

A CADASTRAL MODEL FOR LOW VALUE LANDS
- THE NSW WESTERN LANDS EXPERIENCE

by
Paul R Harcombe

A Thesis

Submitted in Fulfilment of the Requirements for the Degree
of
Master of Geomatics

Department of Geomatics
The University of Melbourne
Parkville Victoria 3052

ABSTRACT

The operation of the cadastre in the semi-arid lands of Western New South Wales has remained relatively unchanged since early settlement. This thesis examines the problem of sustainable resource use and how the introduction of a Multipurpose Cadastre can provide a more certain future. The development and use of a consistent spatial framework, comprehensive datasets, new rules and procedures for boundary definition and demarcation and use of new technology such as the World Wide Web are proposed as improvements to the existing cadastral system.

ACKNOWLEDGEMENTS

The author wishes to thank a number of people who have provided support and encouragement for this research and its outcomes. To Professor Ian Williamson, Professor of Surveying and Land Information, University of Melbourne, many thanks for your energy, vision and guidance from the start to the finish.

To Professor Don Grant AM, former Surveyor General of New South Wales, my sincere thanks for your faith, ideas, counsel and patience, without which this would not have been possible. To my family, my appreciation for your encouragement and patience and sacrificing much of our family time.

TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION.....	1
1.1 OVERVIEW	1
1.2 BASIC CONCEPTS	4
1.2.1 Cadastral Concepts.....	4
1.2.2 Land Tenure and Titling	16
1.2.3 Land Management and Administration	18
1.2.4 Land Degradation versus Ecological Sustainability	20
1.3 REVIEW OF THESIS.....	23
1.3.1 Statement of Problem.....	23
1.3.2 Research Objectives.....	24
1.3.3 Scope.....	25
1.3.4 Relevance	25
1.3.5 Methodology	26
1.3.6 Thesis Structure	27
1.3.7 Information Collection.....	28
CHAPTER 2: WESTERN LANDS OF NEW SOUTH WALES	31
2.1 DESCRIPTION	32
2.1.1 Environmental Characteristics	34
2.1.2 Economic Forces	35
2.1.3 Social Factors	37
2.1.4 Legal and Administrative Frameworks.....	38
2.1.5 Cadastral Systems.....	39
2.2 THE PROBLEM IN THE WESTERN LANDS OF NSW.....	40
2.2.1 Environmental.....	40
2.2.2 Economic.....	46
2.2.3 Social and Political.....	48
2.2.4 An Outdated Cadastral System	51
2.2.5 Legal Access.....	52
2.3 WEST 2000 RURAL PARTNERSHIP PROGRAM	53
2.4 WESTERN LANDS REVIEW 2000	54
2.5 SUMMARY.....	57
CHAPTER 3: CURRENT CADASTRAL SYSTEM IN WESTERN NEW SOUTH WALES	60
3.1 HISTORICAL BACKGROUND	61
3.1.1 Early Development.....	61
3.1.2 Cadastral Surveying.....	63
3.1.3 Land Titling.....	65
3.1.4 Land Administration	65
3.2 CURRENT SITUATION	66
3.2.1 Cadastral Surveying.....	66
3.2.2 Land Titling and Surveying.....	68
3.2.3 Land and Environmental Management.....	70
3.2.4 Spatial Data Infrastructure - the Role of the Cadastre.....	71
3.2.5 Land Administration	72
3.3 THE NEED TO CHANGE THE CURRENT SYSTEM.....	74
3.3.1 The Information Revolution	74

3.3.2	<i>Government and Community Expectations</i>	77
3.3.3	<i>Native Title</i>	78
3.4	CADASTRAL SYSTEMS IN OTHER AUSTRALIAN STATES	82
3.5	SUMMARY.....	84
CHAPTER 4: INTERNATIONAL TRENDS AND OTHER DEVELOPMENTS AFFECTING CADASTRAL SYSTEMS.....		86
4.1	GLOBAL AND NATIONAL TRENDS AFFECTING THE CADASTRE	87
4.2	BATHURST DECLARATION ON LAND ADMINISTRATION FOR SUSTAINABLE DEVELOPMENT.....	90
4.3	TECHNOLOGY	95
4.4	CADASTRE 2014	96
4.5	MICRO-ECONOMIC REFORM.....	99
4.6	SPATIAL DATA INFRASTRUCTURES	101
4.7	SUMMARY.....	102
CHAPTER 5: A VISION FOR MANAGING LOW VALUE RANGELANDS IN WESTERN NSW		105
5.1	REQUIREMENTS FOR THE EASTERN AND CENTRAL DIVISIONS	106
5.2	REQUIREMENTS FOR THE WESTERN DIVISION.....	111
5.2.1	<i>General</i>	112
5.2.2	<i>Low cost</i>	115
5.2.3	<i>Efficiency and Effectiveness</i>	118
5.2.4	<i>Sustainability</i>	122
CHAPTER 6: A MODEL FOR A MULTIPURPOSE CADASTRE FOR WESTERN NSW		126
6.1	COMPONENTS AND CHARACTERISTICS.....	127
6.1.1	<i>Consistent Spatial Framework</i>	127
6.1.2	<i>Comprehensive Datasets</i>	128
6.1.3	<i>Simplified Cost -Effective Processes</i>	131
6.1.4	<i>Occupational Boundaries, Land Consolidation</i>	133
6.2	LEGISLATIVE FRAMEWORK.....	134
6.3	ENABLING TECHNOLOGIES	137
6.4	INSTITUTIONAL ARRANGEMENTS.....	139
6.5	A NEW MULTIPURPOSE CADASTRAL DATA MODEL	141
6.6	SUMMARY.....	144
CHAPTER 7: EVALUATION OF THE CADASTRAL MODEL		146
7.1	COMPARISON OF THE CADASTRAL MODEL WITH CADASTRE 2014	147
7.2	IMPLEMENTATION AND APPLICABILITY TO OTHER JURISDICTIONS	149
7.3	SUMMARY.....	151
CHAPTER 8: CONCLUSIONS AND RECOMMENDATIONS.....		154
BIBLIOGRAPHY		160

TABLE OF FIGURES

FIGURE 1.1: WESTERN DIVISION OF NEW SOUTH WALES3

FIGURE 1.2: CONCEPTUAL MODEL OF A CLASSICAL EUROPEAN
CADASTRE AFTER THE NRC MULTIPURPOSE CADASTRE,
1983 (WILLIAMSON, 1996)8

FIGURE 1.3: MULTIPURPOSE CADASTRE COMPONENTS (BASED ON
NRC 1983) 11

FIGURE 1.4: STRUCTURE OF A MULTIPURPOSE CADASTRE (AFTER
NRC 1983) 12

FIGURE 1.5: A LAND INFORMATION SYSTEM STRUCTURE (LARSSON,
1991) 15

FIGURE 1.6: LAND MANAGEMENT ARRANGEMENTS (DALE &
McLAUGHLIN, 1988)..... 19

FIGURE 1.7: EROSION HAZARD22

FIGURE 2.1: AUSTRALIAN RANGELAND HEALTH INDEX IN 1996/97,
SHOWING BOUNDARIES AS DEFINED BY THE NATIONAL
RANGELAND MANAGEMENT WORKING GROUP, 1994.
SOURCE-NATIONAL LAND AND WATER RESOURCES
AUDIT-“*RANGELANDS – TRACKING CHANGES, AUSTRALIAN
COLLABORATIVE RANGELAND INFORMATION SYSTEM*”. .33

FIGURE 2.2: FARMERS’ TERMS OF TRADE (SOURCE AUSTRALIA
COMMODITIES VOL.2, NO.4, DECEMBER 1995).....47

CHAPTER 1:

INTRODUCTION

This thesis documents research undertaken into the development of a new model for a cadastral system that is appropriate and applicable for low value lands. In this study special attention is given to low value, semi-arid lands in the Western Lands region of New South Wales.

The need for a contemporary cadastral model that is, a system to manage the recording of all interests in land and their interrelationships to support changing Government and community expectations and current trends influencing cadastral systems is investigated. Against a backdrop of a declining rural economy, serious environmental problems and a Government reform program aimed at restructuring rural activities to restore a balance between economic production and sustainable environmental management, a new system is proposed. The background and objectives of this research are explained within this chapter, as well as key concepts and terminologies. An overview of the research methodology and information collection is included in this introduction.

1.1 Overview

Land is fundamental to all forms of human activity; it provides space to live, work and relax; from it human kind obtains food to consume or sell and the shelter to survive. In recent times, the often-destructive impact of human activity on the land has led to the global need for more careful stewardship of the land, together with the increased use and management of its natural resources at sustainable levels.

Land means different things to different people. To some it is a landscape produced from natural processes; to others it is a resource that along with other human inputs can be exploited in order to achieve economic or subsistence production or conserved to guarantee future biodiversity. Land in modern developed societies includes a range of physical and abstract attributes, from rights to build upon the land to rights to use and exploit natural resources for a range of purposes. Systems that provide information about land and rights and responsibilities in land have a significant role in public administration, land use planning, land development and support the operation of land markets, particularly in an age of a rapidly expanding world population.

Human activity has expanded into a number of areas, which are only marginal in terms of existence or viable economic production. In Australia, the world's driest inhabited continent (Antarctica is the driest), these marginal lands are predominantly semi-arid, where the landscape has been shaped over the years by extremely variable climatic conditions, most notably the absence of a reliable rainfall pattern. The predominance of these semi-arid lands in Australia (more than 70% of the continent) requires special consideration for their effective use or conservation.

Semi-arid lands, which are often regarded as being of limited economic value because of their low production potential, require

careful management to ensure sustainable use of land and renewable resources.

Difficulties faced by low value semi-arid lands or rangelands, comprising the bulk of the Western half or Western Division of NSW (Figure 1.1) include:

- 1 Land degradation including soil erosion, woody weed infestation and salinity problems as a consequence of past land management practices.
- 2 Declining water quality, evidenced by the occurrence of blue-green algal blooms, increased turbidity and the need for increased water treatment of potable water.
- 3 Low commodity prices coupled with rising production costs have increased economic pressures on farmers which in turn has forced some to adopt unsustainable practice.

No other region in NSW has experienced such a marked decline in productivity in recent times. Gross income in the region has declined by an estimated \$200 million over the past 10 years (Western Lands Commission, 1992).

Similar parallels can be drawn from other low value, marginal lands from around the world for example North Africa, and in particular those countries adjoining the Sahara (Falloux, 1989).

New technology has given the ability to better collect and use information `the cadastre and land tenure are largely unchanged.



FIGURE 1.1: WESTERN DIVISION OF NEW SOUTH WALES

Global and national strategies have been devised to address the future form of land tenure and cadastral infrastructures necessary to achieve sustainable development.

Australian Federal and State Governments have endorsed a national strategy for ecological sustainable development that has a primary aim to:

“...meet the needs of Australians today, while conserving our ecosystems for the benefit of future generations. To do this we need to develop ways of using those environmental resources which form the bases of our economy in a way which maintains and, where possible, improves their range, variety and quality.”

(Australian Ecologically Sustainable Development Steering Committee, 1992)

The *Bathurst Declaration on Land Administration for Sustainable Development* (United Nations and FIG, 1999) developed as an outcome of a Workshop that brought together 40 international land administration experts from around the globe has investigated the re-engineering of land administration systems and has built upon, updated and broadened previous United Nations endorsed policies in cadastral benchmarks such as the *Bogor Declaration on Cadastral Reform* (United Nations, 1996).

It is within the context of these global and national land policy frameworks that this research attempts to define a solution to re-engineer an existing cadastral system to meet contemporary requirements of sustainable development.

1.2 Basic Concepts

1.2.1 Cadastral Concepts

The recording of information about land for taxation purposes, for its acquisition, usage and distribution can be traced back four thousand years to Egypt and Mesopotamia. This concept of linking man with the use of the land and its attributes by the recording or formal documentation of information has persisted through the centuries. During the Great Roman Empire the Romans recorded land holdings and claims on occupied territories. This practice flourished through to the Middle Ages where the famous Domesday Book was completed during the reign of William the Conqueror in 1086 (Larsson, 1991). The book showed the names of landowners, area, tenures, land uses, number of tenants and quantity and type of livestock. The book was purely textual and was not associated with any map. Various attempts were made in Europe during the 17th and 18th centuries to use maps to support the written records.

A major breakthrough came during the early 19th century when Napoleon I introduced a cadastre based on a systematic survey of each

property that recorded parcel number, area, land use (including land fertility and production) and land value.

Because of the sphere of influence of France during that time, most of continental Europe established systematic cadastral systems, although there were major variations in quality and extent (Larsson 1991). Both the French cadastre and all other European Cadastres of this era were purely fiscal and were used almost solely for taxation purposes. The use of cadastres for legal purposes did not start until later in the 19th century (Williamson, 1983).

The development of the modern cadastre that incorporates legal data on proprietary interests and the importance of large-scale mapping and cadastral surveys have been examined by a number of authorities such as McLaughlin (1975); Dale (1975); Simpson (1976); Larsson (1991) and Williamson (1984, 1983 and 1996).

An internationally accepted definition of the cadastre has been adopted by the International Federation of Surveyors (FIG), which in 1995, produced the “*Statement on the Cadastre*” as follows:

“A cadastre is normally a parcel based, and up-to-date land information system containing a record of interests in land (for example rights, restrictions and responsibilities). It usually includes a geometric description of land parcels linked to other records describing the nature of the interests, the ownership or control of these interests, and often the value of the parcel and its improvements”. (FIG 1995,)

The essential elements of a modern cadastre are summarised by Williamson (1983) as follows:

- A series of large-scale maps showing property boundaries, all buildings and structures and most of the topographic features on the land. The scales of the maps can range from 1:1,000 to

1:100 for urban areas, decreasing to about 1:2,500 or less for rural areas.

- A register or number of registers containing information on ownership, valuation, land use and any other matter dealt with by the cadastre for every land parcel. The basic parcel must be common to all registers (land is of prime importance to the cadastre)
- The cadastre must be complete, that is, every parcel of land in the state or jurisdiction must be displayed on the maps and included in the respective registers, (regardless of whether the land is co-owned, or individually owned or held by specific groups of individuals).
- Each parcel in the cadastre must have a unique common identifier, (enforceable by law) to be used by all authorities dealing with parcel based information. This is the key that links the maps and registers in the system. Common identifiers include:
 - * volume number and folio number derived from title registration.
 - * recorded survey plan number and survey record number.
 - * rectangular land survey system descriptions;
 - * municipal, village or regional unit and parcel number.
 - * map number and parcel number;
 - * municipality, suburb or region and street address; and
 - * geographic coordinates.
- The cadastre must be dynamic, that is, it must be continually updated. There must be legally enforced procedures, which require that all changes to the information in the cadastre must

automatically and immediately update the registers and large-scale maps.

- The information in the registers must be correct and preferably have legal status and be “guaranteed” by the state. This aspect particularly applies to title registration but could equally apply to all encumbrances or matters affecting title.
- The contents of the registers should be public, within reasonable limits. They must be available to all government authorities.
- The large-scale mapping system must be supported by a permanently marked and well-maintained coordinated survey system. Such a system is mandatory so as to be able to integrate all forms of spatial information.
- The cadastre must include an unambiguous definition of parcel boundaries both in map form and on the ground, as a result of cadastral surveys. The most common method of carrying this out is to permanently monument the parcel boundaries, which are then surveyed by ground methods with the corresponding measurements being displayed on technical maps and plans. In such a system the boundaries of each parcel can be precisely defined and located on the ground even if the boundary monuments are missing, or disturbed.

Williamson in 1983, 1984 and more recently in 1996 has developed conceptual models of classic European cadastres that have been adopted in some jurisdictions such as Sweden and Australia. His model, shown below in Figure 1.2, has a particular emphasis on the fundamental importance of cadastral mapping and title registration in the maintenance of parcel based systems. The functions of cadastral mapping, cadastral indexing and maintenance of the local coordinate reference framework should constitute, from an institutional perspective, a Cadastral Office for example Switzerland.

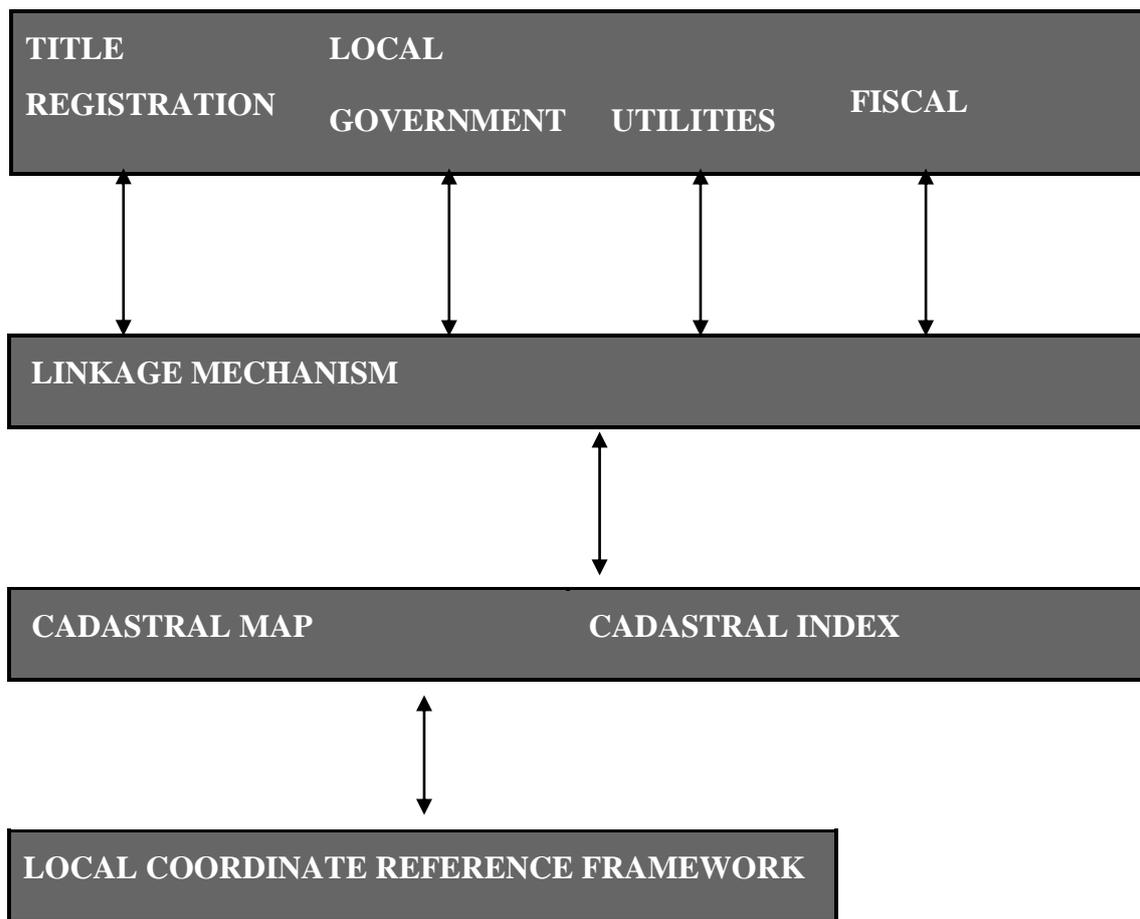
Existing Independent Government Authorities

FIGURE 1.2: CONCEPTUAL MODEL OF A CLASSICAL EUROPEAN CADASTRE AFTER THE NRC MULTIPURPOSE CADASTRE, 1983 (WILLIAMSON, 1996)

According to FIG, the cadastre's main function is to support the public administration of land. The information contained in the cadastre can be used to formulate, implement and monitor land policies, such as those concerning land redistribution, land consolidation, land acquisition and allocation, and land markets.

FIG suggests that a successful cadastre should “provide security of tenure, be simple and clear, be easily accessible, and provide current and reliable information at low cost” (FIG 1995), recognising that any

system should be appropriate to the needs and circumstances of the particular society.

Williamson (1995) suggests that the success of a cadastral system be measured “as a function of how well it achieves these broad social and economic objectives, not the complexity of its legal framework nor the technical sophistication of the cadastral surveys or cadastral map.”

Multipurpose Cadastres

As stated earlier in this section, classical cadastres were concerned mainly with information about land ownership, tenure, land use and value. These fiscal and legal cadastres, although they often draw on data and information from a variety of sources are characterised by their special purpose output products and services. Additional information in the form of datasets of natural or man-made features is sometimes found in cadastral records, particularly those that have been automated.

This extension of the cadastre to include a broader range of land-related information, received from a variety of sources and providing a wide range of services and products to many users is now referred to in a number of jurisdictions as a *Multipurpose Cadastre*.

Dale and Mc Laughlin (1988) define a Multipurpose Cadastre (MPC) as a large-scale, demand-driven land information system designed to serve both public and private sectors and characterised by:

- 1 employing a proprietary land unit (the cadastral parcel) as the fundamental unit of spatial organisation;
- 2 relating a series of land records (land tenure, value, ownership, usage) to the parcel;
- 3 completeness in terms of spatial cover; and
- 4 provides a ready, efficient means of storage, access, manipulation and display of up-to-date information.

The major components of a Multipurpose Cadastre, which is described as a “framework supporting continuous, readily available and comprehensive land-related information at the parcel level” (NRC1983) are as follows;

- A consistent and comprehensive geodetic network, that is, a system of widely spaced permanent marks with known latitude, longitude and height, makes it possible to establish spatial linkages between all relevant land information, so that any features can be related spatially.
- Comprehensive topographic maps, either digital or hard copy, that are large-scale and up-to-date, showing all significant natural and man-made features such as fence lines, roads and utilities.
- A cadastral overlay or series of maps that delineate individual parcels and their unique parcel identifying number that provides a common cross-reference tool for linking other data to the parcel.
- A series of registers or files (data) containing information about ownership, usage, land cover, and other attributes required by the user.

The components of a Multipurpose Cadastre and structure are shown below in Figure 1.3, details of each component are shown in Figure 1.4.

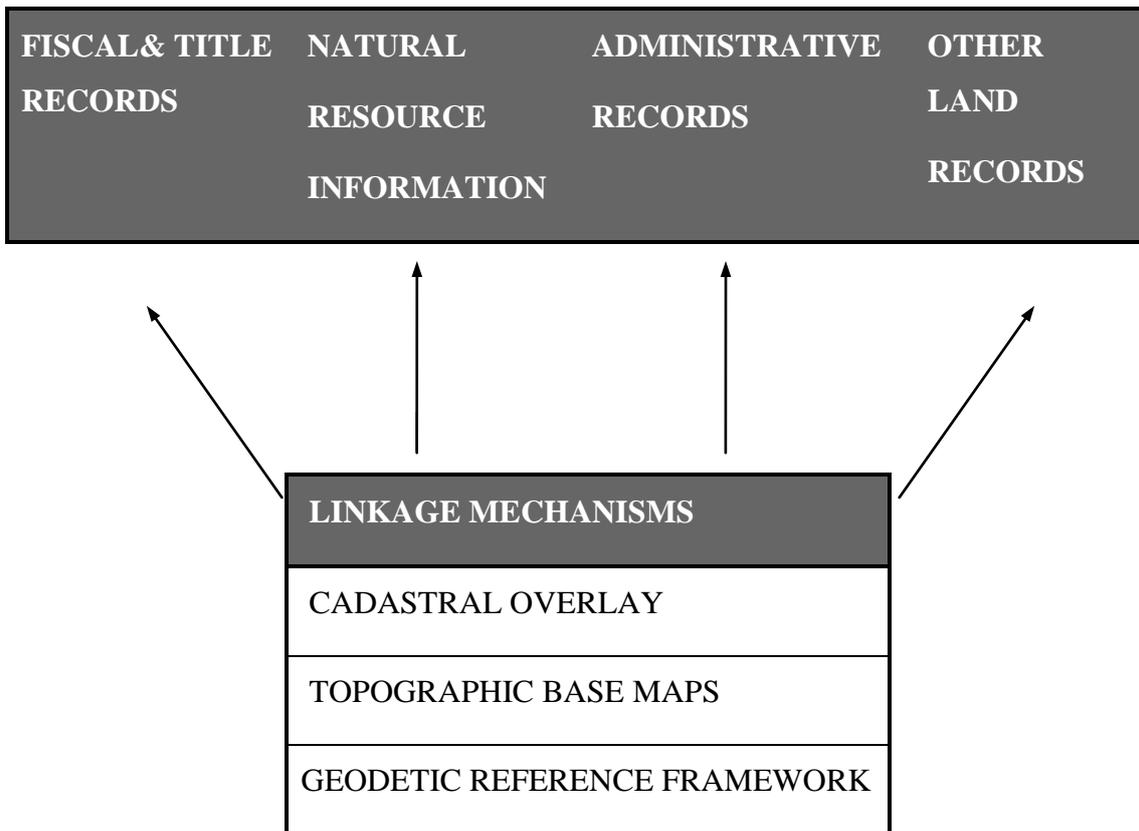


FIGURE 1.3: MULTIPURPOSE CADASTRE COMPONENTS (BASED ON NRC 1983)

One of the main aims of a MPC is to record and describe the growing complexity of the man-land relationship at the parcel level. The changing nature and complexity of rights and interests in land, for example community and Native Title; the requirements for faster and easier access to information about the natural resource base and public infrastructure; and the monitoring of the impact of man's activities, requires information systems that are flexible, reliable and responsive to user requirements involving individual or communal rights.

One of the strengths of the MPC, according to Dale and McLaughlin (1988), is the ability to grow and be adapted to the economic pressures and local needs and deal with information about physical attributes, man-made or natural, as well as abstract concepts such as land and administrative boundaries, land value and land use. The MPC can also be independent of administrative structures, in that it can be implemented centrally or regionally, or both, provided coordination mechanisms are adequate.

TITLE & FISCAL RECORDS	NATURAL RESOURCE INFORMATION	ADMINISTRATIVE RECORDS	OTHER LAND RECORDS
Assessments	Climate	Building characteristics	Aboriginal sites
Easements	Contours	Building permits	Census
Encumbrances	Ecology	Inspections	Criminal activity
Lease plans	Elevations	Land use permits	Economic activity
Legal descriptions	Fauna	Licenses	Hazard maps
Mortgages	Geology	Rates	Heritage sites
Ownership	Geophysical data	Taxes	Land use
Restrictions	Hydrology		Planning
Rights-of-way	Soils		Population
Status	Topography		Recreation
	Vegetation		Tourism
			Utilities
Appraisals Court action Transactions	Remote sensing Photogrammetry Field surveys	Applications Public hearings Regulations	Surveys
LINKAGE MECHANISMS			
Parcel Identifier, Index			
Geographic coordinates			
Street Address			
Common Data Standards			
CADASTRAL OVERLAY			
Cadastral parcels	Conservation areas		
Boundaries	Utility rights-of-way		
Easements	Mining rights		
Riparian Rights			
BASE MAP			
Geodetic Control	Roads		
Public lands	Railways		
Waterways	'As Built' features		
Urban areas	Topography		
GEODETTIC FRAMEWORK			
Coordinates, Location of marks			

FIGURE 1.4: STRUCTURE OF A MULTIPURPOSE CADASTRE (AFTER NRC 1983)

Cadastral systems and the philosophy related to MPC's has continued to evolve in response to changing global and regional needs since the initial modern conceptualisation in the early 1980's. Organisations such as the United Nations in collaboration with the International Federation of Surveyors (FIG) have been instrumental in facilitating the development of policies relating to multipurpose cadastres and their role in supporting sustainable development.

Key policy documents such as the *Statement on the Cadastre* (FIG, 1995); *Bogor Declaration on Cadastral Reform* (UN, 1996); *Cadastre 2014* (FIG, 1998); *Bathurst Declaration on Land Administration for Sustainable Development* (UN/FIG, 1999) are examined in more detail in their own right as documenting drivers for change in Chapter 4: International Trends and Other Developments affecting Cadastral Systems.

Land Information Systems

The terminologies Land Information Systems (LIS) and Geographic Information Systems (GIS) are often used as equivalent terms. There is a subtle but important difference between the two terms, generally found in their origins, scale of operation and type of data handled.

