rely on the knowledge of a few experts to direct allocation (Anderson and Leal, 1989). While this expertise is important, society enhancing activities such as water allocation are more dependent on knowledge of individual tastes, experiences and

circumstances. Such information does not exits in cohesive, integrated form but is distributed among the members of society (Hayek, 1945). As Sowell (1987: 48) explains, "with knowledge conceived of as both fragmented and widely dispersed, systematic coordination among the many supersedes the special wisdom of the few."

In a centralised allocation system, public officials may lack information concerning individual farmers' farming environment, resulting in the implementation of comprehensive plans that are not appropriate under the circumstances (Anderson and Leal, 1989). Centralised allocation may thus place control of water resources in the hands of bureaucrats who lack information and incentives for efficient water allocation. Furthermore, individual users may be encouraged to engage in non-productive activities such as lobbying for subsidies and other special considerations under a system of government control (Frederick, 1986).

Thobani (1997) submits that centralised allocation systems worldwide have all too often resulted in inefficient water use and supply in the following areas: Firstly, despite the growing demand for water and the increasing cost of hydraulic infrastructure, water under public allocation is still used wastefully. Rationing of urban water continues while neighbouring farmers continue to grow low-value, water-intensive crops using inefficient irrigation techniques. Secondly, governments have found it difficult to reallocate water from agricultural to more desirable urban uses, since these shifts often generate conflicts and foster social disruption. Thirdly, public allocation has not proved equitable in many settings as the poorest are not served by piped municipal water and must obtain their supplies from private vendors at higher prices. In addition, farmers are unable to sell any surplus water under public allocation systems, resulting in little incentive for these farmers to conserve water by better soil or water management, or by growing

less water intensive crops. Finally, government control has achieved little success in maintaining water and soil quality, and in protecting ecosystems in the face of municipal and industrial waste, runoff from agricultural chemicals, and poor land use practices.

When water is "owned" by the state, irrigators may derive benefits from public works projects, but they are unable to transfer water. The actions of the agency officials who authorise water allocations would not be driven by the value of competing users, as is the case in a market, because they would not gain monetarily from such transfers, and may in fact lose discretionary power (Anderson and Leal, 1989: 437). When water rights are not transferable between users, then no opportunity cost is attached to water, and an incentive exists for users to use water at the maximum point on the production function (Nieuwoudt, 1996). Administrative allocation can lock water into historical uses, rather than reallocating water as economic conditions change, thus creating substantial efficiency losses (Livingston, 1995). Moreover, administrative allocation often leads to large scale subsidisation of those users with the strongest lobby, who may not necessarily be the users in need (Le Moigne *et al*, 1995).

Griffin and Boadu (1992) note that command and control policies are generally capable of establishing appropriate water allocations, however, the rigidity of these policies causes them to become rapidly outdated. Rather, a decentralised process of reallocation in the place of precise allocations at any one point in time should be emphasized. Thobani (1995) notes that recent government efforts to improve water resource management have moved away from the construction of hydraulic infrastructure to improving pricing policy, and handing management down to water user associations (WUA's) and communities. Given adequate economic incentives, responsibility, and authority, WUA's are able to effectively take over activities

commonly performed by government agencies (Easter and Feder, 1996). However, turnover of costs and responsibilities to WUA's not accompanied by a change in fundamental incentives governing water use, will result in continued reliance on bureaucratic water allocation and the ensuing inefficiencies in water use. As a result this approach functions well when public funds are available and when there is close cooperation among water users. However, as public finances become more strained and conflicts among users grow, the effectiveness of this approach declines.

Rather, decentralisation of water management combined with mechanisms that provide users with better incentives to use water efficiently are gaining popularity. This can be achieved by pricing water according to its opportunity cost. In practice, this is difficult to achieve, especially for irrigation water. Irrigation water charges are typically well below the cost of obtaining additional water (its long run marginal cost), and often below the operation and maintenance costs of the irrigation infrastructure. Raising water tariffs to the long run marginal cost would bankrupt many farmers, which is politically and socially unacceptable (Thobani, 1995).

Even if it were possible for governments to measure and monitor water flows inexpensively, measuring opportunity cost is difficult since it varies according to location, reliability, season, use, and water quality (Thobani, 1997). A more realistic method to effect efficient use of water is to facilitate the operation of a water market, while at the same time allowing for a certain level of government regulation (Thobani, 1995).

2.2) Incentives for water market allocation

The basic argument by market proponents, is that market forces should play an expanded role

in the allocation of water rights, thus encouraging efficiency in water use (Chan, 1989). A water market consists of the interactions of actual and potential buyers and sellers of water commodities. Negotiated transactions generate prices and conditions of sale and use of water rights. As with any market-orientated economic activity, entrepreneurial initiative and identification of new opportunities or underutilised resources, is the driving force in market trades of water rights. The motivating force behind market development is mutual perception by both buyers and sellers that economic gains may be captured by transferring water to a location, season or purpose of use in which it generates higher net returns than under its present use patterns. The returns to buyers must outweigh the costs of obtaining water through the market process. Additionally the market transaction must be attractive relative to all other processes by which buyers could achieve their water supply objectives (Schmid, 1972; Saliba and Bush, 1987: 4).

Cummings and Nercissiantz (1992) explain that the operation of an unfettered water market will result in an allocation that is economically efficient, ie, which will result in water being placed in those uses most highly valued by society in a flexible manner. In contrast to traditional government command and control systems of water management, transferable water rights will introduce competition to maximise efficiency and facilitate exchanges of water rights to move water to higher valued uses (Rosen, 1990).

The market process sends supply and demand signals that enable users to conserve water and coordinate its use. These signals are conspicuously absent under centralised allocation (Anderson and Leal, 1989). Within the market, economic self interest of individual users will cause the elimination of waste and will result in efficient use of water if salvaged water can be sold or put

to a new use (Gould, 1989). Improved water use efficiency in the agricultural sector under such a system, is capable of maintaining agricultural growth while at the same time securing the supply of water to high value uses in urban areas, without the need to develop costly new sources of supply that may be environmentally damaging. This has implications towards reducing costly public infrastructure investment and the cost of water operations and management (Rosegrant and Schleyer, 1994).

Policies that develop markets in tradable water rights establish incentives for farmers to economise on water use and choose less water intensive crops, particularly in the dry season, by forcing them to consider the full opportunity cost of water (Pingali and Rosegrant, 1995). The implicit value endowed in water by the creation of a water market creates a built-in incentive to conserve water voluntarily and employ it in its most productive use, without having to raise water charges (Thobani, 1995). The market clearing price will directly confront the user with the real opportunity cost (Howe *et al*, 1986). With completely defined and transferable water rights, each user would incur the full cost and benefit of his actions. Any water rights holder who ignored the need to allocate water to a higher valued use would see his personal wealth decrease. In this way, knowledge and incentives are linked (Anderson and Leal, 1989).

In terms of efficiency of use, water should be made available to individuals with the expertise and innovative ideas for its use, and they may not be the land owner. This can only be achieved effectively through separable water rights in a market process. As such, water markets allow decentralised information to be brought to bear on water management decisions. Within a water market, a farmer can apply his first hand knowledge of his land, hydrology, irrigation technology, and relative profitability of alternative crops to determine how much water to apply and which

crops to produce (Anderson and Leal, 1989). With bureaucratic solutions to water allocation, the central authority excludes the people who eventually will have to pay for the water - the users, consumers, developers, and manufacturers (Lynne and Saarinen, 1993).

As opposed to administrative water allocation, the market secures compensation for users who relinquish water. Water users are empowered by requiring their consent to any reallocation of water and compensation for transferred water (Anderson and Leal, 1989; Hearne, 1995).

A water market will provide predictable outcomes of transactions, if well defined and enforceable water rights are established. Secure water rights increase producer incentives to make long-term private investments in irrigation and production technology. Users are thus able to invest in water-saving technology knowing they will receive the full benefit of their investment (Rosegrant and Binswanger, 1994; Easter and Hearne, 1995). Place *et al*, (1994: 20) contend that tenure security over a resource is defined by the breadth, duration, and assurance of the right. The breadth of rights is the legal quantity of rights held and the duration is the length of time that a right is legally valid, and is required to be sufficiently long to allow the holder to recoup with confidence the full income stream generated by the investment. Assurance implies that the individual users hold the rights and the duration of the rights in their tenure with complete certainty. This would promote long-term investment and resource conservation. Security of tenure is also important to draw the desired type of farmers into irrigation farming, and may benefit farmers by enabling them to use water rights as collateral to secure lower interest rate loans. A water allocation system in which individual tenure is secure may attract private investment to large public hydraulic projects under construction, enabling them to be completed faster and at less cost (Thobani, 1995).

Water allocation through the market would provide maximum flexibility in responding to changes in crop prices and water values as demand patterns and comparative advantage change and crop diversification progresses (Rosegrant and Binswanger, 1994). This market flexibility would be considerably enhanced if the market facilitated temporary reallocation of water (Gould, 1989). For flexibility to exist it is not necessary for all water to be subject to reallocation. A tradable margin within each major water using area that is subject to low cost reallocation is sufficient. The volumes of water that should be reallocated over time are not large, thus the tradable margin can constitute only a small part of the total water supply (Howe *et al*, 1986).

Within a market environment for a natural resource such as water, individual users face the opportunity cost of selling the rights to the resource through the market, and may have incentives to maintain or improve resource quality. Tradable water rights would thus provide incentives for users to take account of some of the external costs imposed by their water use, thereby reducing the pressure to degrade the resource (Rosegrant and Binswanger, 1994). However, this may not always hold true for water, especially flow resources. As Booker (1990) notes, water has public good attributes while efficient markets require that resources be rival and excludable, and use values well known. Thus some public agency performance may be needed to take account of public values and external effects not incorporated in market decision making processes.

Minimum non-transferable water rights could be reserved for the environment in the initial allocation of water rights, and water could be made available to environmental concerns through the market process (Little, 1994). Market incentives to conserve water also controls soil salinity, which is caused primarily by overwatering (Thobani, 1995).

2.3 Requirements for a market in tradable water rights

In establishing a water market to improve water allocation and use, the problem is to devise an appropriate mix of government activities and market based incentives to direct water transfers (Easter and Feder, 1996). The theoretical requirements to provide for voluntary water trades have been well documented in the literature (Anderson, 1983; Howe *et al*, 1986; Saliba and Bush, 1987; Simpson, 1992), and are briefly discussed below.

2.3.1 Water rights

An efficient water market requires that water rights be well defined and nonattenuated to satisfy the ideal institutional conditions for efficient market performance. Such rights are completely defined, enforceable, transferable, and separate from land ownership (Saliba and Bush, 1987: 23).

Well defined water rights are completely specified in terms of the unit of measurement, reliability, and priority of the right. Water rights must be defined in readily understood and measurable terms so that there is transparency in what is being transferred and what quantity of water the right entails. A system of water measurement must be established and administered. It can take the form of volumetric quantification such as cubic metres, or rate of flow for a set period. The most effective quantification is in volumetric terms as opposed to rate of flow. This is easier if the water being transferred is capable of being stored. The volumetric system assures the buyer and seller of the amount of water being traded and allows greater flexibility in the pattern of use and the timing of delivery. If rate of flow is the measurement of the right, then the pattern of use and timing of the right of diversion must be specified. If a buyer intends changing the diversion pattern then the impact on other users who have the right to divert water from the river at other times must be considered as part of the transfer (Simpson, 1992). In addition, water

rights should be defined in terms of variability or reliability, and priority between household, ecological, livestock, irrigation, industrial and recreational use (Backeberg, 1996). This creates certainty in what is being traded and predictability in the outcome of the reallocation process. Enforceable water rights secure the net benefits flowing from the use of the water right for the right holder. Thus, water rights should be permanent, or very long term, to ensure the security of the right. Transferable water rights create exposure to the opportunity to actually realise higher valued alternatives (Rosegrant and Schleyer, 1994; Anderson, 1983). Water rights should ideally be separate from land rights, as this enables transfers to take place independently of land ownership or land use (Pigram, 1993).

2.3.2 Institutional requirements

A free market in water rights must be administered in such a way that the rights and the title are secure. Constitutional guarantee of title ownership and legal sanction of water transfers is thus necessary to provide for secure water rights and to ensure water transactions are sanctioned by the relevant government jurisdiction. A water market requires an efficient administrative system that will prevent abuses of the system and maintain the proper chain of title over the water rights. Government agency performance in the administration of water transfers is thus necessary to legally sanction water trading, ensure that legal formalities associated with transfers are adhered to, register the right, enforce legislation or regulations, and resolve disputes among users. Without this the transfer of water rights would undoubtedly result in disputes about ownership and rights of use (Simpson, 1992; Livingston, 1995).

2.3.3 Infrastructure requirements

Market allocation systems function best where some degree of infrastructure, such as canals and

storage dams, are in place to allow easy delivery of the water to the buyer. Flexible infrastructure enables sellers to transfer water at a reasonable cost to buyers. For this reason, water transactions tend to take place within existing distribution systems and use sectors. The absence of such infrastructure does not preclude the development of a water market, since, any improvements needed in the physical transfer of water from the place of use of the seller to the place of use of the buyer will be part of the transaction cost to be paid by parties involved. Similarly, any infrastructure and improvements necessary for intersystem or intercatchment transfers must be built as a part of the cost to the buyer of achieving the transfer (Simpson, 1992; Livingston, 1995; Easter, 1996).

2.4 Establishing tradable water rights

In reforming water allocation to create markets in tradable water rights a number of complex implementation issues arise. These issues are discussed below.

2.4.1 Transaction costs

Water markets are constrained by transaction costs, which if too high can reduce the level of trading that can be profitably undertaken and negate the potential economic benefits from the water transfer (Hearne, 1995; Saliba, 1987). Transaction costs in water allocation arise whether water is allocated through administrative control or through the market process, and include (a) the cost of identifying profitable opportunities for transferring water, (b) the costs of negotiating or administratively deciding on the water transfer, (c) the cost of monitoring third-party effects and other externalities, (d) the infrastructure cost of conveying the water and monitoring the transfer, (e) the infrastructure and institutional cost of monitoring, mitigating, or eliminating third-party effects and externalities (Rosegrant and Schleyer, 1994).

In a water market, users would bear the cost of identifying opportunities and negotiating the transfers. Buyers will not undertake a transfer unless returns to water in their intended use outweigh the price and all transaction costs borne by the buyer. Sellers will only agree to a transfer if the price they receive compensates them for returns foregone plus any transaction costs they incur (Saliba, 1987). The costs of conveyance and of mitigating third-party effects would fall on the buyers, who will thus engage in those trades which minimise the total purchase price, conveyance, and mitigation costs. The authority would bear the cost of monitoring third-party effects and would participate in conflict resolution, along with the courts (Rosegrant and Binswanger, 1994).

Water markets thus have some advantages in minimising transaction costs. However, the means in which markets are organised and regulated have a major impact on transaction costs. Excessive regulation can create high transaction costs that greatly reduces the benefit of water trading, while inadequate regulation can impose unacceptable costs on third-parties or the environment (Rosegrant and Schleyer, 1994). In particular, laws protecting the interests of third-parties impose costs on market participants in the form of transfer approval requirements. These include court hearings, title searches and hydrolic studies to determine transfer impacts (Saliba and Bush, 1987: 66). Flexible infrastructure allowing for easy measurement and modification of water flows can reduce the cost of changing the location of water use. The ability to store, measure, and control water flows can allow for volumetric specification of the water right which can reduce the costs of information gathering, negotiation, and enforcement (Hearne, 1995). Technology improvements will increase the efficiency and benefits of water markets by reducing the transaction costs of trading, but significant gains from trade can be achieved without sophisticated technology (Rosegrant and Binswanger, 1994).

Of course, water markets will fail from high transaction costs that result from water rights that are incompletely specified in the unit of measurement, reliability, or priority of the right, and from water rights that are not vigorously enforceable, or from insufficient policing of rights (Backeberg, 1995).

2.4.2 Fairness in initial allocation of water rights

For successful development of tradable rights it is important to reach agreement on the rules of the game, beginning with the perception of fairness in initial assignment of water rights. This objective can be addressed by basing the initial allocation on historical water use, (including both informal and formal water rights held), combined with redistribution of concentrated rights holdings.

The initial assignment of water rights determines who must pay to obtain water and who receives payment (Saliba, 1987). Chan (1989), argues that where initial endowments are too skewed some government coercion might be necessary to get people to agree to allocations they would not voluntarily accept in the interests of equity. Based on the principles of justice, privileged water rights holders must be ready to relinquish some of their water rights to disadvantaged individuals or groups. This should be negotiated between owners of lawful rights and government and not through arbitrary attenuation of rights (Backeberg, 1994). The fact that people with no water rights or poor financial situations have low bargaining power does not disqualify the merits of a water market. Water services should not be subsidised or market values of rights distorted to achieve social objectives, but rather appropriate payment systems such as lifeline rates and grant funding should be considered (Backeberg, 1996). In the short term, lifeline tariffs for basic water requirements can be implemented or vouchers made available for reimbursement by low income

households to target poverty. In the long term, investment in human capital through training and extension to enable individuals to improve livelihoods through their own efforts is necessary (Backeberg, 1995; Backeberg, 1997).

Within individual catchments, agreement by all stakeholders on the initial apportionment of water rights requires a sequence of preparation (water balance per catchment); negotiation (procedures to agree on an apportionment as lawful); and implementation (management by local users with some government support). Sacrifices by some users are likely, through negotiated adaptions in the interest of social welfare. Thereafter the market mechanism should operate (Backeberg, 1996).

Important societal water uses with strong public good characteristics that cannot compete in the market can either be purchased by the public sector, or reserved in the initial allocation of water rights (Easter and Hearne, 1995).

2.4.3 Prior vs. proportional water rights

In specifying initial allocations of water rights, or where water rights already exist and do not have to be created, eg. riparian rights, it becomes necessary to reconcile these rights with either prior or proportional principles (Backeberg, 1995). The choice of type of water rights as either proportional rights or prior appropriation rights has important bearing on the way water transfers are able to proceed. Proportional water rights are defined as a percentage of water flow available in any given year for all users in a system. While the percentage remains constant, actual quantity of water received will vary according to available flow. Individual users receive a specified volume of water according to their individual legal water right allocation, subject to water

availability and allowing for proportional sharing of water shortages. The homogeneity of proportional rights makes market organisation easier, however, users must hold more rights to reach a level of assurance of water supply due to supply variability. This approach is also more flexible and equitable in allocating deficits than the prior appropriation system, providing equal sharing of shortages (Livingston, 1995; Rosegrant *et al*, 1995). In some cases, certain priority uses such as municipal supplies are reduced less, or not at all, while other uses such as agricultural or industrial uses have their deliveries reduced the most. The priorities will be reliant on each region's or country's critical water use sectors (Easter, 1996). Historical information on the probability that certain quantities of water flow will be available at different times of the year, as well as the capacity to store water will improve market efficiency by reducing uncertainty (Dudley and Musgrave, 1988).

The prior appropriation doctrine gives first priority to the older, most senior water rights with lower priority given to rights established at a later point in time (Colby, 1995: 478). During times of drought only senior water rights holders receive water, while in times of surplus flow even junior rights holders receive water. The priority system permits a user to buy varying degrees of water supply reliability. However the heterogeneous nature of the rights, due to varying priority of rights, makes it harder to organise the market. The priority system is thus characterised by a high level of market organisation, requiring comprehensive transfer proceedings and regulations (Rosegrant *et al*, 1995).

Any change in rights from a riparian to a priority based system would be costly. An easier approach would be to establish the existing legal framework of water rights, (who owns what), and then facilitate transfers between users. This could be achieved by allocating existing riparian

owners an equal percentage of the water, or allocating water rights through a licensing system by formula relating to land size of the owner and/or his previous level of use to the available flow (Nieuwoudt, 1995; Eheart and Lyon, 1983).

2.4.4 External impacts of water transactions

Efficiency requires that external effects of a transfer be internalised into the decision making process and that public values relating to water be considered by users in their transfer decisions (Saliba, 1987). If water transfers positively or negatively affect third-parties or ignore important societal public good values, and these are not taken into account in market transfers, then water prices will not reflect full social values (Martin and Brown, 1987).

Public values

Individual users will only consider the full opportunity cost of their water use and transfer decisions if market prices embody water quality, instream flow, and other public interest values (Saliba, 1987). In practice it is almost impossible to incorporate all such interests in market transfers, and an array of potential negative impacts arising from water market activity may influence such public good values. Water quality and instream flow maintenance are two such examples that may generate significant public good values that may be ignored by individual water users. As a result some administrative action may be necessary to take account of these values within a water market (Howe *et al*, 1986). Legislative prescriptions screening against negative ecological impacts resulting from water transfers may be necessary to prohibit transfers with untenable impacts on fish, wildlife, river ecosystems, and other instream uses (Backeberg, 1996; Rosegrant and Schleyer, 1994). Uncertainty about water quality can be addressed through overall water quality regulations or emission charges imposed on water polluters (Easter, 1996).

Such prescriptions require the identification, measurement and specification of water quality changes resulting from transfers as well as instream flow requirements that may not be impinged upon by water transactions (Backeberg, 1996).

To a large extent, public interest in water supplies can be incorporated in the specification of a Reserve, defined as the volume of water in a river system necessary to satisfy basic human needs, instream flows for the protection of the environment, and international obligations where a river system traverses boundaries between countries. For basic human needs, the quantity and reliability of supply, provision for population growth and improvement in water services must be accounted for. Instream requirements will vary according to the time of year, habitat requirements, sediment and salt balances, and other factors specific to each river system (Postel, 1995, as cited by Backeberg, 1997). Thus the balance between public and private interests will not only affect how much water is available in the form of private rights, but also the extent to which private rights are given the definition needed for a water market. This depends on the willingness of legislatures to define the scope of current and future public interests in water. The greater the flexibility given to finding new public interests in future, the less well-defined private rights will be because of uncertainty arising from potential policies that may decrease the quantity of water available to the market and constrain the transferability of private rights (McCormick, 1994).

It is also important that in any water market, state and local governments, environmental groups, and other water interests have access to markets and the legal ability to bid for water rights on the same terms as agriculture, industry, and cities (Saliba, 1987).

Externalities

While markets guarantee equity between buyer and seller, they do not necessarily reflect fairness to third-parties who may be negatively impacted by the exchange (Howe *et al*, 1990). Water markets can fail because of insufficient incentives and accountability due to externalities (Backeberg, 1995). Negative externalities include deterioration in water quality, reduction in water availability due to reduced return flows, diminished economic activity in communities from which water is sold, and a reduction in instream values such as recreation, aesthetics and environmental concerns (Colby, 1990; Howe *et al*, 1990).

The existence of return flows associated with many uses is believed to constrain market allocation of water because the impacts on the users of return flows are generally neglected (Vaux and Howitt, 1984). Large portions of agricultural water drain or seep from fields and reappear as direct or indirect return flows to be used by other farmers or to generate environmental benefits. There is thus a unique but unpredictable degree of interrelationship among water users, and this multiple reuse creates the likelihood of externalities imposed on third-parties (Rosegrant *et al*, 1995; Young, 1986).

In response to the return flow externality, an important specification of water rights lies in the definition of the tradable portion of the right. Rights can be defined as either diversion rights or consumptive rights. Diversion rights specify the quantity of water that may be withdrawn per unit time from a source, while consumptive rights specify the portion of the diversion right that can be permanently removed from the source through evapo-transpiration, or other means. Owing to the technical difficulties involved in calculating exact return flows on a case-by-case basis, it may be more appropriate to calculate averages that specify the volume of water consumed by a

particular activity. These volumes would than serve as limits on the amount of water owners are able to sell. Specification in terms of consumption aims to ensure a constant return flow to the water source, especially when water transfers involve a significant change in use to the original use (Martin and Brown, 1987; Thobani, 1995). Some economists argue that defining rights in terms of a right to divert a fixed amount of water and a right to consume a fixed amount of water would internalise the return flow externality, thus reducing the need for complex transfer proceedings (Griffin and Boadu, 1992). However, consumption does not internalise effects such as changes in timing of use, changes in water quality, and in patterns of use. As a consequence, government regulations will probably be needed to prescribe conditions to mitigate these effects (Gould, 1989).

