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THE ROLE OF LAND AND GEOGRAPHIC INFORMATION SYSTEMS IN ECONOMIC DEVELOPMENT AND ENVIRONMENTAL MANAGEMENT - A DEVELOPING COUNTRY PERSPECTIVE

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ABSTRACT

Economic development and environmental management are often in conflict, particularly in developing countries. This paper examines two projects in Thailand as case studies to show that the use of land and geographic information systems can contribute to both objectives. The paper briefly describes the concept and the role of land and geographic information systems, and looks at their application, primarily in the urban context.

The paper discusses the two major limiting factors in developing appropriate systems in both the developed and developing countries; institutional arrangements at a government level and appropriate education programs.

The first project, the Thailand Land Titling Project, is concerned with reforming the land titling and land administration system for the whole of the country. The second project, the Bangkok Land Information System Project, was a three year project completed in 1992 to examine the feasibility of developing a land information system for the City of Bangkok, a city with a population of approximately 10 million.

INTRODUCTION

The growth in international trade over the last couple of centuries, combined with the Industrial Revolution, saw the development of large cities supporting industry and trade. In many developing and developed countries, such cities are the engines of economic growth. Over the last ten to twenty years this trend is increasing rapidly. This has placed a much greater emphasis on the management of cities as institutions to support the economies of countries. One unfortunate consequence of this growth has been the deterioration of the urban environment and the resulting reduction in the quality of life in cities. Today this is very evident in many, if not most, developing countries where infrastructure is deteriorating, cities are being choked by traffic and the high pollution levels, whether from noise, air or garbage, are increasing at alarming rates, with no real solution in sight.

From another perspective, the ownership of land and its resources has been the basis of wealth for most societies since the beginning of civilisation. However the management of such land and resources, while being central to most societies, has seen many and varied approaches and systems. Traditional agrarian societies, usually based on a complex form of customary tenure,
maintained a balance in the environment which sustained the food supply over generations, subject to the vagaries of nature. Examples of such societies are found in virtually every country in the developing world, whether they are the Australian Aborigines, the North American Indians or as found in the cultures of the Pacific Island nations. The management of the environment in rural areas was generally controlled by a mixture of customary regulation and traditional institutions.

Over the last hundred years or so, a number of factors have contributed to the environmental degradation of these rural areas. First, increasing populations from migration and population growth, have resulted in an increase in "slash and burn" agriculture by rural squatters, the decimation of forests and other damaging practises to the environment. Second, the historical rural balances have changed due to the impact of efficient transportation systems and the development of international markets with a move to cash crops.

Modern land information systems are contributing to help solve many of these problems, whether in cities or rural areas, through an improvement in the management of land in general, with a particular improvement in the environment. To understand the growth in land information systems it is important however to take an historical perspective.

The development of modern civilisation, which grew out of feudal societies, saw the development of systems of land taxation in both urban and rural areas as a major source of government revenue and a way of managing and controlling the population. The Doomsday Book of William I in England and the modern cadastre of Napoleon I in France and many parts of Europe, are prime examples.

With a trend away from land taxes as the primary source of wealth for governments in the 19th and 20th Centuries, and with a move to the development of active land markets and the expansion in the use of bank finance for mortgages in supporting land markets, there has been a trend for cadastral systems to become closely linked to title registration and land ownership.

Over the last century, cadastral systems have developed in sophistication and have developed a multi-purpose role, especially in the last couple of decades with the advent of computer technology. Such parcel based systems are still used as the basis for managing land ownership records as well as valuation data for land tax, but are increasingly developing into parcel based land information systems. In cities, these systems are becoming a basic framework for local government administration, city planning, collection and assessment of rates, managing utilities and transport systems. In rural areas the issuing of individual land titles to land holders are helping to reduce rural poverty, redress regional income disparities and increase the Gross National Product (GNP) of the countries. These initiatives have resulted to some degree in increasing the investment in agricultural lands and ensuring more environmentally sound agricultural practises are adopted.