The term LIS has evolved and grown from European and North American legal and Multipurpose Cadastres associated with land ownership, land tax, area and land use.

GIS, on the other hand, can be traced back to computer aided mapping, and involves the capture, manipulation and interpretation of data "which are symbolic representations of features" (Maguire et al, 1991). The scope of GIS has expanded to involve more than automated map production, with desktop applications now a reality.

The differences between these terms has been defined by Hunter and Williamson (1991) as follows:

“...land information systems tend to be parcel based, large-scale, dynamic, administrative systems having very high integrity and accuracy. They include cadastral systems as a key component and are typically major administrative systems which support government and semi-government activities such as land registration, land tax, land subdivision...and management of utilities and services...whereas geographic information systems are typically medium to small scale...and are usually concerned with a lower integrity and accuracy of data as is common in environmental and natural resource systems.”

Dale and McLaughlin (1988) define an information system as “a combination of human and technical resources, together with a set of organising procedures, that produces information in support of some managerial requirement...A land information system gives support to land management by providing information about the land, the resources upon it and the improvements made to it.”

The outputs from a land information system can be products such as maps, reports, statistics or diagrams in hard-copy, or increasingly, in digital form. Attribute or textual data can be used to describe phenomena of a feature for example soil characteristics, land use, spatial data can describe the location, extent and geometrical relationship between data elements or features on the landscape.

The structure and operation of a land information system is shown in Figure 1.5.

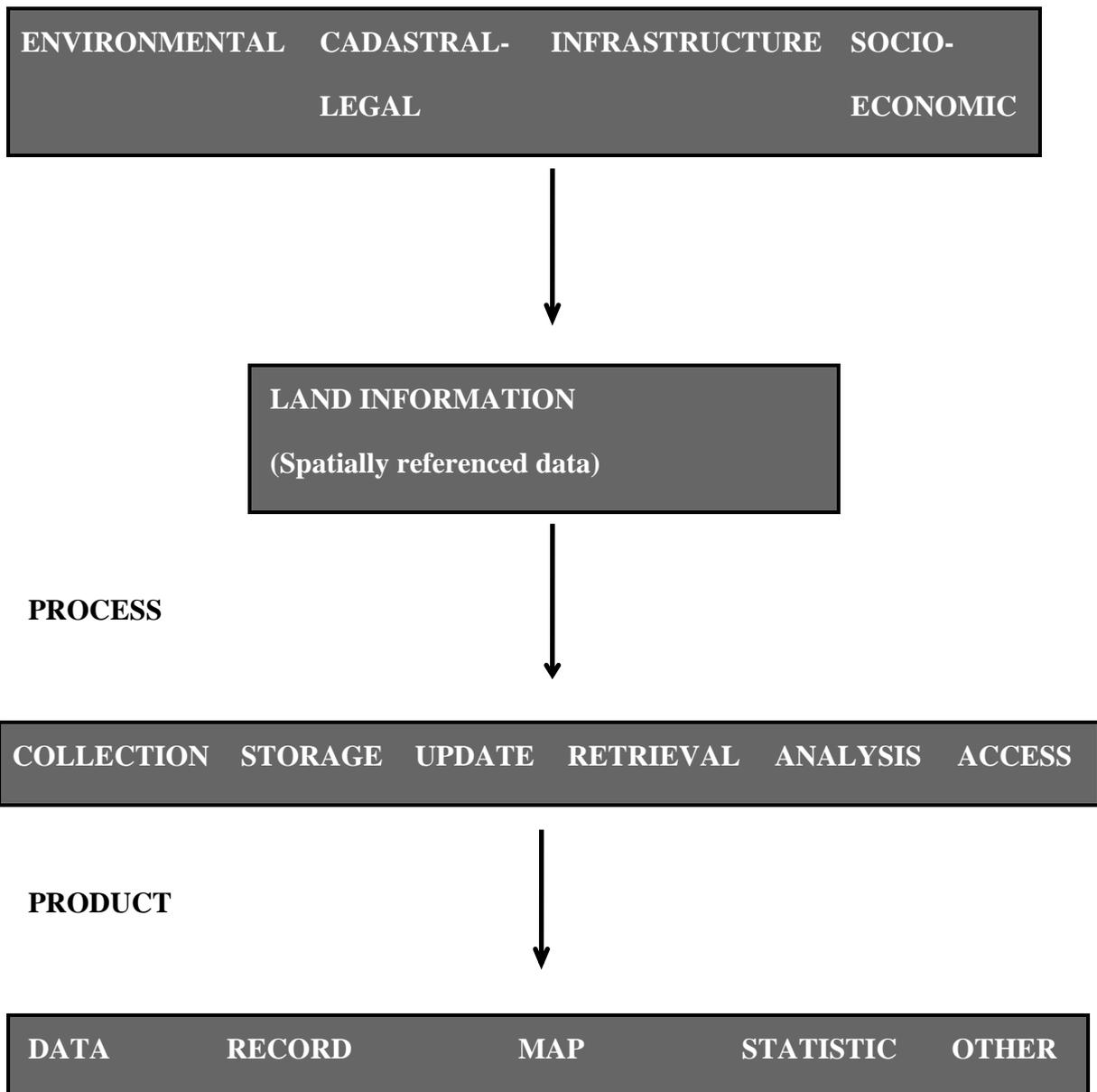
LAND-RELATED DATABASE

FIGURE 1.5: A LAND INFORMATION SYSTEM STRUCTURE (LARSSON, 1991)

As defined earlier, the MPC is regarded as a parcel-based land information system where the data is organised around a proprietary land unit that is, the cadastral parcel. The land information systems of today have become powerful tools for the gathering, managing, analysing, and distributing land related information, by mainly Government users. Advances in technology and techniques now

allow large volumes of data to be processed, analysed and integrated to meet an expanding user base.

1.2.2 Land Tenure and Titling

Throughout civilisation, land has formed a base for most human activity, including the generation of wealth. Human ambition to control the use of the land and to establish a sphere of influence over a certain geographic area has given rise to the use of the term “territoriality” in recent times, “the primary geographical expression of social power” (Grant, 1997). Part of this expression is the ability of the individual to exercise rights on the land, which can have strong ties with the social and political structures and the religious beliefs of most well organised forms of society. In a recording system, the concept of land tenure can, in this context, be defined as “the act, right, manner or term of holding a landed property” or “the nature of legal estate in land”. (FIG Commission 7, 1995). Rights can be both individual and communal and can encompass things associated with the surface of the earth, the air above, and below the surface, such as:

- Agricultural rights
- Air rights
- Building and development rights
- Groundwater and riparian rights
- Mineral rights
- Ownership
- Timber rights

(after Dale and McLaughlin, 1988)

The cadastre may record different forms of land tenure such as ownership, leasehold, easements, licenses, mortgages and different types of common, communal or customary tenure. The various rights associated with the land are commonly referred to as *real property*.

The most important types of land tenure for the purposes of this research are:

1. Ownership, which usually means the exclusive right to use the parcel and enjoy the yield from the land and improvements. It also includes the right to transfer the land to another, to mortgage the property and to lease it.
2. A Lease, gives the grantee or lessee the right to use the parcel or (part thereof) for a limited time, in accordance with the conditions of the contract and relevant legislation.

Land registration (land titling) “is the official recording of legally recognised interests in land and is usually part of a cadastral system. From a legal perspective a distinction can be made between deeds registration, where the documents filed in the registry are the evidence of title, and registration of title, in which the register itself serves as the primary evidence.” (FIG Statement on the Cadastre, 1995)

Land titling, the process of registering titles to land, is considered superior to deeds registration as it usually has lower transaction costs and provides in principle, greater security of tenure and more reliable information.

In Australia, the Torrens system, devised in 1857 by Sir Richard Robert Torrens, which involves the registration and transfer of titles has survived for over one hundred years in all states and territories without significant amendment, despite major changes in society. The fundamental qualities of the system Torrens was aiming for were: reliability, simplicity, low cost, speed and suitability. The Torrens system involves the registration of any real property together with restrictions and charges and the name of the proprietor.

Three important principles are generally followed, namely the **mirror principle**, where the register is supposed to reflect the correct legal situation; the **curtain principle**, which means that no further (historical) investigation beyond the register is necessary except

overriding interests; and the **insurance or state guarantee principle** where the state guarantees that what is registered is true for third parties in good faith and that a bona fide rightful claimant who is contradicted by the register is reimbursed from an insurance fund maintained by the state (Henssen,1995). Due to the guarantee principle, the state must be active in analysing transactions and documents to minimize fraud, damages and compensation.

1.2.3 Land Management and Administration

Land management is “the process of managing the use and development of land resources in a sustainable way. Effective land management is impossible without land information, for example information about land resource, land tenure, land ownership and land use” (FIG, 1995). Land management entails the making and implementation of decisions about land by the individual, community groups for example Landcare and governments. The scale of those decisions can vary from fundamental policy decisions about the nature and extent of investments or developments of land to routine operational decisions made by land administrators, landholders and those whose activities have a direct impact on the well being of the landscape. Sustainability in this context is about good stewardship of the land for present and future generations.

Figure 1.6 illustrates a model showing the relationship between the various land-related functions.

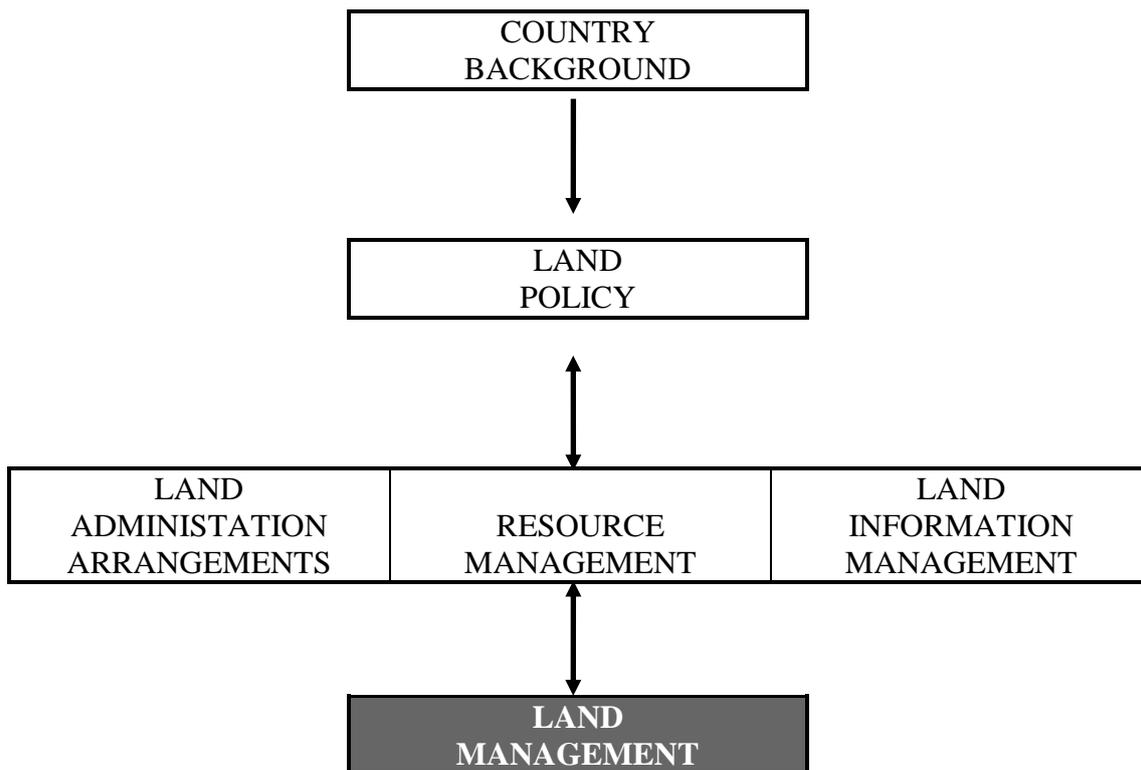


FIGURE 1.6: LAND MANAGEMENT ARRANGEMENTS (DALE & McLAUGHLIN, 1988)

The Economic Commission for Europe Land Administration Guidelines, defines “Land Administration” as:

“The process of recording and disseminating information about the ownership, value and use of land and it’s associated resources. It includes land cadastre, land registers, and land consolidation, valuation and land information systems for sustainable development.”

In the Australian and North American context, “Land administration” is concerned more with the formulation, implementation and monitoring of land policies, such as those dealing with land redistribution, land consolidation, land acquisition and allocation, land use and the operation of land markets.

Land administration activities are normally supported by a formal planning process, which operates within a legislative framework that determines planning procedures and implementation standards.

1.2.4 Land Degradation versus Ecological Sustainability

Multiple use of land under extreme conditions has had a history of negative side effects when economic factors are given precedence over the long-term health of the environment particularly when “normal” accounting procedures do not adequately recognise ecological costs as part of the total costs of production.

Sustainable resource use is as much about human behaviour as it is with environmental condition. The United Nations Food and Agricultural Organisation provides the following definition.

“Sustainable land management combines technologies, policies and activities aimed at integrating socio-economic principles with environmental concerns so as to simultaneously:

- *maintain and enhance production/ services (Productivity)*
- *reduce the level of production risk (Security)*
- *protect the potential of natural resources and prevent degradation of soil and water quality (Protection)*
- *be economically viable (Viability)*
- *and socially and culturally acceptable (Acceptability).”*

(Smyth and Dumanski, FELSM: An International Framework for Evaluating Sustainable Land Management, FAO, 1993).

There are numerous examples worldwide where inappropriate land management practices have led to land degradation and desertification and the consequences of social disruption and economic hardship. Desertification has been defined by geographers as:

“the impoverishment of arid, semiarid and some subhumid ecosystems by the combined impact of man’s activities and drought” (Dregne, 1977).

Globally, desertification is revealed as “a pressing global problem of the first order” (Mabbut,1978).

Numerous studies of Australian agriculture have found that land degradation, and the observable aspects caused by the processes of water and wind erosion, salinisation, waterlogging to be a serious threat to the sustainability of it’s soils.

Land degradation, according to the National Rangeland Management Working Group is:

“an ecological issue occurring when ecological characteristics or processes are changed and the integrity of an ecosystem is threatened or lost. It is related to changes in land and vegetation which makes it less capable of meeting its desired uses, and results from the interaction of vegetation and soil type, climatic variability and land use.”

(Rangelands Issues Paper, 1994)

The Working Group point out, however, that rangeland habitats are not static in condition, nor are they always incapable of regeneration (depending on the degree of degradation), and are undergoing a continual process of adaptation in response to climate and use.

There are various degrees of degradation, for example land degraded but recoverable, land economically unrecoverable, and various types such as soil loss, biodiversity loss, invasion of woody weeds and vertebrate pests. Degradation may be the result of historical management practices and not necessarily the result of management by current landholders.

Similarly, erosion hazard is the susceptibility of a parcel of land to the agents of erosion. It is a function of climate, soil, landform, land use and land management factors. Figure 1.7 below shows the erosion hazard for New South Wales as assessed by the Soil Conservation Service (source-Land Information Centre, Atlas of NSW)

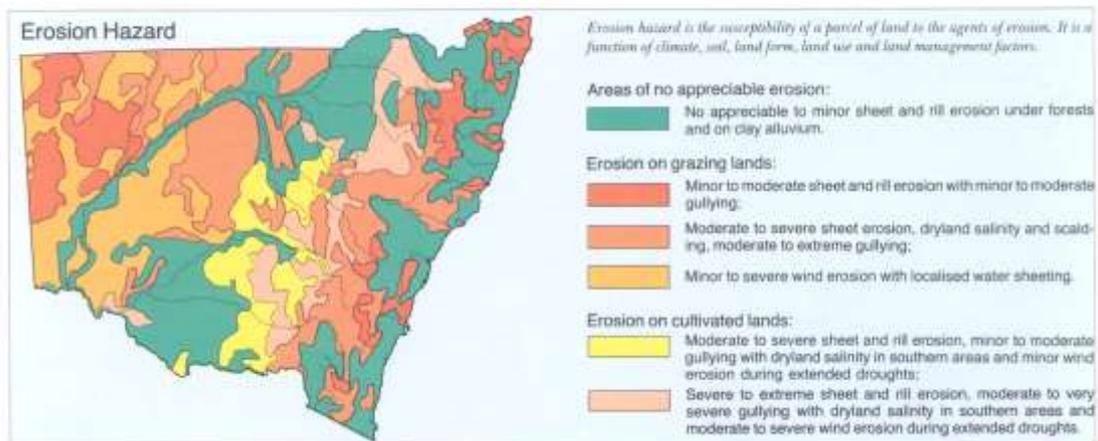


FIGURE 1.7: EROSION HAZARD

Comprehensive, reliable and current information plays an important role in determining the general condition of rangelands over particular areas, and the monitoring of trends.

The rehabilitation of degraded pastoral land may not be cost-effective if significant inputs of labour, machinery and materials are required. Allowing natural processes to rehabilitate recoverable land through de-stocking is probably the most viable option.

The term “ecologically sustainable development” is now widely used as a goal or outcome of most land-related reform programs. In the

context of the Western Lands, the term has been interpreted by the people of the Western Lands of NSW to mean a balance between economic, environmental and social outcomes (Aslin et al, 1999).

Australian Federal and State Governments have endorsed the *National Strategy for Ecologically Sustainable Development* that aims to:

“...meet the needs of Australians today, while conserving our ecosystems for the benefit of future generations. To do this we need to develop ways of using those environmental resources which form the bases of our economy in a way which maintains and, where possible, improves their range, variety and quality.”

(Australian Ecologically Sustainable Development Steering Committee, 1992)

1.3 Review of Thesis

1.3.1 Statement of Problem

The operation of the cadastre over semi-arid and arid low value lands, or rangelands in Australia, and particularly in the state of NSW, has remained fundamentally unchanged since its introduction through the operation of the *Western Lands Act* in 1901. This Act is the principal legislation governing land tenure and land administration and has remained virtually unchanged for a century. Rangeland NSW, covering 42% of the State or 32.5 million hectares, contained within an administrative unit known as the Western Division is in serious trouble. Poor land management, land degradation and a declining rural economy, amplified by an erratic and variable climate has necessitated a comprehensive Government response, to develop policies and strategies to ensure the future viability and sustainability of this region.

It is the author's contention and hypothesis that:

The Cadastral System in rangeland New South Wales has contributed to environmental degradation, poor land management and a declining rural economy. Reform of the cadastre would enable social, economic and environmental systems and practices to be re-aligned to modern expectations and needs.

1.3.2 Research Objectives

The primary aim of this thesis is to examine the feasibility and benefits of, introducing a modern Multipurpose Cadastre into rangeland New South Wales to facilitate sustainable development. There are a number of secondary objectives, including an analysis of the current cadastral system and the historical development of its various components; current trends and factors impacting on the current system and the development of an appropriate vision and cadastral model for application in rangelands, with particular reference to the Western lands of New South Wales.

The central role of spatial data, standards and procedures, and the information systems that manage and use this data and their role in the operation of a Multipurpose Cadastre are examined in the context of global and national policy trends aimed at sustaining and where possible, improving the extent, condition and variety of the various natural resources that sustain humankind.

Cadastral survey standards and the application of modern positioning technology such as the Global Positioning System (GPS) are also taken into account. The relationship between cadastral surveying, rules and procedures for land parcel boundary definition and demarcation and rearrangement of property boundaries to facilitate better land management are considered as part of the overall reform package.

As the thesis is primarily concerned with cadastral reform, a number of suggested solutions are proposed, which can be integrated as part of a larger institutional reform agenda or implemented incrementally according to political, institutional and economic settings.

1.3.3 Scope

The scope of the project focuses on the examination and possible adoption of “world’s best practice” cadastral systems to the Australian (NSW rangeland) scene. Accepted, successful cadastral concepts from developed North American and European systems and their suitability for adaptation to improve the current NSW system, based on existing Statute and English Common law were investigated. The International Federation of Surveyors (FIG), and in particular Commission 7, which has responsibilities for cadastre and land management, was regarded as the principal authority on international best practice, as well as other internationally recognised experts.

The project does not look in detail at other systems in other countries, rather the concepts and factors that are successful and may be appropriate for adoption. As no two cadastral systems are exactly the same, even amongst Australian jurisdictions, the research examines structural models.

It is outside the scope of this project to define or recommend; other than at the conceptual level, detailed processes and procedures that underpin the operation of a modern cadastre, this is left to the relevant institution or authority.

1.3.4 Relevance

The need to effectively utilize land to feed the world’s growing population; to promote increased investment in agriculture; for effective stewardship of the land and its sustainable economic development and environmental management requires an appropriate cadastral system to record rights, interests and responsibilities and

provide secure title. For marginal low-value lands, the challenge is to sustain ecosystems whilst maintaining some economic productivity.

The advent of modern computer technology has allowed cadastral systems in developed countries to evolve into a multipurpose role. In urban areas, parcel based land information systems are providing a framework for local government administration, planning, collection of rates and taxes and management of public infrastructure such as utilities and transport systems.

The application of successful modern cadastral concepts can also provide substantial social benefits to the “ people in the bush”, in terms of better access to land -related information and a simpler system for the recording of interests in land.

In Australia, the three most important reasons for cadastral reform, identified by cadastral experts who contributed to the *Bogor Declaration and the Bathurst Declaration* are:

- Socio-economic applications of cadastral information
- Environmental consciousness
- Economic decision-making

All of the above reasons are applicable to rangeland Australia, as the viability of the current humankind-land relationship is being re-examined by Government and stakeholders.

1.3.5 Methodology

The Case Study methodology has been adopted as the basis for the development of an appropriate cadastral model. The Western lands of New South Wales, known administratively as the Western Division, has been chosen as the case study area. Considering the complexity of cadastral reforms, the Western lands, as a case study for low-value lands, enables a better understanding of problem areas and appropriate solutions.

The Case Study methodology involves an analysis of the setting; creation of an hypothesis (Section 1.3.1); description of the system in the context of accepted cadastral principles; comparison with other jurisdictions; and the design of jurisdiction specific solutions which can be imported and modified, if appropriate (after Williamson, 1998).

The methodology also requires:

- A comprehensive literature review, further described in Section 1.3.7
- Data collection from various sources, contacts and media (hard and soft copy)
- Analysis of the information collected and structuring according to subject matter
- Evaluation of the material and the model proposed against internationally recognised benchmarks
- Conclusion of findings and relevance to the setting and hypothesis

1.3.6 Thesis Structure

The thesis is structured into the following chapters to generally follow the Case Study Methodology:

Chapter 1: Introduction

Chapter 2: Western Lands of New South Wales

Chapter 3: Cadastral System in Western New South Wales

Chapter 4: International Trends and Other Developments Affecting Cadastral Systems

Chapter 5: A Vision for Managing Low Value Rangelands in Western New South Wales

Chapter 6: A Model for a Multipurpose Cadastre for Western New South Wales

Chapter 7: Evaluation of the Cadastral Model

Chapter 8: Conclusions and Recommendations

The structure of the thesis is intended to set, firstly the scene in terms of the nature of the problem in the context of accepted concepts and principles; secondly to describe the particular characteristics and the requirements of the cadastral system as it affects the case study area and; finally, to propose a contemporary vision and solution for the problem area and evaluate the proposition against accepted cadastral benchmarks such as *Cadastre 2014* and the applicability to other jurisdictions.

1.3.7 Information Collection

The major sources of information for this thesis are listed below:

An analysis of relevant literature was made principally through the use of library resources at the University of Melbourne and Charles Sturt University, Bathurst. In addition, access was gained via the World Wide Web to a number of sites in Australia, Europe for example FIG, OICRF, and North America for example Universities of Maine and New Brunswick, that contains information held by various international authorities on the cadastre, definitions, concepts, trends and potential solutions.

Information on the operation of the current cadastral system and problems was gained mainly from Government sources, both Federal, through the Australian Bureau of Agriculture and Research Economics (ABARE), and State through the NSW Department of Land and Water Conservation (DLWC) and the Department of Information Technology and Management (DITM), the agency responsible for the state's land titling, mapping, surveying and valuation functions.

Staff at the Western Region office of the Department of Land and Water Conservation, provided a valuable resource of historical and

current information on land administration and management in the Western Division of NSW.

During the course of this research two major Government reform initiatives were undertaken. The first was a joint Commonwealth/State initiative known as *WEST 2000*; a structural adjustment and environmental management program.

The second initiative was the *Western Lands Review 2000*, a State Government initiated review, focussed on the legislative and institutional opportunities to improve “sustainability” of the Western Division. These two initiatives and in particular, the *Western Lands Review, 2000* provided a great source of specific and useful information on “Western” problems, issues and recommendations for improvements to the existing situation.

Rangeland management is being further researched through the auspices of the National Land & Water Resources Audit, that has published a draft discussion paper on behalf of the National Rangelands Monitoring Coordinating Committee titled:

Rangelands- Tracking Changes, Australian Collaborative Rangeland Information System (NWLRA, 2001)

The Australian Rangelands Information System is being touted as the foundation for sustainable management of our Rangelands.

Landholders and land-related professionals who have operated in rangeland NSW were also consulted on an opportunity basis to gain information and feedback.

Visits and discussions were undertaken with various authorities on cadastral/land management systems including:

Professor Peter Dale, President of FIG

Professor D M Grant AM, former Surveyor General of NSW and Australian Delegate to FIG Commission 7

Mr H Houghton, Director of Survey and Mapping, DOLA, Western Australia

Mr Paul Kelly, Executive Director, Information Systems, NSW Department of Land and Water Conservation

Mr H.Knoop, Surveyor General of Lower Saxony, Germany

Mr Jim Riddell, Chief, Land Tenure Service, Food and Agriculture Organisation (FAO), United Nations

Mr Bill Robertson, former Director General/Surveyor General, New Zealand Department of Survey and Land Information

Professor I P Williamson, Professor of Surveying and Land Information, University of Melbourne, Victoria

Mr Geoff Wise, Western Lands Commissioner and Regional Director, Far West Region, NSW Department of Land and Water Conservation

CHAPTER 2: WESTERN LANDS OF NEW SOUTH WALES

This chapter describes the study area and the key environmental, economic, social, legal and administrative factors that are currently at work shaping the environment, administrative landscape and way of life in the Western Lands of New South Wales. The depth of the serious economic, social and environmental problems faced by people living in “the Western Lands of NSW” is also examined and includes an analysis of the current cadastral system and its contribution to land and environmental management.

2.1 Description

In mainland Australia, an examination of any atlas showing climatic zones will reveal that more than 75% of the continent is classified as arid or semi-arid. (Harrington et al, 1984). All of the largest States and Territories - namely Western Australia, Queensland, South Australia, Northern Territory and New South Wales, contain large tracts of semi-arid lands, commonly referred to as rangelands. Each year they generate income from wool and meat (approximately \$1 billion), tourism (approximately \$1 billion) and mining (approximately \$12 billion), according to the National Land & Resources Audit. In the draft discussion paper titled “*Rangelands-Tracking Changes, Australian Rangelands Information Systems*”, dated January 2001, it is asserted that rangelands nationally represent the largest group of the nation’s ecosystems still in a relatively pristine condition. They include savannah, desert, woodland and shrub steppe.