With large water transfers from agriculture to urban uses, the transferred water represents a lost resource base. Secondary economic impacts resulting from a reduction in agricultural acreage can effect the remaining farmers and businesses that supply agricultural customers. Indirect employment and income losses can be substantial in the area of origin. The severity of these area of origin impacts will depend on whether or not the new use is inside the economic area encompassing the area of origin, whether the proceeds of the sale are reinvested in the area, and the strength of forward and backward linkages between agriculture and the supplying and processing sectors. However, on the national level, the direct and indirect losses of income and employment may be offset by gains in the importing area (Griffin and Boadu, 1992; Howe *et al*, 1990).

Upholding the opportunity cost criterion that third-party impacts be accounted for in the transfer decision requires procedures to identify and value impacts, by either including affected parties

in the transfer process or securing compensation once external effects become evident. However, upholding the opportunity cost criterion may make water rights transfers more complicated and costly, thereby trading off one aspect of efficiency for another (Saliba, 1987).

Even with appropriately defined water rights, most water market transactions do not take place under conditions of perfect competition in practice, and as a result all the costs and benefits in natural resource management will not be taken into account. Some administrative control and structure must therefore be placed upon water marketing if water transfers are to serve society broadly (Griffin and Boadu, 1992). Public institution performance is then necessary to protect against monopoly development, third-party impairment from water trades, and to resolve conflicts amongst water users in so far as the definition and enforcement of property rights is concerned (Rosegrant and Binswanger, 1994; Veck, 1995).

2.4.5 Water user associations (WUA's)

A minimum level of institutional capacity at the local level, such as WUA's, are necessary to ensure that water trading in a catchment area is able to develop and to operate the system. WUA's can improve market efficiency by implementing trades and providing information regarding water availability, potential buyers and sellers of water rights, and market prices. WUA's enable participation in water management on a local level, and encourage private financing and accountability in water allocation (Backeberg, 1996; Easter, 1996).

CHAPTER 3

EXPERIENCE WITH TRADABLE WATER RIGHTS

This chapter endeavours to briefly outline the documented success experienced with tradable water rights in a number of counties of the world, including Pakistan, India, Spain, the Western US, Chile, and Mexico.

3.1 Pakistan and Northern India

Informal water markets have emerged in Pakistan and Northern India among farmers along surface water courses or canals, despite the illegality of the majority of these transfers (Easter, 1986). Farmers are allocated use rights for a certain period of time, during which time all available flow is theirs to utilise. Trading of use rights for the all or part of the irrigation time allotment have taken place. However, such trades are plagued by high transaction costs because of the significant level of coordination required among farmers to achieve transfers. The illegality of these trades also makes it impossible for government officials to assist in coordinating trades or reducing transaction costs (Easter, 1996)

3.2 Spain

In Valencia, Spain, an auction water market has been in existence since the previous century. Both irrigators and non-irrigators are allocated time allotted water use rights from the canal watercourses. Water flows in the canals are largely constant owing to the high incidence of control and storage that exists in the system, effectively transforming rights to volumetric units with a high implied reliability. The market is based on an auction every Sunday morning in the village of San Juan, where buyers bid for tickets for particular irrigation times during a particular

cycle of canal flows (Easter, 1996). An analysis of the market by Maas and Anderson (1978) found that it produced higher net returns than two alternative systems used elsewhere in Spain.

3.3 The California Water Bank

California experienced severe drought conditions between 1987 and 1992. In order to allow for more efficient water distributions during this time, the California State Government set up Drought Emergency Water Banks to facilitate the allocation of water in 1991 and again in 1992. Both Banks were essentially institutions designed to transfer water from low-valued uses to high-valued uses during a period of intense scarcity. The Banks were managed by the Department of Water Resources (DWR) which served as the broker for water transfers by drafting contracts for the purchase and sales of water.

In the 1991 Bank, the DWR set a fixed purchase price for water of $100/1000m^3$, and purchased $1013000m^3$ of water. Half the water came from farmers who fallowed their land and sold the water their crops would have consumed to the bank. One-third of the water came from farmers who substituted surface water rights with ground water rights and sold the surface water to the Bank. The remaining water came from surface water that was in excess of requirements for some water districts in Northern California. A sale price of $140/1000m^3$ was set by the DWR, and the Bank sold $488000m^3$ of water. Approximately 75 percent of this water went to urban municipal and industrial uses, and 25 percent to highly valued fruit, vegetable and nut crops.

Most of the difference between purchase and sale price was used to pay for carriage water. Thirty percent of transferred water was needed as carriage water to provide for salt protection in the Sacramento Delta. Thirty-seven percent of total water purchased remained unsold in 1991. This

water was purchased from the bank by the DWR and carried over into the 1992 Bank and resold at a lower price (Howitt, 1994).

A dual-contract system was introduced in the 1992 Drought Emergency Water Bank. Under this system, buyers and sellers committed to the Bank early and made a deposit on their anticipated water demand or supply. As a result, demand and supply of water were more accurately forecasted, minimising excess supplies. In addition, much lower purchase and sale prices and a ban on water from fallowed land in the 1992 Bank aimed to limit the surplus.

The 1992 Drought Bank purchased water at a price of $\$40/1000m^3$, purchasing a total volume of $232,990m^3$ of water of which 23 percent had been purchased in 1991. Eighty percent of this water came from farmers who substituted surface water with ground water, and the remainder from surpluses in Northern California surface water supplies. The 1992 Bank resold all the water at a price of $\$58/1000m^3$. About 60 percent of this water went to agricultural uses, 25 percent to urban uses, and 15 percent was purchased by the Department of Fish and Game for instream uses (Israel and Lund, 1995).

3.4 The Western United States (US)

Permanent transfers of water rights occur widely in the Western US, where growing water scarcity and an evolving economy have encouraged the development of physical and institutional infrastructure for water marketing (Colby, 1990). In most Western States, 85 to 95 percent of total water use is consumed by agriculture, making the reallocation of conserved agricultural water to urban uses a more economically attractive option than developing new supplies (Young, 1984). Voluntary transactions of water rights among water users are an important reallocation

mechanism in the Western US today. Most transactions involve transfers of agricultural water to higher valued non-agricultural uses, and generally command a higher price than transfers within the agricultural sector (Shupe *et al*, 1989). However, transfers within the agricultural sector are also common (Cummings and Nercissiantz, 1992).

In none of the Western States could voluntary transfers of water rights be characterised as a free market, since rights to use and transfer of Western water are controlled by a complex and highly developed set of rights and rules, upon which a comprehensive water market system cannot easily be superimposed (McCormick, 1994). Thus, voluntary, negotiated transfers are the rule, aided by market-like entities (Gardner, 1990). Every Western State imposes restrictions on water transfers, generating uncertainty and costs for potential transactors. Such restrictions have been described as inefficient and unnecessary impositions on the market (Tregarthen, 1983). Others, including Colby (1990), argue that these restrictions are necessary to account for third-party effects that would otherwise have not been considered in the transfer process.

The Western US relies on the prior appropriation doctrine for the allocation of surface water which supports ownership of water rights. This doctrine provides for defined and enforced water rights so that trades can and do take place (Anderson and Leal, 1989). Water rights are defined primarily by State law in terms of the quantity of water that may be diverted and the relative priority of the right relative to other rights (Colby, 1995: 478). All users in a catchment area have to possess a permit to divert water, and a seniority is associated with each permit relative to other users. The seniority of the permit protects more senior rights from interference by junior rights, stipulating that more senior (prior) water rights are fulfilled before junior rights, thus reducing uncertainty in supply of individual rights. Water permits are transferable, and more senior rights

have greater value to users and thus command higher prices (Griffin and Boadu, 1992; Livingston, 1995). However, by basing allocation on chronological appropriation of water and not economic returns, the priority system generates a degree of inefficiency from the deprivation of higher valued uses with relatively junior priority in times of water scarcity (Rosegrant and Schleyer, 1994). Equity of initial allocations of rights has not arisen in the context of a water market in the Western US, and available sources have long since been appropriated. The priority of rights permits a user to buy varying degrees of reliable water supply. However the heterogeneous nature of the rights, due to varying priority of rights, makes it harder to organise the market (Rosegrant *et al*, 1995).

Individual States are primarily responsible for regulating transfers of water rights, generally through vigorous bureaucratic processes. Individual users generally have to file an application with the State water agency to transfer a water right. Applicants generally have to hire the services of a lawyer and engineer to assist them in the application process, increasing the cost of achieving the transfer. All States also require public notice of the intended transfers to alert parties who may be affected by the transfer (Colby, 1995: 479). In much of the Western US, water transfers are governed by the no-injury rule to third-parties. Every Western State requires administrative or judicial approval before a transfer can take place, to prevent and moderate third-party effects, especially those arising from return flows (Griffin and Boadu, 1992). The no-injury rule is a recognition that limits exist on the scope of water rights, since junior appropriators have vested interests in maintaining water conditions the same as at the time of their appropriation, and will likely oppose all potential trades involving changes in diversion or use patterns. However, accounting for such third-party effects in the Western US has proved to be an uncertain and imprecise affair, increasing transaction costs and often constraining market

transfers (McCormick, 1994). Objectors to particular transfer may file a protest with the State, which if not resolved between applicant and objector, is resolved through both water courts and the Office of State Engineer (Colby, 1990; Colby, 1995: 479). Most Western States require water court proceedings when a transfer involves a change in point of diversion, purpose of use, or place of use. While such requirements increase transaction costs, certain other institutional arrangements have served to simplify the transfer process. For instance, under Colorado Water Law, transfers within a water company service area do not require court hearings, enabling water to be easily transferred within the area (Saliba, 1987).

Nearly all Western States protect return flows in some manner. Most do so by restricting the quantity of water that may be transferred to historic consumptive use rather than historic quantity diverted (Driver, 1986). The US system of determining the tradable fraction of appropriative water rights in terms of consumptive use, imposes a strong burden of proof on the seller as to how much of the water is tradable, but protects against return flow externalities (Rosegrant *et al*, 1995). The costs involved in this process are usually borne by the applicant. Determination of consumptive rights has been complicated by increasing recognition of instream rights, increasing the likelihood of transfers being disallowed under the no-injury rule (Livingston, 1995). In most areas, approval procedures that aim to protect third-parties are a major cost of implementing a water transaction and may in fact make it unprofitable to undertake otherwise economically beneficial transfers. Trade-offs between costs of protecting third-parties and water transfers which promote efficiency in water use occur under such a system, since transaction costs imposed by policies to protect third-parties and transfer restrictions prevent marginal values from being equated, and inhibit the movement of water to higher valued uses (Saliba, 1987).

Adoption of water-saving technology by an individual farmer is a more attractive proposition, when the conserved water can be used to expand irrigated area or applied to other non-irrigation uses on his farm, or sold to another water user. However, this situation does not apply in a number of the Western US States. In Arizona, there are no statutes preventing the transfer of conserved water, however, the appurtenancy of water rights to land (attachment of water rights to a specific parcel of land) preclude transfers of conserved water to land other than those to which the right was originally assigned. In California, the water code specifically provides for sales, leases, exchanges or other transfers of conserved water, subject to State Law governing water transfers. In Colorado and New Mexico, any user who reduces the quantity of water needed for beneficial use has to apply to the water court for permission to use the salvaged water in another use or sell it to another user. Court approval is only forthcoming if it is demonstrated that existing rights will not be impaired. In Nevada, conserved water is considered unappropriated and any applicant may file to appropriate it (Saliba and Bush, 1987: 64-65)

Most States recognise instream flow maintenance as a beneficial use. Instream users, user groups, and representative agencies are allowed to apply for permits for unappropriated water and purchase rights from existing licensed diverters (Griffin and Boadu, 1992). However, nonconsumptive users generally do not have access to markets on the same terms as farmers, cities, and industry. Public good attributes of instream flows may also make it difficult to translate collective values into dollars to bid for water rights in the market, possibly leading to an inefficient allocation (Saliba, 1987). A wide range of environmental and water quality laws are present in Western Water Law, that prohibit transfers with untenable impacts on fish, wildlife, river ecosystems, and other instream uses (Rosegrant and Schleyer, 1994). However, in some Western States, water quality is not adequately integrated into Water Law, and

impairment of water quality is not a valid basis for objecting to a water transfer (Kapaloski, 1988, as cited by Colby, 1995: 481). In addition, protection against negative indirect economic effects arising from water transfers has been provided for in Western Water Law in the form of area of origin legislation. Some States reserve water for counties in which it originates if the State Water Resource Control Board believes the transfers will deprive the county of water necessary for its present and future development (Rosegrant *et al*, 1995).

Water rights in the Western US will be forfeited following their continuous non-use for a period, that varies between States, from three to five years. This may possibly induce right holders to use their maximum entitlement regardless of the need in order to protect the security of the right. On the other hand, this policy does increase water supply certainty by eliminating any sleeper rights in the overall system (Livingston, 1995). Saliba and Bush (1987: 61) argue that these requirements can provide water rights holders with an incentive to sell or lease their rights rather than not use them and risk forfeiture, although their impact on incentives to sell or lease varies according to state implementation and enforcement procedures.

An analysis by Saliba (1987) in five Southwestern States shows that in each State the market reallocated water from lower to higher valued crop production. However, water is mainly moving to higher valued uses by water transfers out of agriculture to urban uses. Probably the most active water market trading in the West has occurred in the Northern Colorado Water Conservancy District. The price of water rights (on a per acre foot basis measured in 1980 dollars) have varied over the years, averaging $99 in 1961, $504 in 1970, $2895 in 1980, and $1600 in 1983. Rapid urban and industrial growth in the 1970's gave rise to the increases in water prices, while water prices declined after 1980 as urban development slowed (Cummings

and Nercissiantz, 1992). Prices of water rights in resort areas with limited water have been purchased for as much as $10000 per acre foot (Shupe *et al*, 1989). Gains from water transfers in the Western US can be substantial. For example, Chang and Griffin, (1992), estimated gains from trade of water sales in Texas that ranged from $3000 to $16000 per 1000$m^3$. In California, institutional change from a priority right to a market based water system resulted in a decrease in estimated total water consumption from 36741 to 34802 million m^3/year (Dinar, 1993). Vaux (1986) estimates that a reallocation of 10 percent of agricultural water in California to cities could yield benefits of 169 million dollars by the year 2000 and reduce overall water use. Trades within the agricultural sector were estimated to move water from the northern to the southern part of the Central Valley in California, and produce gains of $10 million annually based on 1980 figures.

3.5 Chile

Chile has taken active steps to promote the development of active water markets. The emergence of a water market in Chile was driven by broad economic policy reform, as the country moved rapidly from a radically socialist economy to a market based economy in 1973, and because of an increasing economic value of water, due to scarcity caused by high demand for delivered water, depletion of new supplies, and rising costs of maintaining centralised control of irrigation and urban water (Rosegrant and Schleyer, 1994). The policy reforms aimed to facilitate efficiency and flexibility in resource allocation in agriculture and included the redistribution of water and land to the private sector, the definition of well-defined water and land property rights, and market allocation of both these resources (Schleyer and Rosegrant, 1996). Fairness in initial allocation of water rights appears to have been met by basing allocations on historical water rights and some redistribution of concentrated rights holdings (Rosegrant *et al*, 1995).

Market allocation of water was formalised following the establishment of a system of transferable water use rights under the National Water Code of 1981. This Act specifies water as a national resource for public use, however, permanent and transferable water rights are granted in accordance with this Law. Temporary water rights are also granted under Chilean Water Law, and allow the holder to use water when surplus water is available after satisfying permanent water rights (Schleyer and Rosegrant, 1996). Water rights can be granted by the government on petition, purchased from individual owners, or retained from the rights based on traditional use (including both formal and informal rights held). Water rights are independent of land use or ownership, and are generally proportional rights over a variable flow or quantity, expressed in volume per unit time (Hearne, 1995). Proportionality provides for equal sharing of shortages among all rights holders, and the secure nature of Chilean water rights enables water to be mortgaged or used as collateral for loans. All water rights are specified as consumptive or non-consumptive. Non-consumptive users are required to return the water to the source in a form specified by the right. Consumptive rights are granted for the full quantity of the water right. Return flows may be used by the recipient without the need to establish a right of use, however, this is a contingent right by definition and there is no obligation to supply return flows and the supply is not guaranteed (Schleyer and Rosegrant, 1996). This means that downstream users do not have rights to the return flows of upstream users, nor are downstream return flow users protected by any law from any change in upstream water use that reduces their water supply. By eliminating third-party rights to return flows, transaction costs have been greatly reduced, resulting in active water markets.

Water transfers are generally limited throughout Chile. However, in areas where water is scarce and transaction costs are low, active water markets have developed successfully. In such areas,

transaction costs are minimised by effective WUA's and maneuverable physical infrastructure (Easter and Hearne, 1994). The most frequent water transactions are rentals of water between neighbouring farmers with different water requirements. Renting offers greater flexibility for irrigation and increases efficiency. Rentals are not required to be registered in the respective water registry, and occur primarily between neighbouring farmers owing to excessive transaction costs of long-distance trades. Permanent transfers of water among farmers occur mainly between owners of land unsuited to supporting high-value/high water demanding crops such as orchards and vegetables, to owners able to cultivate these crops. Highly intensive crop farmers who introduce water-saving irrigation technology, also sell water rights to finance the investment (Schleyer and Rosegrant, 1996). Transaction costs generally limit sales of water rights between farmers to those within the same water district. Large volumes of water have been bought by urban water and sewage companies from farmers. Hearne and Easter, (1995), calculated gains from trade from market transfers of water rights within agriculture in the Limari Valley of $2400 per 1000$m^3$. In the Elqui Valley where trading between agriculture and urban sectors took place, the net gains from trade were $790 per share, where one share delivers 1 litre/second.

Water allocation within and between sectors is achieved through the market. No specific protection against negative economic impacts in areas of origin from which water is transferred is provided for in Chilean Water Law, however, it does provide for protection from third-party effects besides return flow externalities (Rosegrant *et al*, 1995). The majority of such water conflicts are resolved through local WUA's. All users are organised into strong and compulsory WUA's. The WUA's own and manage the physical infrastructure, monitor water allocation, and approve water transfers subject to certain conditions. They also distribute the water according to rights and collect fees for administration, distribution, maintenance, and amortisation of

constructed infrastructure. Rights can be withheld from members who do not pay their user fees or who extract excess water (Rosegrant and Schleyer, 1994). The Director General of Water (DGA) has limited power to regulate natural channels and intervene in disputes where problems in the standard WUA avenues of grievances arise. The ultimate arbiter in Chile remains the judiciary (Easter and Hearne, 1994). However, Hearne and Easter (1995) note that its effectiveness in resolving water conflicts has been limited by judicial restraint. Evidence indicates that not only have negative impacts resulting from water transfers been small in Chile, but farmers have benefitted substantially from trading, as have urban water users, who have been able to buy agricultural water without the need to expropriate water or buy land. Negative effects in areas surrounding water demanding urban centres have generally been very limited, owing to the fact that farmers typically sell only a portion of their total water right. Strong environmental protection is lacking in Chilean Water Law, however, all major infrastructure construction or destruction requires DGA approval to prevent third-party effects or environmental degradation. The DGA is also required to monitor natural water courses for public use (Rosegrant *et al*, 1995).

Market participation has promoted efficiency in water allocation and use, in turn encouraging agricultural productivity. Annual growth in agricultural GNP of 5.2 percent was experienced between 1973 and 1990, as opposed to 1.9 percent between 1960 and 1972. Area under wine producing grape cultivation doubled, and area under fruit production quadrupled from 1973 to 1992. This increase in agricultural production has been achieved primarily through the shift from grain, corn, and beef production to fruit production, and occurred without the need for new hydraulic infrastructure (Schleyer, 1992). Employment in rural areas has been stimulated by the shift to export orientated crops, mainly labour intensive fruit harvesting and processing. The market valuation of water has induced individual users to invest in water-saving technology,

enabling a larger area to be irrigated and conserved water to be sold through the market. Water market allocation has reduced subsidies that were historically paid to farmers and urban water consumers, freeing up resources that have been used in targeted subsidies for poor urban users and small farmers (Schleyer and Rosegrant, 1996).

3.6 Mexico

In Mexico, leases and sales of water among farmers for seasonal water took place for many years, despite the fact that many such transactions were not encouraged or were even illegal. Following the economic liberalisation of Mexico in the early 1990's, in which the economy shifted from a centralised, highly regulated system to a market based system, the lease or sale of water was legalised under the New Mexican Water Law of 1992 (Rosegrant and Schleyer, 1994). Water is theoretically held by the Comision Nacional de Agua (CNA) for the Mexican people. The Water Law established water use rights for individual users for 5 to 50 years on a volumetric basis, separate from land ownership or use (Easter and Feder, 1996). Water concessions in which the use and discharge has not changed are generally renewed by the CNA, however, the renewal of concessions involving a change in the use or discharge is considered subject to the overall river basin supply and demand (Easter and Hearne, 1994).

Individual users within irrigation districts (ID's) are organised into strong and compulsory WUA's. Water concessions are made to WUA's, individual users, private firms, ID's, and municipalities. Irrigation concessions were initially based on historical use and allocated primarily to WUA's, ID's, or irrigation units (IU's). These entities in turn determine the reallocation of water concessions to individual farmers (Easter and Hearne, 1994). However, the granting of subsidiary rights by the WUA's ultimately weakens the security of rights to the

individual making the farming and resource allocation decisions (Easter and Hearne, 1995). In Mexico and in Chile, farmers did not have strong interest in the *status quo* which provided them with precarious rights. As a result, strong political support for comprehensive legal reform to establish tradable water rights was received from farmers. This is in contrast to the Western US, where a number of individual users had strong interest in maintaining the *status quo*, and ultimately leading to the number of transfer restrictions evident in Wester Water Law (Rosegrant and Schleyer, 1994).

Mexican farmers are empowered to sell their individual concessions to other user within the same WUA or ID and receive the proceeds of the sale. When water sales do not change the intake or discharge, the only stipulation is that they be recorded. Water sales outside the district require a majority vote of the general assembly of the WUA or ID and approval from the CNA before they can proceed. All such proceeds go to the district and not to the individual. Consequently, water values tend to differ between regions as water sales are primarily within IDs. Future respecification of water districts to combine both IDs and urban areas may create greater potential for trade between agriculture and urban uses (Easter and Hearne, 1994).

Water rights are specified in volumetric terms and the WUA's develop procedures to allocate surplus and deficit water within their control. All surpluses and deficits are allocated proportionally across users. This effectively converts the volumetric right to a proportional right (Rosegrant *et al*, 1995). Water use rights in Mexico are defined as consumptive rights. As a result any agricultural water sales are for the quantity of the water concession used in plant growth, transpired from plant surfaces, and evaporated from the soil surface. Water lost due to seepage cannot be sold (Easter and Hearne, 1994). This essentially grants downstream users the rights to

the return flows and reduces return flow third-party effects. However, it must be noted that water rights holders are not required to maintain a specific amount of return flow over time. The restrictions placed on the sale of water outside a water district assure downstream users in large river valleys of the return flows of upstream users. The new Water Law also makes users pay for any reduction in water quality as a result of their water use (Easter and Feder, 1996). To maintain ownership of a water use concession, the water must be used every three years. In practice, this means the owner must pay the extraction fee for the water, (which for irrigation water is zero). This requirement aims to prevent speculators from holding water free of charge. However, if instream uses are not defined as a use, then such a policy may become a stumbling block for those trying to purchase water for the protection of aquatic ecosystems. It is also unclear how the CNA will determine if irrigators are using their water use rights or not (Easter, 1996). Mexican Water Law provides for a strong regulatory approach to environmental protection. Water quality of non-agricultural discharges is stipulated in the water right, and the central water authority can invoke restrictions on water use in the event of damage to ecosystems or over-exploitation of natural water supplies (Easter and Hearne, 1995).

