EMPOWERING LAND GOVERNANCE THROUGH SUSTAINABLE GEO-INFORMATION MANAGEMENT

NATIONAL LAND COMMISSION
THIMPHU

AUGUST 2012

Funded by DANIDA

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FOREWORD

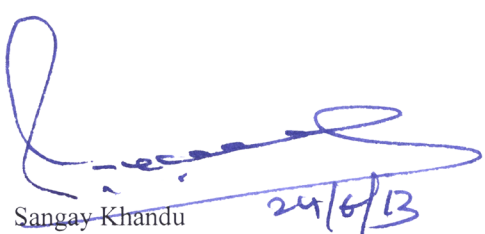
The Conference titled "Empowering Land Governance through sustainable Geo Information Management" was held on 16th August 2012, which was funded by DANIDA under Good Governance Support Programme.

Considering rapid developments taking place in the country, geographic information has become invaluable tool for formulating policies, planning and implementing various socio economic development activities. The spatial data infrastructure (SDI) is a very important component of good governance. SDI is also useful for addressing global issues such as climate change, disaster management and poverty alleviation.

While geographic information is accepted as a common tool for informed decision-making its sustainable management, particularly in Bhutan, has become a matter of concern since most of the activities related to collection and dissemination of geographical information are driven by external projects. The development of national spatial data infrastructure is plagued by lack of resources, coordination and standards. This has resulted in duplication of efforts, data redundancies and waste of resources.

Honourable Minister for Works and Human Settlement, Zhabtog Lyonpo Yeshey Zimba, presided over the opening session. Two distinguished professors Stig Enemark of Aalborg University and Clive Fraeser from Australia also made presentations. Professionals representing various agencies presented on various topics covering land administration, management and NSDI.

This booklet, a compilation of workshop presentations, is expected to enhance the initiative of the National Land Commission to enhance coordination among the stakeholders and create awareness on the importance of NSDI.



Sangay Khandu
Secretary
National Land Commission

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Building strategic partnership for land data sharing and management

(Keynote address by Dasho Sangay Khandu, Hon'ble Secretary, National Land Commission)

Your Excellency Zhabtog Lyonpo, Professor Stig Enemark, University of Aalborg, Professor Clive Simpson Fraser, University of Melbourne, Representative of Danish International Development Agency (DANIDA), Senior officers from various ministries, autonomous agencies and Corporations, ladies and gentlemen. Good Morning!

Today, on behalf of the National Land Commission I would like to take this opportunity to extend warm welcome to our chief guest Hon'ble Zhabtog Lyonpo, speakers and the participants to this conference on "Empowering Land Governance through Sustainable Geo-Information management", the first of its kind in Bhutan.

This conference was made possible with the financial support of DANIDA with following objectives:

1. To discuss Bhutan's land governance paradigm
2. To understand global context and emerging issues of land governance
3. National Spatial Data Infrastructure status and challenges
4. Building strategic partnership for land data sharing and management
5. Legal and spatial challenges for urban planning

Well, empowering land governance through sustainable geo-information management is easier said than done. It requires significant resources, policy, strategy, time and active participation of all the stakeholders. Thus, it calls for a strategic partnership for land data sharing and management.

Some may wonder how sustainable geo-information management could possibly empower land governance. I wish to leave the details to the experts and specialists, but I would like to take this opportunity to highlight current situation and major challenges faced both by the government and people at large; due to non existence of National Spatial Data Infrastructure and policy.

Good land governance can be achieved through harmonizing of policies, streamlining procedures, developing national spatial data infrastructure and rendering efficient and effective services. These areas require macro level decision and a long term strategy.
Most of the decisions affecting people are somehow linked to the knowledge about land. It is a well known fact that the ramifications of poor land governance have direct impact on the overall integrity of the nation and socio economic development initiatives. Land governance underpins poverty alleviation and Gross National Happiness.

On the morning of 24th September, 2007 His Majesty the King commanded the National Land Commission:
"Land is not simply an economic issue – in Bhutan it is an all-pervasive issue affecting the

very livelihoods and welfare of the people – our very Gross National Happiness. If Bhutan is to succeed as a democracy or if our economy is to succeed then the people must have a stake in this success. This important feeling of attachment and belief in the future of the country, will only come about if the people have an effective and secure ownership of land, and equal access to the opportunities that thereafter follow.

Poverty alleviation or economic dynamism – both ends of the spectrum of government priorities are affected by land issues – we cannot alleviate poverty effectively if we do not have the best information and reliable services for land survey, record and transfer in rural Bhutan – similarly we cannot hope to create a dynamic financial sector or attract foreign investment if our land procedures are not transparent, reliable and efficient."

It is in this light that the National Land Commission is making relentless effort in enhancing good land governance in Bhutan. While we have made considerable strides in improving land tenure system we have a lot to do when it comes to actually developing a National Spatial Data Infrastructure (NSDI).

Simply rendering efficient and effective land administration services and ensuring security of land ownership will not necessarily ensure good land governance.

The total arable land in Bhutan is approximately 2428 Sq Km or just about 6.3% (final figure will be available after the NCRP). Out of this 1125.5 Sq Km or 2.93% of the total geographical area is the area under agriculture (LCMP-2010). We have very limited knowledge of more than 93% of our geographical area.

Therefore, the National Land Commission, as a lead agency for mapping and land administration would like to play a proactive role in our concerted effort towards building a National Spatial Data Infrastructure and application. A lack of NSDI and its policy has severely impaired urban planning and infrastructure development, socio economic developments activities, natural resources management and efficient utilization of scarce resources. Therefore, the government needs to be spatially enabled for accurate planning of socio economic developments, timely appropriation of land and carrying out detail socio economic impact analysis. Towards this end, spatial data and capacity to produce and manage spatial data are prerequisites. For these, we require close collaboration and partnership of all the stakeholders to share resources and responsibilities.

In the interest of long term planning and judicious management of limited natural resources comprehensive spatial information is inevitable. No serious attempt was made in the past for NSDI development, although NSDI is as important and crucial as any other infrastructure.

Bhutan does not have proper record of spatial data infrastructure or its policy. Even among the government agencies there is no formal data sharing mechanism despite small organizational structure. The way of producing and managing geo information in Bhutan is erratic and even rampant to some extent.

We need to avoid duplication of efforts in producing spatial information at all cost. This calls for a very close cooperation among geo-information producer and user communities.

Land data generally means information or record related to the properties of land. Different people use this term in different ways depending on the application and their professional background. Spatial data, geo-information, geographical information, geodata, land information etc. are some of the commonly used terms.

It is very important to strategize the entire process of data collection, processing and management. As a nation with limited resources duplication of efforts and data redundancies must be avoided at all cost.

What is the use of geo-information? Traditionally, in Bhutan knowledge about land was limited to land boundaries, trails or footpaths, passes and rivers. People had good knowledge of which pasture to venture at what time, condition of bridges etc.

Today, the world has become very complex and geo-information is used like never before. Besides planning purposes geo-information is important for disaster relief works, to monitor climate change, natural resource management and myriad of other activities. Geo-information is used mainly for one purpose: i.e. to make correct decision. Without a comprehensive repository of geodata and systematic process of data collection and management it will be difficult to reap the benefits of technological advancement in the field of geo-information. As a result, even to carry out basic services like postal coding will become complex and the brunt of bad planning will continue to plague towns and cities.

The National Land Commission has always been strapped with resources, as a result of which the topographic maps produced in 1960s are still being used. However, since 2008 the NLC has started building professional and technological capacity in a big way. This was made possible because of the ongoing National Cadastral Resurvey Programme, initiated as per the Command of His Majesty the King.

Although the cadastral resurvey exercise was initiated with the objectives of strengthening land tenure system, a lot of ancillary data is collected to be used for purposes other than land administration. The volume of land data that is available is enormous on the registered land and if this wealth of land information is not put to use it would be a huge waste of resources. Therefore, the NLC is trying to promote the idea of multipurpose cadastre with improved access to available geo information within its purview.

Some of the initiatives already in pipeline are:

- Declassification of some of the restricted spatial data
- Formulation of spatial data sharing policy
- Awareness campaigns on available geo-information
- Mainstreaming the use of geo-information for 11th Five Year Plan formulation
- Stakeholders trainings and workshops
- Technical backstopping to government agencies

- Harmonizing and bringing about a uniform system of land survey and common reference system

The only GIS coordinating body (CGISC) needs to be revamped to initiate strategic partnership among geo-information communities.

The Commission is also initiating system of forecasting land requirement for infrastructure developments and carrying out socio-economic impact analysis of land intensive undertakings.
The commission is reasonably equipped with necessary hardware, software and professionals. However, there is very limited data pertaining to more than 93% of the country.

Attempts to coordinate geo-information producers and users were made in the past, but could not advance beyond few workshops or meetings.

Building strategic partnership among the stakeholders for geo information sharing is going to be a daunting task, because everyone is looking for what is readily available at little or no cost. While on the other hand it is an expensive affair to collect and maintain geo-information. Isolated initiatives come at a great cost. Significant resources are spent on training the basics of collecting and processing data. Sometimes, agencies buy data that already exists with other agencies.

In the context of our working system and experiences gained so far there is no short cut to achieving a simple and straightforward data sharing way. Therefore, I would like to urge the experts to consider on the recommendation of following steps:

- Inventorying and consolidation of available geodata
- Developing policy and institutional framework
- Developing standards and resource sharing procedures
- Capacity building for application and management of SDI
- Streamlining data management system
- Classification of the responsibilities of stakeholders to update data available with different sectors

The United Nations Geospatial Information Working Group (UNGIWG) recognizes that *"Spatial Data Infrastructure (SDI) are all about reuse of data, reuse of technical capabilities, reuse of skills developed and reuse of invested intellectual effort and capital."*

Finally, may I also highlight that the successful implementation and operation of NSDI in Bhutan will largely depend on how we recognize the importance of geo-information. This will determine our methods of planning, decision making and resources management in the days to come. In this light, the sharing of responsibilities and resources will stand as cornerstones of strategic partnership among the geo-information community.

TASHI DELEK!!

Sustainable Land Governance– a global approach

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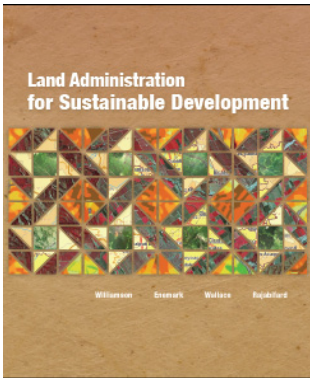
All countries have to deal with the management of land and the people to land relationship. They have to deal with the four functions of land tenure, land value, land use, and land development in some way or another. In Western cultures it would be hard to imagine a society without property rights and land-use planning control as basic drivers for development and economic growth. However, in many countries, and especially developing countries and countries in transition, the concepts of cadastre and land administration are not well developed in terms of mature institutions and the necessary human resources and skills. This paper provides an overall understanding of land administration and governance for sustainable development and especially the significant role the cadastre in support of sustainable geo-information management. The paper ends up addressing the issue of land governance in support of the global agenda.

1. INTRODUCTION

Imagine a country without any basic administration of land. Imagine that tenure to land and property cannot be secured, and that mortgage loans cannot be established as a basis for property improvement and business development. Imagine that the use and development of land is not controlled through overall planning policies and regulations. And imagine a slum area of 250 hectares with more than 1 million inhabitants lacking the most basic occupation rights and without basic water and sanitary services.

Land administration systems (LAS) are about addressing these problems by providing a basic infrastructure for implementing land related policies and land management strategies to ensure social equity, economic growth and environmental protection. A system may involve an advanced conceptual framework supported by sophisticated ICT models as in many developed countries; or it may be through very fragmented and basically analogue approaches that are found in less developed countries.

Until 2008 the developed world often took land administration for granted and paid little attention to it. But the global economic collapse has sharply focused world attention on mortgage policies and processes and their related complex commodities, and on the need for adequate and timely land information. Simply, information about land and land market processes that can be derived from effective land administration systems plays a critical role in all economies (Williamson, Enemark, Wallace, Rajabifard, 2010).



The recent book "Land Administration for Sustainable Development" (Williamson, Enemark, Wallace, Rajabifard, 2010) explores the capacity of the systems that administer the way people relate to land. A land administration system provides a country with the infrastructure to implement land policies and land management strategies. From the origin of the cadastre in organising land rights to the increasing importance of spatially enabled government in an ever changing world, the book emphasises the need for strong geographic and land information systems to better serve our world.

An overall theme in the book is about developing land administration capacity to manage change. For many countries, meeting the challenges of poverty alleviation, economic development, environmental sustainability, and management of rapidly growing cities, are immediate concerns. For more developed countries, immediate concerns involve updating and integrating agencies in relatively successful land administration systems, and putting land information to work for emergency management, environmental protection, economic decision making, and so on.

2. CADASTRAL SYSTEMS

In the Western cultures it would be hard to imagine a society without having property rights as a basic driver for development and economic growth. Property is not only an economic asset. Secure property rights provide a sense of identity and belonging that goes far beyond and underpins the values of democracy and human freedom. Historically, however, land rights evolved to give incentives for maintaining soil fertility, making land-related investments, and managing natural resources sustainably.

Therefore, property rights are normally managed well in modern economies. The main rights are ownership and long term leasehold. These rights are typically managed through the cadastral/land registration systems developed over centuries. Other rights such as easements and mortgage are often included in the registration systems.

Modern land administration theory acknowledges the history of the cadastre as a central tool of government infrastructure and highlights its central role in implementing the land management paradigm. However, given the difficulty of finding a definition that suits every version it makes sense to talk about cadastral systems rather than just cadastres (Figure 1). These systems incorporate both the identification of land parcels and the registration of land rights. They support the valuation and taxation of land and property, as well as the administration of present and possible future uses of land. Multipurpose cadastral systems support the four functions of land tenure, value, use, and development to deliver sustainable development.