Rangelands in western NSW are contained in the Western Division of NSW, which is a land management unit covering 42% of the State and is characterised by its semi-arid climate, low population density and restricted production potential. This area is the size of Great Britain and Ireland combined. About 95% of the total area is held under perpetual lease for pastoral purposes from the Crown by some 1350 pastoralists. There are 4,265 grazing leases that generate \$1.8M in rent each year. (Western Lands Commission, 1992)

The National Rangeland Management Working Group (1994) proposed that the boundary for rangelands or pastoral zone be as used by the Australian Bureau of Agriculture and Research Economics (ABARE 1995) as shown on Figure 2.1

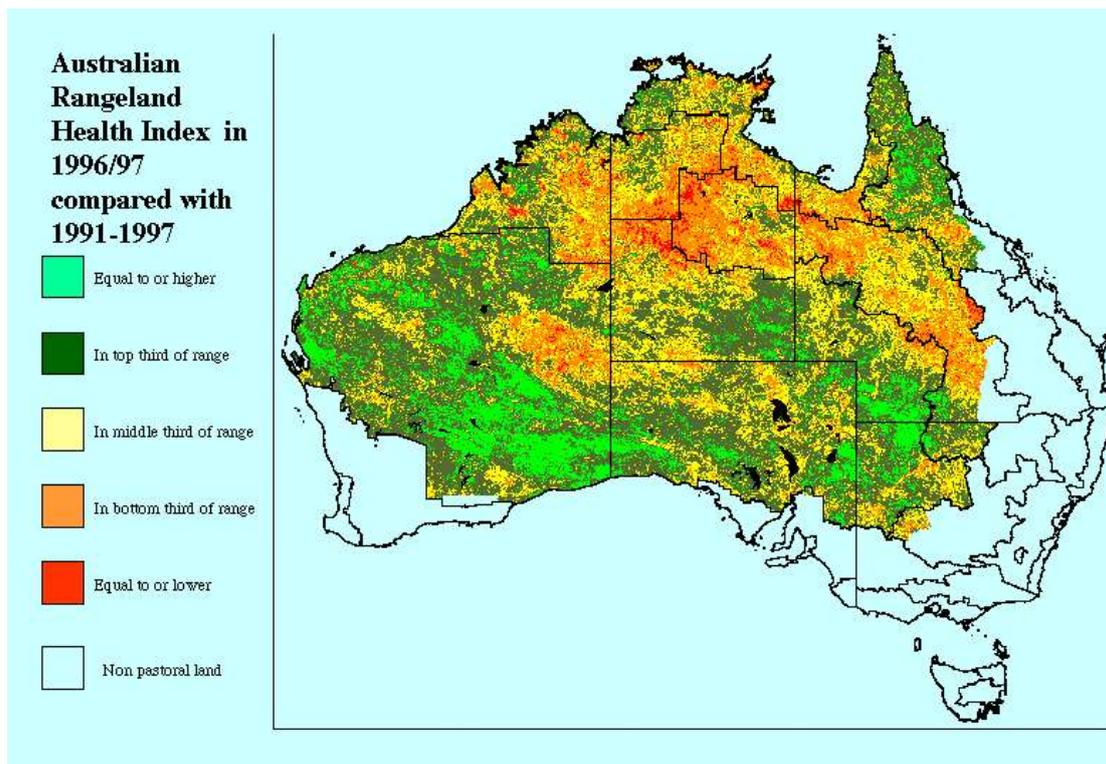


FIGURE 2.1: AUSTRALIAN RANGELAND HEALTH INDEX IN 1996/97, SHOWING BOUNDARIES AS DEFINED BY THE NATIONAL RANGELAND MANAGEMENT WORKING GROUP, 1994. SOURCE-NATIONAL LAND AND WATER RESOURCES AUDIT-“RANGELANDS – TRACKING CHANGES, AUSTRALIAN COLLABORATIVE RANGELAND INFORMATION SYSTEM”.

The Working Group mentioned earlier has developed a more descriptive definition for the area outlined as rangeland by ABARE.

“Rangelands are areas defined by a combination of climatic, vegetation and land use parameters. They are generally native grasslands, shrublands and woodlands that cover a large proportion of the arid and semi-arid regions and also include tropical woodland, and the slopes and plains of northern NSW and southern Queensland. The majority of the Australian mainland, particularly the arid and semi-arid zones, is rangeland.”

(National Rangeland Management Working Group 1994)

2.1.1 Environmental Characteristics

The Western Lands of NSW cover a diverse range of landform types, rainfall patterns and areas of unstable soils. At the ecosystem level, rangelands contain a vast spectrum of grassland, shrubland, forest, woodland and wetland systems and provide general habitat and refuge areas for a wide variety of species. At the species level, many groups are found in the rangelands, including a large number of threatened species. Low unpredictable rainfall, high feral and native animal pest populations, encroachment of woody weeds are some of the most significant natural factors affecting the productivity of the natural resource base.

Rainfall patterns are highly variable with winter rainfall typically dominating with occasional heavy summer rain. Climatic conditions vary from mild to warm winters to hot to very hot summers where temperatures can exceed 50° Celsius. It is not uncommon for sustained high temperatures exceeding 35° C for periods of days or weeks during summer.

The majority of rangelands in the Western Lands contain semi-natural to natural vegetation. The dominant vegetation types in the eastern portion are eucalypt woodlands with a grass understorey followed by eucalypt forests and acacia woodlands with a grassy understorey. Further west towards central Australia (Broken Hill), the dominant vegetation types are the shrublands where acacias, eucalypts and casuarina species dominate the tree layer with a grassy understorey. Bluebush and saltbush (Chenopod species) are widely distributed, forming communities which are drought and salt tolerant and of medium to low palatability to grazing stock. Sparse Open Grasslands are also widespread with tussock grasses such as Mitchell grass common in the rangelands (NLWRA, 2001).

From an ecological perspective, 53 of the 85 bioregions in Australia are recognised as rangelands and cover a wide diversity of habitats. Bioregions covering the western lands of NSW include:

- Darling Riverina Plains
- Broken Hill Complex
- Cobar Peneplain
- Murray Darling Depression

(NLWRA, 2001)

Topographic regions for rangeland NSW include the Central west slopes and plains and the northwest plains with slopes generally ranging from undulating to flat.

2.1.2 Economic Forces

The Western Lands contribute significantly to the economic wealth of the State and Australia with the rural sector on average generating some \$1000 M of income annually, primarily from pastoralism, mining and tourism industries. Pastoralism generates approximately 25% of this income (WEST 2000,1997). Other major land uses in the rangelands include recreation and defence activities.

The climatic characteristics of rangelands limit the agricultural alternatives to grazing, although in recent times attempts are being made for enterprise diversification. Sheep dominates the Western Lands, with significant numbers of animals transferred from the West to other areas for finishing and sales.

There has been a gradual decline in stocking rates since mid-1970 with a sharp decline in 1990 due to low wool prices and drought. (WEST 2000, 1977).

Pastoral agriculture is by far the largest land use in the rangelands and has the potential to have the greatest impact on the natural resource base. It is important to note that the rural agricultural sector has been

accounting for a decreasing share of output in the Australian economy. Although gross value in the agricultural sector has increased, growth in other sectors of the economy has been faster.

Between 1978 and 1994, pastoral agriculture accounted for about 3-6% of the total value of agricultural production in Australia. Although the pastoral zone's contribution to total agriculture is small, its relative contribution has kept pace with other agricultural sectors over time (Beare, et al. 1995).

Sustaining economic returns from pastoralism in the rangelands has been made difficult by the declining prices received by farmers relative to the prices they paid for inputs. In response to this decline in terms of trade, many enterprises have been forced to limit the increases in their average production costs and to look at expanding the scale of their operations or diversification to other enterprises such as tourism (farm stays). There are some 500 leases in the Western Division allocated for agriculture, agriculture and grazing, mixed farming, irrigation or similar purposes, which generate more than \$650,000 rent each year. These leases are consolidated into about 320 holdings with an average rent of about \$2,100 p.a. There are also 2,600 residential and business leases, generating a combined rental of \$470,000 each year.

Economic prospects for the Western Lands are not encouraging. In a recent economic study commissioned by the Western Lands Review (Hyder Consulting, 2000), the current trend model showed a decline in overall production; a rapid rise in the Aboriginal population and retirees; a continuing decline in farm income and an increased dependence (from 23% to 35%) of social security in household income.

The overall conclusion made in the Western Lands Review, 1999 is one of economic decline continuing into 2025.

2.1.3 Social Factors

Large family farms, many of which have passed through a number of generations, and corporate entities are heavily represented in this region. (Beare et al, 1995).

The large size of the holdings and remoteness have required strongly independent people, able to withstand the extremes of climate and economic returns, and overcome limited opportunities for social contact. Rangelands also hold cultural significance for Aboriginal heritage and outback communities as well as conservation value for society.

The “tyranny of distance” is becoming less significant through the advent of better communication technology, such as satellite based information services, increasing use of light aircraft as an alternative means of transport, and the introduction of distributed electronic means of livestock commodity trading. The popular use of motor transport has provided greater mobility and freed rural communities from a dependence on village services. During the 1960’s it was no longer unusual to drive for 1 hour and 100 kilometres into Dubbo for the weekly groceries, by 2000 it has become the “norm”.

These processes have had the effect of rationalising our rural services into regional centres that afford economies of scale. Inland cities such as Dubbo, Wagga Wagga and Mildura continue to grow at rates well above the national average.

The pace of structural adjustment of the farm industry has increased in recent times due to increasing farm debt; this has included small towns and villages whose economic wellbeing depends upon the income generated from rural industries that includes pastoralism.

2.1.4 Legal and Administrative Frameworks

The administrative unit known as the Western Division of NSW comprises the complete Local Government areas of Brewarrina, Bourke, Cobar, Central Darling, Balranald, Wentworth and Broken Hill, plus part of the Walgett, Bogan, Carrathool and Hay Local Government Areas, and also the Unincorporated Area, for which there is no local government.

Commonwealth environmental legislation has a role in the western lands although Commonwealth funding (for example, the National Heritage Trust) clearly has a significant role.

NSW legislation has progressively evolved with additional acts being superimposed on early sectoral and segmented laws dealing with, for example, water, mining, and land. The end result is a complex system of land and natural resource management that is not easily understood by the broader community.

State Departments of Agriculture and Land and Water Conservation in conjunction with the National Parks and Wildlife Service are primarily responsible for policy and administration of natural resource management affecting rangelands in the Western Division.

The *Western Lands Act of 1901* (the Act) has been the principal legislation used to manage land tenure and land use in the West for nearly a century. The Act provides for lands to be made available through leases. State Government through this legislation and administered through successive Western Lands Commissioners has had the greatest influence on the administrative and legal landscape.

The broad powers given to the Western Lands Commissioner through the Act have meant that land management policies have at times, tended to reflect the values of the various Commissioners (Abel et al., 1999). Prior to the 1930's a Board of three commissioners administered the powers conferred by the Act.

The basic premise of the Western Division is the payment of rent by a lessee to the owner of the property- in this case the Crown- for the right to occupy the land for the purpose of the lease, for example grazing. It is not occupation for all property rights. The Crown retains rights outside the lease purpose, for example the right to timber and minerals. In addition, following the Wik decision the rights and interests of traditional owners have now been recognised through Native Title legislation. However, the question as to whether the creation of pastoral leases legally extinguished these traditional rights remains a matter for Government and the Courts to decide on a case by case basis.

2.1.5 Cadastral Systems

The development of the cadastral system in the Western Lands of NSW was characterised during the nineteenth century by largely unregulated occupation, accelerated by the discovery of gold. Various legislative measures, culminating in the introduction of the Western Lands Act, 1901 were used to administer the Western Division.

The demarcation of land tenures, primarily leasehold, followed similar standards of survey for the Eastern and Central Divisions of New South Wales. Rectangular parcels or blocks were surveyed and generally followed cardinal bearings and were laid out across the landscape. The parcels were generally much larger in size than in the east (home maintenance areas varied with carrying capacity from 10,000 to 100,000 acres) with little significance given to the adoption of natural features as boundaries. Roads, railways and major rivers became the “skeleton” of the land parcel fabric, as they were the major conduits of trade and the delivery of services.

Survey accuracy standards were related to topography not land value, hence the flat open rangelands were required to be measured to the same standard of accuracy as parcels on the coastal plain. Accuracy standards can be traced through various directions issued by

Surveyors' General and State Departmental requirements for the survey and alienation of Crown land.

The system that unfolded was one of "isolated surveys", that is, surveys were only connected to adjoining surveys and not to any consistent spatial framework (or geodetic survey). These individual surveys were then recorded on administrative maps, which recorded through manual notation processes the status and tenure of land.

These administrative maps, known as Parish maps, were based on the Imperial geographic administrative structure of County, Parish and Portion. A Parish contained a number of individual parcels or Portions of land and was generally bounded by natural features that contained an area that could be serviced by a Minister of religion. Parishes were agglomerated into Counties that became parts of various settlement districts, which in turn formed components of the various colonies. (Read, 1999). The Parish map has been the principal cadastral record of interests in land in rangeland NSW until the mid 1980's, when pastoral leases were brought under the provisions of the *Real Property Act*. A comprehensive project is underway to preserve much of this history through the use of digital cameras and compression of images on CD's by storing colour photograph digital images of the state's 35,000 parish maps and making them available through a range of media including hard-copy, CD's and online over the World Wide Web (Read, 1999).

2.2 The Problem in the Western Lands of NSW

2.2.1 Environmental

There is increasing public concern for the rangelands habitat and the conservation of Australia's natural resources according to the Western Lands Review, (Hyder Consulting, 2000). Livestock pastoral systems operating in Australia's rangelands have been a focus for attention because of their scale and impact on natural systems.

Land condition is variable across the vastness of the Western Lands and land degradation continues to manifest itself in a variety of symptoms, namely:

- Soil erosion and soil salinity problems as a consequence of past land management practices, that is, extensive clearing of native vegetation, overgrazing.
- Spread of woody weeds and noxious plants, which restrict the productivity of the land by replacing native vegetation and lead to overstocking and over-clearing of non-affected areas. Woody weeds are recognised as a significant threat to biodiversity and sustainability in the Western lands (NSW Farmers, 1996).
- Declining water quality, evidenced by the occurrence of blue-green algal blooms, increased turbidity and the need for increased water treatment for potable water.
- The decline in the diversity and biomass of plants through selective and over-grazing and the use of introduced pasture species.
- Long lasting and severe impacts due to the slow rate of soil formation and vegetation regeneration and the extreme variability of rainfall in arid and semi-arid regions and;
- Effect of changes in burning regimes on biodiversity, with the current regime of infrequent fire leading to declines in the diversity of some rangeland ecosystems.

These effects are often magnified by climatic variations. (Kelly and Harcombe, 1996).

The available quantitative information from reputable sources, suggests the condition of the land base "...has probably approached a steady state after the severe initial impact of Europeans" (CSIRO and DLWC, 1999).

The impact of feral animals (rabbits, cats, foxes, wild dogs, pigs and

goats) on the ecology and biodiversity of the Western Lands of NSW is enormous. Arid and semi-arid areas have the greatest rate of extinction for native mammals of all areas of Australia (Hoser, 1991). Rangelands contain over half of Australia's species of endangered mammals, more than one third of threatened bird species and about half of its threatened plant species (Leigh and Briggs, 1992). As at 1992, in arid areas, 33% of all mammal species were extinct and 90% of medium-sized mammal species were extinct, endangered or vulnerable (Leigh and Briggs, 1992).

The main direct cause of extinction of native fauna in the Western Lands is predation by feral animals (NSW Farmers, 1996). Rabbits, goats and pigs contribute to Total Grazing Pressure that results in degradation of native vegetation and soil erosion.

The pastoral zone is characterised by extensive grazing of sheep and cattle on native pastures and shrubs. Management practices for agricultural and pastoral activities have a direct relationship on the pastoral resource base. Inappropriate clearing, cultivation and overstocking have had negative impacts on the survival of endangered native species and the regeneration and conservation of the pastoral resource base. Changed fire regimes and the spread of woody weeds that displace native vegetation and are unpalatable to livestock have also modified vegetation and habitats and decreased their ability to cope and regenerate after drought and increased grazing pressure.

As mentioned previously, the rangelands contain about half of Australia's threatened plant species and yet Government policy as recently as the period 1978 to 1990, approved the clearing or selective clearing of 620,000 hectares of forests, woodlands and scrubland in the Western Division (Dick, 1992, cites Western Lands Commission records on clearing and cropping for 1978-1990).

Similarly, two thirds of the Mulga region of Queensland, about 2,370,000ha, have been overused or excessively cleared (Queensland

Department of Primary Industries, 1992). It has also been shown that approximately 50,000ha of valuable native Mitchell grasslands have been lost to invasion by *Acacia nilotica* (National Rangeland Management Working Group, 1994). Recent amendments to State Planning Policies and legislation have seen the introduction of controls over clearing of native vegetation and grasslands to address this situation.

The Working Group, referred to above, suggests that the evidence that clearing or significant thinning of natural vegetation can result in climate and annual rainfall change on a local scale needs to be considered. There is also a much broader issue in terms of ecosystems such as rangelands being managed as greenhouse gas sinks for the storage of carbon dioxide and other greenhouse gases. This aspect should form part of Australia's response to mitigate greenhouse gas emissions and prepare for the potential impacts of climate change. In the most recent study into agricultural land cover change by the Australian Bureau of Agricultural Sciences in 1999, land clearing was identified as leading to a loss of biodiversity and in some areas affecting the operation of the hydrological cycle, accelerating processes such as salinity, waterlogging and erosion. This study has enabled the revision of preliminary estimates of annual rates of clearing woody vegetation for the early 1990's down from around 500,000 hectares to 308, 000 hectares.

The National Strategy for the Conservation of Australia's Biological Diversity is aimed at protection of biological diversity and maintenance of ecosystems. One of the objectives of this strategy is to manage biological diversity on a regional basis, *using natural boundaries* to facilitate the integration of conservation and production oriented management. Re-alignment of cadastral systems to accommodate natural boundaries in terms of demarcation and possible rearrangement of property boundaries would assist the integration of conservation and production management.

Better information and education for landholders on the occurrence and range of endangered native flora and woody weeds will enable management practices to be refined and ensure species survival.

Rangelands in NSW form part of the catchment area of the economically and ecologically important Murray-Darling Basin system. A recent occurrence of toxic blue-green algae blooms and increased turbidity in this catchment has focussed attention back on land management practices and their impact on local catchments and water supply works. Surface flows are also important in maintaining significant rangeland ecosystems such as the Menindee Lakes.

Equally important are groundwater resources, which are essential to support almost all-human activities in rangeland Australia. Knowledge of the quality, quantity, distribution and availability of groundwater resources is critical to viability and sustainability of future activities. Recent reforms to water management in NSW under the West 2000 Rural Partnership Program have enabled the trading of water rights and the containment of free-flowing bores and replacement of bore drains with piping. Bore capping and piping will significantly reduce wastage of water as well as control the spread of feral animals and undesirable introduced vegetation species.

Information requirements about the location, extent, dimensions, value and condition of this infrastructure and the natural resource will increase and will need appropriate information systems. The demand for additional water is largely being driven by the growth of the cotton industry within the Namoi, Barwon and Darling River catchments and a seeming insatiable demand for water. Reallocation of existing water licenses and rights has become a major political issue as each sector of the community seeks to ensure what it sees as an equitable distribution.

Water rights, whilst having a physical spatial location for example bore, pump site, etc, are not tied to a land parcel legally. They are regarded as a commodity to be traded by an 'owner' on the open

market. This is a 'new' concept and one that cannot be adequately handled by the current cadastral system. A new flexible cadastral system needs to be introduced to cater for this requirement. A Multipurpose Cadastre is designed to accommodate infrastructure data with the ability to be integrated with natural resource information for better decision making and modelling.

Better Information, Better Decisions

“The increasing complexity of the agriculture industry in terms of international competition, community environmental standards, animal husbandry issues, research and development work requires additional information for decision making” (WEST 2000, 1997)

The ability of rangeland managers to make effective decisions to overcome many of the problems mentioned above hinges on access to reliable, up-to-date information on rangeland condition. Spatial information collected by remote sensing (for example satellite imagery, rectified aerial photography) on a systematic basis provides a cost-effective means of monitoring rangeland condition and land use controls.

Considerable information on the natural resource base is being generated in the Western Lands by a series of projects, including projects by CSIRO, NSW Department of Land and Water Conservation, Murray-Darling Basin Commission (MDBC), National Parks and Wildlife Service (NP&WS) and the Land and Water Research Development Corporation (LWRDC). Much of this information is not always easily accessible or in a useable form for managers or landholders. The integratability and use of this spatial information is dependent on the adoption of agreed, uniform standards and the linkage of this data to a consistent spatial reference system or geodetic network.

Government Regulation has largely controlled land use and resource management, through instruments such as leases, licenses, covenants, agreements and other restrictions as to user. The cadastre is the means of recording these instruments and therefore plays an important role in resource management.

Government laws and regulations governing the use of natural resources have mainly used the parcel/property as the basic unit for administration. The most recent exception being the trading of water rights that are transferable and independent of the property, although they do have to be spatially related on a temporal basis that is, their geographic location can change on each transaction.

2.2.2 Economic

“On average, specialist sheep producers are expected to record a business loss in 1995-96, for the sixth year in a row” (Crowe 1996)

The agricultural sector has been contributing a declining share of output in the Australian economy. While gross value in this sector has been growing, growth in other sectors has been faster. Between 1978-79 and 1993-94, pastoral agriculture in the rangelands contributed around 7% to the gross value of production of all broadacre farming. It accounted for around 3-6% of the total value of agricultural production in Australia over the same period (Beare, et al. 1995).

Over the five year period to 1994-95, declining terms of trade have adversely affected the financial viability of Australia’s farming sector, despite productivity improvements. Farmers’ terms of trade are in decline as shown in Figure 2.2 below.

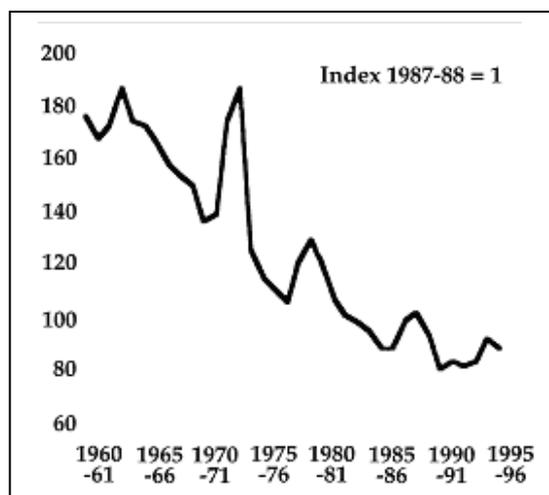


FIGURE 2.2: FARMERS' TERMS OF TRADE (SOURCE AUSTRALIA COMMODITIES VOL.2, NO.4, DECEMBER 1995)

There are some 2,199 properties at an average size of 4000 to 5000 annual farm income for properties was \$45,500 in 1998. Farm business profit has fallen by some 90% over the last eight years to less than \$10,000 during 1996-97. The wool industry and grazing properties are facing a continuing period of property adjustment, lower levels of equity and property values and higher debt.

There are few alternatives to present activities in this zone, apart from abandoning holdings altogether. Adjustment will occur mainly through:

- expanding the size of holdings;
- changing ownership structures;
- genetic improvement of animals; and
- better management of stocking rates

(Gleeson and Topp, 1997)

The decline of the Broken Hill mining deposits has dominated income trends for the aggregate of the Western Division. Income from mineral deposits in the Cobar area have not been large enough to compensate for this decline and even this area is entering another period of decline as world commodity prices for gold and copper remain at relatively low levels.

Though the development and exhaustion of resources dominates the fortunes of the mining industry at the local level, the overall trends in the industry are governed by commodity prices. With cost trends moving steadily downward this has been to the detriment of suppliers of goods and services and also at the expense of future improvement programs, such as woody weed control.

Prospects for increased income from tourism, with “farm stay” holidays, are growing but from a low base when compared to mining and rural income. The tourism industry in the Western Lands is estimated as \$35 million per annum (NIEIR, 1999).

2.2.3 Social and Political

Large family farms, many of which have passed through a number of generations, and corporate entities are heavily represented in the region.

Increasing levels of farm debt brought about by low commodity prices and drought are forcing many families with no immediate or long-term prospect for achieving viability in the pastoral industry to exit the industry.

Access to services is becoming more difficult, particularly financial services as the banking industry rationalises the number of outlets, leading to the closure of branches in small country towns. Similarly, access to health services is being restricted as country areas fail to attract medical staff away from more lucrative city locations (NIEIR, 1999).

The increasing complexity of the agricultural industry in terms of international competition, community environmental standards, animal husbandry issues, research and development work is placing additional pressure on the skills and knowledge base of those in the industry.

Landholders require better access to timely and relevant information to cope with increasingly complex business and personal decision making (WEST 2000).

Until recently Governments have failed to take a co-ordinated approach to solving the environmental, economic and social problems in this region. The creation of the Murray Darling Basin Commission (MDBC) is a tri-state effort to solve the environmental problems in this major catchment that incorporates the bulk of the Western lands.

- The WEST 2000 recovery program is a significant joint State and Commonwealth effort aimed at long-term viability and sustainability in the Western Division. It is an integrated regional adjustment and recovery program that offers landholders strategies and funding for property buildup, improving the productivity of existing properties, management of natural resources including feral animals and woody weeds, training and skills development.

The low population base translates into a small number of political representatives who have a far lesser influence on public policy when compared with representation from urban areas.

The Western Lands Review, 2000 developed a number of key findings related to the socio-economic profile of the Western Lands, as follows:

- Census data for 15 years (1981-1996) and economic modelling indicate that the Western Division's "trend towards higher social security dependence is deeply entrenched"
- Population continues to decline (10 % since 1981) and now stands at some 53,000 people of whom 80 % live in towns.
- The population structure is becoming older, particularly in Broken Hill.

- Against this trend the Aboriginal population has increased by some 66% to 5,800 (1996) and has a higher proportion of children.
- Jobs have declined (2,127) from 17,000 in 1981 in both agriculture and mining.
- Social security represents a quarter of the total household income (\$777 million in 1996)
- Sheep numbers and property values have fallen by about 25% over the past decade
- Farm income is now some 30% of total farm household income, that is, off-farm income or incomes from past earnings are major sources of farm household incomes.
- Prices.
- The wool industry and grazing properties are facing a continuing period of property adjustment, lower levels of equity and property values and higher debt.

(Western Lands Review, 2000)

Aslin et al. (1999), suggest that some policy makers and natural resource managers have not adopted ways of thinking that match today's changed social realities. They have over-simplified mental models that are increasingly inadequate to deal with today's highly differentiated societies and their multi-faceted, multi-scale issues.

What is evident is that society is becoming more complex, more differentiated and with multiple sets of needs and expectations. To meet these challenges, paradigms need to be changed to adopt modern concepts and solutions able to cope with contemporary requirements. It is argued later in this paper that the adoption of a Multipurpose Cadastre will move the existing 19th century system to a system able to meet today's burgeoning information economy.

2.2.4 An Outdated Cadastral System

The operation of a uniform cadastral system for the demarcation and recording of rights over land whilst having benefits to the people of NSW in terms of security of title and confidence in the marking of boundaries delineating different interest, poses some problems for the Western Lands of NSW.

Some of the problems include:

- High costs of cadastral surveys when compared to land value.
- Emphasis placed on marked “artificial” boundaries which represent the legal cadastre as distinct from “as occupied” boundaries which have a greater significance for landholders.

The nature of the cadastral pattern, which, historically, was set out on cardinal bearings forming rectangles enclosing an allotted area, was relatively simple and cheap to establish. This practice however largely ignored natural boundaries such as catchment, soil or vegetation type. Generally only major natural features, such as rivers and lakes were adopted as boundaries. This approach causes major problems to mechanised agriculture and the design and implementation of soil and water conservation measures.

The current value of perpetual leasehold grazing land (albeit including some irrigation and agricultural uses) is estimated by the Valuer General to be in the order of \$380 million, for which a rental of less than 0.5 % or some \$1.8 million is received. If the rental rebate that has been applied over the past 5 years is continued, rental income falls to 0.25 % of the land value, indicating a significant level of subsidisation.

According to the Western Lands Review 2000, the costs of land administration and management of the Western Lands leases equates to the current total rental revenue. There are clearly significant opportunities to reduce the cost of lease administration, rent

establishment and the management of the cadastral system that underpins land tenure and administration.

2.2.5 Legal Access

In the early 1990's Government recognised an inherent legal problem in the network of legal roads for the Western Lands of NSW. In the past, when subdividing Crown land within the Western Division, the practice of ensuring that each subdivided parcel was serviced by a legal means of access in the form of a road, was only partially adopted. Whilst some legal roads were created in the Western Division, in the majority of cases reliance was placed on a covenant in virtually all Western Land leases that the lessee was "not to obstruct or interfere with any reserves, roads or tracks or the use thereof by any person".

