

Assessing the Suitability of Land Administration to Support Natural Resource Management at the Parcel Level

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Key words: land administration, natural resource management, cadastral parcel, land information, natural resource information.

SUMMARY

This paper provides an overview of the practice of land administration and identifies the aspects that are of benefit to natural resource management, and an assessment of the capability of land administration to support natural resource management at the cadastral parcel level.

The international push for the introduction of sustainable development has had an impact on natural resource management. There have been calls for widespread changes to land use and the introduction of sustainable land management practices to help arrest natural resource degradation and loss of biodiversity.

Several authors have suggested that land administration has a role in underpinning sustainable development and therefore natural resource management, however land administration frameworks were generally not developed with natural resource management in mind. As a result there are significant limitations in the application of land administration data and functions to natural resource management. This paper assesses the suitability of adapting existing land administration frameworks and practices to support natural resource management at the land parcel level. The assessment uses the Australian state of Victoria as an example to illustrate the points made.

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1 INTRODUCTION

International publications, such as *'Our Common Future'* in 1987, the *'Rio Declaration'* and *'Agenda 21'* in 1992, and the *'Johannesburg Declaration'* in 2002, have created recognition that concerted efforts are needed to develop sustainable land use practices to minimise further harm to natural resources and biodiversity. Maintaining and enhancing the quality of our soils, rivers and oceans; availability of fresh water; and the maintenance of biodiversity have emerged as key issues globally [World Bank, 2001], and in Australia [Natural Resource Management Scientific Advisory Group, 1999].

The deterioration of Australia's natural resources has resulted from substantial clearing of native vegetation; the introduction of European land use practices not suited to Australian conditions [Yencken & Wilkinson 2000]; and the very high per capita consumption of resources that many commentators argue is unsustainable [DiSano, 1999, UN General Assembly 2000, UN General Assembly 2002]. Australian rural production systems change the nature of the hydrological and nutrient cycles and release increased amounts of water, nutrients, sediments and contaminants into waterways. These changes to natural systems are central to much of the natural resource degradation existing in Australia [NRMSAG, 1999].

If Victoria is to significantly move towards sustainable development it is generally regarded that land use and land management practices that contribute to natural resource degradation will need to dramatically change [Gorrie and Wonder 1999, Yencken & Wilkinson 2000]. One of the keys to improved land management practices is creating an environment where land users understand the implications of poor land management practices, the recommended best practices for their land holding, and the benefits in adopting these recommended best practices. Various policy instruments may be used to encourage change in land use or land management practices, but ultimately the land users must make decisions that reflect the best social, economic and environmental outcome for their land-holding. These decisions must be based on reliable information about the effect of changes to land management practices on the environment, the income derived from the land-holding, and the social cost of change. At present there are significant gaps and limitations in this information at the land-holding level.

Several authors have stated the importance of land administration in supporting sustainable development [UN/FIG 1999, Williamson 2001b]. In Australia, the role of land administration in natural resource management was considered as early as 1990 [Australian Land Information Council, 1990]. Secure land tenure and accurate property valuation support effective property markets, which encourage efficient use of resources associated with the land. Where inappropriate land use is undertaken market failure is said to exist and regulation

is needed to enforce change and enforce penalties. In addition, the provision of digital land information has been regarded as important for effective natural resource management [Ibid].

However, Victoria's land administration system has developed from a judicial cadastre that was designed to support the registration of land tenure, and developed to record the ownership and boundaries of land. The initial priority for Victoria's land administration system was to facilitate the orderly and efficient settlement of land. As a result, it is probable that the institutional, statutory, and policy frameworks of the existing land administration system are not ideally suited for application to natural resource management decision-making. In addition, the land administration information available may need to be improved or altered to improve its benefit to natural resource management.

2 LAND ADMINISTRATION

Land administration systems have evolved from 'fiscal cadastres' developed to record valuation and ownership information to support the collection of taxes, or from 'judicial cadastres' developed to record the ownership and boundaries of land to support land markets (i.e. conveyancing), or from a desire to control the use of land (i.e. land use planning). Land administration activities have historically been performed by separate agencies responsible for each of these three core functions, and management and integration of the information is integral to the process [Dale and McLaughlin, 1999]. As many land administration systems have evolved from cadastres' the basic unit of information is generally the land parcel - or 'cadastral' parcel, although some land administration systems have the name of the proprietor as the basic unit. Typically, the cadastral parcel is uniquely defined and related in the information system to the registered rights and restrictions over that parcel [Ibid].