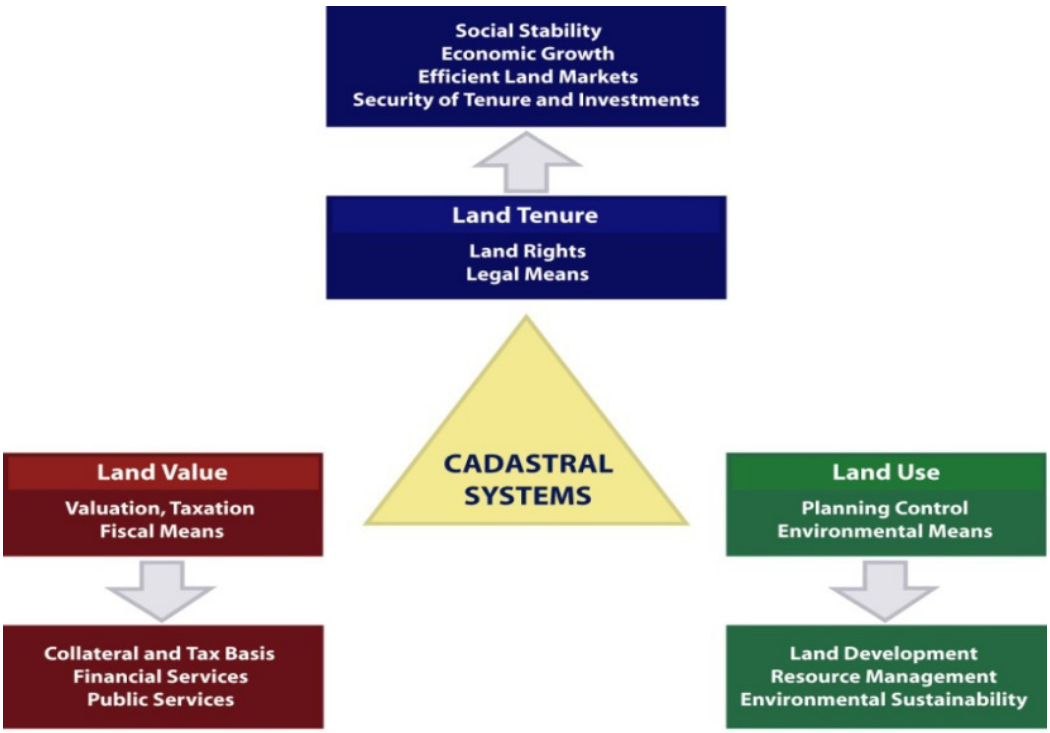


Figure 1: Cadastral systems provide a basic land information infrastructure for running the interrelated systems Land Tenure, Land Value, and Land Use (Enemark, 2004).

By around 2000, cadastral systems were seen as a multipurpose engine of government operating best when they served and integrated administrative functions in land tenure, value, use, and development and focused on delivering sustainable land management. A mature multipurpose cadastral system could even be considered a land administration system in itself.

3. LAND ADMINISTRATION SYSTEMS

A Land administration system (LAS) provides a country with the infrastructure to implement land-related policies and land management strategies. But land administration is not a new discipline. It has evolved out of the cadastre and land registration areas with their specific focus on security of land rights. Consolidation of land administration as a discipline in the 1990s reflected the introduction of computers and their capacity to reorganize land information. The UNECE viewed land administration as referring to "the processes of determining, recording and disseminating information about the ownership, value and use of land, when implementing land management policies" (UNECE, 1996).

The focus on information remains but the need to address land management issues systematically pushes the design of LAS toward an enabling infrastructure for implementing land policies and land management strategies in support of sustainable development.

In simple terms, the information approach needs to be replaced by a model capable of assisting design of new or reorganized land administration systems to perform the broader and integrated functions now required. Such a global land administration perspective is presented in figure 2 below.

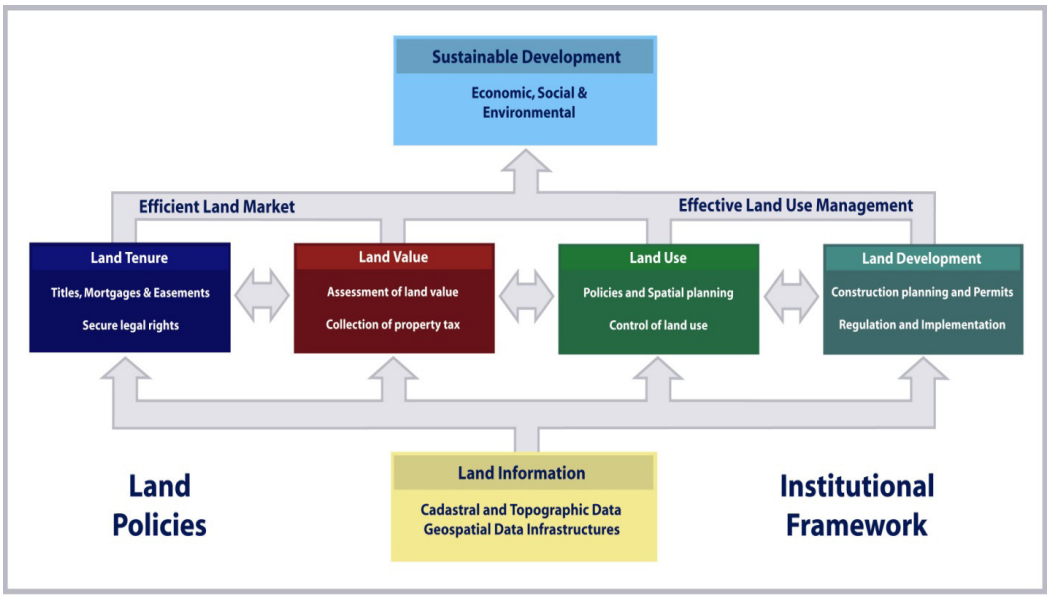


Figure 2. A Global land administration perspective (Enemark, 2004)

The four land administration functions (land tenure, land value, land use, and land development) are different in their professional focus. However, even if land administration is traditionally centred on cadastral activities in relation to land tenure and land information management, modern land administration systems designed as described in figure 2 deliver an essential infrastructure and encourage integration of the processes related to land tenure (securing and transferring rights in land and natural resources); land value (valuation and taxation of land and properties); land use (planning and control of the use of land and natural resources); and, increasingly important, land development (implementing utilities, infrastructure and construction planning). Inevitably, all four functions are interrelated. The interrelations appear because the conceptual, economic, and physical uses of land and properties serve as an influence on land values. Land values are also influenced by the possible future use of land determined through zoning, land-use planning regulations, and permit-granting processes. And land-use planning and policies will, of course, determine and regulate future land development.

The four functions interact to deliver overall policy objectives, and they are facilitated by appropriate land information infrastructures that include cadastral and topographic datasets linking the built environment (including legal and social land rights) with the natural environment (including topographical, environmental, and natural resource issues).

Land information should, in this way, be organized through Spatial Data Infrastructures (SDI) at the national, regional, federal, and local level, based on relevant policies for data sharing, cost recovery, access to data, data models, and standards.

Ultimately, the design of adequate systems of land tenure and land value should support efficient land markets for trading real properties, and the design of adequate systems to deliver land-use control and land development should lead to effective land-use management. The combination of efficient land markets and effective land-use management should support economic, social, and environmental sustainable development.

4. TEN LAND ADMINISTRATION PRINCIPLES

Despite the uniqueness of local systems, the range of cognitive frameworks about land, and difficulties in transferring institutions, design of robust and successful LAS is possible. The ten land administration statements in figure 3 below set boundaries for designers, builders and managers of LAS to help them make decisions about their local system. Overall, the statements are written with the goal of making establishment and reform of LAS easier. The statements implement the modern philosophy in land administration to develop and manage assets and resources within the land management paradigm to deliver sustainable development. They are universally applicable. Countries at early stages of development will not be able to use the full array of technical options or specialist skills, but they can improve their land management through appropriately designed LAS.

The statements reflect a holistic approach for any LAS, and focus on sustainable development as the overriding policy for any national system, irrespective of whether a country implements property institutions, communal land arrangements, or socializes its land. They highlight the importance of information and participation of people. They set the framework in which the historical development of familiar ingredients, like cadastres and land registries, can be meshed with recent innovations, particularly incorporation of social tenures, new complex commodities appearing in highly organised land markets, and the technical potential of spatial information.

1. LAS	LAS provide the infrastructure for implementation of land polices and land management strategies in support of sustainable development.The infrastructure includes institutional arrangements, legal frameworks, processes, standards, land information, management and dissemination systems, and technologies required to support allocation, land markets, valuation and control of use and development of interests in land.
2. Land management paradigm	The land management paradigm provides a conceptual framework for understanding and innovation in land administration systems. The paradigm is the set of principles and practices that define land management as a discipline. The principles and practices relate to the four functions of LAS, namely land tenure, land value, land use and land development, and their interactions. These four functions underpin the operation of efficient land markets and effective land use management. “Land” encompasses natural and built environment including land and water resources.

3. People and institutions	LAS is all about engagement of people within the unique social and institutional fabric of each country. This encompasses good governance, capacity building, institutional development, social interaction and a focus on users, not providers. LAS should be re-engineered to better serve the needs of users, such as citizens, governments and businesses. Engagement with the society, and the ways people think about their land, are core. This should be achieved through good governance in decision making and implementation. This requires building the necessary capacity in individuals, organisations and wider society to perform functions effectively, efficiently and sustainably.
4. Rights, restrictions and responsibilities	LAS are the basis for conceptualising rights, restrictions and responsibilities (RRR) related to policies, places and people. Rights are normally concerned with ownership and tenure whereas restrictions usually control use and activities on land. Responsibilities relate more to a social, ethical commitment or attitude to environmental sustainability and good husbandry. RRR must be designed to suit individual needs of each country or jurisdiction, and must be balanced between different levels of government, from local to national.
5. Cadastre	The cadastre is at the core of any LAS providing spatial integrity and unique identification of every land parcel. Cadastres are large scale representations of how the community breaks up its land into useable pieces, usually called parcels. Most cadastres provide security of tenure by recording land rights in a land registry. The spatial integrity within the cadastre is usually provided by a cadastral map that is updated by cadastral surveys. The unique parcel identification provides the link between the cadastral map and the land registry, and serves as the basis of any LAS and the land information it generates, especially when it is digital and geocoded. The cadastre should ideally include all land in a jurisdiction: public, private, communal, and open space.
6. LAS are dynamic	LAS are dynamic. Dynamism has four dimensions. The first involves changes to reflect the continual evolution of people to land relationships. This evolution can be caused by economic, social and environmental drivers. The second is caused by evolving ICT and globalisation, and their effects on the design and operation of LAS. The third dimension is caused by the dynamic nature of the information within LAS, such as changes in ownership, valuation, land use and the land parcel through subdivision..
7. Processes	LAS include a set of processes that manage change. The key processes concern land transfer, mutation, creation and distribution of interests, valuation and land development. The processes, including their actors and their obligations, explain how LAS operate, as a basis for comparison and improvement. While individual institutions, laws, technologies or separate activities within LAS, such as property in land, a land registry, a specific piece of legislation or a technology for cadastral surveying are important in their own right, the processes are central to overall understanding of how LAS operate.
8. Technology	Technology offers opportunities for improved efficiency of LAS and spatial enablement of land issues. The potential of technology is far ahead of the capacity of institutions to respond. Technology offers improvements in the collection, storage, management and dissemination of land information. At the same time developments in information and communications technology (ICT) offer the potential for the spatial enablement of land issues by using location or place as the key organiser for human activity.

9. Spatial data infrastructure	Efficient and effective land administration systems that support sustainable development require a spatial data infrastructure to operate. The spatial data infrastructure (SDI) is the enabling platform that links people to information. It supports the integration of natural (primarily topographic) and built (primarily land parcel or cadastral) environmental data as a pre-requisite for sustainable development. The SDI also permits the aggregation of land information from local to national levels.
10. Measure for success	Successful LAS are measured by their ability to manage and administer land efficiently, effectively and at low cost. The success of LAS is not determined by complexity of legal frameworks or sophisticated technological solutions. Success lies in adopting appropriate laws, institutions, processes and technologies designed for the specific needs of the country or jurisdiction.

Figure3.Ten land administration principles (Williamson, Enemark, Wallace, Rajabifard, 2010)

5. LAND GOVERNANCE

All countries have to deal with the management of land. They have to deal with the four functions of land tenure, land value, land use, and land development in some way or another. A country's capacity may be advanced and combine all the activities in one conceptual framework supported by sophisticated ICT models; or the capacity may involve very fragmented and basically analogue approaches. Different countries will also put varying emphasis on each of the four functions, depending on their cultural basis and level of economic development.

Arguably sound land governance is the key to achieve sustainable development and to support the global agenda set by adoption of the Millennium Development Goals (MDGs). Land governance is about the policies, processes and institutions by which land, property and natural resources are managed. Land governance covers all activities associated with the management of land and natural resources that are required to fulfil political and social objectives and achieve sustainable development.

The cornerstone of modern land administration theory is the land management paradigm in which land tenure, value, use and development are considered holistically as essential and omnipresent functions performed by organised societies. Within this paradigm, each country delivers its land policy goals by using a variety of techniques and tools to manage its land and resources. What is defined as land administration within these management techniques and tools is specific to each jurisdiction, but the core ingredients, cadastres or parcel maps and registration systems, remain foundational. These ingredients are the focus of modern land administration, but they are recognised as only part of a society's land management arrangements. The land management paradigm is illustrated in figure 4 below.

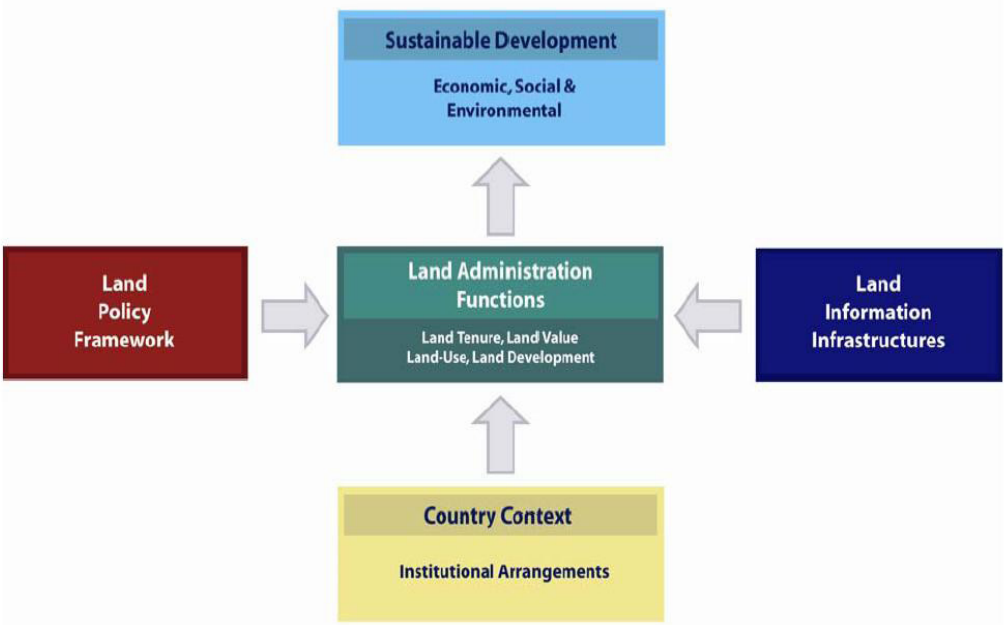


Figure 4. The land management paradigm (Enemark, 2004)

The land management paradigm allows everyone to understand the role of the land administration functions (land tenure, land value, land use, and land development) and how land administration institutions relate to the historical circumstances of a country and its policy decisions. Importantly, the paradigm provides a framework to facilitate the processes of integrating new needs into traditionally organised systems without disturbing the fundamental security these systems provide. While sustainability goals are fairly loose, the paradigm insists that all the core land administration functions are considered holistically, and not as separate, stand-alone, exercises.

