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GIS in land administration

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The efficient and effective administration of land and its associated resources depends upon the availability of good land information. Many countries are computerising their cadastral records and creating large, national databases. Land-related data are now being integrated, analysed, and distributed in ways that until recently were not possible. This chapter looks at issues relating to the exploitation of such datasets and cites examples of successful and developing land information systems. It highlights the institutional, organisational, and business problems that must be addressed if such data are to be fully exploited by governments and private organisations.

1 INTRODUCTION – DEFINITION AND FUNCTIONS OF LAND ADMINISTRATION

This chapter deals with the role of GIS in the administration of land and land resources. Land is both a physical commodity and an abstract concept in that the rights to own or use it are as much a part of the land as the objects rooted in its soil (Dale 1991; Dale and McLaughlin 1988). From a legal perspective, land extends from the centre of the Earth to the infinite in the sky. In this chapter the focus will be on managing information about the surface of the Earth, and as such complements the discussion of the creation and maintenance of framework data elsewhere in this book (Smith and Rhind, Chapter 47). It includes all natural and cultural objects that are attached to the Earth's surface (such as buildings and vegetation), rocks and minerals just below the surface, and areas covered by water (such as the seas and lakes).

The term 'land administration' (UN ECE 1996) as used here is based on a definition adopted by the United Nations Economic Commission for Europe (UN ECE). It refers to the processes of recording and disseminating information about the ownership, value, and use of land and its associated resources. It includes the determination (sometimes known as the adjudication) of rights and other attributes of the land, the survey and description of these, their detailed documentation, and the provision of relevant information in support of land markets. Land administration is part of the overall process of land management and the major components are described in Figure 1.

Land registration is the process of recording, and in some countries guaranteeing, information about the ownership of land either through the storage of contract documents about the land (deeds registration) or by compiling special inventories of land ownership (title registration). The function of land registration is to provide a safe and certain foundation for the acquisition, enjoyment, and disposal of rights in land (Larsson 1991).

A cadastre is similar to a land register in that it contains a set of records about land. A cadastre is an information system consisting of two parts, a series of maps or plans showing the size and location of all land parcels, together with text records that describe the attributes of the land. It may be based on the proprietary land parcel (the juridical cadastre), that is the area defined by ownership; or on the taxable area of land (the fiscal cadastre); or the extent of particular activities on the land (the land use cadastre) (FIG 1995a; Williamson 1996). The type of boundaries recorded on cadastral maps will depend on the definition of the cadastre.

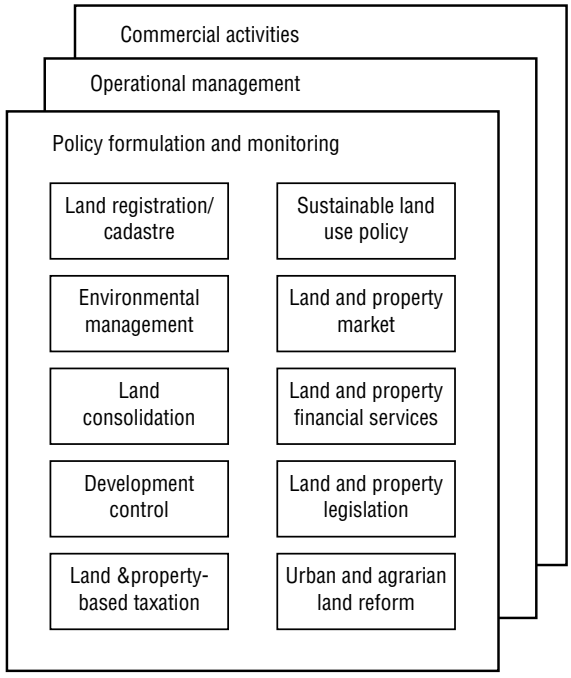

Fig 1. Components of land administration.

A cadastre is distinguished from a land registration system in that the latter has been exclusively concerned with ownership. A land register must operate within a strict legal framework and may not, in practice, cover a whole country since not all citizens may choose to register their lands. The cadastre, however, should be based on complete coverage of a country since it may be used for the purposes of land taxation.

Where the information within a cadastre is based on the proprietary unit, but encompasses both fiscal and land use data, the term multipurpose cadastre is often used. Once computerised, all forms of the cadastre are land information systems (LIS), a term that is applied to systems that manage a wide range of spatial information including environmental and socioeconomic data as well as data related to utility infrastructure systems. A land information system is not necessarily land parcel based and may be restricted in its thematic content and in the extent of area covered.

The introduction of, and adherence to, spatial referencing standards facilitates the integration of otherwise independent LIS. At the country level, the collective term for a number of integrated LIS is a national land information system (or service) (NLIS) providing on-line access to a comprehensive set of land and property information. This is recognised as a fundamental tool in the support of effective land administration.

2 ROLE OF GIS IN LAND ADMINISTRATION

In a number of countries, the separate functions of land administration are being drawn together through the creation of digital cadastral databases (DCDBs). Data conversion has been a relatively slow and expensive process and priority has been given to the computerisation of alphanumeric rather than graphic data. This priority has been set partly because it has been technically easier to convert and handle text data and partly because there is a greater demand by users for text data. Several countries – such as Sweden (CBRED 1995), Austria (BEV 1991), and Great Britain (HM Land Registry 1994) – now provide on-line access to a variety of land-related data. The situation in eastern Europe is slightly different. For example in Hungary (Niklasz et al 1996) the land office records are currently being computerised, but the telecommunications infrastructure is not yet sufficiently developed to provide widespread on-line access to the public. The case histories shown in Table 1 and described later in section 5 provide summaries of six selected land administration projects (in Austria, Hungary, Sweden, the UK, the USA, and Australia) in terms of their scope, organisational structure, outputs, and technical and business contexts.

The linkage of datasets held by different agencies is relatively easy providing that there are systems for defining and referencing parcels. The types of data that may be linked together include:

- data for defining land ownership and supporting land transfer, mortgaging, and investment;
- data for assessing the value of land and property (for example, for taxation or calculating land acquisition compensation);
- data for land market support and analysis, and for identifying trends in rents and prices and their relation to location;
- data for the planning and management of utilities such as water, sewerage, electricity, telecommunications, and cable television;

- data for the management of soils, agriculture, and forestry;
- data on existing forms of land-use;
- data that can support environmental impact assessment.

