Carleton University

A GEOSPATIAL DATA INFRASTRUCTURE IS AN
INFRASTRUCTURE FOR SUSTAINABLE DEVELOPMENT IN
EAST TIMOR

By

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ABSTRACT

East Timor became independent from Indonesia in August of 1999 and shortly thereafter an Indonesia backed militia destroyed critical natural resources and infrastructures. A host of overseas development agencies assisted with humanitarian aid, reconstruction and nation building. East Timor is unique since its Constitution includes sustainable development as a key principle. Sustainable development is dependant on decisions derived from accurate and timely geospatial data and these need to be compiled, stored, managed and disseminated. Geospatial data infrastructures are the inter-sectoral, cross-domain and inter-departmental consensus making mechanisms by which a nation manages its geospatial data assets. Overseas development agencies compiled much data and rendered some maps but these are project specific limiting their utility in other contexts. There is also no formal body coordinating these information resources. East Timor has many data requirements and it is argued that for East Timor to meet its sustainable development mandate an East Timor GDI is required.

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CHAPTER 1

INTRODUCTION

The Democratic Republic of East Timor is a small island state in the South Pacific, approximately 500 km north of Australia (figure 1.1). It is the world's newest nation and on September 27, 2002 it became the United Nations' 191st member. East Timor is undergoing tremendous transformation in a compressed time frame. In a little over three years, it experienced the complete destruction of its physical and social infrastructures, has become a fully independent nation, and is becoming a full-fledged democratic republic. Its nation-building process is unique since it has risen, metaphorically and physically from the ashes of its targeted destruction. Also, thirty thousand citizens were involved in the formulation of its constitution and sustainable development is a key principle of that document.

Sustainable development, as defined by the World Commission on Environment and Development in 1987, is "development which meets the needs of the present without compromising the ability of future generations to meet their own needs" (UNCED, 1992). Sustainable development is also "the reconciliation of society's developmental goals with its environmental limits over the long term" (NRC, 2002:2).

Figure 1.1
Location Map of East Timor
(TimorNet, 2003a)

In East Timor, this implies meeting the immediate needs for reconstruction with long-term sustainability as the focus and within the limits of the island's resources. Concurrently, East Timor is undergoing a process of "Timorization" whereby East Timorese men and women will, for the first time since the Portuguese formally colonized the island in 1511, manage the nation's institutions and natural resources. Timorization and sustainable development are processes currently fraught with obstacles as the citizens are poor, food is insecure, health care is minimal, education levels are low, managerial capabilities are limited, the environment is degraded, and reconstruction is slow, uncoordinated and not carried out sustainably. Furthermore there is no central coordination of all the research and data compiled for reconstruction by aid agencies, of previously existing data from Indonesia or from international research centres that could assist with informing decision-making on development and the environment.

It is now commonly understood that a key determinant of sustainable development is information, particularly geospatial data (UNCED, 1992; NRC, 1993). The idea that decision-making is a 'data-driven process', acknowledges that without useful and reliable data, effective decisions cannot be made. This explains why "agencies, governments, corporations, and even private individuals expend tremendous time, effort, energy and money 'sensing' and acquiring data about their environments" (Lein, 1997:40). Although important, geospatial data on their own are simply discrete objective facts about events of particular places at particular times and are insufficient unless communicated, conceptualized or condensed into information that is meaningful to decision-maker audiences (Sena & Shani in Laurini, 2001:190).

As well, information needs to be accessible, thus necessitating some capacity for it to be stored, managed, retrieved, analysed and disseminated. Therefore, a type of data management, manipulation and analysis system is required so that data can be transformed into useful information. When information is compared, connections are made or consequences are inferred, it becomes knowledge. The operationalization of sustainable development policy stemming from informed decisions is knowledge creation. The collective application of knowledge is wisdom; in this case it is when sustainable development becomes second nature, it is embedded in the institutional and social structures of a nation and becomes part of the value and belief system of its citizens (Sena & Shani in Laurini, 2001:190). At present, East Timor has a limited patchwork of social, demographic, environmental and health information compiled by international aid agencies.

To fully implement sustainable development in all aspects of its society and economy, East Timor will require, among other things, a formal system to collect, manage, store and disseminate spatially referenced data with related attributes. Geospatial data are particularly useful since they are "data, usually stored as coordinates, that describe the location, shape, and spatial relationships of geographic features" and attributes (National Atlas of Canada, 2001). Geospatial Data Infrastructure (GDIs) are mechanisms to coordinate all aspects of geospatial data for the purpose of sustainable development decision-making in all levels of government, industry, and society. GDIs are the institutions, policies, technologies, processes, standards, and framework data (figure 1.2), that direct the who, how, what and why geospatial data on myriad subjects and at various scales are collected, stored,

Figure 1.2
Geospatial Data Infrastructure (GDI)
(Image adapted from Centre for International
Economics, 2000)

manipulated, analysed, transformed and shared. GDIs, like physical infrastructures (e.g., utilities, transportation, etc.) provide “the underlying structure of services and amenities needed to facilitate directly productive activity” (Johnston, Gregory & Smith, 1994:288) they are “labour intensive, indivisible, open of access and have economy wide effects” (Johnston, Gregory & Smith, 1994:288) and they are institutionally and technologically complex.

GDIs are somewhat different from transportation networks, utilities, and community facilities since they are transparent to their users and encompass

the networked geospatial database and data handling facilities, the complex of institutional, organizational, technological, human and economic resources which interact with one another to underpin the design, implementation, and maintenance of mechanisms facilitating the sharing, access to, and responsible use of geospatial data at an affordable cost for a specific application domain or enterprise (Groot & McLaughlin, 2000:5).

GDIs did not explicitly emerge to inform sustainable development but are today considered essential to inform sustainable development strategies (figure 1.3).

Figure 1.3
GDIs inform Sustainable Development

In addition, some GDI initiatives at the national, regional and global scale have sustainable development in their mission statements or as a key issue in their mandates (Ezigbalike, Selebalo, Faiz and Zhou, 2000; GSDI, 2003; PCGIAP, 2003).

If information is considered a key determinant of sustainable development, then GDIs are an effective sustainable development enabling strategy. The United Nations Committee on Environment and Development (UNCED) Agenda 21 positions knowledge, information and data as key assets in Chapter 40, Information For Decision-making. Chapter 40 states that there is a need for sustainable development-related information arising at all levels, "from that of senior decision makers at the national and international levels to the grass-roots and individual levels" (UNCED, 1992). East Timor is committed to sustainable development, but has neither the prerequisite information or the institutional capacity to inform sustainable development decision making, nor a strategic plan to build a GDI. This thesis will argue that the development of a GDI is a strategic step in creating an infrastructure for

Figure 1.4
Infrastructure for Sustainable Development

sustainable development in East Timor as seen in figure 1.4.

East Timor is currently undergoing a massive but largely uncoordinated reconstruction process. Its information and communication technology (ICT) infrastructure is limited at best, and its civic institutions are undergoing Timorization along with managerial capacity building. In short, it currently does not have the mechanisms in place to fully operationalize sustainable development nor does it have the technological and institutional prerequisites to build a GDI. However, it may be possible to develop the necessary organizational structures for the institutional and policy components of a GDI and focus on the technical components at a later time particularly since the “greatest obstacles to information sharing often seem to be behavioural, not technical” (Croswell in Evans, 1997:61). Easily accessible, integrated, geo-referenced geospatial data from disparate sources would improve decision-making regarding important issues such as transportation, the environment, resource management, security and border control (NRC, 2002). Again, section 40.9 of Agenda 21 and the Johannesburg 2002 follow-up support the idea that national and international data and information centres should set up geographic information systems (GIS) as a means to inform sustainable development decision-making.

GDI integrated with sustainable development become more than data and information. They become mutually reinforcing processes in the creation of new knowledge. Strategically integrated, GDIs and sustainable development would position knowledge and its creation as a national resource on par with natural resources essential to East Timor’s economy and society. In new economy literature, knowledge is considered a unique resource since it is a non-rivalrous good, its

consumption does not impede others from enjoyment or benefit from it. Furthermore, knowledge can be exchanged at no cost, but it is not free since economies have to forgo current consumption to pay for the development of new knowledge yet it brings valuable additions that come in embodied and disembodied technologies such as new processes, solar power, etc. (Gera, Lee-Sing and Newton, 1998). Knowledge is a highly valuable and productive commodity, yet few policy environments outside of research and development environments are explicitly created to produce it and fewer incentives are provided to protect it. Knowledge is an intangible asset, difficult to measure and requires long-term investment with uncertain returns. In developing nations or nations undergoing reconstruction investing in intangibles often conflicts with other more pressing needs. The United Nations Committee on Environmental and Development recognizes this "general lack of capacity, particularly in developing countries, and in many areas at the international level, for the collection and assessment of data, for their transformation into useful information and for their dissemination" (UNCED, 1992). This is currently the situation in East Timor.

GDIs are both technologically and institutionally complex. Their development and maintenance are multidimensional, intersectoral, cross-domain and interdepartmental, requiring national scale interdisciplinary consensus building, the cornerstones of knowledge-based economies and democratic processes (FGDC, 2000). A knowledge-based economy (KBE) "is characterised by the need for continuous learning of both codified information and the competencies to use this information. A KBE places great importance on the diffusion and use of information and knowledge as well as its creation" (OECD, 1996:13). In a sense GDIs are environments within which

organizations, nations, and technology interact to foster activities for using and managing geospatial information and to create knowledge (Rajabifard, 2001).

While GDIs are technologically complex, this thesis will primarily focus on their institutional components, which are considered to be the most difficult. To implement the building of the institutional and coordinating structures of a GDI for sustainable development in East Timor will be the primary focus of this thesis. The organizational and cultural transformations required to position sustainable development as a knowledge creation activity and constructing a GDI are critical, particularly if the intent is to create an institutional and organizational framework conducive to learning, information sharing and knowledge creation.

This research topic leads to many interesting research questions; however this thesis will be limited to the following, which are considered central to developing the institutional and organizational aspects of GDIs to create an infrastructure for sustainable development in East Timor.

- I) What new structures would the civil service in East Timor need to develop the institutional components of a GDI to inform sustainable development?
- ii) Could a consensus-building process begin now between departments, across domains, between jurisdictions for the purposes of building information sharing, standards, policy, and framework data working groups before bureaucratic role entrenchment occurs?
- iii) Could GDIs be part of the strategic policy initiative to mandate the collection, management and dissemination of needed accurate geospatial data for reconstruction and sustainable development purposes and initially supported by overseas development agency overseas development assistance (ODA)?
- iv) Among the seven GDI models studied in this thesis is there one in particular that could be adopted and adapted in East Timor to meet the objectives of its new state and its unique culture and circumstance?
- v) Could geospatial data be positioned as a crucial information knowledge resource for East Timor and become an integral part of sustainable development decision-making?

vi) Is it possible to be a nation with a primary resource economy and yet build the necessary institutional capacity for a sustainable development infrastructure?

In addition to the previously stated objectives, this thesis will respond to the following questions:

vii) What East Timorese cultural and social factors need to be taken into consideration in the development of the institutional and organizational components of a GDI?

viii) What mechanisms will enable geospatial information (GI) to become an essential resource for East Timor's institutions and how can this information become part of the operationalization of sustainable development on a daily basis in East Timor?

ix) Can East Timor begin to invest in its human resource capacity in the fields of science, technology, social sciences, cartography, planning, engineering and knowledge management to be able to manage its own GDI in the long term?

x) Can resources aimed toward the implementation of Agenda 21 be used for GDI development in East Timor?

GDI's emerged as extensions of information and communication technology (ICT).

In developed countries, GDI's are considered the result of "early dreams of centralized 'land information databanks' through the 1960s and 1970s to the vision of more complex distributed land information networks in the 1980s" (Groot & McLaughlin, 2000:270). Today, they are an almost 'organic web' of municipal, national, regional and global government, industry, academic and NGO partnerships and relationships purposely evolving within different jurisdictions (Groot & McLaughlin, 2000:270). While GDI's are considered instrumental to informing sustainable development decisions, and considerable resources have been directed toward their establishment in developed countries, they have not received wide ranging attention by international development aid agencies. In addition, ODA strategies to bridge the 'digital divide' and to build ICT

infrastructures have focussed primarily on the installation of computers and have not included content such as data, national geospatial data acquisition processes or geospatial data infrastructures although there has been some support toward standalone GIS projects. GDIs have also not been positioned as nation building strategies for countries undergoing reconstruction. Yet, the UN has passed numerous resolutions on Agenda 21, again re-iterated in Johannesburg that it would support such an initiative. UN recommendations have been to develop indicators of sustainable development, promote their global use, and improve data collection. The UN also recommends encouraging methods of data assessment and analysis, establishing comprehensive information frameworks, and strengthening the capacity for traditional information compilation. Furthermore, "all countries, particularly developing countries, with the support of international cooperation, should strengthen their capacity to collect, store, organize, assess and use data in decision-making more effectively" (UNCED, CH.40 section 40.16, 1992) and sustainable development is a primary ingredient in all UN interventions. Additionally, the UN has a Cartographic Section on Maps and Geographic Information Resources and a UN Geographic Information Working Group (UNGIWG). These are very small units that provide data and maps to inform UN missions and are only beginning to participate in international mapping development strategies. Therefore this thesis will investigate extending GDI expertise, standards, data, knowledge, technologies, and human resources from institutions and neighbouring national, regional and global GDIs to assist with the formation of a GDI unique to East Timor's needs and requirements.

East Timor is geographically well located to benefit from the Permanent Committee on GIS Infrastructure for Asia & the Pacific (PCGIAP), the Australia and New Zealand Land Information Council (ANZLIC), which guides the activities of the Australian Spatial Data Infrastructure (ASDI), Malaysia's National Infrastructure for Land Information System (NaLIS), and, the Japanese National Spatial Data Infrastructure (JNSDI), the Canadian Geospatial Data Infrastructure (CGDI) and to a lesser extent, the Portuguese Sistema Nacional de Informação Geográfica (SNIG). There are numerous other important GDI initiatives in Europe and the United States but these will not be studied since they are not directly connected to East Timor. Also, since East Timor is classified as a less developed country (LDC), the implementation of GDIs in that context will be explored. The focus will be on the institutional components and organizational structures, while GDI-related technologies will not be explored. The objective is to create a GDI to inform sustainable development strategies without a detailed focus on the technology. While GIS adoption and related issues will be explored, the focus will not be on particular applications but rather on how geospatial information technology issues are embedded in GDIs. This thesis will also investigate the possibility of extending the expertise and services of global, regional and national GDIs via overseas development assistance (ODA) to assist East Timor with building its own infrastructure for sustainable development.

For these reasons, and those articulated in Agenda 21, Chapter 40, and the Rio follow-up Johannesburg, 2002, this thesis will explore the implementation of a GDI for the small island nation of East Timor, currently undergoing reconstruction after the massive destruction caused by the Indonesian backed-militia which followed the

referendum of 1999. A central argument is that East Timor could benefit in the long run by developing the building blocks of a GDI during reconstruction and nation building. East Timor has articulated a commitment to sustainable development in its Constitution and GDIs are recognized as effective means to inform sustainable development strategies. It is argued rather than undertake a technological approach to build its GDI that East Timor adopt the institution building required to develop a GDI as well as nurture its human resource capacity in this area. Finally, it is proposed that sustainable development be the reason for building a GDI since they are mutually reinforcing.

This research topic was inspired by the perplexing fact that so many opportunities exist for East Timor to receive ODA to develop a data gathering structure but none has been implemented. East Timor's ICT system, institutions and reconstruction have/are benefiting from well-developed ICTs embedded in the family of aid and financial agencies (i.e. UN, WB, IMF, ADB, etc.), from its historical allies (i.e. Portugal, United States, Canada), neighbouring countries (i.e. Australia, New Zealand, Malaysia, and Japan) and regional associations (i.e. APDIP), yet these do not direct resources toward coordinating data to inform sustainable development. Consequently, East Timor has been mapped in an ad-hoc fashion before and after the referendum by a host of organizations such as Australian Government's overseas aid program (AusAID), United Nations High Commissioner for Refugees (UNHCR), World Bank (WB), University of Texas, U.S. CIA, Lonely Planet and News Agencies. However, these, apart from AusAID are not providing resources for East Timor to carry out its own mapping. Maps are currently being used to inform reconstruction, orient aid workers, locate resources

such as ports, airports, roads, physical features and topography. They are also used for international communication and defence purposes but these initiatives are not part of a national mapping strategy. Australian Defence and AusAID have assisted with the creation of an operational GIS mapping unit staffed by three East Timorese undergoing on-the-job training yet it is very small and is not considered as a national mapping agency. Further, aid agency reports confirm that there is a lack of data to inform their work yet there has been no mention of possibly extending the GDIs in the regions to provide East Timor with much needed data, nor did aid agencies make explicit the need to fund a mapping agency or assist with capacity development in this area. National security issues prompted map making and the development of a GIS mapping unit; it is suggested here that sustainable development be the impetus for ongoing support to construct a GDI.

East Timor is considered an excellent case study since it has a blank institutional slate, with no apparent historical bureaucratic fiefdoms or entrenchment. Its leaders have a spirited commitment and its citizens are eager to develop a new nation by and for East Timorese. While its landbase and population of 750 000 is small, East Timor has an explicit commitment to sustainable development. East Timor's culture, geography, size, and population combined with its unfortunate circumstances may in fact be its assets in this instance: East Timor may be able to bypass the difficulties experienced by more established economies and bureaucracies attempting to build GDIs since it will not have to reorient pre-existing practices, particularly if it can build in consensus making and collaborative work environments from the outset since these are conducive to the information sharing that is an essential component of all GDIs.

The reasons for undertaking this study are many. East Timor is in the process of reconstruction and nation building. It has the opportunity to carry out this daunting task sustainably and to build on human and technological resources from neighbouring countries and historical allies who have well-established ICTs and GDIs. GDIs are an extension of strong ICT infrastructures in evolved KBEs, and few studies have been made on GDIs in less-developed countries (LDCs), GDIs and overseas development agencies (ODAs) or GDIs and reconstruction.

East Timor is in the process of reconstructing its water, electrical, agricultural, civil society and economic systems with the aid of a host of UN family organizations and the governments of Australia, Malaysia, Portugal, Canada, and Japan. Along with the construction of buildings, a civil society, a civil service, and an economy, the small island nation also needs to provide the basics such as food, primary education, clothing and psychological assistance among other needs for its citizens. Furthermore, East Timor was building its ICT infrastructure under the auspices of United Nations Transitional Administration in East Timor (UNTAET) and a host of other organizations such as Asia-Pacific Development Information Program (APDIP), the G8 Digital Opportunity Task (DOT) Force, the governments of Australia and Malaysia and CISCO Systems. In addition, East Timor has to manage its natural resources wisely for the long-term benefit of future generations and to satisfy current needs, and geospatial data can assist with informing these initiatives.

Important advancements have been made with ICT development and other basic reconstruction activities are progressing. Yet, the management of East Timor's population, transportation network, natural resources, agricultural productivity, forests,

education and health systems is advancing in a fragmented fashion. The Democratic Republic of East Timor Ministry of Agriculture and Fisheries has developed a small GIS unit with the help of AusAID and international agencies. Neighbouring nations and historical allies have been providing and developing national scale base and topographic maps and supplying Landsat TM 7 satellite data to inform aid, planning and reconstruction. Plans to manage these data in the long run and to integrate these into an accessible repository have been absent from the agenda as has the development of skills programs to develop the capacity for others to effectively utilize this data.

Finally, East Timor is strategically located in a region where there are excellent and emerging global, regional and national GDIs and it may have the opportunity to build on the ICT infrastructures, GIS programs and expertise of its neighbours. This thesis aims to add to the small body of research that explores the institutional innovations involved with the implementation of GDIs to inform sustainable development in a context not conducive for the immediate absorption of advanced technological innovations but ideal for institutional capacity building. The proposition is that GDIs are more than technology and geospatial data, and that “of equal importance are the individuals, institutions, and technological and value systems that make it a functional entity, one that serves as a basis for many of the business of a nation” (Coleman, 1999). This research will explore the enactment of components of GDIs embedded in international, regional and national institutions for the reconstruction of East Timor. In addition, GDI initiatives are only beginning to be recognized by aid strategies. While standalone GIS projects have received some

support it is hoped that this work will highlight the importance of ODA to support a sustainable development-GDIs rather than GIS projects with limited long term impacts. In this light, the research will focus on the institutions and organizational structures for the nation of East Timor. Organizational theory will inform the analysis and Leavitt's Model of an Organization will inform the approach (figure 1.5).

The model divides organizations into 5 integrated interdependent elements: four intra organizational elements such as social structures, participants, technology and goals with one extra organizational element the environment. Organizations can be viewed as hierarchically nested entities categorized into hierarchical levels of analysis. The intra organizational level focuses "on the people, groups, knowledge, tools, tasks that make up the organization", the organizational level focus is on "organizational processes, boundaries, activity systems and strategies" while the interorganizational level focus "is on understanding the relationships and interactions within and among aggregates of organizations" (Baum, 2002:7).

Social structures comprise normative and behavioural structures. Normative structures are the values, norms, and role expectations in organizations while behavioural structures represent actual behaviour rather than the prescriptives for behaviour. Behavioural structures can be observed in activities, interactions and sentiments. Organization culture is formed by social structures and includes the "basic assumptions and beliefs that are shared by members of an organization, that operate unconsciously, and that define in a basic 'take for granted' fashion an organization's view of itself and its environment experience" (Schein in Dodgson, 1993:382).

Participants are the individuals who, in return for a variety of inducements or personal aspirations contribute to the organization. They are the social actors of the organization and they shape the structure of the organization through their behaviour. All organizations have goals or strategies and they are the conception of the desired ends that participants attempt to achieve through their performance. Technology in this model refers to the machines and mechanical equipment contained and used in organizations, and the technical knowledge and skill of its participants.

These five elements are integrated as part of an organization's structure and are vital since "changes in the structural variables can, by themselves, over brief or extended periods of time, cause changes in human behaviour so as to enhance organizational effectiveness" (Argyris & Schön, 1978:225). These variables are structured into activity systems - routines that are organizational tasks purposely subdivided into separate work units or departments, subdivisions which are said to promote efficiency (Withane, 1987:4). The mechanisms and methods used to integrate an organization's different units can characterize structures. GDIs like all organizations are complex human collectivities constructed to resolve societal problems (Baum, 2002 and Lomi & Larsen, 2001). Also, organizations "are social structures created by individuals to support the collaborative pursuit of specified goals" and "they are deliberately structured activity systems with identifiable boundaries" (Scott, 1998:10, Withane, 1987:4).

Figure 1.5
Adaptation of Leavitt's Diamond of
A Model of an Organization
(Scott, 1998:170)

The research methodology is qualitative and will involve a literature review of reports, journals, texts, Internet sites, institutional policies and mandates from both hard copy, and digital sources. Some electronic mail discussion with the East Timorese GIS unit has also been carried out. Key topics are geospatial data infrastructures (GDIs), sustainable development, organizational structures, and GDIs in less-developed countries (LDCs). Research will be directed at understanding GDIs in general with a comparative analysis of seven GDI models referred to earlier in order to ascertain, document and interpret structures to assess if a particular model is suited for East Timor.

Chapter two will describe the history, geography, socio-cultural composition and social structure of East Timor from the pre-colonial era until the present. The objectives are to identify social, cultural and traditional practices that may influence the way institutions are structured, how people make decisions, assess skills and the relationship people have or had with their environment. This will provide an understanding of the social, cultural and behavioural structures of East Timorese society over time that will be taken into consideration when developing an infrastructure for sustainable development in chapter four.

Chapter three will explore the evolution of GDIs from standalone GIS projects, to subject-specific international collaborative mapping projects and how the knowledge gained from these experiences inspired the development of GDIs. GDIs in general and their components will be described and models from Canada, Malaysia, Japan, Portugal and Australia will be examined as will the regional Asia Pacific and global models. The focus will be primarily on organizational structure, institutions,

collaboration incentives, and mandates. Furthermore, the context of GDI development in LDCs will be discussed.

Chapter four will first demonstrate that East Timor requires data and information to fulfill its constitutional and regulative obligations. Second, that its newly formed government ministries, departments, and units require data and information to plan and provide services to citizens and to manage resources and physical and social infrastructures. Third that ODA documents have recorded a significant number of unresolved issues and problem areas. Decisions to resolve these it is argued could be improved with geospatial data and a GDI is an effective mechanism to coordinate geospatial data related activities. Fourth, an analysis of the seven GDIs studied in chapter three will be provided to assess if any would be suitable for East Timor. Fifth a recommended ETGDI model will be presented and finally the chapter will conclude with some high level policy recommendations.

Finally chapter 5 will conclude with a summary of the key findings and will address the objectives of this thesis.

CHAPTER 2

EAST TIMOR

2 Introduction

This chapter will describe the geography, history, socio-cultural composition and formal and informal social structures of East Timor from the pre-colonial era until the present. The objectives are to identify cultural and behavioural social, cultural and traditional practices that may influence the way institutions operate, how tradition may inform sustainable development today, and how these may influence the structure of a GDI in East Timor.

2.1 Geography and Demographics

East Timor is a small island state (265 km long x 97km) located in the Timor and Sawu Seas, north of Australia and east of the Indonesian Islands of Flores and Sumba as shown on the location map of figure 1.1. East Timor's land area is 14 874 km², and includes the enclave of Oecussi (2 500 km²), the Islands of Adair (144 km²) and Jako (8km²) (Sandlung et al, 2001:2) as indicated on the United Nations Transitional Administration in East Timor (UNTAET) agency map in figure 2.1. It is larger than the Bahamas (13 900 km²) but smaller than Fiji (18 300 km²) (Stanford, 1998:212-216).

Figure 2.1
East Timor Reference Map
(UNTAET, 2001a)

The population in 2001 was estimated to be 800 000 (Sandlung et al., 2001). Population growth in 1999 was estimated at between 2.4 to 2.6% (Phillips, 1999), similar to the natural increase of Malaysia (2.4%), Jordan (2.6%) or Laos (2.9%) (Stanford, 1998). Population growth translates to a yearly increase of approximately 23 000 people (Phillips, 1999). The population density is estimated at approximately 53 people/km² and each village has on average 1400 people and some with as few as 200 people (UN-CCA, 2000:73). The capital city, Dili, is located on the north east coast (figure 2.1) has an estimated population of 200 000. The country is now divided into 13 districts and 65 subdistricts, with 462 villages.

Most are Catholic (90%) with animistic and reformist tones developed during the occupation, with few Muslims and some Protestants (TimorAid, 2001). Bahasa Indonesian is spoken by 90% of the population aged 30 years and under, and by 50% of those over the age of 30 a pattern reflecting Indonesian linguistic integration policies. Prior to the referendum, in 1999 between 150 000 and 200 000 non-East Timorese lived in the country, and most came from West Timor, Sulawesi, Java and Sumatra (Phillips, 1999:54). There are numerous ethnic groups in East Timor each with their own languages as seen in the linguistic map (figure 2.2). There are hundreds of dialects all over the interior of the island (Barbedo Magalhães, 1994). Tetum – one of the two official language was not originally spoken in most geographic areas however, the simplified version spoken in Dili has been adopted by 60% of the population. Generally, people in urban areas speak Portuguese while rural people and youth do not (UN-CCA, 2000:25).

Today, the official languages are Portuguese and Tetum (Constituent Assembly of East Timor, 2002) while other national languages are valued and will be developed by the state (section 13, subsection 2). Language is a strong indicator of rural and urban differences in East Timor and tradition runs deep in rural areas where a strong pre-Portuguese socio-political structure still guides some decision-making processes (Sandlung et al., 2001). In addition, much traditional knowledge regarding biodiversity and the use of plants still exists.

The country has six ecosystem types: marine and coastal zones, arid lowland, moist lowland, mountainous, highland plains and urban areas. The topography consists of very high mountains where 44% have steep slopes of 40% (Sandlund et al., 2001) with a central mountain range called Ramelau. Mount Tata-Mai-Lau at 2964m is the highest peak while many mountains in the east are higher than 2000m. The large coastal plain on the southern coast is 20 to 30km wide, while the northern coast is characterized by steep mountains. The soil is relatively thin, with low water holding capacity and there are some important mineral deposits, particularly oil, found in the Timor Gap.

2.2 History

Numerous key events have contributed to the evolution of East Timor and some of the more influential events are mapped on the time line following (figure 2.3). The data in the time line and the information found in the following subsections come from secondary sources since primary sources of information in English are scarce. There are more sources of information during the period of the Indonesian Occupation

(1975- 1999), however the international literature mostly focuses on topics related to human rights abuse and resistance while scientific data about the environment and socio- demographic information are limited or are available only in Bahasa Indonesian. Between 1999 and the present, international defence and aid agencies just prior to and after the referendum gathered data, produced maps and reports containing many more primary sources of information and these will be referred to throughout.

