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# The integration of built and natural environmental datasets within the context of national spatial data infrastructure initiatives**

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# The Integration of Built and Natural Environmental Datasets within the Context of National Spatial Data Infrastructure Initiatives

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## BACKGROUND

Sustainable development and meeting "the triple bottom line" (economic, social and environmental objectives) requires an understanding of the natural and built landscape in order to observe and monitor change and to create realistic simulations of the evolving environment. This requires access to both built and natural environmental datasets. Over the last decade these needs are being addressed by establishing spatial data infrastructures (SDI) where one of the key objectives is the integration of these datasets, and specifically cadastral (built) and topographic (natural) spatial data. The drive to establish SDIs is also driven by a need for governments and businesses to improve their decision-making and increase efficiency (Gore, 1998), as well as the advent of accessible, powerful information and communications technologies.

In simple terms the concept of a Spatial Data Infrastructure (SDI) was developed throughout the world to deliver easier access to spatial data. An SDI facilitates and coordinates the exchange and sharing of spatial data between stakeholders in the spatial data community. SDI is an evolving concept. It is much more than data and goes far beyond surveying and mapping. An SDI comprises data, standards, access network, institutional arrangements and policies, and human resources, and comprises dynamic partnerships between inter- and intra-jurisdictional stakeholders. A fundamental part of any SDI is the spatial referencing system that ensures all positions conform to well defined horizontal and vertical datum's and to a known quality.

SDIs must be focused and coordinated to maximize investment in data collection, integration and maintenance. Existing SDIs evolved to facilitate cooperation between users and producers of spatial data. If well built, they promote economic development, stimulate better government, and foster environmental sustainability.

Amongst spatial data, cadastral and topographic datasets are the most important for describing the built and natural environment. These datasets are the 'foundation data' (Groot and MacLaughlin, 2000) in modern market economies. Cadastral datasets are the accumulation of individual property boundary surveys undertaken by land surveyors. By nature, cadastral data is very different to topographic data which is produced at medium to small scales over large regions using various techniques.

Cadastral data is usually large to medium scale (1:500-1:10,000) and focuses primarily on boundaries of land parcels and properties shown within cadastral maps. It usually includes details of size, location and nature of land parcels, and in developed systems, a geo-referenced description of the land. Topographic data primarily represents physical features found on the surface of the earth including rivers and lakes, vegetation, landmark features, and hydrology. Topographic data is generally available at various precisions and scales, and can be represented in both two- and three-dimensional form. The nominal scale of these datasets is normally smaller than cadastral data and ranges from medium to small scale mapping.

In all countries, the two foundation datasets were developed to serve different purposes and are usually managed separately. This separation is recognised as a barrier to implementation of sustainable development. Duplication imposes unjustifiable costs on data collection and maintenance. The datasets should adopt the same overarching philosophy and data model to achieve multi-purpose data integration, both vertically and horizontally (Ryttersgaard, 2001). Merging of these datasets at a local level has been achieved to some degree, however, attempts to integrate the datasets at a national level, even where SDIs are well developed, has been difficult and problematic, in both Australia and internationally.

Within Australia for example, separation of the datasets is further institutionalised by law and jurisdictional competencies. National SDI initiatives for better coordination cannot overcome the institutional or data incompatibility barriers despite needs to maximise benefits from investment in data collection and to better inform land management decisions. Technological opportunities for data sharing alone cannot facilitate holistic comprehension of land as a composite of its built and natural components.

## RESEARCH AIMS

This research aims to better understand and describe the technical, jurisdictional, institutional, legal and land policy perspective surrounding the two foundation datasets (cadastral and topographic) in a National SDI. The research will investigate the justification for integrating these two forms of spatial data in support of sustainable development (Figure 1) and develop a model and framework capable of being used in diverse jurisdictions.