Traditionally there has been little or no analysis of data held within cadastral and land registration systems. The advent of computerised databases and GIS technology provides an opportunity to develop a greater understanding of how land markets work and how land may be more efficiently and effectively managed. Improvements in land information management depend, however, more upon institutional than technical issues.

3 LAND INFORMATION MANAGEMENT – THE ISSUES

In many countries, improvements to the existing land administration systems are being driven by developments in technology. Land and property datasets grow ever larger as populations expand and the need for land information in support of development becomes ever more urgent. In order to provide both administrators and data users with accurate and up-to-date information about the land, more rapid and efficient systems must be developed for data collection, update, and distribution. Improved surveying techniques, database management systems, standards to support data integration, and telecommunications will help to solve many of these problems.

Up until now, GIS technology has been too sophisticated, has required specialist users, and has been difficult to integrate into mainstream information technology. This has restricted its widespread adoption by those involved in land administration. As GIS and associated technologies mature and more data become available in computer form, the use of GIS for integrating land-related data becomes more opportune. Increased openness and integration of data are, however, more than technical issues and are often seen as a threat rather than as an opportunity.

The effective implementation of any system of land administration requires the cooperation of a diverse number of government agencies and private sector organisations. Land administration is often viewed as a central government responsibility. As a consequence, involvement of local government or the private sector may be seen as unacceptable since quality control becomes more complex. Furthermore the adoption of common standards – for instance agreement by all agencies to use the same unique property reference number – may necessitate changes in internal procedures that are expensive to implement and of no direct benefit to the work of the individual agency (FIG 1995b). Additionally, cultural or legal objections may prevent the release of datasets. A land registry may be willing to release the name of the owner of a plot of land but not the names of all plots of land held by one owner. A tax office may be forbidden by law from releasing certain property values which may be of a personal nature. A military agency may restrict access to surveying and mapping data, for instance to aerial photographs or even basic topographic maps.

3.1 Key institutional constraints

Some difficulties in integrating data amongst agencies arise from traditional attitudes and a concern to protect jobs. The creation of wide area land information networks often raises more substantive issues. Although none of these issues is unique to the use of GIS in land administration, agreed procedures must be established in each area if the implementation is to be successful. These major constraints are outlined in this subsection prior to discussion in an applications context. Institutional policies are covered in more detail by Rhind (Chapter 56) and the other contributors to the Management Part of the book.

3.1.1 Legal liability

Data held within a land registry or cadastral office are often guaranteed by the State whereas other sources of data hold no liability. What guarantees can be given for the quality of data that have been processed and analysed in a GIS? This topic is discussed in detail by Onsrud (Chapter 46).

3.1.2 Copyright

Copyright is designed to protect data owners. Uncertainty over copyright or lack of agreement over the collection and distribution of royalties can inhibit the use of land information. More openness to information is often perceived as a threat to copyright (Onsrud, Chapter 46; Rhind, Chapter 56).

3.1.3 Data ownership

Where different agencies, both government and private, pool their data, questions of ownership and the control of these data may arise. Who owns the added value derived from data integration? (See Elshaw Thrall and Thrall, Chapter 23; Rhind, Chapter 56.)

3.1.4 Data protection

In many political systems citizens have rights to privacy, hence the use of data for purposes other than that for which they were collected may be constrained. Access to land-related data may be politically or socially sensitive and may need to be controlled by appropriate legislation (Curry, Chapter 55).

3.1.5 Data quality

While the raw text data for land administration should be fit for purpose, old survey data may be less accurate either because technology has improved or because boundaries have legitimately changed since the original survey. Surveys of adjoining properties must match along the common boundaries even if they are undertaken at different times (Smith and Rhind, Chapter 47).

3.1.6 Adoption of standards

Data sharing is synonymous with the adoption of common standards, but agencies may be reluctant to change their own well-tried and tested procedures or to delay implementation until legacy systems can be replaced (see Salgé, Chapter 50).

3.1.7 Data pricing

Procedures for the pricing of products and services and for sharing the costs and benefits of data integration must be consistent amongst agencies. Prices should bring benefits to the data producers without discouraging the use of their data. Too often prices are influenced by the cost recovery levels for a specific agency rather than wider economic benefits (Rhind, Chapter 56).

3.1.8 Financial justification

A business case needs to be made for the investment especially when the land administration system is market driven or outsources some of the operational components (see Obermeyer, Chapter 42).

3.2 Organisational issues

In most countries, approaches to land administration have been fragmented, with different agencies responsible for each activity (Smith and Rhind, Chapter 47). In many European countries there has been a separation between the fiscal cadastre, which has been a responsibility of the Minister of Finance, and the land ownership registration system, which has been part of the portfolio of the Minister of Justice. In countries of the former Soviet Union the land use cadastre often came under the ministry with responsibility for construction and development. In the USA the private sector title insurance companies have had a key role to play in guaranteeing ownership rights while in Australia the private sector has been involved in cadastral surveying, but not title registration.

Since the early 1990s several countries have introduced institutional reforms to rationalise the legacy of a fragmented land administration sector. The reforms vary from fine tuning to radical surgery and are being introduced for the following reasons:

- The business processes are being re-engineered to produce downsizing of organisations and associated efficiencies.
- Government organisations are being encouraged to increase their levels of cost recovery. Land and property information is a very marketable commodity and organisations are turning to the sale of land information and associated value added products to increase their revenue streams.
- Governments are now encouraging the involvement of the private sector in traditional, public sector, land administration activities. Organisations are being forced to define core business activities and to outsource the remaining commercially attractive activities to the private sector. This hybrid approach is perceived to support the market more effectively by facilitating the route to market, improving the provision of services and accelerating the growth of the market.
- The maturing of GIS, database management systems (DBMS), and wide area network (WAN) technologies facilitates the creation of new institutional structures not previously possible and supports integrated management of land and property information (Coleman, Chapter 22; Shiffer, Chapter 52).
- Many governments now publicise ‘open government’ policies and legislate for ‘freedom of information’. The associated institutional reforms and wider and more open access to government-held information support these government initiatives.