Figure 2.3
Time Line of Historical Events in East Timor

2.2.1 The Island and its People before 1511

The island of Timor has been inhabited for approximately 40 000 years and it is estimated that agriculture was adopted by hunter gatherers between 6000 BC.-0. The people of East Timor are thought to be proto-Malayans, dendro-Malayans, Negritos, Dravidians and Melanesians (TimorNet, 2003) and Indo Malay migration to the island occurred between 3000BC and 200BC (Nicol, 1978). The social structure before the Portuguese arrived was very stratified, history was orally transmitted, and the role of women was considered relatively high compared to places where Hinduism, Islam or Christianity were practised at the time (Barbero Magalhães, 1994).

Early 1436 Ming Dynasty records report that the island had rich sandalwood groves (Taylor, 1999) while other reports suggested the Chinese were primarily interested in this precious wood, honey and beeswax. East Timor like many islands in the Pacific (e.g., Borneo, New Guinea, and the Philippines) was characterized by a clearly defined tribal social stratification system as seen in figure 2.4 (UN-CCA, 2000:20, Phillips, 1999:112-113, Taylor, 1999; Ormeling, 1957). In 1618 a Chinese report stated that Asian traders viewed East Timor as a society "with political hierarchies relying heavily on commerce" (Taylor, 1999:2). The economy comprised three units of production: the household garden, the field, and irrigated padi. The economic organization was extended family, extended kin, and the village. In villages a sexual division of labour was governed by ritual, traditional law (adat) and animistic religious beliefs (Taylor, 1999). The hierarchical system consisted of royalty - king and princes, the masses (dato) - chiefs (uma ulum), clans (uma lulik), village councils

Figure 2.4
Pre-Portuguese Social Structure

elders (nai boot), kinsmen, villagers and slaves (ata). There were three administrative levels: the village (desa), the princedom (suku), and the kingdom (rai). Villages (desa) comprised numerous hamlets whose inhabitants were members of a particular clan (uma lulik) that was ruled by a headman and a council of elders. A village was part of the princedom (suco) headed by a family that was subject to the rule of the king (rai). Princes possessed an aristocratic or royal status over the masses (dato) and slaves (ata) that were captured in wars between clans. A culture of exchange and trade dominated with tribute to chiefs, princedoms and kingdoms, while elders (nai boot) distributed land in return for rent (rai teen). Goods were normally exchanged for women in marriage and elders were in charge of negotiating or brokering all forms of family exchange and distribution. Production, exchange and consumption were dominated by strong socio-economic relations expressed in kinship (fukun) relationships and status. Ancestry worship was important. Chiefs (uma ulum) who were also priest and rulers, made offerings to their ancestors and were entrusted with sacred tribal property (Nicol, 1978). The liurai and their families allocated collective land rights to the ema rai (subjects) that was worked by slaves (ata) (UN-CCA, 2000:20). Conflict resolution processes were mediated by elders and chiefs in a peace-making process called "halu damen" or "badam" (Phillips, 1999). Other traditional roles are the "tah tuaf" who oversaw the planting of trees and managed sacred sandalwood groves as a type of conservation strategy or land stewardship.

2.2.2 Portuguese Colonization 1511 to 1975

The Portuguese first visited East Timor in 1511 (UN-CCA, 2000:20) and like early Chinese traders, were interested in sandalwood – a trade that is thought to go as far back at the tenth century (Ormeling, 1958:95). East Timor was part of the 16th century Portuguese spice trade in the far East (Third Millennium Trust, 2001). The first Portuguese trading post was established in 1562. The first governorship, established in 1701 increased the exploitation of sandalwood (Sandlund et al., 2001). The sandalwood trade resulted in deforestation which scarred the landscape in East Timor: reports of denudation date as far back as 1861 (Wallace in Sandlund et al., 2001:19) and by 1915 efforts began to control sandalwood harvesting. The Portuguese also traded Timorese slaves and the island was used as a slave reservoir for Indonesia in 1792 (Ormeling, 1958:180). The Portuguese extracted resources, bought and sold East Timorese, took over trade, and brought missionaries who were successful in spreading Catholicism, that was adopted with very animistic tones (UN-CCA, 2000:20).

The Portuguese colonialists recognized the autocratic power of East Timorese chiefs and tried to extract loyalty by supporting the chiefs they liked and replacing the ones they did not. This attempt to divide and conquer yielded only limited success. By the mid-17th century, this policy was overturned and instead the power of the kingdom system was decreased and the Topasse Portuguese nationals of African descent took over senior positions in the prinedoms, integrating themselves into the Timorese social structure of tribute, labour and exchange. Considerable political influence and economic gain was exerted and extracted this way as seen in the

modified social structure in figure 2.5. The dominant values were strengthened while the economy became more externally rather than internally driven. The Timorese were able to leave the political sphere to the colonialists and were able to resist their influence and maintain their cultural, social and economic system intact. Resistance and resentment of the Topasse and Portuguese increased and the East Timorese continuously invaded Portuguese strongholds resulting in offices and homes being primarily located in Dili and not in the mountains. After 400 years of colonization, the Portuguese were unable move into the interior (Taylor, 1999).

The Dutch and the Portuguese struggled over the sandalwood trade well into the mid-18th century. In 1859, the Dutch and Portuguese colonizers of the Island of Timor agreed on a boundary that separated East and West Timor and in 1949 the Dutch were forced out of their half of the island while the Portuguese held onto the East. The Portuguese maintained an environment of forced labour and slavery which increased resentment that led to an East Timorese uprising in 1912 that was quelled with support from nationals of the Portuguese colony of Mozambique (Nicol, 1978). Early 20th century Portugal was marked by revolution and the creation of a republic (1910 AD.), bringing change to East Timor.

By 1920 a civic style government emerged in East Timor and the kingdoms became official districts (sukos). More change came after the military coup of 1926 and by 1932 Portugal became an 'iron fisted' dictatorial government under the leadership of Salazar that lasted until 1968. At this point the Portuguese attempted to undercut the kinship systems by abolishing the kingdoms. They re-divided the colony into 13 administrative units, similar to the sucos, with two new administrative levels

Figure 2.5
Social Structure Under the Portuguese

the posto composed of groups of sucos, and the concelho, which controlled the posto via a Portuguese administrator as seen in figure 2.6 (Taylor, 1999). While this formal institutional structure seemed to work, the informal traditional social structure remained strong. Suco heads still sought support from the liurai and their retinue, resulting in two co-existing political systems, one sanctioned by force the other by ancient cultural tradition. Absolute power of royal East Timorese families dwindled while their traditional power remained. The liurai maintained their borders, opened roads, received visitors, organized planting and harvesting and the registration of the population for taxes (UN-NPDA, 2002). The two systems met at the level of the suco head, or the village chief, giving the Portuguese system some legitimacy (Taylor, 1999). The fundamental social structures of the kinship system remained, namely ideologies that legitimized traditional rule, a self-regulating political system, a self-sustaining subsistence economy and a culture based on notions of reciprocity and exchange (Taylor, 1999).

After a military coup in Portugal, the Salazar government was on a mission to civilize the colonies. Two groups were singled out: the indigenes (un-assimilated natives) and the nao indigenes (assimilated natives). Assimilados status and Portuguese citizenship was allocated to those able to support their family and to those who possessed 'a good character'. If one owned a business or was an administrator, one did not have to prove oneself. Assimilados were entitled to vote in the Portugal National Assembly and local legislative councils. This distinction between indigenes and nau indigenes "with a limited recruitment of Timorese into the colonial political system was to have an important effect on the emergence of indigenous political

Figure 2.6
Social Structure during the Salazar Dictatorship

elites", influencing the struggle for independence later on (Taylor, 1999:13). This system created a new stratified social structure with the added components of class and ethnicity but there was little interference with traditional kinship ties, customary law and ceremonial authority positions (UN-NPDA, 2002).

The traditional indigenous system remained intact in rural areas during the colonial period and was used against the Japanese Invaders during WW2. Sixty thousand people were killed during the war and the East Timorese greatly assisted Australian troops in 1941 against Japanese invaders (UN-CCA, 2000:21, Mac:1999). Post-war East Timor was run by a group of elites who derived their position from the colonial structures and the indigenous kinship system (Taylor, 1999). After the war, the Portuguese set up 13 suko (administrative) councils, with associated administrative posts, leaving dispute resolution processes to traditional authorities (i.e., adat system, uma ulum and uma lulik). When the sandalwood trade was exhausted coffee plantations were established in the 1950-1960s, yet most East Timorese lived outside the cash economy until the 1970s (UN-CCA, 2000:20). In 1963 the administrative division of East Timor was created with a Lisbon-appointed governor, a legislative council and a government council—the first signs of an administrative structure. A colonial economic class system continued with Portuguese and Chinese merchants dominating decision-making throughout the administration, while the East Timorese were engaged in plantation and subsistence agriculture (Phillips, 1999).

The education, transportation and health infrastructure in East Timor were abysmal at best. Between 1960-1970 the Portuguese constructed new schools and health services mostly to serve Portuguese or mestizo—mixed-marriage citizens and

assimilated children (TimorAid, 2001). A new harbour, a hospital, government offices and schools were constructed, mostly in Dili. Overall the infrastructure remained poor. Education was overseen by the Portuguese with a focus on the history and geography of Portugal, and some arithmetic. There was very little curricula relevant to the East Timorese reality, which helps explain the low retention rate (Taylor, 1999). Most of the educated class lived in urban areas and few received post-secondary schooling while teachers had little or no formal training. Tertiary education options were attending army training camp or technical school or going to university in Lisbon. Before 1970 only two people per year went to university; in 1974, 39 students attended university. Educated East Timorese were given administrative jobs in the government but few ever got this type of employment and the benefits of education did not reach most. By 1975 there were only "two East Timorese doctors, one dentist, two psychologists, two political science graduates and one agriculturist" (UN-CCA, 2000:21). Only one road in Dili was paved by the end of the 1960s and health care was essentially non-existent for the Timorese while the Portuguese flew to Australia for medical services (Nicol, 1978).

Had resources been filtered back into the agricultural sector, the economy would have had a chance. Instead, most of the money went to companies engaged in the export of crops and not toward national development. Furthermore, had a decolonization process been phased in and had the Portuguese not ignored the South East Asian political environment, there may have been the possibility of developing a new politic for East Timor– one that blended political orientations based on traditional ideological forms (Taylor, 1999). This did not occur and after years of Portuguese

administration ancient traditions remained strong and the two never mixed. In 1958 the rural system remained feudal, with familial ties restricting labour incentives and adat controls with adat functionaries considered to be more powerful than government officials. The Chinese continued to play an important role in Portuguese Timor. They were mostly educated in Taiwan, maintained their citizenship and ran the retail outlets. Many Timorese viewed them with disrespect as they were considered to be wealthy profiteers neither interested nor loyal to East Timor. However, many Chinese migrants lived in villages and maintained the same lifestyles as the East Timorese (Taylor, 1999).

Boundaries were an ongoing issue between Dutch and Portuguese Timor and these prompted some map making. In 1908, Dutch Frontier maps (1:500 000) were drawn and between 1923-1928 a 26-sheet series was made (1:100 000). Yet according to Ormeling, a leading authority on the region, these were considered incomplete and inaccurate. Mapping continued, between 1948 to 1949 and the Dutch with the U.S. created a series of air photos of the region at a scale of 1:16 000. In spite of these activities, as a result of the lack of focus on the development of East Timor, few natural resources datasets exist. By the 1950s, there had not been a soil survey and data on the physical and social environment were scarce and migration data were non-existent. East Timor needed assistance "to break through the familiar vicious circle of underdeveloped areas: malnutrition, illiteracy, primitive agricultural methods, and low crop yields, agricultural advise and guidance" (Ormeling, 1958:242). The Portugese colonialists were not forthcoming with any type of assistance.

Boundary discussions between Australia, Indonesia and Portugal were ongoing and in 1972, Australia and Indonesia agreed to a seabed boundary between the north of Australia and the island of Timor; one part went to Indonesia and the other to Australia. A gap was left in the boundary, which later became the Timor Gap, since the Portuguese were not actively involved in the final agreement as seen in figure 2.7 (Solidamor, 2002). The Timor Gap later turned out to have one of the richest oil deposits in the Timor Sea. Needless to say, Australia and Indonesia had strong interests in closing this gap.

The political situation in Portugal was shifting. On April 25, 1974 the dictatorial leadership was ousted by a military coup in Lisbon in what was known as the "Flower Revolution". This began reforms from a fascist dictatorship to a government allowing the growth of local national movements in the colonies (Nicol, 1978). After the coup in Lisbon, the Governor called for the establishment of political parties in East Timor and two parties were formed: the Timorese Association of Social Democrats (TASDI), the precursor to Revolutionary Front for an Independent East Timor (FRETILIN), and the Timorese Democratic Union party (UDC). These formed a coalition that fell and a UDC coup occurred in August of 1975. It is estimated that the fighting associated with the coup killed between 1500-3000 East Timorese. The Portuguese fled to the Island of Atauro and on November 28, 1975 FRETILIN declared independence. Nine days later Indonesia invaded (UN-CCA, 2000:21).

Figure 2.7
Timor Gap Treaty Map - Section C is the Timor Gap
(Government of Australia, 2002)

2.2.3 Indonesian Occupation, 1975-1999

Indonesian troops illegally occupied East Timor on December 7, 1975 after the departure of the Portuguese and only nine days after independence was declared by FRETILIN. The United Nations Security Council condemned the intervention by Indonesia and adopted resolution 384/1975 calling for the withdrawal of Indonesian forces (UN General Assembly, 2000). On July 17, 1976, General Suharto signed a bill of integration and Indonesia formally annexed the territory and proclaimed East Timor its 27th province (UN General Assembly, 2000). There were no international interventions on the ground in East Timor to stop this invasion. During the first month of the Indonesian invasion an estimated 60 000 East Timorese lost their lives, concentration camps were established with approximately 150 of these still in existence by 1980 (UN-CCA, 2000:22). The occupation under the rule of General Suharto from 1975 until 1999 was nothing but brutal. There are numerous documented human rights abuses, disappearances, torture, forced sterilization, the rape of women and numerous massacres. An estimated 200 000 East Timorese died, representing 30% to 40% of the 1975 population (UN General Assembly, 2000). This was also accompanied by forced linguistic integration. Throughout the occupation there was an active resistance movement led by FRETILIN, with factions hidden in the mountains clandestinely supported by rural dwellers.

Indonesia removed collective land rights and implemented corrupt land acquisition processes as part of its common transmigration plan with Indonesian migrants being given the best land. Indonesia maintained the Portuguese civic structure and simply occupied the abandoned Portuguese civil service posts (Phillips,

Figure 2.8
Social Structure under the Suharto Dictatorship

1999). Indonesia extended an administrative layer to the village level, abolished traditional institutions and the kinship system. East Timor was divided into three regions (Wilayah), 13 districts (kabupaten) and 62 subdistricts (Kecamatan), with villages (desa), sub-villages (dusun), and neighbourhoods (rukun warga) (Phillips, 1999:115) as seen in figure 2.8. As a province, it became part of a dictatorial centralized government state structure, with a web of patron-client relationships, among the military, technocrats and influential families (Phillips, 1999). The population in 1975 was estimated at 680 000 with 97% being East Timorese, 2% Chinese, and less than 1% Portuguese (TimorAid, 2001).

During the occupation a resistance movement developed a parallel political structure in the mountainous areas (UN-NPDA, 2002). The resistance movement also selected its own trusted leaders in consultation with the community. Because they were not necessarily selected for their ancestral ties, a new form of functional local governance separate from tradition began to emerge.

The illegal Indonesian occupation was characterized by different phases. The closed phase occurred between 1975 and 1989, where only a very small number of Catholic organizations were involved in the country and they operated within an environment of unrest, insecurity and violence (Phillips, 1999:135). International links were severed, NGO participation was discouraged, and travel restrictions were imposed. Very limited assistance reached East Timor during this phase. Australia was one of the last links, with negotiations over the rights to extract Timor Gap oil lasting 10 years. In 1989 a resource sharing agreement was reached whereby Australia, Indonesia and oil companies "established a Joint Authority (in Darwin and Jakarta) to

jointly develop the 'Timor Gap Zone of Cooperation'. This agreement was formalized into the Timor Gap Treaty, which was signed on 11 December 1989 at a well-publicized ceremony on a plane flying over the Timor Gap, by the foreign ministers of Australia and Indonesia" (Solidamor, 2002). The Treaty came into force in 1991 and was due to last until a review in 2031. The map in figure 2.7 illustrates the agreed upon territories, section A belonging to Indonesia, section B to Australia while section C, is the Timor Gap.

Few aid agencies were involved in the area. USAID remained involved from 1977 onwards, as did Canada's International Development Agency (CIDA) from 1979. AusAID and New Zealand began to provide aid in 1989 – the same year the Timor Gap agreement was signed (Phillips, 1999:133, 137). NGOs, Catholic religious organizations and aid agencies were limited to funnelling resources to NGO-led community development projects.

The open phase began in 1989, and aid agency involvement increased. However overall East Timor received far less per capita overseas development assistance than did countries with similar levels of economic and social development (Phillips, 1999:137). The country also witnessed a significant increase in international journalistic reporting. Human rights abuses were appearing in newspapers and the Dili Massacre hit international headlines on November 12, 1991 putting East Timor on the map in the minds of people around the world. The 1998 drought emergency period marks the third phase and humanitarian assistance significantly increased (Phillips,

1999:138). East Timor's demographic profile had also changed, with 78% of the population being East Timorese, 2% Chinese and 20% Indonesian a significantly different composition from 1975.

The East Timorese economy at the end of Indonesian rule consisted of two distinct economies: a rural subsistence East Timorese agricultural economy and a somewhat modern urban wealthy Indonesian led economy (UN-CCA, 2000:27). Most of the population lived in rural areas (90%) and were engaged in subsistence agriculture (World Bank, 1999:annex1, Sandlung et al., 2001:2, UN-CCA, 2000:8). By 1999 an estimated 50% lived below the international criteria for absolute poverty, less than US\$1/day (UN-CCA, 2000). The per capita GDP was estimated at US\$230 to US\$304 in 1999, well below the 1996 estimate of US\$431, which was less than half the Indonesian average of US\$1153 (1996) (UN-CCA, 2000:8, 26; UNDP, 2001b; East Timor Assessment Mission, 1999b). The least-developed country average in 1999 was US\$1050 (UN-CCA, 2000:8, 26; UNDP, 2001b; East Timor Assessment Mission, 1999b).

The single significant export under the Suharto regime was coffee, a Portuguese legacy. Food self-sufficiency was precarious and staples such as rice, flour, maize and sugar were imported. The island was one of the poorest areas in Southeast Asia, with severe problems of illiteracy, malnutrition, malaria, and tuberculosis. According to Indonesian official statistics, life expectancy in 1996 averaged 52 years compared with the Indonesian national average of 61.5 years; the infant mortality rate was 149/1000 amongst the worst in the world, comparative to those of Afghanistan (163/1000) or Sierra Leone (143/1 000) (Stanford, 1998:212-216). Officially, East Timor depended heavily on transfers from the Indonesian government, which was plagued by

corruption and administrative inefficiencies (East Timor Assessment Mission, 1999b). A detailed assessment of the economy and the environment is unclear at the time since Indonesian data are considered inconsistent; and little scientific data were captured since there was a lack of commitment to any form of development.

East Timor remained a relatively unknown part of the world until 1999. It was a small, far away place difficult to find on a map. The situation was nonetheless monitored by international officials, in particular the UN Security Council that condoned the illegal occupation and the UNHCR that received numerous human rights violation reports (UN General Assembly, 2000). Australia and the U.S. were also watchful of their interests, the Australian Government - the Timor Gap Agreement of 1989 and the U.S. was keen on maintaining access to strategic deep sea routes and the deep sea submarine passages between the Indian and Pacific Oceans along with its lucrative arms trade with Indonesia (Pilger, 2000). The situation in East Timor was also well known by human rights communities who documented and reported massacres, torture, disappearances, forced sterilizations, and rapes to the rest of the world. In 1996 Bishop Dom Ximenes Belo and José Ramos Horta jointly won the Nobel Peace Prize "for their work towards a fair and peaceful solution to the conflict with the Indonesian occupants" (Olso Lusa News Agency, 1996). The profile of East Timor was growing on a global scale and put pressure on the Indonesian Government, in particular its dictator General Suharto.

On May 21, 1998 General Suharto resigned and his vice president and close associate B.J. Habibie was voted in. On 27 January 1999, the newly elected Indonesian President Habibie, under tremendous pressure and struggling to maintain

his post took the world by surprise and announced that East Timor would be allowed to choose between political autonomy within Indonesia or to move towards independence (Guardian Unlimited, 1999). East Timor would be given the opportunity to decide whether it wanted independence from Indonesia or remain a province within its domain. The UN assisted with voter registration and setting up ballots. Concurrently, the militia and pro-Indonesian factions carried out acts of intimidation all over the country.

2.2.4 Popular vote August 30, 1999

On August 30, 1999 a popular consultation/referendum supported by United Nations Mission in East Timor (UNAMET) took place, with a voter turnout of 98.6%. On September 4, 1999 78.5% voted in favour of autonomy from Indonesia and immediately after the announcement a pre-meditated Indonesian-backed campaign of violence, looting and arson took place (UN-CCA, 2000:23, United Nations & World Bank, 1999, UN General Assembly, 2000a). Hundreds of civilians were killed, hundreds of thousands of East Timorese were displaced, homes and buildings were burned and plundered, food stocks were looted and burned and livestock was killed (USAID, 2000). City populations swelled, particularly Dili with approximately 200 000 people arriving from rural villages (Sandlung et al., 2001:2). Most Indonesians left, abandoning their administrative posts. After weeks of destruction, on September 20, 1999 the UN Security Council with the agreement of the Indonesian government finally authorized a multinational force. INTERFET arrived under the unified command of Australia to restore peace and security (United Nations & World Bank, 1999) and the

island was officially handed over to UN Sanctioned International Force In East Timor (INTERFET) on September 27, 1999 (USAID, 2000). On October 25, 1999 the United Nations Transitional Administration in East Timor (UNTAET) was established pursuant to United Security Council Resolution 1272, which gave it full legislative and executive authority and responsibilities for law, order and security. It was mandated to establish an administration, coordinate and deliver humanitarian, rehabilitation and development assistance, and establish conditions for sustainable development (United Nations & World Bank, 1999). Sergio Vieira de Mello (UNTAET) was appointed as the head of the territory's first entirely East Timorese government and Mari Alkatiri, the leader of East Timor's largest political party, FRETILIN, became the new chief minister and finance minister with a new 20-member team (Aglionby, 2001). By December of 1999, the UN had launched a large humanitarian relief effort, and 114 000 refugees returned to East Timor.

2.2.5 Pre Meditated Destruction

The destruction of East Timor was so well planned that the approach for reconstruction was treated much like that of a post-natural-disaster situation. All government records and institutional memory were erased (East Timor Assessment Mission, 1999a). The administrative structures of the government, including revenue and budget functions, disappeared and the Indonesians who occupied these posts fled. This included middle level managers, administrative and professional personnel (United Nations, Executive Board of the UNDP and the UNPF, 2000). The militia and pro-Indonesia East Timorese factions went on a rampage that destroyed the island's already fragile building, road, telecommunication, electric, educational, health and

economic infrastructures (Internews, 2002a). Virtually every modern sector piece of equipment and the remaining physical infrastructures were destroyed. The communication infrastructure was decimated, with all radio transmitters, private satellites dishes and television station cleaned out and the daily newspaper burned out. The already dismal social infrastructure - health care, civil society, social services and education was eliminated. Most houses (70%) were burnt and 75% of the population (+/- 600 000 people) were displaced (UN-CCA, 2000:23; World Bank, 1999; IFRC, 2001, Sandlung et al., 2001:2). An estimated 200 000 fled to West Timor (UN-CCA, 2000:23). Overall there was a lack of public security and food security was at risk since land preparation and planting for the following year was not carried out and fields and seed stores were burned.

2.2.6 Humanitarian Assistance

East Timor's humanitarian relief was administered by UNTAET and consisted of food aid and food security, the return and reintegration of displaced people, support for emergency shelters, emergency water supply and sanitation, and emergency health (United Nations and World Bank, 1999). Many agencies were involved in assisting the humanitarian and reconstruction effort (UN agencies, the World Bank, the Asian Development Bank, AusAID, CIDA, USAID, and many NGOs). There was, however, a clear lack of coordination between aid agencies and NGOs. Because project objectives were unclear, there was a lack of local participation and limited forward planning (UNTAET, 2000a). The "local incapacity to absorb high levels of aid, and the consequent need for coordination amongst aid agencies, and between aid agencies and local NGOs" was a topic recognized by the East Timorese and aid agencies alike

(Phillips, 1999:139). Finally, administering aid in a location that lacks baseline data, maps and knowledge of the condition of the transportation infrastructure and has a malfunctioning telecommunication infrastructure and virtually no demographic information, is very difficult at best.

Sustainable development is an integral component of all UN missions yet during the emergency response, very little thought was given to environmental issues (UNTAET, 2000c). This has caused some significant problems. Particularly, shelter aid displaced the local construction industry; health, agriculture and water infrastructure plans were at odds; and, the transportation of humanitarian goods in large trucks destroyed the fragile transportation infrastructure. Additionally, during this phase “an important amount of data ha[d] been collected in a number of sectors, but there appears to be no centralized databank on East Timor yet within the GPA structure. In health there is no systematic countrywide reporting on nutritional surveillance or morbidity data outside the consultations undertaken in the ports and hospitals” (UNTAET, 2000c). There was “a lack of clear criteria and indicators to measure and monitor progress particularly in relation to the different phases” of assistance and there was no plan for a social safety net (UNTAET, 2000c). Requests were made to collect baseline data from Indonesia however it was not forthcoming with requested information (UNTAET, 2000c).

2.2.7 Transitional Government

A transitional government was established in July, 2000 to set up an effective administration and coordinate development assistance with the objective to build capacity for self government (United Nations, Executive Board of the UNDP and the

UNPF, 2000). The plan was to enable East Timor to embark on a path of sustainable development, to rebuild what existed before, “and at the same time tackle the problems of a newly independent country in the face of the severely diminished level of social capital and in an institutional vacuum” (United Nations, Executive Board of the UNDP and the UNPF, 2000). UNTAET shifted from the provision of humanitarian assistance to enabling nation building. The new mandate consisted of: providing security and maintaining law and order throughout the territory; establishing an effective administration; assisting in the development of civil and social services; ensuring the coordination and delivery of humanitarian assistance, rehabilitation and development assistance; supporting capacity-building for self-government, and, assisting in establishing the conditions for sustainable development (United Nations Transitional Administration in East Timor (UNTAET, 2000a). UNTAET had to reinstate the role of government in East Timor. As part of its mandate, UNTAET began the work of reconstruction with the re-establishment of soft infrastructures, the construction of administrative buildings and the return of electricity to some mostly urban centres.

2.2.8 Reconstruction

The East Timor Assessment Mission stated that for East Timor “the need – and it is enormous because the destruction was premeditated, thorough and massive – is for reconstruction” (East Timor Assessment Mission, 1999b). The reconstruction pertained to every element of the economy, society, and polity.

East Timor had to rebuild every aspect of its physical infrastructure (e.g., transportation, power, water, telecommunication, buildings, etc.), institutions (e.g.,

government, bureaucracy, judiciary, communication, statistical bureau, planning offices etc.), social infrastructure (e.g., health care, social security, education, etc.), and communication along with every sector of its economy (e.g., agriculture, construction, energy, trade etc.). Concurrently rebuilding meant balancing humanitarian assistance to meet the immediate basic needs of the population, along with resource management, consideration for the environment, and long-term sustainability.

Prioritizing the environment during such a crisis situation is difficult to justify, yet a lack of environmental monitoring and coordination has increased demand on forest products resulting in tremendous damage to the fragile road network (Tais Timor, 2000a, Sandlung et al., 2001) since deforestation increased erosion and caused landslides and water contamination (Sandlung et al., 2001). Mitigating environmental damage that affects both immediate needs (i.e., safe drinking water, road access) and long-term needs (i.e., the preservation of soil, and watershed management for food production) was curtailed by an uncoordinated reconstruction process, the absence of reliable information, and a lack of sustainable development principles driving assistance (Phillips, 1999, Sandlung et al., 2001). In short, work was being carried out by numerous organizations that could not assess the overall situation in East Timor (Phillips, 1999, Sandlung et al., 2001) as data were unreliable (Phillips, 1999, Sandlung et al., 2001) and maps related to resources (e.g., forests, agriculture, watershed), physical infrastructure (e.g location of roads and their limitations, power lines, wells, etc.), demographics, climate (e.g., areas most affected by the rainy season), topography, vulnerable areas and so forth did not exist.