The key functions of land administration are recording rights in land, controlling development and use of that land, determining the value of land to support taxation and revenue collection, and information management. The process of land administration therefore involves three key attributes of land – its tenure, value and use [Ibid]. The relationship between land markets, registration, spatial planning and valuation is specifically raised in the Bathurst Declaration [UN/FIG, 1999]. The declaration notes that land markets tend to move towards the most economically efficient ownership and use of land - provided appropriate institutional frameworks apply. These frameworks include the legal framework, which provides a degree of certainty in the ownership and use of land and is aimed at minimising risk in transactions. Key components of this legal framework are the registration of interests in land, the land use planning system, and the associated legislation, which work together to control the use and development of land. Land-use planning impacts on the land market by restricting the supply of land for specific uses and clarifies the restrictions on the use of land.

The purpose of land administration in Australia has been to provide certainty in ownership of land to support land markets, and to record the rights and responsibilities in land. Effective land markets and security of ownership allow development based on mortgages against the value of the land, and Lyons et al [2001] noted that the "Property Council of Australia

advises that virtually all development capital in Australia is directly secured against property (title)”.

The agency with prime responsibility for land administration in Victoria - ‘Land Victoria’ – was created in 1996 “with a clear mandate...to deliver wide ranging business efficiencies and improve customer service” Newnham et al [2001]. The initial functions of Land Victoria included “geospatial information, mapping, survey, valuation, Crown (or unalienated) land management and freehold title creation and registration” [Ibid], and three functions remained outside Land Victoria – the land use planning framework (Planning and Heritage Division, Department of Infrastructure); land as a basis of taxation (State Revenue Office, Department of Treasury and Finance); and land as the basis of rating (78 local councils). Following the state election in 2002 the functions of planning, heritage and building have been combined with Land Victoria in the newly created Department of Sustainability and Environment.

Ting and Williamson [2001] argued that the global driver of micro-economic reform has had a profound effect on the practice of land administration in Victoria and “these reforms have impacted on all levels of government and have resulted in the now common activities of downsizing, privatisation, cost recovery, performance contracts, (and) quality assurance”. The resulting restructuring has had flow-on effects in rural areas in terms of reduction of services, with a resultant negative impact on land management.

Land Victoria, like similar organisations in other jurisdictions, lists protecting the environment as one of its priorities [Land Information Group, 2000]. The reality, however, is that the emphasis in effort has been in developing on-line provision of existing data, and the development of framework and business datasets. A review commissioned in 1993 by the Victorian government [Tomlinson Associates, 1993] found the most important datasets to Victoria were the cadastre, topographic features, and road centreline datasets, however at the time the Tomlinson report was produced sustainable development had not been embraced by government to the extent it currently has. The subsequent development of Victoria’s framework datasets has been consistent with the Tomlinson suggestions, and there is little evidence that environmental issues inform the strategic decisions. There is a need for greater recognition of the issues facing natural resource management in the development of Victoria’s geospatial strategies, spatial data infrastructure, and an appropriate regulatory framework.

3 LAND TENURE

Providing secure property rights has been identified as important to developing markets in which the resources on land are used by those that value them the most [de Soto 1993, Feder 1999, World Bank 2001]. Raff [1999] noted the social and environmental responsibilities associated with ownership of land. Feder [1999] noted that “formal land administration systems serve to reduce the asymmetric information between buyers and sellers by providing a more reliable verification as to the extent of the seller’s land rights, the presence of challenges and encumbrances, and the location of boundaries”. In Victoria, the cadastre is the public register of the tenure, spatial relationships, rights and restrictions, and value in land [Bell and Cleary, 2001]. Government guarantees the ownership of land and selected rights

TS4 Best Practices in Land Administration – Country Perspectives

4/16

David Mitchell, Ron Grenfell and Keith C. Bell

TS4.1 Assessing the Suitability of Land Administration to Support Natural Resource Management at the Parcel Level

FIG Working Week 2003

Paris, France, April 13-17, 2003

associated with this ownership. The government does not guarantee the spatial relationships such as the cadastral boundaries, or the title area, and issues such as adverse possession result in differences between the recorded tenure of land and the equitable ownership. This uncertainty over the spatial relationships of land tenure is supported by a highly regulated surveying system that provides the registered proprietor with security of tenure.