The majority of countries are still locked into fragmented institutional structures to support land administration, primarily because of the intransigence of long established government structures. However, the opportunities associated with implementing NLIS are encouraging governments to look afresh at the institutional structures and, in some cases, to start the transition towards radical reforms. For example, a more holistic approach to land information management was introduced in 1996 in both Sweden and New Zealand. In Sweden, the Parliament approved the amalgamation and rationalisation of two major government organisations: the Central Board for Real Estate Data (CFD), responsible for real estate registration and NLIS management and provision; and the National Land Survey (NLS), the national mapping agency. Figures 2 and 3 illustrate how the organisational structure has been modified in Sweden.

In Sweden, the former CFD has been retained within the core business. However, the new structure includes the formation of a new section, 'Metria', within the National Land Survey organisation, responsible for commercial map publishing and land survey activities. This is the first stage in clearly distinguishing between core business and commercially attractive products/value added services that could be supported and provided by the private sector. The next section of the chapter explores this relationship between the public and private sectors and their roles in providing an NLIS.

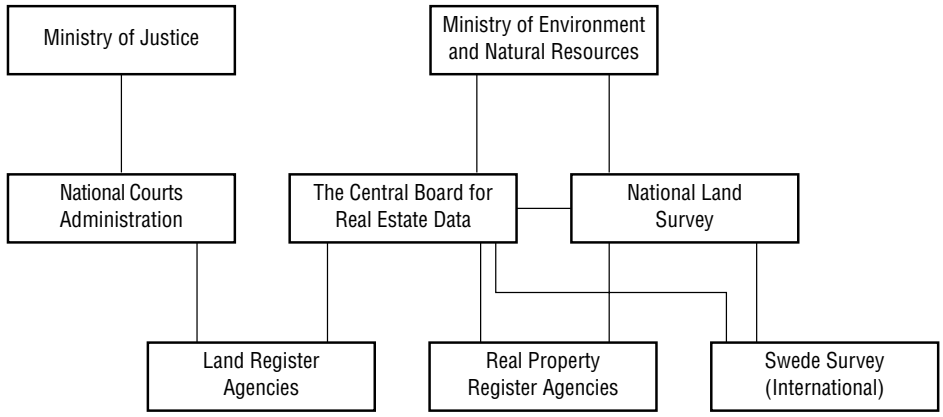

Fig 2. Swedish land administration public sector structure pre-1996 (CBRED 1995).

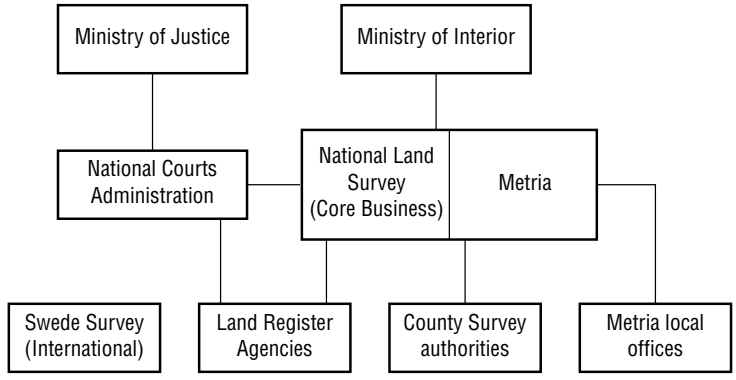

Fig 3. Swedish land administration public sector structure post-1996.

3.3 Business modelling

The creation of an NLIS provides opportunities for stakeholders to increase their data and service provision within their traditional domain. Additionally, the integration of a wide diversity of information through new business partnerships creates new channels to expand into new market sectors.

In order to take full advantage of these opportunities, a strategy for partnership between the public and private sectors needs to be created. The approach being adopted to license these partnership arrangements is varied and is dependent upon: the political culture and associated policies; the scope and complexity of the services; the number of stakeholders; the perceived need to regulate access to, and usage of, information; the level of public sector funding available; 'open information' policies; and the legacy of initial public service ('common good') orientated initiatives. Three main business models have been adopted: centralist; non-interventionist; and facilitating/enabling by limited intervention (see also Rhind, Chapter 56). They vary in the extent of public sector intervention and control.

3.3.1 Centralist model

The majority of existing NLIS have evolved using this model where all activities associated with delivery of the NLIS are under public control. This is the case in Sweden and Austria, for example. These NLIS are typically public information services and provide an efficient route to market for traditional users of public domain information. There are normally no value added resellers of the information to provide innovative products and services beyond the traditional market sector. However, despite constituting a monopoly, this model can provide efficient solutions to a wide user community. A good example is Sweden where the Land Data Bank System (LDBS) now has 22 000 terminals connected to the network for information retrieval by public agencies, municipalities, financial services, real estate agents, and utilities. This generates a staggering 200 000 enquiries per day (Sweden's population is fewer than nine million people) and produced annual revenues in 1996 in excess of US$180 million.

3.3.2 Non-interventionist model

Another approach to the creation and expansion of NLIS products and services is to leave the activities entirely to market forces. This is the case in the USA where the 'Freedom of Information' legislation entitles taxpayers to access some federal information at the cost of media delivery. Since taxpayers have paid for the information generation once, in direct support of government activities, they are then entitled to minimal cost access to the information (see Rhind, Chapter 56). This policy allows the associated benefits to be spread through the national economy by increased commercial activities, rather than being directly generated through narrow, government agency cost recovery projects.

NLIS developed under this business model are typically not as holistic and integrated as those based on the centralist approach, but the burden on the taxpayer is less since the NLIS are mostly financed by the private sector and the resulting products and services are fully market driven. The monopoly of the centralist model is avoided and competition is generated at all levels in the route to market.