2.2.9 Development

After the referendum the East Timorese needed to start anew. Its past could not be used as a blueprint for the future; its present was marred with suffering; and, there was an absence of an infrastructure of any kind, yet the future is dedicated to nation building. As previously discussed the modern sector was destroyed – including manufacturing and services, which were largely controlled by non-Timorese who left the country. Prior to the referendum, virtually all technical expertise was provided by non-Timorese and huge gaps in the set of skills required to sustain a modern economy were exposed after their departure. Reconstruction and development assistance to East Timor included institution-building such as the capacity to advance and formulate policy, draft legislation, development planning, sectoral analysis, the elaboration of baseline studies/analyses/plans to promote poverty eradication, gender equity, sustainable development and the cross-cutting theme of sustainable livelihoods (United Nations, Executive Board of the UNDP and the UNPF, 2000:8). Part of this process included building a culture of public accountability and transparency through the creation of a national record management system and a National Planning and Environmental Unit (NPEU) to assess and prioritize environmental needs and develop environmental guidelines, policies and structures (United Nations, Executive Board of the UNDP and the UNPF, 2000:8, 9).

Numerous UNTAET regulations on the environment were formulated (e.g., forestry and protected places) but their enforcement was difficult since the police force had to choose between the protection of environmental focal points and addressing public security. In addition, as a transitional government, UNTAET, had no real

authority to assume the full powers of law adoption and law enforcement as it was not a democratically elected institution (Sandlund et al., 2001). To address issues of democratic legitimacy, a national council of East Timorese was developed and the presence of East Timorese in UNTAET and East Timor Transitional Administration (ETTA) increased. In 2000, market activity began to recover as people returned to their home areas. Individuals brought in tradable goods and a general environment of security was restored. Limited public transport began to reappear slowly, but rolling stock and fuel shortages were exacerbated by price differentials between Dili and the rural hinterland. East Timor, now faced with the daunting task of developing to meet immediate needs, addressing the pressures of international trade and planning for the long term future.

2.3 The Road to Independence: Building a Culture of Democracy

East Timor included its citizens in the formulation of its constitution and 30 000 citizens participated in a series of 200 hearings held in 65 subdistricts, clearly demonstrating that East Timorese citizens and their represented officials were committed to the creation of their own future (UN Department of Public Information, 2001).

The Constitution of the Democratic Republic (D.R.) of East Timor was ratified by the Constituent Assembly of East Timor on March 22, 2002. The Preamble states that independence was proclaimed on 28 November 1975 by Frente Revolucionaria do Timor Leste Independente (FRETILIN) and formally recognized internationally on 20th May 2002. The fundamental principles of the Constitution found in section 1 (The

Republic), subsection 1, states “the Democratic Republic of East Timor is a democratic, sovereign, independent and unitary state based on the rule of law, the will of the people and the respect for the dignity of human persons” (Constituent Assembly of East Timor, 2002). The D.R. of East Timor is committed to a territorial state organization respecting the principle of a decentralized public administration (section 5, Decentralization, subsection 1.). The new structure distributes power to the districts enabling localities to develop according to their particular cultural, environmental and economic characteristics, while also enabling a more inclusive and participatory approach to governing the territory.

The D.R. of East Timor is particularly unique in its commitment to its nation building-process to “guarantee the development of the economy and the progress of science and technology” (section 6, Objectives of the state, subsection d), along with wanting “to protect the environment and to preserve natural resources” (Section 6, Objectives of the State Subsection f). Furthermore, the spirit of the Brundland definition of sustainable development is found in section 61, Environment which states that “everyone has the right to a humane, healthy, and ecologically balanced environment and the duty to protect it and improve it for the benefit of future generations”. The constitution provides for the preservation of cultural heritage and valuing the personalities of the East Timorese people (section 6, Objectives of the State subsection g), and the creation, promotion and guarantee of the “effective equality of opportunities between women and men” (section 6, Objectives of the State subsection j). It further states that “women and men shall have the same rights and duties in all areas of family, political, economic, social and cultural life” (section 17,

Equality between Women and Men). East Timor is clearly committed and constitutionally bound to adapt and adopt the tools of science and technology, to sustainably manage its territory with the help of all of its citizens and these principles now have a legislated framework.

2.4 Governance

Governance can be described as “the exercise of political, administrative and economic authority to manage a country’s affairs at all levels. It comprises the mechanisms, processes and institutions through which citizens and groups articulate their interests, exercise their legal rights, meet their obligations, and mediate their different interests” (UN-CCA, 2000:92). Additionally, title VI, Public Administration section 137, Public Administration General Principles, reinforces the idea that a public service should be “meeting public interest, in the respect for the legitimate rights and interests of citizens and constitutional institutions”(subsection 1). East Timor has also articulated the need to ensure efficiency and participation by creating a structure that prevents excessive bureaucracy, that is accessible to citizens and receptive to input from citizens (subsection, 2). The technical capacity to create a government and a civil service were, however, slowed since the island had few East Timorese lawyers, high- ranking civil servants, and few East Timorese had ever occupied managerial positions in the former bureaucracy. Under the previous regime, 75% of the civil servants were Indonesian (UNDP, may 2001). Nonetheless, progress has been made and the decentralization of power to the districts has enabled people to participate

more fully in decision-making. Furthermore, a new culture inclusive of women is being nurtured, with East Timor Transitional Administration (ETTA) reporting 16.6% women in the service, with targets of at least 30%.

The new formal governance structure of East Timor maintains the 13 districts (figure 2.9) and 65 subdistricts formally implemented by the Portuguese and the Indonesians but with different functional relationships and levels of authority (UN-NPDA, 2002). The district level now has district officers that are the primary liaison between the central government and subdistricts, and their councils, the village and hamlets (UNTAET, 2000d). District are guided by advisory councils that advise a district administrator on issues of law, infrastructure improvements, agriculture and public services. District councils also accept, hold and manage funds on behalf of subdistricts and villages. Districts are coordinated from the Office of District Affairs and district administrators are the major representatives of the government outside of Dili. They have been delegated with planning, sector and project coordination, consultation and financial management. Each council has two village-elected representatives – a man and a woman – and subdistrict councils will comprise no less than 10 members and no more than 40 with an equal number of men and women (UNTAET, 2000d). Subdistrict coordinators will assist with information dissemination, emergency preparedness, conflict resolution, village integration and bridge communication from the local to the national. Subdistrict coordinators are not considered a separate level of government since they are considered members of the district staff. Hamlet and/or village representatives are chosen by a selection committee, and will have a chief and two trusted members (male and female)

Figure 2.9
Traditional and New Administrative Structure

from the hamlet. Village councils identify, plan and carry out development activities in the village (UNTAET, 2000d). The new administration worked with community-appointed resistance leaders at the district (*chefe do suco*) and subdistrict (*chefe de posto*) levels, as well as traditional leaders who mediated matters between the district and the village. The traditional council of elders (*conselho dos katuas*), local leaders (*chefe de suco*) and hamlet head (*chefe de aldeia*), also remain as part of an informal decision-making structures (UNTAET, 2000d; UN-NPDA, 2002). The influence of elders is still felt in the realm of local conflict resolution and their opinion on whether or not someone is fit for office is often expressed. The unquestioned acceptance of traditional decision-making processes is no longer the rule as groups have expressed the need to move away from allegiances based on lineage toward other types of allegiances such as people's role in the resistance movement, personal capacity and popularity (UN-NPDA, 2002). Women and youth groups have also expressed the need to be included in decision-making processes. Authority structures in local areas are in transition toward a functional rather than traditional process.

Timorization of the public service has been slow but steady. By 2002, East Timorese had been integrated into all major decision-making positions in the transitional administration, 9266 of 10 554 civil service positions were filled and authority was transferred to the districts (1/3 are women). Also, 2500 people have taken Administrative Civil Service Academy introductory courses, which include computer training, and a capacity development plan has been implemented to train senior and middle-level management to develop supervisory skills, to enhance office management and administration skills, train a central human resources office, and to

embed UN cross-cutting themes in areas (such as gender equity, human rights, environmental protection and cultural protection (UN Secretary General, 2001; UN-NPDA, 2002). The previous Civil Service had 28 000-45 000 posts, with Indonesians occupying most of the higher level management positions. The lower positions in the districts were held by East Timorese (Phillips1999:118, United Nations and World Bank, 1999:19). UNTAET and the Joint Assessment Mission recommended a smaller government with 12 203 staff, including 6750 teachers, and 3173 health staff with a lean merit- based civil service (United Nations and World Bank, 1999:19).

2.5 Building New Institutions

East Timor's government and related institutions are being constructed to resolve many current problems stemming from a complicated colonial past. Its goals are to sustainably manage the transition from a post-conflict donor-driven development process toward a democratic, independent and economically viable society. National priorities are to: ensure democratic, social and macro-economic stability, develop a stable state sector, alleviate poverty and unemployment, develop human resources, establish a legislative and regulatory environment, and establish and operate a physical infrastructure (UN-NPDA, 2002). These goals are to be achieved by and for East Timorese. Like all organizations, a government comprises social structures that are formally embedded in the values, norms and roles expectations of the organization. These are manifest in mandates, missions, policies and practices, which in turn are influenced by the actors who formulate them. These actors possess

perspectives that are socially constructed by their class, gender, race and position in the social system, as well as the social and cultural systems of their environments and historical context.

This chapter has identified formal and informal social, cultural and traditional practices that influence the formation of East Timor's institutions. Formal economic, political and social structures have changed with each successive colonial power. The formal kingdom system of exchange and tribute based on a highly stratified kinship system existed prior to the arrival of the Portuguese. The Portuguese colonialists subsequently failed to divide and conquer the kingdoms and instead legitimized this structure by inserting themselves into the system of exchange at the mid-point in the hierarchy and were able to make economic gains and to exert their influence. With time, the upper echelons of the stratified kingdom structure were replaced by colonial administrative posts while the rural villages and hamlets continued to informally maintain the chief, clan, elders and family kinship system of exchange. Furthermore, the Portuguese were never able to fully extend their administration into the rural areas and therefore maintained a dual – economy, namely an urban externally driven economic system based on natural resource extraction and a rural subsistence agrarian economy. The Indonesian occupiers took a more violent approach at undermining the kinship system and imposed an Indonesian dictatorial formal structure. East Timor became part of the patron-client system of the corrupt government, the kinship system was abolished, transmigration programs displaced East Timorese from their land, forced labour camps removed people from their communities and linguistic integration attempted to erase their culture. The Indonesian regime went further than the

Portuguese by imposing its own formal governance structure while also attempting to erase and break all East Timorese informal institutions. As under the Portuguese, however, a dual economy was maintained with a literate urban Indonesian elite and a primarily agricultural rural system. A new culture of resistance emerged in rural and mountainous regions with a new form of leadership clandestinely supported by villagers but not based on the kinship system. Independence abolished the formal Indonesian social structures and instead a new administrative structure emerged with the aid of a host of United Nations organizations. This formal structure of governance is entirely new but based on the old pre-colonial and Portuguese kingdoms and districts as organizational units. It is consultative, merit-based, includes gender equity and is managed and operated by East Timorese nationals. While the previous social structures were traditional or imposed, this one must be learned and develop a capacity to operate at all levels. This capacity development will have to be far reaching and involve all levels of the government, as well as related institutions and citizens. East Timorese society is transitioning into an entirely new formal social form of organizing.

Informal traditional institutions have remained throughout, as have their related normative and behavioural structures. Social stratification, unquestioned support for elders, sexual division of labour and resistance, are norms and values that are part of the basic assumptions and beliefs of most East Timorese. These manifest in how people revert to old behavioural structures that are currently in transition. Some examples include, the difficulty in supervisory roles to delegate work or carry out work evaluations on someone who, in the traditional social structure, is of a higher rank; the

tension between youth who want a say in the decision-making process which goes against the norm of leaving decision-making to elders; the introduction of women into leadership roles normally occupied by men; or the culture of resistance that views change with suspicion.

Organizations have formal social structures that are represented by explicitly defined social positions independent of the personal characteristics and relations of those who occupy them. The new administration has many new formal political, managerial, administrative and decision-making positions in all sectors of the government, across all levels, and distributed in all parts of the country. It is expected that the people who occupy those positions will have tremendous difficulty in keeping traditional practices and kinship relations separate from their formal roles. This process will take time and effort. Maintaining a transparent, merit-based equitable administrative system that is also uniquely East Timorese will require continuous refinement and evaluation.

The linguistic divide between age groups and between urban centres and rural areas will challenge the new government. Furthermore, illiteracy, the shortage of people with a university education, the limited capacity of mid and high level managers combined with low ICT skills are challenges to any administrative system. East Timorese civil servants will have to start with the basics and build broader visions over time as individual skill-sets develop.

Sustainable development could benefit from informal traditional practices. The adat system, conflict resolution, land and forest stewardship, agriculture and the traditional knowledge of plants and medicines could be revived and integrated into a

formal sustainable development strategy. New roles and social positions could be created to accommodate old social structures. East Timor has come a long way considering the challenge was “nothing less than building a new nation from almost zero with the main resource being the resilience, commitment and strength of a people who have struggled so long for their independence” (UN-CCA, 2000:92). It will invariably be East Timorese “funu” (culture of resistance) that will be its strongest ally in overcoming the obstacles of its inheritance.

Finally, GDIs are technologically and institutionally complex organizations. Each GDI is unique and the environment within which it operates can explain its organizational and structural particularities. East Timor’s pre-existing social structure, history and constraints will influence the behavioural structure and decision making processes of the people who will steer, administer and develop the GDI. In turn they will influence the form it will take. Chapter four on GDIs for sustainable development requires the research and analysis of chapter two in order to examine whether or not it is feasible for East Timor to develop the institutional components of a GDI given its past and current circumstance. And if it is feasible the information in chapter two will need to be taken into consideration when designing the organizational structure.

CHAPTER 3

GEOSPATIAL DATA INFRASTRUCTURES

3 Introduction

In advanced knowledge based economies (KBEs) in North America, Europe, and the Pacific, it is clear that accessing, integrating and using geospatial data from disparate sources to guide decision-making on issues such as transportation, the environment, resource management and security, are important while attaching a geo-reference to data further increases their utility (Ezigbalike, Faiz, Zhou and Selebalo, 2000; Li, Davis & Henry, 1998; GSDI, 2001). Geospatial data, are “data, usually stored as coordinates, that describe the location, shape, and spatial relationships of geographic features” (National Atlas of Canada, 2001) and associated attributes. In KBEs, it is understood that the ability to make sound decisions collectively at local, regional, and global levels is enhanced by the implementation of geospatial data infrastructures (GDIs) (GSDI, 2001) that promote geospatial data access and provide compatibility, interoperability and consistency of spatial information across jurisdictions, domains and institutions (Information, Interoperability Institute (3i), 2001). They are also critical at informing sustainable development. The Global Geospatial data Infrastructure (GSDI), the Permanent Committee on Geographic

Information in the Asia Pacific (PCGIAP), and the Malaysia National Land Information System (NaLIS) have explicitly expressed in their mission statements the commitment to sustainable development. Each GDI initiative has its own unique definition and vision. However, for the purpose of this thesis, a geospatial data infrastructure (GDI) is defined as the relevant base collection of technologies, policies, people and institutional arrangements that facilitate the availability of and access to geospatial data as illustrated in figure 1.2 (Groot and McLaughlin., Eds., 2000). Geospatial data infrastructures have evolved from standalone desktop geographic information systems (GIS) to large national, international, regional and global organizations. All GDIs have the same components, including geospatial data, framework data, a data clearinghouse, standards, supportive policies, institutions, enabling technology, and human resources. Each GDI coordinates these components differently. Additionally, each GDI has a unique organizational structure and these vary according to mandates, the availability of resources, social structures, operational environments and organizational culture. These, in turn, are a factor of jurisdiction, organizational form and history.

This chapter will explore the organizational structures of GDIs with a particular focus on institutions, policy and collaboration. The technical components are well defined, particularly with respect to standards, clearinghouses, GIS, and remote sensing, while the political and managerial components are less well understood (O'Donnell and Penton, 1997; Pinto & Onsrud, 1997; Hamid Ali, Fauzi Nordin and Kamalis Adimin, 2001).

The purpose of this thesis is to investigate if it is possible to implement the organizational components of GDIs in East Timor as part of its sustainable development strategy. This approach was chosen as East Timor is currently not considered to be in a position to implement a fully operational GDI nor does it have the technical mechanism to coordinate the collection, storage, maintenance and dissemination of data to inform it. The proposition is that East Timor may be able to begin the visioning, policy-making, issue identification, collaboration and partnership building that GDIs require first and later add the technical components with technical expertise from other GDI initiatives. The GDIs of Canada, Malaysia, Japan, Portugal and Australia will be studied as will the regional Asia Pacific GDI and the Global Spatial Data Infrastructure (GSDI). These initiatives are selected based on their proximity to East Timor, their potential to influence development in the country, their mandates or as a result of historical ties to the nation.

Since GDIs emerged from early small scale geographic information systems (GIS) and international issue-driven collaborative digital mapping projects, these will be briefly explored in sections 3.1 and 3.2. Results and issues from these early projects highlighted the reasons for developing GDIs and will be explained in section 3.3. GDIs are an organizational form that require collaboration and this aspect will be discussed in section 3.4. While each GDI is unique, they share common components, which will be discussed in Section 3.5. As previously noted, five national GDIs will be briefly described, as will the regional and the global initiatives in section 3.6. Finally, since East Timor falls into the category of a less-developed country (LDC) section 3.7 will look at GDI implementation issues unique to that context.

3.1 Small Scale Local Geographic Information Systems

A geographic information system (GIS) "is a computer based information system used to digitally represent and analyze the geographic features present on the earth's surface and the events (non-spatial attributes linked to the geography under study) taking place on it" (GISdevelopment.net, 2001). A GIS is considered a visual decision support and environmental modelling system used by planners at all levels of government, non-profit organizations, academia, industry and some aid agencies (Zhang, 2000; Li, Davis & Henry, 1998). Some GIS software packages have been designed with sophisticated multi-criteria, multi-decision-making modules (e.g., IDRISI, and ArcView/ArcInfo) while other integrated systems are capable of modelling environmental systems, assisting with risk assessments, mapping the patterns of climatic events, transportation networks, and a host of other applications. GIS help resolve spatial problems but their implementation beyond the desktop require attention to socio-technical issues and organizational change (Masser & Craglia, 1997:108).

GISs are used in national mapping agencies (NMAs), are an integral technical business function for an entire organization such as a utilities company (Canadian Oil and Gas GIS - in early 1990s), or are cross-departmental decision support tool that serves different business functions such as road management, land use and locating recreation centres in a municipal government. Municipal governments have specific goals to manage infrastructures such as water, housing, utilities, roads, implementing

social policy delegated from higher level jurisdictions and collecting property taxes.

GIS are a useful technology for integrating data to assist managers, planners, developers and city councilors with meeting these goals.

3.2 International Collaborative Digital Mapping Projects

Prior to the adoption of the Rio UN Agenda 21 in 1992, emerging knowledge based economies (KBES) in Europe, New Zealand, Australia and North America implemented GIS to make planning, resource management and environmental decisions at local, national, regional, and global levels. These were applied to issues such as the management of municipal infrastructures, national forests (e.g., GIS of the Bavarian Forest Administration (FORST-GIS), classifying land use (e.g., Canada Land Inventory (CLI)), and transnational environmental projects (E.g., Great Lakes Information Network (GLIN), Baltic Drainage Basin Project). These projects had significant impacts on environmental management, have provided consistent region-wide strategies, encouraged interdisciplinary thinking and enhanced public participation (Evans, 1997). They were logical extensions of a standalone enterprise or intra-organizational GISs since decision-making regarding geographic features such as lakes, forests, drainage basins and environmental problems do not adhere to the socially constructed concepts of national borders. Furthermore, problem resolution requires data and knowledge embedded in numerous domains of expertise. Some of these projects were issue driven; others recognized the need to develop common datasets. In 1987, a Joint Project Group was formed by the International Geographical Union (IGU) and the International Cartographic Association (ICA) to propose the

development of a World Digital Base for Environmental Science Projects and in 1992, Australia, Canada, the U.K. and the U.S. collaboratively published the Digital Chart of The World (DCW) (McLaughlin and Coleman, 2001). In 1994, the heads of mapping agencies in Europe came together to discuss a common topographic data base that resulted in identifying the need for a coordinated approach to geographic information in Europe. The following year, national representatives and department heads involved with geospatial data from each member state gathered to discuss developing a European GIS (Masser & Salgé, 1997).

These and many other projects shifted intra-organizational projects to multi-institutional, cross-domain and trans-border collaborations. New institutional and policy issues resulting from these collaborations included: cross border contracts; ownership and licensing; standards; interoperability; data sharing and dissemination policies; mediating individual need versus collective goals and sustainable funding along with a host of technical issues. In addition, the mandate of national mapping agencies (NMAs) were extended to engage at the scale of the region, and nations had to agree on studying legal issues such as copyright, liability, and the misuse of information across borders (Masser & Salgé, 1997).

Both intra- and inter-organizational strategies related to GIS implementation and collaborative GIS projects required modifications in the structures of organizations. Some of these structural changes were to accommodate new policies, requiring changes in social structures and the adjustment of cultural structures to accept change. Other critical adaptive issues were the diffusion of responsibility and authority

and the modification of the roles and responsibilities of participants to enable new bridging, extending and collaborative roles beyond departments, organizational boundaries or national boundaries.

These successful efforts and their related issues ignited the progression of developing provincial, national, regional and global geospatial data infrastructure (GDI) (GSDI, 2001). These projects along with advances in information and communication technology (ICT) and in particular, the Internet and the need to reduce costs and avoid duplication, sparked the need to increase cooperative efforts. Additionally, international development aid agencies such as the UN began to formally associate sustainable development with the need for geospatial data. In particular, Agenda 21 Section 40.2 identified gaps in the information required to resolve environmental problems and to advance sustainable development namely:

considerable data already exists ...more and different types of data need to be collected, at the local, provincial, national and international levels, indicating the status and trends of the planet's ecosystem, natural resource, pollution and socio-economic variables. The gap in the availability, quality, coherence, standardization and accessibility of data between the developed and the developing world has been increasing, seriously impairing the capacities of countries to make informed decisions concerning environment and development (UNCED, 1992).

GDI's are viewed as part of sustainable development strategies since they help fill the knowledge gap to achieve sustainable development. Some GDI initiatives have formally included sustainable development as part of their mandates in particular the PCGIAP, GSDI and the Colombia SDI (ICDE).

Geospatial data infrastructures (GDIs) are an extension of the information communication technology (ICT), infrastructures of knowledge based economies (KBES) and have formally emerged in the last 15 years at national, regional and global scales (Coleman & McLaughlin, 1997). GDIs can also be collaborative transnational domain specific projects such as the Fédération Internationale des Géomètres (FIG) Land Administration for Sustainable Development, the FAO Geospatial Application to Support Sustainable International Agriculture (GASSIA) or the African Environmental Information System (EIS) and Global Map. This critical mass of jurisdiction-wide efforts are the result of an increase in the importance of geospatial data handling within organizations to resolve business, government, social, and environmental problems.

The most advanced GDIs are currently in developed countries (e.g., Canada, U.S., Japan, U.K., Singapore, Australia, New Zealand , etc.) while LDCs are emerging as key players (e.g., South Africa, Malaysia, and Columbia). GDIs are like other forms of better-known physical and tangible infrastructures (i.e., roads, power lines, information communication and railways) yet unlike these, GDIs are invisible to their users and in their more advanced stages they are extremely technologically and institutionally complex (Information, Interoperability Institute (3i), 2001). GDIs like health or education infrastructures are viewed as a legitimate role of government support to the community can provide a common, consistent infrastructure upon which a variety of government, private sector and community activities can take place (PCGIAP, 2001).

Current models have evolved over time through a process of inter-sectoral and cross-domain geomatics technology and process invention, adoption, adaptation and diffusion. ICTs fuelled the formation of KBEs and GDIs are an extension of these. Strong national research and development programs, well established post-secondary institutions, and a developed industrial and service sector economy with a highly educated workforce are associated with these innovations.

David Coleman and John McLaughlin (1997) have extensively studied national GDI initiatives and have identified five community perspectives which are actively engaged in their development. These five perspectives are: institutional, data, technology, market, and/or application driven. Data driven communities are concerned with the management-led process to share data and support international standards. Technology driven communities believe that the technology push cannot be underestimated; that compatibility through standardization increases market choice; and that tools and standards will shape the form and content of the spatial information marketplace. Communities with institutional perspectives look at inherent mandates, responsibilities, limitations, conflicts and financial constraints of organizations as well as the constituencies involved. They are concerned with administration and financing. Issues are articulated by senior government program managers and are concerned with organizations, internal and inter-organizational cooperation, inter-sectoral relations, and public management in times of austerity, cost recovery and accountability with a supply side view regarding bureaucracy, decentralized organization and conflicting information policies. Those with a market driven perspective are concerned with short-term returns rather than long-term plans.

They are interested in value-added activities (i.e. geodemographics) and expanding markets, and push for immediate returns of open source solutions and proprietary issues and public-sector concerns. This community is only interested in public policy when it relates to private and public sector initiatives. Finally the application driven communities are interested in the new knowledge that can be derived from the geospatial data. They are end users and view data as a commodity. The authors caution that these are not mutually exclusive categories but that it is important to understand how these sometime competing perspectives influence GDIs.

3.3 Reasons For Implementing GDIs

Changes in technology, increase in skills and awareness, the need for standards and the growth of collaboration on data intensive projects are some of the previously mentioned reasons for implementing GDIs. Beyond technological issues, there are a number of other factors associated with their implementation such as: responses to complex environmental problems; the growing demand for maps; interoperability; duplication of effort; the cost of searching for data; and the significance of the geomatics sector.

Responses to complex environmental, social and economical issues require consideration of many data themes and many organizations recognize the powerful analysis potential when various geospatial applications are integrated with numerous spatially referenced variables and attributes (Tosta & Domaratz, 1997; GSDI, 2001).

Recognition of this complexity has increased demand for tools and data to carry out these analyses namely

the proliferation of digital datasets, the number of organizations with limited ability to produce needed data, the considerable power of geospatial data processing tools to integrate data, and the complexity of modern-day life have created an opportunity to develop an infrastructure to share the data needed to support complex decision-making (Tosta & Domaratz, 1997:19).

The number of data users has increased particularly in areas of social policy in the health and social welfare sectors and for community-based research where skills in the area of data analysis are emerging. Data are required for municipal social audits, provincial evaluation, and national indicator initiatives while environmental NGOs, developers and land managers also require data and have the ability to analyse them. The field of geodemographics is also growing and it is industry driven and data intensive. Finally, some suggest that 80% of all data is spatial – an indication of the need for this information to be easily accessible. This demand is changing the way national organizations make policies and structure their organizations to meet this demand. It has necessitated the creation of new intra and inter-governmental relationships to meet the needs of these different communities (Edward, 1998).

Interoperability has also been identified as a key reason for the implementation of GDIs. With numerous organizations at all levels developing myriad standalone GIS using many different hardware and software to resolve particular problems, it became clear that data could not easily be shared among them. Most organizations realized that the 'stovepipe', 'silo' or, as expressed in Malaysia, the 'Island' approach to developing datasets was inefficient, as it limited the integration of data (Tosta &

Domaratz, 1997:19; Groot & Georgiadou, 2001; Hamid Ali, Fauzi Nordin, and Kamalis Adimin, 2002). The lack of interoperability prompted the standards community to push software, hardware and data content developers to agree on methods to organize, store, and transfer data.

The duplication of effort is a costly problem. Many organizations share common interests and often produce data for the same geography to meet different needs. In other cases different jurisdictions develop maps to meet the needs of different nested scales and they require the same data at different levels of generalization. Sharing a common standard framework dataset was viewed as more time and cost efficient. Sharing responsibility in production, maintenance and dissemination of common files used by many levels and departments of government has become a more efficient use of human resources.

The cost of searching for data is significant (GSDI, 2001). In Western Canada before the development of the Canadian Oil and Gas GIS, geologists and geophysicists were spending 60% of their time looking for data and only about 20% doing something with it (Groot & Georgiadou, 2001). Once the enterprise GDI was built the cost of access to data was reduced by a factor of 10 (Groot & Georgiadou, 2001). The longer a dataset is a standalone initiative, the costlier it becomes to integrate while the cost of a GDI increases exponentially with the number of datasets (GSDI, 2001). A GDI is considered to accelerate development, planning and decision-making by decreasing the cost in the delays of finding suitable data (GSDI, 2001). Data clearinghouses are the technical solution offered to reduce the time to search for data.