The Mexican Water Law permits markets to operate freely within ID's or WUA's, whilst at the same time allowing a government role in water planning and allocation. The responsibility of water management is decentralised to WUA's, who are important to the overall effectiveness of the water market. In many cases WUA's make infrastructural changes or effect changes in allocation rules to ensure buyers of water rights receive the additional supply. The ease with which separate WUA's can make these changes affects transaction costs of water sales (Easter and Hearne, 1994).

3.7 Thailand

In Thailand, market failures have been ignored with devastating effects on water security and efficiency of water use (Livingston, 1995). There are no formal institutional rules governing water allocation in Thailand, and in the absence of such rules, the informal rule of right by intrusion and capture applies (Randall, 1983; Johnson *et al*, 1990). Individual users simply obtain a "water right" by diverting as much water from the source as desired. However, such "rights" are inherently insecure since there are no constraints preventing additional diverters entering the system or preventing other existing diverters from extracting more water. The inevitable chaos and conflict resulting under such a system demands the development of institutional arrangements capable of dealing with these problems (Livingston, 1995: 207).

3.8 South Africa

Water scarcity in South Africa only emerged as an increasing problem from the early 1980's when the country's water economy entered into the mature phase. Water policy until 1997 was reliant largely on the following three points: (1) supply augmentation to arising water scarcity problems; (2) water allocation as a strictly government function; and (3) water resources management through the centrally controlled bureaucratic function by the Minister of the Department of Water Affairs and Forestry (DWAF) (Backeberg, 1994).

Until 1997, the system of surface water rights, comprising 90 percent of available water resources in South Africa, was based on riparian ownership. This linked water rights to land ownership or use. According to the 1956 Water Act there were no ownership rights, and decision-making powers regarding transfer of various types of rights rested with the Minister of the DWAF (Backeberg, 1994; Backeberg, 1997). Only since the mid 1980's, has a gradual relaxation of

central control over water management occurred. Amongst others, changes in water management have included the limited transfer of management responsibilities to farmers on state irrigation schemes, and the delegation of certain water management decision making powers to the DWAF officials in certain catchment areas (Backeberg, 1994).

Until 1992 the official public policy of the DWAF was that transfers of water use authorisations was a legislative function and market trades were not considered as a policy option. Section 63(6) of the 1956 Water Act (Government Gazette, 1956) made provision for water transfers subject to ministerial approval. This policy along with the preference for supply augmentation in times of shortages made it very difficult to obtain approval for water transfers. The authority to permit transfers in certain instances was only delegated to regional DWAF officials in 1989 (Government Notice 966 of 19 May 1989), pending the acceptance of an internal policy for this purpose. The formulation of this policy was concluded in 1993 (Department of Water Affairs and Forestry, 1993). As a result, no water market activity occurred prior to 1994 because of: (1) institutional failures stemming from the lack of private decision making powers over water management and water transfer issues; (2) high transaction costs arising from common property problems of riparian rights to water, and stringent legislative requirements for water transfers by the Minister; (3) water rights were linked to land ownership or use through riparian rights to water; and (4) preference for judicial and bureaucratic allocation of water rights was retained by the DWAF (Backeberg, 1994; Backeberg, 1997).

CHAPTER 4

RESEARCH METHODOLOGY

4.1 Collection of data

4.1.1 The study areas

Two separate irrigation areas were identified for inclusion in this study, namely the Lower Orange River from Boegoeberg to Augrabies in the Northern Cape Province, and the uMhlatuze River in the Nkwaleni Valley of KwaZulu-Natal. The Lower Orange Region was chosen for analysis since this area has one of the highest incidences of market trading of water rights among farmers in South Africa. Owing to the arid nature of this region, crop production is wholly reliant on irrigation water. The uMhlatuze River was identified as an area where farmers have periodic shortages of irrigation water. However, no market trading of water rights has as yet taken place in this area. Cultivation in the Nkwaleni Valley is heavily dependent on irrigation water, owing to high temperatures and evaporation rates experienced in the Valley, and severe conflict exists between irrigators and downstream industry for water during drought periods.

4.1.1.1 The Lower Orange River Catchment

Within the first study area, the study was conducted among irrigation farmers in the Boegoeberg and Kakamas Irrigation Schemes along the Orange River between Boegoeberg to Augrabies in the Northern Cape Province. The study area falls within the Lower Orange River catchment, and can be divided into two river reaches. The first stretches from Boegoeberg to Upington and incorporates the Boegoeberg Irrigation Scheme. The second stretches from Upington to Augrabies and incorporates the Kakamas Irrigation Scheme. The lower catchment areas of the

Orange River system are arid and characterised by extensive pan areas and internal drainage basins, low rainfall and high potential evaporation rates (McKenzie *et al*, 1991). The precipitation of the region declines from 400mm per annum in the East to less than 200mm per annum in the West. This precipitation is inconsistent and occurs as thunderstorms in late summer and early autumn. The coefficient of variation in seasonal rainfall is of the order of 50 percent, so that droughts are a common phenomenon. Soils in the region are generally characterised by shallow, stony and poorly developed clay and loam soils that are unsuitable for field crop production. Shrub Karoo vegetation predominates and has limited grazing potential (National Regional Development Programme, 1991). The Lower Orange region experiences the hottest conditions in South Africa and also the highest evaporation rates. At Goodhouse, temperatures of up to 47.8°C and a mean January maximum of 39.3°C have been recorded. Evaporation rates at Upington from a Class A pan of more than 600mm per month have been recorded in January, with a mean monthly evaporation rate of 311mm.

River Reach 1: Boegoeberg Dam to Upington

This river reach consists of areas irrigated by canal from the Boegoeberg dam and by river abstraction. The cropping programme of this river reach is presented in Table 4.1. There are currently 27 838 ha under irrigation along this river reach, and Table 4.1 shows that the high value grape crop accounts for over half the total production area, and is highly suited to the climatic conditions of the region. The remainder of the irrigated area is under field crop production, primarily cotton and wheat.

Table 4.1: Cropping Programme for the first river reach of the Lower Orange River from Boegoeberg to Upington: July 1995.

Crop	Area (ha)			
	Boegoeberg IA (canal)	Upington IA (canal)	Upington IA (river)	River abstraction
Lucerne	860	564	36	450
Maize	300	282	18	270
Wheat	1900	3317	212	360
Cotton	2200	3599	230	270
Grape	4200	7519	481	720
Vegetables	-	-	50	-
Total Crop Area	9460	15281	1027	2070

(Source: Sanderson and Donkin, 1995:5-32)

River Reach 2: Upington to Augrabies

This river reach consists of the Kakamas irrigation area which is irrigated by canal from the Neusberg weir, as well as river abstraction. There are currently 7068ha under irrigation along this river reach. The cropping pattern for this area presented in Table 4.2 shows that grape cultivation is again the predominant enterprise. Cotton and wheat are also grown, with small amounts of maize and lucerne.

Table 4.2: Cropping Programme for the second river reach of the Lower Orange River from Upington to Augrabies: July 1995.

Crop		
	Kakamas IA (canal) (ha)	River abstraction (ha)
Lucerne	58	42
Maize	58	42
Wheat	506	362
Cotton	564	404
Grape	3498	2502
Total Crop Area	4684	3352

(Source: Sanderson and Donkin, 1995: 5-36)

4.1.1.2 The Nkwaleni Valley

Within the second study area, the study was conducted among irrigation farmers of the Nkwaleni Irrigation Board (NIB) along the uMhlatuze River in Northern KwaZulu-Natal. The study area extends downstream from the Goedertrouw Dam to the confluence of the uMfuli and uMhlatuze Rivers. This area is semi-arid with mean annual precipitation and evaporation rates of 766mm and 1618mm respectively, making crop production in the area heavily dependent on irrigation water. Fertile alluvial soils derived from Beaufort and Middle Ecca are found in the Valley (KwaZulu Department of Agriculture and Forestry, 1990). A total of 6361 ha are irrigated in the Nkwaleni Valley. A total of approximately 3690 ha are irrigated by direct river extraction from the uMhlatuze River, while 2671 ha are irrigated by canal abstraction from an earth lined canal. Sugar and citrus are the predominant crops produced in the Valley. Sugar is produced on almost 50 percent of cultivated land, citrus on approximately 40 percent of the cultivated area, with the remainder primarily under banana production. The Nkwaleni Valley is an important citrus producing area of the country, providing in excess of 30 percent of South Africa's grapefruit crop

annually.

4.2 Sampling technique

One cross sectional survey sample was drawn from each of the two study areas respectively. In the Lower Orange Region, a list of farmers within the Boegoeberg and Kakamas Irrigation Schemes was obtained from the Department of Water Affairs and Forestry (DWAF) in Upington. The population was stratified so as to maximise the variation on the measured variables between strata. Three strata were identified. The first stratum, consisting of farmers in the study area who had bought water rights from other farmers is termed Buyers. Farmers who had sold water rights to other farmers, stratum two, represent the Sellers. Finally, stratum three, which encompasses farmers who have river water rights but have not engaged in any water market activity, represents the Control.

A cross sectional survey of a sample population of 54 farmers was conducted in November 1997. The sample population consisted of the entire population of 11 farmers who had purchased water rights from January 1995 to November 1997, a simple random sample of 25 farmers (40 percent) who had sold water rights, and the entire population of 18 farmers who had neither bought nor sold water rights. A questionnaire was completed by individual sample farmers during personal interviews conducted by the author. Nine, 21 and 14 usable questionnaires were obtained from strata one, two and three respectively. The non-usable questionnaires were due to missing values or the absenteeism of farmers during the survey period. As a consequence, the descriptive results that are presented in Chapter 6 represent the population parameter estimates for the Buyer and Control groups, while the descriptives for the Seller group represent the estimated population parameter estimates.

The larger number of sellers as opposed to buyers may be due to the fact that farmers were able to sell water rights to farmers in the Lower and Middle Orange Regions and secondly, because a few large farmers within the study area purchased water rights from multiple sellers to satisfy their water requirement.

Within the Nkwaleni Valley, the total population of 25 farmers comprising the NIB was surveyed during May 1998. A questionnaire was completed by individual farmers during personal interviews conducted by the author. Twenty-two usable questionnaires were obtained from the survey. Two groups were identified from the sample data. The first, potential Buyers, comprises of farmers who wanted to buy water rights, while the second, Non-Buyers, includes potential sellers of water rights and farmers who are neither potential buyers nor sellers of water rights.

4.3 Data analysis

A case study was conducted in each of the selected study areas. In the Lower Orange Region, the case study aimed to identify the institutional arrangements that have facilitated the development of market trading of water rights, the manner in which water rights are traded between farmers, and the overall operating system of the irrigation scheme. In the Nkwaleni Valley, the case study aimed to identify the institutional arrangements under which the irrigation scheme operates, and the potential for market trading of water rights. The outcome of these case studies are presented in Chapter 5.

In addition to computing descriptive statistics (presented in sections 6.1 and 7.1), discriminant models were estimated to distinguish, firstly, between farmers in the Lower Orange Region who bought or sold water rights, secondly, between farmers who bought or did not buy water rights,

and between farmers in the Nkwaleni Valley who either wanted to purchase water rights or did not want to purchase water rights. Variables considered in the models are discussed in section 4.3, and the results are presented in sections 6.4 and 7.3. This section provides a brief overview of the technique used.

4.3.1 Discriminant analysis

Discriminant analysis is concerned with the separation of two or more groups of individuals defined by the research situation (Klecka, 1975: 435; Manley, 1986: 13). The objective of discriminant analysis is to find a linear function which distinguishes between groups using discriminating variables, measuring characteristics on which the different groups are expected to differ (Manley, 1994: 107). In this analysis, the objective is to distinguish between Buyers and Sellers, Buyers and Non-Buyers of water rights on the Lower Orange River, as well as potential Buyers and Non-Buyers of water rights on the uMhlatuze River. Groups are forced to be as statistically different from one another by forming a weighted linear combination of the discriminating variables (Klecka, 1975: 435).

The discriminant function takes the form:

$$D_i = d_{i1}X_1 + d_{i2}X_2 + ... + d_{ij}X_j$$

where D_i is the discriminant function score

d_{ij} are the weighting coefficients

X_j are the standardised values of the discriminating variables

The standardised weighting coefficients (d_{ij}) show the relative contribution of its associated independent variable (X_j) to the linear function. Independent variables with relatively larger d_{ij} contribute the most to discrimination between the groups. Estimated discriminant scores for each group are compared to the mean for each classified group, and group membership is classified into the group with the most similar score (Klecka, 1980: 38).

Discriminant analysis is based on the assumptions that the within-groups covariance matrix is similar for all groups and the discriminating variables have a multivariate normal distribution. Violations of the assumptions do not render the analysis useless as this is a very robust technique. Provided the discriminant scores are univariately distributed for each group, the analysis is still reliable (Truett et al, 1967: 521).

The importance of a discriminant function can be gauged using the canonical correlation coefficient and Wilks' Lambda. The former is a measure of the association between the discriminant function and dummy variable defining group membership. The squared value of this coefficient is the proportion of variance in the discriminant function explained by the groups. Wilks' Lambda is an inverse measure of the discriminating power of the discriminant function. The smaller the value, the better the discriminating power (Klecka, 1975: 442).

4.4 The discriminant models

4.4.1 Variables considered in the discriminant model distinguishing between Buyers and Sellers of water rights along the Lower Orange River

Variables expected to distinguish between Buyers and Sellers of water rights along the Lower

Orange River are presented in Table 4.3

Table 4.3: Definition of variables used to discriminate between Buyers and Sellers of water rights along the Lower Orange River, (n=30).

Variable	Definition
Bght	= 1 for Buyers and 0 for Sellers.
Tblgp	= 1 if respondent grows table grapes, 0 otherwise.
Retrn	A proxy variable calculated as the ratio of farm gross margin from irrigation enterprises to total farm irrigation water requirement.
Iritec	= 1 if respondent uses micro and/or drip irrigation, 0 otherwise.
Incont	Ratio of actual irrigated area to total farm size.
Potdev	Ratio of undeveloped arable land to total potential arable area.
Usear1	= 1 if respondent is located in the River reach from Upington to Augrabies and uses 50 to 75 percent of his potential arable area, 0 otherwise.
Usear2	= 1 if respondent is located in the River reach from Upington to Augrabies and uses 25 to 50 percent of his potential arable area, 0 otherwise.
Usear3	= 1 if respondent is located in the River reach from Upington to Augrabies and uses 0 to 25 percent of his potential arable area, 0 otherwise.
Vine	=1 if respondent grows wine and/or raisin grapes, 0 otherwise.

Market proponents contend that water rights will move from lower to higher valued users through the market mechanism. It is thus hypothesised that "outer land" water rights will transfer from farmers who are not using the water rights and who grow primarily wine and raisin grapes (**Vine**), to farmers growing table grapes (**Tblgp**). The estimated return (**Retrn**) per unit of water applied is expected to be an important discriminant variable, with water rights gravitating to the most efficient users of water. Buyers are thus expected to have a higher return per unit of water applied than Sellers. In a water market both Buyers and Sellers have an incentive to adopt water-saving technology as water has an opportunity cost. Any transaction costs will drive a wedge between Buyers and Sellers of water rights, consequently forcing buyers to be more frugal users of water rights. Buyers would probably be making greater use of micro and drip irrigation

systems (**Iritec**) than Sellers. An institutional control variable, (**Incont**), measuring the ratio of actual irrigated area to total farm size was included in the analysis. The ratio of this control variable is influenced by the initial bureaucratic allocation of water rights to "inner" and "outer land", as well as the subsequent reallocation of water to undeveloped "outer land" through the market. No *a priori* expectation is associated with this variable. Buyers were expected to have proportionally more arable land than Sellers that could be developed for irrigation purposes (**Potdev**). The availability of high potential "outer land" is expected to be an important factor in influencing farmers' decisions regarding water trading. Buyers are hypothesised to be located in the River Reach from Upington to Augrabies and be using only a fraction of their available arable land (**Usear1, Usear2, and Usear3**).

4.4.2 Variables considered in the discriminant model distinguishing between Buyers and Non-Buyers of water rights along the Lower Orange River

The above set of discriminating variables was also used to differentiate between Buyers and Non-Buyers of water rights along the Lower Orange River and are presented in Table 4.4.

It was again hypothesised that water rights would move from lower to higher valued uses through the market mechanism. Buyers are consequently expected to be growing table grapes (**Tblgp**), while Non-Buyers are expected to be producers of wine or raisin grapes (**Vine**). Water rights are likely to gravitate to the most efficient users, thus Buyers were expected to have a higher return (**Retrn**) per unit of water applied than Non-Buyers. Buyers were again hypothesized to be making greater use of micro and drip irrigation systems (**Iritec**), and have proportionally more arable land that could be developed for irrigation purposes (**Potdev**) than Non-Buyers. The institutional control variable, (**Incont**), measuring the ratio of actual irrigated area to total farm

size was included in the analysis. No *a priori* expectation was again associated with this variable. The availability of high potential "outer land" was expected to be an important factor in influencing farmers' decisions regarding water trading. Buyers were hypothesised to be located in the River Reach from Upington to Augrabies and be using only a fraction of their available arable land (**Usear1, Usear2, and Usear3**).

Table 4.4: Definition of variables used to discriminate between Buyers and Non-Buyers of water rights along the Lower Orange River, (n=44).

Variable	Definition
Bght	=1 if respondent bought water rights, 0 otherwise.
Retrn	A proxy variable calculated as the ratio of farm gross margin from irrigation enterprises to total farm irrigation water requirement.
Potdev	Ratio of undeveloped arable land to total potential arable area.
Tblgp	=1 if respondent grows table grapes, 0 otherwise.
Iritec	=1 if respondent uses micro and/or drip irrigation, 0 otherwise
Incont	Ratio of actual irrigated area to total farm size.
Usear1	=1 if respondent is located in the River Reach from Upington to Augrabies and uses 50 to 75 percent of his total potential arable land, 0 otherwise.
Usear2	=1 if respondent is located in the River Reach from Upington to Augrabies and uses 25 to 50 percent of his total potential arable land, 0 otherwise.
Usear3	=1 if respondent is located in the River Reach from Upington to Augrabies and uses 0 to 25 percent of his total potential arable land, 0 otherwise.
Vine	=1 if respondent grows wine and/or raisin grapes, 0 otherwise.

4.4.3 Variables considered in the discriminant model distinguishing between potential Buyers and Non-Buyers of water rights in the Nkwaleni Valley

The set of discriminating variables expected to differentiate between Buyers and Non-Buyers of water rights in the Nkwaleni Valley are presented in Table 4.5.

Table 4.5: *Definition of the variables used to discriminate between potential Buyers and Non-Buyers of water rights in the Nkwaleni Valley, (n=22).*

Variable	Definition
Bght	=1 for potential Buyers and 0 for Non-Buyers.
Sugr	=1 if respondent grows sugar cane, 0 otherwise.
Citrs	=1 if respondent grows citrus, 0 otherwise.
Potdev	Ratio of undeveloped arable land to total potential arable area.
Incont	Ratio of actual irrigated area to total farm size.
Iritec	Ratio of cultivated land under drip and/or micro irrigation.
Suff	=1 if respondent does not have sufficient water to irrigate all potential arable land, 0 otherwise.

Potential Buyers of water rights are expected to be those farmers who require additional water for their farm operations or to expand production on previously unscheduled land. An institutional control variable, (**Incont**), measuring the ratio of actual irrigated area to total farm size was included in the analysis. No *a priori* expectation is associated with this variable as the ratio of this control variable is ultimately influenced by the historic bureaucratic allocation of water rights. Potential Buyers of water rights were hypothesized to have proportionally more arable land that could be developed for irrigation purposes than Non-Buyers (**Potdev**). Buyers were also hypothesised to be those farmers who had adopted water-saving micro or drip irrigation systems (**Iritec**) as a response to irrigation water scarcity. Buyers were also expected to be those farmers who did not have sufficient water rights (**Suff**) to irrigate all of their available arable land. Crop choice was also expected to be an important variable in determining whether a farmer wanted to buy water rights or not.

4.5 The Pongola River

A third region that was identified as a potential study area for incorporation in this study

extended along the Pongola River from the Pongola Irrigation Settlement at Pongola Town, downstream to the Jozini Dam in Northern KwaZulu-Natal. This region was chosen for analysis since irrigators along the Pongola River generally experience severe seasonal water shortages during the winter months. The region experiences relatively low rainfall and high temperature and evaporation rates. Mean annual rainfall and evaporation rates at Pongola measure 674mm and 1699mm respectively, while the area experiences a mean summer temperature of 28°C and a winter mean of 16°C. Soils in the study area are primarily apedal, with irrigable Hutton and Oakleaf soils found on the inside bends of the river (KwaZulu Department of Agriculture and Forestry, 1990). This area was also chosen for analysis since Pongola farmers were responsible for the initiative to construct the Paris Dam, to improve water supply and stability throughout the year in response to water scarcity in the face of growing agricultural and economic development in the region.

When complete, the Paris Dam will stabilise irrigation supplies to Pongola's existing 170 sugar cane growers, provide drinking water for 250000 nearby rural inhabitants, and provide direct impetus for the development of sugar production on 700 ha of land by previously disadvantaged small-scale growers. The total scheme includes the construction of (a) the dam wall and necessary infrastructure, (b) canal infrastructure to carry water to the irrigators, ans (c) pipelines to carry drinking water to the rural communities. The total cost of R190 million will be shared among the government, the Pongola cane growers, and the Illovo Sugar Mill at Pongola.

A list of irrigators along the Pongola River stretching from Pongola to the Jozini Dam was obtained from Impala Irrigation Board (IIB). The population was stratified so as to maximise the variation between strata. Two strata were identified. The first stratum, consists of irrigators

drawing water exclusively from the existing canal infrastructure of the IIB, while the second stratum includes irrigators withdrawing water directly from the Pongola River. A sample population of 45 farmers was drawn from the total population of farmers, and included a simple random sample of 20 of the 116 canal irrigators, and the total population of 25 farmers extracting water directly from the Pongola River.

A cross sectional survey of the sample population of 45 farmers was initiated by the author in October 1997, using a questionnaire to be completed by individual sample farmers during personal interviews. Interviews with eight individual canal irrigators and two river extractors were initially undertaken. Eight usable questionnaires were returned from the canal irrigators, however, the two river extractors refused to participate in the research. As a result of intervention in the survey at this stage by the IIB, and at the request of the IIB, the survey was terminated.

At the time of the survey, an undertaking to include all irrigators downstream of Pongola Town into the IIB was in the process of being initiated. This required the incorporation of all river extractors, previously independent of IIB control, to fall under the management of the IIB along with the existing canal irrigators of the IIB. The resulting institutional structure would enable the IIB to effectively allocate, monitor, and charge all users for irrigation water, as well as collect a levy imposed on all cane producers in the area to finance their share of the construction costs of the Paris Dam.

River extractors, operating independently of IIB control until such time, had enjoyed unmonitored use of their riparian water rights. River irrigators were accordingly not charged for

any water extracted from the Pongola River, however, they did contribute an annual fee towards the construction of the Paris Dam. As a result, river extractors were highly suspicious of the intentions of this study, generating considerable opposition to particular questions included in the survey questionnaire relating to their legal water right, monitoring of water extraction, water pricing, and land values. Until such time as the water rights and prices of river extractors have been completely defined, and effective monitoring of river water extraction implemented, opposition to this study remains likely.

From the eight questionnaires completed by the canal irrigation water extractors, the following information was extracted: All eight farmers were producing sugar cane exclusively. From this evidence it appears that the relative crop profitability of any potential Buyer or Seller would be similar. The region generally receives sufficient rainfall to support dryland sugar cropping, although such an undertaking would be highly risky. As a result water is not a critical factor of production, and irrigators are able to receive relatively favourable yields in dry years owing to the higher sucrose content of the cane. None of the eight farmers wanted to sell or rent out water rights at the time of the survey. All stated they were using their entire water right allocation in their farming operations. Similarly, none of the respondents stated that they wanted to purchase or rent water rights at the time of the survey. In response to any future water surplus experienced by the farm, no farmers were willing to sell or rent out any potentially unused water. Similarly, in response to any future water shortage for their farm operations, only one respondent reported that he would be willing to purchase water rights to secure a higher water supply reliability. However, an additional four respondents stated that they would be willing to rent water rights.