3.3.3 Facilitating/enabling model (by limited intervention)

This compromise model avoids the extremes of the previous two models and provides a framework to encourage partnerships between the public and private sectors to generate NLIS opportunities. The degree of intervention by the public sector varies: in the UK the model planned entails a low degree of intervention. In this approach the public sector's role is to facilitate generic development of standards for public and private sector data suppliers, to simplify the route to market, and to resolve access and data protection issues. This low intervention model encourages both the private and public sectors to generate competing information services.

An example of the higher end of the intervention model is the approach being adopted by the Dutch National Cadastre. Instead of leaving the private sector to identify opportunities independently and create information services, the Dutch National Cadastre has formed a private company, KADATA, to invest directly in other private sector companies involved in providing information services. The associated organisational structure of the Dutch National Cadastre and its relationship with the private sector is illustrated in Figure 4. This approach clearly orchestrates the route to market, ensuring that maximum use of the Dutch National Cadastre's information assets is made, encouraging market opportunities and shortening the timescale for the generation of the value added products and services.

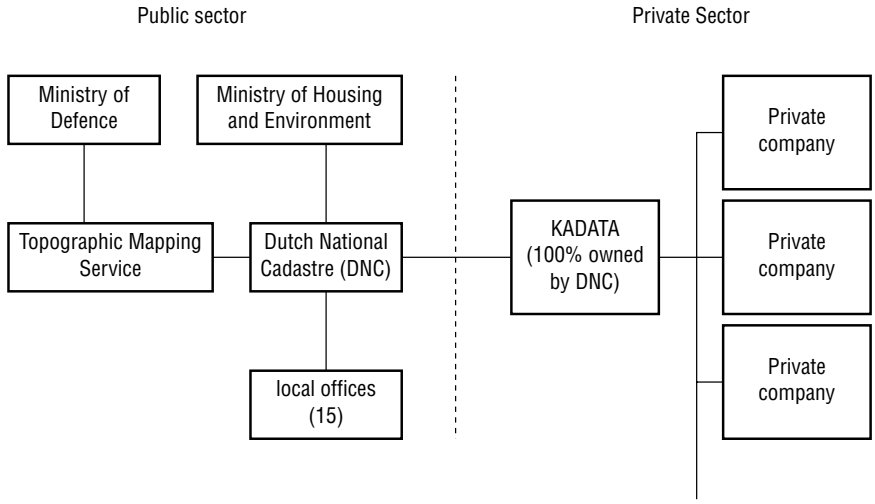

Fig 4. Dutch National Cadastre organisational structure (1996).

4 TECHNOLOGY SUPPORTING GIS IN LAND ADMINISTRATION

The majority of mature NLIS projects have initially concentrated on the provision of textual information services to support land registration and property transaction activities. These information services were developed during the 1980s when network bandwidth was at a premium and GIS technology for converting and managing national databases of cadastral index maps was largely unproven. An example of this form of implementation is found in Sweden where a hierarchical DBMS on a centralised mainframe server provides information services over the Public Standard Telephone Network (PSTN) to alphanumeric client terminals. These text-only NLIS solutions have only been feasible in countries supporting a parcel-based cadastre with formal parcel referencing systems, negating the need for a reference map and GIS technology. They are clearly limited in their mapping capabilities.

The advance of GIS technology to support very large spatial DBMS, the availability of digital map data through national map conversion projects (for example, the UK completed digital mapping coverage at basic scales in 1995 and Sweden will convert all the cadastral index maps by 2001: see Rhind, Chapter 56), pressure from value added resellers (VARs) to support map-based services, and the proliferation of higher network bandwidth, have all promoted the provision of map-based NLIS solutions. For example, Austria has implemented a 'Videotex'-based solution for on-line access to cadastral index maps. A Videotex solution is one which displays user-selected pages of text on a conventional television screen. In contrast, the UK plans to provide an 'on demand' digital map component for its NLIS project.

The latest generation of NLIS are providing wider access to geographical information through the adoption of Internet/Intranet solutions. This is the case in Hungary where a frame relay-based WAN has been implemented to support access to land registration and cadastral mapping data by key customers, such as notaries. The advantage of this technology is that customers can access the information using standard Internet browsers.

NLIS provide ease of access through the transparent integration of a diverse set of discrete datasets, many of them authoritative. Successful NLIS require common spatial referencing standards and appropriate GIS technology to support spatial data servers, federated DBMS, temporal management, high security, charging mechanisms, efficient WAN technology, and effective client customisation tools. These technical issues are explored in detail in other chapters in this volume (see Batty, Chapter 21; Coleman, Chapter 22; Sondheim et al, Chapter 24).

5 CASE HISTORIES

Since the late 1960s, many countries have pursued the vision of NLIS, as a result of which several relatively mature systems are now in operation around the world. The sources of these NLIS initiatives and the priorities for the products and services to be supported vary widely, reflecting the institutional, economic, and political circumstances of the countries involved. To compare the evolution of these NLIS and to highlight the lessons learned, six case studies from Austria (BEV 1991), Australia (Hesse and Williamson 1990), Hungary (Niklasz et al 1996), the UK, the USA (Steel 1996), and Sweden (CBRED 1995) have been detailed in Tables 1(a) and (b). These case studies vary in maturity, objectives, commercialism, economic context, and success.

5.1 Key issues and trends in NLIS implementation

NLIS have traditionally been financed and implemented solely by the public sector as a means of providing wider access to government information and improving the quality of service to the public. This is the situation in Sweden where the investment in NLIS is primarily designed for the 'common good'. Increasingly, partnerships between the public and private sectors are playing an important role in accelerating the implementation and scope of the NLIS. In Australia and the UK, the private sector is providing financial, technical, and marketing leverage to the projects. This leads to more efficient service delivery and through a wider range of value added services, increases the revenues obtainable.

Many of the more mature NLIS were initially funded to support the collection of a property-based tax; a fiscal cadastre. However, the corresponding information services are increasingly being used in the areas of collateral risk analysis, conveyancing, environmental assessment, and geomarketing.