The geomatics sector is an important industrial sector. In Europe the lack of a

GDI was slowing development in the region. The lack of a mandate on geographic information was thought to slow the progress of joint strategies, which in turn increased costs for acquiring and converting data, and reducing competitiveness by diminishing the production of new goods and services (Masser & Salgé, 1997). It became critical to have a European GDI to enhance competitiveness and to stimulate growth of geographic information services and products (Masser & Salgé, 1997). GIS, spatial data and remote sensing are part of a large industrial sector in the U.S. industry. Federal agencies spend billions per year to manage and collect domestic and global data (Masser & Salgé, 1997). In Europe, 0.1 percent of GDP per year of 6 billion European Currency Unit (ECU) was spent in 1995. The Canadian geomatics industry generated \$1.6 billion Can in 1994 and employed 21 000 people (Industry Canada, 1998). In Canada, promoting innovation in the geomatics industry is considered an integral component of its GDI; numerous industry-government partnerships have been created, and the Geomatics Industry Association has 90 registered members (GIAC, 2003) while the GeoInnovations program funds private sector projects (GeoConnections, 2003).

3.4 GDIs and collaboration

GDIs are complex organizations that require collaboration from different expertise and issue communities, stakeholders and users each with their own particular needs and expectations. This collaboration involves crossing domains, departments, hierarchies, organizations and jurisdictions. As an organizational form they can be characterized as network organizations, cooperative networks, or virtual organizations.

They are founded on being “interconnected with other organizations through a wide array of social and economic relationships, each of which can constitute a social network” (Gulati, Dialdin and Wang, 2002). They are characterized by an interdependent stakeholder community including amongst others professional associations, standards communities, data suppliers, government departments, and international cartographic bodies. GDIs exemplify decentralized, modular types of structures characterized by cooperation and indirect leadership whereby participation and work is organized among all participants in a knowledge value creating process such as subject-directed working groups, committees and task forces (Wingard, 1997). Furthermore, GDIs assist with the resolution of complex socio-economic and environmental problems which, in and of themselves, require cross-disciplinary cooperation. Additionally, they reflect differing cultural and social values, which will be discussed later in this thesis (Edwards, 1998).

There are many reasons for inter-organizational and inter-departmental collaboration as previously mentioned. In this section the organizational aspects of data sharing will be examined, as will formal organizational structures, impediments to collaboration and organizational incentives. Pinto and Onsrud suggest that information sharing is one of the key reasons for the existence of GDIs and provide three contexts within which this occurs. The first context is project-driven or situation specific, as exemplified by early issue-driven collaborative environmental projects. The second is when agencies have separate problems but share the need for the same information as was the case for European Umbrella Organization for Geographic Information

(EUROGI). The third is the need for standardized or generalized patterns of exchange, a requirement of any data-intensive collaborative project (Pinto & Onsrud, 1995).

Data sharing is not just a technical or economic issue, it affects the social structure of organizations. Data sharing between organizations incurs both behavioural and organizational changes that affect the social structure. The technology itself poses problems but organizational issues are considered the most difficult to overcome. Collaboration increases the distribution of authority thereby enabling flatter organizations, incurs shared responsibility, increases interests in partnerships, highlights the need for multifaceted knowledge, and promotes adherence to and agreement of standards (Tosta & Domaratz, 1997). These issues change how departments operate with each other or with other organizations, and how managers share responsibility. They can also blur the roles and responsibilities within an organization. Collaboration may require horizontal data sharing – namely across public sector organizations at the same level – or vertical data sharing across levels of public sector organizations to provide, maintain and apply geospatial data.

Organizations have both formal and informal structures as well as goals that can induce or impede collaboration. Superordinate goals are often a motivational force for collaboration and these are “goals that are urgent and compelling for all groups involved, but whose attainment require the resources and efforts of more than one group” (Sherif in Pinto & Onsrud, 1995:52). Some compelling reasons for collaboration are cross-border security threats and disaster relief.

Impediments to collaboration are varied. They include technical choices such as specialized applications which thwart interoperability; data, software and hardware costs; or policy issues such as legal restrictions and organizational superordinate goals; economic arrangements such as cost recovery; and, political issues such as negotiations between competing organizations (Evans, 1997). A lack of an organizational model to structure cooperation is also considered an impediment (Bamberger, 1995). Finally, the absence of an arm's length overarching body to facilitate data sharing also impedes the will to share (Ventura, 1995). The U.S. National Research Council Mapping Science Committee and the Federal Geographic Data Committee (FGDC) in their workshop on the Future of Spatial Data and Society (1997) have agreed that the difficulty to resolve policies around data access, custodianship and copyright will continue to be problematic for some time to come. The creation of a GDI therefore includes political support and commitment which is closely tied to funding, the encouragement of ministerial or interdepartmental cooperation, and the involvement of politicians.

While some agencies choose to work together, some are told to do so by higher level government orders (e.g., circulars, treaties, Presidential orders, etc.). Other agencies are compelled to do so due to declining budgets, which stimulate the need to seek data sharing opportunities, information redesign and integration or to reduce costs and increase profits, or changes in a lead agency's mandate.

3.5 GDI Components

While GDIs differ in their scope, jurisdiction, and organizational structures, they comprise the same interdependent components such as institutions, data access mechanisms, standards, supportive policies, and framework data as seen in figure 1.2. Each component is normally represented by a working group of subject-matter experts who identify issues, develop guidelines or implement programs. Given the goals of this thesis, the following overview of GDI components focusses on political, social, and institutional characteristics.

3.5.1 Institutions

Institutions shape the order and behaviour in organizations and they are the meaning system in which organizations reside (Palmer, Woosley Biggard, 2002). They are the field within which organizations are “constrained by regulative, normative and cognitive structures” (Palmer, Woosley Biggard, 2002:259). Regulatory structures are the rules and laws; normative structures are the expectation of behaviour; and cognitive structures are theoretical practices that dictate efficient and effective processes. Institutions establish rules and conventions and form structures, within which departments operate. Institutions direct the mechanisms to create framework data, store hardware that enables access to data, and shape the organizations where people carry out these functions. The PCGIAP considers its institutional framework as the key to providing the policy and administrative arrangements for building, maintaining, accessing and applying standards and datasets (PCGIAP, 1998).

GDIs as organizations are shaped by visions that are normally formulated collaboratively among the heads of the organizations involved (e.g., NMAs),

community perspectives (standards, technical, etc.), the political climate and, at times, users (NRC, 1993). The institutions that facilitate the work of GDIs are often new non-departmental entities such as secretariats (e.g., GeoConnections), steering committees (e.g., FGDC), management boards, or promotion agencies (Japan-NSDIPA). In other cases older departments are given additional responsibilities or functions are merged to facilitate this work such as in the case of a survey engineering department within a NMA.

A number of policies are closely tied to institutional issues. These include: data maintenance, custodianship, types of partnerships, coordination functions, delegation of responsibilities, financing, privatization, (NRC, 1997) and also socio-political stability which affects the legal context (GSDI, 2001). Some suggest that the success of any GDI depends more on institutional arrangements than on the technology – namely the coordination of agency activities is key and cooperation is the “critical ingredient that will make or break the best devised plans” (NRC, 1993:115).

Cooperation is best achieved when agency roles are defined. The U.S. National Academy of Public Administration (NAPA) recommended that national goals, GDI definitions, and a charter for a GDI council be developed (NRC, 2001). They also recommended that laws be modified to encourage smoother partnerships, particularly cooperative R & D and for the realignment of current laws to the current mode, along with the final recommendation to draft a statute with all levels of government involved (NRC, 2001). In Canada, an accord is in the process of being signed by provinces and territories to ensure formal collaboration with the national GDI secretariat and to define the level of engagement. In Malaysia, the government has formalized

participation through circulars. Other mechanisms to formally express collaboration and partnerships between government agencies are memorandums of understanding (MOUs), committee terms of reference (TOR), partnership agreements, shared funding programs, partnership programs, and executive orders. The intensity and the incentive to collaborate can be measured according to the degree of commitment and the decrease in an individual's or agency's autonomy over a particular area of work (Azad & Wiggins, 1995). Partnerships are based on the concept of shared responsibility, shared cost, shared values and shared projects. Other formal mechanisms to collaborate or share resources are written contracts, joint programs, board membership, resource transfer, and personal meetings (Azad & Wiggins, 1995).

Collaboration has encouraged the adoption of new roles and the development of many programs. Information officers coordinate geospatial data production, maintenance, integration and the relationship building between users and services (NRC, 2001). In the U.S., a Cooperative Agreement Program has encouraged resource sharing projects, greater networking and inter-agency coordination to develop structures to build national information resources. Other programs are community demonstration projects that encourage dataset development and support, or rural community programs aligned with national connectivity projects such as the Sustainable Communities initiatives in Canada. In other cases, skill development programs have grown to ensure there is a broad base of new geographic information (GI) talent from universities and community colleges.

3.5.2 Standards

Standards facilitate data sharing and enable a common set of norms, production standards and assurances related to all aspects of geospatial data. In addition, standards “provide safety and performance requirements for products and services” (CCRS, 2003). Standardization is the process of “getting people to agree on an acceptable technical solution, not the development of the best or cheapest approach” (CCRS, 2003). Tim Evangelatos, a pioneer in the Canadian geomatics sector once said in passing to the author “that without standards there are no GDIs”.

There are international and national standards (e.g., ISO, OGC, CGSB). Some standards are adhered to voluntarily; some are enforced by legislation. While some standards focus on professionalism (ISO), others like the Open GIS Consortium (OGC), focus on implementation (CCRS, 2003). Some datasets may adhere to any number of geospatial data standards. Conventions are also important, particularly in the field of cartographic presentation. These are often culturally specific, normative and habitual.

Standards are collaboratively developed by domain specific committees and nations often appoint members to these. Committees announce the standard and disseminate it for testing and comment (e.g., FGDC or ISO). Often organizations adopt, or are mandated to adhere to certain standards to ensure interoperability with other GDI initiatives. Geospatial data standards foster the ability to share data and preserve original meaning, create more complex applications, stimulate commerce, increase data utility, and facilitate analysis between disciplines. In short they facilitate partnerships, coordination and collaboration (Côté, 2001).

3.5.3 Framework Data

Framework data are common fundamental datasets, or fundamental base map layers, upon which other data can be integrated at a particular restricting for a particular jurisdiction. They can also be described as a fundamental dataset that many government agencies, regional groups, and/or the private sector require to achieve their objectives and responsibilities (GSDI, 2001). The determination of framework data themes is normally carried out with members of all sectors of the economy. Framework datasets are specific layers comprising content specifications, procedures, technology and guidelines that provide for integration, sharing, custodianship, institutional relationships and business practices to encourage maintenance and use (GSDI, 2001). Common themes are: geodetic, topographic, administrative boundaries, road networks, hydrography, political, place names and cadastre. In development, they require significant resources, institutional commitment and cross-domain relationships. They must also follow strict standards, develop sharing agreements and well-defined business practices (NRC, 2001; GSDI, 2001). Some framework data are provided for free while other data that are anchored to a framework are considered value added and may be sold at a high price (GSDI, 2001). Other issues related to framework data include the choice of projections, common feature identifiers associated with real world features to enable cross referencing, and common identity codes.

Framework data were identified as key in early GIS collaborative projects and without these, work can be impeded or can be significantly slowed. Furthermore, these fundamental datasets assist with reducing duplication of effort and enable the cross referencing of information across domains.

3.5.4 Policies

There are hundreds of GDI policies covering many issues related to rules, regulations, laws, data access, production and custodianship. The most contentious are those related to legal issues such as copyright, licensing, privacy, liability, contracting and property rights. These in turn influence access policies such as data pricing – namely cost recovery or free distribution – program funding, data production choices, and which content. Treasury boards often pressure data producing agencies in governments to adopt greater cost-recovery policies that affect copyright and data licensing while data producers must determine pricing strategies to meet competing interest (Lopez, 1997). Policies affect user communities such as intermediary users who add value and decision-making communities who require data to guide choices on a variety of subjects. Government data dissemination policies particularly affect the GIS industry when information is considered a national resource that stimulates innovation, R & D and competitiveness; when information guides government programs and services, sustainable development or a citizen's rights to use information to hold government accountable. The debate on cost recovery or open access is also philosophical. It addresses the right for citizens to express themselves at will versus the right to possess exclusively those elements of culture that were once shared with others (Lopez, 1995). Political orientation toward government transparency affect

access policies. In some countries survey maps are considered to be strategic military documents with restricted access. In other cases the fear of political repercussions affects the release of certain datasets that relate to health, ethnicity and environmental contamination. There are also production policies which deal with issues of interoperability which, in turn, affect software choices, the adoption of standards, quality control, framework data production methods, and the type of clearinghouse. Policies also dictate how much of an organization's overall resources will be dedicated to a particular function and the degree of collaboration. Policies are normally aligned with the goals and missions; attuned to the environment within which an organization operates; and formally embedded within an organizational structure. As previously discussed, policies can both enhance or impede data sharing, collaboration and partnerships. Frequently the lack of formal policies at the higher levels in an organization cause the greatest difficulties. The U.S. National Research Council noted that even when the dataset is small or when a small number of organizations are involved as part of a production team, "the coordination and cooperation required for data sharing have often been difficult to obtain. Policy issues such as levels of incentives, mandates, access, pricing, privacy, and liability have only recently begun to be addressed" (NRC, 1993:3). Impediments to sharing data are institutional, organizational or behavioural rather than technical. They also affect all sectors (Onsrud & Rushton, 1995).

NMAs, statistical agencies and land registration offices are some of the largest producers of spatially referenced data (Lopez, 1997) and their dissemination policies impact GIS industries since these "provide the raw material upon which innovative

information industries add value to public information” (Benjamin and Wingand. 1995 in Lopez, 1997:37).

High-level policy frameworks affect data access and pricing. Two models are provided here, a proprietary dissemination model and an open geospatial data dissemination model. The former is a single central government agency as the producer and seller of geospatial data. The latter has a central government agency as a producer that disseminates data at the cost of production to intermediary users who add value. Partnerships between the private sector and government have created new policy issues such as ownership, selling rights, who has copyright, etc. There is also much debate on the loss of control over the type of information disseminated and who ultimately controls framework data and the value-added data. The growth of international collaborative projects has prompted the formulation of data-sharing agreements between organizations and across national borders. This growth has resulted in important activities regarding the harmonization of supportive policies to enable this process.

3.5.5 Access

Clearinghouses, directories, and catalogues are the technical embodiments of data-sharing policies. Clearinghouses are a network of Internet portals that are interconnected by a common metadata cataloguing standard and by agencies that agree to make these portals accessible to each other. They are reliant on ICT infrastructures, computing power and the Internet. Individuals within organizations register their data holdings in the clearinghouse via an online form organized according to a metadata standard and then choose to make their data available for free or for

sale. Metadata standards “establish the terms and definitions to provide a consistent means to describe the quality and characteristics of geospatial data” (Tosta & Domaratz, 1997:22) and the FGDC metadata standard has become the de facto international standard (NRC, 2001). Clearinghouses are equipped with tools for searching and querying data by themes, maps, coordinates or the names of organizations or place names. In some cases it is possible to search numerous metadata catalogues at once with the use of z39.50 server sharing standard. In Africa catalogues adhering to metadata standards are disseminated by CD-ROM as the ICT infrastructure is not widely available.

3.6 National GDIs

Nations recognize that information is a key national asset and that government intervention is required to coordinate all its aspects (Masser, 1998). Furthermore “shifts in national priorities concerning the availability of geographic information to promote economic development, support and emerging information infrastructure; and monitor the global environment may require the development of explicit and coherent national information policies ” (Burkert, 1992 and Sillince, 1994 in Lopez: 1997:45). A study that reviewed GDIs indicated that most national GDIs “promote economic development, stimulate better government, and foster environmental sustainability” (Masser, 1998:7). They encompass better planning, such as emergency preparedness, government modernization, resource management and more open government as a result of the greater dissemination. The direction of national GDI initiatives is thought to be shaped by respective national requirements and stakeholder communities

(Coleman & McLaughlin, 1997). The national GDI models that will be explored in this thesis are the Canadian GDI, the Malaysian National Infrastructure for Land Information Systems, the Japanese National SDI, the Portuguese SDI, and the Australian SDI. Each is unique and includes the components discussed in section 3.5. The difficulties encountered with their implementation will not be included in the following discussion as these were encountered throughout, particularly in section 3.2 with the reasons for GDI implementation. The following is limited to describing their models of organizing and wherever possible to understanding the formal mechanisms used to promote collaboration.

3.6.1 Canadian Geospatial Data Infrastructure (CGDI)

Canada is federation with a history of collaboration, compromise, and negotiation among its 13 provinces and territories and this is reflected in its mapping achievements and the form of its GDI. The first North American multi-participant GIS project took place in Canada in 1973 when the Council of Maritime Premiers participated in developing the Land Registration and Information Service (Forrest, 1998). In 1995, the Canadian Council of Geomatics (CCOG) proposed and endorsed a study for a Canadian Geospatial Data Infrastructure and resolved that the Inter-Agency Committee on Geomatics (IACG) undertake to build it. The IACG accepted the challenge in 1996 to develop the framework for a CGDI involving provinces and territories (Evangelatos & Labonte, 1998). The IACG recommended a 'soft leadership' approach and a consortium model for all decision-making with non-mandatory standards in a partnership environment (Evangelatos & Labonte, 1998; Masser, 1998; & Edwards, 1998). As momentum grew, it became clear that a national secretariat

with adequate funding was required to build the infrastructure. In 1999 GeoConnections was formally endorsed in the Budget Speech for \$60 million Can for five years (Government of Canada, 1999).

The CGDI is coordinated by the GeoConnections Secretariat. The mandate of GeoConnections is to

develop the Canadian Geospatial Data Infrastructure (CGDI), which will coordinate Canada's numerous databases of geographic information and make them accessible through a common window on the Internet; and enable partnerships between federal, provincial and territorial governments, the private sector and the academic community (GeoConnections, 2003).

Also, the mission states that "organizations will use CGDI specifications to implement operational systems, ensuring their ability to share and use geospatial information and services. The CGDI will succeed through those who use it and contribute to it and at present 15 federal departments and agencies have dedicated their efforts to ensure a co-operative effort. It has the potential to provide significant and lasting social, environmental, and economic benefit to the people of Canada" (GeoConnections, 2003). GeoConnections clearly includes both users and producers and has outlined the benefits of geospatial data at a very high level. The focus is a "market-driven strategy to facilitate growth and profitability of Canada's geospatial information industry" (Performance Management Network, 2000:3). It aims to be a national as opposed to a federal initiative and participants expect horizontal data agreements between all federal agencies and vertical agreements with provinces (Coleman, 1999).

As seen in figure 3.1 GeoConnections is advised by a Program Advisory Network and each advisory node is guided by a term of reference (TOR) developed by its members. Membership represents all sectors and some members participate in more than one node in order to ensure knowledge transfer among subject areas. Chairs rotate every two or three years and membership fluctuations are necessary to meet objectives. The Advisory Network is guided by five policy thrusts related to its components namely, access data, framework data, geospatial standards, partnerships and supportive policies. GeoConnections also includes seven funded programs that support data clearinghouse activities, the construction of framework data, to foster collaboration through partnerships, “accelerate the development of promising and advanced geo-info technologies” (GeoConnections, 2003), and support remote and aboriginal communities. Finally, the GeoSkills program aims to strengthen the skill in the geomatics sector while the Atlas of Canada disseminates authoritative maps on themes important to the nation. Network nodes are analogous to working groups or committees found in other national and international GDI initiatives. The government encourages partnerships with the private sector and the Geomatics Industry Association of Canada (GIAC) is actively involved. In addition GeoConnections developed clear partnership agreements. There are a number of formal incentives to encourage collaboration and define relationships. Private sector partnership incentives are 50-50 cost share in projects; for aboriginal and remote communities projects are cost shared at 65-35. In other cases resources are provided to cover the costs of converting datasets to framework data standards. Memorandums of understanding

(MOUs) delineate partnerships at the federal level, and the federal government is currently negotiating an accord with the provinces and territories. There are also some collaborative production arrangements with some provinces (Coleman, 1999).

GeoConnections is directed by a management board of senior officials from the federal agencies represented on the Inter-Agency Committee on Geomatics (IACG), provincial/territorial representatives from the Canadian Council on Geomatics (CCOG), and representatives from academia and industry. The management board decides on high level policy issues, planning and funding for programs. GeoConnections is housed and led by Natural Resources Canada and is advised by the program advisory node. The Secretariat has a staff of 10 including a director, program coordinator, and provincial/territorial appointed Coordinator along with event planning and communication personnel. This does not include personnel who administer the various programs.

Canada has also demonstrated important international collaboration by making its clearinghouse interoperable with the U.S. and Australian clearinghouses. It has also supported the development of access tools, is actively engaged in international standards activities and participates on Global Map and the Global Spatial Data Infrastructure (GSDI). Finally, Canada has a mix of free and cost-recovery policies that guide the dissemination of some datasets and discussions on whether these impede a citizen's right to know and keep government accountable are ongoing.

Figure 3.1
GeoConnections Organizational Structure
(Adapted from GeoConnections, 2003)

3.6.2 National Infrastructure for Land Information System (NaLIS) in Malaysia

Malaysia is a parliamentary constitutional monarchy with a federal government structure that centrally manages its nine states. In the mid-1980s the Malaysian Department of Survey and Mapping (DSMM) developed the foundation to build a digital central cadastral database and a national topographic database, and other agencies also developed important datasets (Hamid Ali, Fauzi Nordin, and Kamalis Adimin, 2002). Most early GIS initiatives were standalone systems or islands of information systems that were not interoperable (Bin Mohamed, 1998, Hamid Ali, Fauzi Nordin, and Kamalis Adimin, 2002). In 1994, the Ministry of Land and Cooperative Development (MLCD) carried out a GDI feasibility study that produced a proposal for a land information infrastructure for the purposes of managing data on key infrastructures and for the sustainable development of forests, gas, water and soil (Masser, 1998). A GDI was considered necessary since various LIS developed in the 1980s could not be shared among government agencies, there was duplication of effort, and there were management and departmental data fiefdoms guarding data resources (Hamid Ali, Fauzi Nordin, and Kamalis Adimin, 2002). The MLCD approved NaLIS for the 1996-2000 7th development plan.

NaLIS was established by the government to promote and facilitate the sharing, access, dissemination, exchange and use of GI among Land Related Agencies (LRAs) at all levels of government to ensure that accurate, timely, correct and consistent land information is available for planning for development and land resource management (Bin Mohamed, 1998). Task forces were created to implement federal and state level

infrastructures and in 1997 the Prime Minister's Department issued guidelines for the establishment of NaLIS.

The organizational structure as seen in figure 3.2 comprises the National Land Council housed in the MLDC; it is the highest decision-making body and gives direction to the NaLIS National Coordinating Committee that manages the development and operations of the infrastructure. It also develops and implements central policies and decision-making regarding operations. It is chaired by the Secretary General of the MLDC and the Deputy chair is the Director General of the Department of Survey and Mapping (DSMM). Members of the committee are from central mapping agencies, federal LRAs, and state governments. The NaLIS secretariat administers the committees and human resources. There is also a state coordinating committee chaired by the State Secretary comprising members from state LRAs. NaLIS also has a Planning and Implementation Committee (NPIC) which oversees the work of three technical committees (TCs) that direct NaLIS, namely Framework TC, Technical and Standards (TC) and the Clearinghouse TC (Hamid Ali, Fauzi Nordin, and Kamalis Adimin, 2002). These three TCs are also responsible for developing cross-committee policies, data preparation, standardisation, system networking, application customisation, outreach, R & D and human resource (HR) development. The Framework committee has produced some important policy and guideline documents in the form of circulars such as role of LRAs, NaLIS operations Charter, custodianship guidelines, trusteeship, authority, data integrity, and access (Hamid Ali, Fauzi Nordin, and Kamalis Adimin, 2002). Agreements between the MLCD on behalf of the federal government and state authorities are also formalized in MOUs. Data needs and gaps

Figure 3.2
 NaLIS Organizational Structure
 (Hamid Ali, Fauzi Nordin, and Kamalis Adimin, 2002)

are being identified through a survey to all LRAs. NaLIS representatives have been actively engaged in standards development at ISO Technical Committee 211 and the Standards TC ensures compatibility, while the Malaysian Standard 1074 in data exchange is being upgraded. NaLIS also has a clearinghouse and most LRAs operate gateway servers that are currently or soon will be linked to the clearinghouse. A testbed is being developed to manage data over the Internet and a prototype is under development. Outreach has consisted of workshops, seminars, conferences, corporate videos, application tutorial CDs and brochures. R & D has mostly been an out-sourced activity as in-house capacity is limited or staff are overstretched. Personnel is being continuously trained with courses formulated and conducted by the Centre for Geographic Information and Analysis or at the University Teknologi Malaysia along with seminars and workshops to expose new groups. Finally, survey maps in Malaysia are considered as classified documents which restrict access and value-added activities, while NaLIS activities are restricted to public sector agencies only (Masser, 1998) which may limit innovation in the private sector and the ability of citizens to keep the government accountable.

3.6.3 Japanese National Spatial Data Infrastructure (JNSDI)

The Japanese National Spatial Data Infrastructure (JNSDI) was the result of a government reaction to the Kobe earthquake in 1995. A Liaison Committee of 21 Ministries and Agencies (LCMA) using GIS was set up in 1995 under the supervision of the Japanese Cabinet (Masser, 1998). In 1996, the LCMA published a plan of action with the objective of promoting the development of a GDI by 1999. This included, among other things, metadata and institutional role clarification. Industry plays an

important role in the development of the JNSDI and a National Spatial Data Infrastructure Promoting Association (NSDIPA), which is a quasi-governmental association, was set up and includes 80 private sector organizations (Masser, 1998). The NSDIPA is to develop a public and private sector partnership on the development and sharing of geospatial data with the objective to carry out activities involving the national government, local governments and various organizations to support the geospatial data needs of the private sector (NSDIPA, 2003).

The NSDIPA is coordinated and administered by a secretariat that provides support to the steering committee that prepares business plans to guide the activities of seven working groups and committees as seen in figure 3.3. The committees and working groups receive support from the research committee. The working groups (WGs) develop framework data, research the legal and policy issues, and develop the GIS CYBERfair-clearinghouse. The Technical Information Committee liaises with Japan's prefectures and GIS promotion associations while also participating in information exchange seminars, conferences and workshops (NSDIPA, 2003). The International Committee participates in OGC and other standards meetings, and public relations.

The Ministry of Construction, which manages all infrastructures, and its Geographic Survey Institute (GSI) is responsible for mapping and surveying. The GSI carries out survey administration, full mapping production activities including reproduction and publication, prepares national scale thematic and base maps, conduct R & D, and promotes international cooperation in the field. The GSI is a strictly national organization with a well-defined public purpose, particularly regarding

Figure 3.3
Organizational Structure of the JSDIPA

emergency preparedness. The GSI is also the Secretariat for Global Map, an important international global framework data initiative. The government supports close collaborative work in the area of geomatics R & D via joint research programs among research institutes, the government and private companies, particularly in the area of standards development. Access to geospatial data in Japan is limited to the public sector, quasi-government organizations and universities. There is strict copyright on use and permission must be asked to use the data for projects for which they were not originally intended (Masser, 1998).

Information in English on the JNSDI is limited and the available information is poorly translated making it difficult to assess the exact interconnections between the GSI, the Government of Japan R & D strategies, how research institutes are involved, the nature of the relationship between the prefectures and the national government, and membership of the NSDIPA. It is assumed, however, that the NSDIPA informs how the JNSDI is to be built while the GSI is the implementation organization.

3.6.4 Sistema Nacional de Informação Geográfica (SNIG) in Portugal

The Sistema Nacional de Informação Geográfica (SNIG) was created by Government of Portugal decree in 1990. At the same time, a National Centre for Geographic Information (CNIG), a research centre and central administration agency, was created to coordinate and integrate different levels of administrative data (Masser, 1998; Arnaud, 1993). CNIG is supported by the Secretariat for Science and Technology which is the central hub for five regional organizations (Arnaud, 1993). SNIG is considered an important innovation toward the modernization of the Portuguese administration and it was the first country in Europe to have an operational

geospatial data clearinghouse and centrally coordinated geospatial information resources in Portugal.