All eight survey respondents believed that a water market would not function along the Pongola River under the *status quo* or following the completion of the Paris Dam. Respondents believed

that no tradable margin of water exists at present as farmers presently use their entire water allocation in irrigating their scheduled area. In addition, almost all irrigable land is under production, eliminating the possibility of purchasing or renting water to develop previously uncultivated land with no water rights. In response to seasonal water shortages during the winter months, farmers placed great faith in the construction of the Paris Dam. All eight survey respondents believed that the Paris Dam would satisfy all their future water needs by improving water availability during the winter months, thus providing an adequate supply of water with high reliability throughout the year. The stability in water supply brought about by the Paris Dam is expected to increase average cane production from 97 tons per ha to more than 104 tons per ha. Since all irrigators are committed to the supply side response of augmenting water supply through the construction of the Paris Dam, to which they are contributing monetarily, and from which they expect increased water supply and stability, and crop profitability, little support for a water market concept existed among such farmers. From the limited analysis of irrigation farmers it appears that no demand for water market development exists since there is no perceived scarcity of water among the Pongola sugar growers following the construction of the Paris Dam.

CHAPTER 5

AN ANALYSIS OF WATER MARKET ALLOCATION IN THE STUDY AREAS

5.1 Water rights trading along the Lower Orange River

5.1.1 An overview of water rights trading along the Lower Orange River

Farms within the Lower Orange River irrigation scheme consist generally of "inner land" and "outer land". "Inner land" is arable land between the river and the canal whose area was scheduled after the completion of the canal in the early 1930's and in terms of the 1956 Water Act. "Inner land" is thus coupled to a canal water right. "Outer land" is land situated adjacent to, but inland from the canal. This land did not initially have a water right coupled to it, and remained unscheduled until 1977 when determination of the basic water right was completed (Department of Water Affairs and Forestry, 1997a).

Through Government Notice 2064 of 7 October 1977 (Government Gazette, 1977), the maximum extent of land comprised in any piece of land in the Lower Orange River Government Water Control Area which could be beneficially irrigated was determined to be either (a) 30 ha per owner, (b) the extent of land effectively irrigated on any property at the time of this notice up to 80 percent of the area of such a property which was suitable for irrigation, or (c) the extent of any piece of land scheduled in terms of the 1956 Water Act.

Basic determination meant that each riparian property within the Lower Orange River Government Water Control Area was allocated water rights for 30 ha, provided the riparian land

was situated within the limits of a distance of 2000 metres horizontally from the bank, and a height of 60 metres vertically above the bed of the Orange River, and which in the opinion of the Minister of Water Affairs was suitable for the production of agricultural crops under irrigation.. The maximum quantity of water provided annually for the irrigation each hectare of land was also determined to be 15000m^3 of water (Government Gazette, 1977).

The maximum area for basic determination of 30 ha included the "inner land" area irrigated from the canal. Any property with an irrigable "inner land" area smaller than the basic determination of 30 ha was entitled to a river water right for "outer land" comprising the difference in area, provided it met with the above provisions (Department of Water Affairs and Forestry, 1997a). An allocation made in terms of this determination was based on direct abstraction from the Orange River (Government Gazette, 1981). Thus "outer land" incorporated in the basic water right was allocated a river water right. In this way a farmer irrigating 15 ha of "inner land" from the canal could apply to the Department of Water Affairs and Forestry (DWAF) to have a river water right of no more than 15 ha incorporated into his "outer land" property provided it was determined that he held 15 ha of irrigable "outer land" that satisfied the provisions as set down by the Minister (Department of Water Affairs and Forestry, 1997a). In addition, farmers were given the opportunity to buy rights of surplus water after the completion of the then H. F. Verwoerd dam in 1977, over and above their water right allocation in terms of the irrigation scheme.

From 23 November 1979, the DWAF determined that the maximum extent of land which could be irrigated to be 30 ha per owner of one or more pieces of land, provided that it was determined that the State was the separate owner of the land in terms of the 1966 Agricultural Credit Act or

the 1961 State Land Disposal Act (Government Gazette, 1979). Thus any riparian "outer land" that was purchased from the state was entitled to a basic water right quota from the river of 30 ha in its entirety, provided it met with the provisions as set down by the Minister (Department of Water Affairs and Forestry, 1997a).

In 1981, the maximum extent of land that could be irrigated was amended to four times the basic determination. Such an allocation was made for the balance between the standard determination and the maximum area of land that could be irrigated in terms of this amendment. Each allocation, however, could not exceed 80 percent of the irrigation potential of the property as determined by the Department of Agriculture. These allocations were also based on direct abstraction from the Orange River (ie: river water rights) (Government Gazette, 1981, Government Gazette 1985). As a result, the bulk of irrigable "outer land" in the Lower Orange River Government Irrigation Schemes received a river water right in this manner. However, some of these water rights lay largely unused as a few farmers found it uneconomic to develop their "outer land" because of the unsuitability of this land for cropping enterprises. This situation generated a bank of unused water rights that expedited the subsequent development of water rights sales from low to high potential "outer land" owners (Department of Water Affairs and Forestry, 1997a). Chamberlain (1998) estimates that between 15 and 20 percent of "outer land" water rights were unused prior to the development of the market.

Legal sanction of certain water right transfers between farmers came by way of Government Notice 966 of 19 May 1989, whereby the Minister delegated to certain officials the authority to permit water allocated to one piece of land, to be used on another piece of land, in circumstances where a policy had been determined by the Minister to handle such applications. This policy was

only formulated and issued to the regional DWAF offices in March 1993. This enabled water to be temporarily or permanently transferred from one property to another, or to the property of another farmer by means of lease agreement or sale of the water rights. All such transfers were subject to certain provisos that had to be satisfied in the application process. In the consideration of applications for the permanent transfer of water rights from one owner's land to another, the following conditions had to be adhered to: (a) It had to be technically possible to supply water to the property to which the scheduling was to be transferred, and all costs, if any, inherent in moving the point of supply had to be borne by the buyer. (b) There had to be sufficient irrigable land on the property to which the water was being transferred. (c) The Regional DWAF Office, Department of Agricultural Development, and local extension officers had to support the transfer from an agricultural perspective. (d) The property from which water rights were transferred could not be encumbered by the Land Bank, or no objection to the permanent transfer of the water indicated by the Bank (Department of Water Affairs and Forestry, 1993).

It appears that this policy was not implemented in the same way by the Deputy Chief Engineers of the regional DWAF offices and a more pragmatic approach was followed by some. This explains firstly why water right transfers only began in 1994, and secondly why water transfers occurred more in some catchment areas than in others, even though water scarcity existed and more profitable cropping alternatives existed (Backeberg, 1998).

Water transactions in the study area were first initiated in late 1994, and were driven by the desire of large scale table grape producers to expand their operations. These farmers typically possessed considerably more high potential "outer land" suitable for cultivation than their basic water right encompassed, generating a gradual escalation in demand for water rights for this land. These

observations are consistent with Schmid's (1972) assessment that in any market orientated economic activity, entrepreneurial initiative and identification of new opportunities or underutilised resources is the driving force in market trade of rights. Increasing water demand culminated in the DWAF notifying farmers within the irrigation scheme of their opportunity to firstly, incorporate a basic water right into their "outer land" and develop this land for irrigation purposes, and secondly, to purchase any additional water rights for irrigable "outer land" from other farmers with unused water rights. Until this time, most farmers with unused "outer land" water rights were unaware of their ability to sell water rights. A lack of buyers and limited opportunity to expand irrigation rendered a water right with negligible opportunity cost. Following the subsequent interest displayed by table grape farmers in purchasing "outer land" water rights, and the indication by the DWAF of farmers' ability to sell water rights, the unused "outer land" water rights acquired value and fostered an incentive to these farmers to sell. Facilitating water rights sales between farmers, represented an internal shift in policy by the DWAF to reallocate existing but unused water rights. Such a change aimed to encourage economic growth within the irrigation scheme without the need for new claims to be made on the river.

5.1.2 Water rights allocations along the Lower Orange River

The quantity of the annual basic water right, specified as a certain volume per ha per year, was set by the DWAF according to hydrological conditions and anticipated water demand for the coming water year. Farmers paid an annual levy for their water rights depending on whether the water was extracted from the canal or river, and whether the water was an original allotment or surplus water purchased from the DWAF. For the 1997 water year, farmers paid R450.45 per ha for canal water and R24.50 per ha for river water. Farmers with surplus water rights paid the

annual levy of R80.82 per ha in the 1997 water year, as well as having paid the once-off charge to purchase the surplus water rights from the DWAF. The purchase price of surplus water obtained from the DWAF as determined in the Government Gazette No. 13297 (1991) was R550/ha for any area up to 60 ha; R690/ha for any area between 60 and 90 ha; and R830/ha for any area greater than 90 ha. River water comprised approximately 26 percent of total irrigation water supply in the Boegoeberg and Kakamas Irrigation Schemes, while canal water comprised approximately 74 percent (Department of Water Affairs and Forestry, 1997a).

Individual farmer's river water rights had a high implied reliability. A river water right of 15000m^3/ha/year was effectively declared in each year since river water rights were initially allocated in 1977, despite the variability in river flow. Annual river flows at Upington from 1943-1996 varied from 1413 to 28944 million m^3, with a mean of 8515.57 million m^3 and standard deviation of 5751.61 million m^3, as shown in Figure 1 below.

Only in 1993 was a restriction placed on water extraction, with a 50 percent reduction in water rights for the first four months of the water year due to severe drought. This was restored to its original value for the remainder of the year after favourable rains (Department of Water Affairs and Forestry, 1997a).

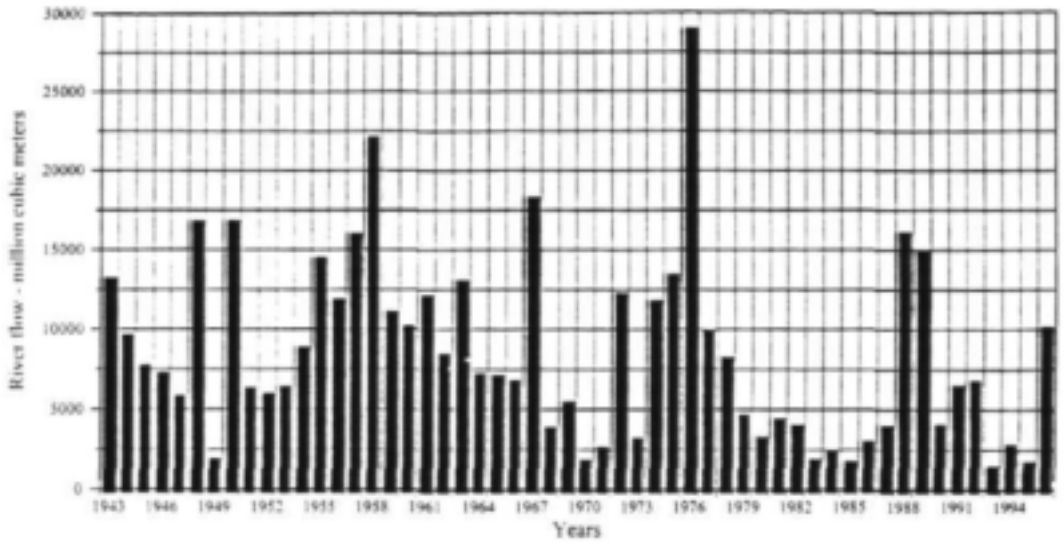

Figure 1. Annual river flow of the Orange River at Upington: 1943-1996

(Source: Department of Water Affairs and Forestry, 1997b).

5.1.3 Transfers of "outer land" water rights along the Lower Orange River

Development of limited water market activity was achieved within a centralised non-market water allocation system that was highly controlled and regulated by the DWAF. Trading of water rights emerged despite significant bureaucratic regulation imparted on the water market. While some regulation of water trades is desirable within the context of a water market, much of the regulation governing transfers of "outer land" water rights along the Lower Orange River serves to increase transaction costs unnecessarily, as will be explained below.

The transfer process as specified by the DWAF was clearly defined and well understood by potential market participants. Transfer of water rights was facilitated by administrative procedure that was guided heavily by bureaucratic regulation, since it required proving any land for which an application had been filed to incorporate a basic water right quota, or for which an application had been filed to purchase water rights, was suitable to irrigation. This involved a bureaucratic

process in which farmers were required to obtain a cultivation certificate from an appointed soil scientist from the Department of Agriculture, serving as proof as to the extent of their property's "outer land" that was irrigable; within 2km of the river; and not higher than 60m than the river.

To incorporate a water right into his "outer land", a farmer had to file an application with the regional DWAF office. An evaluation of the irrigability of the candidate land, according to the criteria laid down by the Minister mentioned previously, would be carried out at a cost to the farmer, by the appointed soil scientist. The farmer would be issued with a "cultivation" certificate, serving as proof of the extent of his land for which he was applying for water rights that was suitable for irrigation. The soil scientist's report, together with the application for incorporation of the basic water right quota, would be appraised by the DWAF head office in Pretoria. Following approval of the application, a water right coupled to the land area specified by the "cultivation" certificate, up to a maximum of 30 ha, would be granted to the farmer by the regional DWAF office.

Farmers with water rights for "outer land" that they chose not to develop, could indicate to the DWAF their intention to sell the water rights, while farmers requiring additional water rights to develop land over and above that incorporated in the basic water right, could indicate their intention to buy. This information was passed on by the DWAF to potential buyers/sellers. In most instances, sellers actively sought out potential buyers for their water rights. A potential buyer would have to obtain a "cultivation" certificate for the land for which he intended to buy water rights. Both buyer and seller were required to file a joint application, with the services of a lawyer at a cost to the buyer, with the regional DWAF office to have the water rights permanently transferred from the seller's property to that of the buyer. The application was

submitted to the DWAF head office in Pretoria for consideration and approval. Following approval to transfer the water, the transaction would be concluded by the regional DWAF office, and the transfer of the water right formally registered. Most transfers took three to six months, with certain transactions lasting up to one year in duration.

Water transactions were achieved at lower cost to Sellers than Buyers. Sellers faced transaction costs of R200 to R600 per transaction, stemming primarily from to the cost of hiring a soil scientist to assess the "outer land" for which they were applying to incorporate a basic water right, as well as the effort in completing and filing the transfer application. Buyers of water rights faced higher transaction costs arising primarily from the legal cost involved in the application and transfer process, as well as the cost of a soil scientist to assess the land for which they were applying to buy water rights, and the effort in filing the application. Farmers involved in multiple water rights purchases frequently made use of a broker to direct their water rights acquisitions. Broker fees were generally charged as a percentage of purchase price for each transaction. Transaction costs faced by buyers generally ran into a few thousand Rands (R2000 to R6000) per farm. In addition the onus was on the buyer to bear any infrastructure costs needed in transferring the water to the future point of use. This generally involved the cost of electricity, pumps and pipes, and represented a significant investment on the part of the buyer.

Transfers of "outer land" water rights within the Lower Orange River were for the full quantity of the water right quota. This is in contrast to transfers in the Western US where each transfer requires the determination of the consumptive use or return flow to assure the rights of other water users (Michelsen, 1994). Since no return flow had been calculated and implemented for water rights within the Lower Orange irrigation scheme, there was no onus on buyer or seller to

determine the effects of the transfer on the other water users. This enabled transfers to be achieved through administrative procedure with no lengthy adjudication processes, to ensure there were no adverse impacts associated with each particular transfer. Transfers were however constrained by the rules for the approval of transfer as laid down by the Minister, essentially limiting water transactions between farmers with irrigable "outer land".

Water trading activity between farmers initially proceeded fairly cautiously since the onset of trading in late 1994, but rapidly gained momentum with most transfers occurring during 1996. However, the frequency of transfers tapered off significantly towards the end of the latter year due to two factors. Firstly, most farmers with unused "outer land" water rights had by this time alienated these rights, and secondly, the proposed new Water Law created much uncertainty among farmers about the security of water rights, profoundly stifling market participation (Burger, 1997).

5.2 Water allocation in the Nkwaleni Valley

5.2.1 The institutional arrangements governing water allocation in the Nkwaleni Valley

Initial allocations of water rights in the Nkwaleni Valley were also dependent on land characteristics of individual farms. "Inner land"* water rights of 50 ha per farm were allocated in the initial settlement of the irrigation scheme in 1933. Each individual settlement consisted of 50 ha of "inner land", and approximately 170 ha dry land ("outer land"). The scheduling of the total irrigable area in the Nkwaleni Valley was concluded in 1994, following the declaration

* Arable land between the river and the canal, that was allocated a canal water right

of the Nkwaleni Irrigation District as a government water control area by the DWAF in 1977. Individual farmers were allocated a water right permit for up to 80 percent of their potential irrigable land, consisting generally of both a canal and river water right. In accordance with the issue of permits for scheduled land, riparian land was allocated a water right for 20 ha plus 30 percent of the potential irrigable area, provided it was within 2km of the river and not higher than 60m than the river.

Water allocation within the Nkwaleni Irrigation Board (NIB) is highly regulated and well controlled. Farmers are required to place a water order with the water bailiff of the NIB each Monday morning, for a certain volume of canal and/or river water to be extracted from a specified pump during the following week. DWAF at Goedertrouw Dam would accordingly release the specified volume of water into the canal and river in the following week. All pump meters are calibrated to measure electricity units used in pumping water from the source. A conversion factor is used to determine the volume of water and pro rata charge for the water extracted. Monthly monitoring of individual pump meters is undertaken by the water bailiff to ensure that ordered water and actual water use is equivalent, and that water allocations are not being exceeded. Most canal water is delivered through fixed flow dividers that apportion water on a fixed volume throughout the year.

After rain has fallen in the Valley, the canal is closed by the water bailiff and river water extractors are able to cancel their weekly water orders. This situation prevails until irrigators once again require irrigation water. Following good rains, water overflowing the Goedertrouw Dam, and entering the system from downstream inlets, is deemed to be extra water by the DWAF. This allows farmers to cancel weekly water orders and extract as much extra water as necessary. Extra

water extracted from the river is not deducted from individual farmers annual water allocations. However, it is metered and each farmer is required to pay the cost thereof. Some farmers have constructed storage dams to improve their flexibility of water use and water supply availability throughout the year. Such farmers are able to take advantage of lower cost pumping times and store this water for irrigation.

5.2.2 Water rights allocations along the uMhlatuze River

The volume of the annual water right allocation is set by the DWAF at the onset of each water year, according to hydrological conditions and expected demand for the water year. Historically, an annual water levy was charged to irrigation farmers for the full water right allocation, regardless of whether the entire water allocation was extracted by the individual farmer. However, an agreement reached between the DWAF and NIB in 1996, gave farmers the opportunity to pay a pro rata levy for each cubic metre of water used, up to their maximum water allocation, for a period of six years. This policy attempts to encourage irrigators to use their water rights more efficiently, generating water savings that can be temporarily reallocated to industry. Farmers paid R135/12600m^3/ha for their full water allocation of both canal and river water in 1997. Canal irrigators paid an additional canal maintenance fee in the region of R34/ha for the 1997 water year. These levies appear to be relatively small in comparison to development costs of arable land and potential returns from irrigation.

Water rights on the uMhlatuze River have a low implied-reliability as a result of variability in river flows. River flow measured downstream at Goedertrouw from 1980-1997 varied from 18.86 to 179.92 million m^3, with a mean of 89.30 and standard deviation of 49.84 million m^3, as shown in Figure 2 below.

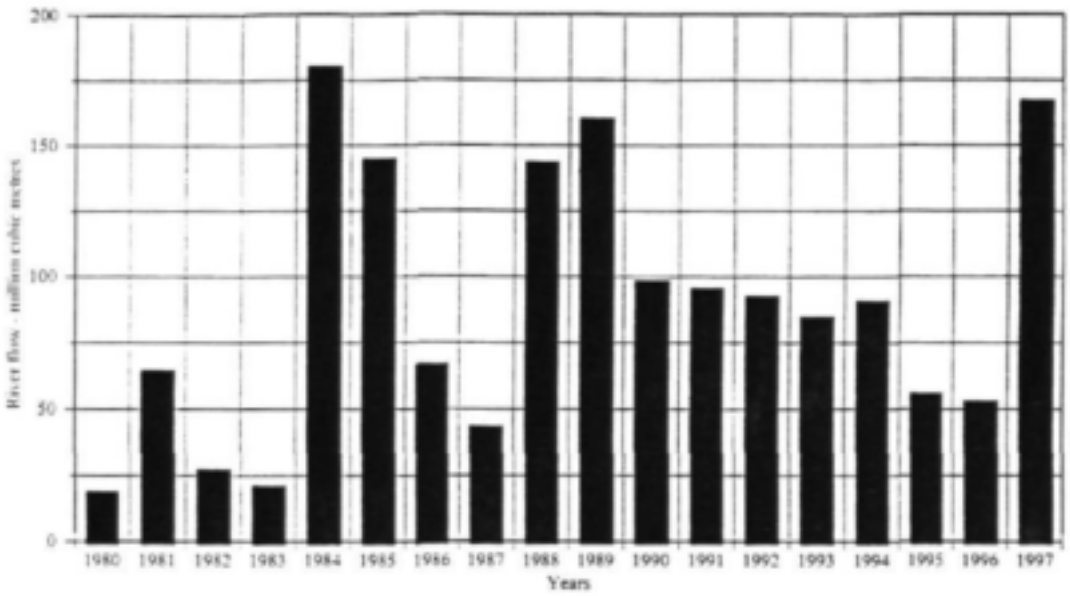

Figure 2: Annual river flow of the uMhlatuze River at Goedertrouw: 1980-1997

(Source: Department of Water Affairs and Forestry, 1998a).

Although a water right allocation of 12600m^3/ha was declared for both canal and river rights since the area was declared a water control area in 1977, these rights are essentially highly variable, since restrictions on water extraction have frequently been enforced. Restrictions take on one of three phases. The first phase involves a 50 percent reduction in irrigation water allocations. Phase two results in a 70 percent reduction in irrigation water allocations and a five percent reduction in the downstream industrial water allocations of Empangeni and Richards Bay. The final phase of restrictions for severe drought conditions is a 90 percent reduction in irrigation water allocations and a 10 percent reduction in industrial water allocations. Restrictions that have not gone further than phase one have occurred in four years over the past 18 year period. Restrictions that have progressed to phase two have been invoked three times over the same period, while phase three restrictions have been implemented in two years. As a result, irrigation water along the uMhlatuze River exhibits both low reliability and priority.

CHAPTER 6

RESEARCH RESULTS: THE LOWER ORANGE RIVER

6.1 Characteristics of respondents

Eight of the nine Buyers were located in the second river reach from Upington to Augrabies, while all 21 Sellers and all but one of the Control farmers were located in the first reach from Boegoeberg to Upington. Table 6.1 summarises the average farm size characteristics of the three strata. Buyers generally have larger farms with more irrigated land than the other two strata, as well as proportionally more arable land that can be developed for irrigation purposes (67 percent) than either Sellers (25 percent) or Control farmers (24 percent).

Table 6.1: Farm characteristics of survey farmers in the Lower Orange Region: November 1997.

	Average farm area	Average arable area	Average actual irrigated area
Buyers (n=9)	1280.5 ha	449.2 ha	166.5 ha
Sellers (n=21)	132.0 ha	70.7 ha	52.7 ha
Control (n=14)	87.5 ha	45.6 ha	40.5 ha

A cropping programme summary of the survey farmers is presented in Table 6.2. About 64 percent of Buyers' irrigated land is under table grapes, 16.5 percent under raisin and wine grapes, and 18.2 percent under horticultural crops (date, vegetable, melon and citrus). The Sellers and Control farmers are more diversified, with more than 50 percent of their irrigated land under field crops (wheat, maize, cotton, and lucerne) and the remainder under raisin and wine grapes.