The earliest NLIS (e.g. Sweden), are text-only information systems, with no integrated support of digital cadastral mapping; just centroids of parcels. This approach has been feasible because of the existence of formal parcel referencing systems and was used because of the lack of other digital mapping data and the restrictions on available telecommunication bandwidth. These restrictions are now being removed and the emerging generation of NLIS are supporting integrated text and spatial information. Austria was one of the first to provide remote access to cadastral map data through videotext facilities and a core aspect of the UK NLIS will be support for spatial information by default. Several new solutions, such as the Realtors Information Network (RIN) in the USA, are using the Internet to provide information services. These Internet-based services will support multimedia and virtual reality facilities.

The ultimate success of NLIS is dependent upon the level of integration achieved among the wide variety of land- and property-related datasets. Some current NLIS have a limited level of integration, because of the lack of a coherent approach to information management in general and land in particular. This is further compounded by missing or inconsistent standards for spatial referencing (parcel-, postal-, and administrative area-based referencing systems are all common). These deficiencies have led NLIS to be narrowly focused, limiting their market value. It is only through the adoption of national and regional spatial referencing standards, such as the national BS7666 referencing standard in the UK, that the necessary level of integration will be achieved to support comprehensive NLIS.

The creation of national coverage of the fundamental datasets required to support NLIS is a long term, major investment. In Sweden, national coverage was achieved over a 20-year period at a cost of US$15 per property. In Hungary, the land registration information for over eight million properties, contained within the property sheets, was converted in seven years at a cost of US$5 per property. Figure 5 is an example map from the Hungarian digital cadastre. Experiences from the more mature NLIS, for example Sweden, indicate that the operation and maintenance of NLIS can be fully supported through cost recovery and can be commercially very successful once a critical mass of land and property data has been created. This leads to a large customer base attracted by a wide range of value added products and services.

6 THE VISION

To date, two approaches have been adopted when harnessing computers to the needs of land administration. The first is to use PC technology to improve the management of some of the processes,

Table 1(a) Summary of three case studies of land administration projects.

	Austria *Database of real estates*	*Hungary* *National Land Registration System*	*Sweden* *Land Data Bank System (LDBS)*
Introduction			
Source of initiative:	– Ministry of Justice/Ministry of Economic Affairs	– Ministry of Agriculture (MoA)	– Ministry of Housing
Political profile:	– medium	– MoA medium/modernisation programme; high	– High; Parliamentary involvement
Initial objective/focus/ applications:	– create computerised integrated data bank for land registration and cadastral/surveying sectors – inclusion of daily land registration update information – enable public electronic access from any location	– improve efficiency of land registration and support land restitution programme including land compensation (5.6 out of 9.3 million hectares involved in privatisation) – support increased transaction demand associated with transition to market economy	– support ease of transfer and mortgage of real estate – reduce manpower and improve quality of existing registers – facilitate access to national information for a broad range of land management activities
Funding:	– Austrian public resources	– predominantly by European Union with substantial counterpart funding	– Swedish public resources
Maturity/timeframes:	– approximately 20 years from concept and design	– modernisation initiated 1989 and expected to take 20 years to complete	– approximately 25 years from concept and design
Institutional/Organisational			
Lead agency:	– shared responsibility between main organisations	– MoA has unified authority (since 1971) for registration and cadastral activities for both rural and urban areas	– the Central Board for Real Estate Data (CFD) was originally formed to manage and coordinate the LDBS project. The CFD was amalgamated with the National Land Survey (NLS) in 1996
Main organisations involved:	– Ministry of Justice/Land Register Department – Ministry of Economic Affairs/ Federal Office of Metrology and Surveying and Department of Electronic Data Processing	– MoA/Department of Lands and Mapping – Ministry of Justice and local notaries	– Ministry of Justice/National Courts Administration – Ministry of Interior/NLS – Metria/NLS (commercial mapping/ surveying activities and services)
Policy formation:	– not known	– no intergovernmental body below cabinet level to guide policy	– not known
New legislation required:	– yes	– yes – substantial new sets of legislation to support land restitution and modernisation programme	– yes, including new Land Code to simplify transfer of real estate and legislation to support the digital registers as definitive
Extent of collaboration:	– central government (legal requirement for two separate registration and cadastral systems to correspond – therefore obliged to reciprocate information) – Ministry of Economic Affairs provides the service while the Ministry of Finance provides the network	– central government, local government, and utilities	– central government, local government, and private sector organisations involved. These partnerships have been key to success
Centralisation/ decentralisation:	– all data managed centrally within Ministry for Economic Affairs – updating from decentralised local land registry offices (four regional courts/187 local courts) and 68 local cadastral offices which are networked	– highly decentralised system with one Capital Office, 19 County Offices, and 116 District Land Offices. 4300 personnel	– one central database fed from 60 local survey authorities and 93 local land register offices with additional links to other systems
Public/private relationship:	– private sector involvement through notaries and licensed surveyors providing updated information	– private sector provides surveying services	– service provided entirely by public sector, but some development financed by the financial services sector

Table 1(a) Summary of three case studies of land administration projects (continued).