In addition the majority of rights and restrictions associated with ownership are not included on the register. For example, some easements that exist in equity are not recorded on the register. This results in a major impediment to the conveyancing of real estate, as the buyer has to establish all existing rights and restrictions over the property, and determine if the spatial relationships shown on title agree with the occupation on the ground. Lyons et al [2001] noted that information of this type was needed when buying or selling land to ensure the efficiency of land markets and therefore facilitate economic and social development within the State. Bullard [2002] argued: “too often governments clearly define the rights of ownership without considering or defining the responsibilities of these land owners”. A new model for the provision by government of information on these social and environmental rights and responsibilities is needed. Providing information on all the rights and responsibilities related to land would benefit the State economically through the reduction in conveyancing costs and more efficient land markets, socially through increased wealth, and environmentally through less disputes over the allocation of natural resources.

Another structural limitation in existing land administration practices is the objective of exclusivity of tenure. Riddell and Palmer [1999] argued that the implied goal in the “justification of the vast majority of land administration projects” is exclusivity of use (and therefore exclusivity of tenure). It would be reasonable to apply this to the Torrens system of land registration in Victoria, which derives from the common law principles of protection of property rights. Exclusivity of use is at odds with much of the existing use of land which increasingly involves partial rights, temporal rights and distributed rights [Ibid].

There is a need to fundamentally change land administration policy and practice to consider partial rights such as native title interests, and rights over the land and its resources. The inclusion of customary rights and native title interests in land administration systems has been recognised as an issue in the implementation of sustainable development in Agenda 21 and by various authors [UN/FIG 1999, van der Molen 1998, Williamson & Ting 1999].

3.1 Statutes limiting the rights over natural resources

The *Water Act 1989* gives the Crown the right to the use, flow and control of all water in a waterway and all groundwater. Section 8 provides that a person has the right to take water, free of charge, for that person's domestic and stock use from a waterway or bore on their land. The owner also has the right to use rainwater for any purpose on their land. The Act expressly maintains that rights conferred under Section 8 are limited only to the extent to which an intention to limit it is expressly contained in the Act. If the Minister declares a water shortage in a region the Act allows for the Water authority to temporarily qualify all or any of the rights to take water from that area or system.

The State government controls the extraction of ground water through requiring a license for the construction of all groundwater bores. Fifty groundwater management areas have been identified in Victoria and a Permissible Annual Volume has been established representing the sustainable yield of the aquifer [Taylor and Blackmore, 1999].

3.2 Registered rights over natural resources

The rights, responsibilities, and interests recorded on the register are commonly referred to as ‘registered interests’, and can include the type of tenure, registered easements and covenants, caveats, mortgage details, and the rights and reservations of the State [Lyons et al, 2001]. Victoria’s Land Registry is responsible for recording rights on the register and on title, through creating new titles, recording transfers of ownership, recording changes to interests in land, and making the information available.

Profits a Prendre have been established to grant rights to undertake forestry on land owned by another. This approach has limitations, as the holder of the right does not own the commodity until it is harvested. The Victorian *Forestry Rights Act 1996* was introduced to overcome these limitations and it established the facility for a land-owner to enter into a ‘Forest Property Agreement’ with another to grant rights to trees grown on the land. The agreement is recorded on the certificate of title and the burden of the covenant in the forest property agreement runs with the land. This legislation enables a Forester to own the trees growing on another property without entering into a lease or a license that would involve exclusive use of that land. The Act does not apply to Crown land and requires all aspects of rights to the forest and land surrounding the trees to be specified in the agreement. Normally a restrictive covenant over land is enforceable only if expressed as a negative restriction on the owner of the land, however the *Forestry Rights Act 1996* explicitly permits positive covenants to be included in the Forest Property Agreement [Blair, 1997].

