Is technology a blessing or a curse in land administration?

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ABSTRACT

This paper looks at the use of technology in the acquisition, storage, processing, and communication of cadastral data. If cadastral systems are to service the broader interests of society and support sustainable development then it will be important to address the core issues of the information society, including the protection of intellectual property rights and the privacy of the individual. Computerisation is not only changing how cadastral systems operate but also how and by whom the data are used. The most significant development will however be in the ways that value is added to the data through new forms of analysis.

Key Words and phrases: *Automation, Cadastral Surveys, Computerisation, Data Analysis, Electronic Commerce, Privacy, Tenure, Use and Value.*

1. Introduction

Anyone who has visited an old Deeds Registry with its piles of paper and bundles of files often tied with pink ribbon will have realised that there must be a better way to record land transfers. Often described as 'mausoleums of parchment', the old deeds registration systems were both inefficient and, from a land management perspective, ineffective. They contained much data but little information. The computerisation of such records is leading to major changes in our understanding of land markets - but only slowly. Furthermore the use of information technology (IT) is creating a number of problems that did not arise in the olden days. This paper reviews some of the issues surrounding the use of IT, from data capture through data storage, retrieval, analysis and display to the general use of land related information.

The most time consuming and expensive task in building a modern land administration system is the collection of new data and the conversion of old records into digital form. In an estimate of the time and cost of the current land reform programmes in east and central Europe where cadastral mapping is being updated, a recent study (ACE, 1998) has suggested that for a medium-sized central European country with a population of 10 million people, an area of 100,000 sq. km. and around 75,000 cadastral maps, there would be:

Activity	Time until completion	High accuracy cadastral mapping	Medium accuracy cadastral mapping
a. Establishing basic technical infrastructure	5 - 10 years	35m.US$	35m.US$
b. Loading / verifying title data	5 - 7 years	25m.US$	25m.US$
c. Loading cadastral mapping (high accuracy)	15 years	1,500m.US$	
d. Cadastral map data conversion (medium accuracy)	7 - 10 years		75m.US$
e. Operational costs at 25 Million US$ per year	10 years	250m.US$	250m.US$
f. Re-investments / renewal / maintenance at 10% per year	10 years	35m.US$	35m.US$
g. Value-added services development	5 - 10 years	25m.US$	25m.US$
h. Total costs for 10 year period in millions of US$:		**US$ 1,870m.**	**US$ 445m.**

Similar costs arise in new land titling programmes. World Bank figures suggest that recent major property formalisation projects have had total estimated costs ranging from US$20 million to more than US$250 million with loans ranging from US$2 million (to support feasibility studies) up to approximately US$100 million (Dale & McLaughlin, 1999). In general these costs have covered:

1. institution strengthening: 10 - 15%
2. mapping: 20 - 25%
3. adjudication and surveying: 30 - 50%
4. registration: 20 - 25%.

Of these, items 2, 3 and 4 have all involved new technologies.

2. Data Capture

The creation of a modern land administration system may involve new surveys of existing or intended land parcels, or the conversion of existing paper records into computerised form. Data capture is not just a technical survey operation since there must be agreement on the ground as to what is being measured, who owns the land and where the boundaries lie. Although technology can help to speed up some of the processes of creating and updating a cadastral system, it is essential that land owners are consulted and are confident in the results of any data acquisition programme. This may also apply when converting existing land information into digital form. Computerisation is expensive not so much in terms of hardware and software but more in terms of the time and effort needed to carry out the conversion processes.

From a purely technical point of view, the compilation of original cadastral plans may be undertaken using ground methods or by aerial survey.

Increasingly global positioning systems (GPS) are being used to densify survey control networks and to fix the position of some property boundaries. The results reduced to rectangular co-ordinate form can then be fed directly into a computer for processing and display. The location of boundary beacons can also be recorded using electronic systems such as the Total Station. The resulting co-ordinate values can be easily processed and stored as evidence in case of boundary disputes or where boundaries are moved or boundary marks are lost and need to be replaced.

