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Geospatial Data Infrastructure for Sustainable Development of East Timor

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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. Accurate and timely geospatial data can assist sustainable development decision making. Geospatial data infrastructures (GDIs) are the intersectoral, cross-domain, inter-departmental consensus-making mechanisms by which a nation can manage its geospatial data assets. Aid agencies compiled much data and rendered some maps, but these were project specific, limiting their utility in other contexts. Currently no formal body is coordinating these information resources. East Timor has many data requirements, and an East Timor GDI will help meet the constitutional mandate for sustainable development. Seven GDIs models are examined, and elements from them are selected for a proposed hybrid GDI for the nation. It is argued that the major need is for institutional rather than technological development.

INTRODUCTION

The Democratic Republic of East Timor became the United Nations' 191st member in 2002, shortly after its physical and social infrastructures were totally destroyed. Today a new nation state is being created with sustainable development as a core value.

Sustainable development is best achieved when decisions are made with reliable, accurate, relevant, and timely spatially referenced data. Geospatial data infrastructures (GDIs) are a good mechanism to manage these data (Masser 1998, p. 7; Lopez 1997). A GDI is a collection of technologies, policies, people, and institutional arrangements that facilitate the availability of and access to geospatial data (Groot and McLaughlin 2000). It directs the who, how, what, and why of geospatial data at various scales as the data are collected, stored, manipulated, and analyzed (Ezizbalike, Selebalo, Faiz and Zhou 2000). Sustainable development is "development which meets the needs of the present without compromising the ability of future generations to meet their own needs" (UNCED 1992) and "the reconciliation of society's developmental goals with its environmental limits" (NRC 2002). East Timor is balancing the provision of essential services to its citizens with trying to sustainably manage its natural resources.

The reconstruction of East Timor's information and communication technologies (ICTs) benefits from the well-developed ICTs of various aid and financial agencies operating in the country as well as those of its historical allies (Portugal, United States, Canada), neighboring countries (Australia, New Zealand, Malaysia, Japan), and regional and overseas development agencies. Unfortunately, there is little coordination of information among these actors. Consequently, East Timor has been mapped in an ad hoc fashion before and after the 1999 referendum by a host of international organizations to inform reconstruction, orient aid workers, locate resources, facilitate international communication, and support defence. Australian Defence and AusAID have assisted with the creation of a small geomatics (geospatial technology) unit, and no plans exist to manage these data or build the capacity to effectively utilize them throughout the government of East Timor. Aid agencies complain of a lack of data to inform their work, and there is no mechanism to collect and coordinate existing data.

East Timor's culture, geography, size, and population, combined with its unfortunate history, may in fact be its assets in terms of building a GDI. East Timor does not have the difficulties experienced by more established economies attempting to build GDIs, since it does not have to change existing practices and structures. It may be able to build consensus-making and collaborative work environments from the outset. A GDI is more than technology and geospatial data; "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 much of the business of a nation" (Mapping Sciences Committee 1993). GDI initiatives are beginning to be recognized by aid agencies as good governance strategies.

East Timor is located in a region where excellent GDI examples and considerable geospatial experience exist: the Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP); the Australia and New Zealand Land Information Council (ANZLIC), which guides the activities of the Australian Spatial Data Infrastructure (ASDI); Malaysian Geospatial Data Infrastructure (MyGDI), formerly known as National Infrastructure for Land Information System (NaLIS); and the Japanese National Spatial Data Infrastructure (JNSDI).

Both Canada and Portugal have aid and historical ties to East Timor, and the Canadian Geospatial Data Infrastructure (CGDI) and the Portuguese Sistema Nacional de Informação Geográfica (SNIG) could provide assistance.

We argue that building a GDI at an early stage is a good governance strategy for East Timor, particularly if the national government is to meet its responsibilities to sustainably manage its territory. The new government needs data and information to fulfill its constitutional mandate, to make informed decisions, and to address social, economic, and environmental issues. We examine a number of GDI models and identify elements to be incorporated in a proposed GDI for East Timor. A GDI is a key mechanism for sustainable development and should be built sooner rather than later. The initial focus should be on institutional, organizational, and managerial components followed by technological components, and outside assistance will be required to help build indigenous capacity.

INDEPENDENCE OF EAST TIMOR

After centuries of Portuguese colonial neglect and a 25-year brutal Indonesian illegal occupation, a referendum supported by the UN Mission in East Timor (UNAMET) took place on August 30, 1999 (figure 1). In that referendum 78.5 percent of citizens voted in favor of autonomy, and immediately thereafter a premeditated Indonesian-backed campaign of violence, looting, and arson took place (UN-CCA 2000, UN and WB 1999, UN General Assembly 2000).

Hundreds of civilians were killed, and all government buildings and records were destroyed (UNDP and the UNPF 2000), leaving limited institutional memory.

On October 25, 1999, the United Nations Transitional Administration in East Timor (UNTAET) was established with full legislative and executive authority and responsibilities for law, order, and security in order to begin the process of sustainable development (UN and World Bank 1999). Many aid agencies supported the humanitarian and reconstruction effort, but there was a lack of coordination. There was also a lack of local participation and very limited forward planning (UNTAET 2000a).

At independence East Timor was one of the poorest areas in Southeast Asia.

Every aspect of East Timor's physical infrastructure, institutions, social infrastructure, and communications and every sector of its economy had to be rebuilt.

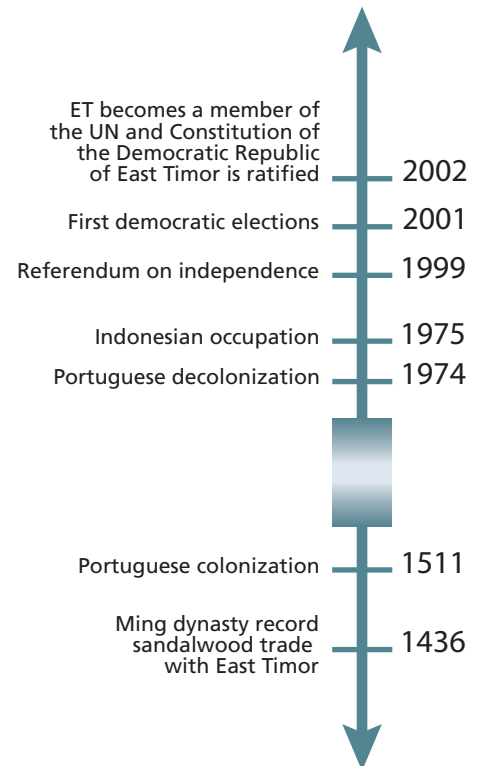


Figure 1. Historical timeline.