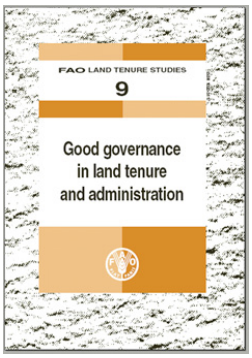
Land policy is simply the set of aims and objectives set by governments for dealing with land issues. Land policy is part of the national policy on promoting objectives such as economic development, social justice and equity, and political stability. Land policies vary, but in most countries they include poverty reduction, sustainable agriculture, sustainable settlement, economic development, and equity among various groups within the society.

Land management activities reflect drivers of globalization and technology. These stimulate the establishment of multifunctional information systems, incorporating diverse land rights, land use regulations, and other useful data. A third driver, sustainable development, stimulates demands for comprehensive information about environmental, social, economic, and governance conditions in combination with other land related data. The operational component of the land management paradigm is the range of land administration functions (land tenure, value, use and development) that ensure proper management of rights, restrictions, responsibilities and risks in relation to property, land

and natural resources.
Sound land management requires operational processes to implement land policies in comprehensive and sustainable ways. Many countries, however, tend to separate land tenure rights from land use opportunities, undermining their capacity to link planning and land use controls with land values and the operation of the land market. These problems are often compounded by poor administrative and management procedures that fail to deliver required services. Investment in new technology will only go a small way towards solving a much deeper problem: the failure to treat land and its resources as a coherent whole.

5.1 Good Governance

Governance refers to the manner in which power is exercised by governments in managing a country's social, economic, and spatial recourses. It simply means: the process of decision-making and the process by which decisions are implemented. This indicates that government is just one of the actors in governance. The concept of governance includes formal as well as informal actors involved in decision-making and implementation of decisions made, and the formal and informal structures that have been set in place to arrive at and implement the decision. Good governance is a qualitative term or an ideal which may be difficult to achieve. The term includes a number of characteristics as shown in figure 5.



Good governance is:

- Sustainable and locally responsive: It balances the economic, social, and environmental needs of present and future generations, and locates its service provision at the closest level to citizens.
- Legitimate and equitable: It has been endorsed by society through democratic processes and deals fairly and impartially with individuals and groups providing non-discriminatory access to services.
- Efficient, effective and competent: It formulates policy and implements it efficiently by delivering services of high quality
- Transparent, accountable and predictable: It is open and demonstrates stewardship by responding to questioning and providing decisions in accordance with rules and regulations.
- Participatory and providing security and stability: It enables citizens to participate in government and provides security of livelihoods, freedom from crime and intolerance.
- Dedicated to integrity: Officials perform their duties without bribe and give independent advice and judgements, and respects confidentiality. There is a clear separation between private interests of officials and politicians and the affairs of government.

Figure 5. Characteristics of good governance (adapted from FAO, 2007).

In short: sustainable development is not attainable without sound land administration or - more broadly - sound land governance.

6. BENEFITS TO SOCIETY

From this global perspective, land administration systems act within adopted land policies that define the legal regulatory pattern for dealing with land issues. They also act within an institutional framework that imposes mandates and responsibilities on the various agencies and organisations. They should service the needs of individuals, businesses, and the community at large. Benefits arise through the land administration systems guarantee of ownership, security of tenure and credit; facilitating efficient land transfers and land markets; supporting management of assets; and providing basic information and efficient administrative processes in valuation, land use planning, land development and environmental protection (see figure 6 below). LAS designed in this way forms a backbone for society and is essential for good governance because it delivers detailed information and reliable administration of land from the basic foundational level of individual land parcels to the national level of policy implementation.

Support for governance and rule of law	The formalization of processes used for land management engages the public and business, and, in turn, this engagement leads to their support for the institutions of government.
Alleviation of poverty	A primary means of alleviating poverty lies in recognizing the homes and workplaces of the poor, and their agricultural land as assets worthy of protection.
Security of tenure	This is the method of protecting peoples' associations with land. It is the fundamental benefit of formal land administration. Ensuring security throughout the range of tenures used in a country helps provide social stability and incentives for reasonable land use. Conversion of some of the rights into property is the core process of commoditization of land needed for effective markets.
Supporting formal land markets	Security and regularity in land arrangements are essential for successful, organized land markets. LAS manage the transparent processes that assist land exchange and build capital out of land.
Security for credit	International financing norms and banking practice require secure ownership of land and robust credit tenures (that is, tenures which support security interests in land) that can only exist in formal LAS.
Support for land and property taxation	Land taxation takes many forms, including tax on passive land holding, on land based activities, and on transactions. However, all taxation systems, including personal and company taxation, benefit from a national LAS.
Protection of state lands	The coherence of a national LAS is dependent on its coverage of all land. Thus management of public land is assisted by LAS.
Management of land disputes	Stability in access to land requires defined boundaries, titles and interests. If a LAS provides simple, effective processes for achieving these outcomes, land disputes are reduced. The system also needs additional dispute management processes to cover breakdown caused by administrative failure, corruption, fraud, forgery, and transaction flaws.
Improvement of land planning	Land planning is the key to land management, whether the planning is institutionalized within government or achieved by some other means. Impacts of modern rural and urban land uses affect adjoining land and beyond. These impacts need to be understood and managed by effective land planning assisted by LAS.
Development of infrastructure	Construction of power grids, gas supply lines, sewerage systems, roads, and the many other infrastructures that contribute to successful land use, require LAS to balance private rights with these large scale infrastructure projects, whether provided by public or private agencies.
Management of resources and environment	Integration of land and resource uses is a difficult aspect of LAS design. Land and resource titles require complicated and mutually compatible administrative and legal structures to ensure sustainability in short and long terms.
Information and statistical data	Each agency needs to appreciate the importance of information generated through its processes for the public, business and government generally. More importantly, everyone needs to understand the fundamental importance of integrated land information for sustainable development.

Figure6.Traditional benefits of Land Administration Systems (Williamson, Enemark, Wallace, Rajabifard, 2010)

7. SPATIALLY ENABLED GOVERNMENT

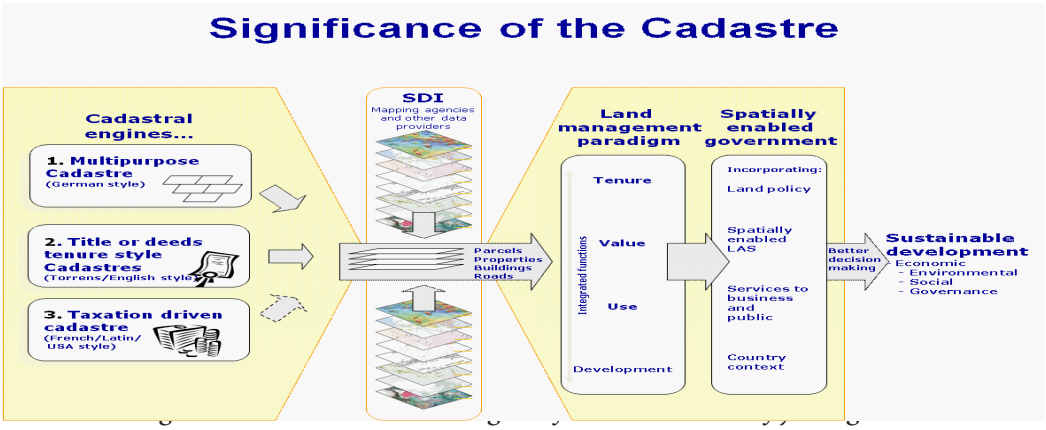
Place matters! Everything happens somewhere. If we can understand more about the nature of "place" where things happen, and the impact on the people and assets on that location, we can plan better, manage risk better, and use our resources better (Communities and Local Government, 2008). Spatially enabled government is achieved when governments use place as the key means of organising their activities in addition to information, and when location and spatial information are available to citizens and businesses to encourage creativity.

New distribution concepts such as Google Earth provide user friendly information in a very accessible way. We should consider the option where spatial data from such concepts are merged with built and natural environment data. This unleashes the power of both technologies in relation to emergency response, taxation assessment, environmental monitoring and conservation, economic planning and assessment, social services planning, infrastructure planning, etc. This also include design and implementation of a suitable service oriented IT-architecture for organising spatial information that can improve the communication between administrative systems and also establish more reliable data based on the use of the original data instead of copies (Rajabifard, 2010).

A spatially enabled government organises its business and processes around "place" based technologies, as distinct from using maps, visuals, and web-enablement. This relates to institutional challenges with a range of stakeholder interests including Ministries, Local Authorities; Utilities; and also civil society interests such as businesses and citizens. Creating awareness of the benefits of developing a shared platform for Integrated Land Information Management takes time. The Mapping/Cadastral Agencies have a key role to play in this regard. The technical core of Spatially Enabling Government is the spatially enabled cadastre.

7.1. The Cadastre as an Engine of LAS

The land management paradigm makes a national cadastre the engine of the entire LAS, underpinning the country's capacity to deliver sustainable development. This is shown diagrammatically in figure 7. The diagram highlights the usefulness of the large scale cadastral map as a tool by exposing its power as the representation of the human scale of land use and how people are connected to their land.



(Williamson, Enemark, Wallace, Rajabifard, 2010)

Wherever the cadastre sits in a national land administration system, ideally it should assist the functions of land tenure, value, use, and development. This way the cadastral system becomes the core technical engine delivering the capacity to control and manage land through the four land administration functions. They support business processes of tenure and value, depending on how the cadastre is locally built. They identify legal rights, where they are, the units that form the commodities and the economy related to property. These cadastres are much more than a layer of information in national SDI.

The diagram is a virtual butterfly: one wing represents the cadastral processes, and the other the outcome of using the processes to implement the land management paradigm. Once the cadastral data (cadastral or legal parcels, properties, parcel identifiers, buildings, legal roads, etc.) are integrated within the SDI, the full multipurpose benefit of the LAS, so essential for sustainability, can be achieved.

The body of the butterfly is the SDI, with the core cadastral information sets acting as the connecting mechanism. This additional feature of cadastral information is an additional role, adding to the traditional multipurpose of servicing the four functions. This new purpose takes the importance of cadastral information beyond the land administration framework by enlarging its capacity to service other essential functions of government, including emergency management, economic management, effective administration, community services, and many more functions.

The diagram demonstrates that the cadastral information layer cannot be replaced by a different spatial information layer derived from geographic information systems (GIS). The unique cadastral capacity is to identify a parcel of land both on the ground and in the system in terms that all stakeholders can relate to, typically an address plus a systematically generated identifier (given addresses are often duplicated or are otherwise imprecise). The core cadastral information of parcels, properties and buildings, and in many cases legal roads, thus becomes the core of SDI information, feeding into utility infrastructure, hydrological, vegetation, topographical, images, and dozens of other datasets.

8. SUPPORTING THE GLOBAL AGENDA

The key challenges of the new millennium are clearly listed already. They relate to climate change; food shortage; urban growth; environmental degradation; and natural disasters. These issues all relate to governance and management of land. The challenges of food shortage, environmental degradation and natural disasters are to a large extent caused by the overarching challenge of climate change, while the rapid urbanisation is a general trend that in itself has a significant impact on climate change. Measures for adaptation to climate change must be integrated into strategies for poverty reduction to ensure sustainable development and for meeting the Millennium Development Goals (FIG/WB, 2010).

8.1 Climate change and natural disasters

Adaptation to and mitigation of climate change, by their very nature, challenge governments and professionals in the fields of land use, land management, land reform, land tenure and land administration to incorporate climate change issues into their land policies, land policy instruments and facilitating land tools.

More generally, sustainable land administration systems should serve as a basis for climate change adaptation and mitigation as well as prevention and management natural disasters. Climate change increases the risks of climate-related disasters, which cause the loss of lives and livelihoods, and weaken the resilience of vulnerable ecosystems and societies.

Adaptation to climate change can be achieved to a large extent through building sustainable and spatially enabled land administration systems. This should enable control of access to land as well as control of the use of land. Such integrated land administration systems should include the perspective of possible future climate change and any consequent natural disasters. The systems should identify all prone areas subject to sea-level rise, drought, flooding, fires, etc. as well as measures and regulations to prevent the impact of predicted climate change.

Key policy issues to be addressed should relate to protecting the citizens by avoiding concentration of population in vulnerable areas and improving resilience of existing ecosystems to cope with the impact of future climate change. Building codes may be essential in some areas to avoid damage e.g. in relation to flooding and earthquakes. Issues may also relate to plans for replacement existing settlements as an answer to climate change impacts.

In disaster zones relevant measures should be taken to build the preparedness for managing any disaster events. Land issues are an important component in the emergency relief phase. Land is necessary for emergency shelter and protection of displaced persons, and the selection of sites for emergency shelter can lead to long term conflict or tenure insecurity. Land is also necessary for restoration of livelihoods, and land grabbing after a disaster is a key risk to effective protection and emergency shelter activity. Humanitarian actors are therefore confronted with land issues as they undertake emergency shelter and

protection activity (UN-HABITAT/FAO, 2010).

Vulnerable countries such as Bangladesh and most small island states often claim to be the victim of climate change "crimes" caused by the richer part of the world. This issue of global responsibility is in the heart of the current climate change agenda. Loss of healthy life years as a result of global environmental change is predicted to be 500 times greater in poor African populations than in European populations.