GPS is capable of producing a precision of measurement that is in excess of what is needed for land titling or the resolution of boundary disputes. Although high precision surveys currently require more sophisticated technology and data processing than is available from high street shops, the trend is clear. There will be cheap GPS systems that will produce very precise survey measurements and this may in consequence increase the level of disputes between neighbours. In many jurisdictions, the re-location of property boundaries is decided on the basis of evidence in which marks on the ground take precedence over what may be recorded in abstract mathematical form - monuments make better evidence than measurements. As cheaper measurement systems become available this may be reversed and this could result in misunderstanding between neighbours.

The use of aerial or satellite photography provides an alternative approach to recording property boundaries. In the case of aerial photography, as with GPS, high precision measurements can be taken allowing boundary lines to be measured to an accuracy of a centimetre or so. In order to use such techniques, the boundaries of properties must be visible from the air, either in the form of fence or hedge lines or else as markers in the ground that have been painted in such a way as to make them visible from an aircraft. Aerial surveys have the benefit of economies of scale - the more properties that are to be measured at one time the lower the unit costs; conversely if only a few boundary points are to be surveyed, the cost becomes relatively high. Aerial photography, however, facilitates the collection of other data, such as land use or the location of topographic features that may be surveyed at minimal additional cost, justifying the greater expense.

In spite of claims that satellite imagery can be used for cadastral surveying, remote sensing is still too crude a set of tools for such a purpose and, like the use of photogrammetric techniques, addresses only part of the cadastral problem. The key issue is to get neighbours to agree on the ground as to who owns what land. Every boundary must be identified correctly and whereas a synoptic view may meet the needs of general land administrators, remote sensing techniques do not normally satisfy the requirements of land owners or development control officers.

In order to exploit the opportunities created by modern land information systems there must be minimum standards of measurement accuracy and precision. Both ground survey and photogrammetric techniques may be used to achieve these. In the case of initial surveys over a wide area, photogrammetry offers a system for mass data capture at relatively low cost per land parcel.

The crucial issue then becomes one of maintenance and the creation of cost effective ways of keeping the data up to date, carrying out subdivisions or retracing old property boundaries. Neither photogrammetry nor satellite remote sensing is able to contribute much to this part of the process. The maintenance of the cadastral survey framework is therefore still a time consuming and relatively expensive activity that can only be carried out by ground survey.

The problem of ensuring data are kept up to date also occurs when converting existing land records into digital form. The computerisation of the existing land records is essentially an administrative process that should not change the legal status of any parcel. The electronic record system must however be designed in such a way as to accommodate change as and when formal mutations on the land occur. Conversely it must block changes that are not authorised.

Overall, new surveying technologies have re-awakened the debate about appropriate standards of precision in measurement and how these standards should evolve over time. They have also moved the emphasis for surveyors from measurement to the management of data. Although GPS technology in particular is having an increasingly important impact on the measurement of parcel boundaries and on the construction of property maps, the greatest impact on land administration has come from information-handling technologies rather than from surveying.

3. Data Storage and Retrieval

Good land administration requires access to good land information. The storage of data in computers has become relatively easy once the data have been digitised. The volumes of data for land administration are large but the price of data storage has fallen dramatically over recent years and techniques for the rapid retrieval of data are efficient and effective. The speed of progress has however created challenges since land information may need to be retained for centuries. Many of the technologies of a decade ago are now obsolete and it is in practice impossible to read some old data files since they were written on systems that are incompatible with today's hardware and software.

All land titling data needs to be archived, preferably for hundreds of years back to the root of title. Given that it is often difficult today to read electronic data that were recorded in the 1970s and 1980s, what prospect is there for data now held in electronic form to be readable in for example AD2200? Paper lasts for hundreds if not thousands of years but photographic film does not. Even so, it was not until 1999 that the UK Parliament decided to record its Acts on paper rather than on vellum! Will CD ROM's and such electronic devices be like paper or like film? And whereas humans can read text written in AD1800, will computers in the future have the same capacity for backwards compatibility? Sweden has recently gone over to a full electronic archive but some would regard this as a risky process.