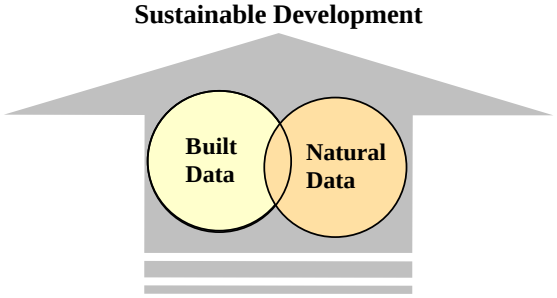


**Figure 1:** Integration of datasets to facilitate sustainable development

The research has four aims:

1. Investigate the problems and issues in integrating data in National SDIs within Australia and related International case study countries, through an analysis of:
   a) History of integration of cadastral and topographic mapping and related National SDI initiatives.
   b) Capacity for and policies relating to data integration of cadastral and topographic datasets.
   c) Institutional support for and barriers against data integration of cadastral and topographic datasets.
2. Develop a framework model for the integration of built and natural environmental datasets at a national level, through the development of National SDIs.
   d) Investigate interoperability issues of national topographic datasets and state/territory cadastral (and other relevant) datasets and develop a methodology to prioritise SDI datasets.

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| | e) Develop a justification and strategy to integrate these datasets in support of sustainable development. |
| 3 | Identify the benefits of the integration framework model for Australia and developed and transitional countries in the Asia-Pacific region, with reference to case study countries. |
| 4 | Undertake a publication strategy. |

## SIGNIFICANCE AND INNOVATION

### Research Problem

This research will investigate the problems associated with the integration of built and natural environmental datasets within the context of a National SDI from a technical, institutional and land policy perspective. These issues include interoperability, data models and standards for this integration, particularly between federal topographic and state cadastral datasets.

These problems are institutionally recognized widely within Asia and the Pacific region and acknowledged by PCGIAP. ANZLIC – The Spatial Information Council (ANZLIC) and the Public Sector Mapping Agencies Australia Ltd (PSMA) in Australia have pioneered integration on a project by project basis, identifying a spatial base for the national census and producing the Geocoded National Address File (GNAF). PSMA's success as a clearinghouse for the Australian SDI indicates the potential for an organization to coordinate the Federal Government's natural environmental and the State's built environmental datasets. There are limitations however in the ability to harmonise individual state data together with federal data that are inherently heterogeneous.

Despite some successes, lack of understanding of the importance and necessity for access and interoperability between the two forms of data remains among policy makers at state and federal levels, a problem identified by the state and federal partners as well as case study countries in this research. The research will therefore investigate and clarify the relationship between integration of the two forms of spatial data and capacity to deliver sustainable development. Lack of understanding is a universal problem as identified by United Nations resolutions, and also identified as a major barrier to achieving sustainable development within a National SDI initiative.

### Significance

The research will develop a framework for data integration and national implementation of SDI capable of servicing needs of both developed and transitional countries. The framework models, technologies and strategies used for collection, manipulation and access of data will all constitute significant outputs. Increasingly, cadastres and SDIs use the latest information and communications technology (ICT). Simultaneously with improvements in access technology, the project will deliver improved functionality and usability of spatial data particularly in situations of growing need for integrated data: for instance, risk management (fire and flood), coastal management, tree cover, land degradation and salinity, water, improved land use planning, heritage protection and native title management.

The technical, institutional and policy issues concerned with integrating framework datasets are recognised internationally as a major priority by UN conferences in Asia-Pacific and the Americas [Resolution 5, 6th UN-Regional Cartographic Conference for the Americas, New York 1997 (E/CONF.90/3); Resolution 5, 7th UN-Regional Cartographic Conference for the Americas, New York 2001 (E/CONF.93/3)]. For example, Resolution 15 adopted by the 14th UN Regional Cartographic Conference for Asia-Pacific (UNRCC-AP) calls for an investigation into "issues, problems and solutions concerned with integrating digital cadastral mapping with large-scale topographic mapping within the context of a wider national spatial data infrastructure" (14th

UNRCC-AP, 1997). An approved strategy for this investigation requires exploration and justification of associated conceptual, institutional and technical issues (16th UNRCC-AP, 2003).

Use of integrated cadastral and topographic data to deliver sustainable development objectives was identified in the UN Bogor Declaration on Cadastral reform- section 4.7 (FIG, 1996) and the UN Bathurst Declaration on Land Administration for Sustainable Development (FIG, 1999). These declarations also highlight the need for sharing of integrated data among nations, particularly to address common ecological problems.

The project builds on international and regional collaboration within the Asia-Pacific region through a partnership with Working Group 3 (Cadastre) of the Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP). This committee brings together 55 developed and developing countries, forming the basis for the development of case studies. The regional context will provide Australian industry with detailed insights into the strengths, weaknesses and opportunities in spatial information and particularly cadastral and topographic mapping. The project will also establish a wider network of government officials, private sector practitioners and academics in the region strengthening Australia's competitiveness.