The measures of building integrated and spatially enabled land information systems does not necessarily relate to the inequity between the developed and less developed countries. Implementation of such systems will benefit all countries throughout the globe. Therefore, the integrated land administration systems should, in addition to appropriate registration of land tenure and cadastral geometry, include additional information that is required about environmental rating of buildings, energy use, and current and potential land use related to carbon stock potential and greenhouse gases emissions. This also relates to the fact that climate change is not a geographical local problem that can be solved by local or regional efforts alone. To address climate change, international efforts must integrate with local, national, and regional abilities.

8.2 Millennium Development Goals

The eight Millennium Development Goals (MDGs) form a blueprint agreed to by all the world's countries and the world's leading development institutions. The first seven goals are mutually reinforcing and are directed at reducing poverty in all its forms. The last goal - global partnership for development - is about the means to achieve the first seven. These goals are now placed at the heart of the global agenda. To track the progress in achieving the MDGs a framework of targets and indicators is developed. This framework includes 18 targets and 48 indicators enabling the on-going monitoring of the progress that is reported on annually (UN, 2000).

Land professionals – such as surveyors and other geospatial professionals – have a key role to play driving land administration systems in support of efficient land markets and effective land-use management. These functions underpin development and innovation and form a kind of "backbone" in society that supports social justice, economic growth, and environmental sustainability. Simply, no development will take place without having a spatial dimension, and no development will happen without the footprint of the land professionals.

The MDGs represent a wider concept or a vision for the future, where the contribution of the global surveying community is central and vital. This relates to the areas of providing the relevant geographic information in terms of mapping and databases of the built and natural environment, and also providing secure tenure systems, systems for land valuation, land use management and land development. These aspects are all key components within the MDGs.

In a global perspective the areas of surveying and land administration are basically about people, politics, and places. It is about people in terms human rights, engagement and dignity; it is about politics in terms of land policies and good government; and it is about places in terms of shelter, land and natural resources.

8.3 Rapid Urbanisation

Urbanisation is another major change that is taking place globally. The urban global tipping point was reached in 2007 when over half of the world's population was living in urban areas: around 3.3 billion people.

This incredibly rapid growth of megacities (with more than 10 million inhabitants) causes severe ecological, economic and social problems. It is increasingly difficult to manage this growth in a sustainable way. It is recognised that over 70% of the growth currently happens outside of the formal planning process and that 30% of the world´s urban population live in slums or informal settlements, i.e. where vacant state-owned or private land is occupied illegally and used for illegal slum housing. In sub-Saharan Africa, 90% of all new urban settlements are taking the form of slums. These are especially vulnerable to climate change impacts as they are usually built on hazardous sites in high-risk locations. (UN-HABITAT, 2008)

Urbanisation is also having a very significant impact on climate change. The 20 largest cities consume 80% of the world's energy use and urban areas generate 80% of greenhouse gas emissions world-wide. Cities are where climate change measures will either succeed or fail.
Rapid urbanisation is setting the greatest test for land professionals in the application of land governance to support and achieve the MDGs. The challenge is to deal with the social, economic and environment consequences of this development through more effective and comprehensive spatial and urban planning, resolving issues such as the resulting climate change, insecurity, energy scarcity, environmental pollution, infrastructure chaos and extreme poverty.

9. FINAL REMARKS

Digital Cadastral Systems underpin efficient management of the four key functions within the land management paradigm. And the large scale digital cadastral map is a key tool in providing the representation of the human scale of land use and how people are connected to their land. The role of cadastral systems has evolved over time from primarily serving as a basis for land taxation and/or security of land tenure towards being the key driver for achieving good governance of land and natural resources in support of national policies and the global agenda.

Land administration systems, in principle, reflect the social relationship between people and land recognized by any particular jurisdiction or state. However, land administration activities are not just about technical or administrative processes. The activities are basically political and reflect the accepted social concepts concerning people, rights, and

land objects with regard to land tenure, land markets, land taxation, land-use control, land development, and protection and management of natural resources. Sustainable land administration systems provide clear identification of the individual land parcels and land rights attached to these parcels. This information on the people to land relationship is crucial for accommodating the new vision of spatially enabled society.

The information on the people to land relationship also plays a key role in facing the global agenda through adaptation to climate change, management of natural disasters, alleviation of poverty, and management of rapid urban growth. Sustainable land governance and the operational component of integrated and spatially enabled land administration systems therefore need high-level political support and recognition.

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High-Resolution Imagery in Generating Spatial Information
Satellite Mapping in Bhutan

By Clive Fraser, University of Melbourne, Australia, Dorji Tshering, National Land Commission, Bhutan and Armin Gruen, Federal Institute of Technology, Switzerland

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High-resolution satellite imagery (HRSI) has significant potential for producing 3D spatial information products. Nowhere is this more apparent than in remote areas of the world such as the small Himalayan Kingdom of Bhutan. A project was designed to both demonstrate the utility of HRSI for medium-scale map production, and to pass these technological skills and tools to the Bhutanese. The authors show the potential shown by HRSI in meeting the spatial information needs of a developing country.

To support national development initiatives, Bhutan needs more comprehensive topographic and cadastral mapping. In many fields, ranging from environmental management to land and infrastructure development, and from town planning to forestry and agriculture, progress has been impeded by a lack of medium scale maps; most maps are at least thirty years out of date and thus of questionable quality.

Figure 1, Gasa Dzong (administrative and religious centre), with 6,500m-high Khang Bhum in the background

Mapping Needs

The challenges in providing map data are daunting; Bhutan has, for example, only one airport and two aeroplanes, both commercial jets. The mountains offer challenges for aerial photography, complicated by airspace restrictions in neighbouring countries that preclude commercial aerial photographic missions. As a result, there has been no aerial photography mission of any significance since 1991. The ongoing collaboration with the Survey of India to acquire new aerial photography has not, over the past several years, resulted in useful imagery. A potential solution at hand is high-resolution satellite imagery (HRSI), which offers an attractive alternative to aerial photography for spatial- data generation in remote areas. Ideally, 50cm to 1m-resolution satellite images (Figure 2) could be used for topographic map compilation, but with an area of approximately 40,000km² to cover, cost constraints must be considered. A second, more cost-effective option involves the use of 2.5m-resolution imagery, but while the metric performance of SPOT5, CartoSat1 and ALOS PRISM approaches that required for 1:25,000 mapping, it is widely acknowledged that the feature information required at this scale cannot generally be extracted from such imagery. Further options involve use of both 1m and 2.5m imagery, including ALOS PRISM or SPOT5, to provide DEM data, along with topographic feature information for less populated rural areas. Imagery from Ikonos, WorldView or Quickbird, to name three prospective sources, could provide from single images (monoplotting mode) 1m-accurate 3D mapping of the principal towns and high-priority areas.

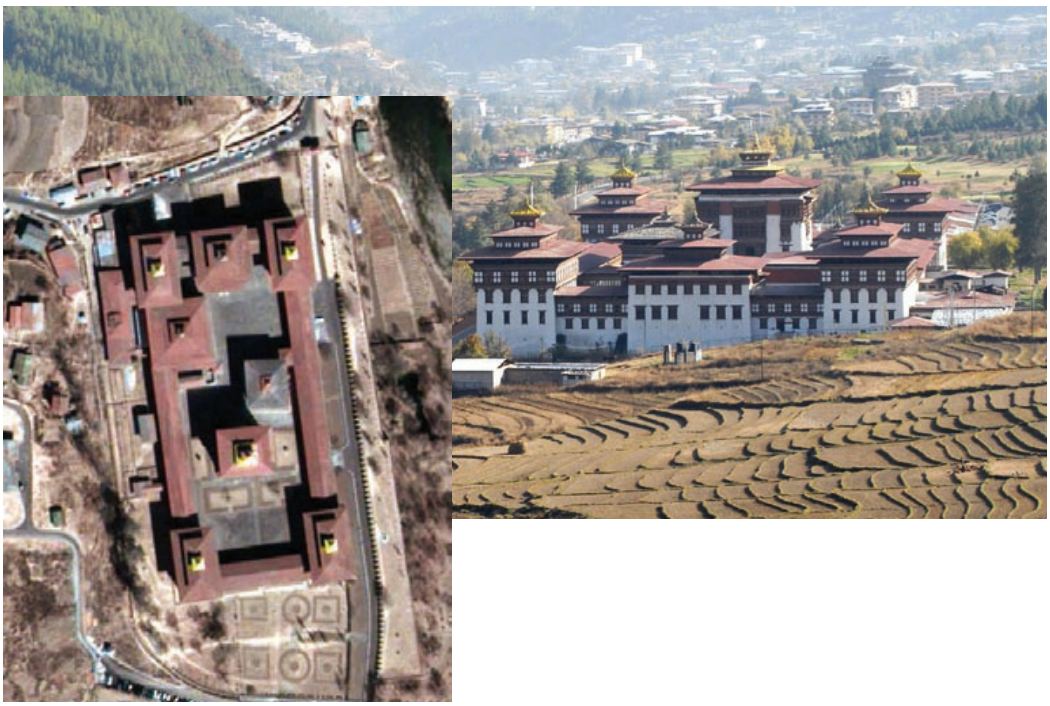

Figure 2, Trashichho Dzong as seen from the ground (above) and by QuickBird HRSI at 60cm resolution (left).

The Project

Over the past five years, a research project to assess the potential of HRSI for 3D spatial data generation in Bhutan has been underway. The main participants are The National Land Commission of Bhutan, the Department of Geomatics at the University of Melbourne and the Institute of Geodesy and Photogrammetry at ETH Zurich. The aim has been twofold. Firstly, to evaluate HRSI as a data source for meeting Bhutan's mapping needs. And secondly to assist the National Land Commission by way of technology transfer in the form of training and the provision of software tools and sample HRSI data that will enable Commission personnel to improve their skills. Through the generosity of HRSI providers, stereo Ikonos, Quickbird,SPOT5 and ALOS PRISM imagery has been made available to the project, as have the software systems of Barista and SAT-PP, from the Cooperative Research Centre for Spatial Information at the University of Melbourne and ETH Zurich, respectively. (See for a description of ALOS, GIM International, May 2006, Vol. 20, No. 5). The capacity building that this has enabled has included the generation of DEMs, orthoimagery and landscape visualisations, and 3D-feature extraction via monoplotting. The latter has been applied to tasks as varied as road centerline mapping and the coarse verification of cadastral data. Moreover, the imagery has facilitated the creation of high-precision testfields for verification of new sensor orientation models for HRSI, and DEM generation strategies for mountainous terrain. The outcomes that have had, or currently have, the potential for immediate impact upon the enhanced provision of spatial information by the National Land Commission are summarised below.

Geopositioning Accuracy

The first question posed by the Bhutanese was, with what accuracy feature points can be positioned from HRSI, especially when the opportunity for establishing ground control is limited. The answer was found through experiments involving Ikonos, Quickbird, SPOT5 and ALOS PRISM stereo imagery (three-line images in the case of PRISM). An array of sixty GPS-surveyed points was established in an area of 50 x 60km with elevation range of 1,900m to 3,300m and with most points along the relatively few roads. For 1m-imagery, the use of rational polynomial coefficient (RPC) bias correction, which requires a single ground-control point (GCP), yielded ground point positioning to 1-pixel accuracy. The 1m accuracy easily sur passes requirements for Bhutan's 1:25,000 mapping and is also sufficient for coarse verification of digital cadastral maps compiled over the past twenty years, often from plane-table surveying. The orientation of the SPOT5 and ALOS images was performed using a rigorous sensor model, due to the absence of RPCs. Here too, 1-pixel geopositioning accuracy was obtained from as few as four GCPs. Computations were carried out independently with SATPP and Barista, and equivalent results obtained.

Abbreviations
ALOS Japan's Advanced Land Observing Satellite
GNH "Gross National Happiness"
HRSI high-resolution satellite imager
SAT-PP Satellite Image Precision Processing software

RPC rational polynomial coefficient
JAXA Japan Aerospace Exploration Agency
SRTM Shuttle Radar Topography Mission

DEM Generation

The next step was to assess the quality of DEMs of the mountainous terrain produced from stereo-image pairs. Because of the absence of 'true' terrain surface data, a hierarchical approach was adopted. First, DEMs were generated using area-based matching with geometric constraints, as implemented within SAT-PP. Computed elevations were then compared with available checkpoints, the RMS error being generally in the range of two to 2.5 pixels. The DEM data from Ikonos (Figure 3) and QuickBird was then used as a basis to assess the precision achieved with the SPOT5 and PRISM imagery. The results indicated an agreement between the DEMs from the 1m and 2.5m-imagery of 5-7m RMS, except in areas where the terrain was excessively steep, where many blunders were detected in the samples of more than a million points. Nevertheless, all HRSI stereo pairs produced DEMs consistent in quality with expectations. While it is always tempting to adopt the freely available 3-second SRTM DEM for Bhutan, such radar-derived terrain data has quite severe accuracy limitations in Bhutan's mountains, where the average slope may well be higher than 30%. Comparisons between 250,000 points from a Quick Bird derived DEM and the corresponding SRTM DEM revealed a high RMS discrepancy value of 13m, with 32% of the SRTM elevation values being classed as blunders.

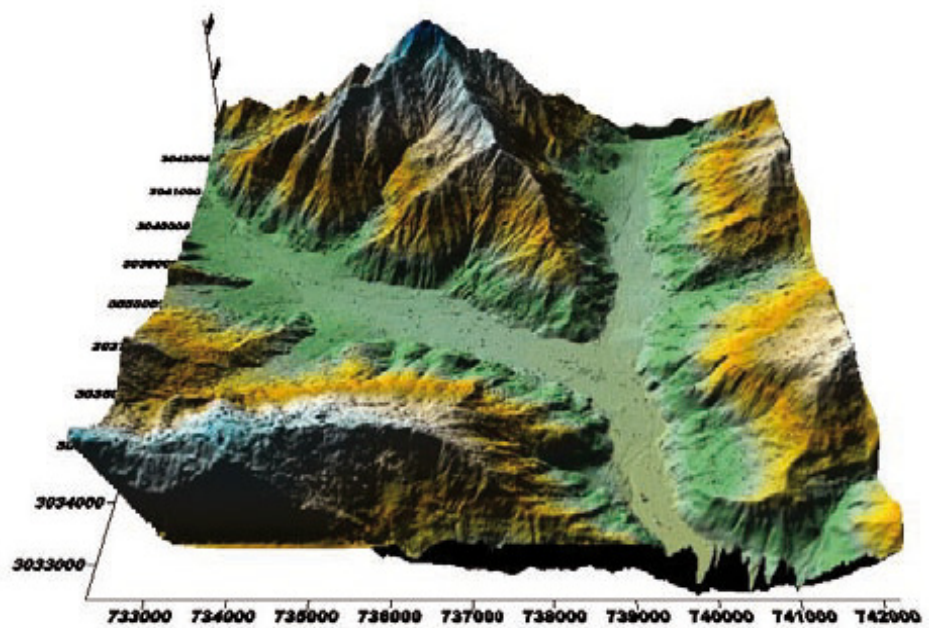

Figure 3, DEM covering 120km2 of the Paro Valley, generated from Ikonos stereo imagery: elevation range, 2,200 to 3,700m.