Rebuilding meant balancing immediate humanitarian needs with long-term sustainability. Giving sustainable development priority during such a crisis situation is difficult to justify, and environmental mismanagement during reconstruction caused much destruction (Tais Timor 2000a; Sandlung et al. 2001; Phillips 1999).

Constitution of the Democratic Republic of East Timor. Thirty thousand citizens participated in a series of 200 hearings held in 65 subdistricts to create the East Timor Constitution (UN Department of Public Information 2001). The Constitution includes “the development of the economy and the progress of science and technology” along with the protection of the environment and the preservation of natural resources (Constituent Assembly of East Timor 2002). Furthermore, section 61, Environment, 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 the creation, promotion, and guarantee of the “effective equality of opportunities between women and men.”

Governance. Governance is “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, p. 92). GDIs are mechanisms for a good governance strategy. In the East Timorese context, governance means “a high degree of simplicity, flexibility and adaptation to ongoing and dynamic change” (UN-NPDA 2002, p. 70) and a lean, merit-based civil service (UN and WB 1999, p. 19).

The new administrative structure consists of 13 districts (figure 2) and 65 subdistricts with appointed and elected public officials at each level. The traditional councils of elders, local leaders, and hamlet heads also remain part of an informal decision-making structure (UN-NPDA 2002). Stratified local male- and elder-centered hierarchical authority structures remain strong in rural areas (Barbero Magalhães 1994, UN-CCA 2000, Phillips 1999, Taylor 1999, Ormeling 1957), but allegiances based on lineage are being challenged, as women and youth want to be included in decision-making processes (UN-NPDA 2002).

Citizens have been integrated into all major decision-making positions in the administration (one-third of them women), and authority was transferred to the districts. The administrative Civil Service Academy has given introductory courses which include computer training, and a capacity development plan has been implemented to train senior and middle managers (UN Secretary General 2001; UN-NPDA 2002). There are few computer technicians, engineers, and social scientists. ICT is a new concept, and there remains a need to develop an information and technology culture. Computer literacy is low, although some returned refugees have had some exposure. There have been few opportunities to develop professional associations around ICT, standards, geomatics, or other technical issues related to GDIs. It will take time before the institutional and research capacity in this area can be built.

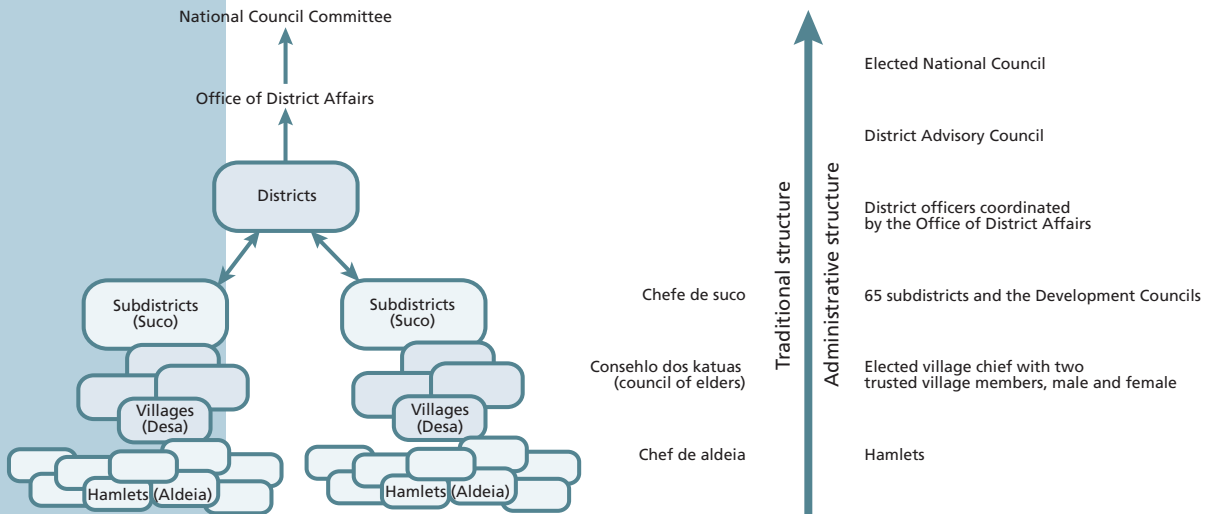


Figure 2. New administrative structure.

Compiled from UN-NPDA 2002, UNTAET 2002, Phillips 1999, UN and WB 1999, UN-CCA 2000.

The new government's goals are to enable the transition from a postconflict, donor-driven development process toward a sustainable democratic, independent, and economically viable society. National priorities are to ensure democratic, social, and macroeconomic 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) by and for East Timorese.

DATA AND INFORMATION REQUIREMENTS

Constitutional and regulative responsibilities. Rules, regulations, and responsibilities embedded in constitutional and regulative frameworks guide the actions of state institutions and the behaviour of citizens. East Timor is committed and constitutionally bound to sustainably manage its territory by protecting the environment and promoting sustainable behaviour and related determinants such as culture, heritage, health, security, social welfare, and the economy, which are all data-intensive activities. A key determinant of sustainable development is information, particularly geospatial data (UNCED 1992).