3.6.5 Australian Spatial Data Infrastructure (ASDI)

The Australia Spatial Data Infrastructure (ASDI) is a network of jurisdictional GDIs that are linked by adherence to common standards, policies and administrative arrangements (Holland, Nairn, Baker, Irwin, Boersma, Burbridge and Robertson, 1999). There is no central repository of national scale data. However, state and territorial data initiatives are coordinated by their jurisdictions and guided nationally by the Australia and New Zealand Land Information Council (ANZLIC). Geospatial data are accessed by a clearinghouse connected to jurisdictional directories. The states and territories are responsible for the ASDI operational environment such as the collection of key datasets (Edwards, 1998). The private sector is involved in map production with state and territorial agencies in Australia. The federal government provides the ASDI support in the following areas: national leadership on policy development, provision of a Commonwealth focal point by informing ministers and the Cabinet, development of national datasets in different federal agencies, skills and standards. The primary objective of the ASDI is to ensure that geospatial data users can access consistent datasets to meet their own as well as national requirements.

The ASDI has four components: an institutional framework of policies and administration arrangements to build, maintain, access and apply standards; technical standards to define the characteristics of fundamental datasets; fundamental datasets to be produced within the institutional framework and fully compliant with standards; and a distribution network, the means by which the data are disseminated in

accordance with policies, standards and the institutional framework (Holland, Nairn, Baker, Irwin, Boersma, Burbridge and Robertson, 1999).

ANZLIC is the agency that guides the policy and institutional ASDI environment. ANZLIC was formed in 1991 and both New Zealand and Australia are full time members. It is an inter-governmental council that coordinates land information and the management of GI for both Australia and New Zealand. It was originally established in 1986 by agreement with the Australian Prime Minister and the Heads of State and Territories to coordinate data collection and transfer, and to promote the use of that information in decision-making as seen in the organizational structure of figure 3.4 (Holland, Nairn, Baker, Irwin, Boersma, Burbridge and Robertson, 1999). ANZLIC's vision is for Australia and New Zealand to have the land and geographic information needed to support their economic growth and their social and environmental interests. ANZLIC's mission is to "provide leadership for effective management and use of land and geographic information to achieve that vision" (Holland, Nairn, Baker, Irwin, Boersma, Burbridge and Robertson, 1999). ANZLIC's role is to facilitate communities in defining the components and characteristics of the ASDI and to develop national priorities and custodianship arrangements (Masser, 1998; Holland, Nairn, Baker, Irwin, Boersma, Burbridge and Robertson, 1999). The objective is to ensure "the required national consistency, content and coverage to meet national needs" (ANZLIC, 1996:5) and that all jurisdictions focus efforts in the national interest. National sponsors and custodians are appointed to manage fundamental datasets in consultation with ANZLIC to ensure that priorities are aligned. This responsibility includes dissemination, pricing and licensing. The coordinating body for the Australian federal government is the

Figure 3.4
ANZLIC Organizational Structure
(Adapted from Holland et al, 1999.)

Commonwealth Spatial Data Committee (CSDC) with a chair at ANZLIC. It is responsible for coordinating Commonwealth interests and the development of the Australian Spatial Data Directory (ASDD). It also developed the Australian Spatial Data Transfer Policy (CPISTP), Commonwealth custodian guidelines, identified custodians, and led agencies to manage various categories of data (Holland, Nairn, Baker, Irwin, Boersma, Burbridge and Robertson, 1999).

ANZLIC's membership consists of the heads of the NMAs of Australia's six states and two territories, the New Zealand NMA, and the Commonwealth Spatial Data Committee (CSDC). Members represent numerous geographic interests from their respective jurisdictions and also act as coordinators within their jurisdictions (Masser, 1998). The CSDC and ANZLIC work closely to support the ASDI. The decision-making process of ANZLIC relies heavily on a consensus model as it has no executive power to enforce compliance (Masser, 1998). The national Intergovernmental Committee on Surveying and Mapping (ICSM) is a coordinating body that has aligned its priorities toward the development of the ASDI and has formed eight thematic framework data working groups. The Australian Surveying and Land Information Group (AUSLIG) is a federal agency and provides the secretariat for ANZLIC, the CSDC and the ICSM.

AUSLIG is located in the Federal Department of Industry, Science and Tourism and represents the Federal Government at ANZLIC, ICSM and CSDC. It supports international activities such as the regional Asia Pacific SDI. Formally, AUSLIG implements Commonwealth policy on ASDI, and coordinates international activities. It

is the custodian of framework datasets and formally liaises with state and territorial agencies on the implementation of the data clearinghouse, and other information centres.

ANZLIC has carried out a number of important activities such as the publication of discussion papers and custodianship guidelines; establishment of a metadata working group; implementation of a clearinghouse and directory of nodes. It has also held a Ministerial Forum to gain political support and identify and improve national datasets. Finally, it conducted research on policy issues related to copyright, liability, privacy, etc. (Holland, Nairn, Baker, Irwin, Boersma, Burbridge and Robertson, 1999).

3.7 Regional and Global GDIs

Globalization of international trade and cross-border environmental monitoring compel governments to cooperate rather than compete, promoting a "convergence of data development and dissemination objectives" (Lopez, 1997:55). As previously discussed in section 3.2, international collaborations are somewhat more complicated as they operate in a patchwork of national policies that govern spatial data creation, maintenance, quality, standards adoption, etc., that do not always align in member states. Other external difficulties differentially affect transnational GDI development. These include national security priorities, the geography of each nation, the different stages of economic development, population numbers, political systems, and mediating social, cultural and linguistic diversity (Rajabifard, Chan & Williamson, 1999). The Pacific Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP) and the Global Spatial Data Infrastructures (GSDI) are building on the experiences of

early transnational mapping activities to address these challenges and are extending the work of national GDIs. The following section will explore the mechanism by which these are organized.

3.7.1 The Pacific Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP)

The Pacific Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP) was formed in 1995 following a recommendation (Resolution 16) from the UN Regional Cartographic Conference for Asia and the Pacific in May 1994 in Beijing. The committee's membership consists of directorates of national survey and mapping organizations or equivalent national agencies. Members would also have the authority within their own nations to build and coordinate GDIs, along with those responsible for the acquisition and processing of fundamental datasets, and key agencies responsible for their maintenance and distribution. Members represent the 56 nations the UN classifies as Asia and the Pacific. The Asia Pacific SDI provides the institutional framework, international standards, fundamental datasets and the distribution network (Kai, 2001). It will be a network of databases located throughout the regions to provide the fundamental datasets needed to achieve the region's economic, social, human resources development and environmental objectives (Kai, 2001). The inter-regional institutional framework will provide the mechanism to share experience, coordinate the development of datasets, adopt technical standards including a common geodetic frame to enable other value added activities, adoption of common policies and the implementation of intergovernmental agreements on data sharing through a data clearinghouse using standard metadata descriptions. It is a distributed

database with participating database custodians linked with standards and protocols and it contains only the necessary datasets upon which others can be built (Kai, 2001).

The belief of the PCGIAP is to start with national initiatives and to work up to the region. The goals of the PCGIAP are to “maximize the economic, social and environmental benefits of geographic information in accordance with Agenda 21 by providing a forum for nations from the Asia and the Pacific” (PCGIAP, 2003) to cooperate on the development of a regional GDI, to contribute to the GSDI, and to consult and share on matters of common interest.

The primary justification for the PCGIAP is based on the need for GI across all UNCED Agenda 21 priorities and the explicit statement in chapter 40 that geospatial data are critical for environmental decision-making. Other justifications are that cooperation will be a cost-saving strategy for the region, as information will in time reduce land conflict, resolve cross-border environmental issues, disaster and resource management. In addition, the PCGIAP will conduct demographic research in the region, inform the management of international treaties on the environment, and build a GI industry in the region (PCGIAP, 1998).

The PCGIAP in time will create the Asia Pacific Spatial Data Infrastructure (APSDI) with framework data for the region as the main focus, along with the determination of individual nation's needs. Fundamental datasets, are those where there is a demand for consistent regional coverage and will be developed between custodians and communities of users. These will be linked within a policy framework to enable data sharing, adherence to agreed-upon standards to ensure interoperability, develop

agreements on custodianship, formulate inter-governmental agreements on data sharing, and develop a clearinghouse that uses metadata. The PCGIAP will also provide the technical and institutional framework to ensure consistency, content and coverage to meet regional and international needs.

In the PCGIAP model geospatial datasets would be supported by sponsors who ensure “that the dataset is widely available to the community as part of a regional spatial data infrastructure and has a structure and resources to support its implementation. These data would relate to the core business of the agency or organization” (PCGIAP, 1998:5). These sponsors would liaise and cooperate with PCGIAP to ensure the dataset is assembled, maintained and delivered in an accessible and consistent fashion. In the interim, the PCGIAP will carry out this function until a sponsor is found. Custodians in this model would have responsibilities similar to those of sponsors but they would manage the operational environment of a particular dataset in exchange for the right to share the fee for data access, market and distribute the dataset to certain classes of users, and access and use data administered by other custodians (PCGIAP, 1998). The PCGIAP would also enable access to education in the region in order to increase the region’s skill sets with universities and research institutions.

The PCGIAP has an executive committee, supported by a secretariat, that addresses both the institutional and policy matters of the PCGIAP statutes and definitions, and will support regional working groups such as geodetic network, fundamental datasets, development needs in the region as seen in figure 3.5. Executive board members represent China, Australia, Japan, Iran, Malaysia, India,

Philippines, Russia, Brunei and the Cook Islands. PCGIAP currently has four WGs, namely Regional Geodesy chaired by Australia, Fundamental Datasets chaired by Iran, Cadastre chaired by Malaysia and Institutional Strengthening chaired by the Philippines. The Institutional Strengthening WG is mandated to enable capacity building, education and training, needs identification, the search for funding options for member country GIS, and related development to improve participation of member countries in the PCGIAP (Kai, 2001).

The PCGIAP collaborates with other global mapping programs and will provide a vehicle for Asia and the Pacific to contribute to it. The APSDI will therefore be developed with due consideration of Global Map and the GSDI. Funding is a critical issue and the committee will seek opportunities for national GDIs, make funding agencies aware of their import, and encourage AP nations to consider participating. The PCGIAP is also formally linked to other United Nations Regional Cartographic Conference (UNRCC) Permanent committees such as UNESCO for Asia and the Pacific Regional Space Applications Program for Sustainable Development, International Association of Geodesy, The Fédération Internationale des Géomètres (FIG), the International Steering Committee for Global Spatial Data Infrastructure (ISCGM), the GSDI, UNRCC-for the Americas, EUROGI, and ISO (Kai, 2001).

Figure 3.5
Organizational Structure of the PCGIAP
(Adapted from Holland et al, 1999)

3.7.2 Global Spatial Data Infrastructure (GSDI)

The first GSDI meeting occurred in Bonn in 1996 with 60 representatives from the geospatial data community. In 1997, participants at the second conference agreed to link local, national and regional GDIs in a global project with a focus on multinational and multilateral cooperation to build a GSDI to foster worldwide sustainable development (Holland, Nairn, Baker, Irwin, Boersma, Burbidge and Robertson, 1999; GSDI, 2001). Once operational, the GSDI will encompass “the policies, technologies, standards and human resources necessary for the effective collection, management, access and delivery, and utilization of geospatial data in a global community” (Coleman & McLaughlin, 1997:8). The definition adopted at the 1997 GSDI Conference is “the policies, organizational remits, data, technologies, standards, delivery mechanisms, and financial and human resources necessary to ensure that those working at the global and regional scales are not impeded in meeting their objectives...” (Holland, 1999:2). The initiative is intended as a non-competitive, collaborative endeavour that will build on and unify common activities in the field of GI exchange and data harmonization (GSDI, 2001).

The GSDI is directed by a steering committee with members from around the globe. The organizational structure is that of an umbrella organization that brings together regional and national committees, and other related institutions in “the context of flexibility, inclusivity, simplicity and subsidiarity” (Holland, 1999:8). The executive committee comprises representatives from Asia Pacific, Europe, Africa-Middle East, and the Americas, and members who represent nations or particular interests. A

GSDI secretariat will administer and support the communications of the organization. A steering committee will support the work of four WGs and operations required to implement the umbrella organizational structure. The other three WGs are Technical, Communication and Awareness to promote the GSDI, and Legal Economic. Some of the early outcomes have been to pool knowledge resources in the production of the SDI cookbook and its dissemination, and the implementation of a survey of national GDIs (GSDI, 2001). The GSDI also has a number of programs such as GDI capacity building around the world to identify and allocate resources, disseminate training manuals, educate decision-makers, facilitate supportive policies, and continue to support the work of GSDI until it is operational (GSDI, Bucharest Resolutions 2002).

Key GSDI stakeholders are national mapping agencies (NMAs) that develop framework data and industry, which provides the technology, data and services to support GSDI activities. The GSDI has received support from established national GDIs. Certain communities have demonstrated significant support for its development. These are military organizations such as NATO and U.S. Defense, the International Hydrographic Organization, some developed nation public sector data producers, members of Global Map and members from the scientific and environmental community (Coleman & McLaughlin, 1997).

At present the GSDI mandate is broad and not all nations can participate equally in its development. Therefore, certain themes deemed necessary by the scientific community will be pursued. These are Global Map datasets themes such as elevation, vegetation, land use, transportation, and administrative boundaries all built with common specifications (Holland, 2001).

3.8 Geospatial Data Infrastructures (GDIs) in Less-developed Countries (LDCs)

The national GDIs examined in this thesis are extensions of well-established ICT infrastructures, or in the case of Malaysia a well-established urban mainland ICT infrastructure, that benefited from strong R & D within their respective states and a highly educated workforce. These nations also have a history of digital mapping and mostly have strong geomatics sectors. Regional and global GDIs are enabling institutions that will extend the work of national GDIs. GDIs and GIS are predominantly the brainchild of industrialized nations and may not be completely transferable to less-developed countries (LDCs) contexts without consideration of the differing contexts. Ezigbalike, Selebalo, Faiz and Zhou (2000) consider GDIs to be more than data, technology, institutions, policies and standards; they consider them as the foundation and fabric for all activities and services of society and community. They also consider users as integral and refer to the following in their definition of a GDI:

the people including user, provider and value adder who are interested at a certain level of area that starts at a local level and proceeds through state, national and regional levels to global level (FIG, 1999).

Like developed nations, LDCs require data, have similar data sharing and production issues, and share many of the same institutional, policy and organizational concerns. While the problems are the same, arguably these issues are accentuated in the LDC context due to the scarcity of technical, human, educational and financial resources. Information scarcity in LDCs has clearly been articulated in Rio Agenda 21, Chapter 40 and reiterated at Rio +10 in Johannesburg 2002. The need for data in

developing countries cannot be overestimated, and McLaughlin and Coleman (2001) noted in their paper on Geomatics in the New Millennium that:

recent inventories of national mapping efforts confirm that only limited coverage is available in many developing countries. Further, while we quip that we know more about the backside of the moon than the bottom of the ocean, the sad fact is that is very true.

We can see high resolution images of Mercury, and have mapped the entire moon but we know little of vast areas on the continents of Africa, Asia or Latin America.

LDCs, like their developed counterparts, maintain myriad geospatial datasets in their respective NMAs, surveyor generals, or physical planning offices at all scales. Additionally, like many institutions, geospatial datasets are built to support only the administrative responsibilities of their organisations or to fulfill the objectives of a particular ODA-funded project and therefore suffer from the problems associated with standalone systems or worse, the problem of competing aid agency priorities.

Many issues are particular to LDC contexts. Some relate to physical infrastructures such as a limited telephone system that does not always reach rural areas and the absence of high bandwidth which limits the exchange of data over the Internet. Also, the electrical infrastructure in many LDCs mostly services urban areas and the supply is not constant causing power surges that damage equipment. In spite of the numerous initiatives to 'bridge the digital divide', access to computers is limited and when they are available there are a limited number of people with the skills necessary to use them. Overall computer literacy is low and Internet and Email communication are only just emerging as useful tools in some urban areas. Academic institutions are not able to supply graduating students with the necessary skills.

Regarding mapping, most activities are done manually and NMAs have explicit mandates to manage land and related data, but they do not always have the capacity to do so. In other cases NMAs are not responsive to user needs – namely “the onus is on the user to adapt to the available data, rather than on the data producers to develop new products in response to the needs of the users” (Ezigbalike, Selebalo, Faiz and Zhou, 2000:7). Generally, interorganizational barriers impede cooperation between agencies and the flow of information between agencies is slow, mostly because these are organized according to the old paradigm of map management and not information management (GSDI, 2001; Ezigbalike, Selebalo, Faiz and Zhou, 2000:7). Other encountered difficulties relate to power – namely “a fundamental problem underlying data sharing and distribution is the belief that one gains power and influence from withholding information and controlling it” (GSDI, 2001:97) while true power really lies with those who share the data. Furthermore, the upper levels of government in LDCs do not appreciate the need for a GDI nor is there prerequisite understanding of how GDIs inform sustainable development. Without this high level support, organizations are reluctant to change their structures and purse strings are unlikely to be loosened (Ezigbalike, Selebalo, Faiz and Zhou, 2000).

In spite of these difficulties, many nations are developing a geomatics industry and the early workings of GDIs. Some African countries are beginning to develop data clearinghouses, repositories, data warehouses, and geospatial databases. However, these initiatives suffer from the same problems that early GIS collaborative projects

experienced, namely a lack of metadata and database standards, a lack of coordination between mapping efforts, and duplication of effort (Ezigbalike, Selebalo, Faiz and Zhou, 2000).

Tunisia is creating a geomatics industry to serve a geospatial data infrastructure for sustainable development, and Lesotho is developing an inter-sectoral Committee on Environmental Data Management (CEDEMA) mandated to develop a culture of environmental data exchange, data management, establish quality standards and management policies, develop indicators, monitor trends, and recommend mitigation measures (Ezigbalike, Selebalo, Faiz and Zhou, 2000). In South Africa "agreements between parties on issues relating to data with a view of developing a South Africa Data Committee Environmental Information Systems (EIS)" are well underway (Ezigbalike, Selebalo, Faiz and Zhou, 2000:9). Colombia is in the early stages of developing a GDI (ICDE) and faces common GDI constraints such as decreasing budgets, the lack of high level support, limited capacity for R & D, a lack of knowledge about the GI market and a general lack of agreement on policies (GSIDI, 2001). There are also some early GDIs supported by ODA. The U.S. Agency for International Development (USAID) and the U.S. Geological Survey (USGS), in cooperation with organizations in the Americas, are establishing an Inter-American Geospatial Data Network (IAGDN) with a clearinghouse based on the same technology as the FGDC (Anthony, Klaver, and Quenzer 1998). The project is in its early stages and one of the activities is the coordination of an inventory of current datasets in the region, particularly to identify their content, quality and extent and strategies to document these (i.e. metadata). There are also some important subject matter GDIs such as

Geospatial Applications to Support Sustainable Agriculture (GASSIA) that is promoted by a strategic alliance of R & D organizations, remote sensing data providers, the Food and Agriculture Organization (FAO) and United Nations Environment Program (UNEP) with the explicit objective of informing sustainable agricultural development. Finally, the U.S. National Research Council (NRC) has released an important report on Geographic Information for sustainable development in Africa and refers to a large number of important GI initiatives on the continent.

The adoption of GDIs in a LDC context will require special considerations of less well resourced organizations in terms of technology, skill, finances, ability to share data, the lack of telephone infrastructures or fully functioning electric grids. Furthermore, differing levels of development, cultures related to information sharing, and political ideology that affect information dissemination will also have to be considered. The literature on the subject of GDIs and GIS in developing countries is growing and many lessons have been learned. Again, it can be argued that these issues are often the same as those in developed countries except that external issues differentially accentuate these problems. A comprehensive analysis of these was not carried out since it is beyond the scope of this thesis, however they will be referred to and considered in the discussion on building a GDI for sustainable development in East Timor in Chapter 4.

CHAPTER 4

A GEOSPATIAL DATA INFRASTRUCTURE FOR THE SUSTAINABLE DEVELOPMENT OF EAST TIMOR

4 Introduction

The crisis is over in East Timor and priorities are shifting to nation building, Timorization and re-construction. Concurrently, the small island state is struggling to sustainably provide the necessities of food, employment, health care, public safety and education to its citizens. East Timor has made a commitment to sustainable development but for it to become a reality, it is argued that data, information and the processes by which these inform decision-making need to be prioritized as part of its nation-building process. These will have to become explicit in the institutional and social structures of its civil service, educational institutions and society. Decisions based on information derived from accurate and reliable geospatial data will require implementation, testing and adaptation to cumulatively create knowledge. Geospatial data infrastructures (GDIs) are offered as the mechanisms to enable the creation and ongoing growth of sustainable development knowledge.

The current situation in East Timor may not be suited to building a GDI, particularly technical components, but the organizational, collaborative, and political aspects can be advanced now while the necessary capacity to absorb the technical aspects is developed. A GDI is considered a priority for East Timor since much development work is ongoing without reliable, accurate and integrated information. In addition, many datasets are being compiled by overseas development agencies (ODAs) but these data have not been stored into any central agency or repository in East Timor. aid workers may not have transferred the knowledge to East Timorese citizens on how to collect and analyze these data. Furthermore, there are many physical and social issues that affect sustainable development and geospatial data and related attributes can greatly advance planning and management decisions on those issues. Finally, the Constitution of the Democratic Republic of East Timor includes a commitment to both sustainable development and the use of science and technology to assist the country in becoming a full-fledged democracy and GDIs are considered part of the technological process that enables physical and social science research to advance both sustainable development and democratic goals.

This chapter will argue that in the short run, sustainable development in East Timor is contingent on creating the organizational and institutional components of a GDI. In the long term, it is contingent upon developing the technological components. First, it will be demonstrated that East Timor requires data and information to fulfill its constitutional and regulative obligations. Constitutional principles, mandates, regulations and laws are implemented in institutions and East Timor's new departments and ministries are mandated to implement regulations and constitutional

principles in their operations. Government departments, ministries and district offices require data and information to plan and provide services to citizens and to manage resources and physical and social infrastructures. The people who work within them require the necessary capacity to use this information. Second, numerous overseas development agency reports related to humanitarian assistance, reconstruction and project funding include explicit references to sectors of society, economy and environment which require information for problem resolution. However, data to inform these issues are scarce or unreliable. Accurate and timely geospatial data and their related attributes enhance problem resolution and GDIs are considered effective at coordinating all aspects of geospatial data. Third, since GDIs are offered as a mechanism to operationalize sustainable development, an analysis of the models presented in chapter 3 will be provided to determine if any of these are suitable for East Timor. Fourth, should a suitable model be selected, implementation will have to take into consideration the lessons learned from early GDI initiatives in less-developed countries (LDCs), the current context in East Timor and the historical social structures presented in Chapter 2.

4.1 Constitutional and Regulative Responsibilities

All nations have rules, regulations and responsibilities embedded into their constitutional and regulative frameworks. These guide the actions of the state, its institutions and the behaviour of its citizens. East Timor is clearly committed and constitutionally bound from the very beginning of its nation-building process to sustainably manage its territory with the help of all of its citizens. Sustainable

development includes among many other elements, environmental protection, the promotion of sustainable behaviour related to consumption and production, and their related determinants such as culture, heritage, health, security, social welfare and the economy.

East Timor has a series of regulations and sections in its constitution formulated to address aspects of the environment, economy, society, data gathering and the use of science and technology (table 4.1). The Constitution of the Democratic Republic (D.R.) of East Timor was ratified by the Constituent Assembly on March 22, 2002. Prior to ratification, the East Timor Transitional Administration (ETTA) with United Nations Transitional Administration in East Timor (UNTAET) drafted a series of regulations to guide the processes of nation building. Those that pertain to the environment and data gathering are also listed in table 4.1.

The following provides details on some of the principles and regulations that pertain to sustainable development in the Constitution. As discussed in Chapter 2, East Timor's forests have been mismanaged for centuries and the recent crisis only worsened the situation. A forestry regulation was immediately drafted to ban the export of timber and slash-and-burn agriculture. The regulation does, however, make provisions for the wise use of forest products for traditional agricultural purposes or constructing traditional and religious structures. It also includes the provision for sustainable management and the carrying out of a forest inventory. East Timor has areas of particular inherent environmental, cultural and historical value and a regulation on protected places was developed for the purpose "of protecting designated areas, endangered species, coral reefs, wetlands, mangrove areas, historic,

cultural and artistic sites, conservation of biodiversity and protection of the biological resources of East Timor” (Reg. 2000/19). A list of the protected places is included in the regulation and the possibility of designating new sites on the basis of scenic and natural qualities, rare biological resources, and habitat for endangered species were also included. Apart from inherent value, these locations are considered important for their potential to generate tourism revenue – in particular the promotion of eco-tourism. There are a number of renewable and non-renewable resources in East Timor and Section 61, Environment Subsections 2 and 3, are explicit on the need to preserve and rationalize natural resources, while also promoting actions aimed at protecting the environment and “safeguarding the sustainable development of the economy”. Part IV, Economic and Financial Organization, also states that “the exploitation of the natural resources shall preserve the ecological balance and prevent destruction of ecosystems”. The constitution has made explicit the relationship between the long-term economic benefits that can be derived from managing natural resources and the environment.

The restoration of public security was a critical process for enabling people to carry out their daily activities and a civil police force was created for that purpose. However, borders still pose significant security threats. A border regime regulation was set up and a Joint Reconnaissance Survey (JRS) of the borders between East and West Timor was completed and demarcated on May 22, 2002. The JRS comprised members from the Indonesian mapping agency, East Timorese officials and both ministries of foreign affairs, while logistical support was provided by UNTAET’s peacekeeping force and the Indonesian Military (UNTAET, 2002). Accurate maps are

Table 4.1

Constitutional Principles and Regulations Related to the Protection of the Environment,
its Related Determinants and Data Gathering

Data compiled by the Author from the UN Transitional Administration in East Timor

Regulation 2000/8 Revenue System	D.R. East Timor Constitution Section 6 Subsection 1. on the decentralized public administration
Regulation 2000/9 on a Border Regime	D.R. East Timor Constitution Section 6, Objectives of the State Subsection f on the protection of the environment and to preserve natural resources
Regulation 2000/17 on the Reduction of Deforestation	D.R. East Timor Constitution Section 6, Objectives of the State Subsection g on the preservation of cultural heritage and valuing the personalities of the East Timorese people
Regulation 2000/19 on Protected Places	D.R. East Timor Constitution Section 56 on Social Security and Assistance
Regulation 2001/3 On the Establishment of the Central Registry	D.R. East Timor Constitution Section 57 on Health
Regulation 2002/4 Business Registry	D.R. East Timor Constitution Section 59 on Education and Culture
Regulation 2000/15 Telecommunication	D.R. East Timor Constitution Section 61 on Environment
D.R. East Timor Constitution Section 6 of the - Economic and Financial Organizations	Timor Gap Agreement of July 5, 2001
D.R. East Timor Constitution Section 6, Objectives of the State Subsection d Science and Technology	D.R. East Timor Constitution Part IV, Economic and Financial Organization, Title 1, General Principles, Section 139, Natural Resources Subsection 3

critical for international peace-keeping, while border regimes enforce immigration and travel regulations, control the transport of goods, the quarantine of livestock, and the collection of taxes and tariffs which are all intensive national data collection activities.

The provision of education, health and social services and the management of business activities require demographic data. A census or a registry is the means to collect these data. East Timorese laws were created to ensure that a census is taken, and to mandate the development of an electoral, business and land registry and a tax regime. Related to these are provisions on the right to honour privacy (section 36), the protection of personal data (section 38) and also the right to disseminate non-private data (section 53). These data are collected and these ethical conduct provisions ensure that citizens in East Timor have the right “to truthful information and protection of their health, safety and economic interests” (Constituent Assembly of East Timor, 2002).

The implementation of environmental regulations requires management that is dependant on indicators, trend analysis, monitoring and mitigation and their reliability is contingent on timely and accurate information. A forest inventory will provide information on quotas for use of timber for traditional practices and inform tree-planting activities. Protected places can be mapped and their borders monitored, while criteria for the selection of new locations can be input into decision support tools. The protection of ecosystems provides opportunities for eco-tourism, which is good for the economy and provides justification for preservation. National security is very

important and creating the need for accurate maps to demarcate boundaries and hot spots is critical. A well-managed border regime can avoid health threats to flora, fauna and foodstocks. It can also provide economic trade data.

Finally, enabling a civil society requires voter registry data, a census to provide geodemographic data to inform the design of services (e.g., education, health and etc.) while land registries and cadastres provide the necessary information for land management. These subject-specific datasets on their own are very useful, however the power of these data resources lies more in their integration. For example, forests can also be protected places; deforestation affects ecosystems while slash-and-burn agriculture affects them both; and new roads enable tourists to visit protected places but can also lead to deforestation and cause soil erosion. Complex issues require an integrated approach to problem resolution, planning and management which requires data on different subjects but the same location. It is the requirement for this type of integrated analysis that has sparked the need for standards and policies related to data gathering, storage, discovery, dissemination and interoperability.