This clause was traditionally interpreted by administrators and by virtually all lessees as providing unrestricted rights to members of the public to use any track or constructed road within the boundaries of a Western Lands lease.

There is some doubt as to the legal standing of this clause. As a result, the Government has taken steps towards implementing a program to re-establish a network of legal roads within the Division to provide adequate access for lessees, the general public and for community purposes.

To establish this network, tracks in current use which may be legally established as roads need to be accurately identified, then assessed or adjudicated as to whether the track is used solely for internal property management purposes or whether other persons, including adjoining lease holders, have used it from time to time for access.

The re-creation of a legal road network, that is, the "skeleton" of the cadastral pattern is a catalyst for cadastral reform and presents an ideal opportunity to examine and adopt a more relevant system.

2.3 WEST 2000 Rural Partnership Program

In February 1997, the Commonwealth and NSW State Governments signed a Memorandum of Understanding that committed both to fund an integrated regional adjustment and recovery program for the following 3-5 years. It is a plan for long-term viability and sustainability for the Western Lands of NSW.

WEST 2000 offers a range of strategies to landholders including:

- *“Effective build-up and productivity enhancement measures for those pastoral families with short-term financial constraints but long-term viability prospects.*
- *Training opportunities for those landholders that want to improve their resource management and business skills.*
- *Re-establishment support for those families with no immediate or long-term prospect for achieving viability in the pastoral industry.*
- *Funding to undertake trials, field days and seminars on the issues associated with total grazing pressure.*
- *Funding to enhance rural counselling services.*
- *Enhancement to the current ‘cap and pipe the bore’ scheme.*
- *Examining alternative industries, which may increase the options for enterprise diversification within the Western Division.*
- *Funding to review Government acts, regulations and policies that apply to Western Division landholders. They will be evaluated to ascertain their relevance, operation and impact on landholders and the pastoral industry.*
- *Assistance to support a coordinated approach to clear woody weeds and conduct Rabbit Calicivirus follow-up work.”*

The most relevant strategy to this research is the measure aimed at institutional reform. The objective is to identify and remove the institutional impediments to reform in the region. This includes the review of Acts, Regulations and policies to evaluate their relevance and their degrees of coordination and duplication.

The WEST 2000 institutional reform agenda provides a framework and a vehicle for cadastral reform and the opportunity to implement a new cadastral model based on community requirements and expectations. Most importantly a conduit has been established between Government at all levels and landholders with a common goal to increase the viability of the Western Division.

2.4 Western Lands Review 2000

On 11 March 1998, the New South Wales Minister for Land and Water Conservation, Mr Richard Amery, announced the establishment of the Western Lands Review.

The Minister emphasised the Review was to identify the fundamental management and legislative constraints to sustainability in the Western Division and to develop appropriate recommendations for the NSW Government's consideration. The primary needs were to implement long-term sustainable management and improve the economic, environmental and social base of the Western Division. The Review was to include broad public consultation.

The Minister identified a clear need to resolve land administration problems and to develop greater flexibility in rural land use, including for example, sub-leasing for tourism and temporary use for activities such as moviemaking. He further emphasised that the Review would include a strongly consultative process and that the *"... government policy and State laws ... [need to] meet not only the present, but also the future requirements of the people of the Western Division"*.

Of most interest to this area of research is Term of Reference 3:

“Recommend actions required to implement sustainable management and use of the western lands resources, including appropriate legislation, institutions and tenure agreements”.

The Review undertook an evaluation of land tenure and supporting legislation and examined three fundamental questions:

- Should lease tenures be retained on the following categories of land: pastoral; agricultural; small-scale rural, including hobby farming and rural residential; and urban?
- If lease tenures are retained, what principles and procedures should underpin tenure reform?
- Should a mode of lease administration, tied to lease tenure, be retained over all or part of the Western Division?
- The Review came up with a number of key findings in relation to land tenure and the need to reform the overall system which can be summarised as follows:
- Experience in the United States, Canada and New Zealand indicates:
 - Rangelands are retained as public lands with land use rights (grazing or agriculture) given and specified in lease tenure.
 - Privatisation (‘freeholding’) of broad pastoral leases has been rejected to ensure rangelands are available for multiple use and multiple users.
 - Land tenure is expanding to accommodate an increasing array of land uses and management practices.
 - Lease tenure is becoming more adaptive and flexible including facilitating structural adjustment.

- Lease agreement should focus on outcomes rather than prescriptive conditions, associated with broader definitions than grazing such as “primary production”.
- Land uses are allocated consistent with land capability, appropriate protection of natural resource values, and needs of resource users.
- Private rights are enhanced where the resource is scarce, highly valued or require the leaseholder to make substantial capital or operational inputs. Freeholding is considered (for example with urban leases) in such situations.
- Leasehold is an appropriate form of tenure and should be retained in rangelands (relatively low value, low investment, fragile land resource base) and where there is substantial other party interests such as nature conservation, Native Title, and kangaroo shooters.
- Lease agreements can recognise the primary responsibility for leasehold management rests with the leaseholders who should have the powers of decision making, though subject to the public’s legitimate interest in sustainable natural resource management. The stewardship role of leaseholders and agreements (consistent with land capability) can balance public (conservation, recreation) and private (rural, production and development) outputs.
- Native Title will continue to impact on the ‘purpose’ of ‘grazing’ leases, though the opportunity exists to adopt a ‘primary production’ purpose and allow minor impact land uses (such as tourism) under the Commonwealth Native Title legislation.
- Public purposes (tourism access, multiple use, conservation and recreation areas) are not well developed and provision

should be retained (by agreement, sale, or rent adjustment) to accommodate such uses.

2.5 Summary

The problem in the Western Lands of New South Wales is an ongoing legacy of an inappropriate attitude towards the land and its use, brought by European occupation. It is widely believed that significant damage to natural ecosystems and biodiversity of the Western Lands occurred around the turn of the last century, before the start of the Western Lands Act, and continued until the decline in rabbit populations in the early 1950's.

Scientific evidence and considered evaluation by reputable authorities indicate that during the last 150 years there has been a marked change in species composition and an increase in land degradation, leading to some landscapes becoming unproductive 'wastelands' through overgrazing and the cumulative effects of poor land management practices. In some rangeland types vegetation change is extensive and irreversible unless large inputs of capital are made available for rehabilitation. Soil degradation is highest in Mulga and Mallee country and woody weed invasion is generally attributed to overgrazing and the reduced incidence of fire.

Native fish populations are declining. Measures of total phosphorus, nitrogen, salinity and turbidity trends in the major river and stream systems in the Western Division demonstrate that they are in a poor state. In general, the further downstream, the poorer the water quality. Modelling of salinity levels in NSW western rivers is predicting significantly higher levels in future decades.

The semi-arid nature of the Western Division means that time scales for cumulative effects causing land degradation, rehabilitation and change are usually very long. These features have meant that there is a scope and magnitude to the problem which Governments and

administrators find difficult to plan and deliver services and programs consistent with the scale of needs.

The system of land tenure and land use remain largely unchanged since the establishment of the Western Lands Act in 1901, which was predicated on a prescriptive approach to land use control and utilisation of the land for economic purposes. The Western Lands Act has become increasingly redundant as it lacks a clear set of objectives and has been overtaken by other legislation focussed on planning and resource management.

The cadastral system and in particular the methods of defining rights and responsibilities remains unchanged since the late 1800's when leases were surveyed in rectangular patterns without much regard to natural features or efficient farm management practices. The reliance on marked or 'artificial' boundaries which do not coincide with fenced or 'as occupied' boundaries makes little sense to users who can utilise an area they have fenced and occupied and yet pay rent and taxes on a different area which is their formal lease area.

There is a high cost for cadastral surveys when compared to land value, mainly due to the uniform accuracy standards applied across the state, which apply equally to high-rise commercial lands as well as pastoral leasehold.

Clearly, the rigid and prescriptive administrative and legal frameworks that have been applied in the past without adequate consideration of environmental, economic and social factors are in need of overhaul if the Western Lands are to be given the opportunity to move towards a sustainable balance between development, rehabilitation and conservation. Native Title is emerging as one of the major issues confronting administrators and lessees in the Western Lands of NSW. Currently, the applicability of Native Title to grazing leases and therefore the vast majority of the Western Lands is unclear. It is most likely that clarity will be improved through Court precedents or the use

of land use agreements, rather than through additional legislation. The current cadastral system will not be able to cope with the management of overlapping European and Native Title interests and other planning and resource constraints.

In the words of John Kerin, Chairman of the Western Lands Review:

“Continuation of the current system of laws and government operations is unlikely to bring about the improvements needed in the Western Division”

The resilience of the land and its outdated laws and administrative systems to cope with contemporary demands are severely limited. The burden of years of exploitation of the land, particularly during times of climatic extreme, has placed the capability of the land in a precarious position. Leaseholders are looking at diversification of enterprises that are not as natural resource dependent, to supplement the meagre incomes they are currently able to extract from depleted landscapes. Whilst pastoral activities will most likely continue, fundamental cadastral reform can bring down administrative costs and provide better information for decision-making.

CHAPTER 3: CURRENT CADASTRAL SYSTEM IN WESTERN NEW SOUTH WALES

It is the intention of this chapter to explore the historical development of the Western Lands so as to gain an understanding of the existing cadastral system from the surveying, land titling and land management perspectives.

The current situation is examined to give an overview of cadastral and related systems and contemporary societal needs that are driving the need for change. The role of the cadastre in the realisation of a Spatial Data Infrastructure for the state is examined. Other factors, such as the Internet and Native Title that are influencing Government, business and community expectations and the way of life are considered in terms of the need for cadastral reform.

3.1 Historical Background

3.1.1 Early Development

The settlement and early colonisation of NSW followed the English (feudal) system of granting rights to colonists and the recording of those rights by the registration of deeds. In the Western Lands of NSW, the “Squatting Era” between 1830-1884 was characterised by largely unregulated occupation of the Western Region, accelerated by the discovery of gold. Pastoralists occupied “runs”, large tracts of land that were only regarded as suitable for grazing. The Robertson *Land Act of 1861*, brought some control to settlement by introducing selection before survey with the *Crown Lands Act 1884* dividing “runs” into Leasehold Areas (short term leases) and Resumed Areas (available for settlement as smaller homestead leases) and introducing local land boards which took land allocation out of political control.

Legislation was subsequently introduced to encourage closer settlement and fairer allocation of land by the provision of new tenures, classification of land, survey before selection, and the “one man one selection” principle. The *Western Lands Act 1901* was introduced to administer the Western Division after a Royal Commission inquiry. The inquiry followed a severe drought and depression that led to the abandonment of many holdings and the need for a period of financial and environmental rehabilitation.

European settlement of the Western Division can be characterised into a number of phases that are summarised below. These phases tend to overlap and merge so that dates are indicative only.

- *Squatting: from the 1830’s. Early European occupation was viewed as illegal by Government attempting to regain control over its nomadic citizens and unsurveyed lands. Recurring drought created many financial casualties, however a number of squatters established a semi-nomadic existence across climatic zones. This system was adapted to drought and was far more flexible than the*

system of leaseholding imposed from the 1860's when Government increased its control over land administration.

- *Pastoral Optimism: from the 1860's. Population, above average rainfall and foreign investment resulted in increasing sheep numbers. This ended at the turn of the century. A combination of major drought, bankruptcies, low wool prices and heavy sheep mortality prompted a Royal Commission of Inquiry into the Western Lands. This Commission led to the legislation under which the Western Division still operates. The Western Lands Act, (1901) provided for leases to be issued in perpetuity to family enterprises, and restricted land use primarily to grazing and occasional cropping.*
- *During this period of squatting some of the larger "Squatters Runs" caused severe land degradation, particularly during the 1890's due to severe drought and to a lesser extent at the beginning of this century.*
- *Closer Settlement: from the 1920's. The resettlement of returning servicemen to the Western Division began after World War I and was initially based on a British model. In some cases, the squatters' large holdings were sub-divided to make room for new tenants. Minimum stocking rates were imposed on tenants. The policy brought increased stocking rates, more soil movement and greater equity in land ownership but contributed to increased economic failure.*
- *Soil Conservation: from the 1940's. Emphasis was placed on controlling soil loss through vegetation clearing restrictions and the regulation of livestock numbers. Minimum stocking rate regulations in the Act were changed to regulate stock carrying capacity. Myxomatosis was released to control rabbits. After 1960's, the trend moved to the consolidation of properties to make them more financially viable and to reduce overstocking, though property subdivision continued in the 1970's.*

- *Broadening Issues: from the 1970's. Declining agricultural commodity prices resulted in a diminished significance for pastoralism as part of the economy. A number of broader issues began to emerge. Aboriginal people won citizenship, and were supported in attempts to protect cultural heritage and regain land by new laws. Small areas of National Park were established.*
- *Globalisation: from the 1980's to the present. Attempts to gain fairer world trading rules and growing pressures to liberalise trade has coincided with declining desire by the Commonwealth Government to buffer these external forces. Exposure to the market has left marginal producers vulnerable to the contraction of important markets in Asia and the former Soviet Union and a continuing trend towards increased usage of synthetic fibres. Decreasing terms of trade and world wool prices have exerted increasing pressure on the rangelands' stocking rates and encouraged land use diversification."*

(Abel et al, 1999)

More recently there has been the introduction of statewide natural resource management laws to protect endangered fauna, native vegetation, wilderness habitat, water and the environment generally. These new laws have had an effect on the Western lands by diluting the effectiveness of land administration across a number of agencies, with ensuing coordination difficulties.

3.1.2 Cadastral Surveying

The demarcation of these grazing leases over the rangelands followed standards of survey established to support the introduction of the Torrens system of registration of title. These accuracy standards were related to topography and not land value. The scarcity of features or improvements also meant that general boundaries principles could not easily be applied or adopted.

This meant that in theory, a cadastral survey over “flat” land for the purposes of alienation, long-term lease or subdivision had to achieve the same accuracy standards (1:8000 linear misclose ratio) whether it was in the urban area of Sydney or over leasehold lands in the Western Division.

The fixed boundary system or “running survey” was an efficient means of marking out land to which the principle of *terra nullius* was applied (that is, the land was empty of meaningful or recognizable human settlement when colonised, and therefore no prior land rights from indigenous peoples needed to be considered or acknowledged). This system imposed European values and precise measurement upon that was generally regarded as a harsh and untamed environment.

From 1950 to the late 1970’s a large number of surveys were undertaken in the Western Division due to pressure for soldier settlement after World War II and the subsequent withdrawal of land from the larger holdings. Other lands also became available from expiring leases held by pastoral companies. These surveys were undertaken by contracted and Department of Lands surveyors. The Government supplemented the actual cost of survey with the incoming lessee paying a prescribed concessional survey fee based on area.

Surveys were undertaken in accordance with directions issued by the Surveyor General and the Survey Practice Regulations, 1933. The Department of Lands Survey Directions 1963 for surveys of Crown land were later published as a supplement to the Survey Practice Regulations. Crown land in the Western Division was brought under the Torrens Title system and requirements of the *Real Property Act* during 1986-1988.

The application of these standards has caused many to claim that survey costs over small parcels or leasehold rural lands are more than the value of the land in many circumstances. Even though photogrammetry had developed as an efficient mapping technique Post

World War II, it was not actively pursued as a means of assisting cadastral systems in the Western Lands of NSW until recently.

3.1.3 Land Titling

The Torrens Title system that was applied in the Eastern half of the State, principally to support freehold title and the notion under European law of private property, which gave a landowner exclusive rights (John Locke's "possessive individualism"), was not necessary for pastoral leases. The Crown retained ownership of the land, with the administration of the leases remaining with State Government through various Department of Lands portfolios.

As mentioned previously, pastoral leases, the majority of which were leases in perpetuity were brought under the provisions of the *Real Property Act* during the mid to late 1980's. This provided lessees with the State guarantee of title with regard to their interests and meant that NSW was one step closer to having all parcels of land uniquely identified and recorded in the Automated Land Title System (ALTS) or automated Torrens Title Register.

3.1.4 Land Administration

The administration of land in the Western Lands of NSW was largely unregulated until the 1860's, when the colonial Government introduced regulations to control and administer land settlement. Major changes to administration have normally taken place following a failure in the system to support the existing population; generally this has been a result of extended drought. One of the most significant changes occurred at the end of the 19th Century following a decade of drought when specific legislative controls were introduced to manage the Western lands, that is the "*Western Lands Act, 1901*". Government response to periods of drought and economic downturn has typically been to provide financial assistance in the form of subsidies and low-interest loans to aid economic recovery and the imposition of upper

limits on carrying capacity as a measure to assist environmental rehabilitation.

The monitoring of these controls has proved difficult to implement effectively due to the size of the region and the paucity of reliable, comprehensive information on rangeland condition.

The main form of tenure in the Western Division has historically been leasehold over Crown land for specific purposes, most commonly in perpetuity. Formal lease agreements set out the purpose of the lease, which are commonly held by lending institutions. Land with similar characteristics in Queensland, South Australia, Northern Territory and Western Australia and in other countries is also held mainly under leasehold tenure.

A small percentage of the Western Division (3%) has been set aside in the National Parks system for nature conservation purposes. There are approximately 3000 Crown Reserves set aside for a range of public purposes.

A scattering of small freehold parcels exist throughout the Western lands as rural holdings, town allotments, irrigation holdings in the irrigation districts and some homestead parcels scattered within grazing and agriculture leases.

There are also a variety of other land tenures, including 800 plus licenses for pump sites, residential occupations at White Cliffs, leases for extraction of minerals and grazing and other purposes, and leases in the Lower Murray for irrigation purposes.

3.2 Current Situation

3.2.1 Cadastral Surveying

Cadastral surveying in the Western Lands is still little different to surveys carried out in other parts of the state, as accuracy standards are homogeneous. The Western Lands accounts for less than 1% of the

state's cadastral survey activity, according to statistics collected by the Office of the Surveyor General.

Surveyors have traditionally been preoccupied with terrestrial technology; it is only in recent times that remote sensing techniques and in the mid-1990's that satellite positioning has become acceptable and increasingly affordable. In NSW, it has been legally possible since 1964 to use photogrammetric techniques to define irregular natural boundaries. Accuracy standards however, have not changed significantly and are related to topography (slope) and not to land value, land use or client demand. Regulations do allow for surveys not requiring strict accuracies, however to the author's knowledge these have not been applied to Western lands leasehold surveys. In most recent times these requirements have been applied to surveys of aquaculture leases under the *Fisheries Management Act*, for registration and administration of leases.

Total station technology is commonly used, particularly for small parcels and subdivisions, with the Global Positioning System (GPS) more recently being employed for larger projects.

Survey marking standards are similar to the eastern and central areas of the state, the absence of reliable sources of hardwood for survey pegs in some areas has seen the adoption of steel marks for corner marking of cadastral parcels. Permanent Marks, forming part of the State Control Survey, (a series of dependent networks further densifying the Geodetic Network) have been placed in connection with cadastral surveys since Survey Regulations were amended in 1991. However, establishment of their position in terms of co-ordinates in relation to the State Control Survey has not been possible in many cases due to the distances and cost involved in connecting to existing established marks.

Metaliferous mining is a significant activity in the West, particularly around Broken Hill (silver, lead, zinc) and Cobar (copper, gold) and

has required surveys for mining lease purposes. These surveys for lease purposes, as opposed to the underground workings, which have all been connected to the State Control Survey, are to similar standards for alienation purposes for obvious safety and risk management purposes. Many of these lease surveys have been connected to the State Control Survey and co-coordinated to enable integration with other mine infrastructure surveys.

3.2.2 Land Titling and Surveying

Parker, et al (1995), conclude, “The Torrens system must undergo reforms to keep pace with society. A revamping of old principles and a rethinking of common acceptances are required in order to prepare the land registration system for the future.”

The Torrens system itself has not changed its fundamental principles since it's inception over 100 years ago. Questions about the system's reliability, simplicity, low cost, speed and suitability are being posed as society moves towards the 21st century.

Reliability in the context of the degree of dependence on title boundaries and the exacting standards of survey maintained by Australian surveyors has been the subject of criticism for some time. Authorities such as Ruoff (1957) have pointed out the seemingly unnecessary emphasis on relative survey accuracy.

“...nowhere is it more evident that modern surveying is near to being an exact science than in several Australian states where a standard of extraordinary accuracy, surely second to none.... is maintained. ...If the degree of perfection sought is such that the amount of public time and money expended are out of all proportion to the results achieved, it may be questioned whether the surveyor is fulfilling his most useful function in the community. ... It is

pertinent to remember that the measurements on the diagram of a title can never be absolutely perfect but only as perfect as the information upon which they are founded” (Ruoff, 1957).

It is important to remember that Government policy required that all original surveys of Crown land had to be to “alienation” standards as prescribed by the Surveyor General. There was no distinction made between surveys for freehold title and surveys for leases over Western Division rangelands.

Advances in survey technology such as Electronic Total Stations and the Global Positioning System (GPS) combined with modern communications and transport mean that relative and absolute accuracy of centimetres can be achieved relatively easily over large properties (greater than 10,000 ha). However, one must ask the question, **how accurate do the boundaries need to be located?**

This question is particularly relevant, when the lessee removes the surveyor’s peg and replaces it with a fencepost 300 millimetres in diameter, or when a new fence not on the original line, but a vehicle width, away replaces a fenced boundary.

The real purpose of delineating land boundaries to an accuracy necessary to provide confidence to landowners when dealing with land appears to be losing ground to the capabilities of modern technology.

It has been suggested by Parker, et al (1995) that:

“For better reliability - remove the duplicate of title and tailor the required accuracies to need; for a simpler system-abolish utility easements; for a lower cost system-convert to a national Torrens system; for speedier transactions-implement electronic lodgement of plans and land registration documents; for better

suitability-continue to ask questions which will enable the Torrens system to adapt to changes of the future.”

Since 1 January 1987, all dealings with Western Lands Leases must be registered in the Torrens system. Most perpetual leases are based on Crown plans of survey, since refiled at the Land Titles Office in the Deposited Plan file. Few have limitations as to boundaries or qualifications on title imposed. It should also be noted that State Governments have at various times imposed moratoriums on the conversion of perpetual leasehold land to full Torrens title.

3.2.3 Land and Environmental Management

During the 19th Century, Government largely regulated management of the region with a view towards exploitation of natural resources to maximise economic productivity and the production of wool and other commodities for traditional European and domestic markets. The 20th century has seen an emphasis on managing the land for future generations whilst extracting some economic production-the economic imperative is now being balanced against the land's capability. The 21st Century is likely to see an early period of structural adjustment as uneconomic enterprises are forced to diversify, agglomerate into bigger holdings or simply cease to exist as global commodity prices continue to stay at low levels. Land degradation is likely to continue, particularly increasing salinity problems in both soil and water environments, requiring more rehabilitation programs such as Landcare.

Environmental management has focussed on a number of significant reforms:

- Water reform, where the allocation and use of water, one of the State's most valuable resources, is under major review to ensure all uses, including farming, domestic use and the requirements of

natural ecosystems are balanced to ensure sustainability. Reallocation and redistribution of water rights managed through licenses is a major component of these reforms.

- Vegetation reform, where regulatory controls through the *Native Vegetation Conservation Act, 1999*, are being placed on the clearing of natural vegetation to retain habitat and prevent soil degradation requires a sound information base for monitoring land cover change. Vegetation mapping is playing an important role in compliance monitoring and the preparation of regional planning strategies.
- Conservation of biodiversity, through the *Endangered Fauna Act, 1991* and establishment of conservation reserves and conservation arrangements whereby pastoralists are engaged to monitor and manage flora and fauna.

The above reforms, which require a sound information base of natural resource information, are implemented through some form of re-engineering of rights, responsibilities or obligations that can be recorded and managed through the application of a modern Multipurpose Cadastre.

3.2.4 Spatial Data Infrastructure - the Role of the Cadastre

In Australia, the Australia and New Zealand Land Information Council (ANZLIC) is promoting the development and implementation of a national spatial data infrastructure for Australia. New Zealand is also moving in this direction, however, the nature of its government structure which has less institutional barriers, will see realisation of a fully integrated spatial data infrastructure (SDI) at an earlier date than in Australia.

“Such an infrastructure comprises the fundamental data sets required to underpin economic growth and social and environmental

policy development. It includes the interrelationships between those data sets, the management of them, and the means of access to and distribution of those data. The infrastructure includes the materials, the technology, the organisational arrangements and the people necessary to acquire, process, store and distribute those datasets”(ANZLIC, 1997).

One of the datasets identified as fundamental to the operation of the SDI is the cadastre and in particular, the digital representation of the spatial cadastre or Digital Cadastral Database (DCDB), as it is more commonly known. When combined or integrated with the legal and fiscal perspectives in a digital form and available to the Government and community via the World Wide Web, the prospect of online conveyancing comes closer to reality.

A number of Australian jurisdictions are already well down this path with NSW well placed in terms of Web enabled cadastral datasets, integrated to textual datasets at the Land Titles Office and Valuer General’s Office.

The comprehensive recording and management of all rights and interests in land as a component of the national SDI cannot be overstated, particularly as the business and broader community will increasingly use geographic coordinates and street address (key elements of a MPC), as means of accessing and navigating through the virtual world recreated through the SDI.

3.2.5 Land Administration

Whilst Local Government has significant responsibilities for development standards, these standards have a greater impact in the urban areas, land use policies affecting leasehold tenures are still administered through the State Government through various State

Environment Planning Policies (SEPP's); the operation of the Western Lands Act, 1901; and conservation legislation administered by the NSW National Parks and Wildlife Service (NP&WS) and the Department of Land and Water Conservation.

The plethora of associated NSW Acts that apply to the Western Lands administration and management are listed below:

- *Aboriginal Land Rights Act, 1983*
- *Agricultural and Veterinary Chemical Act, 1994*
- *Catchment Management Act, 1989*
- *Crown Lands Act, 1989 (Crown Lands Consolidation 1913)*
- *Endangered Fauna Act, 1991*
- *Environmental Planning and Assessment Act, 1979*
- *Fisheries Management Act, 1994*
- *Forestry Act, 1916*
- *Heritage Act, 1977m, 1996*
- *Local Government Act, 1993*
- *Mining Act, 1992*
- *Local Government Amendment (Ecologically Sustainable Development) Act, 1997.*
- *National Parks and Wildlife, 1974.*
- *Native Title Act, 1994.*
- *Native Vegetation Conservation Act, 1997.*
- *Protection of the Environment Operations Act, 1997.*
- *Petroleum (Onshore) Act 1992*
- *Rivers and Foreshores Improvement Act, 1948*
- *Roads Act, 1993*

- *Rural Fires Act, 1989*
- *Soil Conservation Act, 1938*
- *Threatened Species Conservation Act, 1955*
- *Water Act, 1912*
- *Wilderness Act, 1987*

(Western Lands Review, 2000)

A range of historic Acts also has relevance (eg. *NSW Buttenshaw Act, 1934; NSW Closer Settlement Act, 1984; NSW War Service Land Resettlement Act, 1948, 1957*).

With rural and regional Australia still undergoing structural change, Governments continue to monitor land policy and will intervene when service providers and industry “downsize” as efficiency measures. Government intervention has typically taken the form of facilitating alternative industries to relocate or alternative employment to those disadvantaged by industry reform.

In the late 1990’s, water, soil, vegetation and biodiversity management reforms remain as the highest environmental priorities.

The completion of the automation of the Crown Land Information System in 1999, with the spatial components integrated and maintained as part of the DCDB has been a major step forward in better land administration through access to up-to-date and complete land information, the challenge remains to link this information to natural resource information for better informed decision making.

3.3 The Need to Change the Current System

3.3.1 The Information Revolution

“Electronic connectivity and communication are fundamental to the survival and thrival of our regional communities. It is by the enterprising use of the

opportunities provided by technology that regional development will be supported. The continuing focus of technology application must be the enabling of people to meet the challenges and take advantage of the opportunities offered in the knowledge age”.