A series of regulations and sections in the Constitution address the environment, economy, society, data gathering, and the use of science and technology (table 1). They include promotion of the wise use of forests and protection of areas of inherent environmental, cultural, or historical value. A border regime was created to regulate the transport of goods, the quarantine of livestock, immigration, and the collection of taxes and tariffs, which are intensive national data collection activities. Borders remain a security problem requiring accurate maps to support international peacekeeping efforts. The provision of education, health, and social services and the management of business activities also require demographic data. Laws were created to ensure that a census is taken and to mandate electoral, business, and land registries and a tax regime. Ethical-conduct

Regulation or constitutional principle
Regulations
2000/9: Border regime 2000/15: Telecommunication 2000/17: Reduction of deforestation 2000/19: Protected places 2000/20: Revenue system 2001/3: Establishment of central registry 2001: Timor Gap Agreement 2002/4: Business registry
Constitutional principles
Section 6 Economic and financial organizations Subsection f: Protection of the environment Subsection g: Preservation of cultural heritage Subsection d: Science and technology Section 56: Social security and assistance Section 57: Health Section 59: Education and culture Section 61: Environment Section 139: Natural resources

Table 1. East Timor regulations and constitutional principles related to environmental protection.

Source: Constituent Assembly of East Timor 2002.

provisions were introduced to 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).

Government departments and ministries. Regulative frameworks require institutions to operationalize laws, directives, and constitutional principles. A government administration carries out this function, and table 2 lists 36 new departments, units, and ministries. These require data and information to inform managerial decisions and to address crosscutting issues such as economy, health, education, and agriculture.

Environmental, social, and economic issues. The lack of information and data about East Timor (Sandlund et al. 2001; Phillips 1999; UN-CCA 2000; Ormeling 1957) make it “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, p. 31) is acute, and there are few scientific sources and even less social science information. The destruction of government records only compounded the problem (Phillips 1999). The Department of Census and Statistics includes provisions to supply other departments with data; however, there is no mechanism to ensure that departments and ministries manage their data in a standardized way, nor is there a central agency that coordinates departments to ensure cooperation and collaboration on information needs.

Reconstruction, humanitarian, and aid efforts suffered from a lack of coordination between overseas development agency (ODA) projects and government departments. Many issues such as health and environment require an integrated management approach together with research in the physical and social sciences and appropriate institutions to conduct it (Sandlund et al. 2001).

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

Table 2. East Timor government departments and ministries.

The appendix lists issues, projects, and needs for a variety of subjects related to spatial data in East Timor. Currently, there are more issues than there are maps or datasets. Many issues are project and subject specific or follow the mandates of the organizations that fund them, and their data are not easily transferable to other contexts. Since projects are not integrated, information and data collected do not address the interrelated causes and effects of problems, nor are the benefits of sharing and integrating specialized knowledge realized. GDI framework data, clearinghouses, and working groups would help meet these data needs.

Ongoing data collection activities. Some data gathering and mapping projects have been implemented, important datasets are being compiled, mapping projects are ongoing, and potentially very useful maps exist. There is, however, a pressing need for their coordination, interoperability, and integration. Data on many topics are still missing (see appendix), and to date there is no central data clearinghouse, archive, library, or coordinating body to manage these.

Choosing a GDI model. East Timor has significant unmet data requirements. There is no central data- and information-coordinating body, and ICT capacity and related education levels are low. There is an opportunity to start building a GDI now, particularly since there is no bureaucratic entrenchment, and the initial administrative and steering functions of a GDI could be created as governmental units, departments, and ministries are being developed.

Seven GDI models were examined for applicability to East Timor: Sistema Nacional de Informação Geográfica of Portugal (SNIG), Canadian Geospatial Data Infrastructure (CGDI), Australia and New Zealand Land Information Council (ANZLIC), Japan National Spatial Data Infrastructure (JNSDI), the Malaysian Geospatial Data Infrastructure (MyGDI) (formerly National Land Information System [NaLIS]), Asia-Pacific SDI (APSDI), and global SDI (GSDI). None of these was found suitable for the current context in East Timor, but selected elements of each could be combined to form a hybrid GDI.

GDI have distinct operational and implementation functions with coordinative, administrative, and managerial elements. Secretariats, advisory boards, steering committees, working groups (WGs), and partnership programs are managerial components, while mapping, standards, framework data, interoperability, metadata, and clearinghouses are technical. Some national GDIs (e.g., JNSDI and MyGDI) have their managerial elements as formal extensions of their national mapping organizations, while others (e.g., SNIG, ANZLIC, and PCGIAP) have separate institutions to carry out and guide these activities. An accord, directive, or order formally mandating the existence of a GDI can also guide and define the activities of committees.

The MyGDI and JNSDI models (figures 3 and 4) centralize decision making and restrict information to the public sector. Given East Timorese traditions, elements of a centralized decision-making structure need to start the process while collaboration and consensus building are nurtured. Malaysia has integrated geomatics and GDIs into education curricula at all levels and offers ongoing training programs. This could be a method to develop, coordinate, and integrate geomatics capacity in East Timor, particularly in its university and polytechnic. Information and data could be coordinated centrally but managed by departments and units. Data should be made available at no cost to the public, nongovernmental organizations (NGOs), and other government departments. The MyGDI and JNSDI models are restrictive in this respect.

East Timor is small, with distinct rural and urban economies. Most government offices, electrical services, and the limited ICT infrastructure are located in urban areas. Government authority and responsibilities have been redistributed to the 13 districts, 65 subdistrict offices, and villages (figure 2); however, offices are rudimentary, gathering data manually and sending it to urban offices for computer input. Rural areas have low literacy, numeracy, and education levels. For these reasons, the jurisdictional Australian model is not recommended. The ASDI model relies on advisory and policy direction from ANZLIC (figure 5) to coordinate state and territorial GDIs. The ASDI does not have a central data