Table 6.2: Irrigation land use percentages of survey farmers in the Lower Orange Region: November 1997.

	Percentage Irrigation Land Use				
	Table Grapes	Raisins & Wine Grapes	Field Crops	Horticultural Crops	Total
Buyers (n=9)	64.0	16.5	1.3	18.2	100.0
Sellers (n=21)	0.3	44.0	54.0	1.7	100.0
Control (n=14)	2.0	36.0	56.0	6.0	100.0

Significant differences are also apparent in the irrigation systems used by the three groups of farmers. A summary of irrigation system use in Table 6.3 shows that Sellers and Control farmers employ flood irrigation systems exclusively, while Buyers use primarily micro systems (54 percent), and to a lesser degree flood systems (30 percent) and drip systems (16 percent).

Table 6.3: Irrigation system use percentages of survey farmers in the Lower Orange Region: November 1997.

	Irrigation system use percentages				
	Micro	Drip	Flood	Macro	Total
Buyers (n=9)	54.0	16.0	30.0	-	100.0
Sellers (n=21)	0.5	-	96.0	3.5	100.0
Control (n=14)	3.0	3.0	94.0	-	100.0

Four Control farmers were not using the "outer land" for which they had water rights. The remaining Control farmers were using their "outer land" chiefly for grazing, and the irrigation of small parcels of vineyards or field crops. This information is presented in Table 6.4.

Table 6.4: "Outer land" water rights use of Control farmers along the Lower Orange River: November 1997, (n=14).

Crop	Hectares	Crop	Hectares
Table Grapes	10	Wheat	24
Raisins & Wine Grapes	35	Maize	24
Cotton	14		

6.2 Prices and values for "outer land" water rights on the Lower Orange River

Descriptive information summarising the comparative transaction details of the sample Buyers and Sellers of water rights, are presented in Table 6.5 below. Table 6.5 shows that all water trades were permanent in nature. No temporary water trades had taken place. Sample Buyers of water rights entered into more contracts per individual (4.33) than the sample Sellers of water rights (1.19), and exhibited a greater range in the number of contracts per individual (13) as opposed to the Sellers (1). The lower number of water contracts per Seller is borne out by the fact that Sellers of water rights tended to sell their "outer land" water right or portfolio of "outer land" water rights to a single Buyer, whereas the larger Buyers invariably had to purchase water rights from a number of Sellers, all selling a fairly uniform volume of water. This latter point is emphasised in Table 6.5 by the fact that the average volume of water traded per transaction by sample Buyers (413550m^3) is only slightly higher than that of the sample Sellers (353850m^3). However, the sample Buyers of water rights traded a greater volume of water (1792050m^3) per individual than Sellers (421350m^3), and exhibited a greater range in the volume traded per individual (6642000m^3) than the sample Sellers (1350000m^3).

Table 6.5 shows that the purchase price of "outer land" water rights for Buyers ranged from R800 to R5000/15000m^3, while the sale price for Sellers ranged from R3000 to R4600/15000m^3.

Table 6.5: Comparative descriptive statistics of water trades by sample Buyers and Sellers of water rights in the Lower Orange River, November 1997.

BUYERS (n=9)	Min	Max	Mean	Sum	Std dev	Nature
No. of water contracts per Buyer	1.00	14.00	4.33	39.00	5.27	Permanent sale
Water volume traded per Buyer	150000 m^3	6792000 m^3	1792050 m^3	16128000 m^3	2471700	"
Water volume traded per transaction	114000 m^3	966000 m^3	413550 m^3	-	258900	"
Ave purchase price per ha per transaction	R800.00/ha	R5000.00/ha	R3386.20/ha	-	755.44	"
Total ave purchase price per ha	-	-	R3296.04/ha	-	-	"
SELLERS (n=21)	**Min**	**Max**	**Mean**	**Sum**	**Std dev**	**Nature**
No. of water contracts per Seller	1.00	2.00	1.19	25.00	0.40	Permanent sale
Water volume traded per Seller	150000 m^3	1500000 m^3	421350 m^3	8847000 m^3	302250	"
Water volume traded per transaction	144000 m^3	1500000 m^3	353850 m^3	-	289950	"
Ave sale price per ha per transaction	R3000.00/ha	R4600.00/ha	R3440.00/ha	-	473.46	"
Total ave sale price per ha	-	-	R3529.93/ha	-	-	"

Table 6.6: Combined descriptive statistics of water trades by sample Buyers and Sellers of water rights in the Lower Orange River, November 1997.

BUYERS + SELLERS (n=30)	Min	Max	Mean	Sum	Std dev	Nature
No. of water contracts per individual	1.00	14.00	2.13	64.00	3.15	Permanent sale
Water volume traded per individual	150000 m^3	6792000 m^3	832500 m^3	24975000 m^3	1468350	"
Water volume traded per transaction	114000 m^3	1500000 m^3	390300 m^3	-	270750	"
Ave transaction price per ha per transaction	R800.00/ha	R5000.00/ha	R3407.21/ha	-	655.99	"
Total ave transaction price per ha	-	-	R3378.89/ha	-	-	"

Finally, from Table 6.5 the mean purchase price paid by Buyers was R3296.04/15000m^3, while the mean sale price received by Sellers of water rights was R3529.93/15000m^3.

Table 6.6 above summarises the transaction details of the sample Buyers and Sellers of water rights in aggregate. Table 6.6 shows that volume traded per individual ranged from 150000 m^3 to 6792000 m^3, with a mean of 832500 m^3. Water volume traded per transaction ranged from 114000 m^3 to 1500000 m^3, with a mean of 390300 m^3. Finally, the sale price for "outer land" water rights ranged from R800 to R5000/15000m^3 [b], with a mean sale price of R3378.89/15000m^3. A cursory examination of land prices within the study area found that dry land suitable for irrigation and for which a farmer could obtain water rights sold for R1000 to R2000 per ha, while undeveloped arable land coupled to a water right generally sold for R6000 to R10000 per ha. This information confirms that the trading value of "outer land" water rights is approximately R4000[c] per ha.

If the mid-value of undeveloped arable land with a water right is considered to be R8000 (mid-point between R6000 and R10000), and the mid-value of irrigable dryland is considered to be R1500 (mid-point between R1000 and R2000), then it can be seen that the sum of the value of irrigable dryland and the value of a water right (R1500 + R3400 = R4900) is considerably lower

[b] The overwhelming majority of water rights sold for R3000/15000m^3 or R3500/15000m^3. The variation in market prices may be the result of market information imperfection for the R5000 transfer, while the R800 transfer may have been the result of a family transfer.

[c] This figure was calculated as R6000 - R2000 = R4000.

than the value of the undeveloped arable land with a water right. From this it can be deduced that higher security and value is attached to land with a water right.

Net present value analysis of the sale price of "outer land" water rights was used to calculate the shadow price of "outer land" water rights in the Lower Orange River. The results of this analysis are presented in Table 6.7.

Table 6.7: The sale price and estimated shadow price of "outer land" water rights in the Lower Orange River, November 1997.

	MIN	MAX	AVE
Sale price of "outer land" water rights (R/15000m^3/ha)	R800.00	R5000.00	R3387.89
Estimated shadow price of "outer land" water rights using a 10 % discount rate (R/15000m^3/ha/annum)	R104.50*	R524.50	R362.39
Estimated shadow price of "outer land" water rights using a 15 % discount rate (R/15000m^3/ha/annum)	R144.50	R774.50	R531.33

* R104.50 = {(R800 * 10%) + R24.50}

In Table 6.7, the rental value of "outer land" irrigation water was calculated as the sale price, multiplied by the real discount factor, plus the annual tax for "outer land" water rights. The annual tax on river water for "outer land" of R24.50 per 15000m^3/ha was added to calculate the shadow price of water before tax. Real discount rates of 10 and 15 percent were used in the calculation. According to Nieuwoudt (1987), the rental rate of return on farmland is about 4.6 percent. However, higher discount rates of 10 and 15 percent for water right quotas were used in this analysis, and can be attributed to uncertainty surrounding water rights. This follows Ortmann (1987), who used a capitalization rate of 15 percent for sugar quotas in an analysis of land rents and production costs in the South African Sugar Industry. The higher discount rate for sugar quotas than for land is attributed to uncertainty about losing the quotas, since such quotas may be abolished. Similarly, uncertainty about water rights is expected to lead to a higher

discount rate for water than for land.

The data in Table 6.7 show that the rental value of "outer land" water on the Lower Orange River is estimated to range from R104.50 to R524.50/15000m^3 per annum using a 10 percent real discount rate, and from R144.50 to R774.50/15000m^3 per annum using a 15 percent real discount rate. The average rental values of irrigation water using a real discount rate of 10 and 15 percent were calculated as R362.39 and R531.33/15000m^3 per annum respectively.

Torell et al (1990) calculated an average market rental value for water in storage that ranged from R92.43/15000m^3 [d] (or $1.52/acre/foot) in Oklahoma to R507.72/15000m^3/ha (or $8.35/acre/foot) in New Mexico in the Ogalla aquifer in the Western US over the period from 1979 to 1986. From these data it appears that average water values in the Lower Orange River are not significantly different from the values in the Western US, given the range in prices in both countries, uncertainty about the discount rate, and differences in time periods and land use.

Of the 1075.20 ha of land for which the sample Buyers had purchased water rights, Table 6.8 summarises the existing and the additional future intended development of this land. Table 6.8 shows that water rights have been purchased almost exclusively for viticulture, particularly table grape production. Existing table grape production amounts to 8.1 percent of the land area for which water rights were purchased, while future intended table grape production accounts for an additional 51.5 percent of this land. Future intended raisin and wine grape production amounts to approximately 23.3 percent of this land area.

[d] In this calculation an exchange rate of R5.00 = $1.00 was used (1997).

Table 6.8: Existing and Future Intended Use of Purchased Water Rights by Buyers of water rights along the Lower Orange River, (n=9).

Existing Development		
Crop	Micro irrigation (ha)	Drip Irrigation (ha)
Table Grapes	117.4	15.0
Raisins & Wine Grapes	10.0	9.0
Vegetables	-	80.0
Additional Future Intended Development		
Table Grapes	513.8	40.0
Raisins & Wine Grapes	170.0	80.0
Citrus	30.0	-

Of the reported 589.8 ha of water rights that were sold by the 21 Sellers, 370.2 ha had been used as grazing land and a further 219.6 ha was unutilized. The discrepancy in selling area and buying area is explained in that only a random sample of 40 percent of the Sellers was drawn, while the entire population of Buyers was drawn in the survey. The Buyers generally purchased water rights from multiple Sellers. Sellers were also able to sell water rights to farmers in the Middle Orange River, and may have under-reported water rights sales in the survey.

6.3 Farmer responses to water trading activity along the Lower Orange River

Farmers were requested to motivate the reason for engaging in or abstaining from water rights transactions. The nine Buyers all revealed buying water rights to irrigate crops on previously unscheduled land, while three farmers also bought water rights for the additional reason of securing a higher degree of water supply availability for dry periods. Table 6.9 displays the reasons of the 21 Sellers for selling "outer land" water rights. Ten of the 21 Sellers sold water

rights because of poor "outer land" soils coupled to the water right, while five sold water rights because of steep slopes on their "outer land".

Table 6.9: Reasons for selling water rights reported by Sellers of water rights along the Lower Orange River, (n=21).

Reason	No. of farmers
Water unused because of poor soils on land coupled to the water right	10
Water unused because of steep slope on land coupled to the water right	5
Farm has enough water for its operations	3
Too expensive to develop the land coupled to the water right	2
Farmer perceives he will lose unused water rights under the new Water Law	1

The reasons for Control farmers not engaging in water market transfers are displayed in Table 6.10. As expected, farmers who did not buy additional water rights generally did not require any additional water for their farm operations, while farmers who did not sell water rights were commonly using the water right in their farm operations, or retained the rights to maintain a higher degree of water supply availability.

Table 6.10: Reasons for not buying or selling water rights by Control farmers along the Lower Orange River, (n=14).

Reasons for not buying water rights	No. of farmers
No additional water required for farm operations	11
Prices of water rights too high	4
No one is willing to sell their water rights	1
Reasons for not selling water rights	**No. of farmers**
Entire water right used in farming operations	9
Excess water retained to maintain a higher level of water supply security	6
No one wants to buy water rights	1

No renting activity for temporary transfers of "outer land" water rights had developed in the study area. Farmers' incentives to rent in water rights for "outer land" for temporary periods of time may have been constrained by the high fixed costs involved in developing "outer land" for irrigation purposes. Higher transaction costs faced by Buyers, especially the associated fixed cost component of hiring a lawyer in the transfer process, may have prevented market participation of certain farmers, by driving a wedge between buying and selling prices. This would have been significantly larger for small transactions of water rights.

Monitoring of river water extraction does not appear to be a critical issue at present on the Lower Orange River. From the sample of farmers in the survey who responded to the question on river water extraction (n=30), 83 percent stated that farmers did not have unlimited access to river water during times of water abundance. A further 83 percent stated the DWAF monitored their water extraction, while the remainder were unsure as to who performed the monitoring function. Fifty-five percent believed that monitoring was performed by the inspection of pump meters, while the remainder were unsure as to the method of monitoring. Seventy-two percent of farmers believed it was not possible to withdraw more river water than their specified right without any resulting penalties. However, 40 percent of farmers were unsure as to what these penalties would be, while 27 percent believed farmers would have to pay a higher levy for any water extracted above their quota. Thirteen percent believed offenders would be formally charged, and 20 percent believed farmers' sluice gates would be closed for a period. The study shows that although rights are enforced, a high percentage of farmers (40 percent) were unsure of penalties resulting from over-extraction. This may be due to the majority of farmers with river water rights either only irrigating a fraction of the land coupled to the water right, or not making use of the water rights at all. This substantial buffer of unused rights may mean that monitoring of river water extraction

is not a critical issue to farmers. This situation may change in the future as more water rights are exercised, requiring more intensive monitoring of pump meters and the existence of a transparent penalty structure.

In addition, 80 percent of sample farmers reported having good information about water availability in future months, while all farmers reported being unable to claim compensation for pollution or reduced flow as a result of the actions of another party. The latter point may be a reflection of the fact that no externalities were stated by market participants to have arisen from water rights transfers. Increased seepage from "outer" to "inner land" could be a negative externality associated with transfers of "outer land" water rights. Since most "outer land" is under controlled micro irrigation, the extent of this externality would possibly be minimised.

6.4 Discriminant function results

6.4.1 Discrimination between Buyers and Sellers of water rights along the Lower Orange River

It was hypothesised that Buyers would be cultivating table grapes as opposed to Sellers who would be cultivating raisin and wine grapes. Buyers are expected to have a greater return per unit of water applied, and make greater use of micro and drip irrigation systems as opposed to Sellers. Buyers are also expected to have proportionally more arable land available for expansion, be located in the river reach from Upington to Augrabies and use only a small fraction of their potential arable land. The results of the discriminant analysis are presented in Table 6.11.

Table 6.11: Estimated discriminant function between Buyers and Sellers of water rights along the Lower Orange River, (n=30).

Explanatory variable	Standardised Coefficient	F-value
Tblgp	0.760	18.33*
Retrn	0.730	14.87*
Usear2	0.612	6.69*
Usear1	0.610	6.47*
Incont	0.596	6.53*

* denotes statistical significance at the 1 percent level of probability

F-value	15.5*
Wilks' lambda	0.061
Canonical correlation	0.97

The most significant variable discriminating between Buyers and Sellers was whether the farmer grew table grapes (**Tblgp**) or not, showing that water rights tended to move to the highest valued agricultural uses. The second most important discriminating variable was the expected return per unit of water applied (**Retrn**), showing that water gravitated to the most efficient users of water, best able to utilise the resource in their farm operations. These two variables have a correlation coefficient of 0.17. The location of the farmer in the river reach from Upington to Augrabies, and whether he was utilising 25-50 percent (**Usear2**) or 50-75 percent (**Usear1**) of his arable land were the next most significant variables respectively. **Incont**, the ratio of actual irrigated land to total farm size was the least significant variable discriminating between Buyers and Sellers.

The overall F value of 15.5 indicates that the four retained independent variables together distinguish significantly between Buyers and Sellers. The Wilks' Lambda of 0.061 and canonical correlation coefficient of 0.97, indicate the function is effective in classifying respondents correctly. The discriminant function correctly classified 100 percent of both Buyers and Sellers

of the existing data set, as presented in Table 6.12. However, this classification rate is upwardly biased as the same cases were used to estimate the discriminant function and classify cases.

Table 6.12: Summary of grouped cases correctly classified for Buyers and Sellers of water rights along the Lower Orange River.

Actual group	No. of cases	Predicted group membership	
		(0)	(1)
Sellers (0)	21	21 (100%)	0
Buyers (1)	9	0	9 (100%)
Percent of grouped cases correctly classified:			100%

6.4.2 Discrimination between Buyers and Non-Buyers of water rights along the Lower Orange River

The results of the discriminant analysis to determine which variables distinguish between Buyers and Non-buyers are presented in Table 6.13.

Table 6.13: Estimated discriminant function between Buyers and Non-Buyers of water rights along the Lower Orange River, (n=44).

Explanatory variable	Standardised Coefficient	F-value
Retrn	0.632	11.34*
Tblgp	0.410	5.86*
Potdev	0.409	4.58*
Usear2	0.322	3.06*
Incont	0.261	1.94*
Vine	-0.195	1.11*

* denotes statistical significance at the 1 percent level of probability

F-value 33.15*
Wilks' Lambda 0.157
Canonical correlation 0.92

The most significant variable discriminating between Buyers and Non-Buyers was the estimated

return per unit of water applied (**Retrn**), showing that water rights tended to move to the most efficient users of water. The next most important variable was whether or not the farmer grew table grapes (**Tblgp**), showing that water rights transferred to the highest valued agricultural uses. These two variables had a correlation coefficient of 0.44, which was non-significant at the 1 percent level. The third most important variable, **Potdev**, shows that Buyers have proportionally more arable land that can be developed for irrigation purposes than Non-Buyers. The location of the farmer in the river reach from Upington to Augrabies, and whether he was utilising 25 to 50 percent (**Usear2**) of his arable land was the next most significant variable. **Incont**, the ratio of actual irrigated land to total farm size was the fifth most significant discriminator between Buyers and Non-Buyers. Finally, the least significant variable, **Vine**, shows that Non-Buyers tend to be wine and raisin grape farmers.

The overall F value of 33.15 indicates that the four retained independent variables together distinguish significantly between Buyers and Non-Buyers. The Wilks' Lambda of 0.157 and canonical correlation coefficient of 0.92, indicate that the function is effective in classifying respondents correctly. Explanatory power was checked by comparing predicted with actual group membership. The discriminant function classified 100 percent of the cases correctly as shown in Table 6.14, but the classification results of 100 percent are upwardly biased since the same cases were used to derive the discriminate function and classify cases. The disparity in size of the two sample groups may also have biased classification in favour of the larger group.

Table 6.14: Summary of grouped cases correctly classified for Buyers and Non-Buyers of water rights along the Lower Orange River.

Actual group	No. of cases	Predicted group membership	
		(0)	(1)
Non-Buyers (0)	35	35 (100%)	0
Buyers (1)	9	0	9 (100%)
Percent of grouped cases correctly classified:			100%

6.5 Gross margin analysis of representative farms along the Lower Orange River

The estimated overall gross margin per ha of irrigated land for representative farms of Buyers and Sellers of water rights along the Lower Orange River was calculated as additional evidence of Buyers' incentives to purchase water rights and expand production of their farm enterprises. Gross margin data published in the Combud (1996) for the Lower Orange Region in the Northern Cape Province was used in this analysis.

Table 6.15 below shows the estimated gross margin per ha of irrigated land for the representative farm of a Seller of water rights. In this calculation, the potential contribution of pecan nuts to the overall gross margin per ha of irrigated land was excluded owing to difficulties in obtaining gross margin information for this crop, and because this enterprise comprised only 1.2 percent of the total production area of the sample Sellers. Table grapes were also excluded because this enterprise represented only 0.3 percent of the total area under production by the sample Sellers.

Table 6.15: Gross margin analysis of a representative farm for Sellers of water rights along the Lower Orange River, July 1996.

REPRESENTATIVE FARM : SELLERS

	PARAMETER		ASSUMPTION
1	**Total irrigated area**	52.7 ha	Taken from the average irrigated area of Sellers obtained in the survey
2	**Effective irrigated area**	51.8 ha	Calculated as the total irrigated area less the proportional area under table grapes and pecan nuts
3	**Farm enterprises**		
	Raisin & wine grapes	23.1 ha	Taken from survey data of the proportional
	Wheat	13.4 ha	shares of each enterprise of total production
	Maize	9.8 ha	of Sellers
	Cotton	3.0 ha	
	Lucerne	2.5 ha	
4	**Irrigation technology**		
	Flood: Raisin & wine	23.1 ha	Taken from survey data of the proportional
	Wheat	13.4 ha	shares of each irrigation system used for each
	Maize	9.8 ha	crop by Sellers
	Cotton	3.0 ha	
	Lucerne	2.5 ha	
5	**Gross margins per hectare**		
	Flood: Raisin & wine	R6 157.10[1]*	* Taken from the representative Combud
	Wheat	R1 107.34[2]*	enterprise budgets compiled for the Lower
	Maize	R1 211.10[3]*	Orange Region (July 1996)
	Cotton	R4 083.87[4]*	
	Lucerne	R5 258.48[5]*	
6	**Average gross margin per hectare for irrigated land of representative farm**		
	GM/Ha = R 3751.62		

Assumptions :

(1) Production age: 25 years, 15 km from receiving depot
(2) Double tillage, 15 km from coop
(3) Double tillage, 15 km from coop
(4) Early cotton - one summer harvest, 15 km from coop
(5) Production age 4 years

Table 6.16 below shows the estimated gross margin for extensive mutton sheep in the study area. Owing to the limited potential of "outer land" as grazing for livestock in the study area, only marginal returns from livestock enterprises are possible. Consequently, agricultural production is synonymous with irrigation water along the Lower Orange River.

Table 6.16: Crop budget analysis for extensive mutton sheep in the Gordonia District, July 1996.

	CROP BUDGET **GRAZING LAND : GORDONIA DISTRICT**
1	**Average gross margin per hectare for extensive mutton sheep**
	GM/Ha = R16.77[1]

Assumptions
(1) : 1000 Dorper ewes with a 100% weaning percentage, 18% ewe replacement, 10% mortality, lambing during March/April, market at age 5 months, 40% in feedlot.
Taken from the representative Combud enterprise budgets compiled for the Northern Cape Province (July 1996)

The estimated overall gross margin of the representative farm of sample Buyers is shown in Table 6.17. In this calculation, the potential contribution of citrus, melon and vegetable enterprises to the overall gross margin per ha were excluded owing to informational deficiencies regarding the gross margins of these enterprises, because they were produced on only one of the sample Buyer's land and represented only 0.8 percent, 4.6 percent and 5.3 percent of total crop production area respectively. Maize and wheat were similarly excluded as these two enterprises together were grown on only 0.05 percent of the total irrigated land of Buyers respectively. Gross margin data for vineyards under micro irrigation, and for date production were not available from the Combud. Gross margin information for the vineyards were obtained directly from sample respondents, while the gross margin data for dates were obtained from Lanok.

Table 6.17: Crop budget analysis of a representative farm for Buyers of water rights along the Lower Orange River, July 1996.