	Austria *Database of real estates*	*Hungary* *National Land Registration System*	*Sweden* *Land Data Bank System (LDBS)*
Project Overview			
Implementation approach milestones:	– concept and design 1974–1978, prototype 1978 – systematic and compulsory implementation – computerisation of cadastral text 1979–1985 – computerisation of land register text 1981–1991 – computerisation of cadastral index map started 1991 with completion planned for 2000	– phased implementation at District Offices then County Offices – computerisation begun in 1990 – national property sheet text data computerised by end of 1997 – on-line Information Services initiated on Wide Area Network (WAN) 1997 – national digital cadastral mapping programme begun in 1996. Completion estimated in 2010 (55000 cadastral maps)	– pilot county operational from 1976 – systematic and compulsory implementation – computerisation of key textual data – 1969–1995 – on-line information service – 1984 – computerisation of cadastral index maps started in 1993 with completion for rural maps scheduled for 1997 and urban maps 2001 – incremental addition/linkage of further registers ongoing
Text and graphics:	– text based with graphics elements being developed	– initially property sheet text has been computerised, followed by computerisation of cadastral mapping	– Property Register, Land Register, Property Tax Information, and Building Register are all text based Digital Cadastral Index Map is under development, but not planned to be integrated with the LDBS information service
Number of parcels/ properties:	– total of 11 million parcels nationwide, with many sub-units, held by two million owners. Defined using 30 million boundary points	– 6.6 million land parcels nationwide plus 1.6 million apartments	– total of 4 million parcels nationwide
Products/Services			
Customers:	– primary – land registry and cadastral/surveying offices, municipalities and other regional authorities – secondary – notaries, lawyers, surveying engineers, credit institutions, estate agents	– Land Offices, government agencies, local government, notaries, utilities, land and property market	– primary – registration and surveying/mapping agencies – secondary – financial services (mortgage), estate agents, valuation offices, local government, planners, natural resource managers
Data available:			
– owner	– yes (updated daily)	– yes	– yes
– value	– not digital	– yes	– yes
– use	– yes (30 categories)	– yes	– yes (based on tax classification)
– unique reference	– yes	– yes (within District)	– yes
– geocode	– yes	– no	– yes
– cadastral map	– yes (approximately 60% coverage in 1996)	– yes (incrementally from 1996)	– partial, Digital Cadastral Index Map under development
– survey detail	– partial	– yes (incrementally from 1996)	– partial
– links/references to other documents	– yes (databases at Ministry of Finance, Ministry of Agriculture, and Austrian Statistics)	– yes (incrementally from 1997)	– yes, e.g. Mortgage Certificate Register
On-line:	– yes, both text and cadastral index map	– due 1997 for text and graphics	– yes (LDBS text only)
Added value services:	– yes (support of digital agrarian maps to support EU CAP subsidies, and integration with soil quality information)	– planned in 1997 following market research	– yes, property valuation, support of estate agents
Demand:	– 38 million transactions per year in 1996	– substantially increasing as land and property market emerges. Demand in 1996 outstripped ability to provide service	– 200000 enquiries per day – average annual increase of 10–20% over past five years
Number of terminals:	– 3000 permanent on-line and 4000 modem connected terminals supporting 10000 users in 1996	– initial 500 subscribers to Information Service planned in 1997	– 22000 terminals nationwide

Table 1(a) Summary of three case studies of land administration projects (continued).

	Austria *Database of real estates*	*Hungary* *National Land Registration System*	*Sweden* *Land Data Bank System (LDBS)*
Technology			
Network:	– WAN 2 mps France Relay network, offices connected with 64–128 kbs bandwidth lines	– Frame Relay (permanent virtual circuits) based WAN planned from 1997 to support Intranet solution	– WAN
Hardware:	– Mainframe server, UNIX server and PC clients	– District Land Offices supported by PC-based LANs	– mainframe
Business Modelling			
Level of investment:	– not available	– computer systems in 116 District Land Offices US$8 million – wide area network linking 150 offices US$1 million – computer systems in 20 County Land Offices US$3.5 million – Property Sheet conversion US$0.5 million (plus counterpart resources) – digital cadastral mapping/conversion >US$300 million	– approximately US$150 million (so far by government)
Revenue:	– 1.2% of registered value of property charged for transaction of ownership – average of US$0.30 charged for each on-line transaction. Annual revenue 1996 = US$10 million – US$10 per texual query in paper – US$1 per texual query in digital form – US$0.20– US$4 per graphical query in digital form	– direct charges set low by Parliament as a service and not commercially for any cost recovery targets. However, other Government departments use data as an essential input to revenue raising activities (duties, local property taxes)	– service is provided for the 'public good' and NLS are not tasked with generating a profit from the LDBS – US$1.5 for a single parcel information transaction
Costs:	– Federal Computing Centre costs US$650 000 per month – work in developing system estimated at a total of 850 person years	– Department of Lands and Mapping Annual budget of US$40 million	– data conversion, database development and maintenance, additional data (e.g. centroid) – US$15 per property or approximately 0.02% of property price – LDBS annual operating costs US$3 million
Savings:	– Land Register 35% staff reduction – cadastre 10% staff reduction over ten years – significant reduction in physical storage space	– modernisation only approach to support quantum leap in number of transactions associated with burgeoning land and property market – manpower eventually when data conversion completed	– staff reductions of 50% achieved in key areas
Cost recovery:	– not available	– cost recovery currently very low (10%), but set to increase as Department of Lands and Mapping achieves Agency status	– yes, independent reports advise that LDBS has recovered investment

Table 1(b) Summary of three case studies of land administration projects.

	UK (England and Wales) *National Land Information Service*	*USA* *Realtors Information Network (RIN)*	*Australia* *New South Wales (NSW)* *Digital Cadastral Database*
Introduction			
Source of initiative:	– Domesday 2000 (initiated in 1991): a private sector organisation, aims to ensure access to data on ownership, value, and use of all land in Great Britain by the year 2000 – incorporated as part of government Citizens Charter Initiative 1992	– the US National Association of Realtors (NAR)	– Land Information Centre of New South Wales (the Centre)
Political profile:	– low	– low: a private sector initiative	– facilitate access to spatial information and to provide increased efficiences/ establishment of Public Enquiry System/avoid costly duplication and incompatibility of datasets
Initial objective/focus/ applications:	– NLIS established in 1992 with aim of facilitating access to land and property records	– the RIN was conceived to counter the threat posed by the proliferation of 'homes for sale' on the Internet – NAR was losing control of the housing market and RIN was developed to retain NAR's key role within the property industry	– fundamental spatial referencing for all land subdivision in NSW supporting land registration, government land administration, and planning – one consistent database used by all levels of government and the private sector
Funding:	– joint funding by central government departments	– RIN was set up as a private company with initial loans from NAR	– NSW State government
Maturity/timeframes:	– initiated 1991	– on-line services initiated on Internet in 1993	– initial capture phase 1988–1994, now in ongoing update and upgrade phase
Institutional/Organisational			
Lead agency:	– NLIS Committee established to test feasibility – chaired by Chief Land Registrar/ Chief Executive of Her Majesty's Land Registry (HMLR) and with representatives of all main organisations involved	– The US NAR	– Land Information Centre of NSW
Main organisations involved	– HMLR/Ministry of Justice/20 regional offices, Ordnance Survey (OS)/ Department of Environment, Valuation Office/Inland Revenue, Department of Environment, Royal Institute of Chartered Surveyors, Domesday 2000, Bristol County Council	– all realtors that are members of NAR	– Land Information Centre – NSW Land Titles Office – Sydney Water Board – Hunter Water Board
Policy formation:	– Citizens Charter Unit in Cabinet Office/ NLIS Committee	– NAR	– Australia New Zealand Land Information Council – Intergovernmental Committee on Surveying and Mapping – Land Information Centre
New legislation required:	– no	– no	– N/A
Extent of collaboration:	– central and local government and professional organisations	– internally within NAR	– state government agencies, local government, and utilities

Table 1(b) Summary of three case studies of land administration projects (continued).