Further outcomes include a solid technical foundation for data sharing and a strategic policy position upon which sustainable development initiatives can be based. Figure 2 shows how the integration of foundation data in a National SDI facilitates better decision making in disciplines such as Land Administration, helping to achieve the social, economic and environmental objectives of sustainable development. This research will test this model and develop a framework and strategy to sustain the fiscal, technical, human and political resources critical to the achievement of this vision.

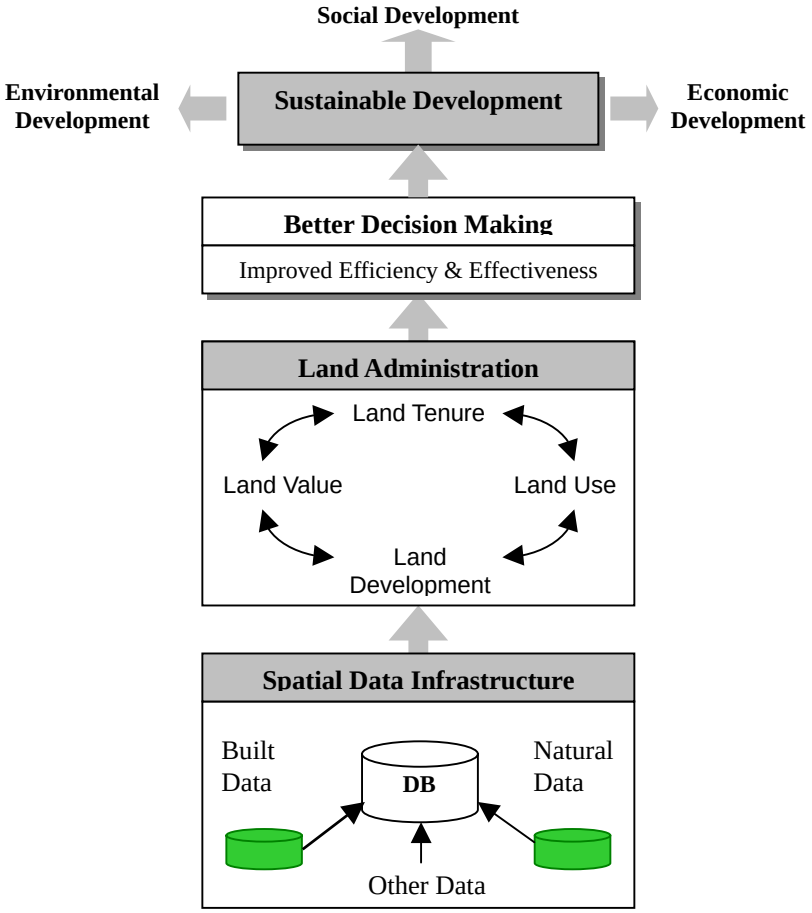


**Figure 2:** Integration of Built and Natural Environmental Data within an SDI to support Sustainable Development Objectives

## NEW METHODOLOGIES AND TECHNOLOGIES

The primary aim of the research project is development of a methodological framework for institutional initiatives in integrating cadastral and topographic data. The project relies on new and cutting edge technologies in ICT to develop opportunities for data integration and access.

The research will advance knowledge and understanding of the ability of National SDIs to deliver sustainable development objectives in a modern information society. This will be achieved through the development of new concepts and policies to integrate medium to small scale topographic datasets with large scale people relevant datasets (especially cadastral data).

The development of integrated datasets for a nation is a cultural and institutional challenge more than a scientific one. Therefore, this research aims to develop a data model, framework and strategy to facilitate organisations to better tackle this challenge and be more proactive in developing relationships at all levels of government. This includes a critical examination of philosophies, structures and processes and is significant to the project's industry partners.

## APPROACH AND TRAINING

### Methodology

The research requires diagnosis of the benefits of and capacity for integration of two different forms of data (built and natural environment) in countries of variable national capacity, from developing economies to developed economies in the Asia-Pacific region. The varying degrees of development of SDIs within these nations requires a case study approach. The approach is justified when topics must be defined broadly, when contextual conditions (and not just the phenomenon of the studies) are relevant, and when multiple and not singular sources of evidence are relied on.