As a result there is an increasing recognition that land information systems are fundamental to economic development and environmental management in both cities and rural areas.

**CADASTRAL, LAND AND GEOGRAPHIC INFORMATION SYSTEMS**

As stated, cadastral systems of one form or another have developed in most developed and developing countries during the last one or two centuries. They have been the central component in establishing land taxation systems and land ownership systems, and in supporting land markets and efficient land administration in general. A definition of cadastre which has general acceptance is:

*A cadastre is a complete and up-to-date official register or inventory of land parcels in any state or jurisdiction containing information about the parcels regarding*
ownership, valuation, location, area, land use and usually buildings or structures thereon.

Such cadastral systems have developed into parcel based land information systems over the past couple of decades, as shown in Figure 1 [Williamson, 1985].

Over the last one or two decades the term "land information system" (LIS) has increasingly been used world-wide to describe the management of spatial data of all forms in a government context. The term has been used in many countries as the "global" term to include all cadastral and parcel based, environmental and natural resource systems at both small and large scales. The term has been used to describe systems and processes, with minimal emphasis on technology.

The term "geographic information systems" has not been generally used for administrative systems although it has been considerably used in the environmental and natural resources areas particularly at small scales and in a project context. There are exceptions to the lack of use in administrative areas, particularly in North America and countries heavily influenced by North American technology. The term has been used more in reference to the associated technology rather than the administrative systems themselves.

The terms land and geographic information systems are particularly aligned with computerised systems to manage or manipulate spatial data, with their expansion having seen similar growth to the information technology industry.

It is important however to recognise the fundamental difference between these two major data sets and the associated systems which inevitably have to be managed and coordinated within one overall system. First, land information systems tend to be parcel based, large scale, dynamic, administrative systems having very high integrity and accuracy of data. They include cadastral systems as a key component and almost always have grown out of an existing cadastral system. They are typically major administrative systems which support government or semi-government activities such as land registration, land tax, land subdivision, local government administration and the management of utilities and services. They primarily support the rating base for our cities and are key targets for governments as they move to privatisation.
Geographic Information Systems on the other hand are typically medium to small scale, more often that not use raster rather than vector data, are generally one-off or project oriented and are usually concerned with a lower integrity and accuracy of data as is common in environmental and natural resource systems. Geographic information systems do not usually support a major rating base and usually have a large component of public good. However they are equally important to LIS, albeit for different reasons.

There are other sub-groups of spatial data such as socio-economic data and demographic data which have much in common with geographic information systems. However, from an institutional and political perspective, the data sets surrounding these areas have not developed to the extent of the parcel-based or natural resource groups and are not significantly influencing the future direction of systems at this time, although that could change in the next few years with the development of emergency services or public health using LIS/GIS for example.

The concept of a land information system for a large city has important differences from statewide LIS based on cadastral systems. Urban LIS for land administration are almost wholly parcel based since such activities in cities and within the operation of local government are based around ratepayers and their properties. Cities are also increasingly developing small to medium scale GIS to support city planning and strategic planning for such activities as transportation studies, monitoring demographics and environmental management. The concept of an urban LIS is shown below with regard to the City of Bangkok. Whereas national LIS are typically concerned with land ownership and land taxation, urban LIS are more concerned with local government activities, the provision of urban services and the management of utilities.

THAILAND LAND TITLING PROJECT

Thailand is primarily a rural economy centred around the thriving metropolis of Bangkok. It is one of the world's largest exporters of rice. During the last decade however it has developed rapidly growing manufacturing and tourist industries. It is a country of about 60 million people with nearly ten million of those living in Bangkok.

The Thailand Land Titling Project (LTP) is a 20-year project administered by the Department of Lands (DOL) in Thailand and is jointly supported by the Royal Thai Government, the World Bank and the Australian International Development Assistance Bureau (AIDAB). It is considered by the World Bank and the international authorities to be a very successful project combining technical, institutional, management, legal, training and education components. For more detail on this project see Angus-Leppan and Williamson [1985] and Williamson [1990].