Orthoimagery

Assessments were carried out of the orthoimagery produced by all four satellite sensors, employing DEMs derived from these same sensors, comparing planimetric position against GPS-surveyed checkpoints. The accuracies were basically equivalent to the above figures, though a little poorer. A thorough analysis of orthoimage generation from Ikonos and QuickBird imagery using a SPOT5- or ALOS-derived DEM has still to be undertaken, since a near-nadir image would usually be preferred over one of the more oblique images from each stereo pair. Nevertheless, considering the very narrow field of view of 1m HRSI sensors, only small planimetric error effects would be anticipated for modest errors in the DEM.

Figure 4, Monoplotted track in one Ikonos image (left) backprojected into second image (right) to illustrate high metric accuracy.

Figure 5, Digital cadastral data overlaid onto an Ikonos orthoimage.

Monoplotting

Once a DEM of sufficient quality is in place, monoplotting from single, oriented images becomes a viable approach for extraction of 3D points, lines and polygons. The Barista system also supports 3D building modelling via monoplotting. Tests of monoplotting performance using Ikonos and Quickbird images with DEMs from SPOT5 and ALOS PRISM showed that geopositioning accuracy to one to three pixels may be readily achieved, even in steep terrain. The left-hand image in Figure 4 shows a monoplotted line of a steep road. After back projection into the right image, the degree of correspondence between left and right is a verification of positional integrity. One interesting potential application of monoplotting from HRSI lies in the identification and rectification of discrepancies in digital cadastral data. Figure 5 shows a section of the cadastre in the Paro area of western Bhutan, registered with the Ikonos orthoimage. Differences between boundary data and the current situation on the ground are readily apparent. Moreover, the provision of HRSI and the ability to reliably position boundary points is beneficial in the resolution of land disputes.

Concluding Remarks

The project will be continued, but with the focus more upon practical implementation and technology transfer. For example, the photogrammetric section of the National Land Commission is now using Barista for monoplotting. An extension of the project will involve the use of HRSI for 3D-modelling of an archaeological site in the Bumthang Valley.

Acknowledgements

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Development of National Spatial Data Infrastructure (NSDI) for management and administration of Spatial Information under NAGIS, through shared and concerted effort

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A brief insight into NDSI

Most of the base spatial data are created by the National Mapping Agencies at different resolutions to address developmental issues at national, regional and local levels since land is fundamental to all kinds of development activities. In addition to this, other agencies make use of base information and generate other data sets which would be input data to other line agencies. Therefore, data sharing and inter-operability of data becomes crucial to use existing data among the stakeholders. The host of issues related to spatial data is tackled through nationally recognized body through "National Spatial data Infrastructure, NSDI".

" The National Spatial Data Infrastructure (NSDI) is the technology, policies, criteria, standards , human resource and related activities necessary to acquire, process, distribute, use, maintain, and preserve spatial data". Basically it is harmonized through series of agreements on technology, standards, institutional arrangements, and policies to facilitate geospatial information users.

Some of the main principles are the data and metadata (data about data ie. it mentions the details of data which may include, and not limited to, source, age, accuracy, methodology, formats, coordinate system of data etc.) and should not be managed centrally, but input given by the data originator and/or owner, and that tools and services connect via computer networks to the various sources. It provides a base or structure of practices and relationships among data producers and users that facilitates data sharing and usage.

Due to its nature (size, cost, and number of varied producer and users) an NSDI is usually government-related and housed under a relevant and competent agency.

Software components

A NSDI should enable the discovery and delivery of spatial data from a data repository, via a spatial service provider, to a user. Hence, the basic software components of an NSDI could be:

1. a software client - to display, query, and analyze spatial data (this could be a browser or a Desktop GIS),
2. a catalogue service - for the discovery, browsing, and querying of metadata or spatial services, spatial datasets and other resources,
3. a spatial data service - allowing the delivery of the data via the Internet,
4. a (spatial) data repository - to store data, e.g. a Spatial database

5. GIS software (client or desktop) - to create and update spatial data

Besides these software components, a range of technical standards are necessary that allow interaction between the different software components. Among those are geospatial standards defined by the Open Geospatial Consortium (e.g. OGC WMS, WFS, GML etc.) and ISO for the delivery of maps, vector and raster data, but also data format and internet transfer standards by W3C consortium

Need for NSDI for Bhutan

A lot has been talked for NSDI for Bhutan in recent years to develop and implement NSDI, but not much is done to achieve the optimum utility of current geographic data readily available with different line agencies.

Elements of NSDI in Bhutan

1 Adopting a governance structure that includes representatives of all stakeholder groups to guide the development of the NSDI.
The NSDI can only be maintained and enhanced through the collaborative efforts of many organizations. A well-coordinated, concerted at all levels of government led by the NLCS under the aegis of CIGISC, is needed to leverage resources, minimize redundancies and cost of data collection and maintenance. A governance structure that fosters collaboration and shared responsibilities among stakeholders is critical to support decision making through spatial planning and analysis.
On this front, there is a body, National Agency for GIS Coordination NAGISC, that has been instituted with stakeholders across the country who use spatial information ranging from government agencies to educational institutes.

2 Implementing nationally coordinated programs that include collection, documentation, access, and utilization of data for host of applications and specific to each user agency.
Standardization is critical to the achievement of interoperability among diverse geospatial data suppliers and users. The national acceptance and utilization of Standard data is the first step toward interoperability. Already existing standards in terms of national coordinate systems and geo-databases are to be revisited and concretized, agreed among the stakeholders and used, facilitated by the CIGIS.

3. Ensuring that the NSDI is recognized across the nation as the primary mechanism for assuring access to reliable geospatial data.
The geospatial community must be able to communicate the benefits and value of the NSDI beyond the current user communities. A strategic communications plan and training programs that support NSDI implementation will contribute to reaching this goal.

The stakeholders, through NAGIS, promote the efficient and effective usage of national standard data in their work place and refrain from using unauthorized spatial data sets.

There has to be policy interventions in terms of providing required trainings to agencies concerned to develop applications for strategic and accurate planning. The CGISC, may reach to general public through broadcast and print media. In addition NSDI pamphlets for users would guide users produces annually would help to guide users in their day today their work.

4. Take an Inventory of available data among the spatial data user communities.
It is desirable to know which data is collected and by which agency. This will reduce data redundancy and quality is ensured since specialized professionals will perform the task. The data inventory will help to locate the data and the agencies concerned will not resort to doing it all over again which would be costly affairs to the agency concerned and the government.

On this issue NAGISC has made an earnest start by collecting data inventory from stakeholders
Production of "Meta data" i.e. data about data in a standard format accepted and endorsed by CIGIS. A user would know the age of data, source of data, data collection methodology, accuracy etc. before it is actually used for desired purpose. Meta data has to be current and updated as and when spatial data is updated. Meta data will speak about suitability of a given data set in any application.

On this issue NAGIS has already circulated a format and stakeholders have submitted the data of metadata. However, this has to be updated since the metadata is outdated. The meta data format needs to be discussed for up-dating metadata on quarterly basis.

5. Data policy and Procedural guide lines to Technical working Groups.
This is a critical aspect of the NSDI. This needs rigorous consultations with stakeholders to have a comprehensive data policy and mechanisms with working guidelines for data sharing ,updating and pricing of spatial data .NLC has worked out its data sharing policy and may be useful for stakeholders to develop their and later could be consolidated for NAGIS.

6. Formation of spatial Data policy Decision making body constituting higher level bureaucrats and supported by Technical working group.
Since the spatial information is fundamental for all physical development encompassing producers and users based in different agencies it is important to have decision makers at the top level of NSDI management to fine the spatial policies with other government policies and take desired decisions.

From the inception of NAGIS there were higher level officials identified and NAGIS had, in the past, initiated several meetings and beginning has been made. Presently, Hon'ble secretary of NLC is the president and other higher level government officials and from NGOs may be selected to form top layers of decision making body. Since the concept, in fact the entire work, is of technical nature the decision makers may have to be technically supported by Technical working group identified from stakeholders.

Bhutan's Thram System

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Abstract
Due to unavailability of proper documents the earlier system of land tenure in Bhutan is unclear. Remnants indicate that recording of landholdings was initially done for tax purpose.

Several rounds of cadastral surveys and Sa-Thram compilations were initiated. In spite of the fact that Bhutan accords high priority on strengthening land tenure system land issues are on the rise. This can be attributed to two main reasons: population growth and socio economic development. Land price has increased exponentially within a short span of time. Land issues and conflicts are getting increasingly prominent, complex and sensitive.

As per the Command of His Majesty the King the nationwide cadastral resurvey started from Lhuentse in June 2008. The National Cadastral Resurvey Programme (NCRP) is by far the most elaborate and expensive land titling undertaking initiated in Bhutan. The NCRP was initiated with the objectives of strengthening land tenure and security of ownership and to resolve land issues and conflicts. The programme also has numerous long term benefits.

Key words: Sa-Thram, land tenure, cadastral survey, land administration, multipurpose cadastre

1. Introduction

A word 'Thram' literally means a record, but its connotation is more than just a list of things. For instance, a list of things in a grocery shop is not a Thram, but a record of religious artifacts in a temple is called a Thram. Therefore, Thram is referred to as the main record that is official and reliable. Sa-Thram refers to an officially accepted record of landholdings.

"some form of practice of land estimation did exist as far back as the Bhutanese history ventures, which was accepted as the basis for taxation by the land users and the local chieftains" (Measuring towards perfection (MTP), 2008).

There has never been any major conflict over land in Bhutan. This may be due to availability of abundant land vis-à-vis small population size or attributed to a well accepted customary land tenure system.

Land use by way of shifting cultivation, pastoral-nomadic practice and long term occupation through mass forest clearing were common practice in all regions. Such practices occurred unabated. Customary unwritten rules prevailed over land use, resources sharing, land boundaries and even the movement of men and livestock from place to place.

Efforts to systematically record land holdings in Bhutan were made only after the 17th century; first in the western region and gradually in rest of the country.
During the last century the purpose of land recording, unit of measurement, contents of the Sa-Thram, land policy and the relationship between land and landowners have changed significantly.

2. The origin of Sa-Thram system

The origin of Thram system can be traced back to a time when land offered to the religious communities by lay people as Yoe jo[1] were recorded for collection of annual Tho jo[2] from the share croppers.

Laypeople offered yoe jey for religious purposes due to several reasons. Some offered out of reverence. Some offered land as payments for performing funeral rites and regular rituals. Many offered land to religious communities to avoid tax, since land owned by religious communities were not taxed. The advantage of such an arrangement was that the owner can continue to cultivate land by offering Tho jo annually. Probably, the amount of Tho jo was lesser than tax. Secondly, associating with religious communities, in some ways, was believed to bring merits. However, a certainty of losing permanent ownership of land was something that was not seriously thought of. This system gradually declined as a result of tax liberalization, abolishment of slave system, land reforms and several rounds of cadastral surveys and Sa-Thram compilations.

The system of recording landholdings offered as Yoe Jey was eventually replicated for assessment and collections of land tax in kind and labour conscription. Name and village of the owner, name of the land, type and amount of produce and amount of tax payable were some of the vital information in the Thram. Thus, the early system of recording individual landholding in Bhutan can be considered as a fiscal cadastre (MTP, 2008).

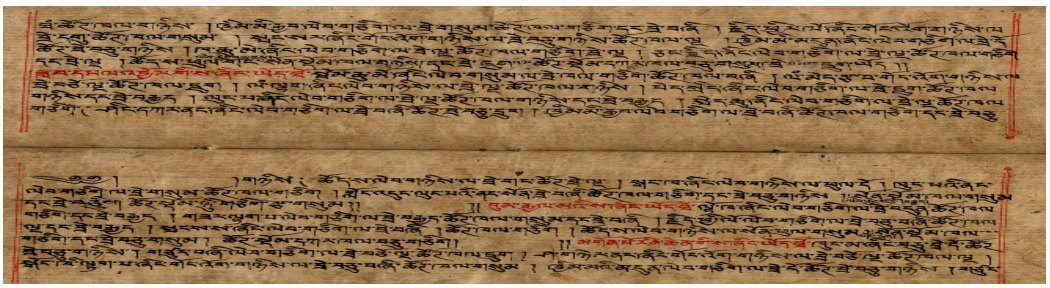
Different kinds of Sa-Thrams existed. There were Sa-Thrams held by the government, religious communities, noble families and individuals. Sa-Thrams in custody of the government were Chagzhag Sa-Thrams and other Sa-Thrams were known as Lagzha Sa-Thrams.
Contentions, as a result of the difference in the contents of different Sa-Thrams were common. Obviously, information in the Chazhag Sa-Thram prevailed in terms of determining both legal ownership and tax assessment. The Lagzha Sa-Thrams were declared invalid in 1957.

3. The Martham Chem

The Thram Martham Chem is thought to be the earliest comprehensive official record

[1] Land offered to religious communities by lay people as donation or payment for performing funeral rites and regular rituals. The owner would normally continue to use land as sharecropper.
[2] Proportion of agricultural produce that the sharecropper is liable annually

of landholding in Bhutan. Although Sa-Thrams existed as early as 17th Century the Martham Chem was compiled in 1919 during the reign of the First King and was revised in 1936 during the reign of the Second King (MTP, 2008). The Martham Chem contains land owner's name, name of the land, number of terraces or bunds, amount of produce and tax. Two main shortcomings of Martham are lack of proper indexing and difficulty in updating, which was done by scratching using sharp objects and overwriting. This Sa-Thram is the ultimate reference and basis for subsequent Sa-Thram compilations and cadastral surveys.