	UK (England and Wales) *National Land Information Service*	*USA* *Realtors Information Network (RIN)*	*Australia* *New South Wales (NSW)* *Digital Cadastral Database*
Centralisation/ decentralisation:	– initial pilot integrates autonomous, centralised information systems	– highly decentralised system with all NAR members contributing real estate information to RIN	– there is one centrally maintained DCDB. There are 150 subset copies licensed to other agencies, local government and various other users
Public/private relationship:	– initially a public information service, but private sector involvement planned in the role of service provider and data providers	– private sector initiative	– private sector companies used for initial data capture phase and property subdivision work
Project Overview			
Implementation approach/ milestones:	– HMLR direct, on-line access 1993 – OS national large-scale digital mapping complete 1995 – NLIS Demonstrator launched 1995 and over 250 demonstrations by end 1996 – phase 1 – analysis and publication of content and format of data held by relevant organisations completed – phase 2 – development of British Standard 7666 Land and Property Gazetteer and creation of pilot dataset completed – phase 3 – development and implementation of Conveyancing Pilot Project in Bristol to be first application implemented using NLIS – operational 1997 – future – expansion by market forces to create a mature multipurpose NLIS	– RIN information services initiated on Internet – GeoData facility provided as GIS front end to RIN to support geographically based enquiries	– capture phase 1988–1994 – managed in over 1800 rectangular map tiles – spatial data integrity enforced by the GIS (horizontal and vertical topology) – aspatial (attributes) data integrity checked at GIS front end and enforced by the RDBMS – updates included within 5 days of plan registration
Text and graphics:	– both combined in information service	– GeoData provides map-based front end and spatial analysis tool to RIN – text and images provided to describe real estate	– spatial and aspatial datasets available – spatial relative accuracy range 1:500 – 1:100 0000
Number of parcels/ properties:	– potentially 22 million registerable titles of which approximately 15 million registered in 1996	– in 1996 there were over 164 000 residential properties listed on RIN	– 4.1 million polygons – total storage 6Gb (spatial 4Gb, aspatial 2Gb)
Products/Services			
Customers:	– conveyancing pilot project will initially have solicitors and their clients as customers	– general public interested in buying residential properties	– government agencies (federal and state), local government, utilities, land and property market, mining and engineering companies etc.
Data available: – owner – value – use – unique reference – geocode – cadastral map – survey detail – links/references to other documents	 – yes – no (legislation prevents access) – no – yes – yes – yes (general boundaries) – no – NLIS Demonstrator allows access to land registers, local land charges, planning information, national grid references, information on property type – Conveyancing Pilot Project – variety of additional data providers have expressed interest including British Geological Society, National Rivers Authority, Bristol Water, National Coal Authority, Companies Register	 – yes – yes – residential properties only – yes – no – no, just location map – no – index to related services available	 – yes – indirect – indirect – yes – yes – yes – yes – relational database links

Table 1(b) Summary of three case studies of land administration projects (continued).

	UK (England and Wales) National Land Information Service	*USA Realtors Information Network (RIN)*	*Australia New South Wales (NSW) Digital Cadastral Database*
On-line:	– yes	– yes, through Internet	– data are conveyed on a variety of media over the Land Information Centre's wide area network or by e-mail. In 1997 the Land Information Centre made digital information more readily accessible through use of the Internet and the development of more efficient data distribution systems
Added value services:	– many planned, including estate agent and financial services applications	– state and National Association news and events – NAR membership directory – on-line supermarket for purchasing products for realtors – property adverts, accessible to public on WWW	– the use of the least squares adjustment technique and the collection of survey coordinate data from plans are being assessed as possible methods of upgrading the spatial accuracy of the DCDB
Demand:	– market research indicates high market demand and business case	– >80 000 maps per day over the Internet	– the Land Information Centre is undertaking market research of clients' needs for the DCDB in terms of data supply (frequency, currency, format), need for pre-registered data, electronic lodgement, and clients' use of updates
Number of terminals:	– information service still being planned	– too early to determine	– 220 terminals networked to the central database with numerous additional terminals linked at user copy sites
Technology			
Network:	– WAN planned	– Internet	– network features Ethernet with hubs, routers and switches, UTP and Fibre Optic cabling. Move to 100 Base T planned in 1997 – duplicate copy of dataset in Sydney incrementally updated each night via ISDN WAN for data distribution
Hardware:	– servers mainframe and UNIX based, clients PCs	– spatial Internet server	– the Land Information Centre employs 120 X-terminals, 38 UNIX workstations, 3 file servers, 1 database server and miscellaneous servers for network management etc.
Business modelling			
Level of investment	– the costs will be shared between the public and private sectors	– unknown	– capital investment of US$8.5 million in hardware and software – US$22.5 million to complete the survey network and accelerate the digital capture of the cadastre – US$3 million to enhance the DCDB by creating a spatial version of the Crown Lands Information Database – US$45 million for the Geodetic, Survey, and Photogrammetric control network – significant investment in the source materials from which these databases have been derived, representing an estimated replacement cost of US$150 million

Table 1(b) Summary of three case studies of land administration projects (continued).