The original motivation for the LTP was to increase Gross National Product (GNP) in the rural economy by issuing land titles to all freehold parcels of land (in 1983 only about 25% of land parcels had titles) based on the premise that this would lead to increased security of tenure, and improved husbandry and investment in the land, thereby resulting in increased agricultural productivity. In addition it was believed that such a program would assist with a reduction in rural poverty and would assist in balancing adverse income disparities in rural areas.

The above motivation resulted in the primary objectives of the LTP being to accelerate the issuing of land titles over a twenty year program such that all eligible land holders in Thailand would have title to their land. There are about 20 million parcels of land in Thailand. A parallel objective was to improve the overall efficiency of the land recording system in Thailand. Two separate but related objectives were the establishment of a national valuation system for all landed property and the production of large scale mapping for all urban areas of Thailand including Bangkok.

The first five-year phase of the project commenced in 1985 with a budget of about US$70 million. However, it must be realised that this was a large additional resource being provided to an already very large government department — large by any standards. For example, in 1985 the Department of Lands had about 10,000 qualified permanent employees (most with tertiary
qualifications) and was decentralised through about 700 provincial and district land offices. The second and current five year phase of the project has a budget of about US$100 million. This phase is continuing the titling process as a major activity, but is placing more emphasis on developing a national land information system and building up the fledgling Central Valuation Authority.

The major components of the project are:

1. **A rural mapping and titling program** covering all freehold parcels in Thailand. This program includes survey control, photo mapping at a scale of 1:4,000 across all rural areas of Thailand, cadastral survey, adjudication and the issuing of land titles for approximately 15 million rural land parcels (noting there are approximately 7 million land titles in Australia for comparison).

2. **A land administration component** including legislative reform, decentralisation of land administration functions, improved design and operation of land registration practises, improved storage and handling of records, improved map and parcel identification and a major building program of land offices. In general this component aims to make records secure, up-to-date, efficient and purged of obsolete material.

3. **The preparation of up-to-date urban land parcel maps** at a scale of 1:1,000 and associated parcel indexes for all urban areas in Thailand including Bangkok.

4. **The development of a national valuation system** based around a new valuation profession resulting in equitable valuation rolls for all local authority areas of Thailand.

5. **The development of a national land information system (LIS) strategy** based around the parcel records within the DOL.

6. **A major organisation, management and operations review** and subsequent implementation focusing on the administrative structure, financial systems, administrative computing and accounting systems.

7. **A major socio-economic study** to determine the actual socio-economic benefits of land titling in rural areas based on longitudinal studies.

8. **A major education and training component** which has included internal training in the DOL; short, medium and long term training and education in Australia; establishing a new valuation diploma; and upgrading the surveying programs at Chulalongkorn University and Bangkok Institute of Technology.

**BANGKOK LAND INFORMATION SYSTEM PROJECT**

The City of Bangkok is an excellent case study to examine the problems and strategies in developing an integrated land information system in a large Third World city. The Bangkok Land Information System (BLIS) Project builds on the success of the previously mentioned larger Royal Thai Government/World Bank/Australian funded Thailand Land Titling Project since 1983. As stated above this project has the objective of upgrading the cadastral mapping base, improving the land titles records and improving the valuation base for the City. One of the most important aspects of this project is the institutional arrangements for its establishment and management. The project exhibits an exceptionally high level of cooperation and collaboration between the key participating agencies including the Bangkok Metropolitan Administration (BMA), the Metropolitan Water Authority (MWA), the Metropolitan Electricity Authority (MEA), Telephone Organisation of Thailand (TOT) and the Department of Lands (DOL). Each of these organisations has invested money and people into the joint project. The project is also being supported by the Australian International Development Assistance Bureau (AIDAB). See Williamson and Mathieson (1992 and 1993) for details.