CROP BUDGET
REPRESENTATIVE FARM : BUYERS

	PARAMETER	ASSUMPTION	
1	**Total irrigated area**	166.5 ha	Taken from the average irrigated area of Buyers obtained in the survey
2	**Effective irrigated area**	146.9 ha	Calculated as the total irrigated area less the proportional area under citrus, melons, vegetables, wheat and maize
3	**Farm enterprises**		
	Table grapes	118.2 ha	Taken from survey data of the proportional
	Raisin & wine grapes	16.4 ha	shares of each enterprise of total production
	Dates	12.3 ha	by Buyers
4	**Irrigation technology**		
	Micro: Table grapes	81.8 ha	Taken from survey data of the proportional
	Raisin & wine	9.5 ha	shares of each irrigation system used for
	Dates	4.7 ha	each crop by Buyers
	Flood: Table grapes	36.4 ha	
	Raisin & wine	6.9 ha	
	Dates	7.6 ha	
5	**Gross margins per hectare**		
	Micro: Table grapes	R 28 244.52[(1)]***	
	Raisin & wine	R 6 157.10[(2)]**	
	Dates	R 12 805.64[(3)]****	
	Flood: Table grapes	R 20 155.84[(4)]*	
	Raisin & wine	R 6 157.10[(5)]*	
	Dates	R 12 805.64[(6)]****	
6	**Average gross margin per hectare for irrigated land for representative farm**		
	GM/ha = R 22 481.69		

Assumptions :
(1) Age limit 25 years, 900 km from market
(2) Age limit 25 years, 15 km from depot
(3) Without tissue culture, sold on regional market
(4) Age limit 25 years, 900 km from market
(5) Age limit 25 years, 15 km from depot
(6) Without tissue culture, sold on regional market

* *Taken from the representative Combud enterprise budgets compiled for the Northern Cape Province (July 1996)*
** *Gross margin data for wine and raisin grapes under flood irrigation was used as no published gross margins for these crops under micro irrigation were found*
*** *Gross margin data for table grapes under micro irrigation were obtained from Carstens Boerdery, Kakamas. Owing to variation in gross margins for different varieties of grapes and according to different locations along the River, a very conservative estimate of R 28244.52/ha was used.*
**** *Gross margin data for dates was obtained from Lanok. No gross margin for dates under flood irrigation were available so the gross margin under micro irrigation was used. Using conservative figures, a gross margin of R12805.64/ha was calculated.*

The gross margin analysis shows that the potential return to the Buyers' representative farm land per annum, ranges from R6157.10/ha to R28244.52, which is significantly higher than the return earned by the representative Sellers' farm land, ranging from R1107.34/ha to R6157.10/ha. This serves as secondary empirical evidence of Buyers' incentives to purchase water rights for undeveloped irrigable land and to expand production.

CHAPTER 7

RESEARCH RESULTS: THE UMHLATUZE RIVER

7.1 Characteristics of respondents

Potential Buyers of water rights along the uMhlatuze River had a smaller farm size mean of 376.7 ha, as opposed to Non-Buyers with a mean of 524.4 ha. Potential Buyers also had proportionally more arable land on average (14.5 percent) that could be developed for irrigation purposes than Non-Buyers (7.8 percent). Potential Buyers' irrigated land was primarily under sugar (70 percent) and citrus (26 percent) production, while Non-Buyers irrigated less sugar (56 percent) and more citrus (38 percent) on average than Buyers. Irrigation system use is similar on the average between both groups. Buyers use overhead sprinklers (71 percent), micro (22.5 percent), drip (4.3 percent), and under-tree sprinklers (2.2 percent). Non-Buyers were found to use overhead sprinklers (61 percent), micro (22 percent), under-tree sprinklers (14 percent), and drip (1.5 percent).

7.2 Farmer responses to potential water rights trading along the uMhlatuze River

The survey revealed that no water market activity had occurred in the Nkwaleni Valley. No farmers had purchased or rented water rights from another farmer, nor had any sample farmers sold or rented out water rights to another party. Forty-one percent of the sample farmers stated that they were in the situation where they needed additional water at present. If permitted to freely buy or rent water rights, 41 percent stated that they would like to purchase water rights at present, while only nine percent stated that they would be willing to rent water rights - and only as a second option to the purchase of water rights. The reasons why these farmers had not bought or rented in water rights in the past are presented in Table 7.1 below. The table shows most

potential Buyers believed no one was willing to sell their water rights.

Table 7.1: Reasons preventing potential Buyers of water rights in the Nkwaleni Valley from buying.

Reason	No. of farmers (n=9)	
	Purchase	Rental
water rights purchase/rental is too expensive	1	1
irrigation board does not allow water rights purchases/rentals	2	-
it is illegal to purchase/rent in water rights	2	-
no one is willing to sell/rent out their water rights	6	1
water savings from a scheduled change to drip irrigation may satisfy water requirement	2	-

The nine potential buyers of water rights were willing to buy water rights for 295 ha, at an average of 32.8 ha per farm. These respondents stated that the water rights would be used to irrigate 201 ha of sugar cane and 94 ha of citrus. Fifty-nine percent of respondents stated that they were in the situation where they may require additional water for their farm operation in future. If permitted to freely purchase or rent water rights in future, 50 percent of all respondents stated they would be willing to purchase water rights if necessary, while 45 percent stated they would be willing to rent water rights if needed in future. Four farmers indicated that investments in sugar cane and citrus orchards were long term investments warranting only the purchase of water rights, since temporary water rights would increase risk involved in the production process.

No survey farmers stated that they had any excess water for their farm. Similarly, no farmers reported that they would like to sell or rent out any water rights at the present time. Similarly, no survey respondents believed that they were in the situation where they may have excess water for their farm operation. Only 22 percent of all sample respondents stated that they would be

willing to sell any excess water that they had for their farming operations in future. Fifty-four percent, however, conceded that they would consider renting out any excess water rights that they may have in the future. A cursory examination of land prices in the Nkwaleni Valley reveals that dry land suitable for irrigation generally sells for R1000 to R1200 per ha, while undeveloped arable land coupled to a water right generally sells for R4000 to R5000 per ha. This information suggests that water rights would transfer for a somewhat lower price than on the Lower Orange River.

Growing industrial and municipal water demands from Empangeni and Richards Bay have placed enormous pressure on water supplies in the uMhlatuze River. Industrial concerns have invested in excess of R100 million in an emergency pumping scheme, piping water from the Tugela River to the Goedertrouw Dam. Plans are afoot by the DWAF to increase this pumping scheme on a significantly larger scale. Additionally, industrial concerns have approached farmers within the NIB with the intention of purchasing a portion of their water rights for both industrial and mining uses downstream. As yet no transfers of water rights have taken place with farmers preferring to retain their water right allocations.

Survey farmers' perceptions about water trading in the Nkwaleni Valley are elicited in Table 7.2.

Table 7.2: Individual farmers' perceptions about water trading within the Nkwaleni Valley, May 1998.

Statement (n=22)	Yes	Uncertain	No
Do you believe farmers should be able to trade their water use allocations?	14	2	6
Do you believe there is sufficient demand for water in your area to facilitate the operation of a water market?	13	3	6
Do you believe a water market could function successfully in your area?	11	2	9

The majority of respondents believed farmers should be able to trade water rights allotments, and that sufficient demand for water exists in the Nkwaleni Valley to facilitate a water market. However, 41 percent of respondents believed a water market could not function successfully. From their responses it appears that this subset of respondents are not familiar with the implications of a water market. Thirty-six percent of these respondents believed no tradable margin of water would exist as farmers required all their water in their farm operations, and would consequently not be willing to sell or rent out water rights. These respondents contended that no farmer would willingly sell water rights as this would render the land agriculturally useless. However, the respondents did not consider the compensation received for such a transfer, or the fact that the value of the land to which water is transferred would increase. The other five percent of these respondents believed a tradable water margin could not exist as this water would automatically be reallocated to industry in dry years. Twenty-three percent of all sample respondents believed sales of irrigation water to industrial uses should not be permitted as this would take land out of production and erode the agricultural potential of the area. Similarly, the farmers did not consider the compensation that they would receive for the sale of any water rights.

Of the 11 respondents believing market trading of water rights could take place, two perceived that most properties required certain amounts of water to develop uncultivated land. Five respondents believed that a market could develop in response to the scarcity of water and low rainfall in the area. This could be achieved through the switch to more efficient irrigation technology in response to continually increasing water charges, enabling conserved water to be sold or rented out.

Water allocation and monitoring of water extraction is well enforced in the Nkwaleni Valley. All 22 survey respondents reported that their water extraction was monitored monthly by the water bailiff of the NIB. through the reading of electricity meters on individual pumps. Ninety-one percent of the sample farmers believed that it was impossible to withdraw more water than their specified water right without any resulting penalties. Fifty percent of farmers believed that offenders would have their pumps locked for a period and their water allocation reduced, 41 percent stated that this scenario would never occur as monitoring of water extraction was too frequent and effective to permit any overuse, and finally, nine percent of farmers stated that potential offenders would be formally charged. Ninety-one percent of farmers believed these penalties would be strictly enforced. In addition, 81 percent of sample farmers reported having good information about the expected availability of water in future months, while only 45 percent expected to be able to claim compensation from pollution or reduced return flow as a result of an upstream user.

7.3 Discriminant function results

7.3.1 Discrimination between potential Buyers and Non-Buyers of water rights along the uMhlatuze River

The results of the discriminant analysis to determine which variables distinguish significantly between Buyers and Non-Buyers of water rights along the uMhlatuze River are presented in Table 7.3.

Table 7.3: Estimated discriminant function between potential Buyers and Non-Buyers of water rights in the Nkwaleni Valley, (n=22).

Explanatory variable	Standardised Coefficient	F-value
Sugr	2.295	24.49*
Incont	-2.017	14.19*
Citrs	-1.595	9.97*
Iritec	1.224	8.51*
Potdev	1.033	3.83*

* denotes statistical significance at the 1 percent level of probability

F-value 5.86*
Wilks' Lambda 0.353
Canonical correlation 0.810

The most significant variable discriminating between potential Buyers and Non-Buyers was whether or not the farmer grew sugar cane (**Sugr**). Potential Buyers of water rights have large holdings of sugar cane from which favourable returns from irrigation could be attained. The second most important variable, **Incont**, shows that potential Buyers of water rights are using their total farm area less intensively than Non-Buyers. The third most significant variable, **Citrs**, shows that potential Buyers of water rights generally have less citrus than Non-Buyers. The sign of this variable may be circumspect, but may be attributable to the recent fall in grapefruit prices. The fourth most important variable was whether the farmer had adopted water-saving micro and/or drip irrigation systems (**Iritec**). The least significant variable, **Potdev**, shows that potential Buyers of water rights generally have a greater proportion of their total arable area that can be developed for irrigation purposes than Non-Buyers.

The overall F value of 5.86 indicates that the five retained independent variables together distinguish significantly between Buyers and Non-Buyers. The Wilks' Lambda of 0.353 and canonical correlation coefficient of 0.81, indicate a good discriminant function but suggest that

some discriminating information has not been extracted by the independent variables. The discriminant function classified 95.45 percent of cases correctly as shown in Table 7.4 below. This classification rate is upwardly biased as the same cases were used to estimate the function and classify cases. Additionally, bias resulting from the small sample size (n=22) which falls short of the acceptable sample size of 30 cases may have been introduced into the discriminant function.

Table 7.4: Summary of grouped cases correctly classified for potential Buyers and Non-Buyers of water rights along the uMhlatuze River.

Actual group	No. of cases	Predicted group membership	
		(0)	(1)
Non-Buyers (0)	13	12 (92.3%)	1 (7.7%)
Buyers (1)	9	0	9 (100%)
Percent of grouped cases correctly classified:			95.5%

CHAPTER 8

TRADABLE IRRIGATION WATER RIGHTS UNDER THE NEW SOUTH AFRICAN WATER LAW

In South Africa, water policy and legislation has been completely reformed since 1994. The Water Law review process has been described by the White Paper on National Water Policy (Department of Water Affairs and Forestry, 1997c), and has resulted in the new National Water Act No. 36 on 26 August 1998 (Government Gazette, 1998). This chapter endeavours to describe and evaluate the Water Policy in South Africa with specific reference to the policy scenario of establishing tradable water rights, and to evaluate specific principles of the new Water Act that may affect the allocation and market transfer of irrigation water rights.

8.1 An evaluation of the new National Water Policy

This section attempts to describe and evaluate the relevant portions of the new National Water Policy with reference to the policy scenario of establishing tradable water rights.

The new Water Policy provides the framework for water markets in South Africa. These Water Policy reforms have changed the institutions that define rights, exposure to rights of others, privileges and responsibilities with respect to water resources (Nieuwoudt, 1998). The new Water Policy guiding water management in South Africa hinges on the following key issues:

(1) The National Government views it role as the custodian of the nation's water resources and its powers in this regard will be exercised as a public trust. Water is considered too valuable a commodity in the new Water Policy for its management to be handed over to its users

(Department of Water Affairs and Forestry, 1997c).

(2) The main aim of the new Water Policy is to address the issue of equity, although other issues of protecting the environment and ensuring water is used as a scarce commodity are also important. In achieving these aims, water policy only guarantees water required to meet basic human needs and maintain environmental sustainability as a right. All other water uses will be recognised only if they are beneficial in the public interest, and *"will be subject to a system of allocation that promotes use which is optimal for the achievement of equitable and sustainable economic and social development."* Water use allocations claimed under the Water Act of 1956 may be recognised in the new law to the extent that these are allocations recognised as being beneficially used in the public interest. The new Water Policy provides for the regulation in the public interest of all existing claims and future allocations. To the extent that future allocations, redressing the results of past racial discrimination, result in the reduction of existing valid allocations, these reallocations will be protected by the Constitutional provisions for corrective action which specifically recognise the right of the Government to establish such legislative programmes (Department of Water Affairs and Forestry, 1997c). Thus Water Policy places significant emphasis on the reallocation of existing water rights through bureaucratic discretion.

(3) The riparian system of allocation, in which the right to use water is tied to the ownership of land along rivers, will effectively be abolished. Water use allocations will no longer be permanent, but will be given for a "reasonable" period. To facilitate the process of allocation and review, licenses will be granted on a five year cycle with a maximum length of forty years (Department of Water Affairs and Forestry, 1997c).

(4) The proposed system of allocation of water use authorisations will function on an administrative basis, with administrative water pricing used to assist in the allocation process. In promoting the efficient use of water, the policy will be to charge users for the full financial costs of providing access to water, including infrastructure development and catchment management activities. In addition, all water use, wherever in the water cycle it occurs, will be subject to a catchment management charge which will cover actual costs incurred, as well as a resource conservation charge where there are competing beneficial uses or where such use significantly affects other users (Department of Water Affairs and Forestry, 1997c). Tariffs for water supplied will be charged to all water users, and not only to users on existing Government Water Schemes.

(5) Trading in water-use allocations as a price setting mechanism is not strongly supported in the National Water Policy. The Water Policy states that provision may be made to enable the transfer or trade of these rights between users, with Ministerial consent. However, the National Water Policy states the view that trading in water-use allocations as a price setting mechanism has limitations, and would not be free from administrative burdens. Difficulties inherent in creating a system of allocations which could be freely traded, and in transporting water are highlighted by the National Water Policy. As a result of these perceived problems, the view is taken that prices generated by trading in water-use allocations will not necessarily reflect the real value of the resource (Department of Water Affairs and Forestry, 1997c).

In the light of water policies that have facilitated successful water markets around the globe, the South African Water Policy differs in a number of aspects. Firstly, water legislation regarding water trading is vague compared to active promotion of water markets as a policy option found

in the US, Chile and Mexico. This will create much uncertainty about legal water market transfers. Secondly, water use rights in South Africa will not be perpetual as found in the US and Chile. This attenuation of rights will affect the exclusiveness of rights as well as reducing the potential for market transfers of water. Thirdly, local management of water resources, including water market function, found in the US, Chile, and Mexico is important in minimising transaction costs of water trades. The South African approach of authorising trades only upon Ministerial consent may increase transaction costs unnecessarily.

The National Water Act No. 36 of 1998 makes provision for the transfer of water use authorisations in Section 25(2) under the following conditions:

" A person holding an entitlement to use water from a water resource in respect of any land may surrender that entitlement or part of that entitlement -

(a) in order to facilitate a particular license application for the use of water from the same resource in respect of other land; and

(b) on condition that the surrender only becomes effective if and when such application is granted."

In addition Section 26(l) states that *" the Minister may make regulations relating to transactions in respect of authorisations to use water, including but not limited to -*

(a) the circumstance under which a transaction may be permitted;

(b) the conditions subject to which a transaction may take place; and

(c) the procedure to deal with a transaction."

In effect, the National Water Act permits a person to transfer their water entitlement only if a particular license application has been approved to use that water on another piece of land, subject to any regulations considered appropriate by the Minister. This legislation is very vague and creates much uncertainty about legal water market transfers in future.

Two important points can be drawn from the National Water Policy and National Water Act. Firstly, for the first time in South African Water Policy statements regarding water trading are

included as an option for water allocation. However, preference is still given to administrative price setting for water resources. Secondly, while the National Water Act mentions transactions of water use authorisations as a possible option in water allocation, the effected legislation makes very unclear provision for legal transfers of water use licenses. This will create much uncertainty about legal water trades. As a result, water market trades will not be facilitated by the new National Water Policy because firstly the National Government intends to implement a comprehensive plan of administrative price setting for water, with the policy option of water market price setting relegated to a secondary role, if it is to be considered at all. Secondly, water legislation regarding water trading in the National Water Act is very vague, and transfers will be subject to Ministerial discretion.

The primary intention of the new Water Policy is to make use of the limited duration of water licenses as a means to reallocate existing water rights, based on bureaucratic discretion. Although there is limited opportunity for market trades, attenuation of water rights and regulation of water markets will result from the National Water Act, and will lead to certain inefficiencies if water market trading is prevented or inhibited. Measuring opportunity costs under administrative price setting is impossible (Thobani, 1997) thus leading to the possible implementation of inappropriate price structures. Public officials may also lack information regarding individual farmers' farming environment, resulting in the implementation of inappropriate plans (Anderson and Leal, 1989). Finally, efficiency of water use will not be optimised, since administrative price setting will not create incentives for the rationalisation of water use, nor result in the transfer of water to its highest valued uses to the extent that is possible under a scenario of water market trading.

8.2 An overview of principles governing the allocation and transfer of irrigation water use rights under South Africa's new Water Law

8.2.1 Irrigation water allocation under the new Water Law

The particular principles on which the new National Water Policy is based that have implication for the allocation of irrigation water rights will be discussed in this section.

Principle two in the White Paper on Water Policy (Appendix 1) states that *"all water, wherever it occurs in the water cycle, is a resource common to all, the use of which shall be subject to national control."* This effectively transforms all water, including irrigation water, into public property whose allocation, and right of use, shall be subject to government control. This policy provides for the continuation of centralist intervention in water management, with the opportunity for even greater bureaucratic command and control over water resources.

According to principle three (Appendix 1), *"there shall be no ownership of water but only an authorisation for its use that shall not be in perpetuity."* In the National Water Act (Government Gazette, 1998) it is consistently stated that water cannot be privately owned. As a consequence there will be "no private ownership of water, only authorisation for a use right" for water that will be held for a temporary predetermined period. The riparian doctrine will be discarded in the new Water Law since principle four (Appendix 1) states that *"the location of the water resource in relation to land shall not in itself confer preferential rights to usage. The riparian principle shall not apply."* Existing water users will have to apply for registration of their use, which, on approval, will be converted into a rolling water use licence granted on a five-year cycle with a maximum length of forty years. At the end of the licence period licence holders will have to

apply for licence renewal, which will be considered along with all new applications within the catchment (Department of Water Affairs and Forestry, 1997c). Applications for licensing may be rejected if the licensing authority is of the opinion that the intended use of the water will adversely affect the quantity or quality of the water resource, an ecosystem that depends upon the water in the watercourse, or the authorised use of some other person. Existing water rights, for which no application for registration has been made, will be assumed to be abandoned and considered available for allocation to other uses (Government Gazette, 1998).

Existing water rights may only be recognized under the new Water Law to the extent that they are "beneficially used in the public interest", where the public interest will be determined by government officials. The White Paper on Water Policy (Department of Water Affairs and Forestry, 1997c) states that claims, allocations and uses which are not beneficial in the public interest will not be recognised under the new Water Law. In allocating water, prior consideration will be given to the water requirements of each water resource management area, the need to reallocate water to the Reserve (incorporating environmental and basic human consumption requirements), long term planning for inter-basin transfers, equity reallocations as well as to existing users (Department of Water Affairs and Forestry, 1998b).

As a result of these policies, irrigators face the possibility of forfeiture of some or all of their water rights, if their use is deemed not to be in the public interest, when considered along with water allocations to industry and municipalities, equity reallocations to previously disadvantaged persons, and the Reserve. Irrigators with undeveloped land for which they have water rights also face the possibility of losing these rights under the new Water Law. Since the Minister has absolute discretion in determining water allocations in the public interest, ultimate control over

the magnitude of the total irrigation water allocation is also vested in his power. However, bureaucratic determination of water allocations in the public interest may not be based sufficiently on economic criteria, leading to a restrictive production environment for irrigators and constraining efficiency in water allocation, use, as well as farm production. The allocation of water use licenses of insufficient duration to irrigators under the new Water Law will stifle farmers' investment decisions, resulting in a counterproductive environment to improving the efficiency in water use, since irrigators will be deterred from investing in costly water-saving irrigation systems. The duration of licenses should be sufficiently long, with a perpetual time span, and be inherently secure in order to allow farmers to recoup with complete confidence the full income stream generated by their investment.

The National Water Act (Government Gazette, 1998) explains that water licenses will not give a guarantee of the assurance of supply or quality of the water, and water use licenses may by notice be temporarily controlled, limited or prohibited. As a result, irrigators may not hold their water use licence and duration of the licence with complete assurance, possibly constraining long-term investment and resource conservation. Farmers should be given the assurance that their water use licenses will only be restricted during drought periods, with proportional sharing of shortages among irrigators, and similar restrictions imposed on other water use sectors.

Uncertainty still exists in South Africa as to how these proposed principles of the new Water Law will be applied. Following the Australian example, the implementation of a new water allocation system may not penalise farmers as severely as expected. For example, water entitlements in Australia were specified for certain period of years and were conditional on the beneficial use of the water. However, in practice, entitlements were almost always renewed as a matter of

course (Agricultural and Resource Management Council of Australia and New Zealand, 1995). The Australian policy has since changed from limited duration to perpetual water licenses (Syme and Nancarrow, 1997). Such practices thus ensure that farmers enjoy a greater degree of tenure security over water entitlements than suggested in the legislatures.

Government's role in South Africa as the custodian of the public trust in managing, protecting and determining the use of water will be the foundation of the new Water Law (Department of Water Affairs and Forestry, 1997c). Principle 12 (Appendix 1) specifies that *"government is the custodian of the nation's water resources. Guided by its duty to promote the public trust, the National Government has ultimate responsibility for, and authority over, water resource management, the equitable allocation and usage of water and the transfer of water between catchments and international water matters."* Furthering government's role as custodian of the nation's water resources, Principle 13 (Appendix 1) states that *"the National Government shall ensure that the development, apportionment, management and use of those resources is carried out using the criteria of public interest, sustainability, equity and efficiency of use in a manner which reflects its public trust obligations and the value of water to society while ensuring that basic domestic needs, the requirements of the environment and international obligations are met.* Public trust will be the legislative measure by which the Minister will achieve the objective of the DWAF of water related constitutional reform in a way that takes account of the public nature of water and the need to ensure there is fair access to water. To the extent that future water allocations, in addressing equity issues, result in the reduction of existing licenses, these reallocations will be protected by Constitutional provision (Department of Water Affairs and Forestry, 1997c). Thus the proposed Water Law makes government exclusively responsible for water allocation, and advocates public interest above private interest in the evaluation of

efficiency, equity and sustainability objectives by the government as custodian of the nation's water resources (Backeberg, 1997). However, there are no clear cut criteria on which government can base decisions regarding the "optimal use" of water, and any decisions taken in the public interest will be subject to political bias.

8.2.2 Transfers of irrigation water use licenses under the new Water Law

The promotion of any market related mechanisms as a primary tool to allocate water is lacking in the new Water Act, and instead total reliance on administrative mechanisms for water allocation is emphasised. The new Water Law does propose that provision may be made for market trading of water use allocations in limited areas should this approach become desirable, but this will be subject to central control with particular attention paid to whether equity objectives and fair resource allocations are achieved by the market (Department of Water Affairs and Forestry, 1997c).