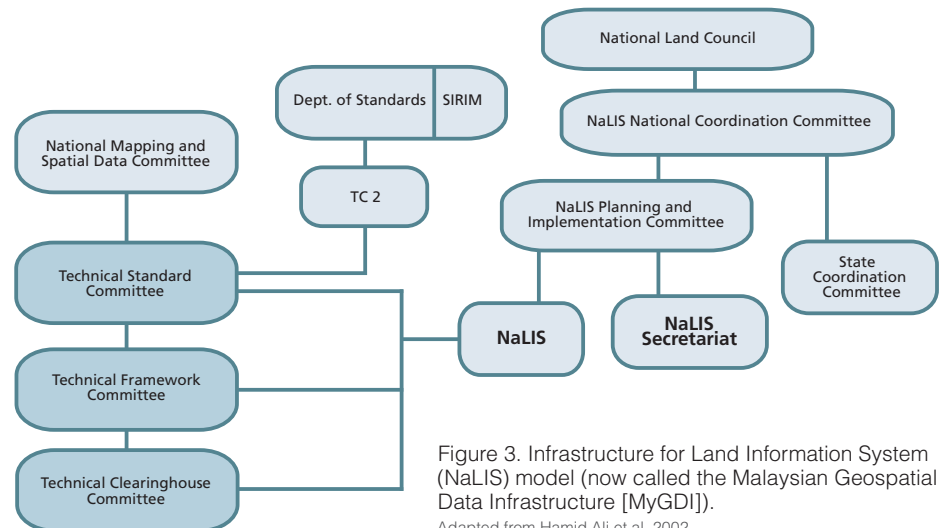


Figure 3. Infrastructure for Land Information System (NaLIS) model (now called the Malaysian Geospatial Data Infrastructure [MyGDI]).

Adapted from Hamid Ali et al. 2002.

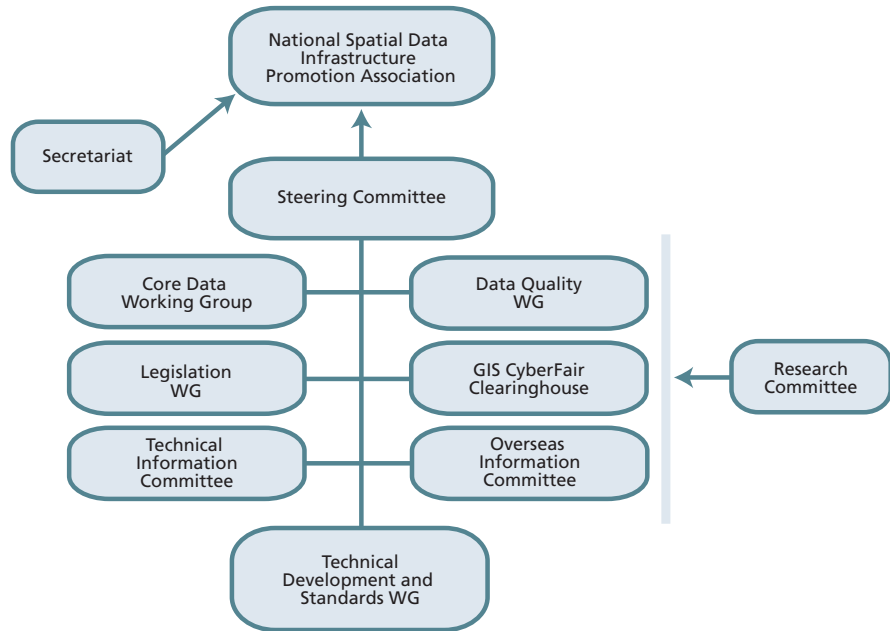


Figure 4. Japan National Spatial Data Infrastructure Promotion Association (NSDIPA) model. Adapted from Masser 1998 and NSDIPA 2003.

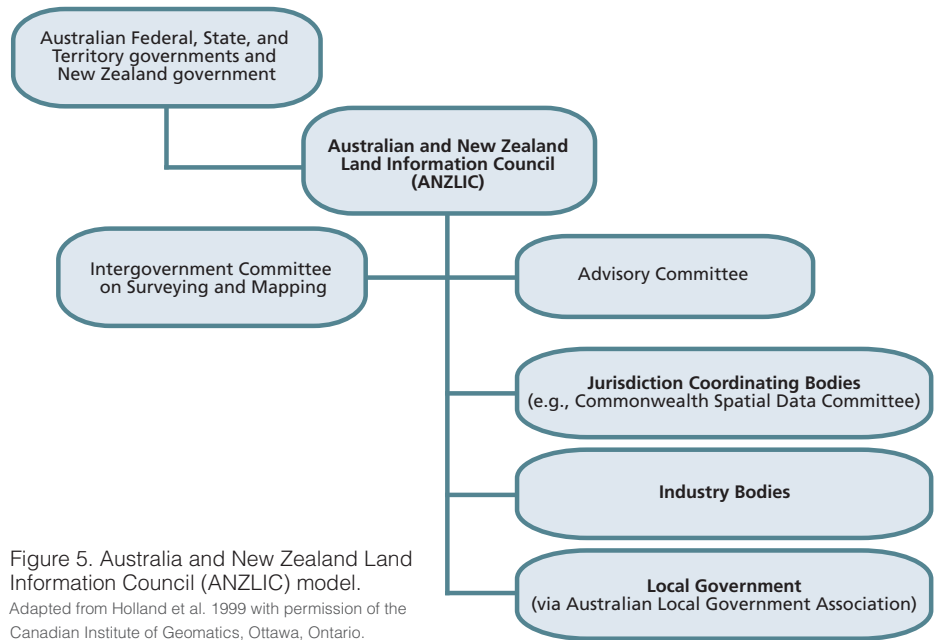


Figure 5. Australia and New Zealand Land Information Council (ANZLIC) model. Adapted from Holland et al. 1999 with permission of the Canadian Institute of Geomatics, Ottawa, Ontario.

repository, but instead jurisdictional GDIs adhere to policies, standards, and mapping processes that enable the creation of national framework datasets and clearinghouses linked to a central hub. Rural offices in East Timor do not have the necessary physical infrastructure to house equipment, the electrical and telephone infrastructure to power equipment and transmit data, or the institutional, managerial, and technical capacity to coordinate a jurisdictional GDI. Local offices can contribute data, develop community mapping projects, learn surveying techniques, and provide local knowledge to inform spatial data and populate national thematic datasets. These offices are map and data end users and should be included in GDI development plans.

Given the ICT and academic capacity in East Timor, the GSDI model (figure 6) is also not suitable. It is an association of professionals, industry leaders, communities of interest (e.g., defence, hydrography, Open Geospatial Consortium [OGC]), and established international mapping, cartographic, and surveying associations. East Timor could benefit from the skill development, international outreach, and capacity-building support offered by members of the GSDI community. The APSDI is also a jurisdictional model (figure 7), but its UN-type administrative reporting structure might be cumbersome. The APSDI mechanisms of defining roles and responsibilities could be useful. GSDI and APSDI could assist East Timor with dataset development activities, support to attend meetings and conferences, and the PCGIAP skill development and training programs.