Technology such as GIS, modelling software and decision-support systems in the hands of capable scientifically and technically trained people greatly improves the possibility to carry out an integrated analysis. Understanding and applying the results of an integrated analysis is greatly enhanced when policy makers have the necessary social science, managerial and public administration training. High-quality decisions require the right tools, people and information and the D.R. East Timor Constitution

recognizes the need for science and technology to advance the economy and protect the environment (section 6). At present, the capacity to carry out an integrated analysis to inform sustainable development is limited.

The implementation of sustainable development requires the participation of all members of society in all their different roles. Section 5 of the constitution makes explicit the need for all areas of the country to be involved in governance by adopting the principles of a territorial state organization with a decentralized public administration that distributes power to the districts. This enables localities to develop according to their particular cultural, environmental and economic characteristics while enabling a more inclusive and participatory approach to governing the territory. The decentralized approach to health (section 57) and the environment (section 61) is designed specifically to encourage the participatory management of the health system and the environment. The provision of universal free education is also a necessary pre-condition to democratization as citizens will be provided with the means to read, write and develop numeracy. A society that invests in the education of its citizens is building its human resources for the long term. Formal education can also be combined with traditional knowledge. The ability to combine census and environmental data with local knowledge can be the beginning of an integrated and informed approach to resolving local problems with national strategies.

Regulative frameworks require institutions to operationalize laws, directives, and constitutional principles and embed these into the policies, norms, practices and the value systems of their organizations. A government administration is one of the formal institutions that carries out this function and table 4.2 lists the newly formed

departments and units in East Timor. These departments are mandated to oversee the management of land, water, public infrastructures, environment, security, labour, population, civic participation, communications, economy, international relations, education, social affairs and health.

To date, 36 departments, units and ministries have been set up and details of their mandates are too numerous to mention here. However, the following illustrates the data requirements for some. The Environmental Protection Unit (EPU) is a statutory agency that implements environmental protection measures and enforces regulations to ensure that natural resource governance practices are in place (United Nations and World Bank, 1999). It was set up very early since the condition of the environment in East Timor was considered a national hazard. The Department of Census and Statistics was formed under ETTA and will be responsible for providing baseline data to other offices as required for their work. The census will include demographic, sociological, economic and geographical data necessary for the planning and implementation of economic and developmental policies and for the structuring of public services such as health, education, transport and social affairs (ETTA, 2000a). The mineral resources section was established by Cabinet in the Department of Economic Affairs to manage and regulate natural resource exploitation and exploration activities (UN Secretary General, 2001). It will oversee the Timor Gap Agreement signed on July 5, 2001 between East Timor Cabinet Ministers and Australia. The agreement provides East Timor with 90% of oil and gas production in the areas covered by the 1989 Australia-Indonesia Timor Gap Treaty and East Timor

Table 4.2
East Timor Government Departments and Ministries

Agricultural Affairs	East Timor Health Authority	Labour
Border Service and Control Unit	Division of Social Affairs	Judicial Affairs
Census and Statistics	Economic Affairs	Land and Property
Central Payment Office	Education	Mineral Resources Section of the Department of Economic Affairs
Central Fiscal Authority	Environmental Protection Unit	Ministry of Economic Affairs
Civic Education	Finance	Office of Communication and Public Information (OCPI)
Civil Service and Public	Fisheries	Political Affairs and Timor Sea
Employment	Foreign Affairs	Power Services
Civil Registration Unit	Information Technology Post Telecommunication (ITPT)	Public Utilities (Power, Water and Sanitation)
Civilian Police	Inspector General's Office	Reconstruction
Commerce, Industry and Tourism	Internal Administration	Social Services
Communications	Investment Promotion	Transport

can also have control of its own fiscal scheme, while revenues from the treaty are split 50/50 (UN Secretary General, 2001). This will provide East Timor with the means, if managed well, to finance its state activities.

These administrative units require the collection, processing and analysis of data into meaningful indicators and maps to effectively locate, administer and manage their mandated activities. The people who work in these units will require the training to be able to carry out these functions. The EPU will need to develop criteria on the wise use of natural resources to enforce regulation. Environmental impact assessments are tools often used in these types of institutions and these are cross-domain data intensive activities. The census will provide a wide range of data that can be used to understand population growth, which in turn, can inform possible demand for new services and where best to locate these. The construction industry in East Timor will benefit from knowing the demand for housing and infrastructure provided by the census while the mines and minerals department can benefit from surveys that map deposits, quarries and stocks to inform the industry's supply needs. In addition, the management of the Timor Gap agreement will require data for shipping, oil and gas exploitation, and accounting and accident prevention.

The Department of Census and Statistics include provisions to supply other departments with data, however, there does not seem to be a mechanism in place to ensure that departments and ministries manage their data in a standardized way, nor is there a central agency that performs a coordinating function between departments to ensure inter-departmental cooperation and collaboration on information issues. As

previously mentioned, the power of data resources comes from the ability to integrate different sources; without a formal entity coordinating national data assets it may prove difficult to seamlessly integrate this information, as is the case in most developed countries. With timely planning, East Timor could potentially avoid the issues faced in most countries by developing a data coordinating body now to ensure that all sectors, departments and jurisdictions work collaboratively to develop policies and standards to ensure that data could be used in a variety of contexts.

4.2 East Timor's Geospatial Data Requirements

The lack of information and data about East Timor cannot be underestimated. Many authors (Sandlund et al., 2001; Phillips, 1999; UN-CCA, 2000, Ormeling, 1958) have made explicit reference to the fact that they were operating with a lack of understanding of the big picture and that it was "difficult to give an accurate, well-researched overview of the environmental problems" (UN-CCA, 2000:88). The "lack of updated and reliable information regarding natural resources and biodiversity in East Timor" (Sandlund et al., 2001:31) is acute and there are few scientific sources, with even less social science information. Anthropological information exists but the focus is on the cosmology of indigenous people or is biased on the resistance movement (Sandlund et al., 2001). The destruction of government records did not help and neither did the fact that the Portuguese never conducted a proper census (Phillips, 1999). Further, "given the circumstances of Indonesian rule over East Timor, there are serious questions about the reliability of data" they would provide (UN-CCA, 2000:17). Even if data were available from either country the situation has changed

so much and they would no longer be considered relevant. Ormeling's early 1957 observations regarding the lack of data still ring true today.

Knowledge on some topics is also very low. There is legislation on biodiversity but few East Timorese are knowledgeable about this topic and implementing practices will be thwarted by this lack of knowledge. Information on biodiversity and a range of other subjects that require an integrated approach (e.g., health, environment, poverty) to their management will require a long-term commitment to capacity development in the area of research in the physical and social sciences within universities, schools and government institutions (Sandlund et al., 2001). This education process should not be limited to the public service; it should also involve local communities, district officers, university students and NGOs.

The agricultural sector is critical at alleviating food insecurity in East Timor, yet "there is a clear need for getting more baseline data" (Phillips, 1999:23) and a "sophisticated data collection is necessary to get a good picture of the agricultural economy. Such data is, however, costly beyond the capacity of statistical agencies in many developing countries" (Phillips, 1999:27).

Reconstruction, humanitarian and aid efforts suffer from a lack of coordination between ODA projects and government departments. One example stands out, the Entomology and Vector Control Laboratory set up by the WHO requested that steps be taken to eliminate all types of stagnant water sources in urban areas to control mosquitos that carry malaria and dengue haemorrhagic fever (WHO, 2000a). Food security projects in urban areas were recommending that *kkang kung* a green leafy vegetable crop, grow in city swamps in specially prepared beds, and major drainage

canals, and low in flow areas (WHO, 2000a). Food security and health promotion in this case were at odds and this is but one example that was observed in the various reports read by the author.

While data are scarce, a few interesting data gathering and mapping projects have been implemented. A human resources development database is being developed by the WHO and HealthNet International will track health employees and their related skills to assess the location and need for particular types of training (WHO, 2001b). A health surveillance system was put in place and data from the system has enabled planners to “coordinate and guide the work of the NGOs involved in providing clinical and public health services in East Timor. The work of WHO in the field of health surveillance will subsequently form the foundation for a national disease surveillance system”(WHO, 2001b). The health sector in particular is receiving much needed ODA assistance. CORDAID (Catholic Organization for Relief and Development), a Dutch organization, supports hospital management (ICRC, 2001) and the WHO will implement an integrated Management of Childhood Illness (IMCI) program to develop a health plan to reduce infant mortality rates (IMR) and Under 5 mortality rates (U5MR) (WHO, 2001b). The Red Cross workplan for East Timor will be complete by 2010 and includes health care in the community, disaster preparedness, disaster response, promotion of humanitarian values and will incorporate some community mapping to locate, first aid posts and planned national blood program (IFRC, 2001).

Infrastructure data are also being collected. A Japanese road inspection team has gathered information on the condition of the roads and bridges that was later

presented in maps to communicate repair plans to the donor community (UNTAET, 2000). Also ongoing are some natural resource activities such as a community-based forestry program, which has empowered many to manage their natural resources (UN Secretary General, 2001).

Some socio-demographic information is being gathered and a household survey will inform a Country Economic Memorandum. A Poverty Reduction Paper has provided the new government with baseline data and policy options necessary for the medium and long-term planning and expenditure framework for the nation (World Bank, 2001, Nov. 5). The UNDP participatory poverty assessment project is gathering data from local communities to identify and finalize development strategies to reduce poverty, while an NGO collaborative project with UNICEF, the World Food Programme, Health Net, IRC and other NGOs have proposed to conduct health and nutrition assessments (WHO, 2001b).

Environmental impact assessments are a sustainable development tool and AusAID activities will ensure that these are a part of all of its activities in East Timor. AusAID will be promoting "sustainable agricultural practices, improved sanitation, clean water and better management of natural resources. The program will also provide capacity building assistance to ETTA's Environmental Protection Unit" (AusAID, 2001b). Also, the UN Common Country Assessment (UN-CCA) is establishing a database of development indicators in cooperation with relevant aid partners (WHO, 2001b).

A number of organizations are carrying out mapping projects. However, like most of the previously mentioned data-gathering activities – with the exception of the health sector – their activities do not seem to be coordinated while the literature made

no mention of a central data repository. A school mapping exercise was conducted to collect data on school facilities, their catchment areas, the projected student population and retention rates (UNTAET, 2001b). Other mapping activities have included high risk areas of malaria to inform environmental health impact assessment to anticipate adverse health impacts and mitigation measures for all water and agriculture related projects that may act as pathways to malaria creation (WHO, 2001b). Some land capacity and agricultural systems maps were created as part of a project to restore meteorological stations and to carry out an agricultural survey and database development (United Nations and World Bank, 1999:26). Other maps were produced for those involved with the transitional work and reconstruction. The Japanese government had proposed a project to develop a Topographic Information Systems for establishing a cadastre in East Timor (Watanabe, 2001). Just after the referendum the Australian Defence Force, with AusAID and the Environmental Systems Research Institute, Inc. (ESRI) conducted mapping activities under the project title of TOPOSS (Topographic Support System). TOPOSS was designed to provide defence force commanders with immediate access to the latest GIS and image-processing technology via mobile units in the field for the development of topographic maps (Australian Defence and ESRI, 2003). AusAID has also supported the development of a small GIS unit called Agricultural Land Use GIS (ALGIS) in the Ministry of Agriculture and Fisheries. It is staffed by ODA workers and three East Timorese undergoing on-the-job training. They have produced a series of useful maps delineating the boundaries of districts, sub-districts and villages, and some soil survey, geology, precipitation and land use maps that will be used to restore food security to the

country (AusAID, 2002). Numerous international mapping and data agencies such as AusAID, Grupo de Estudos de Reconstrução – Timor Lorosae (GERTiL), the Australian Centre of the Asian Spatial Information and Analysis Network (ACASIAN), CRISE a group from the Portuguese National Centre of Geographical Information (CNIG) and the Fédération Internationale des Géomètres (FIG) have made maps of East Timor available online. Other maps are being disseminated by the University of Coimbra in Portugal, the political party FRETILIN, le Monde Diplomatique, and Foundation for Nature Research and Cultural Heritage Research (NINANIKY) in Norway. However, efforts have been directed at reconstruction or to inform newswire services and many are older scanned maps. Remote sensing images of East Timor are received from the United States Geological Survey (USGS) operated Landsat 7 TM satellite and processed by the Australian Centre for Remote Sensing (ACRES, 2001). The Portuguese Government is also assisting with the production of national coverage GIS-generated base and topographic maps as part of their reconstruction aid package to the region (GERTiL-FA.UTL Regressa a Timor, 2001). Furthermore, GERTiL a unit from the Portuguese GDI are presently developing a GIS for Timor Lorosae, with the intention to create a useful tool for the planning and reconstruction of East Timor. Some of the 1/25 000, 1/50 000, 1/250 000 maps, in both vector and raster formats, are currently in production for coffee plantations, geology, etc. The information for this Portuguese GIS assistance initiative were collected from field research by two teams that visited East Timor in December 1999 and in March 2000. It is unknown if these potentially helpful information resources will be given to the East Timor civil service.

While important datasets are being compiled, mapping projects are ongoing, and potentially very useful maps exist, there remains a tremendous need for their coordination, and data on myriad subjects are still missing. While much data have been gathered, reports reviewed by the author do not mention a coordinated non-project-based approach to managing ODA data and information apart from ALGIS. It is assumed that these data are with various NGOs, government departments and agencies but not in a central repository, archive or library in East Timor. It is also assumed that most of these data is in paper format and the digital data remain with respective aid agencies as NGOs and government offices are not necessarily equipped with computers and computer literacy remains low. If this is the case, it can be assumed that knowledge related to the processes of data management remains with respective aid workers and the data are in their home offices and not in East Timor. If this assumption is correct very little capacity on data-related management was developed in East Timor and collected data will be difficult to access in digital form, while the task of assembling all of the information that was gathered will be difficult. Finally, the expertise to compile and assess results remains with ODA workers.

While there have been some excellent data-gathering and mapping projects, there are still many issues identified within ODA reports, assessments and Internet sites that have not been resolved. Table 4.3 lists issues, projects and needs on a variety of subjects related to sustainable development in East Timor. It was compiled by the author from ODA reports, reconstruction assessments, and humanitarian relief agencies newsletters, UNTAET and ETTA statements for the purpose of assessing potential data needs. At present, there seem to be far more issues than there are

maps or datasets. Also, many of the issues identified from the literature are project or subject specific and the literature does not make reference to a coordinated approach to project activities – again the health sector is an exception. Furthermore, there does not seem to be a forum in place to enable agencies, government departments, district offices or NGOs to gather and jointly share results and analysis in a multi-disciplinary environment. All of these research and project activities would follow the mandates of the organizations that fund them and their data may not be easily transferable to other contexts. Since projects are not integrated, the gathered information would not lend itself well to address the interrelated causes and effects of problems nor are the benefits of collaboratively sharing and integrating specialized knowledge accrued.

The first column of table 4.3 lists categorized issues and projects related to sustainable development in East Timor. The information discussed in section 4.1 is not included in this table since reference to these data have already been made. The second column refers to the geospatial data and information needs related to the items in first column. This column provides a list of related data and information requirements related to the issues in the first column. This is by no means an exhaustive list but it illustrates the broad range of issues that need to be addressed in East Timor. These data come from a variety of sources and more often than not interrelationships between the issues were not addressed. For example, water is a cross cutting-issue related to irrigation, hydroelectricity, sanitation, illness vectors, soil erosion and tourism and the data requirements for these interrelated issues are very similar particularly framework data upon which these themes can be represented. The same can be said for forests, agriculture and many of the other identified issues.

Table 4.3
Issues in East Timor and Associated Geospatial Information

(Developed by the author from the following data sources, Agence France-Presse, 2001; East Timor - Governance and Public Sector Management, Capacity development Program overview; ETTA-IT, 2001; ICRC, 2001; WHO, 2000 aug WHO, 2001b; Internews, 2002a; Phillips, 1999; Sandlund et al., 2001; Tais Timor No 8, 2000; TaisTimor, August 2000; TFET, 2002; TimorAid, 2001; UN Secretary General, 2001; UN-CCA, 2000; UNDP, 2002; United Nations and World Bank, 1999; UNTAET, 2000a; UNTAET, 2000/27; UNTAET, 2000 update; UNTAET, 2001c; UNTAET, 2001b)

Problems, Issues, Sectors and Projects Related to Sustainable Development	Geospatial Data and Information Requirements
<i>Agriculture, Animal Husbandry, Fishing</i>	
<ul style="list-style-type: none"> -Agricultural rehabilitation project to improve food security survey data -Animal Husbandry - cattle, goats, pigs, poultry, -Coffee - export crop -Fishing industry -Food security plan (UNDP) -Irrigation -Mountain slopes are steep -Need to import rice, eggs, sugar, flour -Rainy season - dry season -Self sufficient in fruit and vegetables and beef -Staples - corn, rice, cassava, gourds -Sugar Cane Production 	<ul style="list-style-type: none"> -Agricultural survey maps -Climatic data (precipitation, temperature, etc.) -Hydrographic maps -Land capacity maps for agricultural production (slope, cover, bioregion, precipitation, etc.) -Land classification and use maps -Land allocation data and maps -Range land data -Soil survey maps -Topographic maps -Vegetation cover
<i>Air quality</i>	
<ul style="list-style-type: none"> -Car emissions -Lack of car maintenance -Mosquito fumigation -Old cars 	<ul style="list-style-type: none"> -Car registry with attributes -Mosquito vector maps -Wind maps
<i>Biodiversity</i>	
<ul style="list-style-type: none"> -Knowledge that will affect the implementation of regulations is limited 	<ul style="list-style-type: none"> -Ecological models -Flora and fauna data -Habitat and hunting ground maps -Protected places data & maps

Problems, Issues, Sectors and Projects Related to Sustainable Development	Geospatial Data and Information Requirements
<i>Border Control</i>	
<ul style="list-style-type: none"> -Citizenship -Controlling -Monitoring -Quarantine -Taxes -Travel permits 	<ul style="list-style-type: none"> -Border regime & travel data -Border survey maps -Census Data -Defence maps -National accounting system -Registry of dangerous animal diseases, pests or invasive plant species -Remote sensing images -Tax registry -Travel document data
<i>Buildings</i>	
<ul style="list-style-type: none"> -Building registry 	<ul style="list-style-type: none"> -Administrative land records -Building permit data -Cadaastre -Land management -Legal land records
<i>Economy</i>	
<ul style="list-style-type: none"> -All banks and credit unions destroyed -Business Registry -Dili Market waste generation -Distribution network has collapsed -Household economic survey to alleviate poverty -Local construction materials not used as part of the housing aid (marble, bamboo, thatch, cement) -Revenue system -Tax collection 	<ul style="list-style-type: none"> -Census -Inventory and capacity of natural resources -Inventory and Location of markets -Land, air and water transportation network maps -Location of pathways of pollutant dispersal -Location and capacity of waste sites -Location of sources of pollution -Mines, quarries and minerals maps
<i>Education</i>	
<ul style="list-style-type: none"> -Age of students -High school -Illiteracy -New buildings -Post secondary -Presence of girls -Student to teacher ratio very high 50-60 / 1 -Supplies -Teacher population 	<ul style="list-style-type: none"> -Cadaastre -Demographic data - age profiles & population growth -Labour force survey -Location of buildings -Retention rate data -School catchment areas
<i>Elections</i>	
<ul style="list-style-type: none"> -Election Registry -Privacy -Voter Registration -Voting Stations 	<ul style="list-style-type: none"> -Demographic data -District, subdistrict and village maps
<i>Emergency Preparedness</i>	
<ul style="list-style-type: none"> -Disaster response 	<ul style="list-style-type: none"> -Emergency plans -Evacuation site -Inventory of hazardous sites and reporting plan -Land use maps -Meteorological data

Problems, Issues, Sectors and Projects Related to Sustainable Development	Geospatial Data and Information Requirements
Energy	
<ul style="list-style-type: none"> -Diesel generators -Generation capacity -Hydroelectric stations -Power lines -Power station rehabilitation -Removal of kerosene subsidy increased reliance on wood for cooking -Solar energy -Time of coverage unstable 	<ul style="list-style-type: none"> -Climatic data for solar and wind power generation -Data on peak demand locations -Demographic data -Electrical system infrastructure and management maps -Forestry maps -Fuel consumption needs data -Hydrographic maps -Location of infrastructure
Sensitive, protected Places and Cultural Sites	
<ul style="list-style-type: none"> -Biodiversity -Coral reefs -Designated areas -Endangered species -Governance is required -Historical sites -Lake Irralalarus - flora and fauna -Mangrove areas -Wetlands 	<ul style="list-style-type: none"> -Floral and fauna maps -Inventory and location of protected areas -Location of historical and cultural sites -Location of sites or issues that threaten protected places -Management plan -Special research project of Lake Irralalarus -Transportation network maps -Wetlands maps
Forestry	
<ul style="list-style-type: none"> -Community-based forestry program -Fuelwood -Loss of fuel subsidy increased demand for fuel causing conflicting priorities with reforestation programs -Mangroves -Palm wine -Population dislocation increased demand of forestry products in urban areas -Sandalwood trade -Slash and burn agriculture -Soil Erosion -Tamarind 	<ul style="list-style-type: none"> -Demographic data -Endangered species -Forest management sites -Forest product inventory -Forest inventory -Fuel demand studies -Land use maps -Plantation maps -Road network -Soil survey -Topographic maps -Vegetation cover maps
Health	
<ul style="list-style-type: none"> -AIDS -Asthma -Communicable disease surveillance system -Community Health Centres -Dengue fever -Diet improvement program -Environmental health impact assessment -Epidemiological bulletins -Family planning -First aid posts -Food insecurity -Gastroenteritis illness -Health posts -Health programs -Hospital services -Human Resource Development -Lack of district and subdistrict health services 	<ul style="list-style-type: none"> -Cadaastre -Demographic Data -Distribution of disease vectors -Fumigation sites -Health indicators -Labour force survey -Location and capacity of institutions and catchment areas -Location of water sanitation services -Maps of mosquito vector -Mortality rates -Social and natural vectors -Water quality data

<ul style="list-style-type: none"> -Lack of understanding of water sanitation -Lower respiratory illness -Malaria -Maternal mortality -Mobile health clinics -Mosquito fumigation - moved insects inside -National health surveillance health network -National blood program -National TB program & diagnostic centres -Need for new laboratories, pharmaceutical drug program -Obstetric care -Pit latrines and sewage -Population density -Tuberculosis -Vector Borne Disease Control Working Group 	
Information Communication Technology (ICT)	
<ul style="list-style-type: none"> -Access to land for towers, and wires, right of persons to appeal law -Archive -Basic telecommunications services -Computerization of certain functions such as census -Effective wireless system is in place -Internet sites -Internet ISP -Internews -Linking schools and hospitals to the Internet -Newspaper distribution -Postal Service -Power Lines -Printing consortia -Radio bands, station -Radio service being used to encourage hook up & boil water advisories -Records management system -Rehabilitation of the infrastructure -Satellites -Server Cables, hubs, routers, -Television broadcasting -Transmission towers 	<ul style="list-style-type: none"> -Cell phone towers -Communication network -Energy needs data -Infrastructure location data w/attributes -Land use data -Location of post offices and capacity -Reach of radio waves -Readership data -Spatial location maps to locate towers
Labour	
<ul style="list-style-type: none"> -ICT training -Lack of trained health personal -Lack of trained teachers -Lack of civil engineers -Lack of computer technicians, network specialists no programmers, or dBASE managers -Lack of Occupation Profile -Shortage of mid to top level management 	<ul style="list-style-type: none"> -Demographic Data -Statistics Occupation Profile -Education Profile Statistics -Inventory of education and training programs
Land	
<ul style="list-style-type: none"> -Land titles -Property rights 	<ul style="list-style-type: none"> -Cadastre -Land use data -Land allocation data
Problems, Issues, Sectors and Projects Related to Sustainable Development	Geospatial Data and Information Requirements

Problems, Issues, Sectors and Projects Related to Sustainable Development	Geospatial Data and Information Requirements
<i>Mines & Minerals</i>	
<ul style="list-style-type: none"> -Marble -Oil and gas reserves - Timor Gap Agreement -Phillips Petroleum Pipeline -Resource exploitation and exploration -Salt 	<ul style="list-style-type: none"> -Hydrographic data -Infrastructure maps and management plan -Location and capacity of mines and quarries -Resources needs analysis -Shipping data -Survey map
<i>Population</i>	
<ul style="list-style-type: none"> -Registry 	<ul style="list-style-type: none"> -Census -Registry
<i>Shelter</i>	
<ul style="list-style-type: none"> -Housing shortage in Dili -Shelter kits displaced local economy and their transport damaged roads -Traditional building materials-bamboo, palm leaf roofs, 	<ul style="list-style-type: none"> -Cadaastre -Distribution of shelter kids -Geodemographic data -Location of traditional materials -Needs analysis data
<i>Soil Erosion</i>	
<ul style="list-style-type: none"> -Agricultural runoff -Deforestation -Demand on fuelwood -Flash floods -Clogging of irrigation systems -Mountain slopes -Mudslide -Siltation -Watershed management 	<ul style="list-style-type: none"> -Hazards and vulnerables sites data -Hydrological data -Irrigation management data -Land use data -Land classification -Soil survey -Topographic map -Transportation network
<i>Tourism</i>	
<ul style="list-style-type: none"> -Air travel -Beaches -Ecotourism 	<ul style="list-style-type: none"> -Coastline data -Data on tourist preferences -Decision supports for land-use for facilities -Location of historical sites -Location of protected places -Location of facilities -Location of places of interest -Transportation network
<i>Transportation</i>	
<ul style="list-style-type: none"> -Bridge reconstruction and repairs -Bridges being destroyed by flash floods -Dili port is in poor condition -Motor vehicle registry -Only 11 East Timorese civil engineers -Only 55% paved in asphalt -Only 12 buses -Port improvement -Port has no lights -Rehabilitation of navigation systems -Rehabilitation of roads -Road conditions are very poor 	<ul style="list-style-type: none"> -Coastline data -Disaster relief data -Elevation data -Fleet management data -Flight route maps -Geological maps -Hydrographic data -Infrastructure location maps and management schedules -Labour force survey -Pavement and road management maps -Ridership preference and needs data -Road network maps with attributes, transit route maps

Problems, Issues, Sectors and Projects Related to Sustainable Development	Geospatial Data and Information Requirements
<i>Treaties</i>	
Convention on International Trade in Endangered Species (CITES)	-Location of sites that fall under treaties
<i>Urban Issues</i>	
<ul style="list-style-type: none"> -Crime&Social unrest -Lack of urban planning -Population dislocation to urban areas increased demand for fuelwood from surrounding areas -Population Density is a vector of disease & causing stress -Rural - urban migration is high particularly with youth -Sewage 	<ul style="list-style-type: none"> -Cadaastre -Census -Crime data -Epidemiological maps -Location of infrastructure capacity and services -Location, capacity and waste flow of sewage facilities -Migration data -Waste management and dump plans
<i>Waste Management</i>	
<ul style="list-style-type: none"> -Garbage truck fleet management -Garbage - smells, transported in rain, smoke is toxic, lack of a collection system -Locating -Road network 	-Inventory of waste sites, capacity, type of waste,
<i>Water</i>	
<ul style="list-style-type: none"> -Access to fresh water -Agricultural runoff causing eutrophication -Coastal zone -Domestic Sewage, pit latrines -Drainage canals -Drinking water wells were poisoned and dead bodies were dumped in them -Flash floods -Hydroelectricity -Irrigation rehabilitation -Lake Irralalarus -Purification -River management -Sanitation services -Siltation -Soil erosion -Stagnant water -Water supply rehabilitation -Water pumps were stolen -Watershed management 	<ul style="list-style-type: none"> -Geophysical data -Irrigation and water diversion needs data -Land use maps -Location of water users -Location of sewage treatment facilities -Location of water bodies & courses with flow and condition data -Location and capacity of dams -Meteorological data, precipitation -Mosquito vector data -Water consumption data

4.3 Analysis of National, Regional and Global GDIs

As demonstrated above, East Timor has many geospatial data and information requirements. Currently some data exist but few strategies are in place to strategically coordinate the collection of data beyond the scope of particular issues or projects. The data that have been collected are not being stored or archived in a central repository and at worst may be in the hard drives of ODA workers and not in East Timor. To meet national priorities, govern, and implement sustainable development East Timor's data would need to be well managed and "this goal can be accomplished by producing, organizing, storing and distributing data cooperatively using SDI concepts" (NRC, 2002:37). A national geospatial data infrastructure for East Timor would enable the nation to compile, manage and integrate its geospatial data and information requirements to inform sustainable development. If East Timor (ET) were to build a GDI it would need to develop a formal organization to coordinate and administer activities. There are a number of national, regional, and global GDI initiatives that an ET GDI could emulate. These may, however, not suit East Timor's current context and needs. Chapter 3 examined seven models, and their organizational components are summarized in table 4.4. As previously discussed, these were selected as they are national GDIs in the pacific region, are from nations that are allies, or because these may provide opportunities to assist East Timor with technological expertise and/or capacity building. Five fully operational GDIs were examined, namely those of Canada, Malaysia, Japan, Portugal and Australia (CGDI, NaLIS, JNSDI, SNIG and ASDI). The

regional Asia Pacific SDI has its institutional components operational while only the policy framework for data and technology implementation are in place. The GSDI is still undergoing institutional formalization.