A page of Marthram Chem(MTP, 2008)

4. The Chain Survey

Although chain surveys were carried out as early as 1940s in different parts of the country the results could never be compiled and put to any practical use. Several Sa-Thram compilations were made. The most notable one is Ashi Tashi Thram of Trashigang Dzongkhag.

The first cadastral survey on a nationwide scale was carried out during the period 1965s to 1968 (Dasho Sangay Rinzin). One objective of chain survey was to convert the unit of land measurement from soendre[4] and langdo[5] to acres. The main outcome of the chain survey was the compilation of Acre Zindre Thram and indexing the Thram numbers in a proper format. The survey of all landholdings in the country using a 66 feet Gunter's chain within a period of four to five years appears to be a herculean task. The verbal accounts of some eyewitnesses suggest that all land parcels were not actually surveyed. It appears that the area estimation or "Migtshe" and mathematical conversion of 3 langdos of Kamzhing and 4 langdos of Chhuzhing to one acre were practiced extensively. Since cadastral maps were not prepared the location information was missing.

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[3] As per MTP, 2008 the Chain survey started in 1964

[4] soen is seed and dre is a container

[5] Area that could be ploughed by a pair of oxen in a day

5. Plane Table Survey

In June 1980 during the 52nd Session of the National Assembly the people's representatives 'pointed out that though the acreage of land-holdings is shown less in the land-deeds, the actual acreage of such holdings is large. Therefore, it was proposed that the Government should conduct a resurvey of landholding in the country,' (52nd National Assembly Session, 1980).
By then, the cadastral resurvey by plane tabling (PT) method was already underway in Paro. The original cadastral mapping by PT survey started in 1979 and ended in 1997, after 18 long years.
The most significant breakthrough of the PT survey was the adoption of mapping reference system by using survey control points, extended from the Geodetic Trigonometric Survey (GTS) stations.

The Acre Zindre Thram was used as the basis, but the actual parcel boundaries were surveyed and mapped as shown by the owners and claimants. All parcels were assigned parcel identifier numbers, but map sheet numbering system was introduced only some years later.

Areas were computed from the maps using gridded charts and instrument known as planimeter. Areas of parcels and vital information such as parcel identifiers and land use categories were updated in the "Draft Thram".

PT survey was the most important and difficult undertaking to strengthen land tenure. The survey practically involved surveying all parcels and drawing maps with bare hand. The mapping was done in two different scales of 1:2500 and 1:5000, depending on the terrain and status of land development. The main outcome of PT survey was the preparation of first cadastral maps. This historic endeavor was associated with some limitations. Parcels were surveyed, mapped and updated in the "Draft Thrams" as shown by the owners and claimants. It was later realized that the results of PT survey could never be formalized without carrying out another round of verification survey to authenticate the claims.

6. The New Sathram Compilation

The PT survey gave birth to another round of survey- the New Sathram Compilation (NSC), which started from Paro in 1985. The NSC continued from Samtse in 1990 and completed only in 2005 from Zhemgang, after 17 long years. During NSC if the area of PT survey was equivalent to the area of Acre Zindre Thram the field verification was not necessary. However, if there was significant difference in the areas the boundaries were resurveyed.

As per Resolution 13 of the 58th Session of the National Assembly held in June 1983 excess land can be regularized with or without having to pay for the cost of land and tax, depending on the land category. The excess lands from Chhuzing (wetland) with same number of bunds were regularized without having to pay the cost. The NSC was legally complicated and challenging.

The main objectives of the NSC were:

- To verify the legality of the land claimed during the PT survey
- Segregate legal[6] and illegal[7] lands
- To compute and formalize excess land
- Compile New Sa-Thrams

During the course of verification numerous plot categories were introduced. Illegal lands were categorized as 'Y' plots. Legal plots surrendered after adjustment of equivalent excess area and willfully surrendered excess lands were categorized as 'Z' plots. Legal plots that were not used for over 12 years were forfeited and categorized as 'X' plots. Government lands occupied by houses were categorized as 'T' plots.

While the NSC was elaborate in many ways the time for excess land cost payment could not be enforced uniformly and the decision on informal landholdings could not be reached. Therefore, the NSC produced three different areas of the same land: the PT survey area or 'Revised Area', the area that is eligible for formalization or 'Kaapa Legal Area' and the 'New Thram Area' that is updated with or without excess land depending on land category and payment status.

The excess land cost payment deadline was extended till 30th June 2008, but many people could not meet. Matters relating to excess and informal landholding were discussed in several sessions of the National Assembly.

Meanwhile, people informally transacted lands that were yet to be regularized. Government acquired private lands falling in different categories for infrastructure developments. Land prices and issues soared significantly within a short span of time. In the words of Dasho Karma Ura "fortunes are made and lost in land dealings". Such a situation called for another round of cadastral survey and Thram compilation.

[6] Land that has always belonged to and used, with or without registration in the Sathram

[7] Government land claimed without proper use or occupation

7. The National Cadastral Resurvey Programme (NCRP)

After the enactment of the Land Act 2007 the use of Chhazhag Thrams, cadastral maps and heaps of land documents became as uncertain as their dilapidated state. Three rounds of nationwide cadastral surveys and Thram compilations since 1964 have narrowed the difference between de facto and de jure land ownerships. Customary rights and formal land records have been used in conjunction, with frequent contradictions.

The status of land records, cadastral survey technology and organizational capacity to dispense land administration services fell short of the magnanimous provision of the Act that envisages "to manage, regulate and administer the ownership and use of land for socio-economic development and environmental wellbeing of the country through efficient and effective land administration, security of land tenure, equal opportunity to land, facilitation of operation of land market, effective use of land resources and conservation of the ecosystem."

The Land Act, 2007 promulgated several major changes, some of which are:

- Nationalization of Tsamdro (pasture land)
- Nationalization of Sokshing
- Systematic cadastral resurvey and adoption of coordinated cadastre
- Pegging of parcel boundaries

It may be important to note that majority of the landowners failed to meet the deadline for the payment of excess land cost. T he Land Act 2007 is silent on the issue of excess land. Further, the Act restricts encroachment into the government reserve forest.

In 2006 the Agriculture Minister conveyed the Royal Command to reinstate 'X' plots or the forfeited land which were forested and unutilized for over 12 years.

When the National Land Commission was institutionalized there were more than 12000 backlog land transactions, accumulated during 1992 to 1998 when the government froze land transactions. Due to all these developments land administration in Bhutan has become more complex and ambiguous.

The National Land Commission was institutionalized in 2007. The same year, His Majesty the King Commanded the National Land Commission to carry out nationwide cadastral resurvey. As per the Command the NCRP was started from Lhuentse Dzongkhag on 5th June, 2008 with following objectives:

- Resolve all land issues
- Verify and rectify errors
- Update Sa-Thrams
- Execute pending and fresh land transactions

- Survey all land parcels using very accurate digital instruments to establish coordinated cadastre
- Develop very reliable land information system
- Develop multipurpose cadastre

Resolving pending land issues required retrospective application of certain legal provisions and invoking important resolutions of past National Assembly Resolutions and Government directives. Certain provisions of the Land Act 1979 were applied. These initiatives were taken after seeking necessary approval.

Illegal landholdings categorized during the NSC were re-verified for reassessment of the genuineness of the claims. Critical parcel boundaries points were pegged. Land ownership types were defined. A very accurate control network is established covering all registered parcels. Parcel boundaries were surveyed using very sophisticated instruments that can render very high positional accuracy. Spatial and Sa-Thram databases are seamlessly integrated.

8. Conclusion

No Bhutanese is born landless. They become so over time. The people of Bhutan have enjoyed free hold ownership of land for generations. Land touches the hearts and sentiments of every Bhutanese. As a result of series of land reforms and initiatives to strengthen security of landownership generations of Bhutanese will enjoy undisputed ownership of land.

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Massive Rice Offering in Wangdiphodrang in Zhabdrung Rinpoche's Time

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A newly discovered book of 1679, perhaps the oldest extant land record, shows that there was a survey of taxable fields and taxable houses of Wangdi district (Shar mTsho brGyad kyi khral Zhing khral Khyim gyi Deb gTer) to collect rice taxes as fresh-harvest offering for blessing tithes (dbang yon thog phud).

At the end of eight months' stay of the two Portuguese Jesuits - Father Estavao Cacella and Father Calbral - with Zhabdrung Rinpoche in Cheri in 1627, Father Cacella noted that Zhabdrung Rinpoche was famous for "his abstinence, as he never eats rice, meat or fish...." (Baille L. M. 1999). Yet rice became the main instrument of his political economy. The 3232 households of Wangdi district offered on an average 359 kg of rice every year, a breath taking quantity that might have made people gasp for air as they carried on their backs up to the dzong. Wangdi dzong can be imagined holding and rolling rice reserve from the 1,144,636 kgs of rice (quantity corrected for missing values) it collected every year as fresh harvest offering for blessing the paddy growers by Zhabdrung. One can picture dzong builders, pazaaps (dpa' rtsal pa), monks and officials by bags of rice and packs of dairy products seasoned in the well-ventilated Wangdi dzong. Ranks of high officials were evocative of food entitlements, like tshogs thob (meal entitled), dro rgyar thob pa (breakfast entitled), and lto bzan dkyus ma (ordinary food entitled) (Ardussi and Ura, 2000). The volume of rice collection also gives us an idea of the food supply available for the construction of gigantic structure like Wangdi dzong in 1638.

A sprightly man named Wangchuck from Wache in Jena gewog of Wangdiphodrang turned up in my house in late 2010 to show two hand written copies of voluminous pecha gutshem (dgu 'tsems) that had back spine stitches, and with edges dog-eared that bibliophiles would adore. One copy had 327 folio-pages and the other, smaller in size, had 431 pages. There are minor content differences between them. The first copy of the document was written in tshuyig and stamped after every few pages with black seal with imprint of cross-dorji (dorji ja dram). The second copy was also in tshuyig with its text interspersed with stamps of red seal of "Wang 'dus" (ie. Wangdiphodrang). Each copy weighed approximately 2 kgs. I arranged, with the prompt help of Home Minister Minjur Dorji, for both the copies to be bought by the National Library of Bhutan where they are archived and safe from the ravages of rats, silverfish, fire hazard and negligent handling. It is fortunate that the family of Wache Wangchuck had kept these documents in his custody after getting it from his grand-uncle who was the last nyerchen (lord steward) of Wangdiphodrang.

The document is titled "don drub zhas pa sa mo lug los shar tsho brgyad kyi khral zhing khral khyim gyi deb gter gsal bai me long zhas bya bzhugs." It translates as "The treasure book of Female Earth Sheep Year that clarifies like mirror the taxable fields and taxable houses of the eight-parts of Shar". Don drub is synonym for sheep year in astrological lexicon (Astrologer Sonam Tenzin 2012). This new source will be referred hereafter as TB, as the abbreviation of the Treasure Book.

No measurement is neutral although it is often made to appear so: how it is done is absolutely driven by the purposes and ideology beyond the metrics themselves. TB begins by introducing its primary purpose as being an unchanging reference to stabilize rice tax collection. TB was intended to prevent "the sale and purchase of taxable fields out of which the respectful, happy, and faithful subjects offered harvest-fresh offerings, in return for blessing (dbang yon thog phud), to the unity of skillful and compassionate bodhisattvas of all directions, Palden Lama Dudjom Ngagi Wangpo Choglas Nampar Gyalwa, (ie. Zhabdrung Rinpoche)." I would like to translate briefly the rationale given in the document for Zhabdrung to collect the grain offering. "The grain offering was collected in order for the people to generate their merits by supporting the noble community (monk body) and by making offering as vast as ocean to the three roots (Buddha, Dharma, Sangha). The grain offering was collected also to turn the wheel of cloud-vast offerings without ever ceasing, according to the mandalas of secret tantra so that the sentient beings will gain two types of merits (dmigs bcas bsod nams dang dmigs med yeshes kyi tsogs) either immediately or indirectly" (dgos dang brgyud)."

TB ends with pointing out tersely the consequences of evading cash and commodity taxes (skam khral and rlon khral). The frequent reference to skam khral undermines our assumption that cash taxes were absent in those days, unless it meant something different. TB notes that "People living in evil times would attempt to be outside the purview of the taxation of the government of Choje Dukpa, by bribing the high officials with food and wealth (pon la zas nor sgye bsud btang ste) in some cases". TB goes on to say "In other cases, wealthy households, who could be in close and pleasurable company of the high officials, would be removed from the tax register. But the friendless poor could be crushed like mustard oil-seeds and driven into oppressed hardship." TB says "There is nothing more intensely amoral than these activities in the relationship between officials and the subjects." Frauds and scams involving high officials and wealthy people were known then. TB declares that "Henceforth cases of evading cash taxes (skam khral), of changing commodity taxes into cash taxes by altering tax books, by adding or deleting, (rlon khral skam khral la sgyur bai khrel yig bris bsub byed pa) can bring harm to the perpetrators up to seven generations by the heart-blood drinking oath-bound, protectors of the teachings." Our world would be beautiful if we have an ethical tax system and there were divine multi-generational tax inspectors who have perfect memory of tax records over seven generations. TB ends by proclaiming, "The oath-bound protectors of the teachings of the Buddha would certainly save those with right attitude, faithfully serving the government of Choje Dukpa from unharmonious accidents in the present life." At the end, TB states that "the protectors of the teachings will surely assist the people in ultimately obtaining the profound enlightenment because of the grace of honouring the command and seal of Zhabdrung Rinpoche on the crown of their heads" (mthar thug byang chub kyi go 'phang bla na med pa thob pai stong grogs mzad nyes pa zhabs drung rinpoche' bka' rtags kyi phyag rgya spyi bors bcings pai' mthu las bslu ba med).