(Professor David James, Vice Chancellor, University of Ballarat, 2000)

The advent and rapid development of information technology that has the ability to capture, process, store, query and display large sets of spatial and textual data has given decision makers powerful tools for resource management.

Digital photogrammetry can be used to create comprehensive three dimensional models over large areas with the ability to spatially locate features on the ground such as railways, dams, fence lines, track centrelines, waterways, catchments etc which can be used as land parcel boundaries with an estimated accuracy of $\pm 3\text{-}5\text{m}$.

In the latter part of 1999, a US corporation, heralding a new era of digital geo-information collection from space launched a new commercial 1-metre high-resolution earth observation satellite system, known as IKONOS. Previously this high resolution satellite imagery (HRSI) technology was only available to the military, now however, this technology is set to revolutionize the applications of environmental remote sensing, topographic mapping and positioning, and geographic information systems (GIS). This satellite system promises to rival both aerial photography and ground-based methods for mapping and surveying. At the time of writing, a 3-year collaborative research program is about to commence to develop the appropriate methods and procedures to render the HRSI technology suitable for high accuracy geo-information collection tasks that are currently very costly to carry out. One specific area of research is the potential to use this technology for cadastral mapping of pastoral leases in rangeland NSW. The aim of the project in this context is:

“To ascertain whether 1m satellite imagery has sufficient metric integrity to provide cadastral survey data to required accuracies, specifically in rural New South Wales, and to develop appropriate mathematical models and computational procedures to allow the exploitation of IKONOS imagery in the LIC for the purpose of both establishing initial digital cadastral data and updating existing vector information in a land information database. A significant experimental component is envisaged in this work”

(ARC Research Grant Proposal, University of Melbourne, 1998).

Global Positioning System (GPS) technology can be used to capture spatial information and other attribute information relating to natural resources or the “as built” environment. GPS is also a powerful tool for completing and densifying geodetic networks. This technology gives a capability of navigating across the natural landscape, as well as navigating through virtual reality landscapes created from digital mapping techniques, where can model and analyse the impacts of man’s activities. The decision in May 2000, attributed to President Bill Clinton to remove Selective Availability (a method of deliberately degrading the accuracy of GPS for civilian users) has given civilian users access to a single point positioning service of better than 10 metres, where previously the best available accuracy, without the use of differential techniques, was 100 metres for 95% of the time. Advances in the provision of Differential GPS services through the establishment of additional continuously operating GPS reference stations will see the availability of positioning services of better than 0.2 metres in the next few years. The adoption of a cadastral system able to utilise this technology to maintain and update spatial accuracy and to navigate through 3 Dimensional models of the real world would provide tangible benefits to the administrators and users of the system.

Geographic Information Systems provide a capability to store, analyse and manipulate geographic data and the ability to integrate various data types, particularly where temporal studies are involved (Grant, 1997).

Recent advances in the availability of spatial data on the Internet, such as aerial photography, Survey Control information, Land Titles, Deposited Plans and access to an integrated property information prototype provide access to fundamental cadastral and property information that are required for the effective operation of a modern Multipurpose Cadastre.

The combination of these enabling technologies can deliver the comprehensive, reliable information sources required for better decision-making.

3.3.2 Government and Community Expectations

A period of sustained lower than average rainfall, spanning a number of seasons during the mid-1990's, coupled with low commodity prices and declining productivity and environmental quality has forced Government and the rural community to change the structure of life in the "outback". A period of rural adjustment is underway. Some of the measures by Government are aimed at promoting sustainable land management practices that improve environmental values, whilst others look at strengthening those farm businesses that are economically viable in the long term. Financial institutions are rationalizing services in rural areas, by closing small branch outlets, which is causing some grief to small rural communities and those unable to cope with electronic transactions or travelling long distances to a larger centre.

Transacting business on the Internet is becoming much more widespread, with the concept of "*E-Commerce*" or electronic commerce gaining momentum. The availability of the Internet and an updated telecommunications system has had the potential to overcome the remoteness in the Western Lands. However, there have been recent

reports that there are still problems associated with poor levels of service and high costs that need to be overcome.

Governments are looking to shift from a control of inputs orientation to one focused on realizing environmental, economic and social outcomes established through community involvement in decision-making. This should include the delivery of easily accessed resource and policy information databases, in addition to monitoring mechanisms.

In the foreword to the Western Lands Review, the Chairman, John Kerin, points out that:

“The primary role of Government should therefore be to create a legislative and operational system, directed towards the resolution of market failure.

With regard to the Western Division’s natural resources, the role of Government should be to:

- *Provide the policy and institutional framework (for example, laws and leadership);*
- *Provide land and natural resource information, planning and monitoring services;*
- *Provide programs to improve land management and resource conservation; and*
- *Provide resource conservation incentives and compliance systems.”*

3.3.3 Native Title

The concept that indigenous land rights pre-exist and survive the establishment of sovereignty in colonized lands has existed in British common law for well over two centuries. Other former British colonies such as Canada, New Zealand and the United States of America, have long recognized that two land tenure systems exist.

Aboriginal people have distinctive value systems and cultural traditions that differ greatly from European values, which until recent times were mainly concerned with the exploitation of natural resources for the generation of personal wealth.

Aslin et al, 1999, provide an overview of Aboriginal values and attitudes towards the land as follows:

“Aboriginal culture holds that the landscape and its plants and animals provide a record of the activities of ancestral beings who behave in a human-like way. Present day traditional Aboriginal people see themselves as descendants of those beings, closely identify with particular ones as totems, have special connections with landscape features associated with their totems, and have rituals to perform in which they essentially become their ancestors. Looking after the land or ‘caring for country’ involves carrying out traditional ceremonies and land management practices that maintain the land’s health or productivity, and ensure important species survive. Aboriginal people feel a strong responsibility for their traditional lands and need continuing access to them to maintain their cultural connections and care for these lands.”

In Australia, on 3 June 1992, the High Court of Australia delivered its historic judgment in the *Mabo v. Queensland* case, ruling that Australian common law recognized Native Title. The judgment also overturned the legal concept of *terra nullius* (a land belonging to no one).

Native Title is defined in Section 223 of the Native Title Act 1993 as “the communal, group or individual rights and interests of Aboriginal people or Torres Strait islanders in relation to land or waters where:

- a) *the rights and interests are possessed under the traditional laws acknowledged, and the traditional customs observed, by the Aboriginal people or Torres Strait islanders; and*
- b) *the Aboriginal people or Torres Strait islanders, by those laws and customs, have a connection with the land and waters; and*
- c) *the rights and interests are recognized by the common law of Australia”.*

(National Native Title Tribunal, 1997)

Some general principles arise from the Mabo decision, which indicate that Native Title may still exist on:

Vacant Crown land;

State Forests;

National Parks;

Public Reserves;

Beaches and foreshores;

Land held by Government agencies or in trust for Aboriginal communities;

Waterbodies where not privately owned; and

Any other public or Crown lands.

Most importantly for rangelands in Western NSW, Native Title may co-exist with pastoral leases. Native Title can only be extinguished by valid grants of land or waters to people other than Native Titleholders in ways that exclude co-existing rights or by the construction of public works such as schools, hospitals and other amenities that are inconsistent with indigenous Native Title rights and interests.

The High Court’s *Wik Decision* in December 1996 ruled that Native Title might survive on a pastoral lease if there was a clear intention to extinguish Native Title when the lease was granted. However, Native Title cannot take away pastoralists rights under the terms of their

existing leases, nor can their leases be taken away or removed by Native Titleholders. As a result, “the Western Division has been thrown into administrative and landholding chaos with uncertainty of tenure, adverse impact on the value of assets, frustration of contractual commitments, and a substantial limitation of activity, both present and future.” (Benecke, 1997)

From the Indigenous point of view, Williams and Johnston (1994) found access to land as a fundamental issue throughout Australian rangelands and came to the conclusion:

“...that in all the rangeland areas, Aboriginal people wish to retain access to their traditional lands primarily for non-economic reasons (spiritual, social, historical). They also wish to control some land and implement multiple-use regimes incorporating small-scale pastoralism and agriculture, while living in dispersed groups on the land.

The Indigenous position on Native Title reflects these values (National Indigenous Working Group on Native Title, 1997). It takes the view that Indigenous people should have the right to protect their culture and the right to negotiate over development on Native Title land. However, it advocates respect for the rights of all title-holders on a non-discriminatory basis.”

Land administrators, in order to avoid the possibility of granting an invalid lease, have taken the approach that no contracts, leases, licenses or other Crown dealings will be entered into or offered, until the situation is clarified.

The *Native Title Act 1993* provides a means for making Native Title claims over land.

A fundamental component of any claim is the requirement to describe spatially the area or land being claimed both in words and graphically in the form of a map. This requirement to translate a geographic area of interest into a map relies upon access to suitable spatial information. The availability of digital spatial information showing all interests in the subject land that is accurate, reliable and current is essential for the process of Native Title determination to operate effectively. The various jurisdictional DCDB's provide a good basis for converting the written claim into a map, which is more easily communicated. The addition of topographic information and/or rectified photography gives a means of showing graphically the relationship between European interests which are delineated artificially on the ground and traditional interests that are defined geographically through relationships to natural features and landmarks. The development of a national spatial dataset depicting Native Title applications is gaining momentum with the National Native Title Tribunal active in lobbying jurisdictions for a national approach to information provision and access that will minimise duplication of effort. (Bowen, 1997)

The concepts and principles of a Multipurpose Cadastre will readily meet the requirements for the recording and determination of Native Title applications, as well as managing existing European interests and the relationships between the “new” and the “old”.

3.4 Cadastral Systems in other Australian States

The development of cadastral systems in the various Australian states followed the pattern established by the colonial administration in NSW that primarily was aimed at rapid land settlement and economic expansion of primary production to support domestic and European markets.

In South Australia, which was not a convict settlement, but “a society of well regulated gentlemen and honest yeomen”(Whitelock,1977), the founders of the colony decreed that no land would be granted free or

sold cheaply to any settler but it would be offered for sale at a fixed minimum price.

All Australian states adopted cadastral principles that included, inter alia, what is now universally known as the Torrens Title System, a system of licensing surveyors and a system of “running surveys”. The passage of time and many studies (Williamson, Grant et al) have identified many deficiencies in the cadastral system including:

- errors are propagated as a result of the “running survey” approach.
- surveys are difficult to relate with adjoining work.
- system does not provide for the efficient updating of cadastral maps.
- existing procedures do not fully take advantage of new survey equipment that is becoming increasingly coordinate based.
- the system does not adequately reflect the location or extent of land parcels.

(Kentish, 1994)

The surveying of rangelands in other states has generally followed the same methods and standards that have been applied to all rural surveys requiring the lowest accuracy. Regulators in recent times have used discretionary powers to lower accuracy standards and use GPS for pastoral lease surveys. In Western Australia, the Surveyor General accepts surveys of pastoral leases using GPS measured to “appropriate standards”(Browne, 1997)

In South Australia, relatively recent legislation (1992), allows the designation of “Coordinated Cadastre Areas” where adjusted coordinates for parcel corners become accepted as *prima face* evidence of boundary position. A surveyor inquiring on this system will gain access to a coordinate listing, indicating the status of the coordinate and a simple plan to cross reference the coordinates to the corners.

Recent research in Queensland by Hannigan & Farmer (1995) advocates major changes related to the physical rearrangement of farm or property boundaries and possible changes in the types of tenure that may be held e.g., group titles extended to a catchment area.

3.5 Summary

The Western Lands of New South Wales has evolved from an exploitive European land settlement approach to a point where the existing paradigm of economic use of the land needs to give way to a view focussed towards ecologically sustainable development. Significant ecological problems coupled with declining productivity and decreasing economic returns are forcing Governments to intervene to stabilise systems, and provide measures to rehabilitate degraded natural resources, such as the West 2000 program.

Existing land tenure and administrative systems have remained largely unchanged since the turn of the 20th Century, when the *Western Lands Act, 1901* was introduced.

The cadastral system similarly has also remained largely unchanged in terms of the processes of adjudication and demarcation, although some automation of processes has taken place including the automation of leases on the Automated Land Titles System (ALTS). Costs of surveys are still high when compared to land values, because of the stringent accuracy standards that are applied uniformly across the State.

The existing cadastral system is unable to cope with the increasing complexity and number of rights and responsibilities, such as water rights which can be traded by individuals without transfer of the parcel and Native Title which all need to be stored, managed and made accessible to meet contemporary user requirements. With continuing trends of declining productivity and land value the existing system must be responsive to these changing circumstances and provide a lower cost means of “knowing where my rights are.”

Society's thirst for relevant, consistent and current information is critical to decisions that are made on a daily basis that affect the land, livelihoods and people. The people of the Western Lands of NSW have a special case for access to information to help overcome isolation and remoteness. Communication infrastructures are becoming more affordable and reliable and offer the opportunity for cadastral and natural resource textual and spatial information to be made available over the Internet.

Other Australian states with similar rangelands, with similar tenures have adopted a more flexible approach to survey accuracy with a subsequent decrease in transaction costs, which could readily be adopted in New South Wales.

The scene is set for an opportunity to reform the cadastral system as Government and in particular the people of the Western Lands of NSW are looking for improvement strategies.

CHAPTER 4: INTERNATIONAL TRENDS AND OTHER DEVELOPMENTS AFFECTING CADASTRAL SYSTEMS

“There is now a world-wide revolution in the way people think about the human-land relationship.”

(FAO and FIG- Future Collaboration in Cadastral Reform in Rural Economies in Transition, 1994)

It is the aim of this chapter to document global and national trends and developments that are affecting cadastral systems. Whilst many of these trends are at a scale well above the particular circumstances of the rangelands in the study area, the operation of a global economy nevertheless affects commodity prices for exports that have traditionally accounted for a significant income for pastoral activities. Microeconomic reform is examined for its affect on Government services such as the cadastre and the capture and management of fundamental spatial data needed to populate the concept of a Spatial Data Infrastructure. These trends will shape the nature of the appropriate cadastral model that may be applicable to the study area as well as a possible broader application in other jurisdictions.

4.1 Global and National Trends Affecting the Cadastre

There is growing interest world wide for clearer, more secure rights in land, as many countries move towards new economic structures, such as the former Soviet republics and developing nations in Africa, Asia and Latin America. As the world population increases rapidly and effective sustainable resource management becomes imperative, simple but effective cadastral structures must be available. These structures must be able to support the operation of land markets and the supply of land-related services, land use planning and cope with the greatly increased demand for resources and facilities while ensuring that there is minimum damage to the environment.

The World Bank, the FAO and numerous authorities have argued the importance of the legal recognition of property rights in land supported by appropriate cadastral systems for the delivery of improved agricultural productivity, effective land markets and economic development.

The Food and Agriculture Organisation of the United Nations (FAO) has made the following statement on cadastral reform at a Round Table Meeting in Melbourne in March, 1994:

“There is now a world-wide revolution in the way people think about the human-land relationship. It is not only taking place in the former Soviet countries, but in indigenous common property systems as well. Formerly quiet and seemingly isolated tribal societies are suddenly demanding some form of cadastre and registration to protect their patrimony and cultural integrity. Indeed, it is a world-wide phenomenon.”

(FAO and FIG, 1994).

The development of a global consumer economy which is market driven permeates all sectors of individual economies and to a large extent dictates commodity prices for example wool, sheep export prices which in turn influences business profitability even in remote areas such as rangeland Western NSW.

It is recognised globally that in rural areas, the formal recording of rights, responsibilities and restrictions in land are important for:

- “ improved sustainable resource management
- the promotion of increased investment in agriculture
- more effective stewardship of the land
- facilitating the planning and development of national cadastral infrastructures so that they may fully service the escalating needs of greatly increased urban populations. These will result from the rapid expansion of cities that is already taking place and which is projected to continue into the 21st century”.

(FAO and FIG, 1996)

Recognition of these trends and needs was addressed through the United Nations Interregional Meeting of Experts on the Cadastre who met in Bogor, Indonesia in March 1996. The outcomes of that meeting are known as “**The Bogor Declaration**”. The need to implement improved cadastral systems can arise for a number of reasons. The meeting identified a number of justifications for cadastres and cadastral reform:

- 1. Supporting Land Management and Economic Development** by providing better information for land use planning, land administration, and support for socially desired land use and environmental considerations.
- 2. Improved Protection of Land Rights** including the reduction and avoidance of land and boundary disputes; the increase in efficiency

of property transfers and dealings; increased security of land rights and dealings and fraud prevention.

- 3. Supporting the Creation or Development of an Efficient Land Market** through the provision of secure title for economic development; increasing revenue for central and local government by accurate identification of land use activity and property values; and unification of different systems.
- 4. Simplification of Processes** through the standardisation and, in some cases, automation of procedures and removal of duplication between institutions.
- 5. Computerisation** to provide fast, cost effective access to information and improve integrity of data.

A vision for the cadastre shared by the meeting was to:

“develop modern cadastral infrastructures that facilitate efficient land and property markets, protect the land rights of all, and support long term sustainable development and land management”.

Any resulting infrastructures will support security of tenure and allow land rights to be traded in an efficient and effective way and at affordable costs.

The Bogor Declaration has become an important milestone in the development of cadastral systems, particularly in the Asian and Pacific regions. The United Nations through this and other programs, such as the Habitat II Global Plan of Action continues to recognize that efficient and effective cadastral systems are essential elements for environmental management, economic development and social stability in both developed and developing countries.

4.2 Bathurst Declaration on Land Administration for Sustainable Development

Arising from the *Bogor Declaration* was a resolution urging the United Nations to hold a global workshop on land tenure and cadastral infrastructures in support of sustainable development. The resolutions resulted in the Workshop on Land Tenure and Cadastral Infrastructures for Sustainable Development held in Bathurst, Australia in October 1999. It was followed by an open International Conference in Melbourne where the *Bathurst Declaration* was presented. The United Nations Department for Economic and Social Affairs and FIG participated in both events.

The Bathurst Workshop brought together 40 international land administration experts from around the globe to examine the major issues relevant to strengthening land policies, institutions and infrastructures. The *Bathurst Declaration* calls for a global commitment to halve the number of people around the world without access to secure property rights by the year 2010. It also identifies the need for policy and institutional reform to facilitate sustainable development.

To realise this global commitment the Workshop proposes a set of recommendations as follows:

- 1 Providing effective legal security of tenure and access to property for all men and women, including indigenous peoples, those living in poverty and other disadvantaged groups.
- 2 Promoting the land administration reforms essential for sustainable development and facilitating full and equal access for men and women to land-related economic opportunities, such as credit and natural resources.
- 3 Investing in the necessary land administration infrastructure and in the dissemination of land information required to achieve these reforms.

- 4 Halving the number of people around the world who do not have effective access to secure property rights in land by the Year 2010’.

The workshop in confirming the Bogor Declaration extending the professional debate on desirable land administration and recognizing that the community of nations have committed themselves to the various United Nations Global Plans of Action arising out of the UN Summits over the last decade, recommends the following:

- 5 Encourage nations, international organisations, Non-government Organisations (NGO’s); policymakers, administrators, and other interested parties to adopt and promote the Bathurst Declaration in support of sustainable development.
- 6 Encourage all those involved in land administration to recognise the relationships and inter-dependence between different aspects of land and property. In particular there is need for functional co-operation and co-ordination between surveying and mapping, the cadastre, valuation, physical planning, land reform, land consolidation and land registration.
- 7 Encourage the flow of information relating to land and property between different government agencies and between these agencies and the public. Whilst access to data, its collection, custody, and updating should be facilitated at local level, the overall information infrastructure should be recognised as belonging to a national uniform service to promote sharing within and between nations.
- 8 Improve security of tenure, access to land and to land administration systems through policy, institutional reforms and appropriate tools with special attention paid to gender, indigenous populations, the poor and other disadvantaged groups. In many nations this will entail particular efforts in areas under customary or informal tenure and in urban areas

where population growth is fast and deficiencies are most prevalent,

- 9 Recognise that good land administration can be achieved incrementally using relatively simple, inexpensive, user-driven systems that deliver what is most needed for sustainable development.
- 10 Recognise that the acceptable rise in the incidents of violent dispute over property rights can be reduced through good land tenure institutions that are founded on quality land information data. Good land information underpins good governance. Where conflict arises, there must be inexpensive land dispute resolution mechanisms in place that are readily accessible to all parties concerned.
- 11 Encourage national and local government bodies to document and manage their own land and property assets.
- 12 Recognise that land markets operate within a range of land tenures of which freehold is but one. It is important to facilitate the efficient operation of land markets through appropriate regulatory frameworks that address environmental and social concerns.
- 13 In order to increase knowledge of the global situation of land administration issues such as the range of tenure issues, gender, urban agglomeration, land disputes, problems and indicators with a view to producing a global atlas and related documentation. Much of the needed data are already available in different UN databases.
- 14 Recognizing the difficulties in interpretation of the many land administration related terms, develop a readily accessible thesaurus, translated into appropriate languages, to facilitate a better understanding of the terminology used. Further, on the basis of selected criteria, use this to prepare examples of best

practice in the field of land administration. This can be done using work already completed by FIG and FAO.

- 15 In view of the crucial importance of human resources in the management of land, ensure that there is sustained education and training in land administration. In particular, international bodies should seek to develop multi-disciplinary, multi-national training courses in land administration and make these available at the local level through the use of modern information technology.
- 16 International and national agencies, NGO's and other interested parties to arrange workshops and conduct studies with regard to such matters as the quality of access to land and information, gender issues, customary law and indigenous rights, land tenure systems, interaction between land and water rights, maritime cadastres and the management of land administration systems.
- 17 In order to co-ordinate foreign assistance, countries seeking help should play a more active role in the coordination of aid and prepare a country profile analysis, describing the status of land administration and the need for improvements. Based on this the countries should then prepare a master plan to which all land administration, initiatives and projects should adhere.
- 18 In order to ensure sustainable development of territorial oceans claimed under UNCLOS (United Nations Convention of the Law of the Sea) the United Nations emphasise the need for claimant countries to develop their capability to support effective marine resource administration through the national spatial data infrastructure.
- 19 Undertake analyses and develop performance indicators that can monitor the effectiveness of land administration and land tenure systems in relation to sustainable development and poverty alleviation.

20 That the Workshop and FIG strongly support the “Global Campaign for Secure Tenure” undertaken with the implementation of the Habitat Agenda, presently launched by the UNCHS (Habitat) and commit to promoting activities in terms of this campaign in future FIG programs.’

(UN&FIG, 1999)

The Declaration calls for a recognition that good land administration can be delivered using relatively simple, user-driven systems that can be achieved incrementally. The system being proposed for the Western lands is simple in that the accuracy and re-establishment methods are less stringent and utilises modern positioning and information technology.

The Declaration makes recommendations for the re-engineering of existing systems to reflect changing priorities in society and the following considerations:

- Statutory survey requirements need to be more flexible and relate to the character of the information and the use of information for multiple purposes. Co-ordinates of boundary points should form the fundamental geo-reference, however this needs to be balanced against the current hierarchy of evidence developed through Common and Statute Law that establishes monuments above measurements.
- Systems need to be able to accommodate a range of information that may not be exclusively parcel-based, such as Native title, water rights and overlapping rights.

The Declaration is a defining document in terms of the evolution of land policy and cadastral systems. For the proposals outlined in this thesis, the Declaration provides guidance and confirmation of the model proposed.

4.3 Technology

Technology, and in particular the Internet, is driving change at a dizzying pace. As a tool available to any who can afford a computer and a suitable access mechanism it is particularly relevant to rural users as it is location independent, although performance can be limited in some areas due to inadequate telecommunications infrastructure.

One of the major advantages that it offers for rural *E-Commerce* is that it can eliminate significant freight and travel costs in areas such as livestock sales and property sales. Wesfarmers Dalgety, a major national rural services company, provide a range of services including property sales. On the 20 May 2000, the company completed the first auction of a rural property that included live bids over the Internet. Similarly, livestock trading has been taking place live over the Internet since 1992, where livestock do not leave the property and are sold to bidders using video footage and a standard set of descriptions to provide an objective basis for comparison and sale.

Health services in the form of online medical examinations are now being performed for patients in remote areas to reduce travel and response times for medical practitioners and improved access.

The ability to undertake transactions via the Internet provides the opportunity for land markets to operate electronically, where manual (hard-copy) processes are replaced by digital means. Online Multipurpose Cadastres are already operating in other jurisdictions, notably in Canada (New Brunswick). In Australia, Land Victoria is sponsoring the development of an online Multipurpose Cadastre through the Department of Geomatics, University of Melbourne. The prototype model allows the user to search and view all related rights, responsibilities and restrictions on land in a uniform manner, ultimately enabling land transactions to be performed over the Internet (Majid, 2000). The prototype provides access to the following “land-related attributes”; parcel address, parcel identifier, ownership, street map,

parcel coordinates, surrounding parcels, valuation, survey plan, building information, Native Title areas and Census information.

In the context of what is needed for the additional requirement of natural resource management of the Western lands, the addition of access to rectified imagery and natural resource datasets to the above attribute model would provide a sound basis for a technologically up-to-date solution.

Satellite based positioning technology is expected to improve in terms of accuracy and affordability, giving the community greater access to an inexpensive means of navigation, and technology that can be readily integrated with other systems for example precision farming.

Property owners will in the near future be able to download cadastral boundary information off the Internet and navigate to their property boundaries or any area with a particular right or restriction for example conservation area to an accuracy of better than 10 metres.

Similarly, the availability of “desk-top” GIS is becoming more affordable. The land manager now has a large array of software that can sort, analyse and apply spatial data for a range of farm and land management applications. To “fuel” these information requirements new data access and management models need to be developed and implemented that are flexible and capable of evolving to match changing technology and community expectations.

4.4 Cadastre 2014

In 1998, Commission 7 of the International Federation of Surveyors published a significant document called “*Cadastre 2014-A Vision for a Future Cadastral System.*” The document describes the outcomes of a Working Group, tasked with the development and documentation of a clear vision for cadastral systems in the future as well as providing a benchmark against which cadastral systems worldwide can be measured in terms of their development and reform.

The Vision for Cadastre 2014, developed by the Working Group is as follows:

“Cadastre 2014 is a methodically arranged public inventory of data concerning all legal land objects in a certain country or district, based on a survey of their boundaries. Such legal land objects are systematically identified by means of some separate designation. They are defined either by private or public law. The outlines, the identifier together with descriptive data, may show for each separate land object the nature, size, value and legal rights or restrictions associated with the land object.

In addition to this descriptive information defining the land objects, Cadastre 2014 contains the official records of rights on the legal land objects.

Cadastre 2014 can give the answers to the questions of where and how much and who and how.”

(FIG, Commission 7,1998)

Cadastre 2014 replaces traditional concepts of the cadastre and land registration with a comprehensive land recording system and introduces the concept of legal land objects, which is described as “a piece of land in which homogeneous conditions exist within its outlines.” A land object is simply a right, responsibility or interest in land that can be defined or related to an area on the earth’s surface by either a public or private law.

The document includes 6 key Statements on the Cadastre, which describe the characteristics of Cadastre 2014. These six statements deal with the technical development, institutional and financial structures and mission and purpose that form the definition of Cadastre 2014. The first three statements are of particular relevance to this research.

Statement 1 on Cadastre 2014 describes the scope and content of the system as follows:

“Cadastre 2014 will show the complete legal situation of land, including public rights and restrictions!”

In the context of rangeland NSW, the cadastre must be able to record all interests in land, including Crown (State and Federal Government) interests, Native Title, Local Government and any private interests for example mortgages, easements.

Statement 2 on Cadastre 2014 comments on the likely form and organisation of the system in the future:

“The separation between maps and registers will be abolished!”

Technology now enables the automation of many processes and the ability to manage and integrate spatial information (for example maps and surveys) with textual information such as land title and valuation registers. The traditional separation between surveyor and solicitor responsible for different processes, supporting land markets will become blurred. In NSW, current proposed models for the electronic lodgement of survey plans via the Internet for land titling and land information purposes has the surveyor as the lodging agent and not a separate party as currently exists.