The Centro Nacional de Informação Geográfica (CNIG) in Portugal is a government-arm's-length research centre that guides the GDI activities of SNIG. This type of steering agency could be useful to East Timor and could be based in the Universitas Timor Timur (UNTIM). The funding could come from aid agencies, research-granting institutions, and government. Necessary courses, skills, and training programs could operate in the university, along with geomatics laboratories. Participants would include civil servants from all departments with geospatial data requirements; officials from districts, subdistricts, and villages; educators; professors; librarians; and NGOs. This cross section of stakeholders could collaboratively steer the development of a GDI for East Timor.

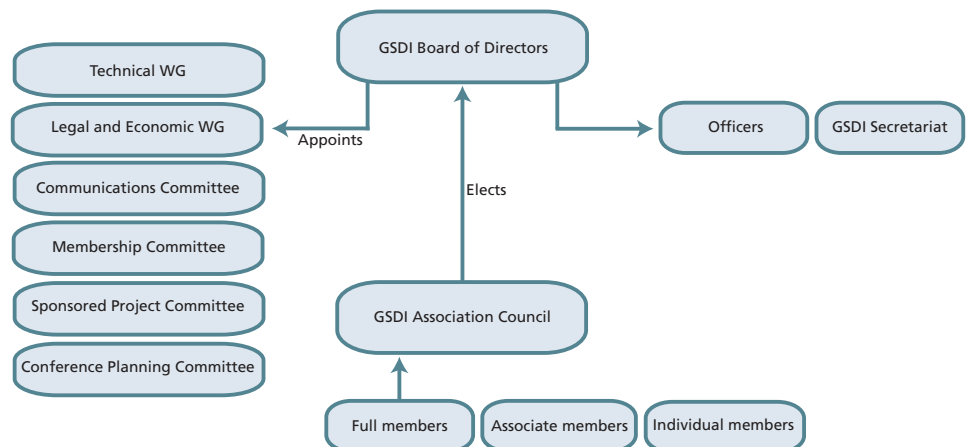


Figure 6. Global Spatial Data Infrastructure (GSDI) model.

Adapted from the GSDI Association Organizational Chart 2006 with permission.

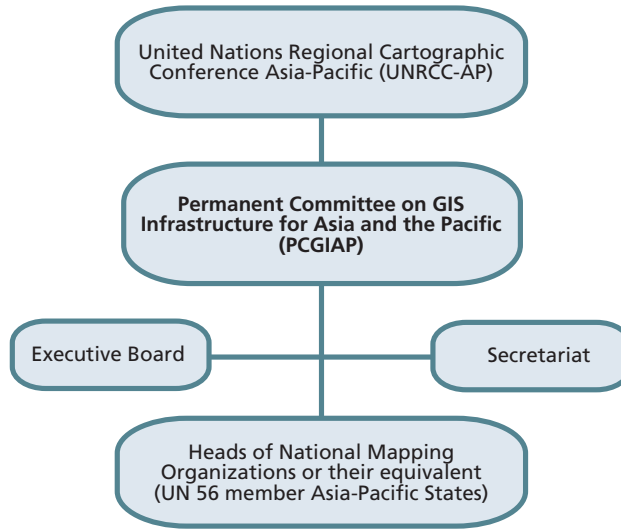


Figure 7. Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP) model. Adapted from Holland et al. with permission of the Canadian Institute of Geomatics, Ottawa, Ontario.

The Canadian model (figure 8) includes librarians, municipalities, information end users, and so on, along with geomatics experts. The CGDI includes application advisory nodes (i.e., WGs) and formal programs to develop partnerships and support from the private sector. The program advisory network is separate from operations and is a network consensus-making environment. In East Timor an informal social structure of problem resolution is based on consensus, and production is carried out by a massive network of familial and social ties. Building on an inclusive traditional decision-making social structure would ensure participation and align methods with cultural norms. WGs on a variety of themes such as health, agriculture, aid agency data could be part of the GDI.

Proposed East Timor GDI. An equivalent of Portugal's CNIG could guide application area WGs. This would ensure formal collaboration between academia, educators, and the public sector, which could result in mutually beneficial training opportunities. Executive-level membership from the civil service would ensure that decisions are implemented. Application WGs could focus on data needs and develop policies and standards similar to NaLIS. Crosscutting WGs on aid agency data coordination and strategic training could be formed. Other WGs could include health, agriculture, transportation, utilities infrastructure, natural resources, and social infrastructure. The research center could be responsible for analyzing WG needs and providing recommendations on data standards and policies. Once data requirements are identified and the civil service is more governance oriented, the GDI application WGs could evolve into technical ones dealing with standards, framework data, and related topics.

An East Timor GDI (figure 9) could be housed in the Information Technology Post Telecommunication department, which has some ICT capacity, or in the Office of Communication and Public Information, so as to build on its information and dissemination experience. The secretariat can provide administrative