The dating of the document can be ambiguous because the document does not specify the exact rabjung or the sexagonal cycle. Female earth sheep year, the year when TB was written, can be any of the following years: 1619, 1679, 1739, 1799, 1859. But the larger

context of history can be studied to find out which of these years can be the particular female earth sheep year. A comparative analysis of TB with other relevant documents also narrows down the date of TB.
So, when was it first written? 1619 is too early for rice taxation to have started in Wangdi district. It is barely three years after Zhabdrung reached Bhutan, and he would not have been able to organize systematic collection of rice offerings. On the other hand, he would have needed substantial supply to feed his militia that repelled a huge Tibetan invasion in that year. Further, we cannot pretend to be able to judge the effect of a monk-statesman, who could accomplish such marvels, on mass psychology. He could have inspired a new level of philanthropy of rice. Most likely, TB was written in 1679 to document the land tax system that Zhabdrung started during his life, and updated in 1687. 1679 coincides with the second last year of the rule of the able expansionist administrator, builder of six dzongs in the East, and a brilliant general, Minjur Tenpa (1613-81), who commanded successfully Bhutanese forces in the war of 1675-79 with Tibet, but whom the fratricidal, unethically ambitious and scheming Kabje Gedun Chophel overthrew in 1680.

TB explicitly mentions that it was revised and updated in earth female rabbit year (sa mo yos lo) in Punthang Dewachen Phodrang. Again, the rabjung is not specified, leaving us to define the year by understanding the greater context of history. Earth female rabbit year can be any of the following years: 1627, 1687, 1747, 1807, 1867. Considering that Punakha fortress was built in 1637, 1627 can be ruled out. We can also rule out 1747 or any later years for one reason. The biography of Desi Sherab Wangchuck gives us different administrative divisions of Wangdiphodrang and a different number of households. Those administrative divisions are conspicuously silent in TB. In the biography of Desi Sherab Wangchuck, Tsirang and the villages and households under Tsirang drungwog were clearly enumerated. There is no mention of Tsirang drungwog or any village in Tsirang in TB. It seems that Tsirang was yet to be incorporated into the tax system at the time of writing TB. Confidently, TB was updated in Punakha dzong in 1687. A stronger reason for proposing 1679 as the most probable date of TB is that it directly links harvest-fresh offering of paddy (dbang yon thug phud) to the blessings or empowerment given by Zhabdrung Rinpoche who is mentioned by his grand full title. We do not know when the passing away of Zhabdrung was made publicly known, but it is thought that it was kept secret for a long time, although Zhabdrung himself directed that the secret be maintained for 12 years. His state funeral (dgongs-rdzogs) was publicly performed only in 1754 (Ardussi, forthcoming Ch. 3). The direct emphasis on Zhabdrung in TB indicates that tax collection needed invoking his charisma and personal authority.

Estimates of population of Bhutan have not so far been found in old texts. What is usually found is counts of households known as gungs or houses (mi khyim or khyim) because households were the basis of tax. In fact, even if the occupying family came to an end through deaths or lack of issue, the house as a tax-basis continued through tsa-tong (rtsa-stong, literally empty root household) system whereby the tax of the empty house was paid by any family who took over its properties. TB lists the houses and vegetable plots in Wangdiphodrang at that time. The purpose of recording the number of houses or households in other old documents in general was related to taxation, distribution of

mangyed, or distribution enthronement gifts (khri-ston gnang-sbin) by the government (Ardussi and Ura 2000; Je Ngawang Lhundrup's biography of Tenzin Rabgay KMT 2005, p.159). But the counts of those household liable to taxation did not include households and families that were not paying taxes for one reason or other. TB also omitted such households.

Ardussi and Ura (2000) estimated the total population of Bhutan by going through the household data found in the passages related to the enthronement of Zhabdrung Jigme Dragpa I (1725-1761) in 1747. They also estimated total population for other years - 1796 and 1831- from additional sources. A fraction of the population were added to represent those who did not pay taxes and were thus not listed in the biography. However, I came across certain official agency who estimated past populations of Bhutan by absurd 'backward projections' at 3% a year, a logic that will show that Bhutan had no human being at certain point in medieval period! His enthronement account is part of the biography of Desi Sherab Wangchuck (reign 1744-63). In that article, Ardussi and Ura estimated also the population of Wangdiphodrang in 1747, which is summarized here.

According to the biography, there were seven major administrative units of Wangdi districts: Shar (Dangchu) drungwog, Jena drungwog, Jargang Penlopwog, Gaseng drungwog, Naynying drungwog, Uma Penlopwog, and Tsirang Drungwog excluding Indians subjects. The total number of households under Wangdi including Tsirang drungwog was 3,701 under 36 different locations of major settlements by names. Tsirang drungwog was part of Wangdi district in 1747. The total number of households in 1747 is uncannily close to the number found in TB in 1679.

According to household level data found in TB, in 1679, there were 3,232 households in Wangdi who were paying yearly rice offering in various quantities to the government. When Tsirang drungwog's villages are excluded to facilitate comparison, the household number in Wangdi district in 1747 was 3,566. Between 1679 and 1747, about 334 new households were established.

Like the rest of Bhutan, since 1679, the number of rural households had not increased significantly over three centuries, in this district. 2005 population and housing census found that Wangdi district had 6,227 households (p.47). Out of this total, 4,773 were rural households. In the special demographics dynamics of Bhutan influenced by several factors including monkhood, immigration had played a greater role than internal growth or decline. Once immigration from north or south ceased, population changed slowly.

On an average, each household paid 359 kg (257 dre) of rice as fresh harvest offering for blessing, as rice tax was known euphemistically. If a kilogram of rice is valued at Nu 60, the value of yearly rice offering by each household in Wangdi district was Nu. 21,590.
TB furnishes us detailed data to do certain estimation. At the aggregate level, the results show that 3232 households listed under 74 villages grew paddy in 26,693 terraces. The district of Wangdi as a whole had to pay paddy offering equal to 1,635,195 dre which is equal to 817,597 dre of rice, which is further equal to 1,144,636 kgs of rice, when a dre is

multiplied by 1.4 to convert to a kg. The value of rice offering in the district as a whole was Nu. 68,678,220 when a kg of rice is costed at Nu 60.

We do not know the acreage of rice cultivation in the district at the time of Zhabdrung Rinpoche or nearly three decade after his passing away when TB was drawn up. TB does not give data on area by such measures as langdo. It however meticulously records the number of terraces owned by a household head who is mentioned by name along with his or her house and vegetable plot. It would seem that the acreage and output of rice were higher compared to today's level. The fields left fallow today due to breakdown of irrigation channels brought from intake heads far away; lack of labour; competition from Indian rice; absorption of rice fields into urban lands; and relatively higher wages in non-farming sectors are the bases for this observation. One could physically verify whether the numbers of terraces mentioned in TB in a village are still being farmed.

Total rice production of Wangdiphodrang in 2010 according to the Ministry of Agriculture statistics was 7,645,000 kg of paddy (DoA 2010, p.7) which is equal to 3,822,500 kg of rice. For crude estimation, I assumed that 2010 paddy output level to hold for 1679 in Wangdi district. When the rice offering of 1,144,637 kg that is recorded in dre equivalent in TB is divided by 3,822,500, about 30% of the rice production in 1679 was offered to the government of Zhabdrung. That amount of rice could be sufficient to feed 3000 persons a year.

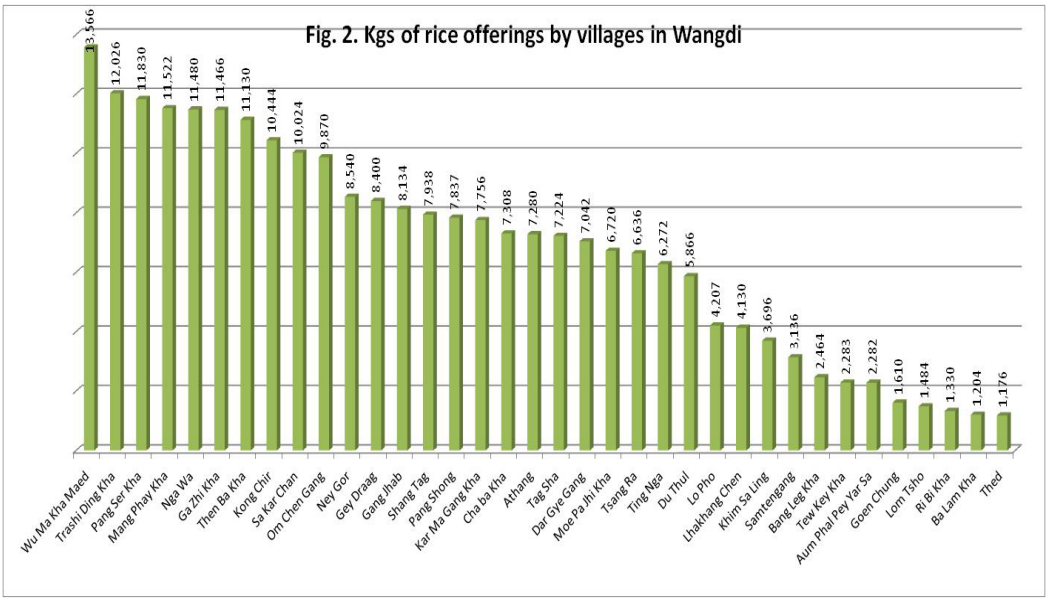
Maximum offering by a household was 1,680 kg of rice (worth Nu 100800) and the minimum offering by a household was 14 kg of rice (worth Nu 840). Top five and lowest five individual patron-tax payers from Wangdi district in terms of yearly rice offering are shown in a Table.

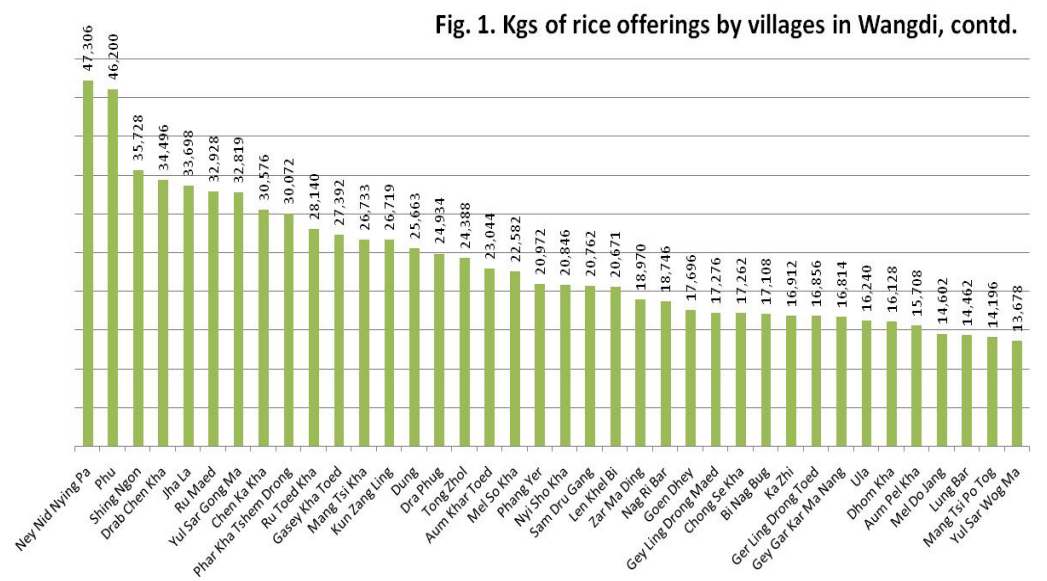
Top Five		
Village	**Householder**	**Kgs of Rice**
Zarmading	Lamkey	1,680
Samdrugang	Shakang Phuntshog	1,540
Mesokha	Norbu Tshering	1,400
Jhala	Gyalwang	1,400
Rumed	Namgay Tshering	1,330
Lowest Five		
Village	**Householder**	**Kgs of Rice**
Nyishokha	Thrung Thrung	28
Mangtsikha	Karpa	28
Gaygar Karma Nang	Delek	28
Gaygar Karma Nang	Tshering Drukpa	28
Sakar Chen	Phuntsho Tshering	14

Villages who made maximum amount of rice offering were in descending order of amount Rumed, Zarmading, Samdrugang, Ula, Phakhatsemdong, Rutoedkha, Draphug, Phu and Jala. The villages which had the maximum number of terraces were in descending order Kunzaling, Nishokha, Jala, Neynyingnyingpa, Gaylingdrongtoed, Kashi. The correlation between the quantity of rice offering and the number of terraces owned by a household was not strong. R^2 between the amount of rice offering and terrace number was weak: .29. There was no proportionality. It seems size of offering was dependent on motivation, not land size. But the number of households in a village and the numbers of terraces in a village were strongly correlated; R^2 = .85. These two variables went together.

It is instructive to compare many information found in TB, pertaining to 1679, and data

on landholding today. Land titles have increased from 3,232 to 7630 over 333 years. TB shows that in 1679, out of 3,232 households in Wangdi, 82.5% of householders in whose names paddy land titles occur were male; 17.5% were female. Land records in 2012 show a near reversal in the way landownership is recorded in Wangdi district. In Wangdi district at present, men have 29.2% of the land titles in their names while 70.8% of land titles are held by women. In the country as a whole, land records in 2012 show that 53% of land titles are held by women; 47% are men's. Women in Wangdi are mistresses of rice terraces, an unbeatable record in one aspect of gender equality.





Ensuring Sustainable Agriculture and Natural Resources Management: Assessment of current Information Management System

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Background:

This is a summary of the paper presented during the workshop organized by the National Land Commission in August 2012. The paper examines the existing mechanisms of bio-physical information collection and sharing by the various sectors and agencies. Data collection is very expensive in Bhutan. How do the agencies and institutes store, share information, and adopt tools to do analysis? For example, annually a big portion of arable lands is converted into other forms of land use like infrastructure development. There is also a huge pressure on protected areas from the construction of roads, power transmission lines and resorts. What data did we use in the past to take these decisions? How do we improve current information management systems to enable sound evidence based decision-making.

1. What do we know about our Biodiversity richness?

Bhutan is very rich in the forest and water resources. The recent land cover map 2010 estimated that the cultivated arable land is 2. 9%, forest cover 80 % (of which 70.4 % is tree and 10 % under shrub), protected and biological corridors make up 51.32% of the total geographical area of the country. The protected areas are rich in flora and fauna. For example the conservation management plan (2012 to 2017) of Wangchuck Centennial Park (WCP) in central Bhutan alone has recorded 693 species of vascular plants, 41 mammal species, 250 bird species, and 46 species of butterfly have been recorded in area of 4914 sq.km. The focal fauna species listed under vulnerability assessment included are Tiger, Snow leopard, Red panda, Takin, and Musk deer. Unlike other parks of developed countries, WCP has around 1601 households living inside the park touching 10 geogs of five dzongkhags.