3.3 Trading rights over natural resources

Water has been identified as an increasingly scarce resource [Riddell & Palmer 1999, World Bank 2001] and we will need improved quantity and quality of water distribution to meet the basic requirements of urban and rural users [Riddell & Palmer, 1999]. One solution being employed by various natural resource management agencies is to establish trading rights over resources, with water trading established in Victoria and legislation enabling the trading of carbon credits. Closely tied to this is the need to identify partial rights over resources in the manner applied to forest resources or groundwater. Policy reform in these areas is seen as fundamental to implementing change [Gorrie and Wonder, 1999].

Carbon rights may be considered to be the legal rights over the carbon dioxide absorbed by trees which would enable the land owner to claim credit if a taxing system was established that accepts carbon rights to offset carbon emissions. The *Forestry Rights Act 1996* allows the establishment of a Forest Property Agreement between the land-owner and the Forester in which ‘forest property’ is vested in the Forester. In May 2001 the *Forestry Rights Act 1996* was amended to recognise ‘Carbon Sequestration Rights’ and enables ownership of these

rights separate from ownership of land and trees. Carbon rights allow investors to buy or sell carbon as a third party, without affecting the ownership of the trees or the land [Natural Resources and Environment, 2001b].

Victoria has a comprehensive system of trading surface water entitlements under the *Water Act 1989*, which enables the allocation of water to authorities and for water entitlements to be clearly defined. Water trades may be made directly between farmers, through a water broker or through the water exchange. Much of Australia is currently experiencing drought conditions and this has highlighted the scarce nature of water as a resource and the need for more secure water property rights. 'Draft Water Entitlement and Allocation Principles' have been developed by the federal government (CEOs Group on Water, 2002), with consultation currently underway. A significant issue raised in this review has been the need to determine the value of water entitlements and water property rights.

The trend towards specifying partial rights over resources and the subsequent trading of these resources requires institutional change. Most jurisdictions have one land register dealing with land tenure issues however advances in technology allow consideration of multiple registry utilities for land tenure, and rights over individual resources [Riddell and Palmer 1999]. Further debate is needed on whether details of rights over resources should be recorded on a register and guaranteed by the relevant natural resource management agency.

4 LAND VALUATION

The value of a property must be determined when buying or selling the land, creating leases over the land and when taxing the property, or when there is a need to determine the assets of the proprietor for the purpose of death duty, or inheritance, or providing finance. Valuations are also needed for investment management and insurance purposes. Each of these actions requires the determined value to be close to the market value if the property was sold [Dale and McLaughlin, 1999]. Valuer General Victoria has a coordinating role in the determination of valuations for council rates through the 'Valuations Best Practice' program, which requires councils to cause a valuation of all rateable land to be made every two years. Victoria is the only state or territory in Australia in which the municipalities undertake rating authority valuations and provide the valuation information to the State government.

The most common method of valuation used in Victoria is the market comparison approach, which seeks to determine the value of a property from transactions of similar comparable properties. Under Section 157 of the *Local Government Act 1989* a Council may use the site value (SV), net annual value (NAV) or capital improved value (CIV) system of valuation, and each of these are provided by the valuer to the council, and recorded in a database for taxation and rating purposes. This valuation information is used by local government to determine rates, the State Revenue Office to assess land tax, and by catchment management authorities for the assessment of drainage and stream improvement levies. Data collected to undertake the valuations include recent sales information, cadastral data, aerial photography, zoning information, and soils maps. Site visits are undertaken where appropriate to clarify the changes that might affect the value – for example, changes to unproductive land on rural properties.

At present the information gathered in the valuation process is held by the local government and not made publicly available. This results in a property market that is less informed than the valuers who are attempting to predict the market value of each property. Mass valuations performed for Victorian local government use the cadastral map-base (Vicmap Property) and the council GIS to generate valuation maps. Maps are produced that show the percentage change in SV or CIV from one rating period to the next, and the ranges of site value per hectare to allow an evaluation of valuation trends and anomalies [Valuer General Victoria, 2002].