All five studied national GDIs are in democratic countries that are characterized as knowledge based economies (KBES); three are in close proximity to East Timor and these nations have already formally contributed to mapping and reconstruction activities (i.e., Australian Defence Project TOPOSS, Japanese road management maps and cadastre development, and Malaysian ICT support). The Portuguese have assisted with an information repository at the University of Coimbra and Canada has provided some NGO ODA support. All national GDIs have a secretariat to administer activities and these are located in the branches of their respective governments where the national mapping agency or a national surveying agency is located. Portugal is the exception with its secretariat being a separate research institute. All national GDIs have strong government support with a steering committee or an advisory board that has executive level membership from all sectors and jurisdictions. The Japanese model in particular has strong private sector support through a quasi-governmental association. These committees and boards guide high level activities and often make funding decisions. The Malaysian and Japanese models have central government decision-making structures and direction comes in the form of charters or directives from NMAs. National scale datasets and clearinghouses are built and operated by their NMAs and these are public sector initiatives only. The Canadian and Australian models are consensus making networked structures. The Canadian model operates as a

Table 4.4
Organizational Components of National, Regional and Global GDI initiatives

Canadian GDI	Malaysia NaLIS	Japan National SDI	Portugal SNIG	Australia SDI	Asia Pacific SDI	Global SDI
Organizational Structure						
Formal network consensus decision-making model	Central government decision-making structure	Central government decision-making Structure with a Quasi Government Association	Unknown	Network consensus decision-making model separating operations and coordination between national and states & territories	UN type government structure	Informal umbrella organization of nations and international professional associations, initiatives and aid agencies
Working Groups						
Advisory nodes: -Access - Sustainable Communities -Framework Data -Skills Network -Atlas of Canada -Technical Advisory Panel -Policy -Standards -Emergency Response -Marine -Sustainable development & Resource Mgt. -Nat. Ground Transport	Technical Committee: -Frame-work -Technical -Standards -Clearing-house.	-Core Data -Legislation -Technical information -Technical Development & Standards -Data quality -Clearing-house -Overseas information Committee	-Institutional framework -Technical - Standards -Fundamental data -Distribution network	-Metadata	-Regional geodesy -Fundamental Data -Cadastre -Institutional strengthening	-Technical Communications -Awareness -Legal & Economic

Canadian GDI	Malaysia NaLIS	Japan National SDI	Portugal SNIG	Australia SDI	Asia Pacific SDI	Global SDI
Governance						
Directed by a Management Board, administered by a Secretariat, advised by a Program Advisory Network of WGs	Directed by the Central National Coordinating Committee, Planning & Implementation Committee manages operations w/land related agencies; Charter	National SDI Promoting Association directs private sector needs, Steering committee guides business planning, administered by a Secretariat and WGs supported by a Research committee	National Centre for Geographic Information (CNIG) coordinates data resources, Administered by the Secretariat for Science and Technology	Is advised by ANZLIC, State Gov ts coordinate jurisdiction GDIs, national agencies develop policy, states & territories coordinate implementation, Secretariat provided by AUSLIG	Inter-regional institutional framework starting, Executive Board directs policies,	Steering committee of interested nations and experts, Executive Committee represents 4 regions, Administered by a secretariat,
Government involvement						
Natural Resources Canada administers funds and houses operations, High ranking officials on Mgt board and on WGs, all provinces and territories represented	MLDC manages operational environment, MLDC w/DG of Survey Mapping chair Central Coordinating Committee, LRAs adhere to the NaLIS policies	Ministry of Construction Geographic Survey administers and coordinates	Developed by Government Decree	States & territories sit on ANZLIC & implement, CSDC and ICSM represent national interests at ANZLIC, AUSLIG provides the secretariat, ministerial forum	Participation of all AP 56 nations and their related GI agencies, Nations may be sponsor and/or data custodians	Participating nations that have operational GDIs and international military and hydrographic associations
Collaboration						
CCOG and IACG formal members of Mgt Board, co-production, shared funding, TOR, MOUs, Canadian Geomatics Accord, framework data conversion funding	Custodian-ship guidelines, circulars, TOR, Trustee-ship guidelines, MOUs between national & state Gov ts.,	Information in English is unavailable but communications, workshops and promotion are important	SNIG is primarily a portal for public and private agencies to promote data, services and products	Discussion papers, clearly defined jurisdictional responsibility, cross jurisdiction participation on all committees	Custodian-ship, dataset sponsoring, conferences, developed nations support LDCs to attend conferences,	Conferences, opinion papers, co-authoring of capacity building documents

Canadian GDI	Malaysia NaLIS	Japan National SDI	Portugal SNIG	Australia SDI	Asia Pacific SDI	Global SDI
<i>Skills development</i>						
Travel expenses for students to attend conferences, short courses and scholarships	Education & training programs, Courses formulated by University Teknologi Malaysia, tutorials on CD-Rom, conferences	Supports ODA training	Information in English was unavailable	Discussion papers	Enable education and training in the region w/universities and other institutions	GSDI Cookbook, training, capacity building in LDCs,
<i>Implementation</i>						
Natural Resources Canada, Clearinghouse development subcontracted to private sector	National Planning & Implementation committee but housed in MLDC	Govt. GSI		States and territories implement with AUSLIG & ICSM	In future a coordinated network of nationally based custodians	
<i>International</i>						
Presence at GSDI, PCGIAP, standards development, Global Map	International standards	Formal collaboration in standards community, provides the secretariat for Global Map Supports ODA projects	Information in English was unavailable	AUSLIG represents ASDI PCGIAP, Global Map,	All 56 AP nations, formal collaboration with Global Map, UNRCC, UNESCO, PRSPP for Sustainable development, FIG, IAG, GSDI, EUROGI, ISO, UNRCC-Americas	Informal network of international committees, Global map, and ODAs

formal network through its Program Advisory Network comprising experts and officials from all sectors. National datasets and the clearinghouse are managed at the federal level. Provinces, territories and other federal data-producing agencies collaborate by sharing datasets, co-producing datasets, by aligning their datasets to national standards, or building tools. The Australian model has separated operations and advisory functions by jurisdiction. National institutions advise on policies, data custodianship, themes and standards while territories and states coordinate GDI operations in accordance to national guidelines. There are no national repositories but instead jurisdictional GDIs and framework data custodians. English information on the Portuguese model is limited and operational details are not available from their Internet site, however the limited available information suggests that SNIG is a portal advertising data and services. Each national GDI has specialized working groups (WGs) that carry out research and advise on particular GDI components. The Canadian, Japanese, and Australian WGs address all GDI components and ensure that cross-cutting themes such as policy or standards are represented, while NaLIS WGs are more technical in nature and each address relevant GDI policy and institutional components. Collaboration comes in many forms; all include formal networks of cross sectoral and jurisdictional participation through WGs, steering committees, and advisory boards. Each have dedicated budgets from their respective treasury boards to carry out these functions and have dedicated human resources to these activities. SNIG was formed by government decree, Malaysia included NaLIS in its five year plan and the Ministry of Finance in Canada endorsed a large budget. In the case of Malaysia the national government directs participation, a charter is followed and formal

circulars ensure adherence to policies, custodianship, and data management processes while MOUs formalize cross-jurisdictional participation. The Canadian model uses MOUs between federal departments and an accord is being signed among federal and provincial governments. Cost sharing, co-production, partnerships, and industry programs are also mechanisms to collaborate in the Canadian model. Information on Portugal is limited, however, it seems from its Internet site that the incentive to collaborate is the opportunity to advertize on its portal. In Australia, the program is collaboratively led at all levels, ANZLIC has no enforcement mechanisms and therefore all institutional issues are agreed to on a consensus basis and clearly defined responsibilities direct activities. In Japan, the promotion association ensures private sector interests are represented by the state and that there is a market for GI and GIS. All national GDIs ensure a presence in international forums, in particular standards communities, SDI and mapping conferences, and global initiatives. All five also have human resource development components such as supporting students to attend GDI conferences and producing discussion papers. Malaysia has integrated GDI education and training at all levels of its education institutions while also offering ongoing university training programs for NaLIS employees.

The PCGIAP and the GSDI are organizations that steer the building of GDIs. Neither has an operational GDI and both aim to create a clearinghouse and framework datasets at their respective scales. PCGIAP follows a UN-type structure, with similar components as the national GDIs. A key difference is that all activities are coordinated between nations. The principles behind organizing the PCGIAP are similar to ANZLIC in that it would not build a SDI but would advise on policy issues; it may operate a

clearinghouse with the assistance of industry partners, while participating nations would coordinate their own operational activities. Also, there would not be a central database of framework data but instead different nations would be given custodianship and/or sponsorship responsibilities to build and maintain these according to regionally agreed upon standards and specifications. The GSDI is still undergoing formalization and remains an umbrella organization of institutions, projects and stakeholders. It is currently building on the knowledge of its members through the joint-authorship of capacity-building documents for LDCs, such as the SDI Cookbook. Collaboration for the PCGIAP is supported by the UN, and financial incentives are provided to support LDC participation at meetings and conferences while funding is being sought to support implementation and dataset sponsorship. For the GSDI participation is interest-based and some developed countries support LDCs to attend conferences. Both include support to assist LDCs to develop technical and mapping capacity including training opportunities. Also both international GDIs have clearly defined provisions to align their activities with international mapping initiatives.

The GDI literature reviewed for this thesis comes mostly from nations considered to be knowledge based economies (KBE). Canada, Japan, Australia, and Portugal are commonly known as KBEs and Malaysia has a very strong urban mainland ICT infrastructure, a highly educated cosmopolitan mainland urban citizenry and a strong national focus on technology. Their institutions have had extensive experience with the organizational change brought on by the adoption of information and communication technology (ICT) and have gained much experience with digital mapping and remote sensing. In fact, GIS was the product of emerging KBEs (Canada,

U.S., countries in Europe). In advanced KBEs, social structures have adjusted to new ICT processes, protocols and rules. Values and norms are embedded into related institutions while the knowledge related to GIS, ICTs and GDIs is tacit among most civil servants in NMAs and related geomatics firms. Clearly, from the research and analysis provided in Chapter 2, East Timor is at a different stage in its development. To illustrate the different needs, the FGDC content metadata standard is excellent for institutions that have an understanding of the definition of metadata, its value, and its use; however, for a country like East Timor there are few documents to explain how it would get this information into a computer, prepare the information, transfer the data or present the information to users (Anthony, Klaver, and Quenzer, 1998).

The PCGIAP has indicated that it would assist with training and capacity development for NSDI building in the region. An examination of the PCGIAP Internet site and promotional material suggests that training plans are discussed and potential training sites have been identified but information on the type of training that will be provided is absent. At a glance, it seems that it would primarily be technological in nature and not institutional or policy related. Also absent was a formal mechanism that would support a group of NMA officials in the region or their staff to extend their national mandates to support neighbouring countries, to share existing datasets that overlap onto other nations or an outreach program that would provide long-term institutional and/or mentoring support for long-term national GDI development. The literature suggests that PCGIAP is an excellent forum of high-ranking officials and experts in the field of GIS to collectively share their knowledge, expertise and negotiate their national and regional framework data and clearinghouse needs. However, it

seems disconnected from the reality of countries in the region like East Timor, which have very rudimentary and simple needs and limited capacity. East Timor needs data, the capacity to manage and analyse that data, long-term financial resources to support that management and institutional support on an ongoing basis to build an ET GDI. It is unclear if PCGIAP could assist East Timor with these long-term requirements or if East Timor could contribute to APSDI. The GSDI membership like PCGIAP is highly skilled, come mostly from KBEs, and certain communities have particular and specific global interests. It is uncertain how East Timor could contribute, participate or benefit from such a forum. The GSDI Cookbook is very relevant to LDCs who have some GIS experience and have some knowledge of GDIs and their benefits. However the capacity in East Timor may not be at the level required to readily absorb the information contained in the document.

Finally, none of the seven GDIs studied in this thesis have formal arrangements to assist ODAs to coordinate their data acquisition activities. In the case of East Timor, the richest and most relevant datasets are those just recently gathered by a host of ODAs. These ODA-gathered datasets are not necessarily available in useable formats, and are specific to one project or sector limiting their utility in other areas. Further clouding the issue are donor agencies that have their own solutions often resulting in inter-agency competition in lieu of cooperation (GSDI, 2001). Large-scale reconstruction, humanitarian assistance, or development aid activities such as those ongoing in Afghanistan, and emerging in Iraq, could benefit from a GDI structure supported by members of GSDI or APSDI. That structure would be put in place at the same time assistance is provided and would coordinate all ODA data related activities.

These data could then be returned to the aid recipient country in a useable fashion to inform their development. East Timor could certainly have benefited from a coordinated ODA data gathering process and it may have to dedicate human resources to find, organize, and integrate the ODA work already done, and in the short run may have to coordinate ongoing ODA data gathering activities. A GDI WG may have to be created specifically for that purpose.

4.4 East Timor Geospatial Data Infrastructure for Sustainable Development (ET GDI)

The objective of this thesis was to determine if, given its situation, it would be possible for East Timor to develop the organizational and institutional components of a GDI and then develop the technical part to meet its sustainable development requirements. Of the seven GDIs studied in this thesis, two are in fact only organizational and institutional models and are not at the stage of technical implementation. These are the regional and global models. Neither has an operational GDI but both have organizations and a management structure with formal working groups that will eventually guide operations when resources become available and as opportunities arise. The regional model is more advanced and has formally articulated its policy framework to achieve implementation and is actively seeking funds to sponsor framework datasets and to build a regional clearinghouse. The GSDI does not yet have a policy framework but is engaged in outreach, capacity building and training. Further, all five national GDIs have distinct operational and implementation functions and also coordinative, administrative and managerial functions. Secretariats, advisory boards, steering committees, working groups, partnership programs, and so on, are

managerial while mapping, framework data, interoperability, metadata and clearinghouses are technical. Some national GDIs have their managerial elements as formal extension of their of NMAs (e.g., Japan and Malaysia) while others have separate institutions to carry out and guide these activities (e.g., CNIG-Portugal, GeoConnections-Canada, ANZLIC-Australia and New Zealand , and PCGIAP-Asia Pacific). These seven models demonstrate that it is possible to separate operational and managerial functions and that it is also possible to have an organization that formulates the policy environment to enable implementation at a later stage.

As discussed, East Timor has significant unmet data requirements. There is currently no formal government or non-government entity in place to nationally coordinate existing data and related activities. Currently there is no NMA other than a small mapping unit in the Ministry of Agriculture and Fisheries. East Timor does have a high commitment to sustainable development and to the adoption of science and technology to advance national objectives. East Timor also has a new civil service with 36 formally mandated ministries, departments and units that have furnished offices, some computers, staff undergoing different levels of civil service training, basic ICT and a commitment to the delivery of services to citizens. Given the context, it is recommended that East Timor develop an East Timor GDI (ET GDI) to ensure its data are managed and disseminated. At present the technological, bureaucratic, managerial, academic and scientific capacity in East Timor is very low, delaying full technological implementation at this time. However, the administrative and steering elements of an ET GDI could be developed until skill, capacity and opportunities arise

to develop a fully operational ET GDI. This would build the relationships required for implementation and for identifying issues.

As noted East Timor does not have a NMA, nor does the current civil service have a history of surveying and mapping. While this may seem problematic, this situation provides a new opportunity to create a NMA that would from the start include user and stakeholder needs. The government has a commitment to citizen participation with its centralized yet distributed government structure and to information dissemination to enable citizens to keep the government accountable. Together these points do not lead to the conclusion that East Timor should adopt the Malaysian and Japanese GDI models. Both of these are centralized decision-making models with managerial and implementation functions as extensions of or part of their NMAs, which East Timor does not have. Both restrict information to the public sector or quasi governmental organizations which would not be in keeping with East Timor's mandate to include citizen's participation and disseminating information to keep government accountable. However, given the long tradition of rigid hierarchical social and administrative structures in East Timor, an element of centralized decision-making at the beginning, with formal forums to ensure collaboration, may be more attuned to normative and cultural social structures. Furthermore, Malaysia has integrated GI and GDI into the education curricula at all levels and ongoing training programs are offered. This could be a method to coordinate and integrate GI capacity in East Timor, particularly in the university and the Polytechnic.

East Timor is a very small island state: its population is under 1 million people and its land area of 14 874 km² is very small. There are two economies operating at once,

an urban economy and a primarily rural subsistence agrarian economy. This weakness is compounded by a linguistic divide, whereby both official languages – particularly, Portuguese – are spoken primarily in urban areas and rural areas speak local dialects. Most government offices, electrical services and the limited ICT infrastructure are located in urban areas – primarily in Dili. Government authority and responsibilities have been redistributed to the 13 districts, 65 subdistrict offices and villages, however offices are rudimentary and most work and data-gathering activities are carried out manually and documents are currently sent to head offices in the capital for input into computers. Further, district and subdistrict offices are in rural areas where literacy, numeracy and education levels in general are not very high. For these reasons, the Australian model is not recommended. The ASDI model relies on advisory and policy direction from ANZLIC to coordinate state and territorial implemented GDIs. The ASDI does not have a central repository of data but instead jurisdictional GDIs adhere to policies, standards and mapping processes that enable the creation of national framework datasets and clearinghouses that are linked to a central hub. East Timor's districts and subdistricts would not have the necessary physical infrastructure to house equipment, the electrical and telephone infrastructure to power equipment and transmit data, the institutional and managerial capacity or the necessary technological skills at this time to coordinate jurisdictional GDIs. Districts, subdistricts and village officials can, however, make important local data contributions, develop community mapping projects, learn surveying techniques and contribute local knowledge to inform sustainable development and populate national thematic datasets. Furthermore, these

offices would in some respect be data contributors and value-added map end-users and therefore should be included in GDI development plans.

East Timor is nation building, creating a civil service and undergoing timorization. The limited labour force data has indicated that there are few computer technicians, engineers and social scientists. ICTs are a new introduction to the civil service and an information and technology culture has not had the time flourish. Computer literacy is generally low, while some training is ongoing and some returned refugees do have some exposure. Since the East Timorese have not had the opportunity to govern themselves until now, and because the economy is primarily natural-resource based, there have been few opportunities to develop professional associations around ICT, standards, GIS, and a host of other technical issues related to GDIs or ICT. East Timor has received academic support from university and educational institutions primarily in Portugal, Australia and neighbouring countries. NGO consultants have offered service support on a wide range of topics related to sustainable development and physical infrastructure development. This support has enabled some capacity building in the country, however, not enough time has elapsed to develop R & D incubation units, social science research units or science and technology centres. Therefore, few academic associations exist and are not expected for some time to come.

Given the small number of people with technical and academic expertise and the historical evolution of the economy, the GSDI model is also not recommended. It is primarily an informal association of professionals, industry leaders, communities of interest (e.g., defence, hydrography, OGC), and established international mapping, cartographic and surveying associations. East Timor does not have this base of

expertise upon which to build a GDI. East Timor could however benefit from the skills development, international outreach and capacity-building support offered by members of the GSDI community. For similar reasons the APSDI model is not recommended for East Timor since it relies on the same level of skilled personnel mostly from established national NMAs like the GSDI but also because its operational model is similar to the ASDI. Furthermore, the administrative reporting structure of UN-type agencies may be somewhat cumbersome for East Timor, which is just developing a bureaucracy. However, East Timor could benefit from dataset development activities in other international jurisdictions and associations, support to attend meetings and conferences for networking purposes, and PCGIAP skill development and training programs once they are developed and if suited to East Timor's context. Also, while the UN structure is cumbersome, the formal mechanisms to define roles and responsibilities could be of benefit once and if East Timor decides to embark on building an ET GDI.

English information on the Portuguese model is limited, and it seems that it is primarily a portal to advertise data, services and technology that may not meet East Timor's operational requirements at this time. Of interest is CNIG, which is a government arm's length research centre that guides GDI activities. This type of steering agency could be useful for East Timor. It could be based in the Universitas Timor Timur (UNTIM) and seek funding from ODAs, research granting institutions and some funding from government. It would be located in a university setting where necessary courses, skills and training programs could operate, where laboratories could be set up, and multidisciplinary research supported. Membership would include civil

servants from all departments that have geospatial data requirements, officials from district, sub-district and some villages, educators from the Polytechnic, professors, librarians and NGOs. This would enable a cross-section of stakeholders to collaboratively steer the development of a GDI and be in an environment where skills could be developed to use technology and conduct geospatial data analysis. African officials have also recommended an independent agency to oversee the management of information resources on the continent and within African nations (Ezigbalike, Selebalo, Faiz and Zhou, 2000).

The Canadian model has the same type of high-level professional association and membership issues identified with GSDI and APSDI. However, it is far more inclusive of non-GI experts: some participants are from libraries, municipalities, and information end users. The CGDI process also includes application advisory nodes (i.e., WGs), that represent each GDI component, and formal programs to develop partnerships and support for the private sector. It is, however, weak on skills development and it is difficult to assess its formal international affiliations even though high ranking officials have been participating in both APSDI and GSDI. Further, the program advisory network is separate from operations while the people involved with implementation are members of WGs – particularly the technical – access, framework data and standards nodes. The CGDI is a network consensus-making environment that could be adopted by East Timor. The informal traditional social structure of problem resolution was based on consensus, and production was carried by a massive network of familial and social ties, albeit in a very hierarchical fashion. Informal networks in East Timor are very broad and strong, as discussed in Chapter 2. These have persisted through time

even when the Indonesian occupiers tried to coercively abolish them. The nature of these networks is also changing: women are being given a greater role, youth are given a greater say and they are becoming more merit-based rather than kin or elder-based. Building on an inclusive traditional decision-making social structure would ensure participation and align methods with cultural norms. In the case of East Timor, it may be possible to develop application WGs to identify cross-cutting data requirement priorities to meet immediate and relevant needs. Concurrently, these WGs would be responsible in the short term for developing policies and standards related to data management, dissemination and use similar to the NaLIS WGs. These WGs would have the primary responsibility of determining critical data sets and methods to acquire these essential data and to coordinate with other WGs to ensure they are transferable to other application areas. In the long run, once data requirements have been identified, experience gained and training programs in place, application WGs would be replaced by typical GDI WGs such as technical, standards, access, human resources, institutional and framework data and members from application areas would change their participation within these new WGs. Also in the short run, it could form a skills development WG that would identify training requirements, international learning opportunities and develop university and polytechnic curricula for East Timor. Training should be aligned with the skills in East Timor and the context of the issues it faces. It should perhaps be more attuned to the casual GI user rather than GI scientists and engineers (Britton, 2000). This training, like the public administration training, should be cross-cutting and should include management, planners, technical staff, researchers and educators to ensure a broad base of knowledge and support at all levels and

sectors (Britton, 2000). Based on East Timor's data requirements, some of the potentially useful application WGs could be health, agriculture, transportation, utilities infrastructure, natural resources and social infrastructure. And given the uncoordinated state of ODA activities, a WG could be dedicated to coordinate ODA data gathering activities to ensure that these are centrally stored and are compiled in a standardized fashion to increase their usability in other contexts.

As previously discussed, East Timor has particular needs and a specific context that may not be suitable for the adoption of any of the seven studied GDI models, while a hybrid ET GDI could include elements of each (Figure 4.1). The Portuguese SNIG research centre advisory board or steering committee is one organizational element that could guide application area WGs as found in the Canadian Program Advisory Network. This would ensure formal collaboration between academia, educators and the public sector, which could result in mutually beneficial training opportunities while executive level membership from the civil service would ensure that decisions are implemented. Application WGs would focus on data needs in particular areas and could develop policies and standards as do Malaysian NaLIS WGs. Two cross cutting WGs should also be formed, namely an ODA data coordinating WG and a strategic training WG. The former would ensure that ODA data gathering activities are coordinated and the latter would ensure that a capacity plan is created to ensure the necessary education is provided to ensure a fully functional GDI in the future. The research unit would be responsible for analysing WG needs and providing recommendations on data standards, policies, data management, etc. In the long run, once data requirements are identified and the civil service has become more

governance oriented, the GDI application WGs would evolve into typical GDI WGs (i.e., Standards, Access, Framework Data, Technical, and etc.). Also in the short run, the social structures of the centralized models from Japan and Malaysia could be adopted into the normative decision-making structure of an ET GDI until formal consensus-making processes have been re-learned. An ET GDI secretariat could be operated from the Ministry of Agriculture and Fisheries (MAF) since it has developed some mapping capabilities and has some exposure to issues related to data integration. Alternatively, to avoid “branding” the secretariat with agriculture or fisheries, it could be located in the Information Technology Post Telecommunication (ITPT) department that will have built some ICT capacity or in the Office of Communication and Public Information (OCPI) where it could build on the information and dissemination experience of this unit. The secretariat would provide administrative support to the application area WGs and the research/steering committee. The secretariat may temporarily store and disseminate data and ODA reports until such time a formal database, clearinghouse and NMA are developed. Neither the Canadian nor the Portuguese models have strong skills development program, however, the strategic training WG could seek support from PCGIAP, GSDI and neighbouring nation training programs while funding could be acquired from ODA agencies, research institutes, granting agencies and international mapping associations. The public administration could also provide some funds to the university and the Polytechnic to cover civil servant training programs and pilot studies. The university can provide social science, as well as agricultural, civil engineering, and legal knowledge while the Polytechnic can develop mapping, database and cartographic technical training programs. Programs could be designed for both

Figure 4.1
Organizational Structure of an ETGDI

students and public servants at all levels. Both post-secondary institutions could collaborate on pilot studies such as community mapping, data gathering, surveying, traditional knowledge mapping and so forth, with particular government departments. Numerous international organizations have already produced some maps and eventually these datasets should be shared with East Timor once the capacity to manage these are in place and the ODA coordinating WG would be tasked with this activity. In the long run, private sector involvement could be nurtured in East Timor, however it is recommended that in the short run public and academic sectors build capacity. Once some capacity has been built, and students graduated from university and the Polytechnic, some R & D incubation centres could be developed between public, private and academic institutions to spark a private GI sector.

These recommendations are derived from an analysis of the available literature on East Timor and the author recognizes that these are not informed by personal "on-the-ground" experience or personal interviews with East Timorese officials, citizens or ODA workers. Most of the information was from secondary sources which can miss subtle yet critical issues. An Agriculture and Land Geographic Information System (ALGIS) progress report was received by facsimile from Vanessa Loney, the AusAID Program Officer, East Timor Section and it provided some context on the situation in East Timor. For example, staff are being trained and have attended some training programs and some conferences in Australia. A LAN has been installed and there are three fully operational computers with necessary peripherals. Staff can print maps on demand with some supervision and land use data have been compiled. Finally, a decision support system for the Ministry of Agriculture and Fisheries (MAF) is under

development. Some of the greatest difficulties have been budgetary restrictions. The Council of Ministers may not approve the request for additional staff and a pre-existing coordinating committee could not be revived due to institutional reorganizing. The Geography and Cadastre Division will leave the MAF and likely move to the Ministry of Land and Property. The request to have ALGIS answer directly to the Minister will instead be re-established as a subunit of a proposed Research and Extension Centre that will answer to the minister (AusAID, 2002). The unit may also be relocated and staff are concerned that the new location may not be adequate for equipment management. It is also uncertain if the ALGIS unit would survive if ODA support is discontinued. The unit is trying to build up its profile and is disseminating an information and marketing pamphlet throughout the civil service.