Statement 3 on Cadastre 2014 describes how modern information technology will dictate the operation of the future cadastral system:

“The cadastral mapping will be dead! Long live modelling!”

Rather than drawing objects on maps or in registers after they have been captured or defined, modern information technology allows the collection of real world objects by GPS and remote sensing methods and the management of those objects and their interrelationships in a computerised system. Such an approach allows greater flexibility in the

generation of products such as maps, reports and statistics and their distribution by electronic means such as the Internet.

Cadastre 2014 also makes some predictions on the accuracy of the system and the fundamental basis of delineation. The authors of Cadastre 2014 state that the system will be based on fixed boundaries and not general boundaries as exist in some countries, notably UK. Under this system, boundaries are located by coordinates that are surveyed to an accuracy according to user needs and the need to differentiate between various land objects for example Native Title and pastoral (European) leasehold.

Cadastre 2014 also suggests that land objects “will be localised in a common reference system”. In the context of Australian terminology, this means that all spatial information is connected/referenced to the State Geodetic Networks, which in turn are based on the Geocentric Datum of Australia, a new earth-centred datum, to be adopted nationally from 1 January 2000.

Cadastre 2014 is seen by many in the cadastral reform arena as a significant document, as it presents an international “snapshot” of cadastral trends in the 1990’s, as well as influencing the thinking on future cadastral infrastructures. The concepts and principles reinforce the importance of cadastral models able to support multiple purposes and needs that is, Multipurpose Cadastres.

4.5 Micro-economic Reform

In Australia since the late 1980’s, micro-economic reform (measures which increase the ability of the economy’s resources to produce goods and services efficiently) has been high on the agendas of all levels of Government. These reforms have changed the shape of the Australian public sector, principally through the development of a new contractual structure within State Governments called the purchaser-provider model. Based on this model, the senior policy makers in each

department act as purchasers and define the outputs. Internal and external service providers that include Government Business Enterprises that are part of government but run in a commercial manner on an independent basis produce goods and services on a competitive basis. This has affected state cadastral mapping and valuation agencies and to a lesser extent land titles offices, which have the shared responsibility of maintaining the cadastral system. The result has been the need to justify from an economic rationalist point of view the benefits of any cadastral reform program and the delivery of information infrastructure. This new management structure has created an emphasis on efficient service provision, which has caused many providers to closely examine activities that historically were done in the public interest. Agencies will not go outside the bounds of their core business to undertake activities that may have “whole of Government” benefits. This provides a whole new range of institutional impediments to cadastral reform programs. The concept of “partnering”, where agencies agree on mutually beneficial business outcomes and undertake shared activities is gaining acceptance, particularly where there are common processes for the collection and maintenance of spatial data.

There have been some successful moves in Australia to integrate the cadastral, topographic and other fundamental datasets to form one National/State digital map base and an increasing trend to merge the mapping and land titling functions into a single administration. The establishment of a national market for spatial data has had a significant effect on institutional structures. New structures such as the Public Sector Mapping Agencies (PSMA) have had to be created. PSMA is a strategic alliance between all state and territory mapping agencies to produce national spatial datasets to meet the requirements of Census collection agencies and national utilities.

The automation of processes is accelerating due to the demands for faster access and is being pushed along by the information revolution. Land title and valuation registers have been automated and digital

cadastral parcel data is being demanded by a wide range of users, being led by public and private utilities and local government to support land and geographic information systems and asset and facilities management.

In Australia, the introduction of Australian Accounting Standard No.27 (AAS27) has placed an additional obligation on all levels of government to have a complete, up-to-date, inventory of all public assets, which includes, inter-alia, the quantity, condition and value of assets. Land in public ownership is one of those assets. The location, tenure, land use, improvements and restrictions on the land are elements recorded in a modern multipurpose cadastral system, which can also support integrated access to a wider range of land related data, particularly with traditional topographic and imagery data.

4.6 Spatial Data Infrastructures

Following an Executive Order by United States President Bill Clinton in 1997, to define and create a Spatial Data Infrastructure for the United States, the concepts of Spatial Data Infrastructures are being developed in a number of countries around the world.

The cadastre as a land information system containing interests in land forms part of that infrastructure. In his view of future directions for Spatial Information Management in Australia, Williamson (1999) included a conceptual model of a parcel based geographic information system based on a legal cadastre. Williamson suggests that the institutional change in his model, which reflect trends in Australia and overseas, provides an efficient mechanism for providing both textual and spatial cadastral data as key components of a jurisdiction's spatial data infrastructure.

The apparent drive towards holistic development of SDI's provides an impetus for the adoption of new cadastral structures and concepts such as the Multipurpose Cadastre.

The Australian and New Zealand Land Information Council (ANZLIC), the peak national policy body, has developed a model for the Australian Spatial Data Infrastructure (ASDI) that comprises four core components:

1. *Institutional framework* comprising policy and administrative arrangements.
2. *Technical standards* defining the technical characteristics of the spatial (or geographic) datasets
3. *Fundamental datasets*, the essential component to the ASDI, produced within the institutional framework and complying with the technical standards.
4. *Distribution networks* through spatial datasets are made accessible to the community, in accordance with the agreed policy and standards.

In simple terms, the ANZLIC vision is a distributed database network, linked by common protocols and standards to ensure interoperability, each managed by data custodians with the incentives and resources to maintain the database to the standards and expectations of the community.

The emphasis in recent times has been in defining, building and maintaining key national infrastructure datasets, which in most cases has involved the consolidation of jurisdictional datasets.

4.7 Summary

Globally, there is a vital interest in systems that support the security of land rights, restrictions and responsibilities as Governments grapple with expanding populations, competing interests for natural resources and sustaining the generation of food and wealth from the land for economic well-being. Developing nations are faced with increasing pressure to formalize land rights to protect cultural heritage and avoid disputes as well as providing a basis for the operation of land markets.

The formation of global markets has had dramatic changes on traditional markets and increased competition forcing producers to find ways to decrease costs and meet the sometimes complex, changing needs of contemporary society.

Global market trends now dominate commodity prices with shortages in one part of the world providing an economic windfall to other producers who may have enjoyed more favourable conditions. Even pastoralists in rangeland western New South Wales are subject to global demand and prices for their products, traditionally wool and wheat. Low commodity prices have had a severe effect on the profitability of these enterprises, forcing many producers to diversify and/or find off-farm incomes.

Global technologies such as the Internet and GPS are fuelling the demand for information that is relevant, current and readily accessible for better decision –making. Governments are looking to the creation of national Spatial Data Infrastructures (SDIs) to support growing national requirements for spatial data, particularly in the areas of defense, taxation and statistics, infrastructure projects and natural resource management. Textual and spatial cadastral data are seen as one of the fundamental datasets of SDIs.

Governments view micro-economic reform as a means to global competitiveness, where the drive is towards producing goods and services on a more cost efficient basis. This has affected the delivery of Government services through the adoption of new institutional models including the regulator /provider model, where the regulator defines outcomes and outputs and the service provider through contractual arrangements delivers the services on a competitive basis. Many State land titling and mapping agencies are well down this path, trading as Government Business Enterprises. Reform of the cadastre is principally the role of the regulator, however one of the goals of reform is cost-efficiency, which should provide benefits to all stakeholders in the system.

The publication of *Cadastrre 2014*, by the International Federation of Surveyors (FIG) and the *Bathurst Declaration on Land Administration for Sustainable Development*, by the UN and FIG are viewed by many as important milestones in the development of cadastral models worldwide. These documents not only provide a benchmark of the current status of cadastral systems for over 40 jurisdictions, but they also provide a vision for the future that will mould the evolution of systems internationally. Of significance to this research is the recognition worldwide of the concept of Multipurpose Cadastres as the most appropriate cadastral model for the recording of the increasing number and complexity of rights, restrictions and responsibilities. Given the applicability of Multipurpose Cadastres to low value rangelands argued in this thesis, the opportunity exists to apply the same concepts to other parts of the world faced with similar circumstances. The need for change is apparent; the issue is not when but how.

CHAPTER 5:

A VISION FOR MANAGING LOW VALUE RANGELANDS IN WESTERN NSW

“The Western Division is unprepared for global change. Substantial changes to its legal and administrative framework are needed so that rigidity gives way to resilience.”

(Abel et al, 1999)

In this chapter, rangelands in Western New South Wales are differentiated from other higher value lands in the eastern and central divisions of the state in terms of the required cadastral system and in particular, parcel boundary accuracy. A vision for a modern Multipurpose Cadastre is described that supports the long-term economic viability and environmental sustainability for the study area. Overall it will be evident that the needs of the low value rangelands can be met through the adoption of modern cadastral concepts such as the Multipurpose Cadastre, which have wide acceptance in North America and some parts of Europe.

5.1 Requirements for the Eastern and Central Divisions

Eastern Division

The State of New South Wales, since early settlement, which developed westwards from the Sydney and the coastal plain, was divided for land administration purposes into three divisions, namely the Eastern, Central and Western Divisions. The Eastern Division, comprised the coastal belt and Great Dividing Range, contained the majority of the State's population due to its access to port and transport facilities, higher rainfall and rich soils capable of sustaining higher population densities. Land values along the coast are the highest, where population densities in some parts of the Sydney region (that is, Kings Cross) are comparable with Asian cities such as Hong Kong.

Land parcel densities and the density of various interests in land, which can extend into three dimensions, are the highest in the State and require demarcation to the highest accuracy technically achievable at affordable cost. Disputes over boundaries, according to statistics held by the New South Wales Board of Surveyors, can involve differences of the order of a few centimetres. Most complaints come from urban areas.

The author has seen many cadastral surveys involving easements for support or overhanging eaves involving a few centimetres that have been an area of dispute between neighbours.

The requirements of a cadastral system for high value, densely populated areas needs to be able to accommodate complex interests (in three dimensions) and an accuracy able to delineate different interests fixed in an absolute sense to the order of a few (1-3) centimetres, based on a modern, reliable geodetic

framework (coordinated cadastre) and thereby capable of being integrated with other datasets. This need for high relative and absolute accuracy lends itself to an approach where cadastral corners can be described mathematically with coordinates on the State geodetic reference system and managed in a computer database, rather than as images either in hard copy or digital form- a coordinated cadastre.

Access to cadastral information must ultimately be available via the Internet with an ability to transact online conveyancing available ideally within the next 2-5 years. The first phase of this evolution is already largely in place as some spatial and legal cadastral information and survey control datasets are currently available via the Internet.

In the case of legal cadastral information, this is available through information brokers or value added resellers of land title information.

The spatial cadastre, which at the present time is represented by the Digital Cadastral Database (DCDB), is available via the Internet to licensed users, including daily updates, although these updates may be up to 14 days after the date of registration of the plan. The complexity of the DCDB, in terms of the related layers and attributes is already significant. There are 20 attributes for each parcel including street address, suburb, Local Government Area (LGA), State Forest, National Park, Proclaimed Survey Area, etc. Administrative boundary layers mentioned above are also held in separate layers and maintained coincident with the base parcel fabric.

The main requirements that set the high value lands of the Eastern Division apart from other areas are:

- The higher number of boundary disputes in urban areas, related to the uncertain location of boundaries.

- The operation of the cadastre in three dimensions-stratum plans of survey defining different interests, above and below ground level.
- The higher values of land and the enormous value of assets located on parcels for example commercial, industrial, high-density residential, when compared with other Divisions of the State
- The greater density of rights and restrictions in urban areas, mainly for public and private utilities and access.

Definition and demarcation of these interests needs to be to an appropriate level of accuracy to ensure that risks to real property are minimised, when compared to the costs of rectifying development that has been sited on the wrong parcel or area. Land valuations can be adversely affected even if there is some uncertainty about the dimensions of land. Most financial institutions insist on a reliable Identification Survey (survey showing the parcel, any improvements or restrictions) of a parcel and its improvements to identify any deficiencies or encumbrances that may affect the value or land use potential before providing finance for land transactions.

Central Division

The Central Division comprises the tablelands, slopes and plains, Western Lands of NSW of the Great Dividing Range and contains a number of regional centres that serviced agricultural activities, mainly grazing and wheat production in the early days.

Activities have since diversified to encompass tourism, mining and a broad range of agricultural pursuits as markets have changed and new products with higher economic rates of return for example agroforestry, cotton, oilseeds have become viable.

A number of regional centres are approaching populations of 80-100,000 for example Albury, Wagga Wagga and Dubbo, and are experiencing growth as they are large enough to attract secondary and tertiary industries.

Rural holdings in the Central Division are much smaller than in the Western Lands of NSW due to the higher production rates possible, corresponding with higher land values than the Western Division, but substantially less than the coastal belt.

The range of land uses in the Central Division is much broader than in the western areas of the state also due to more productive landscapes and better access to larger water resources, enabling irrigated crops to be grown, for example, cotton and the more intensive viticulture.

Until recently, little research has been undertaken on survey accuracy requirements for rural land parcel boundaries. The Queensland University of Technology over the past five years has undertaken considerable research into land consolidation models (Hannigan and Farmer, 1996). In 1998, a study was undertaken in rural Queensland to determine from responses to a questionnaire the accuracy requirements of landowners for land parcel boundaries. The needs of users of cadastral information, principally utility organisations and local authorities were also canvassed.

The study took place in the Linthorpe Valley, about 150km west of Brisbane on the Darling Downs. The predominant activity is dairy farming, with some pig farming and crop production. Land in the Darling Downs, in comparative terms, is amongst the most valuable agricultural land in the State, rivalling the sugar cane farming land on the Queensland coast. The author of the study (Stock, 1998) points out the difference between the study area and the lower value lands in Western

and Central Queensland, usually only suitable for grazing. The survey and conclusions were not intended to provide results that were representative of Queensland as a whole, however the study provides the only contemporary indication of rural cadastral boundary user needs for areas of comparative land value and land use.

The research indicates that landowners require that their boundaries be accurate to about +/- 0.2m, while users of land parcel boundary information required a lesser accuracy of about +/- 0.5m.

The most important conclusions from this study relative to this research and the needs of the Western Division of NSW are that:

- "...the current methods for reinstatement of rural boundaries aim for higher accuracy than is necessary by users of boundaries and information about them...
- ...the research confirms the claim of many previous researchers about the difficulties in determining the accuracy requirements of naïve users."

(Stock, 1998)

It is suggested that the study area and findings of the Queensland research would be applicable in the rural lands in the Central Division of NSW due to the similarity in land value, land use and density of parcels. The study also highlights the need to differentiate cadastral accuracy for different regions of the state with rural characteristics and lower land values, which in turn correspond with lower user expectations in terms of boundary reinstatement.

5.2 Requirements for the Western Division

There is a need to describe a vision for the Western Division in terms of a cadastral system that will set a clear future direction, without compromising the interests of future generations or the environmental values of the Western Lands of NSW.

The Western Lands Review, 2000 has proposed a broad vision for the future management of the Western Division as follows:

“ Management of the Western Division that meets the current and future economic, social and cultural needs of its people and conserves its natural resources ”

(Western Lands Review Report, 2000)

This statement was developed within the context of National and NSW agreements. The principal agreements being the *National Strategy for Ecologically Sustainable Development*, mentioned previously in chapter 1.2.4 and the *National Principles and Guidelines for Rangeland Management*, developed by the Australian and New Zealand Environment and Conservation Council (ANZECC).

The National Principles and Guidelines for Rangeland Management are based on a 25-year vision for the rangelands:

“The Australian community is committed to achieving ecologically sustainable rangeland management, supporting diverse social, cultural and economic activities.”

Three goals were identified to attain the above vision:

1. Conservation and management of the natural environment
2. Sustainable economic activity.

3. Recognition and support for social, aesthetic, cultural and heritage values, diversity and development.

The above visions for the future management of the Western Division and rangelands on a national basis provide a direction and framework within which any proposed cadastral system must operate and support.

The concept of a *resilient* economy, one that is able to vary with the “lows” caused by climatic variations, natural disasters and depressed commodity prices with minimal Government intervention yet remaining viable is seen as appropriate for the Western lands. In the context of management, the Western Lands Review relates *resilience* “to the capacity of the Western Division’s land and water systems to vary, yet remain within their present inherent characteristics, despite disturbances.”

Based on the above key Government directions, the author has adopted this vision for a cadastral system for the Western Division of New South Wales.

Vision Statement

“By 2005, the Western Division of New South Wales, will have an appropriate, modern, online, Multipurpose Cadastral System, that supports effective land markets, sustainable environmental management and a resilient rural economy.”

5.2.1 General

At the global level, concerns about environmental management, sustainable development and social equity issues such as indigenous rights have been the subject of a number of international instruments such as Agenda 21, Habitat II Agenda (1996) and the UN Social Summit 1995. Concern now focuses

on how land can be better managed in a variety of circumstances, whether for town planning purposes or for rural agricultural development (Ting and Williamson, 1999). The relationship of humankind with the land is being re-examined as community attitudes are changing away from materialism to quality of life (Aslin et al, 1999).

One of the major trends is a shift in thinking away from the short-term economic imperative towards longer term economic planning which balances the land's capability and use of available natural resources. This change in attitude towards concern for the environment and taking a longer-term view has also permeated attitudes in the Western lands of New South Wales. In the Australian context, this has been suggested as being reflected in Australia's rangelands as a shift towards non-materialist national goals such as encouraging non-consumptive or low impact resource uses, pursuing social equity through Aboriginal reconciliation, conserving biodiversity and achieving ecological sustainability. There is a much wider set of values and aspirations being espoused than those which existed when pastoralism was widely accepted as the Western Division's dominant land use (Aslin et al, 1999).

The Western Division is limited in its agricultural and grazing potential by the limited amount of water resources and landscapes that are either depleted or have low capability for production. Exploitation by humankind, both European and to a much lesser extent indigenous populations has seen the rapid extinction of many native species of fauna and a significant long term environmental degradation problem, manifesting itself in a variety of ways, the most sinister being soil salinity.

Whilst the Western Division historically made a significant contribution to the economy of the State, new sustainable levels of resource use must be found. This region of the State, due to

it's particular characteristics, namely low value, sparse settlement, low development activity and hence low survey activity, needs to be addressed in a different way from the rest of the State. As it is still principally leasehold and the Crown is the landowner, the opportunity exists to implement reform that would affect approximately 1350 lessees. Any new or re-engineered cadastral system will also be required to manage Native Title as this single issue is currently and probably will continue to have a large impact on the Western Lands of NSW in the immediate future. Recent studies have reinforced that land title issues are a top priority for many stakeholders in the Western Lands of NSW. Further that stakeholders would value recommendations for reform that lead to simple, streamlined legislative and regulatory processes that are easy to understand. Legislation and regulations need to be clearly related to explicit goals related to social, economic and ecological sustainability for the Western lands (Aslin et al, 1999).

It is suggested that any future strategy or vision for low value rangelands needs to include:

1. Sustainable land-use in the long-term bringing together the concepts of economic and environmental sustainability with productivity sustained or enhanced over the long-term (NSW Farmers Association, 1996).
2. Comprehensive, integrated datasets related to land markets, land management, natural resources and the "as built" environment for better decision-making.
3. Simplified, cost-effective processes which underpin the operation of the cadastre, for example, "online" conveyancing and land administration, demarcation/re-establishment of cadastral boundaries using fast and efficient techniques such as the Global Positioning System (GPS) and photogrammetric techniques.

4. System of land parcel boundaries and interests in land clearly defined, easily relocatable, more closely aligned with catchment and sub-catchment boundaries and enclosing areas regarded as viable economic farming/grazing units.
5. A system capable of storing, relating and managing the duality that exists between European and Indigenous tenure systems as that relationship evolves.

The last four elements listed above form components of a Multipurpose Cadastre (MPC), as previously defined in Chapter 1. Hence, the vision aligns with cadastral systems that are widely accepted in North America and some parts of Europe. The vision suggests an implementation date of 2005; this timeframe aligns with the expected scheduled completion for the capture of fundamental spatial datasets (aerial photography, satellite imagery, vegetation and soils mapping, Native Title claim identification) and the development and maturity of standards and procedures for online conveyancing. Land consolidation models may well be developed within this suggested timeframe, however the implementation of such models will take much longer given the limited capacity of leaseholders to cope with radical change in tight economic times.

5.2.2 Low cost

It is argued that any modification to the existing cadastral system should be related to the value of the land and the ability of the land market to operate within a cost framework affordable by those wishing to purchase or transact business.

As has been pointed out in Section 2.2.2 farm incomes have been in steady decline over recent years, despite productivity improvements.

Whilst the infrastructure to manage the cadastre is supported largely through the state as a centralised function, albeit with a single regional office located in the region for land administration purposes, Government is looking at ways to drive down costs through business process re-engineering. This involves processes such as digital survey lodgement and conveyancing, leading to online conveyancing.

Cadastral survey costs for either reinstatement or creation of boundaries to the existing standards can be high when compared with land value. Typical costs for reinstatement/creation of boundaries and marking using conventional techniques (Total Station terrestrial technology) are generally \$300/ linear kilometre, depending on the difficulty of the terrain (Langford, 1997).

For an average leasehold of 10,000 hectares (ha) or 100 square kilometres, a full perimeter survey of 140 kilometres would cost in the vicinity of A\$12000 or more than 25% of the land value (A\$4/ha). Compare this with a boundary reinstatement survey for a standard residential parcel (600 square metres, A\$100000 value) in Sydney that would cost in the order of A\$1000-2000 or 1-2 % of the unimproved capital value.

Clearly, survey costs are out of proportion with land values in the Western Division, even though the number of transactions /cadastral mutations constitute less than 1% of the state's total survey activity. Low land values combined with low economic returns indicate that the system of current survey costs based on current accuracy criteria cannot be justified. The application of GPS for boundary demarcation purposes can provide cost savings over conventional techniques, especially if survey accuracy standards are relaxed to allow use of single frequency units and kinematic and/or real-time differential techniques (Kelly and Harcombe, 1997).

The cost of acquiring some of the necessary spatial data that is geodetic, rectified aerial photography, topographic and “as built” datasets is not a significant cost when compared to land value (< 5%). The provision of the above datasets, according to the Surveyor General’s Department, is estimated at A\$14/square kilometre or 14 cents/hectare, based on 1998 figures obtained from the project manager (Larsen, 1998).

Adoption of existing occupations, for example, fence lines, railways, etc would further reduce the need and cost of cadastral survey marks in the future, if adjudication methods could be efficiently combined with other recognised reform activities.

In terms of attitudes by stakeholders towards accuracies, the accuracy of lease surveys varies considerably depending upon size, age and location. Anecdotal evidence suggests that it is not uncommon to find errors in these surveys in the order of 10-30 metres in some of the older (pre-1901), larger surveys. Permissible misclose accuracies of 1:4000 at the time, would allow errors of up to 10 metres for a 40-kilometre perimeter; 35 metres for a perimeter of 140 kilometres which would enclose a 10,000-hectare lease. Leaseholders will often replace a fence a vehicle width away from the original, which may have been on the boundary, rather than remove and replace on the original line for cost reasons. One conclusion that can be drawn is that pastoral lease holders have lived with errors /uncertainties in boundary surveys of the order of 10-30 metres for many years and are not greatly concerned with reinstatement of fenced boundaries to better than a vehicle width, that is, 2-3metres.

Pickard (1994) describes numerous examples of multiple generations of boundary fences erected in parallel and separated by a few metres in his research into technological change in fences in semi-arid New South Wales.

In summary, a low cost method of definition, reinstatement and demarcation of cadastral boundaries is required. It is contended that real-time differential GPS, used to establish new boundaries to an amended accuracy of ± 3 to 5m would provide significant savings over the existing system.

A cadastral model that can be populated with relevant spatial data relatively cheaply in comparison to land value assessed and administered via the Internet would be more cost effective than the existing largely paper-based system.

5.2.3 Efficiency and Effectiveness

Government and business expectations are for continuous improvements to business processes that in turn can drive down costs for better service delivery to the community and increase profit margins in the business sector.

Given the significant downturn in rural commodity prices affecting businesses in the Western Division and the critical economic situation, cadastral reform must deliver a cheaper system for managing and delineating cadastral interests.

From the Government perspective, greater efficiency means a long-term reduction in resources, principally staff to carry out administrative functions that is, the issuing of titles, leases, licenses, planning and development consent conditions, etc. A suitable vision for the cadastre in terms of Government economic efficiency would be one that ideally, achieves full cost recovery or at least partial cost recovery, based on a “user pays” philosophy.

The system needs to be effective in terms of modelling and managing an increasingly complex administrative and natural landscape as interests in land extend into 3-dimensions, for example, mining interests. The natural environment is being

continually modified in some form by man's activities. Protection of natural values and biodiversity is being undertaken largely by regulatory means introducing controls which operate over land parcels, or land areas, in the case of Native Title. Information and data essential for the operation of a modern cadastral system is spread across a number of agencies and custodians and can be in a range of formats and forms both hard copy and digital. Internet browsing software and technology can provide a means of accessing distributed datasets and presenting spatial and textual information in a form capable of integration using GIS software tools.

From the business and community perspective, cadastral systems need to enable efficient transactions about land; the purchase, sale, mortgage, encumbrance, usage or restriction. The current largely paper-based system relying on manual processes is regarded by many as being cumbersome due to the large number of agencies and authorities involved and the "paper trail" of approvals, consents, seals and signatures.

Relevance and Social Acceptance

"What is certain is that Australian cadastral systems are rapidly moving to multi-purpose systems much more akin to their Western European and North American counterparts, for similar reasons of increased complexity of decision-making about land (land use) due to concerns about sustainable development and social justice."

(Ting and Williamson, 1999)

Australia, like many developed nations is caught in the midst of the information revolution. It is hard to imagine Australian society continuing to develop without some form of electronic

media forming part of everyday life. Preoccupation with using electronic media as a primary information source and means of doing business appears more than just a passing fad, if the fortunes of computer hardware and software giants such as Intel and Microsoft are any indication.

The remoteness and isolation of many of those who live in the Western Division means that the only regular and reliable form of communication with the world at large is through the electronic media, including television and the Internet. Distance learning education for isolated families is now delivered via the Internet in a number of instances. Using the Internet is becoming a necessity for accessing a range of services; often in distant locations- access to land information would be simply another service available.

Native Title is no longer only a concept in the minds of the indigenous population, it is a legal reality, albeit in its formative stages. Legal and cadastral systems are still adapting to this new form of tenure in terms of the information required to make effective management decisions. The spatial components of Native Title will need to be mapped in a similar fashion to other forms of title. However, the location of Native Title boundaries is much more closely tied to natural features, making the Multipurpose Cadastre much more relevant than the existing system through its ability to integrate topographical and natural resource information with the European administrative landscape.

The European paradigm of land parcellation has been dominated by the concept of artificial fixed boundaries since early settlement. In the early 21st century, however, the landscape now shows the presence of 200 years of European occupation. Whilst major natural features such as rivers, lakes, cliffs, etc still exist, the rural landscape (apart from the remote

wilderness areas) is covered by fence lines, railways, powerlines, vehicle roads and tracks, mining operations and agricultural activities. No longer are there exceptionally large areas of featureless semi-arid land, the concept of coordinated, occupational boundaries or “what you see is what you own” is far more relevant to an Australian scene where land settlement patterns (in this region) are relatively mature.

Landholders in the region are now more attuned to land condition and systems that can monitor and manage the rangeland. This change in attitude can be found as part of the NSW Farmers Conservation Policy for the Western Division, which states under the heading of soil erosion that:

“Voluntary satellite monitoring of rangeland condition should be encouraged where it can be verified by ground truthing” (NSW Farmers, 1996)

The information revolution and the motor vehicle have removed much of the isolation for remote communities. A modern cadastral system accessible via the Internet and able to be delineated on the ground by GPS and interfaced with precision farming systems would be readily accepted. Many farmers are now technology aware and are using GPS to accurately determine paddock areas, monitor production and improve their understanding of soils and crop performance. (Lyon, 1999)

The people of the Western Lands of NSW have proven their ability in the past to adapt to new systems when faced with adverse circumstances. Adoption of occupational boundaries that are physically monumented through existing man-made or natural features and supported by an information system accessible via the Internet will complement land reform

agendas already in place such as the WEST 2000 scheme and the Western Lands Review, 2000.