In the old days, a land owner would go to a land registry, ask a clerk to retrieve specific data from the land books and in due course a copy of the register would be provided. Such systems still operate today, for example in Slovenia where it takes one week for the land book officers to respond to queries. Slovenia is currently computerising its system to provide almost instant retrieval of the data and, in due course, there will no doubt be on-line access to the database from a wide area network. The land registries in countries such as Sweden and Austria already operate such networks and the demand from many different sectors of the community for access to their land related data is considerable and growing. Elsewhere, land registries and cadastral offices are moving slowly in the same direction.

The computerisation of the land records is, however, giving rise to concern over who may have access to the data and who may add value to other people's data sets. The European Community, for example, is currently debating the rights and wrongs of access to government-held information. It is seeking to produce guidelines recommending the extent to which the data may be exploited commercially and the protection that should be provided against invasions of privacy. Such issues arise essentially because of computerisation. They are of course not unique to land administration but they are important to resolve before full exploitation of the data becomes possible.

Apart from reducing the costs of data conversion and the problem of maintaining the records up to date at all times, the key issues in data storage and retrieval are institutional, rather than technical and relate to data usage.

4. Data Processing

Almost all cadastral and land registration systems currently focus on record management rather than information exploitation. There has been much promotion of geographic information systems (GIS) but in reality GIS technology has been little used in land administration other than for drawing maps. Computer aided design packages linked to data base technology that allows spatial searching satisfies the basic needs of land administration as currently practised. To date there has been little analysis of the spatial nature of land related data. In addition, the concept of information as a corporate resource has not been accepted and few governments, either national or local, exploit the opportunities created by the land and property data that they hold.

This is in part because the tradition of land registration has been to provide a service concentrating on each individual land parcel as a separate object, in part because until recently a critical mass of data has not been available in computerised form, and in part because there has been a lack of vision about what may be possible.

There has been a polarisation of attitudes between cadastral surveyors responsible for geometric data, the lawyers concerned with abstract rights in land, the planners focusing on land use rather than value, and the appraisers dealing with market values. The need to integrate all land related data and to analyse them in new ways is only slowly being recognised. The development of land information systems has been driven more by an interest in technology and computer systems than by any attempt to achieve a more holistic approach to the understanding of land and property. Whereas there has been concern to provide a ‘one stop shop’ point of access to all land and property related data, the comprehensive integration of data has not been a prime objective.

Two approaches to data integration are however emerging. In one the centralised cadastral records are being expanded to encompass a wider range of data (for example by adding additional data fields). In the other the separate identity of each data organisation is being maintained but protocols allow their data to be exchanged or linked with those from other organisations. This is greatly facilitated by the growth of technologies offering inter-operability and by the work of the OpenGIS Consortium. Both approaches allow data layers to be built up and displayed on a screen, the former placing more power and authority at the centre while the latter maintains the responsibility for updating the records with those who have the primary interest in the data. Neither approach is concerned with the land as a whole rather than its separate components.

In many countries land management is still a fragmented process in which co-operation between different agencies is limited or non-existent. Although data integration opens up new ways for analysing land and its constituent parts, the opportunities are being missed for reasons that are in part institutional and in part conceptual. At the institutional level there are problems with information sharing especially in cultures where status and power have been dependent on having exclusive access to particular sets of data. Local and wide area government networks are being developed in some countries but in general land and property information is not treated as a shared resource. All too often the horizontal flow of information within and between government departments and ministries is very poor and in some countries is positively discouraged. Only in the last year or so has the concept of ‘joined-up government’ begun to be promoted.