The case studies will assist analysis of historical, policy and institutional comparisons. Comprehensive analysis of the results will identify a cross-section of problems, methods and levels of integration within existing National SDI initiatives. Secondary benefits of the case study approach include giving industry partners a common point of contribution to the project and providing a practical analysis of the research outcomes.

### Case Study Selection

Case studies will be facilitated by the countries involved in PCGIAP. PCGIAP was formed by national mapping agencies of Asia-Pacific in 1995. It aims to maximise the economic, social and environmental benefits of geographic information by providing a forum for nations to cooperate in the development of a regional SDI for Asia-Pacific (APSDI) and to contribute to the development of the global infrastructure.

*Case Study #1 – Australia*

Within Australia (through the activities of ANZLIC and the PSMA), the institutional and technological arrangements to facilitate integration of cadastral and topographic data are partially developed and the country has begun to implement a National SDI. Considerable research still needs to be undertaken however to identify an appropriate national framework to resolve interoperability issues of national topographic datasets and state/territory cadastral (and other relevant) datasets and to deliver the level of integration required to assist development of land policies aimed at sustainable development. The states of Victoria, NSW and Western Australia will be reviewed as part of the case study, with a national perspective supported through involvement by Geoscience Australia.

*Case Study #2 – International case study (Developed and Transitional Countries)*

The international case study is designed to gain access to both developed and transitional countries in order to broaden the focus of research. Countries in the Asia-Pacific region are still developing their institutional arrangements and technological strategies to achieve collection and interaction of data, though developed countries are testing strategies on a project basis. The development of National SDIs varies from country to country, with policy creation and technical development generally being higher priorities for research (especially in transitional countries) than institutional arrangements and data interoperability. A considerable amount of research into developing a national framework for automation of updating and integrating datasets is needed. Apart from Australia, there are six countries participating in the international case study.

In addition to the current defined case study countries within this project (New Zealand, Japan, Thailand, Malaysia and Australia), and due to the importance of involvement of countries affected by the tsunami Indonesia and Brunei Darussalam proposed to joint the case study project during the recent Annual meeting of PCGIAP, held in Bali, Indonesia, May 2005. There was also a suggestion to conduct a pilot project on Borneo Island (which is shared by the three case study countries) as part of the case study project within Asia-Pacific region.

## INTERNATIONAL BENEFIT

International issues concerned with land management, environmental sustainability, water rights, indigenous land tenure and disaster management can only be addressed by accessing integrated spatial datasets within the context of National SDIs. Access and integration are problems due to different state-federal approaches, and because of different institutional structures and cultures, divergent data models and different types or forms of data.

A better understanding of the technical, jurisdictional, institutional and legal dimensions of these two forms of data, and improvement in spatial data access and integration will significantly assist delivery of sustainable development objectives.

By undertaking case studies of how this issue is addressed in different countries, governments will better understand the issues and hopefully learn from their experiences. The review of different countries will also assist in determining “best practice” solutions and improve capacity to evaluate the success or performance of its systems.

The research project will deliver significant benefits to spatial information industry. The project will also enhance interaction between member nations of PCGIAP and the international academic community and companies working in the natural and built environmental data sectors.

## COMMUNICATION OF RESULTS

The importance of communicating the research results to peers and industry is recognised. The results will be published through different media. A key component of the project will also be an International Workshop organised in conjunction with the next UNRCC-AP and PCGIAP Meeting in 2006 in Thailand. This workshop will enable research progress including implementation strategy to be shared with an International audience as well as sharing International experiences within similar projects.

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**Biographical Notes**

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**Prof Ian Williamson** is Head, Department of Geomatics, University of Melbourne, Australia, where he is Professor in Surveying and Land Information, and Director of the Centre for Spatial Data Infrastructures and Land Administration. He is Chair, Working Group 3 (Cadastre) of the Permanent Committee for GIS Infrastructure for Asia and Pacific (PCGIAP). He was Chairman of Commission 7 (Cadastre and Land Management) of the International Federation of Surveyors (FIG) 1994-98 and Director, United Nations Liaison 1998-2002. His teaching and research interests are concerned with designing, building and managing land administration, cadastral, and land and geographic information systems in both developed and developing countries. He has consulted and published widely within these areas.