5.2.4 Sustainability

A growing environmental consciousness and realisation that land is a scarce community resource requiring better planning for future preservation has brought about a change in attitude and a desire for sustainable activities that support our existence.

According to NSW Farmers, recent survey results by the Australian Bureau of Statistics indicated that 71% of people rank economic and environmental issues equal, whilst 18 % rank environmental issues as more important than economic and 7% rank economy as more important. Sustainability by lessees in the Western Lands of NSW is seen as having two aspects that are inextricably linked. For land use to be sustainable in the long term, the concepts of economic productivity and environmental sustainability must be brought together (NSW Farmers, 1996). Many commentators point to a “post modern” shift by Western nations, demonstrated by a decreasing emphasis on materialist values centred on physical survival and security towards values related to quality of life and mental well-being (Aslin et al, 1999). This trend has been interpreted as being reflected in semi-arid zones in Australia by an increasing emphasis on multiple land uses.

It is only in the last few decades that landholders have adopted land management practices that can address the issue of environmental decline caused by an unsustainable European approach. Landholder’s attitudes revolve around profit, productivity and sustainability, whereas conservation groups who are concerned with changing unsustainable land uses to restore biodiversity and land condition.

Any new cadastral model needs to be able to support a vision that includes protection and enhancement of resource capability and biodiversity. As a Multipurpose Cadastre is essentially an information system with the ability to integrate natural resource information with property information, land managers can model the impacts of man's activities in both the short and long term using cadastral and natural resource information and other specialised software tools.

The management of historical records in a Multipurpose Cadastre also facilitates temporal studies and comparisons that can also aid long term planning from both economic and environmental standpoints.

Summary

Cadastral systems need to be appropriate according to the needs of the jurisdiction, Government and stakeholders. The Western Lands of NSW are now strongly influenced by the global economy as far as trade and commodity prices and have an ongoing legacy in the form of degraded land condition as a result of past inappropriate management practices.

The Western Lands of NSW by virtue of its low population, low land value and high environmental value and sensitivity warrants special consideration in terms of an appropriate cadastral system. Interests in land in the Eastern Division where the density of interests is much higher than the Western Lands of NSW, coupled with high land values requires a system capable of adjudicating and delineating interests to an absolute and relative order of accuracy of a few centimetres, in keeping with the current system. It is the nature of interests in land, their complexity and relationship to land value and the environmental considerations that set aside the Western Lands from the rest of the state. Remoteness and difficulties in accessing services can be overcome in part through modern

communication technology coupled with the benefits of the World Wide Web.

The concept of a resilient economy, one that allows the land and water systems to vary, yet remaining within their present inherent characteristics, despite disturbances is gaining favour. There is a major shift in thinking away from the short-term economic imperative towards longer term economic planning that seeks to balance the land's capability and productive use of natural resources. This change in thinking is also mirrored in the evolution of cadastral systems, which have moved from systems supporting taxation, to land as a valuable resource to a system that underpins environmental management, sustainable development and social equity issues such as indigenous rights. New sustainable levels of resource use must be found, particularly as the land is still principally leasehold with the Crown the landholder, although indigenous title is gaining in strength.

Recent studies have reinforced the public view that land title (Native title) issues are a top priority. Any future vision for a cadastral system must continue to support effective land markets and promote sustainable development as well as embracing the notion of a resilient rural economy that is, multipurpose functionality

The author has developed a vision based on the outcomes from the Western Lands Review 1999 and the 25-year vision for rangelands espoused by ANZECC provide a strategic framework within which any proposed cadastral system must operate and support.

Vision Statement

“By 2005, the Western Division of New South Wales, will have an appropriate, modern, online, Multipurpose Cadastral System, that supports effective land markets, sustainable environmental management and a resilient rural economy.”

CHAPTER 6: A MODEL FOR A MULTIPURPOSE CADASTRE FOR WESTERN NSW

“Government policies and programs now focus on removing any remaining institutional impediments and facilitating the capacity of farmers to work with forces of change”

(Wonder, 1995)

The purpose of this chapter is to describe a cadastral model; its components and characteristics and the necessary legislative frameworks and technologies that will allow implementation, building on the vision articulated in the previous chapter. Institutional arrangements necessary to support a modern cadastral system are also discussed.

6.1 Components and Characteristics

The development of a Multipurpose Cadastre suitable for the Western Division rangelands involves the provision of a number of components. The characteristics of each component are described individually and their interrelationships. The elements of a MPC have been defined in Chapter 1 and identified in Section 5.2.1 in terms of their relationship to the author's vision.

6.1.1 Consistent Spatial Framework

A consistent and comprehensive geodetic network, that is, a system of widely spaced marks with known position (latitude, longitude and height) makes it possible to establish spatial linkages between all relevant land information, so that any features can be related spatially. The existing system in NSW sees over 6000 established "high order" geodetic stations, with a further 180,000 established "lower order" Permanent Marks, mainly in urban areas.

Over the past 4-6 years, Land and Property Information NSW on behalf of the NSW Surveyor General has further densified the GPS High Precision network that comprises a layer of geodetic stations at 100km spacing. The establishment of an additional 100 coordinated marks in the Western Division provides a network of permanent marks at nominal 50km spacing across the whole Division. The majority of these additional marks are along main roads, some of which were placed during the establishment of the Australian Height Datum in the early 1970's and until recently only had accurate heights.

The 50km spacing is based on the expectation that Differential GPS techniques will increasingly be used for positioning applications, including cadastral re-establishment, in the future.

The establishment of a statewide network of Continuously Operating Reference Stations (GPS Basestations) at 500 kilometre intervals is being proposed as a whole of Government initiative to provide satellite-positioning services at the sub-decimetre level. This infrastructure, similar to what is being established in Victoria would enable users to access wide area Differential GPS (DGPS) services providing accuracies between 0.1–0.2m. The cost of such services (hardware, software and DGPS signal) are projected to be equivalent to the current cost of an electronic Total Station—approximately A\$15000, which would make this technology viable for boundary demarcation. Networks of control points at the 50 km density would provide quality and integrity checks and a means of legal traceability for both GPS and terrestrial technology, necessary under current national standards and survey legislation for cadastral and other surveys.

The geodetic network and associated subsidiary networks of survey control marks provide the fundamental framework for spatial data integration, mapping control and infrastructure development as well as orientation and datum for GPS and terrestrial surveys.

6.1.2 Comprehensive Datasets

The spatial framework or geodetic survey provides a basis for digital mapping. In the case of the Western Division, GPS controlled photography is being used to generate photogrammetric models that accurately shows natural and

man-made features. It has been shown previously (Kelly and Harcombe, 1996) that this approach is more cost-effective for the capture of road centreline data in terms of coverage and the ability of the data to be used for a range of other purposes.

Such an approach allows:

- (a) Road and Track centrelines to be captured to an accuracy of $\pm 3-5\text{m}$ which can then be used to create road casement/boundaries.
- (b) Fence-lines to be positioned to a similar accuracy, which when shown to be coincident with the “as surveyed” cadastral patterns, and integrated with the Digital Cadastral Database (DCDB) and road casements can be used to create Deposited Plans for legal road definition purposes.

This combination of digital topographic data with the DCDB provides the base mapping components of a modern Multipurpose Cadastre. The enhancement or integration of other natural resource datasets relating to fauna, soils, vegetation and water derived from remote sensing or field survey methods with digital topographic data will also provide land managers with the best information for land-use planning.

The estimated costs of providing this infrastructure, including spatial framework improvement and photogrammetry, based on work done to date is \$14 per square kilometre, as mentioned previously on Section 5.2.2.

Spatial data also lends itself to access and usage via the Internet, which is becoming more commonplace as Web Browser technology matures. Online Multipurpose Cadastres already exist overseas in the maritime province of New Brunswick and a number of Australian jurisdictions are well

on the way towards E-Commerce initiatives for land and property transactions online.

Examples of these initiatives include the Victorian Land Information System, a joint initiative between the Department of Geomatics, University of Melbourne and Land Victoria (Majid, 2000) aimed at delivery of an online Multipurpose Cadastre; and the Integrated Property Warehouse (IPW), an initiative of the New South Wales Department of Information Technology and Management (DITM). IPW is an integrated database comprising land titling information, valuation data and property information such as the Central Register of Restrictions and notices of sale. It is intended to expand the facility to include crown land information contained in the Crown Land Information Database (CLID).

The fundamental datasets proposed as part of the model (geodetic, cadastral, topographic, road and street address) all form components of the Australian Spatial Data Infrastructure and as such, the model lends itself to a national approach to the management of rangelands.

Given the significant income generated from mining activities in the Western lands and the potential for the future, any re-engineered cadastral system needs to be able to integrate mining interests with freehold, Crown and indigenous interests, the Department of Mineral Resources have a Web-enabled Tenure Administrative System (TAS) which could be linked via the World Wide Web with appropriate protocols to other systems to enhance the operation of a MPC. TAS holds all mining interests in NSW including mining and exploration leases, licenses and rights and is based on the state DCDB.

6.1.3 Simplified Cost -Effective Processes

The rapid development of modern communication and information technology such as the Internet provides a means of reducing the problems of isolation and distance, as well as the potential benefits from automation of existing manual processes.

Strategies are being developed for the electronic collection and processing of survey information. The first phase of digital lodgement of survey information is already in place in NSW. Surveyors can now transmit images of their survey plans for titling purposes, assisting the plan examination process and for recording as part of the Deposited Plan file. As at the end of 2000, 75 survey firms in NSW were trialling the electronic lodgement of survey plan image files. Full functionality, including the transmission of geometry files capable of updating the DCDB and being stored as objects in a relational database is scheduled for the last quarter of 2001.

Survey and Drafting Directions for Colliery Surveyors have recently been revised to require surveyors to lodge coal mine survey information in digital form for processing and recording. Some transactions supporting land conveyancing are already partially handled in digital form for example Notice of Sale. It is intended to further automate the lodgement of land dealings in the near future. The recording and processing of rights, restrictions and responsibilities that people have with respect to the land can be streamlined through further automation and be made more accessible “on-line”.

Technical directions have been finalized to facilitate the use of GPS for cadastral surveys, which can provide potential savings over conventional methods for the demarcation, and relocation

of cadastral boundaries. (NSW Surveyor-General's Department, 1997). However, the take-up rate of this technology for cadastral surveys of freehold land has been slow due to the high cost of survey quality GPS (approximately \$80,000 for 2 dual frequency survey units plus radio connections) and a lack of agreed procedures for GPS to satisfy legal traceability requirements under the Commonwealth National Standards and State Survey legislation.

The Surveyor General has already developed standards using GPS for the collection of the state's 3500 aquaculture leases in a joint initiative with NSW Fisheries. The required accuracy standards for these types of leases, not requiring 'strict' survey accuracy after consultation with industry and Government is plus or minus 1 metre. This accuracy is also related to land value as the average value of an aquaculture (oyster) lease is of the order of \$25000 (Derwent, 1998). The process is fully automated from field data capture to management as an integrated layer of the DCDB. Lease plans for lessees and potentially, title issue, can be generated using GIS software. This whole new approach has replaced the previous paper-based administrative system that was characterised by incomplete, unreliable data and cumbersome to administer.

Cadastral survey accuracy standards for various classes of land, however, will need to be revised, particularly for rangelands, to be compatible with the value of the land, user requirements and to take maximum advantage of GPS and digital photogrammetry technology to bring down costs and facilitate the simplification and automation of processes using digital technology.

6.1.4 Occupational Boundaries, Land Consolidation

The re-establishment of a legal road network using digital photogrammetry which enables fence lines or roads or rail lines to be positioned to $\pm 3\text{-}5\text{m}$ and when integrated with the DCDB provides a digital “cadastral mapping” solution rather than a system of individual cadastral surveys.

The adoption of occupations, such as intersection of fences and well established fence lines, roads or railways, which are recorded in a rectified digital photogrammetric model is suggested as an unambiguous, well defined system for the demarcation of land rights over low value rangelands. Whilst this approach seems to depart from the recommendations of Cadastre 2014 by proposing occupational as opposed to fixed boundaries for rangelands, each cadastral “object”, in this case natural or well-defined manmade features such as fence lines, etc would be recorded and described by an “official” co-ordinate in the rectified digital photogrammetry, which would be on public record. The proposal would in effect move occupations to the top of the cadastral boundary hierarchy, followed by co-ordinates (on the National/State reference system), and provided there is an appropriate adjudication process between landholders and a simple mechanism for the amendment of lease dimensions.

A further step could be to investigate the application of land consolidation methodologies, which are well established in Europe, to rangelands. This would involve the re-arrangement of property boundaries to more closely align with catchment and sub-catchment boundaries. Studies in Queensland (Hannigan and Webb, 1995) argue:

“It has been established that the optimum unit for the management of natural resources is the catchment, therefore Reconstruction Schemes

would seek to improve catchment management by re-aligning boundaries to coincide with catchment and sub-catchment divides, and enclosing areas approaching what may be considered a viable economic farming unit.”

Hannigan and Farmer (1995) have developed a broad social, economic, administrative and legal model for implementing farm reconstruction and boundary re-arrangement in Australia. Their study showed that a boundary re-arrangement could reduce ecological conflicts and better accommodate nature's pattern of movement and flows. Further testing will establish the applicability of this model to rangeland Australia. Community/land holder input is an essential component to initiate and drive any re-construction scheme; existing community/landholder environmental schemes such as Landcare may be useful catalysts.

6.2 Legislative Framework

Fundamental legislative reform is necessary to move from a 19th century paradigm, embodied in the *Western Lands Act, 1901*, based on a land management ethos of maximizing economic returns to a more balanced approach between environmental and economic objectives which can be sustained in both the short and long term. A number of recent Government sponsored reviews and initiatives (WEST 2000 and the Western Lands Review, 2000) have reinforced the need to modernize the Western Lands Act.

One of the key recommendations of the Western Lands Review is that:

“The Western Lands Act 1901 be repealed and a new Western Division Resource Act be enacted.”

The aim of the new legislation would be “management of Western Division Leasehold and Crown land to meet the current and future economic, social and cultural needs of its people and conserve its natural resources”; and a purpose of providing “...a legislative framework for the ecologically sustainable development of the Western Division.”

Four of the proposed nine key provisions of the new Act have a direct link to the cadastral model proposed in this research. Those four key provisions are:

- “Providing a natural resource **information base** involving regular **monitoring** of condition and trends in the status of the land and natural resource base of the Western Division
- defining **the rights and limitations** of lessees and other users of Western Division lands so all users can make decisions confident of their rights and limitations; and
- establishing and supporting the **community involvement** process and a **client service focus** by:
 - providing information and service at the appropriate scale (regional for regional planning, personal for financial counseling and property adjustment);
 - recognizing Aboriginal interests in natural resource management;
 - reducing uncertainty and providing efficiency in public decision making through:
 - transparent land and natural resource policies;
 - accountable decision making; and

- matching the decision time frames to those necessary for managers to address the inherent variabilities of the Western Division climate (drought and flood), economy and commodity markets.
- Increasing the level of integration of customer information.”

(Western Lands Review, 2000)

The current *New South Wales Surveyors Act, 1929*, provides for the making of surveys of land and the standards of those surveys, which are contained in subsidiary Regulations. These Regulations, *the Surveyors (Practice) Regulation, 1995*, specify standards of accuracy for surveys of land and will be remade in September 2001 in response to the Government’s requirement for all Regulations to be repealed every 5 years unless it can be proven that remaking of the regulation is in the public interest.

The Surveyor-General is empowered to specify accuracy standards for surveys not requiring ‘strict’ accuracy. These powers have been used to authorize lesser accuracy standards for forestry and aquaculture leases, where the leases have been issued under the Forestry Act and Fisheries Management Act respectively, and not under the Real Property Act. Forestry and aquaculture leases are capable of being brought under the provisions of the Real Property Act and having a title created.

It is contended that these existing powers could be used to authorize a lesser standard of accuracy over leases in perpetuity for grazing purposes issued under the Western Lands Act. The proposed accuracy standards in the model of $\pm 3-5$ meters would only apply to low value pastoral leasehold lands and not leases for residential, business or agricultural purposes, which would remain at existing standards until such time as a more

comprehensive regime for these land use types could be developed.

The Surveyors (Practice) Regulation also permits the use of satellite positioning or remote sensing methods for the determination of boundaries. The author has used rectified aerial photography on a number of Western Lands lease surveys to define irregular riparian boundaries as a cost effective alternative to traversing creek boundaries. This approach was used in conjunction with conventional total station technology. The Regulations as they exist would not preclude the use of GPS for ground control combined with rectified imagery showing well-defined fence lines for the definition of road and parcel boundaries. It is understood that the 2001 remake of the *Surveyors (Practice) Regulation, 1996* will provide greater certainty to users of Differential GPS for cadastral surveys by reference to national standards developed by the Intergovernmental Committee for Surveying and Mapping (ICSM).

6.3 Enabling Technologies

“It is inevitable that satellite imagery will play an increasing role in the physical management of farm business” (Walters, 1997)

The advent and rapid development of information technology that has the ability to capture, process, store, query and display large sets of spatial and textual data has given decision makers powerful tools for resource management.

Digital photogrammetry can be used to create comprehensive three dimensional models over large areas with the ability to spatially locate features on the ground such as railways, dams, fence lines, track centrelines, waterways, catchments etc which

can be used as land parcel boundaries with an estimated accuracy of $\pm 3-5\text{m}$.

The likely availability of High Resolution Satellite Imagery (HRSI) in the near future to the expected 1m resolution level will provide another potentially cost effective tool for capture of spatial data over large areas. Provided the geometric accuracy can be proven, as being superior to digital photogrammetry, the adoption of a Multipurpose Cadastre, based on occupational boundaries, would enable the adoption of this improved technology.

Global Positioning System (GPS) technology can be used to capture spatial information and other attribute information relating to natural resource or the “as built” environment. GPS is also a powerful tool for completing and densifying geodetic networks. The possible development of a Statewide infrastructure of CORS Basestations, which would provide access to real time position to the sub-decimetre level, has the potential to further bring down the costs of re-establishment of boundaries.

Geographic Information Systems provide a capability to store, analyse and manipulate geographic data and the ability to integrate various data types, particularly where temporal studies are involved.

Probably the most significant enabling technology is the Internet. The operation of a Multipurpose Cadastre, essentially a publicly accessible land information system, is greatly enhanced by the ability to operate through the Internet. Textual and spatial information can be transferred via the Net, business processes can be automated allowing online transactions and the remoteness of the Western Division is no longer an obstacle. Socially, there is a growing acceptance amongst the

community that the Internet can provide services, including some health services, essential to modern day life.

The combination of these enabling technologies can deliver the comprehensive, reliable information sources required for better decision-making.

6.4 Institutional Arrangements

Recent developments in the structure of the NSW State Government have seen a consolidation and a push towards integration of the principal agencies involved with the administration of the cadastre. The formation of the Department of Information Technology and Management (DITM) in early 1999 has seen the merger of a number of previously separate cadastral agencies including the Surveyor General's Department, Land Titles Office and the Valuer General's Department with the Office of Information Policy (OIT), the Government's principal policy group for information management. This relatively new Department has as one of its key objectives the delivery of current and reliable land information for Government and community through the development and implementation of whole of Government strategies. To realise these objectives a Government Business Enterprise, known as Land and Property Information NSW has been formed by disassembly and reassembly of the former agencies headed by the Surveyor General, Registrar General and the Valuer General.

The institutional separation that has existed over many years between cadastral mapping and land titling is now coming to an end, which provides an ideal opportunity to move ahead in terms of the adoption of more relevant and appropriate cadastral systems.

Similarly, many of the State Government agencies responsible for natural resource information and policy were merged in the mid 1990's to form the Department of Land and Water Conservation (DLWC). DLWC has responsibilities for managing the State's soils, water and native vegetation and all Crown lands including the administration of the Western Division.

The consolidation of cadastral and natural resource information functions into single Government agencies provides a sound basis for coordination of activities and the development of new cadastral systems.

All of the major database systems contained within the proposed model are the responsibility of these 2 Government agencies. With the exception of the Mining Tenure Administration System (TAS), the Crown Lands Information Database (CLID) and the key natural resource datasets all of the remaining components of the model fall within the ambit of DITM. Current cooperative arrangements between DITM and DLWC see the Land Information Centre maintain the CLID spatial data on a contractual basis to ensure continuing compatibility with the DCDB. All mining interests are referenced to the State Control Survey and managed in a parcel based administrative database (TAS), which uses the DCDB for the base parcel fabric.

Development of the World Wide Web interface is already well underway with a number of spatial datasets and systems available separately on the Web for public access. These datasets/database systems include the Geographical Names Register; Survey Control Information Management System (SCIMS); Automated Land Titles System (ALTS) through information brokers; AIRVIEW-aerial photography; DCDB for bulk updates and Deposited Plan images.

DITM has plans for all of its land and property information to be made available over the World Wide Web through the Integrated Property Warehouse (IPW), an initiative previously mentioned in Section 6.1.2. The IPW would provide a one-stop service and form the “data core” of the proposed cadastral model.

Continuing consultation with stakeholders through the Western Lands Commission and relevant Government ministers will be needed to ensure ownership of the new system as part of a larger reform agenda.

6.5 A New Multipurpose Cadastral Data model

The existing cadastral system, which is mainly paper based has been described in previous chapters, as has the need for cadastral reform. A new multipurpose cadastral model has been proposed and is described in the preceding sections, based on successful concepts and systems from Europe and North America and adapted for Australian conditions. As an information system, a model that conceptualises the relationships between various major statewide [database systems](#) (shown in blue), [data flows](#) (shown red) and users are shown in the following diagram. The model is a composite of other models combining data flows, database systems and user sectors (after Williamson, 1996 and NRC, 1980).

A description of the major database systems is as follows:

- Geodetic Framework-Survey Control Management System (SCIMS)- a relational database containing the latitude, longitude, easting, northing and heights (to differing accuracies) of all Permanent Marks and Geodetic Stations in NSW and related information including locality sketches and administrative information.

- Natural Resource Spatial Datasets- a combination of recognised fundamental spatial datasets held in relational databases by various Government agencies including: soils, water resource, vegetation, minerals, geology and climate.
- Digital Topographic Database (DTDB)- a relational database containing landform, contours, water catchments, drainage, land cover, improvements and physical infrastructure forming the ‘as built’ environment and geographic names. Digital Terrain Models (DTM’s) can be derived from the DTDB.
- Digital Cadastral Database (DCDB)- a relational database to graphical accuracy containing a spatial (geometric) description of all legal land parcels in the State and a number of layers of administrative boundaries including: major easements, Local Government boundaries, State Forests, National Parks, suburbs, localities, Local Aboriginal Land Council boundaries and Proclaimed Survey Areas.
- Crown Lands Information Database (CLID)- a spatial database based on the DCDB showing all Crown land in NSW.
- Mining Tenure Administrative System (TAS)- a spatial and textual relational database based on the DCDB showing all mining interests and tenements and their status covering NSW.
- Rectified aerial photography of all major natural features and improvements to a geometric accuracy of +- 3-5 metres, enabling the coordination of these features for road and leasehold boundary definition purposes.

- Automated Land Titles System (ALTS)- a relational database containing the Torrens Register of land ownership and encumbrances, including all long term (>5 years) leases issued under the Western Lands Act, 1901. Destined to become part of the proposed Integrated Property Warehouse (IPW).
- VALNET- a database containing land valuation information for all freehold land in NSW. Proposed for redevelopment and inclusion in the IPW
- Crown Land Information Database (CLID)- a spatial and textual relational database containing status and tenure details for all Crown land in NSW. Developed as a replacement for the State's Parish Map administrative system. The details of Native Title claims have been included in this system, however the formal operation of Native Title over leasehold land remains unclear.
- Property Hub-an integrated relational database accessing ALTS, VALNET and updated daily from Notices of Sale, providing a database of current land transactions to Local Government for rating and the Office of State Revenue for land tax purposes.
- Central Register of Restrictions- a database containing details of all restrictions affecting title.

Modern object oriented database designs allow the integration of spatial and textual data, generating a wide range of reports and outputs, according to client demand. Spatially enabling textual datasets such as the Titles Register provides a powerful tool for decision-making, particularly if accessible via the World Wide Web where the ultimate goal is to undertake land transactions electronically.

6.6 Summary

The above spatial and textual database systems and their derivatives comprise the fundamental information and business processes necessary for the operation of an appropriate Multipurpose Cadastre for the rangelands of Western New South Wales.

The physical access mechanism is proposed as the World Wide Web (Internet) for both downloading of information and processing of land transactions online. Spatial enquiry 'keys' should include street and road address, geographic coordinate, geographic placename (placenames have coordinates), and/or Lot/ Deposited Plan Number. Alternatively, the user should be able to enquire of the system through a spatially-enabled map that is, starting with a map of NSW, the user should be able to progressively "zoom in" through a topographic or cadastral map to a user defined area or ultimately an individual parcel.

The user segment is both a consumer of cadastral information products and, in some cases, a supplier of updated information, through the operation of statutory processes.

The model is intended to be flexible to accommodate changing technology for example improvements in positioning/data capture technology, the inevitable advances in information technology and changing community expectations as the landscape becomes more complex in terms of overlapping rights and restrictions.

A Cadastral Model for the Western Lands of New South Wales

Land Markets	Community and Business Sectors	Utilities	Local and State Government	Planning and Environmental Management
--------------	--------------------------------	-----------	----------------------------	---------------------------------------

Users



Integration, Access and Searching Mechanism

World Wide Web



Digital Cadastral Database (DCDB) Rectified Aerial Photogrammetry of major features and improvements Crown Lands Information Database (CLID) (spatial) Mining Tenure Administration System (TAS)	Automated Land Titles System (ALTS) Crown Land Information Database (textual) VALNET (valuation data) Property Hub (land transactions) Central Register of Restrictions (CRR)
---	--

Spatial Component

Textual Component



Digital Topographic Database (DTDB) Natural Resource Spatial Datasets
Survey Control Information System (SCIMS) Geodetic Framework

CHAPTER 7: EVALUATION OF THE CADASTRAL MODEL

“The cadastral vision developed by the (Cadastre 2014) working group fully recognises the changing role of governments in society, recognises the dramatic influence of technology on cadastral reform, recognises the changing role of surveyors in society and recognises the growing role of the private sector in the operation of the cadastre”.

(Williamson, 1998)

It is the intention of this chapter to examine the cadastral model proposed in the previous chapter in terms of a comparison with internationally accepted cadastral models and its applicability in other jurisdictions, both within Australia and overseas.

7.1 Comparison of the Cadastral Model with Cadastre 2014

As a starting point, the proposed cadastral model is reviewed in terms of the Key Statements for future cadastral systems, identified in *Cadastre 2014- A Vision for a Future Cadastral System* (FIG, Commission 7, 1999). This document, mentioned in Section 4.3 provides a useful guide to current cadastral trends and a vision for a future multipurpose cadastral system. The six Key Statements contained in *Cadastre 2014* are listed below and a comparison given related to the proposed model.

- *Cadastre 2014 will show the complete legal situation of land, including all rights, restrictions and responsibilities.*

The integration of spatial and textual databases containing all interests in land will facilitate a complete spatial view and full understanding of the situation of all individual parcels of land. Interests include those that extend in 3 dimensions, such as mining interests and indigenous rights such as Native Title that extend over areas that may be defined by natural landmarks.

- *The separation between maps and registers will be abolished!*

The application of GIS and Internet technologies will allow distributed databases to be connected, accessed and presented in a seamless fashion to the user. Whilst spatial and textual databases (maps and registers) may physically reside on different platforms in different locations, Internet Browser technology and the concept of data warehouses (where data is copied from the custodian and combined with other information for the user), such as the proposed Integrated Property Warehouse change the paradigm from “separate” to “interoperable” systems.