The National Water Bill (Department of Water Affairs and Forestry, 1998c) states that a user who is legally entitled to abstract or store water may trade the entitlement. The trade may be for the whole or part of the entitlement to another person, who may, with the necessary approval, use the entitlement under conditions different from those originally attached to it. Additionally, the trade may be for the remainder of the duration of the entitlement or for another limited period. Water use licenses traded for a limited period will automatically revert back to the transferor when the period expires, under the same conditions originally attached to it. All trading of water use licenses will require the approval of the Minister, unless the Minister has assigned authority of approval to the catchment management agency (CMA). However, the policy discussed above in the National Water Bill has been completely revised in the National Water Act of 1998 and

drastically downgraded. Water trading legislation under the National Water Act is very vague, with the Act going only so far as to say that a person holding an entitlement to use water may only surrender that entitlement or part of that entitlement if a particular license application has been approved to use that water on another piece of land, subject to any regulations considered appropriate by the Minister.

Water trades will be achieved through applications for transfer of licenses. The National Water Act (Government Gazette, 1998) specifies that the Minister will prescribe regulations governing the circumstances under which transactions may be permitted, the conditions subject to which a transaction will take place, and the procedures to deal with the transaction. From the National Water Bill (Department of Water Affairs and Forestry, 1998c), applications for water trades will likely be required to be accompanied by the prescribed fee for consideration, and include all necessary information as specified by the Minister or CMA. Applicants must publicly disclose their intention to apply for a trade, which may be exempted if the trade takes place (a) within the service area of the WUA, (b) within a government irrigation area, (c) between neighbouring properties from the same stream, or (d) without significantly prejudicing other water users. Exemption under such conditions will only take place if the use of the water entitlement remains the same, and information regarding the trades are available at the specified office. Applicants may also be required by the Minister to provide, at their expense, any other information not specifically required in the application, as well as an independent assessment of the possible effect of granting the application to trade the entitlement.

The Minister will consider applications to trade water entitlements according to any potential change in quality and quantity of the water resources and the assurance of supply, as well as any

potential effect the trade might have on the water resource, the entitlements of other users, the existing waterworks, the economy - including socio-economic matters, and land restitution claims. This will require a trade off between equity and efficiency objectives in water allocation and use. Following approval, the authority directed as responsible for licensing is required to endorse the licence in question, issue the necessary licenses, and record the trade in the national information system.

On balance, the new National Water Act will not facilitate market trades of water use licenses, despite this policy option being mentioned as an alternative for water allocation. Legislation regarding water trading is vague and the extent of bureaucratic control and regulation of water trading in the new water legislation creates highly restrictive conditions for voluntary transfers between willing transactors. Many of these regulations serve to increase transaction costs unnecessarily, since water trades are required to involve extensive negotiation between the interested parties and government officials. In the trade-off between efficiency and equity in water allocation, it is important and justified that equity objectives are addressed by government through centralist intervention, while efficiency in allocation and use of allotted irrigation water could be enhanced by the promotion of market trading of water use rights.

Market trading of water rights could be introduced in an incremental manner (Backeberg, 1994). The first step would be to permit market trading of irrigation water use rights among irrigators within a WUA control area. Where demand for market trading of irrigation water already exists or develops in future, trading of water rights among irrigators belonging to the WUA should be encouraged. Trades within the irrigation sector of a WUA should be constrained by minimal regulation in order to reduce transaction costs. This could be achieved by allowing farmers to

trade water rights voluntarily amongst themselves without the necessary approval from either the Minister or CMA authority. Authority to approve such transfers should be delegated to the WUA provided the trades took place within the WUA area. The WUA could also ensure that any legal procedural requirements associated with the trade are adhered to, record the transfer and ensure that the trade does not prejudice any other legal water use licence holder. This would require a clear policy in dealing with return flows and conflict resolution among farmers by the WUA. Third-party impacts from trades between irrigators in a localised area would however be arguably small. Conflicts among members beyond the conflict resolving capability of the WUA could be referred to the CMA or Minister, or ultimately the judicial system. Applications to trade water between irrigation users within the WUA control area should not be burdened by excessive fees, require public disclosure of the intention to trade, or require independent assessment of the potential impacts of the trade. Such policies would only serve to increase transaction costs and negate the benefits from water transfers within the localised area.

The second step in market development would be to permit trading of water rights between irrigators and urban users within the WUA area. This would enable water to be transferred to highly valued urban uses in a voluntary and flexible manner. Inter-sectoral trades within the WUA could be subjected to a higher degree of regulation, by requiring approval from the CMA to ensure that the transfer does not impinge on the rights of existing legal water right holders or the Reserve. Procedures to monitor water quality and deal with return flows would have to be introduced before such inter-sectoral trades could take place, since water sold to urban uses may result in a significantly different pattern and quantity of return flow than the original agricultural use, or may even eliminate return flows altogether.

The final step in market development would be to encourage trading of water rights between users belonging to different WUA's in a river catchment and ultimately inter-catchment transfers. Trades between members of different WUA's should be subject to the most stringent transfer requirements. Authority to approve such transfers could be vested in the CMA, with particular attention to whether the transfer would negatively affect any third-party or the Reserve, and within the context of the overall hydrology of the catchment. In such transfers it may be justified to require public disclosure of the desire to trade, to permit existing users who may be negatively affected by the transfer to object to the transfer, and negotiate a compromise. The CMA should resolve disputes that are not settled between the interested parties. More restrictive conditions for trades between different WUA areas would be justified owing to the increased possibility of negative effects on water flow and quality, which in turn may affect the Reserve or impinge on the rights of others.

8.3 Survey farmer responses to the proposed new Water Law

A five-category scale, ranging from 'strongly disagree' through to 'strongly agree' with a given statement was used to elicit the perceptions of sample farmers along the Lower Orange and uMhlatuze Rivers about the influence of the new Water Law on their farm operations and water trading activity. The perceptions of sample farmers along the Lower Orange River about the new Water Law are presented in Table 8.1, while those of the farmers along the uMhlatuze River are presented in Table 8.2.

Table 8.1: Responses of sample farmers along the Lower Orange River to statements regarding the proposed new Water Law, (n=44).

Statement	strongly disagree	disagree	uncertain	agree	strongly agree
The proposed legislation has increased uncertainty pertaining to water market transfers	2	-	3	10	29
The proposed legislation will lead to fewer water market transactions	3	-	6	15	20
You will have less incentive to invest in irrigation technology	4	4	5	10	21
Selling some of your water use licence will jeopardise your future water allocation	4	6	8	10	16
Free unrestrained trading of water use rights is good for farmers	2	-	2	15	25

Within the Lower Orange Region, the proposed water legislation has already had a negative influence in bringing water transfers among farmers to a standstill. This is reflected in Table 8.1 with 88 percent of sample farmers stating that the proposed amendments to the water legislation had created widespread uncertainty pertaining to water market transfers, and 80 percent believing the new legislation would lead to fewer water market transactions. Fifty-nine percent of sample farmers also believed that under the new Water Law, any sale of water to another farmer would jeopardise the success of their application for reregistration of their water rights.

Since all existing rights may not necessarily be recognized under the new water legislation, (ie unused water rights), and applications for renewal will not necessarily be approved, is of great concern to survey respondents in the Lower Orange Region since production is totally dependent on water available for irrigation. This effectively transfers the power of decision from the individual user to the government, and empowers the government with total control over farming operations, since it decides how long a farmer can farm; 5 years or 40 years. This has negative implications on land values if a farmer's application for renewal is not granted, resulting in an

effective nationalisation of property. Temporary water use licenses are expected to result in the devaluation in property values in the Lower Orange Region, negatively affecting farmers' credit worthiness and constraining farm investment decisions (Burger, 1997). Table 8.1 shows that 71 percent of the sample respondents believed that they would have less incentive to invest in irrigation technology under the new Water Law, in which farmers' water rights would be transformed into temporary water use licenses. Table grape farmers, facing establishment costs in the region of R100 000/ha, remain uncertain as to the security of water rights they have purchased to expand production in future, but which will revert to a temporary licence under the new Water Act. In any event, investments in expensive irrigation technologies are unlikely under a system of temporary use allocations that may be controlled, limited or prohibited by government.

Along the uMhlatuze River, a set of four statements were used to capture farmers' perceptions about the new Water Law and some of its likely impacts.

Table 8.2: Responses of sample farmers along the uMhlatuze River to statements regarding the proposed new Water Law, (n=22).

Statement	strongly disagree	disagree	uncertain	agree	strongly agree
The new Water Law has created widespread uncertainty about the long term security of your water use rights n=21	-	-	3	5	13
Under the new Water Law, the collateral value of your property is expected to decline n=22	-	1	5	6	10
Under the new Water Law, you will have less incentive to invest in irrigation technology and other production inputs n=21	5	5	4	4	3
Selling some of your water use right under the new Water Law will negatively influence the success of your reregistration of water use rights n=20	-	1	1	8	10

The table shows that 86 percent of respondents in the Nkwaleni Valley believed the proposed

new Water Law had created widespread uncertainty about the long term security of water rights. Despite the large number of respondents believing that uncertainty over water rights security had increased, only 33 percent of farmers believed they would have less incentive to invest in irrigation technology and other production inputs. Forty-eight percent of the respondents believed they would actually have incentive to invest in irrigation technology under the new Water Law, since water would have to be used more efficiently owing to increasing water levies and the growing scarcity of water. However, 72 percent of the sample farmers felt that the implementation of the new Water Law would be associated with a decline in the collateral value of their property, and 90 percent of respondents believed that the sale of some of their water use rights under the new Water Law would negatively influence the success of their reregistration of water use rights.

The results suggest that under the DWAF policy to attempt to allocate precise water entitlements at a point in time to individual irrigators, these farmers will be unwilling to trade these rights under the new Water Law, owing to significant uncertainty that exists over the duration and assurance of water entitlements.

8.4 The quantification of irrigation water use rights under the new Water Law

Under the new Water Law the first claim on available surface water in a river catchment will be for basic human needs. This is embodied in principle 8 (Appendix 1) which states that *"the water required to ensure that all people have access to sufficient water shall be reserved."* Basic human needs are defined as 25 litres per capita per day (Department of Water Affairs and Forestry, 1998b). The second claim on water in a catchment is for long-run ecological sustainability. According to principle 9 (Appendix 1), *"the quantity, quality and reliability of*

water required to maintain the ecological functions on which humans depend shall be reserved so that the human use of water does not individually or cumulatively compromise the long term sustainability of aquatic and associated ecosystems." The quality and quantity of water to be reserved for ecology depend on the needs of individual catchments. The ecological reserve for each catchment will have to be determined by the DWAF with the aid of appropriate models. Instream flow requirements should be expressed as seasonal low flows, freshes and floods, and encompass the natural variability of drought, normal, and wet years. In determining the ecological reserve it should be noted that instream flow requirement as a proportion of natural flow will vary from river to river, depending on the desired ecological state of the river (Department of Water Affairs and Forestry, 1998b).

These claims on water resources are formally defined as the Reserve under the new Water Law. Principle 10 (Appendix 1) emphasises that *"the water required to meet the basic human needs referred to in Principle 8 and the needs of the environment shall be identified as the Reserve and shall enjoy priority of use by right. The use of water for all other purposes shall be subject to authorisation."* In addition, where river catchments are shared with neighbouring countries, principle 11 (Appendix 1) states that *"shared river systems shall be managed in a manner that optimises the benefits for all parties in a spirit of mutual co-operation. Allocations agreed for downstream countries shall be respected."* Basic determination of water to be assigned to the Reserve, international obligations, and available for allocation to water users in each catchment will have to be undertaken by the DWAF. The reserve has economic implications, in that less water will be available in the form of irrigation water use rights that could possibly be traded through a water market, and other use rights. Trading of water use licenses by farmers under the new Water Law will have to take place within the irrigation water allocation over and above the

water right reserved for basic human needs, ecological requirements and international obligations, as well as other legal non-agricultural water allocations.

Within each catchment, the quantification of irrigation water use rights will have to be undertaken subsequent to the determination of (a) the volume of water needed to satisfy the Reserve and international obligations, (b) the volume of water to be held in the public trust, and (c) the volume of water to satisfy the allocation of future licenses. The quantification of water available for allocation to the irrigation sector within a catchment, and to individual irrigators should be based on that estimated to be available 85 percent of the time (Easter, 1996). Thus in 15 percent of years there will be a shortage and water rights will be reduced proportionately. Where possible, users should be allowed to bank water rights during surplus periods and use them during droughts.

The specification of the consumptive portion of the water use licence is the favoured approach in dealing with return flows. This approach has been adopted in both the Western US and Mexico, and significantly reduces negative third-party effects resulting from water trading activity. This is an important consideration within the context of the new Water Law in South Africa which provides for strong protection of water designated for the Reserve to satisfy basic human and ecological requirements. The National Water Act (Government Gazette, 1998) states that a person must allow the water emanating as seepage or run off after water has been used, to be returned to the source, or to such a water resource, place or area as the CMA may direct. In well watered areas where return flows are not significant, the consumptive portion of the water rights could be specified as 100 percent of the water use licence. In existing state water schemes where irrigators are allocated precise water volumes from impounded water, these allocations are

generally calculated based on the storage capacity of the impoundment and do not include a return flow component. As a result, the consumptive portion of the water use licence could again be specified as 100 percent of the water use licence. This would effectively eliminate transaction costs associated with negative return flow impacts and improve the efficiency of market reallocation of water use licenses.

In other areas it will be necessary for Government to appoint consulting engineers or hydrologists to quantify the consumptive portion of individual water allocations. This information should be submitted together with any application to transfer those water use rights, for the approval of the WUA or CMA. Transfers of water for quantities up to the consumptive portion of each water use allocation should be permitted by the WUA or CMA.

8.5 Catchment management agencies under the new Water Law

The new Water Act emphasises the importance that catchments be viewed as complete management units, under an appropriate management structure that streamlines the functions and structure of bodies responsible for its management. The White Paper on Water Policy (Department of Water Affairs and Forestry, 1997c) advocates the use of integrated catchment management (ICM) objectives to improve management over land, water and other interdependent attributes in every catchment. ICM represents a systems approach to managing water resources within a geographical area that is based on the catchment of a single river system. The ICM philosophy is based on the consideration of the whole natural system, in which individual components do not exist in isolation from one another. The ICM process aims to include both government and local communities in water management decisions in developing a regional scale management plan that incorporates environmental, social, and economic considerations.

The National Water Bill (Department of Water Affairs and Forestry, 1998c) states that ICM will be implemented in individual catchments in a six-phase process. In the first step, the Minister will divide the country into water management areas and establish a catchment management agency (CMA) for each area. The CMA would be responsible for all aspects of water resource management (Department of Water Affairs and Forestry, 1996). This is reflected in principle 23 of the White Paper (Appendix 1) which states that *"responsibility for the development, apportionment and management of available water resources shall, where possible and appropriate, be delegated to a catchment or regional level in such a manner as to enable interested parties to participate."* This provides for a catchment management organisational structure with a certain level of central or regional government authority and user-representative participation. The CMA's would have a wider or more restricted range of functions delegated to them from the DWAF, depending on the requirements of the specific catchments. The second step would involve the development of a system to classify significant water resources in the catchment. In the third step, the Minister would be required to determine the Reserve for each significant water resource in a catchment area. Step four involves the determination of the resource quality objectives for each class of water by the Minister. These objectives involve the determination of instream flows, water level, concentration of particular substances, characteristics of the riverine environment and the water resource, distribution of aquatic biota, and the regulation or prohibition of instream or land uses which may affect the quality or quantity of the water resource. Step five involves the development of water allocation plans. In this process, the Minister will determine which water resources require water allocation plans, what will be included in such plans, how they will be adopted, and when they must be reviewed. The allocation plans will contain principles for allocation and use of water so that recognition is given to existing lawful users, an equitable balance is achieved between social, economic and

environmental water needs, and corrective action is taken to redress past discrimination in allocation of water. The Minister will also develop a method for allocating water administratively, by tender or by auction, after provision has been made for the Reserve, international obligations, existing lawful users and corrective action, and subsequent licenses. The policy regarding trading of water use rights will have to be included in the CMA plan, and the process by which transfers of water rights can be achieved specified in the plan. The final step is to develop strategies to guide future decisions about the development, conservation, protection, use, management and control of each water resource in a catchment by the Minister, or where appropriate, a CMA.

Existing irrigation boards, water control boards and water boards established for stock watering purposes will be restructured under the new Water Law as WUA's. The Minister will have the power to establish a WUA on his own initiative or following the proposal by one or more persons in the proposed area of operation, determine the area of operation of the WUA, and approve its constitution. In addition the Minister will have wide power to intervene in a WUA, to the point of withholding funds, terminating the office of members of management, or taking over the management of the WUA. Membership to a WUA can also be declared as mandatory by the Minister.

In accordance with WUA's established in Chile and Mexico, WUA's could play an expanded role in the reallocation of water use rights, collection of water levies, monitoring of water extraction, maintenance and operation of infrastructure, and in facilitating market trades of water use rights among WUA members. The WUA's would be central to any water market in recording transfers, ensuring legal determinants of water transfers are adhered to, providing market

information and resolving disputes among parties. In most cases the establishment of a WUA could be a natural development of existing irrigation boards and advisory committees on existing water schemes. However, the new Water Law does not provide for extensive turnover of water management to WUA's, but rather retains strong government control over WUA function. Decentralisation of management authority to WUA's would be necessary to promote the establishment of water markets, since conditions in each WUA control area may be unique, and comprehensive plans by government for limited water market establishment may not be appropriate.

The national water pricing policy as developed by the DWAF (1998b) advances a water levy that will be charged to individual users within a catchment management area or sub-catchment management area and will be composed of three costs. The first cost component is an infrastructure charge that reflects the cost of the infrastructure capacity to abstract water. This will be levied only on the users of the infrastructure. The second cost component is a catchment management charge reflecting the cost of regulating, managing and maintaining the water resource. The final cost component is a resource conservation charge that aims to reflect the relative scarcity of water in the particular catchment. The latter two charges will be levied on all water users within a catchment. The objective of the resource conservation charge as stated by the DWAF (1998b) will be to provide incentive for water to be allocated to users who value it highly. As noted in Section 2.1, accurate bureaucratic determination of the scarcity value of water is difficult to achieve since it varies according to location, reliability, season, use, and water quality, and requires effective and inexpensive monitoring of water flows. Promoting the operation of a water market and allowing for the collection of the infrastructure and catchment management levies by a WUA, while at the same time allowing for a certain level of government

regulation, could be a more realistic alternative. To permit a well-functioning water market it will be necessary that water charges levied by the authorities are known in advance and be predictable well into the future.

CHAPTER 9

DISCUSSION AND POLICY IMPLICATIONS

The trading of "outer land" water rights amongst farmers in the Lower Orange River can be viewed largely as an institutional response to the increasing pressure placed on the agricultural water allocation by table grape farmers wishing to expand their operations. While the "outer land" water rights transferred for a price, they did so within a regulated overall non-market allocation environment controlled by the DWAF. The water market that emerged along the Lower Orange River was not fully developed since only the reallocation of unused "outer land" water rights was facilitated through the market function. No inter-sectoral trading was permitted, nor market transfer of canal water enacted. A number of farmers did however switch their own canal water rights to their "outer land" whilst irrigating their "inner land" with their river water right in an attempt to minimise the cost of transporting water to their land. Although water rights and land were not used in fixed proportions, allowing a farmer to save water and irrigate a larger area, or transfer the saved water through the market, no transfers of conserved water had developed in practice. A possible reason for this is that farmers may prefer to retain conserved water for water supply security. No temporary water transfers had taken place, which may be explained by the high fixed costs involved in transporting the water to the "outer land" and developing this land for irrigation purposes, and the high fixed transaction cost of hiring a lawyer in the transfer process.

The market in "outer land" water rights along the Lower Orange River emerged within the centralised non-market allocation environment, despite a significant extent of bureaucratic regulation imparted on the market by the DWAF. While some regulations are desirable to ensure

that negative impacts of water trading are minimised, much of the regulation governing the trading of "outer land" water rights serves to increase transaction costs unnecessarily. These regulations include the overly bureaucratic process to apply for the transfer of water rights, and the necessity to obtain a cultivation certificate prior to purchasing water rights for land intended for irrigation. Nevertheless, a number of institutional arrangements furthered the emergence of the market for "outer land" water rights:

Firstly, the unit of measurement of "outer land" water rights was completely specified as a diversion right of 15000m^3/ha/year. These rights had a high-implied reliability since a river water right of 15000m^3/ha/year was effectively declared in each year since river water rights were initially allocated in 1977, and only in one year was a temporary restriction placed on water extraction. The specification of all irrigation water rights as proportional, allowed the extent and risk associated with restrictions to be spread equally among all rights holders. Under the existing South African Water Law, these irrigation water rights also enjoyed high priority, assuring irrigators of rights senior to industrial water rights, and junior only to household and stock watering requirements. (This will change under the new Water Law, in which the Reserve will be the only right to be assured, followed sequentially by household, industrial, and finally irrigation use allocations.) These factors created certainty among parties as to exactly what was being traded, and predictability in outcome of the reallocation process.

Secondly, "outer land" water rights were transferable between irrigable properties, and trades legally sanctioned by government from March 1993. However, before individual transfers could proceed, the bureaucratically determined conditions laid down by the Minister had to be satisfied. Ensuring that the potential water trade complied with these regulations would certainly have

increased transaction costs, complicating trading through the bureaucracy introduced into the transfer process. As a result of these regulations, water transfers were not simple voluntary trades between two parties, but rather voluntary negotiated transactions between the two parties and bureaucratic authorities. Nonetheless, the transferability of "outer land" water rights among irrigable properties created exposure to farmers with poor "outer land" soils to realise higher valued alternatives through the transfer of these rights to table grape farmers with more fertile "outer land". However, the coupling of "outer land" water rights to land prevented any transfers of irrigation water to higher valued urban uses, eliminating the potential to generate water savings within the agricultural sector that could be reallocated to urban uses.

Thirdly, the controlled environment in which water rights were allocated provided for water rights that were wholly enforceable and secure, assuring that the benefits from the use of the water were secured for the right holder. The extension of legal sanction to water transfers between irrigable properties by the DWAF and guarantee of authorisation of the purchased water rights afforded the traded water rights with a high degree of enforceability and security. Conflicts among users of "outer land" water rights were non-existent, owing to the appearance that only a fraction of allocated "outer land" water rights were being exercised by farmers. While 40 percent of survey respondents were unsure as to what penalties resulted from over-use of such rights, this may be due to a large number of farmers with river water rights either irrigating only a fraction of the land coupled to the water right or not making use of the water right at all. As a result monitoring of these rights at present may not be a critical issue. This situation may change in future as more river water rights are exercised, requiring more intensive monitoring of pump meters and the existence of a transparent penalty structure.

Fourthly, the administrative function performed by the regional DWAF was central to the successful establishment and functioning of the water market. The transfer process as specified by the DWAF was clearly defined and well understood by market participants. The transfer process was however guided heavily by bureaucratic regulation that may have served to complicate transfers and increase transaction costs. The first of these regulations, that a farmer obtain a cultivation certificate at his expense to prove any land for which an application had been filed to incorporate or purchase an "outer land" water right was suitable to irrigation, directly increased the transaction cost. Secondly, both application categories were forwarded to the DWAF head office in Pretoria for approval, providing for a more lengthy approval process than if the regional DWAF office were able to approve transfers. In applications to purchase water rights, no recognition was taken of the fact that the market process would potentially transfer water rights from lower potential soils to higher potential soils. The supervising and recording function of water trades by the regional DWAF office was important in maintaining the correct chain of command over water rights and ensuring transfers were concluded within three to six months. In addition, the DWAF performed an important role as provider of market information, matching potential sellers and buyers. These functions of the DWAF served to minimise transaction costs to an extent, but on the other hand, transaction costs stemming from the elaborate bureaucratic regulations that had to be satisfied before transfers could proceed, and from the approval process governing water rights trading, may have been unnecessarily high. All water trades, however, must take place within certain rules for the market to function efficiently. Certain transaction costs within a water market are essential. Doing away with these transaction costs would dramatically increase the legal costs associated with water trades. As a result, a minimum level of appropriate institutional rules and corresponding transaction costs will always be necessary to promote voluntary transfers within a market environment.