A significant theme emerging in natural resource management policy is the desire to provide a value to land resources to ensure they are considered in the valuation of all land [Hamblin 1998, Natural Resources and Environment 1999]. Of particular importance is the need to consider the land condition and the risk of land degradation when applying a value to the land parcel. Over freehold land this will provide a deterrent to poor land management practices, and more comprehensive valuation information over Crown land will alter the economic priorities in the decision-making process. The challenge for land administration in Victoria is to develop policies for the valuation of natural resources, and models to allow this to happen. This could include information on the value of natural resources, and the cost of natural resource degradation and loss of biodiversity. It could also include the valuation of components of a property value – for example, the value of tradeable rights to natural resources connected to the property.

Hamblin [1998] provided a critique on the valuation of land resources. She noted that valuations of land resources tend to be derived from an estimation of the resource's income-generating ability, the market value of the land, or the estimated return that government can derive from the land in revenues and collateral insurance. The value of natural resources is difficult to estimate as there is currently no market for the individual resources, except for water rights for agriculture.

5 LAND USE

Agenda 21 [UN Sustainable Development, 1992] commented that:

“By examining all uses of land in an integrated manner, it makes it possible to minimize conflicts, to make the most efficient trade-offs and to link social and economic development with environmental protection and enhancement, thus helping to achieve the objectives of sustainable development”.

Control over the use of resources on land has emerged as a significant issue in natural resource management in Australia [NRMSAG 1999, Yencken & Wilkinson 2000], and existing land administration systems provide information and infrastructure that may support land use decisions. Of significance is both the way in which land is used and the need to effect changes in land use. Land use on a particular site is a result of the decisions made by individuals to purchase a property and use it in a particular way; and individual market-based decisions made within an implicit and explicit set of public policies. These policies may

include zoning and land use planning requirements, subdivision legislation, building codes, and council by-laws.

Where these implicit and explicit policies exist they establish restrictions on how properties may be used, and often these restrictions are site-specific. It is this set of public policies that, when combined with the restrictions related to land tenure, comprise the mechanisms available to agencies for enforcing changes to land use, and making decisions over changes in land use.

In most countries the State is the biggest landowner and there is a need to manage public land effectively and efficiently. Land management is an important role of government, and land administration systems assist this management by providing current information on land tenure and land valuation. In Victoria, Crown land may be held under lease or license for a variety of purposes including grazing, cultivation, industrial development, plantation, electricity supply, mining and extraction. Control over the use of Crown land is exerted through a mixture of legislation and policy, and specific controls over land use in connection with leases and licenses exist in the legislation. Control needs to be exercised over both private and public land as actions on public land can affect private land and vice-versa.

Existing land use on freehold land varies widely and some control is exercised over changes to land use through the local council's planning schemes, which establish zones and overlays prohibiting certain activities and requiring permits for others. In Victoria, all decisions on land use change must be consistent with the municipal strategies to gain approval under the planning schemes through the issue of a planning permit. It is possible that planning schemes will need to further limit the types of land use allowed or make a greater number of land use types subject to a planning permit. It is significant that the boundaries of land-holdings on the zoning and overlay maps do not always coincide with the cadastral boundaries in Vicmap Property. However the ability of councils to effect significant change through the statutory planning system is tempered by competing interests. The practice of land use planning involves achieving a balance between the environmental, social and economic demands; between the rights of private property owners, the right of local government to set policy, and the right of the community to have input into the policy formed and decisions made. Acknowledgement of the conflicts facing local government is noted in Clause 11 of planning schemes:

“it is the State Government's expectation that planning and responsible authorities will endeavour to integrate the range of policies relevant to the issues to be determined and balance conflicting objectives in favour of net community benefit and sustainable development” [Department of Infrastructure, 2001].

The ability of councils to affect change in land use through the statutory planning system is also limited where a detrimental existing use is established and lawful under the planning scheme. Clause 63 of the planning schemes provides that the existing use must have been stopped for two years before council can enforce the existing planning scheme requirements.