Bangkok Metropolis, the capital of Thailand, is located on a low flat plain of the Chao Phraya River extending to the Gulf of Thailand. Since established in 1782 as the new capital of Thailand, Bangkok Metropolis has been promoted as the centre of commerce, industry, national culture, national and international transportation and most of the central government administration. The total area of the Metropolis now covers 1568 square kilometres.
Bangkok has many if not most of the problems facing cities in developing countries. There is rapid growth with which the city has difficulty coping. There is a major air and noise pollution and traffic problem. There is no mass transportation system. It takes most people at least two hours to get to work and another two hours to get home. There is no significant sewerage system. The many canals are often open sewers. The utility infrastructure is deteriorating, especially the electricity, telephone and water systems. There are long delays in getting connections. There are inequitable land and building taxation systems that mean the city has difficulty supplying and upgrading infrastructure. The result is a deteriorating urban environment and for many a poor quality of life in the city.

Yet the City of Bangkok is the engine of economic growth in Thailand.

After many study tours, demonstrations by LIS/GIS vendors and numerous pilot projects undertaken by countries as part of their aid programs, the city believed that LIS offered some hope in helping to manage and provide adequate services and infrastructure for the future. This is seen diagrammatically in Figure 2 [Williamson and Mathieson, 1993].

The major organisations in the city, coordinated by the Bangkok Metropolitan Administration (BMA), decided that they wished to expose themselves to LIS concepts and technology. They comprised the BMA, TOT, MWA, MEA, DOL and later the Royal Thai Survey Department (Army) (RTSD). The BMA, with staff numbers in excess of 40,000, is responsible for such services as Flood Protection, Drainage and Sewerage, City Planning, Public Works and Traffic Control, Medical and Health Services, Social Welfare and Community Development, Education and Public Cleanliness and Orderliness.

They consequently bought a relatively large hardware/software (HW/SW) system at open tender. Since there were no staff with any experience of the LIS technology and no professional surveyors in any of the organisations (with the exception of the DOL), although there were a number of geographers in the BMA, they sought assistance from the Australian Government to establish a BLIS Pilot project. Assistance was provided by the Australian International Development Assistance Bureau (AIDAB) in the form of a full-time Technical Adviser and a part-
time Senior Technical Adviser. In summary, the key organisations provided staff and resources, set up a project office and then started to find out the capabilities of the technology. They decided to undertake a comprehensive pilot project involving all participants. The pilot project was started in May, 1990 and was completed towards the end of 1992.

As stated above, the City of Bangkok has had many consultants undertake studies to determine an appropriate strategy to develop a land information system for the City. There was one fundamental weakness in all these studies. They were all done by overseas advisers or organisations under a variety of international aid programs. None of the studies were undertaken by the Thai organisations themselves although they fully cooperated in the studies. The overseas organisations came into the country, did their study, prepared a report and left. Even though little of the experience of these LIS studies remained in Thailand, the studies were critical in raising the level of interest and commitment for BLIS.

Due to the magnitude of the problems in Bangkok and the resulting size and complexity of any proposed land information system, the key Thai organisations in the City of Bangkok came together to undertake their own study and pilot project called the Bangkok Land Information System Project (BLIS). The over-riding objective of the BLIS project was for the relevant Thai organisations to gain experience in designing and building their own systems.

The primary objectives of the BLIS Project are as follows:

1. **Education, training and the gaining of experience of Thai Government officers in the key organisations required to establish a future computerised land information system for the City of Bangkok.** While the pilot project itself will significantly meet this objective in the short term, it was quickly realised that education and training of staff in all the relevant organisations would also be a key in the long term success of BLIS. As a consequence the project will have to assist in the development of a ten year education and training strategy for the introduction of LIS/GIS. Such a strategy will require a major input from the academic institutions already involved in LIS/GIS in Thailand, such as the departments of Surveying Engineering and Geography at Chulalongkorn University. In addition it will certainly require short, medium and long term programs both in Thailand and overseas.

2. **The determination of an appropriate common base map for the City of Bangkok which could be used by all organisations which will be developing land information systems in the City.** Without doubt this is the most important technical objective of the project. Thailand had recognised the importance of cooperation in developing a LIS for the City. Senior Thai Government officials had visited Australia, Canada, Sweden, Germany and France and seen the importance of such cooperation. Even though the necessary cooperation between agencies in all these countries is not always the case, the Thai officials and all the overseas studies emphasised the importance of one common base map and a cooperative effort in developing such a map.