2. Focus on water resource management

This high forest and mountainous country is dissected by the four major river basins running from north to south namely: Amo Chu, Wang Chu, Punasthang Chu and Manas Chu basins. The water from numerous creeks, streams of local watersheds, glacial lakes, monsoon rain, and high snow mountains of the north feed these basins. The potential hydropower generation projected from these river basins is around 30,000 MW. The glacial melt or glacier retreat has been going on for many years, and in the recent decades, the process is speeding up because of global warming. There are also numerous local signs that suggest the local water sources are either drying up or shrinking compare to the past. The field observations suggest that the volume of water contributed by the glacial lakes and

glaciers is small compared to flows originating from local watersheds and monsoon rain. The fast receding glacial water sources is a big concern and a global or regional collective effort is required to reduce global warming. We can work towards maintaining the health of local ecosystem services through the adoption of good water shed management practices so that water discharge is sustained.

3. Good Arable Land is disappearing from our land use map

More than 69 % of the population is dependent on farming that spreads from the wet subtropical (150-600 masl) to the cool temperate (2500-3500 masl) zones. The estimated arable land that is cultivated is around 3% of the total area of the country. The dry land occupies around 61.9 % of the arable land followed by the irrigated land with 27.86 % and horticulture crop cultivation with 10.24 %. The cultivations are mostly on hill slopes, in valleys, alluvial fans, coluvial deposits, and flood plains. The striking feature of this mountainous range is that relief continues to develop and does not allow soil materials to reach advance stage of weathering according to Vambeki. Surface erosion can usually remove earthy materials faster than weathering can produce them and wide climatic diversity within short distances resulting in cool conditions on top of mountains to hot conditions in the lowlands. The increasing population living on these dry lands poses a big challenge to sustainable farming.

There is high demand for infrastructure development, and good arable lands are being used for the construction of towns, real states, schools, farm roads and individual houses. Good paddy fields (irrigated arable land) were lost for infrastructure development from Thimphu, Wangdi and Punakha dzongkhags while Paro and other dzongkhags continue to face increasing pressure. The pressure on forestland is also building up with the increased number of farm roads, mining areas, resort constructions, and power transmission lines cris-crossing the country. During 2010-2011 period, 10,285.77acres of government reserve forestland was allotted to leased land, road and power transmission line constructions and other uses. The recent stories on the proposed golf course in Shingkhar (wetland), Ura geog, Bumthang; proposed 36 km Shingkhar–Gorgan farm road construction through core protected areas; and Nganglam township proposed in biological corridors captured the attention of media and senior bureaucrats. The decisions taken in all these land use changes are mostly not guided by the land capabilities and limitations. There is also almost no consultation with relevant agencies when these decisions are made so whatever information is available is also not put to good use.

4. Tools and Models used:

Remote sensing and geographical information system (GIS) are the tools applied by various agencies in management and analysis of natural resources information. For example, every research centre under the ministry of agriculture and forests has its own GIS facilities to process and analyze data. How gainfully these facilities are put in good use is questionable? Over the years it has been expensive to update technology and support the optimal running of these facilities. There are some private firms setting up such facilities in the market. It is therefore important to assess and utilize these facilities to add value to available data in the

line agencies so that the information generated are more user friendly and can be utilized easily by decision makers.

One good example is the geo database of farm road developed by the Department of Agriculture in 2011. The local firm developed farm road database by using GPS. This survey was carried out to validate farm road conditions using information like gradient of road, conditions of drain, conditions of cross-drainage structure, whether the road is pliable or not, and beneficiary household information. Now there is a provision to update this database regularly.
The Intergovernmental Panel on Climate Change (IPCC) uses models to predict future climate scenarios by using physical data sets from case studies and research findings of various institutes and research organizations. These findings are translated into policy briefs and decisions to draw the attention of world leaders and politicians. For example the IPCC Assessment Report IV predicts that CO2 concentrations from 330-660 ppm might cause a 10 to 50 % increase in growth and yield of C3 crops, and a 0 to 10 % increase for C4 crops. One degree centigrade (C) increase in mean annual temperature (T) would tend to advance the thermal limit of cereal cropping in the mid–latitude (NH) by about 150 to 200 km, and raise altitudinal limit to arable agriculture by about 10 to 200 m; and one degree C warming reduces effective winter chilling by between 10 and 30 %, a pole ward shift of temperate crops. The global warming or climate change debates received worldwide attention because of these findings.

If one can collect good data sets, informed decisions is possible for land use changes by using different models. The Druk Dynamic Information Framework (DDIF) model was put in place under the guidance of the National Soil Service Centre (NSSC). Although the progress has been very slow, the intent was to predict impacts of changes in agriculture and forestry practices on local and regional water balances; can floods or drought be predicated or at least anticipated one or two months into the future; how would changes in land use practices, with varying climate, affect water supply and water quality and how would development of infrastructure affect downstream flow, water quality, and hydropower and fisheries resources.

5. What are our Current Challenges?

There are a number of challenges with the current information management system in the country. The information/data sets are either mostly scattered or not reliable. Even if it is available, access to information is often limited or not possible because of poor institutional linkages. Time series data sets are also missing. For example, data on rainfall, temperature, precipitation is limited and confined to limited zones or locations because of physical barriers while IPCC recommends at least 30 years data for predications or modeling purposes. Moreover, in many agencies, resources to carry out bio-physical and social surveys are very limited and its analysis usually receives very low priority. Another weak area is poor coordination and communication among relevant agencies in ecological and social surveys information collection, synthesis and translation into policy decisions. Use of information produced from geo-information analysis in planning process is also very poor.

6. A way forward to improve information management system

A mechanism should be established to improve coordination and efficient use of resources among institutes in the country. One approach is consolidation of GIS facilities and resources within and among various agencies. There is a need to set up agro-meteorological stations across the country and it should receive top priority in the 11 FYP. A key to reduce duplication or waste of resources is through good consultations among stakeholders in the adoption, and use of different data collection methods and analysis such as the use of standard models. Above all, decisions on major land use changes should be taken based on the analysis of bio-physical resources and there should be consensus at the highest policy making bodies in setting the national priority right. It is also equally important to connect findings from analysis of bio-physical data with the policy decisions through various consultative platforms at various levels to help bring about evidence based policy instruments.

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Application of GIS for Urban Management: a case of Thimphu Thromde

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Key Words: GIS, urban management, utility, city addressing, roads

Abstract:
Urban management is essential for the cities to achieve socio-economic development. If urban cities are not managed at an initial phase, it will result in disorganized system making it impossible to apply optimal solutions. Therefore, for managing cities all over the world, GIS is being increasingly used as a tool for managing urban affairs and to make informed decisions.

In view of the above, Thimphu Thromde has started applying GIS for the development of city address system, utility management and in planning roads. All of these are being addressed in achieving good urban environment through sustainable use of geo-information management.

1. Introduction

Thimphu Thromde(Municipality) is the national capital and the largest urban centre in Bhutan. It spans within an area of 26 Sq Km. Thimphu Thromde is divided into 16 Urban Villages with 21 Precincts as per Thimphu Structure Plan. It is located at 27°30' N latitude & 89°30'E in western Bhutan.

As per the recent household survey under taken by the Thromde, there are about 120,000 people residing within the municipal boundary. Many infrastructures both in content and extent have been added significantly and it is gradually becoming more difficult to manage the urban affairs. Further, it was also pointed out by one of the urban specialist Dale Vanessa Holiday from USA that without GIS, it will become increasingly difficult to manage the city. Therefore, the intend of the paper is to apply Geographic Information System (GIS) in mapping to enable proper management of utility assets, city address and in planning the roads in mountainous terrain with the use of products from high resolution satellite imagery. Further, to demonstrate to other GIS users attending the conference to highlight the applicability of GIS in urban sector.

2. Methodology

The paper will focus on three projects recently undertaken in Thimphu Thromde and will try to qualify as a research paper as this is the first of its GIS application developed so far in Bhutan.

2.1 Study Area

The selected study area is Thimphu Thromde at large. Specifically, utility mapping is limited to the main and distribution lines within the main core area and does not extend to the household level. Secondly, in case of city addressing, the focus is on the recently implemented pilot project which is a part of the core area. Finally, the planning of roads demonstrated is within the Samtenling Local Area Plan.

2.2 Data used

Base map generated from GeoEye image 50cm resolution along with DEM/contours 2m has been used along with the utility survey data from AutoCAD and LISCAD.

Software employed

Sl. No	Particulars	Specification	Outputs
1	AutoCAD	2012	Editing
2	ArcMap	10	Map (Utility,Address,road)
3	ArcGIS Diagrammer	Open Source	Geodatabase
4	Udig	Open Source	Map/SLD
5	GeoServer	Open Source	Publish Address

2.4 Database design

The geodatabase schema was created using ArcGIS Diagrammer for both utility and city addressing. Different feature classes and tables were defined with the associated relationships. On account of road planning, a part of Samtenling area was used.

3. Results and Discussion

3.1 Utility Mapping

The snapshot below is the result accomplished by the following steps:

Created feature classes in ArcCatalog
Created subtypes and domains in ArcGlS Diagrammer
Published as an .xml document
Imported into ArcGIS geodatabase
Simple data loading in ArcCatalog

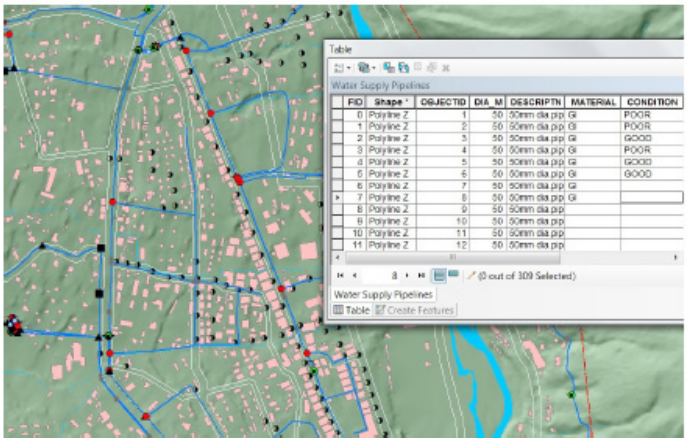

Figure 1 Utility Map showing the water supply lines and the sewerage manholes

The above information would help the utility engineers in their day to day works as well as in optimizing the network. Further this could aid in preparing the annual maintenance budget considering the five year plan. More so this would serve as an input in formulating the utility master plan.

3.2 City Address System

The map below is as a result of the following steps:

Codifying
Mapping
Signing
Numbering
Address Indexing

Figure 2 City Address Index Map showing the house numbers along the named street

The above called out address is related to Building, Street, and Ownership Parcels. Besides postal delivery, for the public: it makes the city more "user-friendly" by improving the system of street coordinates to enable people to get around the city more easily; facilitating the delivery of emergency health, fire, and police services, and locating urban facilities.

For local governments: it increases municipal revenues and improves urban management through the use of tools for planning and managing municipal services and tools to improve local tax collection.

Street addressing helps water, electricity, and telecommunications concessionaires to maintain their networks and collect fees.

Furthermore the same map in ArcGlS could be published online using GeoServer.

Figure 3. Online map showing the information of house number 1

3.3 Planning roads using GIS

The resulting map below shows the alignment of the road

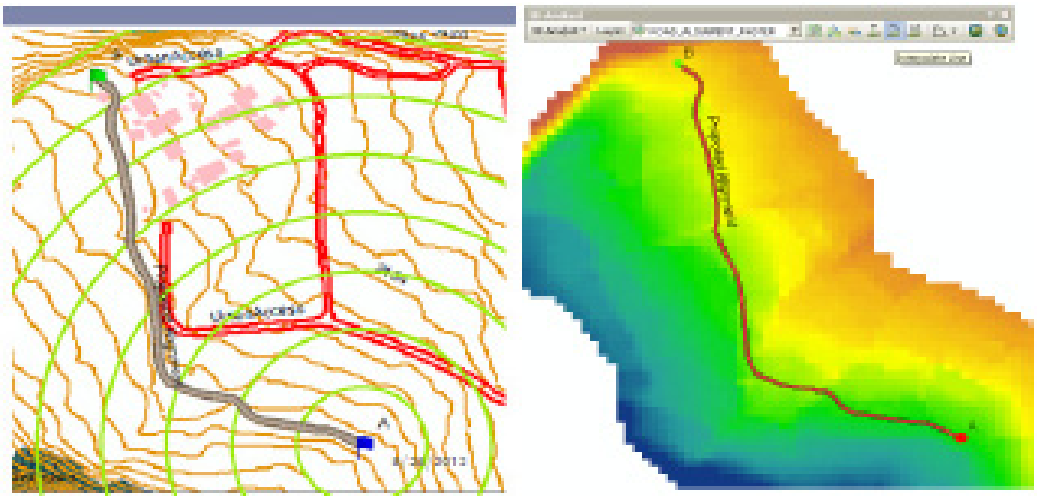

Figure 4 Road alignment using simple buffer technique and interpolation with DEM

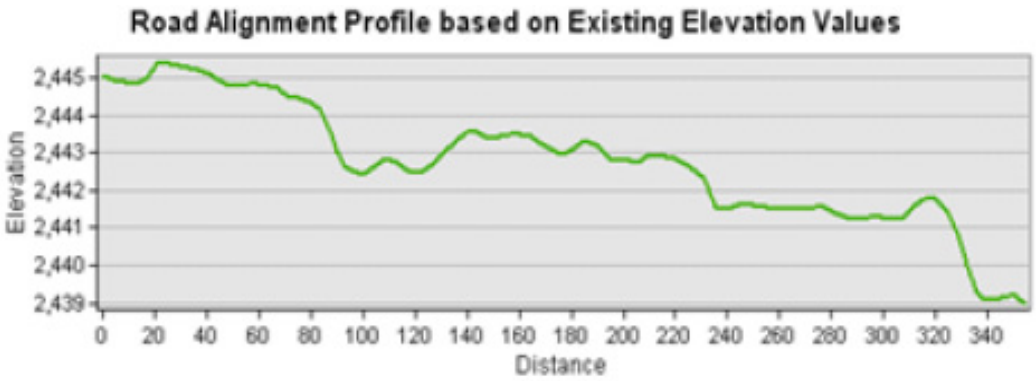

Figure 5 showing the profile based on the elevation values

The above technique could be easily used by engineers to plan road alignment. Many access road proposals within the urban area could be addressed and further extended by considering socio-economic constraints.

4. References

Thimphu structure plan 2002-2027