- *The paper and pencil cadastre will have gone!*

The electronic capture of survey and cadastral information using terrestrial (Total Station), satellite positioning (GPS) and remote sensing (rectified digital photogrammetry) and direct download and processing into computer databases is a far cry from the paper field notes, maps and registers of the past. These automated processes are largely in place albeit in an unintegrated fashion.

- *Cadastre 2014 will be based on cost recovery!*

The use of electronic processes and E Commerce technology will speed up business processes and at the same time reduce costs when compared with manual processes. Whilst the pricing of cadastral information remains a matter of Government policy, the trends are pointing to recovery of costs to cover maintenance of online systems and datasets.

- *Traditional cadastral mapping will be replaced by modelling.*

The modelling of cadastral objects is well advanced in all Australian jurisdictions, where Digital Cadastral Databases have been completed for a number of years and are being improved either through spatial upgrade to “survey” accuracy and through business process re-engineering to improve currency. Object oriented databases are gaining acceptance and are being supported by national initiatives to develop cadastral data models, data dictionaries, data formats and manuals as part of the development and implementation of ASDI.

- *Cadastre 2014 will be highly privatised.*

The cadastral model proposed does not preclude involvement by the private sector. It is expected that private surveyors will continue to be responsible for boundary demarcation and redefinition of leases. Management of the overall system is likely

to remain in Government control, however the model does not preclude privatisation of the system or individual components.

Overall, the proposed model compares favourably with the key ingredients recommended in the vision for future cadastral systems by *Cadastre 2014*.

7.2 Implementation and Applicability to Other Jurisdictions

Any reform program must have political support to have any chance of success. Cadastral reform of the nature proposed, which affects a group of users currently facing difficult economic and social circumstances, must be presented as a means of improving quality of life and the quality of our natural resources on which many depend for their livelihood, well being and existence. Ideally, cadastral reform should be a component of a larger reform agenda focussed on land tenure, land administration and management, so that an holistic approach can be taken to improving the overall framework and not just one important component. Cadastres are by their nature land information systems and should be seen as tools supporting the operation of efficient land markets.

The current political setting sees Commonwealth and particularly the State Government establishing a reform agenda “focussed on the legislative and institutional opportunities to enhance the ‘sustainability’ of the Western Division of New South Wales.” (Kerin, Western Lands Review, 2000). This current favourable political climate should provide a positive driver for the changes necessary to implement an improved cadastral system.

The basic information system components are in place or under development, what is needed is co-ordination between data custodians to ensure data access is not impeded.

The adoption of new technology is not seen as an impediment as all sectors of the community embrace advances in information and positioning technology, such as the World Wide Web and GPS. The NSW Department of Information Technology and Management (DITM), through the Office of Information Technology (OIT) is currently rolling out a network of up to 62 Community Technology Centres (CTC's) in regional and rural NSW. The concept of CTC's is to provide access to affordable, quality information technology and broadband telecommunications through Centres that continuously adapt to meet the challenges of technological, economic and social developments. Communication will be facilitated through the provision of physical and virtual communication networks that will allow knowledge about information technology to be shared and utilised by local communities. This initiative has been funded through the 'Networking the Nation' grant scheme established by the Commonwealth Government. Another important strategy conceived by the State Library of NSW is the *Rural.link* initiative, which is aimed at NSW rural and remote towns and communities with populations of 3,000 or less. The Rural Link project will expand community access to broadband Internet services through one or two way satellite links, with a small number of possible connections via wireless local loops.

It is contended that the adoption of occupational boundaries and land consolidation concepts, which may require agreement between lessees and amendment of title will involve the greatest amount of effort and should be undertaken in the context of regional resource and individual property planning. The development of Regional Natural Resource and Catchment Plans is a major recommendation of the Western Lands Review, 2000 and would provide an opportunity to re-align property boundaries to catchment and sub-catchment areas for improved catchment management as has been shown for rural lands in Queensland (Hannigan and Farmer, 1995).

The survey profession in NSW have been exposed to the concepts of accuracy being more closely related to land use and the use of co-ordinates to describe cadastral parcels for a number of years. Survey practitioners who work in the Western Division have been consulted as part of the research program and are supportive of the proposed model in so far as adoption of lesser accuracy standards and “as occupied” boundaries defined by coordinates from rectified aerial photography.

Given the similarities that exist between all Australian jurisdictions in terms of the Torrens System and standards of survey which remain in the hands of Surveyors General or Surveyors Boards, it is argued that the model proposed for low value rangelands could be applied to other mainland jurisdictions with large areas of rangelands that is, Western Australia, South Australia, Queensland and the Northern Territory. All of these jurisdictions are at similar stages of development in terms of cadastral information infrastructure (Williamson 1996) and are committed to the development of the ASDI, which will deliver the spatial information assets and provide guidance on the development of a data warehouse, using the World Wide Web as an access mechanism. Victoria, Tasmania and the Australian Capital Territory, whilst not having large areas of low value lands are leading the way in terms of realising online Multipurpose Cadastres (Williamson and Majid, 1999). Cadastral reform is on the agenda of all jurisdictions; it is a matter of political priority whether proposals such as this are progressed.

7.3 Summary

Adoption of a Multipurpose Cadastre as proposed could well serve the national interest in terms of a system capable of managing overlapping European and Native Title interests and assisting the process of Reconciliation through unambiguous information about all interests in land.

The proposed model has been compared in this chapter with a number of national and international benchmark documents and policies created by leading authorities and agencies including:

- *Cadastral 2014- A Vision for a Future Cadastral System-* a document by the International Federation of Surveyors (FIG), recognised as the leading international professional body representing the views of surveyors and their vision of where cadastral systems will be over the next decade. This benchmark details the current and likely trends of over 40 countries and is currently being realised in a number of jurisdictions. Recent institutional changes to key NSW agencies involved with land titling, information and valuation follow many of the tenets set out in *Cadastral 2014*. The particular cadastral model proposed in this thesis complies or embraces the elements of a modern, appropriate cadastral system that will support sustainable development and environmental management of Australia's rangelands. It is argued that the proposed model compares favourably with all key elements of *Cadastral 2014* and can also be applied effectively in any Torrens title jurisdiction with access to modern technology and a political will to embrace and adopt sustainable development objectives.
- *Western Lands Review 2000* – whilst *Cadastral 2014* provides an international framework for future systems, the recently completed *Western Lands Review 2000*, provides a national and jurisdictional context within which cadastral reform can occur. It would appear that major reform of land administration systems applicable to the Western lands of NSW only seem to occur around the turn of the century given the current Western Lands Act, 1901 was the result of a major review triggered by a period of disastrous drought and economic recession in the late 1890's. The current review has

been triggered by a combination of adverse seasons coupled with lower commodity prices, caused by global competition and a changing social consciousness away from a purely exploitive paradigm to one of sustainable environmental management and social justice.

The Review will set a new direction in the new millennium that will guide land use decisions, tenure arrangements and a new governance model for the Western Lands of NSW. The cadastral system is fundamental to the operation of land markets and the administration of Crown land, the cadastral model and the vision adopted are wholly consistent with the recommendations and findings of the Review.

CHAPTER 8: CONCLUSIONS AND RECOMMENDATIONS

“ Continuation of the current system of laws and government operations is unlikely to bring about the improvements needed in the Western Division.”

(John Kerin, Chairman, Western Lands Review, 2000)

The purpose of this chapter is to provide a conclusion for the research undertaken and to list the recommendations that arise as a result of the conclusion and findings.

The primary objective of this thesis is to examine the feasibility and the benefits of introducing a modern Multipurpose Cadastre (MPC) into rangeland New South Wales to facilitate sustainable development. The concepts of a modern Multipurpose Cadastre are fully explored in the context of modern authorities and the forces at work driving change. The setting is fully examined to determine whether the characteristics of Western lands in terms of environmental, economic, social and administrative warrant the application of a MPC and the elements that form such a “world’s best practice” cadastral system. The study shows that the current principal legislation underpinning land tenure and administration is outdated and unable to cope with issues such as Native Title and the ever increasing number and complexity of rights, restrictions and obligations which now exist and need to be adjudicated, delineated, mapped and managed as land objects. Information technology and the power of Geographic Information Systems, Global Positioning Systems and the unprecedented growth of the use of the World Wide Web have caused the “information revolution” which through modern communications infrastructure both terrestrial and satellite based, offer people and businesses previously isolated due to their remote location the chance to become part of the “knowledge economy”.

The need for a sustainable future for rangeland Western NSW and the re-establishment of a legal road network are catalysts for cadastral reform. There is also a pressing requirement to address social justice issues, particularly, Native Title that is viewed by stakeholders as one of the most important requiring a Government commitment to the removal of uncertainty. Government and stakeholder recognition that change is inevitable and necessary is an important ingredient as it provides a political will and a driver for reform. The first step in any reform program is recognising and identifying that there is a problem and that it needs to be fixed.

A number of recent Government reviews, triggered by the manifestation of major environmental problems, depressed economic conditions and social justice issues such as uncertainty over the application of Native Title to pastoral leases has focussed attention on the Western Division of New South Wales and the need for change.

The hypothesis put forward suggesting that ***“The cadastral system in rangeland New South Wales has contributed to environmental degradation, poor land management and a declining rural economy. Reform would enable social, economic and environmental systems and practices to be realigned to modern expectations and needs.”*** has been examined in the historical context of a cadastral system supporting a 19th Century approach of exploiting the land and its resources for economic gain. The key question of how the existing system has contributed to these problems has been answered in terms of an existing inflexible, relatively costly system unable to adequately cope with the increasing complexities and expectations of modern society.

As a tool supporting land settlement and taxation, the early cadastral system applied to the low value rangelands in the Western Division was the same applied elsewhere in New South Wales. Parcels were laid out in rectangular shapes on the landscape, enclosing defined areas with little regard for the adoption of natural boundaries (for example soil boundaries, catchments/subcatchments), leading to properties being less than optimum in size and limiting land management options. This approach causes major problems to mechanised agriculture and the design and implementation of soil and water conservation measures. Holistic natural resource information was not available to early land managers for decision-making, principally because the technology was not available.

The costs of cadastral surveys using the existing standards are high when compared to the value of the land. Survey standards for other forms of leasehold tenure, such as leases for forestry and aquaculture purposes have been relaxed to allow the use of new technology such as

GPS and to bring costs into closer alignment with land values. A similar approach can be taken to grazing leases issued under the Western Lands Act, 1901 where surveys would only be required to an accuracy of +/- 3-5 metres where the existing boundaries coincide with long established and accepted occupations such as fence lines, roads, railways, etc. The coordinates of these occupations would be held in a rectified digital photogrammetric database and available along with other property and land related information via the World Wide Web. Existing survey accuracy standards and rules would continue to apply to the relatively small numbers of freehold and perpetual leasehold lands held for residential and business purposes in the towns and villages in the Western Division.

Consolidation of parcels or property buildup is already being encouraged through structural adjustment programs such as West 2000, outlined in Chapter 2. The rearrangement of property boundaries to align with catchment/sub-catchment boundaries has been shown in Queensland studies (Hannigan and Webb, 1995) of rural farms to facilitate better land and natural resource management. It is suggested that this process could be legitimately applied through the regional resource planning process, which has been recommended by the Western Lands Review, 2000 as part of a legislative reform program.

Rehabilitation of degraded land requires reliable information for the planning, implementation and monitoring of natural resource management plans. The existing cadastral system was not designed to access or use natural resource information as a management tool. The advent of satellite remote sensing provides a new instrument for monitoring land condition and land use planning on a regional basis.

Geographic Information Systems, coupled to data streams from a range of sources including online multipurpose cadastral systems, can analyse and predict man's impact on the environment or even model the effect that natural disasters can have on man's endeavours through the recurrence of droughts, floods and fire.

The importance of a consistent spatial framework, in this context the Geodetic Framework, which in Australia is now based on the Geocentric Datum of Australia – an International standard directly compatible with GPS – cannot be overstated. The geodetic framework provides the spatial rigour and a universal means of integrating spatial information. Without this framework, local, regional, state and national spatial datasets cannot be built to a consistent standard. The legacy of early settlement without a ‘general’ survey was a system of unrelated ‘running’ surveys leading to inefficient past cadastral mapping processes.

Social instability caused by such issues as the uncertainty surrounding the application of Native Title to pastoral leases can be ameliorated if information about the claim areas and ultimately the operation of Native Title interests can be managed in a modern cadastral system capable of handling European and Indigenous rights and interests.

It is argued that concepts such as an online Multipurpose Cadastre, use of new technologies, appropriate boundary definition and demarcation rules and procedures and re-arrangement of property boundaries can facilitate better land resource management.

Some components of an online Multipurpose Cadastre are well advanced or underway, these are:

- Consistent spatial framework, that is, geodetic network with marks at a 50 kilometre minimum spacing.
- Comprehensive spatial datasets providing digital base mapping.
- Development of standards, procedures and systems to apply modern technology such as GPS, GIS, Internet etc to improve processes underlying the operation of the cadastre.

Development of appropriate boundary definition and demarcation rules and procedures, including relaxed cadastral survey accuracy standards, more closely aligned to land value.

Australian models of land consolidation are available and need to be further tested for their applicability to rangelands. Cadastral reform has commenced however there is further work to be done to redefine the most appropriate cadastral system for rangelands. Most importantly the people of the Western Lands of NSW need to recognize the need for change to secure a sustainable future.

BIBLIOGRAPHY

- Abel, N., Farrier, D., Tatnell, B., and Mooney, C. (1999) *A Rangeland Enmeshed-the Legal and Administrative Framework of the Western Division of New South Wales*. CSIRO Wildlife and Ecology, University of Wollongong, NSW Department of Land and Water Conservation.
- Ahlich, J.S., (1997) *Site Specific Technologies for Improved Crop Production*, OUTLOOK 97: Proceedings of the National Agricultural & Resources Outlook Conference, Canberra, February, Vol. 2, Agriculture, ABARE, Canberra, pp67-74
- Aslin, H.J., Martin, M.R. and Fenton, D.M. (1999) *Re-valuing the West: Attitudes and values of stakeholders in the future of the New South Wales Western Division*, Bureau of Rural Sciences, Canberra
- ANZLIC , (1997) *Discussion Paper on Spatial Data Infrastructure for Australia and New Zealand*, ANZLIC Canberra
- Australian Ecologically Sustainable Development Steering Committee (1992) *"National Strategy for Ecologically Sustainable Development"*, Bureau of Rural Sciences, Canberra.
- Beare, S., Gooday, J., Doyle, S., and Ockerby, J (1995). *Agriculture in the Rangelands*, Australia Commodities, Vol. 2, No.4, December 1995
- Benecke, I., (1997) *Wik, Worry and Woe in the Western Division*, Law Society Journal, May 1997, pp 54-62
- Bowen, P.J. (1997) *The Spatial Dimension of Native Title*, Presentation to the Annual Research Seminar, School of Geomatic Engineering, University of NSW, 10 November 1997
- Browne, E., (1997) Department of Land Administration, Western Australia, *Personal Communication*
- Christie, E.K., (1986) *Pastoralism and Ecology in Arid Australia*. Longmans, Cheshire, United Kingdom.
- Crowe, L., (1996) *Sheep Industry Performance*, Australian Farm Surveys Report 1996, Australian Bureau for Agriculture and Research Economics (ABARE), Canberra, Australia pp 25-28
- Dale, P.F and McLaughlin, J.D (1988) *Land Information Management*, Clarendon Press, Oxford. United Kingdom. pp 6,26
- Dale, P.F. and McLaughlin, J.D. (1999) *Land Administration*, Oxford University Press, Great Clarendon Street, Oxford

- Derwent, L., (1998), Manager, Aquaculture Leases, NSW Fisheries, *Personal Communication*.
- Dick, R., (1992) *Arguing for adequate clearing controls in Western NSW-the Culgoa River floodplain fauna study*, National Parks Journal, August 1992, pp 13-18.
- Dregne, H.E., (1977) *Desertification of Arid Lands*, Longmans, Cheshire, United Kingdom.
- Epstein F, McLaughlin J.D., (1983) - *Procedures and Standards for a Multi-Purpose Cadastre*. National Academy Press, Washington, D.C.
- Falloux, F., (1989) *Land Information and Remote Sensing for Renewable Resource Management in Sub-Saharan Africa*, World Bank Technical Paper No 108, Washington D.C., United States.
- FIG, (1995) *Statement on the Cadastre*, The International Federation of Surveyors (FIG), Belconnen, ACT, Australia, No.11, 22p.
- FIG Commission 7, (1998) *Cadastre 2014-A Vision for a Future Cadastral System*, The International Federation of Surveyors, Commission 7 (Cadastre and Land Management), Rudlingen, Switzerland, 50pp.
- FAO & FIG, (1995) *Future Collaboration in Cadastral Reform in Rural Economies in Transition: Report of the Round Table Meeting*, International Federation of Surveyors (FIG), Belconnen, ACT, Australia, No.10, 19pp
- Gleeson, T. and Topp, V., (1997) *Broadacre Farming Today-Forces For Change*, OUTLOOK 97, Proceedings of the National Agricultural & Resources Outlook Conference, Canberra, February, Vol.2, Agriculture, ABARE, Canberra, pp53-67
- Grant, D.M., (1997) *Territoriality*, Proceedings of the 1997 Trans-Tasman Surveyors Conference, Institution of Surveyors Australia, Canberra
- Grant, D.M., (1997) *The State and the Business of Spatial Information*, Paper presented at the CONSAS'97 Conference, Durban, South Africa, 26 August 1997
- Grant, D.M. and Krogh, B., (1994) *Cadastral Development in New South Wales: philosophy, politics and polarisation*, 20th Congress of the International Federation of Surveyors, Commission 7: Cadastre and Rural Land Management, Melbourne, Australia, March 5-12, 1994;p.703.1/1-12
- Hannigan, BJ and Farmer, R (1995) *Re-arrangement of Farm Boundaries to Facilitate Beneficial Adjustment in Primary Industries*, Final report of

a Rural Industries Research and Development Corporation Project
1995. ISBN 1864350210

Hannigan, BJ and Webb, RM (1995) *Re-arrangement of Property Boundaries to Facilitate Optimum Rural Land Use*, Land & Water Resources R&D Corp, Technical Report, Sept 1995. ISBN 1 86435 634 0

Harrington, G.N., Wilson, A.D., and Young, M.D. (eds) (1984) “*Management of Australia’s Rangelands*”, CSIRO, Melbourne.

Henssen, J.L.G., (1993) *Cadastral, an Instrument of Land Management*, Surveying World, Vol.1, No.5, 5p

Henssen, J.L.G. (1994) *Multi-purpose Cadastral, a Component of Land Management with a Low Cost Aspect*, 20th Congress of the International Federation of Surveyors, Commission 7:Cadastral and Rural Land Management, March 5-12,1994,p.701.2/1-10

Hoogsteden, C.C.and Van Zyl, C.A., *Cross-leases and the New Zealand Cadastral: Oddity in Numberland*, 20th Congress of the International Federation of Surveyors, Commission 7:Cadastral and Rural Land Management, Melbourne, Australia, March 5-12, 1994, p.707.2/1-12

Hoser, R.T. (1991) *Endangered Animals of Australia*, Pierson & Company, Sydney, Australia

Hunter, G.J. and Williamson, I.P. (1991) *A Land Information System for the City of Melbourne – Technical Specifications. Consultants Report for the City of Melbourne.*

Hyder Consulting (2000) – Western Lands Review – Final Report prepared for the Minister for Land and Water Conservation, 22-33 Bridge Street, Sydney.

James, Professor David (2000), “Vice Chancellor’s Address” , University of Ballarat, Victoria.

Kelly, P.C, and Harcombe P.R., (1996) *Saving the Sunburnt Country*, Australian Surveyor, Volume 41, Number 2, June 1996, pp 103-108.

Kentish, P.M., (1994) *Cadastral Initiatives from South Australia*, 20th Congress of the International Federation of Surveyors, Commission 7: Cadastral and Rural Land Management, Melbourne, Australia, March 5-12, 1994, p.730.1/1-10

Langford, R.R. (1997), Private Surveyor, Dubbo, NSW, *Personal Communication.*

Larsson, G. (1991) “*Land Registration and Cadastral Systems, New York:* Longman Scientific and Technical

- Larsen, J. (1998), Interagency Coordinator, Surveyor General's Department, NSW, *Personal Communication*
- Leigh, J.H. and Briggs, J.D. (1992) *Threatened Australian Plants: Overview and Case Studies*, Commonwealth of Australia, Canberra, Australia
- Lyon, N. (1999) *Justifying precision farming outlay*, Australian Farm Journal CROPS, June 1999, pp8, 9.
- Mabbut, J.A., (1978) *Desertification in Australia*, School of Geography Report No 54, University of NSW, pp127
- Majid, S.A., (2000) *Online Multipurpose Cadastre*, Master's Thesis, Department of Geomatics, University of Melbourne
- Napier, R. (1997) *Business Structures for the Future*, OUTLOOK 97, Proceedings of the National Agricultural & Resources Outlook Conference, Canberra, February, Vol.2, Agriculture, ABARE, Canberra, pp83-92
- National Land & Water Resources Audit, (2001) *Rangelands-Tracking Changes, Australian Collaborative Rangeland Information System, Draft Final Report*, National Land & Water Resources Audit, Level 2, Unisys Building, 91 Northbourne Avenue, Turner, ACT 2612
- National Native Title Tribunal, (1997) *Native Title Questions and Answers*, National Native Title Tribunal, Level 25, 25 Blich Street, Sydney NSW 2000
- National Rangeland Management Working Group, (1994) *Rangeland Issues Paper*, Australian and New Zealand Environment and Conservation Council, Canberra, p30
- National Research Council, Panel on a Multipurpose Cadastre, (1983) *"Multipurpose Cadastre"*, US Government, Washington, DC.
- Noble, J.C., (1997) *The Delicate and Noxious Scrub, CSIRO Studies on Native Tree and Shrub Proliferation in the Semi-Arid Woodlands of Eastern Australia*, CSIRO Division of Wildlife and Ecology, Canberra
- NSW Farmers Association (1996) *Western Division Conservation Policy*, 1 Blich Street, Sydney NSW 2000
- NSW Surveyor-General's Department, (1997) *Surveyor General's Technical Direction: GPS Guidelines for Cadastral Surveys*, Panorama Avenue, Bathurst, NSW 2795
- Parker, J., Hall, D., Barry, J., and Birrell, S., (1995) *Is the Torrens System Suitable for the 21st Century?* Paper presented to the 1995 New Zealand-Australia Cadastral Conference, Wellington, New Zealand

- Pickard, J (1994) *Do old survey plans help us discover what happened to western New South Wales when Europeans arrived?* Paper published in Future of the Fauna of Western New South Wales, Royal Zoological Society of NSW, Mosman, pp 65-73.
- PSMA, (1996) *Report on the PSMA/ICSM Workshop on Digital Cadastral DataBases*, Melbourne 5-7 August 1996. Public Sector Mapping Agencies, Canberra.
- Queensland Department of Primary Industries, (1992) *Mulga Region Position Paper: A Study of the Inter-dependence of the Environment, Pastoral Production and the Economy*, by the Mulga Land Use Advisory Group, QDPI, Brisbane, Queensland
- Read, J.R. (1999), *The Parish Map Preservation Project- the use of Digital Photography, CD's and computers to copy, view (and preserve) old maps*, Paper presented to the Association of Public Authority Surveyors Conference, 1999, Coffs Harbour
- Ruoff, T.B.F. (1957), *An Englishman Looks at the Torrens System*, The Law Book Co. of Australia Pty. Ltd, Sydney, Australia.
- Salt, B. (1997) *Demographic and Cultural Change in the Bush*, OUTLOOK 97, Proceedings of the National Agricultural & Resources Outlook Conference, Canberra, February, Vol.2, Agriculture, ABARE, Canberra, pp119-121
- Smyth and Dumanski, (1993) FELSM: *"An International Framework for Evaluating Sustainable Land Management*, United Nations Food and Agriculture Organisation, New York.
- Stock, K. (1998) *Accuracy Requirements for Rural Land Parcel Boundaries*, The Australian Surveyor Volume 43, Number 3, September 1998, pp 165-169
- Ting, L. and Williamson, I.P. (1999), *Cadastral Trends: A Synthesis*, The Australian Surveyor, Volume 44, Number 1, June 1999, pp 46-53
- United Nations (1996), *The Bogor Declaration, Report from the United Nations Inter-regional Meeting of Experts on the Cadastre*, Bogor, Indonesia, 18-22 March, 1996. International Federation of Surveyors, UK, 10p
- United Nations and FIG (1999), *The Bathurst Declaration on Land Administration for Sustainable Development*, Report of the Workshop on Land Tenure and Cadastral Infrastructures for Sustainable Development, Bathurst, Australia, 18-22 October, 1999, published by the Land Information Centre, Department of Information Technology and Management, NSW

- University of Melbourne, Department of Geomatics (1998), *Accuracy Enhancement of High-Resolution Satellite Imagery for Geo-spatial Information Collection*, ARC Research Grant Application, Department of Geomatics, University of Melbourne, Melbourne, Australia
- Walters, B. (1997) *The Current Situation: Rural Economy*, The Valuer and Land Economist, Volume 34, Number 1, February 1997, pp 57-61
- Western Lands Commission (1992) *The Western Division in Crisis*, Western Lands Commission Discussion Paper, Department of Land and Water Conservation, Bridge Street, Sydney, NSW 2000
- WEST 2000 (1997). *WEST 2000 RURAL PARTNERSHIP PROGRAM*, by the WEST 2000 MANAGEMENT BOARD, NSW Department of Land and Water Conservation, Dubbo, NSW, Australia
- Whitelock, D. *Adelaide 1836-1936*, Queensland Law Journal 1977
- Williams, N. and Johnston, R. (1994) *Not Passing Through: Aboriginal Stakeholders in the Rangelands*, Rangeland Journal No. 16, pp 198-205
- Williamson, I.P. (1983) *A Modern Cadastre for New South Wales*, Ph.D. Dissertation, School of Surveying, University of New South Wales, 318p
- Williamson, I.P. (1984) *The Development of the Cadastral Survey System in New South Wales*; The Australian Surveyor, Vol.32, No.1, pp2-20
- Williamson, I.P. (1984) *Coordination of Cadastral Surveys in New South Wales*, The Australian Surveyor, Vol.32, No.4, pp274-292.
- Williamson, I.P. (1996) *The New South Wales Digital Cadastral Data Base, Current Status And Future Directions*, Report for the Office of the Surveyor General, Department of Land and Water Conservation, NSW, 5p
- Williamson, I.P. and Enemark, S (1996) *Understanding Cadastral Maps*, The Australian Surveyor, Vol.41, No.1, pp38-52
- Williamson, I.P. (1995) *Appropriate Cadastral Systems*, Trans-Tasman Surveyor, Vol.1, No.1, pp57-59
- Williamson, I.P. (1996) *The Operation of Land Markets and Cadastral Systems*, United Nations Interregional Meeting of Experts on the Cadastre, Bogor, Indonesia, 18-22 March, 6p
- Williamson, I.P. (1996) *International Trends in Cadastral Reform*, Proceedings of FIG 63rd Permanent Committee meeting and International Symposia, Buenos Aires, Argentina, 15-19 April, 17p

- Williamson, I.P. (1998) "*Cadastral Reform and the Future of the Surveying Profession*" Paper presented at the 39th Australian Surveyors' Conference, Launceston Tasmania, 8-13 November, 1998.
- Williamson, I.P. and Majid, S.I.A. (1999) *Cadastral Systems on the World Wide Web: A Multi-Purpose Vision*, Paper presented at the 27th Annual Conference of AURISA, Fairmont Resort, Blue Mountains NSW, 22-26 November 1999
- Williamson, I.P. (1999) "*Future Directions for Spatial Information Management in Australia – A Land Administration Perspective*", Paper presented at the 27th Annual Conference of AURISA, Fairmont Resort, Blue Mountains NSW, 22-26 November 1999.
- Wonder, B. (1995) *Australia's Approach to Agricultural Reform*, Paper presented to the United States Government International Agriculture Forum, Washington 13 March 1995, Rural Division, Commonwealth Department of Primary Industries and Energy, Canberra, Australia.