3. **The determination of an achievable long term strategy for the development of BLIS.** From the overseas studies, from visits, from attending conferences and from LIS/GIS vendors, the Thai officials have seen many highly developed and complex systems. The big question in the City of Bangkok was to determine what is possible and what are the priorities in establishing a LIS for the City. Simply, many of the systems and approaches put forward from developed countries may not be applicable to a rapidly expanding city of about ten million inhabitants in a developing country. The project has a clear objective of determining what is possible. The long term strategy will address such questions and issues as:

   - how should the base map be prepared,
   - who should prepare it,
   - who should manage the updating of the map,
   - who should pay for the preparation and updating of the map,
   - what should be included in the base map. Should it only be topographic data or should it
also contain land parcel data? Should it contain all buildings,
should any attribute data be included on the base map,
should the private sector be involved in the preparation of the base map
what are the priorities in developing the LIS, and
what institutional arrangements should be put in place to facilitate and encourage
coordination when each authority wishes to develop its own system in house?

There was a clear recognition with the Thai officials that if the system got too complex it
had little chance of success.

Tied closely to the development of a long term strategy is the determination of the
structure of a future LIS. It is important to remember that there are a large range of data
gatherers and data users in the proposed system all of whom have different needs. For
example the utility authorities are not particularly interested in the land tenure and land
parcel base. They wish to have a map of all the roads and buildings so they can show
their services and customers. On the other hand parcel information is essential for land
tax and planning, although a considerable amount of tax is raised from levies on buildings.

All these activities are at a nominal scale of 1:1,000 however there is an increasing
awareness in the BMA Policy and Planning Department of the need for a smaller scale GIS
based on an existing 1:10,000 scale map series.

Noting the key objectives of the Seventh National Economic and Social Development Plan
(1992-96) for Thailand, it was recognised that the objectives of the service and facility
agencies for the City of Bangkok were to support an acceptable quality of life for the
inhabitants, a clean and healthy urban environment and provision of services to industry
to sustain the country's economic growth. These objectives require timely and correct
information in support of service delivery, maintenance of facilities, management of
resources and collection of taxes. Without such information it is impossible to manage the
provision of services and facilities in a rapidly expanding metropolis. The information is
required to support three major activities, namely strategic planning, land administration
and management of physical infrastructure. These concepts led to the conceptual model
shown in Figure 3 [Williamson and Mathieson, 1993].

Figure 3: Conceptual model of BLIS

In order to provide such information, each service agency needs to establish a unit to create
and manage an AM/FM system, a GIS or a LIS as appropriate. Such systems are central to the management of these agencies whether they are providing water, electricity, telephone services or are managing city planning, property taxation or strategic planning. Each system should be based around a major computing facility, should be part of the organisation's information technology strategy and should be using spatially referenced textual data linked to a number of integrated map bases. These systems will require political support, corporate management, LIS/GIS technical and management expertise, HW/SW, data collection, education and training, and strategic planning.

Economically, strategically and practically, the only way that such systems can be created such that they contribute to the effective and efficient management of the metropolis, is by sharing key spatial and textual data sets. This is important to reduce the major cost of data collection as well as facilitating the combination of data sets from different agencies in future.

In order to achieve this objective, it is considered essential to develop a coordinated system with a user focus across the service authorities in Bangkok to provide the following:

- A Steering Committee to coordinate all policies, initiatives and systems
- A Common Base Map. Such a base map may include such data as houses, roads, canals, parcel boundaries, etc and may include a range of scales such as 1:1,000 and 1:10,000.
- A Common Textual Database. Such data may include building numbers, parcel identifiers, street addresses, building owners, parcel owners, and building and parcel values.
- Mechanisms to ensure that all sectors of the community have access to the data. This will require funding arrangements with all participating agencies in the short term, to acquire the base data, and charging schedules in the medium to long-term to make the data available to all users, whether government or private.
- Mechanisms to maintain, update, provide access to, and to integrate data.
- Mechanisms to ensure that the appropriate individual agency data sets are shared and that data flows are established to ensure that key data generated in one agency can flow to another agency to update the common databases, ie parcel owners from DOL or building numbers from BMA.
- Technical expertise to provide technical advice to the Steering Committee, standards for exchange and data accuracy, specifications for hardware and software (HW/SW), data collection and mapping.