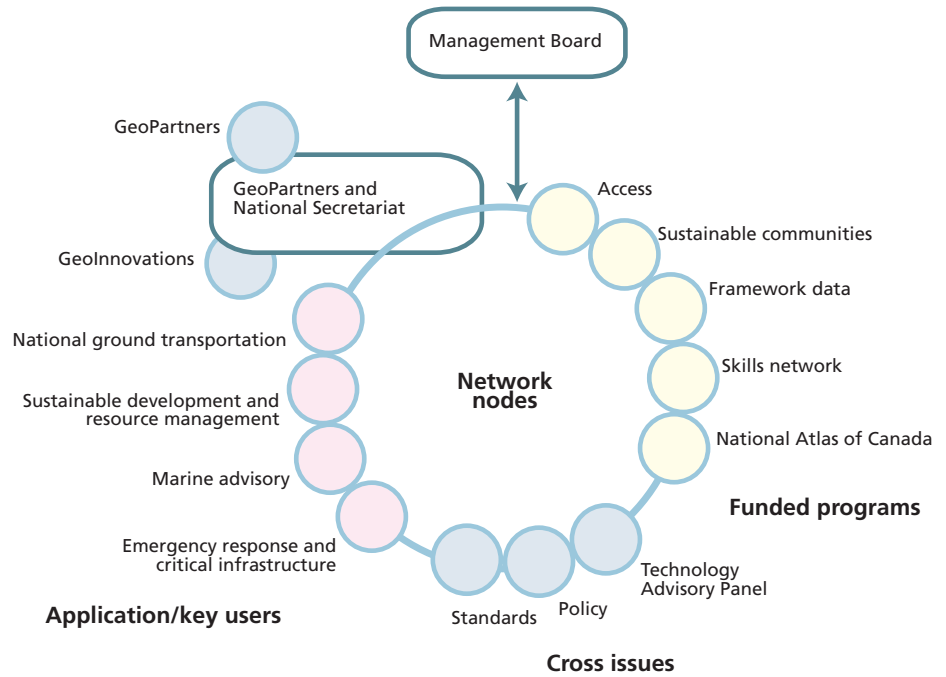


Figure 8. Phase 1, Canadian Geospatial Data Infrastructure (CGDI) organizational model. Adapted from GeoConnections 2003 with permission.

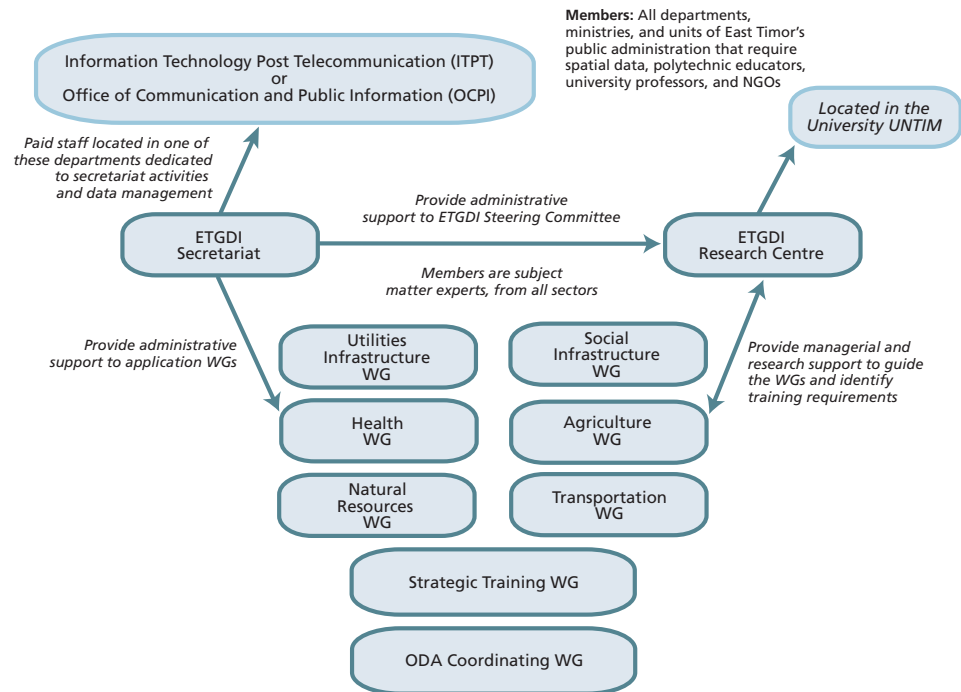


Figure 9. Proposed East Timor Geospatial Data Infrastructure (ETGDI) model.

support to application area WGs and the research/steering committee. The secretariat may temporarily store and disseminate data and ODA reports until a formal database, a clearinghouse, and national mapping organizations are established. The civil service is still restructuring, and an opportunity exists to formalize two new institutions: a GDI secretariat and a research center. This would ensure that the public sector has a formal mechanism to identify interdepartmental, cross-sectoral data needs and begin to coordinate activities.

A strategic-training WG could seek support from PCGIAP, GSDI, and neighboring-nation training programs, while funding could be acquired from aid agencies, research institutes, granting agencies, and international mapping associations. The public administration could cover the costs of civil servant training programs and pilot studies. The university can provide social science, agricultural, civil engineering, and legal knowledge, while the polytechnic can develop mapping, database, and cartographic technical training programs designed for students and public servants. Postsecondary institutions could collaborate on pilot studies such as community mapping, data gathering, surveying, and traditional knowledge in partnership with government departments. Private-sector involvement could be nurtured. Once some capacity has been built and students have graduated, research and development incubation centers could be created between public, private, and academic institutions to spark a private geomatics sector.

These recommendations are offered to stimulate thought and discussion among East Timorese officials grappling with geospatial data issues and decision-making processes. A final East Timor GDI model would have to be worked out in East Timor with officials from all jurisdictions and be formally funded and supported by the Council of Ministers. Few financial resources are directed at nonproject-specific data management activities, as these are not aid agency priorities. These ideas are offered as possibilities, should coordinating and managing spatial data become a central priority in East Timor and aid agencies recognize the possibilities of integrated data and information management as part of reconstruction and nation-building activities. GDIs are good governance initiatives, and building one for East Timor would contribute to sustainable development.

Building a GDI for East Timor. Building a GDI requires political support and commitment, appropriate terms of reference, business solutions along with national solutions, the management of aid funding, project sustainability, organisational change, public-private sector partnerships, and data (Land and McLaren 1998).

Political commitment ensures access to resources and the cooperation of officials, high-ranking politicians, and managers. The proposed East Timor GDI (figure 9) is contingent on broad-based support. Steering committees should represent all stakeholders. Political commitment to finance the operation of a secretariat requires resources for dedicated full-time staff, offices, computers, training, and a budget to support travel and facilitate stakeholder meetings. Staffing issues are critical, and NaLIS officials have identified this as an ongoing problem (Hamid Ali et al. 2002).

Convincing high-ranking politicians of the utility of a GDI is not easy; therefore, an informal forum to enable interested officials, geomatics staff, AusAID officials, and academics to discuss information and geospatial data issues, identify problems, and

demonstrate the need for a coordinated effort should be created. It could enlist PCGIAP support to facilitate roundtable discussions on the benefits of GDIs, show examples from the region to officials and politicians, spark interest, and harness support from the Council of Ministers.