Clearly, the East Timor civil service is still undergoing restructuring. GI capacity is limited, while physical infrastructures such as suitable buildings to store equipment are in high and competing demand. Further, there are only limited landline telephone networks in urban centres. Given this snapshot of East Timorese reality, it may seem unrealistic to consider developing the institutional, let alone the technical aspects of an ET GDI. However, since the civil service is still restructuring there remains an opportunity to formalize two new institutions: an ET GDI secretariat and an ET GDI Research Centre, even if small at first. This would ensure that the public sector has a formal mechanism to at the very least identify interdepartmental and cross-sectoral data and then begin the work of coordinating activities. The AusAID ALGIS Progress Report noted "institutions, even new ones, are not easy to change once established. Individual projects may influence the establishment of new units or departments within

a ministerial structure, but longer term support is required from the government itself" (AusAID, 2002:2). Further, "strengthening the institutional role of a unit or department is highly dependant on internal department recognition of the importance of establishing another unit or department, support comes from the recognition of the importance of services that new units can provide. This often takes longer than the term a project runs" (AusAID, 2002:10). The literature on GDI building is compelling; yet, East Timor may not have exposure or access to this information and knowledge since there is no formal mechanism for it to occur. Developing a compelling argument for an ET GDI will not be easy given the limited knowledge, conflicting priorities and limited resources. However, even if it has only small administrative and steering functions at first, an ET GDI would provide East Timor with an advantage over other GDI initiatives since it would not need to reinvent the proverbial civil service wheel to address the lack of departmental integration regarding information and data resources. Some of the recommendations provided in this thesis may seem irrelevant given the context within civil service departments and the lack of on-the-ground experience of the author. However, these are not intended to be absolutes, but more to stimulate some thought and discussion among East Timorese officials who are grappling with geospatial data issues and a lack of departmental integration but did not have a formal mechanism to resolve them. The AusAID ALGIS did identify the need for a government-wide vision for all of its projects and an ET GDI could be a mechanism to ensure that such vision becomes a formal reality. A final ET GDI model and its implementation in the civil service and academic institutions would have to be worked out in East Timor with East Timorese officials from all jurisdictions, members of the

academic community, NGOs, ODA workers, private sector and citizens. Furthermore, it would have to be formally supported with a budget and by the Council of Ministers. Such a conversation is currently not occurring, and regional and global SDIs are not actively engaged in stimulating such discussions in East Timor, nor has the UN identified this as a priority. In fact, few financial resources are directed at non project specific data-management activities. The research and the recommendations in this thesis are offered as possibilities should coordinating and managing sustainable development data become a central priority in East Timor. The information and research contained herein are considered a place to start should East Timor embark on building an infrastructure for sustainable development – namely an ET GDI.

4.5 ET GDI How to Get Started?

An East Timor GDI (ET GDI) for sustainable development is a long-term institutional and technological project. The Governance and Public Sector Management Capacity Development Programme Overview (2002) states that it will take approximately 25 years before the civil service will have fully transitioned from service delivery to governance. The programme overview recommends a strategic management approach for governance and the public service – namely “it should move away from the current piece-meal ad-hoc approach to one that is more comprehensive and far reaching. Such an approach must allow individual departments and agencies to establish the needed relationships with other organizations inside and outside government” (UN-NPDA, 2002:70). Furthermore, the approach is the development of sustainable capacities at all levels of the public service. In the East Timorese context,

this means “a high degree of simplicity, flexibility and adaptation to ongoing and dynamic change” (UN-NPDA, 2002:70). The ET GDI approach recommended in this thesis is in keeping with the principles of this plan.

Nick Land from Ordnance Survey International in the U.K. now with Eurogeographics and Robin McLaren from Know Edge provide a number of lessons learned from their experience in developing land information systems (LIS) worldwide. While these differ from GDIs as they are subject specific, the process of carrying out such large projects is quite similar. They suggest that success lies on many factors – namely political support and commitment, appropriate terms of reference, business solutions along with national solutions, the management of aid funding, project sustainability, organizational change, public private sector partnerships and data.

Political commitment ensures access to resources and the cooperation of other officials at lower level, therefore including high level politicians and managers in GDI development is key. AusAID officials made reference to this issue since resource allocation and influence ensure sustainability. The proposed ET GDI structure in figure 4.1 is contingent on high-level support from the administration at all levels, membership on the steering committee would be directors, managers, subject matter experts and members of the academic community to ensure ongoing high-level support in a number of critical areas. High-level political commitment is required to finance the operation of a secretariat. The secretariat would require resources for three to four dedicated full-time staff to carry out the administrative functions as discussed above and to scope out early activities. Staffing issues are critical. NaLIS officials have identified this key problem in their secretariat as it does not have full-time dedicated

staff and the turnover is high causing discontinuity issues (Hamid Ali, Fauzi Nordin, and Kamalis Adimin, 2002). The secretariat would also require offices, computers, training, and a budget to support travel and accommodation for members to participate in the research centre and the WGs, and to enable stakeholder meetings.

Convincing high-ranking politicians of the utility of a GDI and why such a structure should exist is another matter altogether. Some visioning would have to occur and early successes such as ALGIS and other mapping related projects need to be effectively communicated and highlighted to encourage buy-in. It is recommended that an informal forum be created to enable interested officials, ALGIS staff, AusAID officials and academics to meet to discuss information and geospatial data issues, identify problems and demonstrate the need for a coordinated effort. ALGIS did have a land use committee that could be revived and extended for this purpose. This informal group could enlist PCGIAP support to facilitate a roundtable discussion on the benefits of GDIs and show examples from the region to officials and politicians, to spark interest and harness support from the Council of Ministers. The preliminary work of ALGIS is impressive, and according to AusAID officials, the demand for maps is growing but capacity is limited.

To ensure buy-in, it is recommended that once the utility of a GDI is demonstrated, a vision should be articulated. The U.S. National Research Council (NRC) (2002) and Ezigbalike, Selebalo, Faiz and Zhou, (2000) from South Africa recommend that a GDI vision be developed and that it is critical that consensus around common interests inform that vision. The GSDI Cookbook includes references to Internet sites with examples of GDI visions from around the world. The

recommendation in this thesis is that sustainable development be included in that vision to ensure that East Timor can meet its constitutional requirements and be in alignment with Chapter 40, of Agenda 21 and the follow-up in 2002. The actual wording and vision should be developed in East Timor with all concerned stakeholders and inclusive of users and politicians. The sections of the constitution and the regulations highlighted in this thesis can provide ideas on the potential content of such a plan (see section 4.1).

Land and McLaren (1998), Masser (1998), and Ezigbalike, Selebalo, Faiz and Zhou, (2000) recommend that well-defined term of reference (TOR) and mandates guide decision-making and that these should be based on local needs, to meet a skill need, and, in the case of aid projects, in a fashion to integrate management functions and to coordinate programs. The TOR should be flexible to adapt to changing government environments and fickle or competing aid agencies. Four of the five national GDIs studied in this thesis have TORs to guide the work of steering committees, advisory boards and WGs. NMAs and national surveying organizations have very specific national mandates that have been extended to include the implementation work of their respective GDIs. The PCGIAP by virtue of its UN type structure has well defined TORs, rules, roles and responsibilities of members, chairs, data custodians and sponsors. East Timor departments, units and ministries have clear roles and mandates and the TORs for an ET GDI should refer to these. These TORs should also refer to regulations and laws and formally include liaison functions with, for example donors, cabinet, and particular departments. The TORs of the national GDIs and the PCGIAP are available from respective Internet sites and the ET GDI Research

Centre or the secretariat could begin some TOR analysis work by exploring these. Furthermore, if application area WGs were created, they could build on the TOR analytical work of the ET GDI research centre and could collaboratively design a contextually valid TOR for application area WGs.

Land and McLaren (1998) also recommend that efforts be targeted at the development of key datasets that will reap the most benefits, provide immediate solutions particularly if aligned with political/problem opportunities. The proposed application area WGs would enable the identification of critical datasets. Sections 4.1 and 4.2 of this thesis have already begun the work of identifying data users, data uses and data requirements. Users would be officials in all 36 government departments, ministries and units identified in table 4.2, district, sub-district and village officials as seen in figure 2.9, and also ODA workers, academics, industry members and citizens. Data uses were identified in table 4.3 and the proposed ET GDI WGs are derived from the findings in this table. Finally, data requirements, beyond departmental and sectoral needs, are identified in table 4.1 Constitutional Principles and Regulations Related to the Protection of the Environment and sustainable development. The specific needs of end-users such as farmers, foresters, shippers, etc., have not been identified here nor have those related to GIS and related technology users. All of these have associated institutional and technical issues that should be considered when developing an ET GDI. A focus on end users provides a service-oriented approach rather than a "government-needs" approach. This, in turn, will provide an environment where real needs can be met (Land & McLaren, 1998) namely, if an agriculture application area WG was developed, it should include in its TOR consultations and

specification development with data providers such as the census, subdistrict officials, farmers, foresters, etc. This would ensure that data needs are understood and the requirements of all of those involved in gathering, compiling, analysing and dissemination of data are met. This also ensures that data are relevant and contextualized. This is the beginning of an integrated approach to problem identification and resolution.

Until comprehensive business plans and project management plans have been designed and some datasets have been gathered and policies have been tested it is best to avoid spending aid or government money on technology up front as this often results in 'boxes on desks' that gather dust since they do not meet needs. An approach that "focusses on broader human and organizational issues as a key component of capacity building rather than emphasizing technology and method" is considered more desirable in LDCs (Britton, 2000:9). ODAs need to be coordinated beyond connectivity but also content (Hall, 2000). To ensure that aid meets its needs, East Timor can adopt a number of guiding principles, including: favouring demand-led rather than technology-led projects; ensuring that support is provided to local initiatives with a foreseeable integration into overall institutions; ensuring autonomy by supporting projects that are small enough to sustain themselves with local finances and human resources; incorporating the soft components of implementation such as capacity building, and social and organizational issues; and, supporting longer-term projects rather than short term-projects (Ezigbalike, Selebalo, Faix and Zhou, 2000; Pfammater et al., 2000). The ODA coordinating WG could be tasked with overseeing some of these activities. And, as previously discussed, aid projects need to be

coordinated beyond the purchase of technology and connectivity and instead be engaged in consultative support to build business plans to meet needs. Furthermore, organizational change, institutional support and management are key. Changing roles and responsibilities and developing new skills require coordinating resources, and, more importantly, the clear justification as to why a GDI or LIS are key may require expensive long-term consultation to ensure buy-in for all members of society (McLaren & Land, 1998). The research centre may require this type of support. Collaboratively writing TORs, consulting with end users, cross-domain and cross-jurisdictional participation in working groups, secretariat and the research centre membership are part of this long term process. Enabling collaboration between and among departments requires modification to procedures and normative behaviour around sharing, power shifts and the dissemination of responsibilities. From a human resources perspective intra or inter-organizational collaboration may require the loosening of schedules; a new position may need to be allocated; and, a new role in the organization may need to be recognized while out of office commitments may need to take precedence over in-office time. These seemingly small changes can positively effect information sharing and organization munificence (Pinto & Onsrud, 1995). Furthermore, the initial objective of this thesis was to develop the institutional components first and then develop the technical. This will provide East Timor the time to gain some experience to identify and develop some basic datasets, to carry out some agreed-upon pilot projects, to learn from mistakes without being bound to use purchased expensive technology that may not meet its needs. This means investing in people first – particularly managers – and developing human resources plans to train

and maintain staff into new career paths. This work could also be done between the public and academic sector. There are a number of partnership and training opportunities that should be explored. A capacity development plan should accompany the management plan so that training is attuned to the identified data requirements of users and in alignment with East Timor's long-term sustainable development needs. There are a number of training strategies such as secondments in other countries, and these should be done in a context similar to the country acquiring the training. Other possibilities are: attending conferences and workshops, short courses, internships, coaching and mentoring, study tours, university and polytechnic courses, the invitation of international researchers and potentially some distant learning. Finally, lessons learned are key and information on these need to be disseminated and this data can be acquired from case studies, regional workshops that promote good practice, project evaluation and reviews (McLaren & Land, 1998).

Once people have received training, a conscious effort is required to ensure that the newly created knowledge is retained and transferred. Retaining knowledge means embedding the knowledge in various repositories so that it may persist and transferring is how one subunit benefits or changes as a result of knowledge in another (Argote & Ophir, 2002). Knowledge can reside in routines, technologies and individuals, learning between groups, departments, divisions or establishments. Some of the methods used to ensure the transfer of knowledge are moving personnel from one department, unit or WG to another. This is considered a "powerful mechanism for transferring knowledge to other organizational units" (Argote & Ophir, 2002:193). When members are moved from one unit to another they are able to transfer tacit as well as explicit

knowledge and subtle understandings to the new unit. They also adopt knowledge from the new unit (Argote & Ophir, 2002). The cross-domain and jurisdictional research centre and WGs are formal methods to ensure transfer of knowledge in a multidisciplinary environment and other methods to ensure collaboration are discussed throughout. East Timorese traditional practices of knowledge transfer should also be explored.

Other recommendations are to develop sound-data sharing policies sooner rather than later, and to focus on the most pressing problems first; to avoid giving into demand and pressures for access that would produce premature decisions; and partnership approaches to data sharing should be encouraged (King, 1995). ALGIS has examined the possibility of cost recovery while the government of East Timor is committed to sharing data with its citizens. These policies are at odds and it is important to identify these conflicting policy issues and address them as soon as possible to avoid confusion and to ensure a long-term national approach is taken to all data related activities.

In LDCs as anywhere else the personal issues related to skill and motivation, cultural context, cultural values, and histories are important. An ET GDI will have to “address cultural norms for learning and communication as well as the processes that govern the development, articulation, and validation of skills and knowledge” (Britton, 2000:10) within East Timorese Culture. Traditional methods and knowledge, as well as social and behavioural structures will assist and in some cases impede progress. These less explicit characteristics of East Timorese culture will influence how WGs operate, the Secretariat will administer, the Research centre will steer and how a GDI will be

perceived and valued. A policy of inclusiveness and transparency are critical, and it is highly recommended that GDI activities include village, subdistrict and district officials to ensure that those who will be the main data producers are considered part of the process. This will ensure that end users get what they need. Participatory and community mapping pilot projects should also make attempts to incorporate local knowledge into the data gathering and representation process.

CHAPTER 5

CONCLUSION

Sustainability is best achieved when development and protective measures are strategically embedded into a nation's governing structures, institutions, across all domains and their associated sectors and when practices become part of the social structures that govern the every day lives of citizens. Furthermore, it is understood that sustainable development is best achieved when decisions are made with reliable, accurate, relevant and timely spatially referenced data. Geospatial data infrastructures are offered as the mechanism to manage geospatial data. Each GDI initiative has its own unique definition and vision, however, for the purpose of this thesis a geospatial data infrastructure (GDI) is defined as the relevant base collection of technologies, policies, people and institutional arrangements that facilitate the availability of and access to spatial data as illustrated in figure 1.2 (Groot and McLaughlin., Eds. ,2000).

The objective of this thesis was to assess if it would be possible for East Timor given its circumstance to develop the institutional, organizational and managerial elements of a GDI to inform sustainable development. First, the development literature referenced in this thesis make it clear that for sustainable development to

become a reality accurate and reliable geospatial data are a requirement for decision making. Second, the literature on GDIs indicated that these are considered the best mechanisms to effectively manage a nation's geospatial data assets (chapter 3). Third, East Timor has many geospatial data requirements (chapter 4, sections 4.1 & 4.2), and many difficult issues (chapter 2 section 2.2-2.5) that require an integrated environmental approach to their resolution. Fourth, ODA agencies have compiled many project-related data sets and maps, a small GIS unit has been formed and a decision support system is being developed. The utility of these data could be significantly increased if coordinated, well managed and stored in an easily accessible repository. Clearly there is a case to be made for the development of a GDI in East Timor.

An analysis of the seven GDI models (chapter 3 and chapter 4 section 4.3) namely, the Canada, Malaysia, Japan, Portugal, and Australia (CGDI, NaLIS, JNSDI, SNIG, ASDI), the regional Asia Pacific SDI and the Global SDI demonstrated that these organizations have separated their institutional, organizational and managerial functions from their technical and operational. Further, the regional APSDI and the Global SDI are not yet operational but the organizational structure and policy framework to guide operations are in place for APSDI while Global SDI is still undergoing formalization. Since well advanced GDIs separate these functions and considering East Timor's current technological, scientific, and educational limitations it is recommended and feasible for East Timor to develop the administrative, steering,

research and WG functions of a GDI before embarking on the technological. This would give East Timor time to develop a vision, business plan and a strategic training plan (section 4.5) and once some data sets have been gathered, mistakes made and learning codified, the technological components can follow. The literature on GDIs, LIS and GIS in developing countries recommends (section 4.5) avoiding the purchase of technology up front and, instead, suggests starting small and incrementally build on experience. Further, recommendations were made to enlist ODA consultative support to draft technology and training plans (section 4.5). Building the institutional and organization components of a GDI first may seem simple, however, the literature suggests the institutional components are the most difficult (chapter 3). East Timor is undergoing reconstruction, democratization and timorization in a very compressed time frame. This is the first time that East Timorese citizens are managing their own institutions, natural resources and implementing sustainable development and much learning is taking place. In addition, citizens have just recently been exposed to computers and the Internet and have not yet developed an ICT culture where data are considered a national information resource on par with natural resources. It will take time for this acculturation to take place, particularly given the nature of the economy, and traditional, normative and cultural structures of its society (chapter 2). An East Timor GDI is a long-term project that will require significant and ongoing support from politicians, high ranking officials, managers, and ODA agencies to get it started and to keep momentum. East Timor needs to invest now in its HR capacity in the fields of science, technology, social sciences, cartography, planning, engineering and knowledge

management to be able to manage its own GDI in the long-term. Like Malaysia (section 3.6.2) relevant training should be incorporated into all levels of the education system. It is also hoped that regional, global and neighbouring GDIs could provide some consultative support, training resources and bi-lateral political support.

Among the seven GDI models studied in this thesis none is considered suitable to East Timor's context but each has elements that have been incorporated into the hybrid ETGDI proposed in sections 4.3-4.4 and as seen in figure 4.1. The East Timor public administration will have to develop some new structures to accommodate the proposed institutional components of an ETGDI to inform sustainable development as seen in figure 4.1. It is proposed that a secretariat be developed to provide administrative support to a research committee, and to support the administrative needs of WGs (section 4.4). The secretariat will require an equipped office, three to four dedicated full time staff and a budget to carry on its activities. It is recommended that it be located in a unit or department that has cross departmental experience, ICT capacity or in the Ministry of Agriculture and Fisheries which currently has a small GIS unit. It is proposed that a research committee be formed to develop a vision, oversee the drafting of a business plan and a strategic training plan and steer the direction of the WGs. It is recommended that it be located in the Universitas Timor Timur and that membership be executives, academics, educators from the Polytechnic, politicians, and district, subdistrict and village officials (section 4.4). Finally to address critical issues, application area WGs on the topics of health, utilities, natural resources, social infrastructure, agriculture and transportation could be created. Their terms of

reference (section 4.5) would include data needs assessments, consultation with users, liaison with cabinet and ensuring that their work is in alignment with the objectives of the research committee and the other WGs. Their membership would be cross-sectoral, cross-jurisdictional and multi-disciplinary to ensure an integrative approach. A strategic training WG should be developed to ensure the necessary capacity to implement and manage a GDI are in place in East Timor. Finally, an ODA data coordination WG should be created to ensure that ODA data are being gathered according to policies and standards. This WG would also be tasked with organizing, storing and disseminating existing ODA data, reports and maps.

The proposed ETGDI structure supports a collaborative decision-making environment. Membership in all of these units ensure inter-departmental collaboration, cross-domain participation, and inter-jurisdictional inclusion. In addition, the TOR will include consultations with citizens, data-users and producers to ensure that it is a needs centred service GDI. Small rural pilot projects are critical, as is providing training to rural officials on data gathering methodologies, and integrated analysis. Further sustainable development should be informed by traditional land management and forestry processes and data to ensure these traditional processes will enrich the sustainable development process and also validates the knowledge of rural people who may be illiterate but have much to share. This also provides an opening to introduce new ideas. This, and a host of many other participatory and community mapping projects pilot projects, should accompany the development of the ETGDI since these types of activities are considered as effective mechanisms to demonstrate the utility of data, maps and inclusion in the process.

The proposed ETGDI organizational structure will be shaped by the cultural and normative structures of East Timorese society. Chapter 2 provided some insight into the traditional rigid social stratification system of kinship ties and rank by age and gender and also the resistance to change. Further East Timorese society is divided by a class system, a dualistic urban and rural economy and regional linguistic differences. Alternatively, the same kinship system was able to mobilize large networks of people to tend to the crops and manage forests, and the traditional peace making process is still practised today. The inclusion of the younger generation and women into the public service is a step in the right direction, as is the increase of a merit based leadership system. However, it is expected that it will take time before a consensus making process free of the above mentioned social structures can be established. It is recommended that a strong central leadership role reinforce the merit based system and slowly build in a shared leadership and consensus making approach to managing. It is suspected that this will take time and concerted effort will be required to overcome subtle but important power dynamics.

It is critical that East Timor develop and support these new ETGDI institutions sooner rather than later, even if only few WGs are in place and membership is small. As AusAID officials aptly pointed out, it is difficult to change established institutions. National GDIs in developed countries struggle with role entrenchment or data fiefdoms and it is recommended that East Timor avoid these problems. If the government drafted a charter, an accord or a directive to mandate public service organizations to participate in an ETGDI and share their data, this problem could be avoided and full

cooperation could be ensured. The civil service is still dynamically changing and it is hoped that East Timor can enlist the support of the PCGIAP and the GSDI to impart to the Council of Ministers the benefits of a GDI.

The most advanced GDIs are in countries with well developed ICTs, high levels of tertiary education, investments in R & D and well established natural and social science communities. These knowledge based economies greatly differ from East Timor which is primarily a resource based economy. East Timor does, however, have a commitment to sustainable development and the use of science and technology to advance its nation building process. Also East Timor would not be the first LDC to embark on building a GDI, namely South Africa, Colombia, Brasil and Mexico have also been doing this work. Most LDCs do have a head start on East Timor in terms of GI experience and it will be necessary that a series of pilot projects be carried out to build experience, and that ALGIS consultative support continue until the unit can be run by East Timorese. The need for a GDI is very high in East Timor, and it is hoped that the nation can secure high level political support as soon as possible to get the ball rolling. Again, this will be a long-term iterative process with many small incremental steps before a fully technological operational GDI is in place. However, each small step toward building a GDI is part of knowledge creation that can become a part of the fabric of East Timor's sustainably and intelligently developed society.

Forming an ETGDI is a strategic policy initiative to ensure that required geospatial data are collected, managed and disseminated to inform the work of reconstruction and sustainable development. Initially it should be supported by ODA, the public

service and research institutions. The type of support required is long-term and consultative to develop business plans, develop a training plan, and facilitate collaboration. Other short term projects that fit with both the training and business plan could also be carried out with ODA support. Further, it is hoped that the PCGIAP, GSDI and neighbouring GDI initiatives can extend their mandates to support East Timor in developing the capacity to manages its data assets.

This thesis demonstrated that it is possible to develop institutional and organizational elements of a GDI first followed by the technological. The civil service would require organizational change, to ensure that all geospatial data gathering activities are coordinated, that responsibilities are shared and to accommodate a new institution, an ETGDI. Also, a collaborative consensus making process is possible in East Timor but it would take some effort to overcome some historical social structures for it to work. It was also demonstrated that East Timor already has a strong mandate to collect, manage and disseminate geospatial data within its constitutional and regulative framework and these activities need be formalized across departments and supported by politicians and high ranking officials to ensure that resources are allocated and the project is sustainable. This thesis studied seven GDIs and did not find a suitable model for East Timor but did adopt elements of these in the design of an ETGDI. Geospatial data are a critical information resource in East Timor, and data are required to inform sustainable development, and if a GDI were built, maps were widely being disseminated, the education system at all levels include GI in their curricula, then geospatial data would grow in import for East Timorese citizens.

However, in the absence of an operating GDI and on-the-ground experience, this author cannot adequately address this point. Much more research on the social structures of the people of East Timor would be required, along with an increase in focus on participatory GIS, community mapping, communications and community development. Many LDCs are building GDIs, and East Timor could do the same, but it would be starting at a much lower level of experience. With time, and a good business and/or training plan, consultative support and financial resources East Timor could build the necessary institutional capacity it requires to build a GDI.

Much new insight has been gained from this work and the research achieved what it set out to do. However, for an ETGDI to become a reality much more work would be required in a number of areas. First, the information and analysis in this thesis would need to be tested and validated with direct experience in East Timor. Second, GDIs are technologically complex and specific technological issues would have to be studied. GDIs are extension of early GIS and international collaborative mapping projects, a comprehensive ETGDI plan would have to include issues related to GIS, socio technical processes, appropriate technology, and GIS in organizations. Further, capacity building is not as trivial a matter as developing a plan and implementing it. Knowledge creation takes time and effort and needs to be carried out in such a way that geospatial data, GIS, maps and GDIs become second nature and obvious to East Timorese citizens. The process of embedding and continuously creating new sustainable development knowledge would also require an analysis in much greater depth than what has been provided here.

Should East Timor decide to build an infrastructure for sustainable development, the research findings and recommendations provided in this thesis are considered a good place to start. It is recognized by the author that many of the issues and ideas presented in this thesis need to be validated with some “ground truthing” in East Timor. It is believed that the analysis is adequate enough to stimulate a conversation on the topic of developing an infrastructure for sustainable development in East Timor among GDI officials, politicians, ODA workers and members of PCGIAP and GSDI. It is hoped that such a conversation can take place.

APPENDIX

List of Acronyms

ADB	Asian Development Bank
ANZLIC	Australia New Zealand Land Information Centre
AP	Asia Pacific
APDIP	Asia-Pacific Development Information Program
APSDI	Asia Pacific Spatial Data Infrastructure
ASDD	Australian Spatial Data Directory
ASDI	Australia Spatial Data Infrastructure
ASDI	Timorese Association of Social Democrats
AusAID	Australian Government Overseas Aid Program
CCOG	Canadian Council on Geomatics
CCRS	Canada Centre for Remote Sensing
CGDI	Canadian Geospatial Data Infrastructure
CGSB	Canadian Geographic Standards Board
CIDA	Canada's International Development Agency
CIVPOL	Civic Police force in East Timor
CNIG	Portuguese National Centre of Geographical Information
CPISTP	Australian Spatial Data Transfer Policy
CSDC	Commonwealth Spatial Data Committee
D.R.	Democratic Republic
DCW	Digital Chart of the World
DOT	Digital Opportunity Task Force

DSMM	Department of Survey and Mapping
EIS	Environmental Information System (South Africa)
ETTA	East Timor Transitional Administration
EUROGI	European Umbrella Organization for Geographic Information
FAO	Food and Agriculture Organization
FGDC	Federal Geographic Data Committee (U.S.)
FIG	Fédération internationale des géomètres
FRETILIN	Revolutionary Front for an Independent East Timor
GASSIA	Geospatial Application to Support Sustainable International Agriculture
GDI	Geospatial data infrastructure
GI	Geographic information
GIAC	Geomatics Industry Association of Canada
GIS	Geographic Information System
GSDI	Global Spatial Data Infrastructure
GSI	Geographic Survey Institute
HR	Human resources
IACG	the Inter-Agency Committee on Geomatics
ICA	International Cartographic Association
ICDE	Infraestructura Colombiana de Datos Espaciales
ICSM	Intergovernmental Committee on Surveying and Mapping
ICT	Information communication technology
IFRC	International Federation of the Red Cross
IGU	International Geographical Union
IMF	International Monetary Fund
INTERFET	UN Sanctioned International Force In East Timor
ISO	International Standards Organization
JNSDI	Japan National Spatial Data Infrastructure

KBE	Knowledge based economy
LDC	Less developed country
LRA	Land Related Agencies (Malaysia)
MLDC	Ministry of Land Development Council (Malaysia)
MOU	Memorandum of Understanding
NaLIS	National Infrastructure for Land Information System (Malaysia)
NAPA	National Academy of Public Administration (U.S.)
NGO	Non governmental organization
NMA	National mapping agency
NPEU	National Planning and Environmental Unit (East Timor)
NPIC	NaLIS Planning and Implementation Committee (Malaysia)
NRC	National Research Council (U.S.)
NSDIPA	National Spatial Data Infrastructure Promoting Association (Japan)
OCG	Open GIS Consortium
ODA	Overseas development agency
PCGIAP	Permanent Committee on GIS Infrastructure for Asia and the Pacific
SD	Sustainable development
SDTS	Spatial data transfer standard
SNIG	Sistema Nacional de Informação Geográfica (Portugal)
TC	Technical committee
UDC	Timorese Democratic Union party
UN	United Nations
UNMGI	United Nations Cartographic Section on Maps and Geographic Information
UNCED	United Nations Committee on Environment and Development
UNCEP	United Nations Committee on Environmental Protection
UN-CCA	United Nations Common Country Assessment
UNGIWG	United Nations Geographic Information Working Group

UNHCR	United Nations High Commissioner for Refugees
UNAMET	United Nations Mission in East Timor
UN-NPDA	United Nations National Planning Development Agency
UNPF	United Nations Population Fund
UNRCC	United Nations Regional Cartographic Conference (UNRCC)
UNTAET	United Nations Transitional Administration in East Timor
USAID	U.S. Agency for International Development
WB	World Bank
WG	Working group

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