Land use planning processes allow existing and future use to be considered by local government when a proposal for change is made, and therefore site-specific information on existing land use is required. Troy [2000] argued that existing approaches to land use planning do not provide an appropriate estimate that allows decision-makers to forecast the nature and magnitude of changes to land use, or indeed if they are more or less sustainable. He argued that decisions on land use or development proposals are based on economic considerations with the goal being to achieve the 'highest and best use' for a particular site. He suggested a new approach is needed in land use planning which "integrates the concerns of the scientist/ecologist and the measures they can provide of the environmental effects of exploitation of resources with those of the town planner who can introduce the social, economic and aesthetic considerations". The right of government to develop and enforce policy for the public good may require better information on existing land use.

6 LAND ADMINISTRATION INFORMATION

In order to improve land management practices land users require reliable and current information [MacLauchlan & McLaughlin, 1998]. Predictive modelling techniques using computer databases have been developed to assess scenarios at various scales in the landscape and decide the most sustainable practice. Decision-support systems exist that allow land managers to identify the impacts of specific land management practices on the natural resource systems (for example the water table) and predict the financial returns from these practices. These systems also allow integrated modelling at the catchment scale [NRMSAG, 1999, p25]. For predictive modelling and decision-support techniques to be effective they must be based on accurate and current data provided at the appropriate scale.

Auditor-General Victoria, in their 2002 report on public sector agencies found that the completeness of property and attribute details maintained within Vicmap Property were of varying quality, and were not sufficient to meet the needs of all users. A significant issue is the inaccuracy of coordinates and attributes for crown parcels. These limitations are not unique to Victoria and they represent issues that need to be resolved to gain the full benefits of the land tenure datasets to natural resource management.

Local government decision-making in relation to land use in Victoria is hampered by poor access to natural resource information. Many of the rural council planning departments do not have the number of experienced staff required to make informed decisions on the sustainability of land use and they rely on information from other sources to support the decisions made. Improved data information sharing arrangements are needed between state government, catchment management authorities and local government [Municipal Association of Victoria, 2002].

Information on the site value of a land holding is readily available. Information on the value of each of the rights associated with property ownership are less clear. More information is needed on the economic and social value society places on natural resources and the cost of environmental degradation. Banko and Mansberger [2001] called for the social and ecological value to be derived for each parcel, and it is in this area that significant opportunities exist. Information on the economic, environmental and social value of the

natural resources on each parcel of land would allow an informed assessment of the impact of changes to land management practices.

Van der Molen and Osterberg [1999] predicted that advances in technology and spatial data infrastructures will continue and allow greater amounts of information to become accessible at a lower cost. They argued that legislation will become more streamlined to provide a more open information environment, the government will continue to guarantee data but the provision may be by the private sector, information will be based on cost-recovery methods, and that the provision of information about land will become an infinitely more important income source for government. Ting and Williamson [1999] noted that there has been widespread recognition of the importance of new technologies to sustainable development, and that these advances have caused major changes in the development of land administration systems. Advances in technology such as improved database capacity, intranet and Internet development, improved microprocessor capacity, and increasingly sophisticated software have provided the opportunity for improvements in the function of land administration [van der Molen and Osterberg, 1999]. Indeed, Ting and Williamson [1999] argued that these advances have dictated the changes in land administration systems. Improvements to spatial data infrastructures need to be based on an analysis of how natural resource management decisions are made to gain significant benefit.

Williamson [2001b] called for a national land administration vision for all countries to provide a clear road map. In Australia, a single national cadastre is technically possible, however a major obstacle is the federal Constitution, as responsibilities for land administration and management reside with the State governments. Lyons et al [2001] noted the Law Council of Australia were pursuing uniformity of property laws across Australia, and that the Property Council of Australia had estimated that uniformity in property laws would save Australia \$1.8 billion per year. This is an international issue with van der Molen and Osterberg [1999] forecasting that European countries will set minimum standards for land administration “as a first step towards harmonisation”.

7 CONCLUSION

Literature on land administration trends suggests it will have a role in sustainable development. Williamson [2001b] stated that the interaction of human societies with land results in “many economic, social, political and environmental concerns”. He further contended that the “dialogue between these competing and overlapping concerns requires a land administration system that is able to support the ever changing relationship between humankind and land, to facilitate complex decision making and to support the implementation of those decisions”.