	UK (England and Wales) National Land Information Service	*USA Realtors Information Network (RIN)*	*Australia New South Wales (NSW) Digital Cadastral Database*
Revenue:	– charging levels still to be set	– unknown	– 18 months after completion of the capture phase, revenues of approximately US$15 million have been realised
Costs:	– unknown	– unknown	– the Land Information Centre budget is US$16.5 million
Savings:	– unknown	– unknown	– benefits arising from avoided costs have been estimated at US$26 million
Cost recovery:	– service provision will be outsourced to private sector, therefore full cost recovery and profit must be ensured	– unknown	– returns on investment have been indicated in economic appraisals to be: • accelerating capture of the DCDB • accelerating extension of NSW Survey Control Network • accelerating the NSW Primary Spatial Database • acceleration of the DCDB is predicted to provide US$79 million in cost savings and revenue over 20 years (1990 figures)

for instance the storage and retrieval of text records; the second has been a more substantial effort to build large databases. Both of these approaches have been driven by the need to improve internal efficiency. In Sweden the provision of access to data for a wider audience was a priority, but in general the linking of land registration data to other spatial data has not been a motive for computerisation. Commercial pressures on land administrators to recover their costs have now combined with a greater market awareness of the opportunities for adding value to land registry and cadastral data to create pressure for more widely-distributed land information networks. Section 3.1 of this chapter listed a number of issues that will have to be addressed before this is possible. The good stewardship of land and property information is essential for sustainable development since land and property play such a key role in national economies.

Some land market data can be effectively distributed through the Internet – for instance some properties for sale in the USA are advertised through this medium. Efficient and effective land management entails much more than good marketing of properties. The interconnections between land tenure, land values, and land use are complex and in general not well understood. GIS offers an opportunity for greater understanding of the role of land and its attributes in economic and social development.

The creation of data in digital form is necessary, but not sufficient, for effective land administration to occur. Experience to date suggests that it is essential that the legal, political, economic, and social issues also be addressed. Given that any inherent problems can be overcome, significant benefits should ensue. Private citizens seeking to move house will be able to locate properties that meet their needs more easily while conveyancing will be cheaper and more secure. Planners will find it easier to locate suitable places for development and determine the constraints on their use. There will be clearer protection for sites of special scientific interest. Property developers and investors will be more secure in their analysis of sites while banks and other mortgage lending organisations will have more information on land and property values and hence be able to reduce their risks in lending money. Architects and builders will have more certain and detailed information about sites. Governments will be able to tax land and property more equitably and make more informed judgements where there are competing proposals for

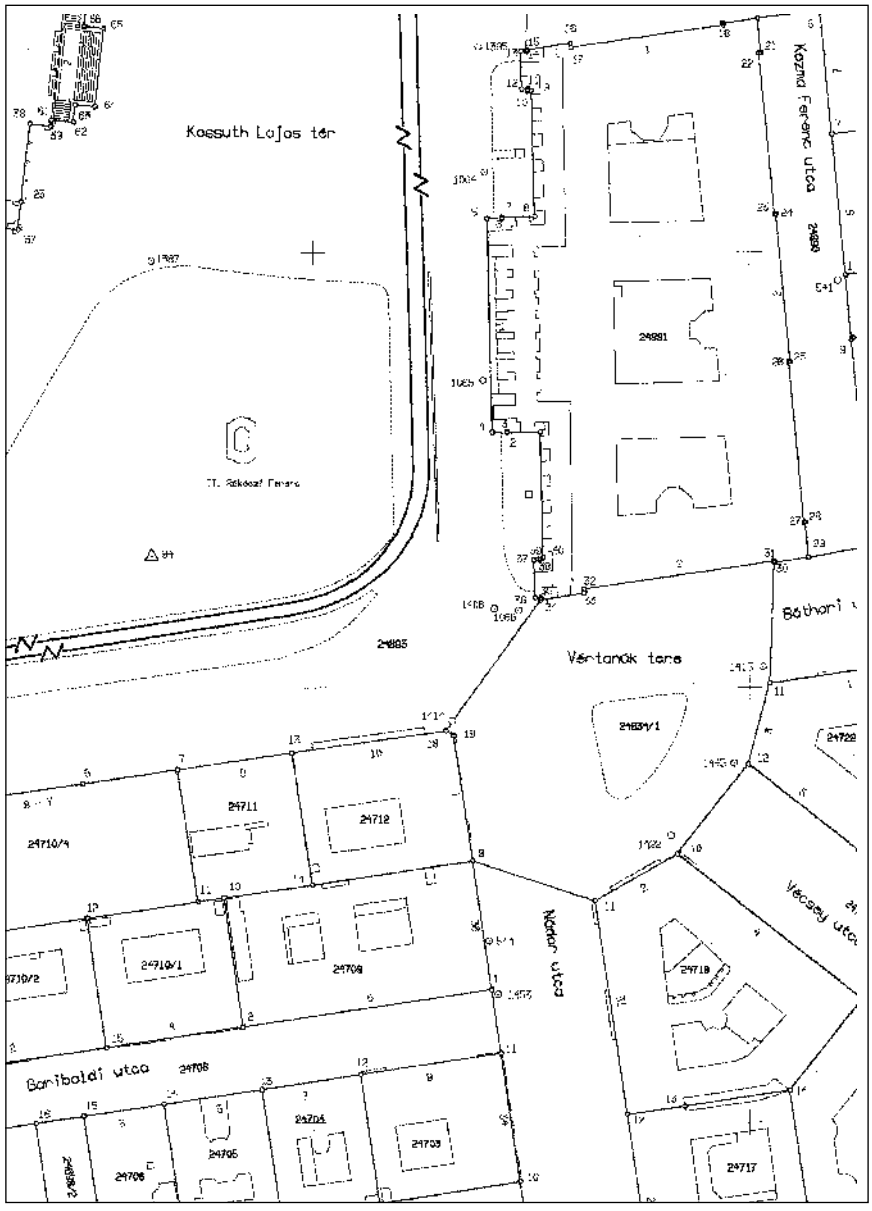

Fig 5. Digital cadastral map extract of central Budapest, Hungary (scale 1:1000)

land use. More than that, an archive will be built up so that future generations will be able to analyse and understand the importance of land to their culture and development.

While all of the above are now possible to a limited extent, computerised land administration systems will significantly enhance the service to the public and to the economy. The UN ECE have suggested that land and property account for over 20 per cent of Gross Domestic Product. Improving the management of land and its associated attributes through improved land information management should produce significant economic benefits both at the national level and also for the individual citizen.

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