There are many obstacles in the way of data integration such as the sharing of costs and benefits in providing and using government data, especially where agencies and sub-agencies have devolved budgets. Uncertainty over how to proceed inhibits the growth of the market in land and property information and reduces the opportunities for departments to recover their costs by selling their data. Additional concern arises over the ownership of data and the extent to which these are subject to copyright. Because of the technical ease with which digital maps, for example, can be copied, new ways of protecting the interests of data providers are having to be developed, resulting in the emergence of use rights rather than ownership rights.

While the laws governing the copyright in individual data sets are now fairly clear, the right to exploit the value of what is added by combining data sets is still uncertain. Given that the key benefit of using GIS technology lies in its ability to add value by combining data from different sources, these legal uncertainties are hampering the development of the information market and hence of the use of the technology.

In many societies there are concerns that greater computerisation will lead to greater invasions of privacy, especially where combinations of data can reveal information that is not in the original data sets. Consider the case of computerised address lists that many commercial organisations now use in support of their business. It is not unreasonable, for example, for the insurance premium on the contents of a house to be related to the level of crime in the area in which it is located. Companies use people's post code to determine the level of their insurance premiums and most people consider this as reasonable. But is it fair if several people in a street fail to pay back money borrowed from a bank and this results in everyone in the neighbourhood being refused the opportunity of a loan? This can happen regardless of the individual's credit-worthiness, on the grounds that he or she lives in an area where there is a high risk of default on repayments.

What constitutes privacy and what rights the citizen has to restrict access to personal data are often obscure. In the UK almost all data are said to be personal, even if the data relate to bricks and mortar since a house can be said to identify its occupants. The use to which personal data are put must be registered in advance of their being collected and these uses are not always possible to foresee. Once the land administration services embark on automating the land transfer process, the whole nature of land information management changes. How much spatial information should be in the public domain and what if any should be the restrictions on its use? Will social attitudes change or will there be opposition to the implementation of labour saving techniques?

Such questions will become more urgent as electronic commerce becomes more common. The land market involves buying or selling property that is a great deal more expensive than a book or a compact disc. The electronic transfer of property rights is technically easy once the data are in digital form but special precautions need to be taken to protect the vendors and purchasers against fraud or mistake. The difficulty lies in ensuring that the transfer is made by the legal owners or their authorised representative. In the old days, documents of transfer had to be 'signed, sealed and delivered' or witnessed for instance by a notary. Electronic signatures can be fraudulently copied hence some people advocate that all land transfers should be personally witnessed by someone authorised so to do, even where there is no notarial system. This will ensure a human check (and hence delay) on what could otherwise be a fully automated process.

Land administration is however about more than land transfers. The processes of data integration referred to earlier are introducing a more radical change to the philosophy of land administration. At the conceptual level it should be self-evident that the way in which land is used affects its value, the manner of use being dictated both by its physical characteristics and planning laws. Conversely, the state of the land market will influence the way in which the land is used and whether for instance it is left derelict or is the focus for construction and development. The form and stability of the real estate ownership rights will likewise affect any property values and the manner in which the land is used.

If there is to be sustainable development then the information about land and property must be managed in a way that allows land resource managers to understand these inter-dependencies. Yet many physical planners say that they are concerned only with the way that space looks and operates and not with what the market will pay for it. Likewise tax authorities ignore the impact that land and property taxes may have on the way that land is used while registrars of title may have no concern other than to record how and by whom the land is currently owned. The new role of land administration is to provide a more holistic view.

Tools to analyse land and property related data are however still crude and inefficient. The prediction of the market value of property, for example, is still more of an art than a science. Land values change over time and space hence in theory they should be amenable to analysis by GIS. In a number of eastern European countries the land tax is being based on objective criteria such as area, soil type, normal rainfall levels etc. that are not directly related to the market price for real property since the latter is so difficult to determine, especially in an immature market. One key element in predicting land prices is the comparison with other market values. These should all be recorded in a comprehensive and up to date land information system such as a multi-purpose cadastre and in future there should be better models for property valuation. There is still, however, little analysis of how such taxes influence land use or what impact they have upon the environment.