**THE BENEFITS OF LAND INFORMATION SYSTEMS IN DEVELOPING COUNTRIES**

The benefits of land information systems (and cadastral and geographic information systems) in developing countries are many and varied. In analysing the benefits it is best to look at urban and rural areas separately, both of which have economic, social and environmental benefits.

As stated by one of the urban research divisions of the World Bank (quoted in Williamson, 1990):

> A well functioning land management system — with all its component parts — is essential for orderly urban growth, a dynamic private sector and an efficient housing finance sector.

Again as pointed out by the World Bank in Williamson [1990], in order to address some of the problems of poor urban land management in developing countries, it is necessary from both an economic and environmental point of view to put in place the following systems in urban areas:

- a legal framework that ensures land can be easily bought and sold
• a system of procedures and regulations to ensure the development of land at affordable cost
• land taxation measures to promote efficiency and equity in land use
• a land registration system which ensures that land ownership can easily be identified and transferred and that property taxes can be assessed and collected

Further justification for improvements in urban land management (and land information management) are seen in the World Bank's Urban Sector Strategy [World Bank, 1988]:

"Usually the lack of secure tenure is not a result of illegal invasion and squatting on public and private land but is due to outdated land tenure laws and inoperative cadastral and land information systems. The lack of land records not only prevents the poor — and many middle income families — from having secure tenure, it also precludes the use of land and houses as collateral for mortgage loans and hinders the assessment and collection of property taxes (which is usually the largest revenue source for local governments)."

The World Bank has also done a lot of work to confirm the benefits of urban property taxation in developing countries [Dillinger, 1988]. The results of the Bank's work over many years show that property tax can be an efficient, equitable means of financing municipal services in developing countries, but in most countries it needs reform.

Simply, appropriate land information management systems contribute to cities running more efficiently, ensure adequate taxes are raised, contribute to improved services and generally lead to cities being able to better play their usual role of being the "engines" of economic growth in the country.

Also as stated above, efficient land information management systems in cities, primarily through assisting in better planning and more revenue through taxes, lead to an improved urban environment as a consequence of improved transportation, sewerage, water, drainage, electricity and telephone services.

The benefits of cadastral and land information systems in rural areas have been documented extensively [Williamson, 1986], however they can best be summarised by the following two quotes from the World Bank's 'World Development Report 1989' [World Bank, 1989]:

"The legal recognition of property rights — that is, rights of exclusive use and control over particular resources — gives owners incentives to use resources efficiently. Without the right to exclude others from their land, farmers do not have an incentive to plough, sow, weed and harvest. Without land tenure, they have no incentive to invest in irrigation or other improvements that would repay the investment over time. Efficiency can be further served by making property rights transferable. (p86ff)

In most countries real estate accounts for between half and three quarters of national wealth. If ownership is widely dispersed, tenure is secure, and title transfer is easy, real estate can be good collateral for nearly any type of lending. Unfortunately, these conditions are not always met in developing countries. Land distribution is often skewed, tenure (if any) insecure, and title transfer cumbersome. One key to a smoothly functioning system of land tenure is land registers supported by cadastral surveys. In many developing countries these are still woefully inadequate or missing altogether. (p87)"

As stated in Williamson [1990], considerable World Bank research has supported investment in land titling in rural areas, with consequent economic and social benefits [Feder et al, 1988]. This research shows the economic benefits of land titling based on the work of the Thailand Land Titling Project described above.
Other examples of the benefits of land information management in the Bank is the work by Francois Falloux [1989] with regard to renewable resource management in Sub-Sahara Africa. This report describes the application of mapping, land and geographic information systems and remote sensing in an institutional and economic framework in rural areas.