Once the utility of a GDI is demonstrated, a vision should be articulated (NRC 2002; Ezigbalike, Selebalo, Faiz, and Zhou 2000). The GSDI Cookbook (2000) includes references to GDI visions from around the world.

Well-defined terms of reference (TOR) and mandates guide decision making, and these should be based on local needs (Land and McLaren 1998; Masser 1998; Ezigbalike, Selebalo, Faiz, and Zhou 2000). They guide the work of steering committees, advisory boards, and WGs. PCGIAP members, chairs, data custodians, and sponsors have well-defined rules, roles, and responsibilities. Terms of reference in East Timor should specify the roles and mandates of departments, units, and ministries as well as regulations and laws, and formally include liaison functions with donors, the Cabinet, and departments. Key datasets should be developed in alignment with political opportunities (Land and McLaren 1998). The proposed application area WGs could identify critical datasets (see appendix). A focus on end users facilitates a service-oriented approach rather than a “government-needs” one (Land and McLaren 1998).

Until comprehensive business and project management plans have been designed, some datasets have been gathered, and policies have been tested, it is best to avoid the purchase of technology that could end up as “dusty boxes on desks.” An approach that “focuses on broader human and organizational issues as a key component of capacity building rather than emphasizing technology and method” is considered more desirable in less developed countries (LDCs) (Britton 2000, p. 9), and aid efforts need to be coordinated (Hall 2000) to ensure that aid meets real needs. The following guiding principles (Ezigbalike, Selebalo, Faiz, and Zhou, 2000) are provided:

- Favor demand-led rather than technology-led projects
- Ensure that support is provided to local initiatives with a foreseeable integration into overall institutions
- Ensure autonomy by supporting small projects that sustain themselves with local finances and human resources
- Incorporate the “soft” components of implementation such as capacity building and social and organizational issues
- Support longer-term projects rather than short-term ones

The overseas development aid (ODA) coordinating WG (figure 9) could oversee some of these activities, and consultative support to build business plans could be provided by the agencies themselves.

Developing the institutional components will give East Timor time to gain some experience and carry out some agreed-upon pilot projects without being bound to the purchase of expensive technology. This means investing in people first (particularly managers) and developing human-resource plans. Partnership and training opportunities could be explored, and a capacity development plan could accompany a management plan to ensure that training meets identified data requirements and is in alignment with East Timor’s long-term needs. Training

strategies could involve secondments in other countries, attendance of conferences and workshops, short courses, internships, coaching and mentoring, study tours, university and polytechnic courses, visits by international researchers, and distance learning. Building on lessons learned is key, and information needs to be disseminated. Case studies, regional workshops, project evaluation, and reviews are good sources of this type of knowledge (Land and McLaren 1998).

A conscious effort is required to ensure that the newly created knowledge is retained and transferred. Retaining knowledge means embedding it in routines, technologies, and individuals and sharing it between groups, departments, divisions, and establishments (Argote and Ophir 2002). Moving personnel from one department, unit, or WG to another enables the transfer of tacit as well as explicit knowledge. The WGs and the research center are formal multidisciplinary knowledge transfer methods. Timorese traditional knowledge transfer practices should also be explored.

Sound data-sharing policies should be developed sooner rather than later, the most pressing problems should be tackled first, pressures for access that could produce premature decisions should be resisted, and partnership approaches to data sharing should be encouraged (King 1995). The geomatics unit in East Timor has explored cost recovery, while the government of East Timor remains committed to sharing data with citizens. This contradiction needs to be addressed so as to avoid confusion and ensure a consistent national approach to all data-related activities. Cost recovery is considered an impediment to knowledge transfer in cash-strapped environments.

A policy of inclusiveness and transparency is critical, and it is highly recommended that GDI activities include village, subdistrict, and district officials to ensure that data producers are involved. Incorporating local knowledge into data gathering could yield positive results.

CONCLUSIONS

East Timor has many geospatial data requirements and difficult social, economic, and environmental issues that require an integrated approach. The context in East Timor is not conducive to the full implementation of a GDI at present; however, administrative, steering, research, and WG functions of a GDI can be developed. This would give East Timor time to develop a vision as well as business and strategic training plans. Once some datasets have been created and integrated, experience has been accumulated, and learning has been codified, technological components can follow. East Timor should enlist outside consultative support to draft policy, technology, and training plans. Building the institutional and organizational components of a GDI first may seem simplistic; however, the literature suggests that the institutional components are the most difficult (O'Donnell and Penton 1997; Sherif in Pinto and Onsrud 1995; Pinto and Onsrud 1997; Hamid Ali et al. 2001). It will take time for ICT acculturation to grow and the data management cycle to take form, particularly given the nature of the economy and traditional, normative, and cultural structures.

An East Timor GDI is a long-term endeavor, and success will depend on ongoing support from all stakeholders and requires investments in science, technology, social sciences, cartography, planning, engineering, and knowledge management.

Relevant training could be incorporated into all levels of the education system. Regional and global GDIs will hopefully broaden their mandates and provide consultative, training, and political support.

The proposed East Timor GDI structure is a collaborative decision-making environment that will include consultations with citizens, data users, and data producers to ensure that needs are at the center. Small rural pilot projects are critical, as is providing training to rural officials on data-gathering methodologies and integrated analysis. Sustainable development should be informed by traditional land management and forestry practices. Participatory and community mapping pilot projects could effectively demonstrate the utility of data and maps and of the inclusion of local knowledge.

The proposed GDI organizational structure will be shaped by the cultural and normative structures of East Timorese society. At first, strong central leadership should reinforce a merit-based system, and slowly a shared-leadership and consensus-making approach to managing can be nurtured. Concerted effort will be required to overcome subtle but important social power dynamics.

East Timor must develop new GDI institutions sooner rather than later, even if it means only a few small WGs at first. As AusAID officials aptly point out (AusAID 2002), it is difficult to change established institutions. If the government drafted a charter, an accord, or a directive to mandate public service organizations to participate in an East Timor GDI and share their data, this problem could be reduced and full cooperation could increase. The civil service is still changing, and East Timor can hopefully enlist the support of PCGIAP and the GSDI Association to impart to the Council of Ministers the benefits of a GDI.