In a number of countries, various performance indicators have been developed to measure whether any development is, for example, sustainable but little use of land administration data has been made in the creation of such measures. This is in spite of the fact that so many data sets are now available in computerised form. A great deal of work still needs to be done in the development of models for land and property related activities and to simulate the relationship between human beings and their environment.

5. Using Land Related Information

Land administration systems need to serve the interests of government, of those active in the land market, and of third parties. Computers were first introduced into the land administration field in the early 1960s, some to manage property valuation records and some to support surveying and mapping. Automation of land registry systems began around 1970, especially in Sweden, Australia, and Canada. Computerisation was used to support accounting procedures, to assist in the examination and checking of surveys and survey plans, to prepare automated indexes and, later, to develop land and property databases. The pioneers in delivering land information services, such as in Sweden and New Brunswick in Canada, developed wide area networks to provide access to the data. In Sweden the system has stood the test of time but in New Brunswick a more innovative approach has been adopted using the World Wide Web as a way to access the centralised land records. The popularity of the web as a means of distributing information is accelerating since unlike early networking systems that were essentially text based, web technology allows access to both text and graphics.

As described by Dale and McLaughlin (1999), “In August 1996 Service New Brunswick (SNB) implemented one of the first commercially available on-line land registry systems in the world, a service that provides province-wide access to a series of integrated land data sets. This service, known as the Real Property Information Internet Service (RPIIS), allows clients to access non-confidential, parcel-based information residing at a password protected SNB Internet site. The service supports browsing and viewing of maps and map-related information over the Internet. Users of this service may search for a property by specifying either a textual or graphical attribute such as a place-name or co-ordinate reference. The software allows users to view and query maps and attributes, select display layers, perform ‘point in polygon’ analysis, and undertake many more core GIS-type operations. Additional textual and multi-media information can be associated with features on the map.”

The growth in interest in Internet-based activities heightens the concerns about the prospect of information ‘haves’ and ‘have-nots’. Current statistics suggest that the on-line user community is largely made up of younger professionals and technical specialists. While the situation is slowly changing, many current users of traditional hard copy records and maps may be either unaware or intimidated by the growing availability and use of on-line data products. The gulf between the data rich and the data poor is perhaps even wider than the gulf between the developed and the less developed nations. What is happening in Canada could as well be happening on a different planet as far as some of the nations in Africa are concerned.

They have neither the data nor the processing capability to manage their land as a resource or to optimise land use in their ever growing cities. Technology may help to achieve the goals of such programmes as the United Nations’ Agenda 21 or its Global Plan of Action but is only a part of what is needed to solve the complex problems of urbanisation and environmental protection.

6. Concluding remarks

The most significant change in land administration over the last decade has been the extent of computerisation of the land registries. The objective of computerisation has been primarily to meet internal requirements for more efficient data storage, more rapid information retrieval and greater ease in updating the records; only in a second phase have the benefits to the public begun to appear. Separate initiatives have taken place in the agencies responsible for cadastral and topographic mapping and these have often been driven more by the technology than by the need to provide a better service. All too often, technology has been a solution looking for problems that have not been clearly defined. There has been an over-confidence in technology and an under-estimation of the human and institutional problems that it creates.

There is no doubt that the future of land administration will be driven in part by technological developments. If this technology is to be harnessed to support sustainable development then new objectives for land administration must be set. Before this is possible there must be clarity over what is meant by sustainability and what parameters can be used to measure it. There must then be an understanding by those involved in land administration about the relationship between their work and its impact on the environment.

Next, moves towards inter-operability and the integration of data must be encouraged both at the technical level where problems of data exchange and compatibility still occur but more especially at the institutional level. Finally new models for understanding land as a whole (rather than its constituent parts) must be developed and the inter-relationship between its various attributes and external factors in the social, economic and physical environment must be explored. Land administration is more than just a data capture, storage, retrieval and dispaly system. The data that are recorded about land and property are not only a valuable resource in their own right, they are also something to which value can be added. New technologies allow this fact to be recognised and exploited.

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