In addition to the economic and social benefits highlighted above, improved cadastral and land information systems can lead to significant improvement in the rural environment through improved agricultural practises which contribute to better stewardship of the land, protection of forests and particularly a reduction in destructive "slash and burn" practises of rural squatters.

THE LAND ADMINISTRATION AND ENVIRONMENTAL MANAGEMENT DICHOTOMY

The importance of LIS/GIS to the economic development and environmental management of countries is increasingly being accepted. However there are two major limiting factors on these systems being implemented successfully in the long term. The first is appropriate institutional arrangements in government to coordinate, manage and give leadership to both government, private and academic sector interests. The second is the need to develop a strong educational base to provide the academic underpinning for the initiatives. Without addressing these two issues the development of land and geographic information systems in the long term will be more a dream than reality.

Historically in most countries the broad range of land administration activities have developed in isolation or at best with weak linkages. The information revolution has put major pressures on these historical institutional structures. This has been especially evident in the areas associated with the management of spatial information which incorporate cadastral, land and geographic information systems.

For over one hundred years land surveyors and related professionals have been the driving force in developing cadastral systems and in the last two decades in developing LIS. These initiatives have been led by Surveyors General, Registrars General and Directors of Mapping, traditionally in departments of Lands. LIS grew out of these organisations.

GIS on the other hand have as grown out of departments of the environment, forestry, agriculture and natural resources, again only over the last decade. Geographers, foresters and environmental scientists have usually been the driving force in GIS for these applications during this period.

Unfortunately LIS and GIS have usually developed separately in both the government and in academic institutions, often with competition between the two groups.

Central government agencies have been established over the last couple of decades to coordinate this growth in LIS/GIS. It has usually been dominated by the well established, better funded, larger and usually more administratively oriented departments like departments of Lands, headed often by a Surveyor General. This has been desirable historically since it was such organisations which provided the digital cadastral and topographic data to support such computerised systems and had access to technology oriented personnel such as surveyors who understood the technical issues surrounding the establishment of the systems. As a result LIS initiatives dominated during the 1970s and 1980s.

However, the 1990s has seen the cost of systems reduce dramatically and large amounts of data becoming available from a range of government and private sources, and new technologies like satellites providing remotely sensed data, as well as maps becoming digital. This is resulting in the 1990s seeing an increasing emphasis on LIS/GIS applications rather than on the associated technologies and data acquisition. This trend has dramatically increased the use of GIS as distinct from the more traditional LIS.
The last decade has also seen the growth of two major thrusts in both government and society which are having a profound impact on the future management of these land and geographic information systems. The first has been the growth of importance of environmental management; this will surely be the high profile issue in the 1990s as it was in the 1980s. The other is the growth in importance of the management of cities and urban areas in both the developed and developing world, as the importance of cities as the engines of economic growth is increasingly recognised. In this context Urban LIS have also developed but in isolation to state or national initiatives although they are based on state-wide cadastral data bases.

The above developments are coming into conflict in a number of jurisdictions as governments grapple with the competing interests within a general move to an information society. The ensuing debate increases substantially as governments in both the developed and developing world often believe that modern information technology (IT) alone will solve many of the problems in managing our environment and our cities, while at the same time returning hundreds of millions of dollars in savings in government expenditure. While there is some truth in the value of IT in these areas, the benefits and savings will only be achieved after major political, institutional, educational and technological changes.

The result has often been major competition between the land administration departments (cadastral/LIS) and the environmental departments (GIS). The difficulties are that the land administration departments supply data and in non urban areas the environmental organisations need the data for applications. This competition has often undermined the development of LIS/GIS in many states and jurisdictions.