The role of land administration is not clearly identified in major environmental or natural resource management strategies. In fact, ‘Our Common Future’ [WCED, 1987] noted that ecological interactions and processes are rarely constrained by the boundaries of land parcels or political jurisdictions. It is clear that changes to the practice of land administration are needed, and this is noted by Williamson [2001b], who argued that a new land administration paradigm is necessary to adapt to the needs of sustainable development.

must be asked is whether the land administration system is the most appropriate system to develop to improve the information available to natural resource managers? Williamson [2001a] argued that it is the only option for the integrated provision of information about land and its resources. He added that if the land administration system is not developed in support of sustainable development, various departments and agencies would seek their own solution in isolation and develop “silos” of information.

Although sustainable development has been cited as a key objective of land administration [Dale and McLaughlin 1999, UNECE 1996], it appears that in practice a key driver has been the push for economic rationalisation. Newnham et al [2001] outlined the recent land administration reforms in Victoria. While the economic benefits are clear, advances in achieving sustainable development due to these reforms are not so obvious. In addition, the move to a single land administration agency reduces the layers of public accountability and may indeed have a negative impact on sustainable development.

Land administration systems are suited to the provision of parcel-based information, which is useful to natural resource management decision-making at the land-holding and local levels. As the cadastral mapbase provides a framework for all parcel-based datasets, it must be complete, current and accurate.

Information on ecosystems and the impacts of human activity needs to be site-specific, and this provides the opportunity for merging the land administration information with information on natural resources and land management practices. Land administration doesn't provide information on the state of the natural resource base, how the catchments or ecosystems function, the extent of natural resource degradation and loss of biodiversity, and the environmental impacts of land use. Land administration information must be supplemented by these datasets if it is to support large-scale changes to land use and land management practices. In addition, information on the social, environmental and economic value of natural resources, and the cost of land degradation and loss of biodiversity must be understood and readily available if the full consequences of land use change are to be understood.

The land use planning system is not geared for extensive natural resource decision-making. The land use planning process involves deciding if applications for changes to land use or development are consistent with suitable land use broadly classified in the planning scheme. These land use classifications do not adequately specify the complexity of land use and land management practices that may be undertaken on a land holding. Changes to the process of land use planning are needed for it to be effective in ensuring unsuitable land use practices are prevented. Existing land use planning approaches don't involve modelling of land use change and this would be of significant benefit to improving land use decisions. Information on the effectiveness of land use change would be assisted by knowledge of the amount of change over time. There is a need to integrate information on the effects of human activity on the natural resource base with information on land use and land use change. Integration of these datasets will require cooperative efforts in Victoria between the Department of Sustainability and Environment, catchment management authorities and local government.

Natural resource management could benefit from the following changes to land administration:

- Making cadastral data complete, accurate and current, and including information on all tenures, rights over resources, and partial rights and interests in land. Land tenure information should include information on the heights and depths of rights over land and resources.
- Making the boundaries of the land use planning datasets (ie zoning and overlay datasets) consistent with the boundaries in the cadastral mapbase.
- Improving the information available to land use planning agencies on the condition of natural resources, areas subject to natural resource degradation and loss of biodiversity, and the effect of changes to land use.
- Developing greater consistency between the land use classifications used for land use mapping, land use planning, and property valuation.
- Amending existing property valuation processes to include a requirement to provide the value of the natural resource on a land-holding, the value of any tradeable rights over those resources, and the change in value due to natural resource degradation.
- Continued improvement to spatial data infrastructures to provide more comprehensive data and information, and access to this information for all stakeholders.

While these recommendations apply specifically to land administration in Victoria, many of the issues raised reflect those experienced in other jurisdictions and the recommendations are readily applicable internationally. The improvements mentioned above would be of benefit to natural resource management by providing clearer property rights, improving the land use planning systems ability to control land use change, acknowledging the value of natural resources in the market value of a property, and providing a comprehensive information base to underpin decision-making. Perhaps the area in which land administration could be of greatest benefit to natural resource management is in the efficient integration of information on land use, land tenure, land valuation with natural resource management at the parcel level.

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David Mitchell has been a lecturer at the Department of Geospatial Science for 6 years and is currently undertaking a PhD on the interface between land administration and natural resource management. He is a member of the federal Technical Advisory Group on Land Use Mapping.

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