Finally, the specification of water rights as diversion rights, allowed for transfers within the Lower Orange River for the full quantity of the water right allocation. Since no return flow requirement had been calculated and implemented for water rights within the Lower Orange irrigation scheme, there was no onus on buyer or seller to determine the effects of the transfer on the other water users. This enabled transfers to take place through administrative procedure with no lengthy adjudication processes, to ensure there were no adverse impacts associated with each particular transfer. However, research conducted by Bruinette Kruger Stoffburg (1998) on evaporation losses from the Orange River downstream of the Van der Kloof Dam, found that irrigation return flows are important and should be considered in any water balance calculation. At Vioolsdift in the Lower Orange River, a tracer monitoring study of irrigation return flow retention times was conducted. Volumetric return flow from applied flood irrigation water was estimated to be in the order of 33 percent. A second return flow analysis at Louisvale, near Upington, measured average volumetric return flow at 30 percent. Finally, a return flow estimation accounting for Total Dissolved Solids indicated that in broad terms, return flows of 15 to 20 percent could be expected along the Lower Orange River (Bruinette Kruger Stoffburg, 1998). Thus, where return flows contribute significantly to the total flow of the river, water transfers should be specified for the consumptive portion of the water right. Where return flows are significant and where water transfers could impact negatively on the ecology of the river, water transfers could possibly be prohibited if this externality could not be internalised by specifying the consumptive portion of the right.

The driving force in market development were the expectations of Sellers that economic benefits from the sale of water rights were more attractive than benefits flowing from their potential use of the water, and the expectations of Buyers that economic gains could be captured from the

expansion of their profitable table grape activities. In accordance with economic theory, the first water to transfer through the market was from the least productive, marginal irrigable land. Participation in the market process resulted in an economically efficient allocation of "outer land" water by placing rights in their highest valued agricultural use in a flexible manner, and have the potential to create employment opportunities and stimulate significant investment through the development of Buyers "outer land" for table grape production.

Discriminant analysis results highlight the efficiency improvements resulting from market allocation. In the first discriminant function between Buyers and Sellers of water rights along the Lower Orange River the most important discriminating variable was whether the farmer grew table grapes or not. This shows that water rights moved from potentially lower valued users, with the opportunity to cultivate only wine grapes, raisin grapes and field crops, to table grape farmers representing the highest valued use of the water right. The second most important variable was the estimated return per unit of water applied showing that water gravitated to those farmers best able to utilize the water in their farm operations. The location of the farm in a potential table grape producing area and the existence of undeveloped arable land on the farm were the next most important variables in determining whether a farmer bought or sold water rights. The discriminant analysis results suggest that irrigation techniques used by Buyers and Sellers were not significant in directing the transfer of water rights. This may be attributed to the opportunity cost for water being similar for Buyers and Sellers, and because irrigation systems are adopted largely for practical reasons linked to crop choice. Flood irrigation systems appear almost exclusively in the "inner land", where soils have a high clay content and water holding capacity. These lands are generally within the flood zone of the river, where the risk of damage to micro and drip systems from periodic flooding is high, and existing canal infrastructure is in place to

allow for easy delivery of the water. The predominance of micro and drip systems on Buyers' "outer land" is explained by the lower clay content and water retention capability of this soil which demands more efficient water application techniques as a result. Micro irrigation is also favoured for its important cooling effect on the table grape crop. As a result, "outer land" is generally amenable mainly to micro and drip irrigation, using water pumped directly from the river, while "inner land" is amenable to flood irrigation systems using gravity fed water from existing canal infrastructure.

In the second discriminant function between Buyers and Non-Buyers of water rights along the Lower Orange River, the estimated return per unit of water applied was the main variable discriminating between Buyers and Non-Buyers. This shows that water tended to transfer to the most efficient farmers, best able to utilize the water in their farm operations. Water rights also moved from potentially lower valued users, with the opportunity to cultivate only wine and raisin grapes, to table grape farmers representing the highest potential valued use of the water right. In addition, the efficiency gains in bringing fertile undeveloped arable "outer land" into production are highlighted by the results, by showing that Buyers have proportionally more arable land that can be developed for irrigation purposes.

While participation in the market proved successful in transferring "outer land" water rights, a number of institutional responses to the *status quo* regarding water trading could strengthen the market and extend its applicability to include all irrigation water rights. These include: (1) Allowing farmers to develop land without the need to obtain a cultivation certificate. In this way the market will determine which land will be developed for irrigation, and farmers can expand production using conserved water or purchased water. Water rights would be expected to transfer

to the highest valued uses generated from the more productive soils. (2) Reducing the bureaucracy involved in obtaining approval of water rights transfers, by eliminating the approval necessary from the DWAF head office, will improve the ease with which market transactions occur. However this may be tempered by providing the regional DWAF office or the CMA with the authority to approve and supervise transactions, as well as to prevent and resolve conflicts among users. (3) Continuing the administrative function performed by the regional DWAF office in recording and monitoring water transfers. The extension of this support to allow for the reallocation of canal water and any conserved water, through permanent or temporary transactions, as and when the demand arises will promote the resultant market. (4) Over time, the restriction that water transfers occur only within the irrigation sector could be relaxed to allow for inter-sectoral trading of water rights. This would allow potential sellers to sell water to higher valued urban uses and receive effective compensation, while at the same time generating the expected water savings within the irrigation sector.

Since water trades along the Lower Orange River generally involved a transfer from non-use to table grape irrigation, changes in the pattern of water use in the study area due to water market activity may create marginal impacts on lower basin water users and the environment. Agricultural users in lower basins may face increased water salinity as a result of increased upstream irrigation water use. The Reserve to sustain the environment and meet basic human needs, and normal flow to satisfy equity objectives must be considered. For these reasons, trading of water use rights in the future will only take place over and above the Reserve; which constitutes basic human needs, instream flow requirements, and international obligations. Procedures to identify negative external effects of a transfer and to resolve conflicts among users by the regional DWAF, along with the definition of a transparent channel for airing grievances

arising from water trading activity, may become necessary as water demand rises.

In contrast to the Lower Orange River, where demonstrated demand by individual farmers preceded the establishment of the water market, it seems unlikely that similar demonstrated demand in the Nkwaleni Valley for change in the institutional framework to enable trading of water rights will develop amongst irrigation farmers under current arrangements. Potential market development is shown by a significant number of farmers who want to purchase water rights at present, and a high and rapidly increasing demand for water by downstream industrial and municipal concerns in Empangeni and Richards Bay. However, this market potential appears to be constrained by the lack of any willing sellers of water rights. A number of reasons may explain this. Firstly, crops produced by potential Buyers (70 percent sugar cane and 26 percent citrus) in the Nkwaleni Valley are not vastly more profitable than crops produced by Non-Buyers (56 percent sugar cane and 38 percent citrus). This contrasts with farmers in the Lower Orange River, where Buyers of water rights invariably produce highly profitable table grapes. Secondly, transaction costs may exceed the difference in value of water to the potential buyer and seller. Farmers may also wish to retain surplus water for security against drought, owing to the unreliable nature of river flow in the region. Finally, farmers appear to be using all their water in their farm operations and may be unwilling to sell water rights for land they have already developed, as this would involve sacrificing the development cost of the land.

Under present conditions, farmers in the Nkwaleni Valley currently have the option of paying only for each cubic metre of water extracted up to their maximum water allocation. Any unused agricultural water is temporarily reallocated to industry downstream by DWAF. This reallocation occurs without the farmers having to spend effort in permanently or temporarily alienating the

unused rights, and reduces risk by ensuring the farmer retains title to the entire water right allocation in future. While many farmers perceived this to be beneficial, farmers with unused water lose income from potential rental (or sale) transactions with industry under such a system. As a result, political resistance to the development of a water market in future may be likely from industrial users, who are currently reallocated unused agricultural water without having to compensate the farmer.

A potential tradable margin of water rights may develop in future as farmers switch to more effective water-saving drip and micro technology in response to rising water levies. These levies have increased over 50 percent annually over the past two years. The existence of a number of private storage dams and extensive canal infrastructure in the Nkwaleni Valley would promote delivery of purchased water rights, and flexibility in the allocation process. Initiating institutional change towards market trading of water rights in the Nkwaleni Valley will require that a number of issues be considered. Water rights are well defined but have low reliability, potentially driving down market prices and constraining transfers. Agricultural water sold to industry will have to be specified as having either industrial or agricultural water priority. If agricultural water sold to industry is given industrial priority, this water will be assured to industry in times of drought, reducing the total agricultural water base that can be allocated to individual farmers by the DWAF. Continued monitoring of water extraction by the NIB and DWAF will be important to ensure the enforceability of water allocations, while guarantee of water right authorisations and authorisation for purchased water allocations under the new Water Act will provide for secure rights. In any event, the emergence of a market will depend on how well transaction costs are minimised by the administrative function performed by the NIB and DWAF, in defining a transparent transfer process, supervising and recording trades, and resolving conflicts among

members. The existing framework of NIB control provides for a highly organised water management structure that could support the development of a water market. This would be important in resolving likely third-party effects resulting from market transfers along the uMhlatuze River, owing to the small and variable flow of the river, and substantial existing demand for water.

The new Water Act has important implications for irrigation farmers. The authorisation of only temporary use rights, will effectively reduce the collateral value of irrigation properties, and distort farmer incentives to make more productive and sustainable use of available water. By invalidating individual ownership of water, the new Water Law severely attenuates water rights and moves away from the present permanent land-linked water rights to a time limited water use allocation, without compensation or recognition that water rights were paid for by the owner in the capitalised land value. For farmers who have purchased water rights, this attenuation of these property rights may be unconstitutional, since the constitution states that *"property may only be expropriated in terms of law of general application for a public purpose or in the public interest, and subject to compensation"*. Increased centralist intervention in water management may place irrigation farmers under increased financial pressure resulting from higher tariffs and levies, and excessive regulation of water usage. Land values could decline in the long term as a result of excessive taxation of water usage and restricted scope for increased profitability. Finally, the restrictive and discriminatory conditions of the new Water Law will likely deter investors in irrigated agriculture.

While equity objectives are important factors to be addressed in the future through government intervention, continued and increased function of water markets could lead to efficiency in water

use and allocation, by forcing irrigators to face the full opportunity cost of water use. In both study areas, a water market will depend on the formal sanction of water trading under the new Water Act. Where water trading is permitted under the new Water Act, it is important that the institutional environment promote the market system. However, it can be argued that the bureaucratic climate in which water transfers will have to occur, will be inhibiting to market development. Firstly, while water use licenses will be well defined in the unit of measurement and be enforceable, these licenses will not be held by irrigators with complete security since they will not be held in perpetuity and will not give a guaranteed assurance of supply or quality. In addition, any water use allocation may be temporarily controlled, limited or prohibited, and irrigation allocations will enjoy the lowest priority. Variability in water rights that exists under current arrangements may increase under the new Water Act from increased bureaucratic control over water allocation and governments commitment to manage water resources in the public interest. These factors will create substantial uncertainty over the security of water rights and may preclude any trading of water use rights. Secondly, while water use licenses may be made transferable in limited areas, any transfers will essentially be limited to rentals for the duration of the temporary water use allocation, thus eliminating the potential benefits accruing from permanent water transactions. Thirdly, the reality of no exclusive private control over water management and temporary water use allocations facing irrigation farmers will stifle farmer incentives to buy or sell water rights in certain instances. Farmers will not have sufficient incentives to invest in water-saving technology and other production inputs if there is uncertainty about water ownership. Investments in the establishment of table grapes average R150000/ha, and if water rights are less secure, the risk associated such an investment will be substantially increased. Incentives to purchase water rights for arable land, to be developed and equipped with costly irrigation systems, will be severely distorted, as will producer incentives to change to more

efficient irrigation techniques or less water intensive crops and use the conserved water to expand production or sell to another user.

The success of market-like allocation mechanisms under the new Water Act will require: (1) Legal recognition of water trading as a primary water allocation mechanism in a particular river catchment. This will extend assurance to transactors of the enforceability of purchased water rights and that the reregistration of their water use licenses will not be compromised through the selling of some of their water rights. Water use licenses must also be clearly specified in terms of their transferability. (2) WUA's should be delegated authority to authorise trades within their control area in an attempt to minimise the bureaucracy involved with the approval process. The WUA administrative function in defining the transfer process, recording the transfers, and preventing and resolving conflicts among members would be important to the establishment and promotion of the market. Market efficiency would be promoted to the extent that the administrative function of the WUA reduced transaction costs in the transfer process defined by the DWAF. (3) Water trades between different members of WUA's should be approved by the CMA to ensure that negative external impacts associated with the transfer are minimised. Where water use licenses are allocated according to the volume of water in storage independently of the return flows of other users, the consumptive portion of the use license could be specified as the full quantity of the water use license. This would eliminate third-party effects associated with water transfers. In areas where the rights of downstream users are dependent on the return flows of upstream users, the consumptive portion of the use right should be specified. (4) The CMA should also involve itself in the resolution of conflicts that arise from potential water trades among and between WUA members. A procedure to identify third-party effects and avenue for airing grievances should be established. In the interest of market efficiency, regulations imposed

on water trading should be limited to those preventing negative third-party effects, and should not constrain voluntary trades unnecessarily. The extent to which bureaucracy in the transfer process were eliminated, the market would operate more successfully. (5) Importantly, water trading will depend on whether water use allocations are allocated for both reasonably long periods of time, and the extent to which they are given certainty (assurance) and definition needed for a market. This will depend on (a) the extent to which individual use rights are legally recognised, (b) minimal government interference in these rights, and (c) the willingness of legislatures to define the scope of the public interest in the water resource. Clearly detailed definition of both current and future public interests in water supplies is unlikely from government given the current emphasis on protecting expanding public interests. As a result, public interests will remain ill-defined and flexible, in turn leading to lack of definition and certainty of individual use rights. Following the Mexican example, water rights should be allocated to irrigators for periods close to 40 years. In Mexico, active development of water markets has taken place despite all water being declared as public property, partly because the majority of irrigation water use rights have been specified for 50 years in length on a volumetric basis separate from land rights (Easter, 1996).

CONCLUSION

Water resources would be used more efficiently and allocative efficiency improved if water use rights could be traded through a water market. In river catchments where water is scarce, the establishment of water markets, along with local water user participation in water management through the organisation of Water User Associations, would improve the efficiency of water allocation over existing bureaucratic allocations by a centralised agency. Government agencies have an important role in such water markets by designing appropriate legislation and regulations governing water trading, and strengthening private and public organisations to administer these rules. An appropriate level of government regulation over water market trading would provide for voluntary trades between water users while at the same time protecting against monopoly development, untenable effects on the environment and other third-parties, and provide a structure to resolve conflicts among water users.

In the Lower Orange River, market development for "outer land" water rights among irrigation farmers can be attributed to the scarcity of water in this region and increasing demand for river water rights by table grape farmers wanting to expand production. The large number of willing sellers, and the role played by the Department of Water Affairs and Forestry in administering market transfers, thereby minimising transaction costs and time to an extent, facilitated the emergence of the market.

Empirical findings presented in this study support the argument that tradable water rights will lead to improvements in the efficiency of water allocation and use. "Outer land" water rights along the Lower Orange River moved from lower valued users with the potential to grow wine

grapes, raisin grapes, and field crops to higher valued users with the potential to grow table grapes. These farmers had the highest estimated return per unit of water applied showing that water rights gravitated to the most efficient users of water. As a direct result of the transfers, previously undeveloped high potential arable land was brought into production. This in turn will lead to an associated increase in investment and employment opportunities, as well as an increase in agricultural productivity.

Improving the efficiency of water market trading along the Lower Orange River could be achieved by the delegation of authority to the regional Department of Water Affairs to approve transfers, extending support to market transfers of canal water and conserved water, and ensuring that water extraction is closely assessed as use of river water increases in future.

In the Nkwaleni Valley, no market trading of water rights had developed along the uMhlatuze River, despite the scarcity of water in the region. Forty-one percent of survey respondents wanted to purchase water rights. However, there were no willing sellers of water rights. Farmers tend to use all their water rights in their farming operations, and capital investment in irrigated land may inhibit the sale of water rights from this land. Irrigators may also prefer to retain excess water for water supply security. In addition, the crops produced by potential Buyers are not significantly more profitable than crops produced by Non-Buyers. As a result, farmers with unused or underutilised water rights may have little incentive to enter into water market transactions. At present, farmers are able to pay only for water extracted up to their maximum water allocation, with any unused water reallocated to industry by the Department of Water Affairs and Forestry. Under such a system, farmers with unused water are unable to realise potential rental or sale income from water transfers, and resistance to a potential future water market from industry may

develop.

Establishing tradable water use rights in South Africa requires a number of institutional and organisational contributions, including procedures for formalising water licenses and resolving water disputes. The quantification of water use licenses of individual irrigators will be necessary. Basic determination of the volume of water available in each catchment for allocation to individual farmers will be needed, after allocations to the Reserve, international requirements, and other use sectors have been satisfied. Individual licenses should be quantified as the estimated volume of water available 85 percent of the time, with proportional sharing of shortages among all irrigators.

The new Water Act will certainly defile the overall farming environment faced by individual irrigators. Under the new Act, the collateral value of irrigation properties will fall, affecting farmers' financing decisions by reducing their ability to raise lower interest rate loans. Farmers' investment and production decisions will also be influenced by the temporary nature and limited duration of water use rights, through the distortion of incentives to invest in water saving technology and other production inputs. If water use licenses are issued for insufficient duration, or if uncertainty about the security of water use licenses increases owing to government intervention in licenses, this will deter farmers from cultivating undeveloped land and establishing costly irrigation systems. Similarly, incentives to change to more efficient water application techniques to generate water savings that may be used to expand production or sold to potential buyers of water rights will also be distorted. This in turn debases the enabling environment necessary for the establishment and operation of a water market.

The overwhelming majority of survey respondents in the Lower Orange Region believed that the new Water Act had created widespread uncertainty about water trading, would lead to fewer water market transactions, and would reduce their incentives to invest in irrigation technology. In both study areas, most respondents believed that any sale of some of their water use licence would negatively influence the success of their reregistration for water use rights. As a result, little support for a water market may emerge under the institutional arrangements specified by the new Water Act.

Addressing equity objectives by improving access to water for previously disadvantaged groups will have to be tackled by government intervention in water allocation. However, in so doing it is important that existing and potential future water markets for irrigation water are not constrained. In areas of the country where water is scarce, the establishment of water markets will improve the efficiency in allocation and use of water use rights issued to individual water users, both within and among sectors. Evidence from Chile and Mexico shows that water markets function best when accompanied by a decentralisation of water management to Water User Associations, which given sufficient incentives and autonomy can perform the functions traditionally administered by government at a fraction of the cost.

Under the new Water Law principles, overcoming institutional and legal barriers for market performance will require that water use allocations to irrigators be specified as perpetual. Existing lawful water rights should be recognised as permanent "water licenses", while new apportionments could be made available with limited duration of variable length. This will empower irrigators to make continued resource related decisions through ownership. Where temporary use licenses are allocated, they should be very long term, with a minimum duration

of 40 years, as in Mexico. Water use rights must be inherently secure and give farmers the assurance necessary for tradable water use rights. Water trading must be also be unequivocally authorised through the relevant legislatures.

For water markets to be considered as a primary allocation mechanism, government must be willing to surrender control over water trades to Water User Associations, as done by the Chilean Government, and focus on oversight responsibilities such as conflict resolution, regulation, and water quality improvement. This however would be highly unlikely given the highly centralised water management climate created by the new Water Act. As an alternative, market based improvements in water use at the district and sector level could be achieved while at the same time allowing government to maintain a greater role in water management by following the Mexican example. This approach permits markets to operate freely within the Water User Association, while trades between Water User Associations require government approval.

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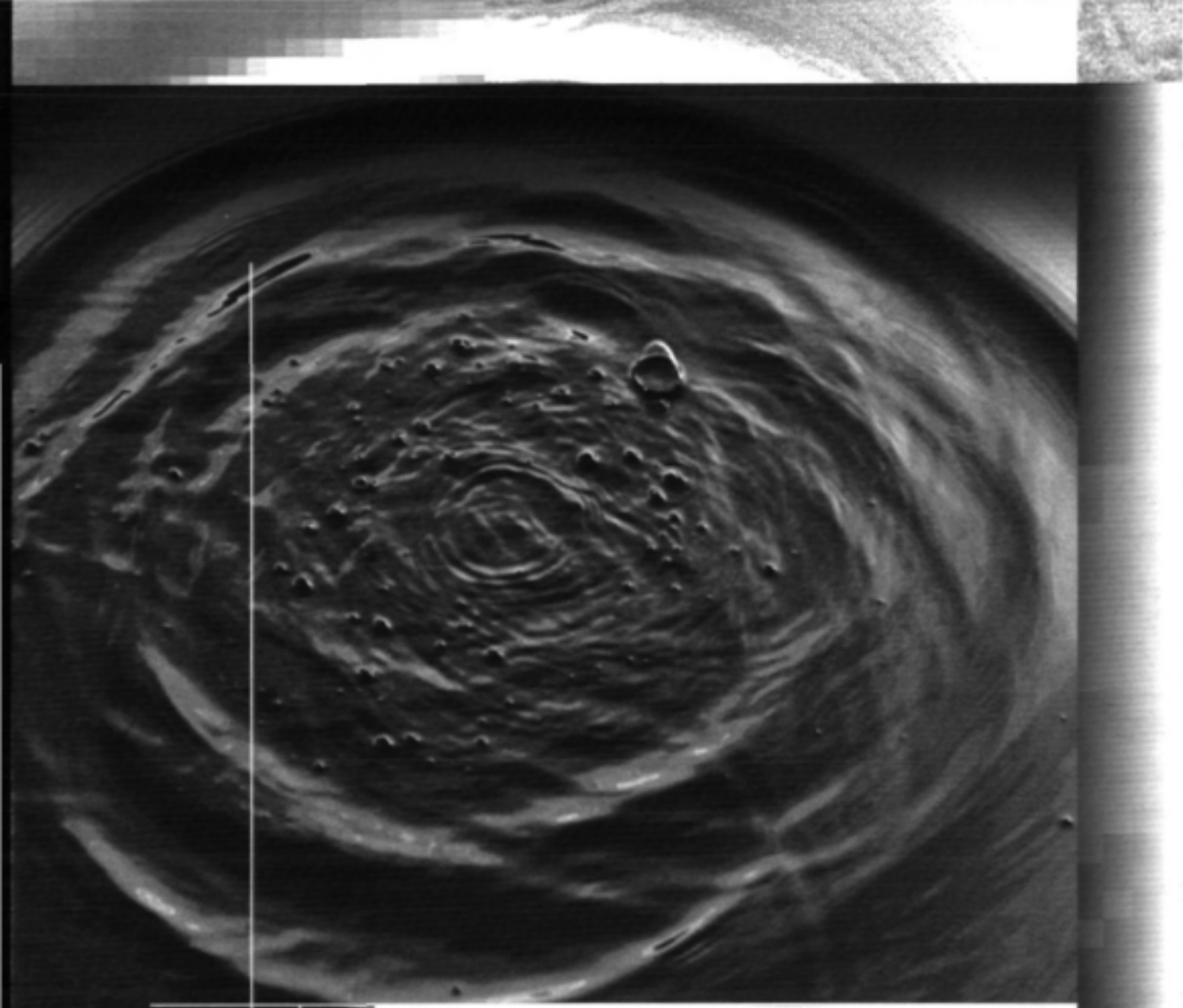

Water Research Commission
PO Box 824, Pretoria, 0001, South Africa
Tel: +27 12 330 0340, Fax: +27 12 331 2565
Web: http://www.wrc.org.za

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