It is important that governments are aware of the significance of taking into account all land related data and particularly the two key areas of cadastral (LIS) and natural resource (GIS) data. The key individuals who coordinate land and geographic information systems must improve their understanding of the political processes and the processes of government. They must realise that it is essential to not only get a balance between the parcel and utility based interest groups and the environmental and natural resource based groups, but governments must realise the importance of rising above these two interest groups to manage land and geographic data within one overall policy for a state or jurisdiction. There are many examples both world-wide, as well as in Australia, where one group has dominated to the detriment of the management of LIS/GIS for the state as a whole.

While it is essential to understand the political processes and the operation of government, it is fundamental that appropriate institutional and political structures are put in place to ensure the success of land and geographic information systems within an information society. Lessons from around Australia and overseas strongly suggest that the management of land and geographic information should be coordinated by a central representative body. This should involve all groups, sectors, government private and academic. It should however be coordinated by government due to the necessity to ensure no duplication, the adoption of suitable standards and overall efficiency.

Experience also suggests that one large government department coordinating land information systems is highly desirable and at the very least one government department controlling the cadastral system (including all land parcel records and the digital cadastral data base for the state or jurisdiction) and the digital topographic data base. All other databases and data sets are specific to an individual user or organisation and will build on these central databases.

There is no doubt that unless satisfactory institutional arrangements are put in place to management both land and geographic information, countries will not be able to capitalise on the benefits of such systems which are primarily in the areas of economic growth and environmental management.

EDUCATIONAL ISSUES
It has been argued in this paper that cadastral and land information systems are essential in the developing world to support economic development and environmental management. The weakest link in developing such systems in both developed and developing countries is education and training. Any program to develop LIS/GIS or reform the cadastre should have a major education component. Since education tends to require a long term commitment many countries only give "lip service" to such initiatives in preference to buying computer systems which they believe will solve their economic and environmental problems. Nothing is further from the truth. A commitment to education is essential if a serious commitment is to be given to LIS/GIS and/or cadastral reform. As background a brief overview of the historical development of education in this area in the developed world is worth reviewing.

In general cadastre and Land Information Systems education programs have grown out of Surveying departments in Australia, North America, United Kingdom (UK) and Europe. Education programs in Geographic Information Systems has grown out of Surveying, Computer Science and Geography departments in Australia and Europe, and Geography departments in the UK, Europe and North America.

LIS and GIS however are closely connected and overlap one another considerably. As stated previously, differences are often based more on the background of the professionals promoting them, however as mentioned there is a general rule that LIS is more concerned with large scale administrative parcel based systems whereas GIS is more concerned with small scale project based environmental or natural resource systems. One point however which is not in dispute is that LIS/GIS are multi-disciplinary.

There are several education models that are appropriate albeit each will have its own strengths and weaknesses. Ideally however an appropriate model in a particular institution should have the following characteristics:

- The multi-disciplinary nature of LIS/GIS must be recognised. Whether the primary department coordinating LIS/GIS is surveying, environmental planning, geography economics, information systems, agriculture, forestry or computer science, strategic alliances should be made between these disciplines to draw on their respective strengths.
- The program should have a good scientific underpinning in the management of spatial information and information science. However it should also have a balanced focus on both science and applications.
- The program should have a least one department actively pursuing research and development in LIS/GIS. The staff in that department should also be able to undertake consultancies in the discipline.
- The program should be primarily post-graduate however at least one surveying or geography department in the institution should have a strong major in LIS/GIS at the undergraduate level.
- At the post-graduate level, a range of programs from graduate certificate, graduate diploma, masters and PhD are required to serve the different community needs.
- A range of continuing education programs should be offered. This can range from seminars, two or three day workshops to international conferences.

**CONCLUSION**

Developing countries will have difficulty addressing many of the environmental issues facing them while at the same time maintaining a viable economy, if they don't manage their land resources and associated land related information in an efficient and effective manner. This demands that they have an appreciation of the role of land and geographic information systems in the management of cities, states and of the country.

This requires two important structures: first, an education system where the complexities of the land related problems and the technologies associated with LIS can be understood and taught.
Second, institutional arrangements in government which can provide the coordination and support for the adoption of the concepts and associated technologies.

REFERENCES


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