A GDI for East Timor would help ensure that required geospatial data are collected, managed, and disseminated so as to inform the work of reconstruction and sustainable development. Outside consultative support is required to develop business and training plans and facilitate collaboration. Other short-term projects that fit with the training and business plan could also be carried out with outside support. The resolutions of the 17th UNRCC-AP/12th PCGIAP meetings in Bangkok in 2006 recommended “that the Government of Timor Leste, member countries of PCGIAP, the UN Department of Peacekeeping Operations and other international efforts, collaborate as appropriate in developing this spatial data infrastructure so as to maximize its value” (PCGIAP 2007). This is very encouraging news indeed, and we hope that the recommendations in this article can be used to inform the development of an East Timor GDI.

Making the case for an East Timor GDI in the face of more pressing national needs is challenging, but recognizing the GDI’s considerable potential for contributing to knowledge creation, an integral component of the fabric of society, lessens the challenge.

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Appendix: Sustainable development issues in East Timor requiring geospatial data and information	
Issue	Requirements
Agriculture, animal husbandry, fishing	
Agricultural rehabilitation Animal husbandry Coffee Fishing Irrigation Steep mountain slopes Importation of rice, eggs, sugar, flour Rainy season, dry season Self-sufficiency in fruit, vegetables, and beef Staples (corn, rice, cassava, gourds) Sugar cane production	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
Air quality	
Car emissions Lack of car maintenance Mosquito fumigation Old cars	Car registry with attributes Mosquito vector maps Wind maps
Biodiversity	
Limited knowledge	Ecological models Flora and fauna data Habitat and hunting ground maps Data and maps for protected places
Border control	
Citizenship Control Monitoring Quarantine Taxes Travel permits	Border regime and 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
Buildings	
Building registry	Administrative land records Building permit data Cadastral Land management Legal land records
Economy	
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 in housing aid (marble, bamboo, thatch, cement) Revenue system Tax collection	Census Inventory of natural resources Inventory 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

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Appendix (continued)	
Issue	Requirements
Education	
Age of students High school Illiteracy New buildings Postsecondary Presence of girls High student/teacher ratio (60/1) Supplies Teacher population	Cadastre Demographic data (age profiles, population growth) Labor force survey Location of buildings Retention rate data School catchment areas
Elections	
Election registry Privacy Voter registration Voting stations	Demographic data District, subdistrict, and village maps
Emergency preparedness	
Disaster response	Emergency plans Evacuation sites Inventory of hazardous sites and reporting plan Land-use maps Meteorological data
Energy	
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	Climatic data for solar and wind power generation Data on peak demand locations Demographic data Electrical system infrastructure and management maps Forestry maps Data on fuel consumption needs Hydrographic maps Location of infrastructure
Forestry	
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 for forestry products in urban areas Sandalwood trade Slash-and-burn agriculture Soil erosion Tamarind	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

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Appendix (continued)	
Issue	Requirements
Health	
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 Health posts Health programs Hospital services Human resource development Lack of district and subdistrict health services Lack of understanding of water sanitation Lower respiratory tract illness Malaria Maternal mortality Mobile health clinics Mosquito fumigation moved insects inside National health surveillance health network National blood program National tuberculosis program and diagnostic centres Need for new laboratories, pharmaceutical drug program Obstetric care Pit latrines and sewage Population density Tuberculosis Vector-borne-disease control working group	Cadastre Demographic data Distribution of disease vectors Fumigation sites Health indicators Labor force survey Location and capacity of institutions and catchment areas Location of water sanitation services Maps of mosquito vectors Mortality rates Social and natural vectors Water quality data
ICT	
Access to land for towers and wires, right of persons to appeal law Archiving Basic telecommunication services Computerization of 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, stations Radio service being used to encourage hook-up and boil-water advisories Records management system Rehabilitation of the infrastructure Satellites Server cables, hubs, routers Television broadcasting Transmission towers	Cell phone tower location analysis maps Communication network Data on energy needs Infrastructure location data with attributes Land-use data Location and capacity of post offices Reach of radio waves Readership data
Labor	
ICT training Lack of trained health personnel Lack of trained teachers Lack of civil engineers Lack of computer technicians, network specialists, programmers, dBASE managers Lack of occupation profiles Shortage of mid- to top-level management	Demographic data Occupation profile statistics Education profile statistics Inventory of education and training programs Labor forecast data

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Appendix (continued)	
Issue	Requirements
Land	
Land titles Property rights	Cadastre Land-use data Land allocation data
Mines and minerals	
Marble Oil and gas reserves (Timor Gap Agreement) Phillips petroleum pipeline Resource exploitation and exploration Salt	Hydrographic data Infrastructure maps and management plan Location and capacity of mines and quarries Analysis of resource needs Shipping data Survey map
Population	
Registry	Census Registry
Sensitive, protected places and cultural sites	
Biodiversity Coral reefs Designated areas Endangered species Governance is required Historical sites Lake Irralalarus flora and fauna Mangrove areas Wetlands	Flora and fauna maps Inventory of protected areas Location of historical and cultural sites Location of sites or issues that threaten protected places Management plan Special research project on Lake Irralalarus Transportation network maps Wetlands maps
Shelter	
Housing shortage in Dili Shelter kits displaced local economy and their transport damaged roads Traditional building materials (bamboo, palm leaf roofs)	Cadastre Distribution of shelter kits Geodemographic data Location of traditional materials Data for needs analysis
Soil erosion	
Agricultural runoff Deforestation Demand for fuelwood Flash floods Clogging of irrigation systems Mountain slopes Mud slides Siltation Watershed management	Hazards and vulnerable-sites data Hydrological data Irrigation management data Land-use data Land classification Soil survey Topographic map Transportation network
Tourism	
Air travel Beaches Ecotourism	Coastline data Data on tourist preferences Decision support for land use for facilities Location of historical sites Location of protected places Location of facilities Location of places of interest Transportation network

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Appendix (continued)	
Issue	Requirements
Transportation	
Bridge reconstruction and repairs Bridges destroyed by flash floods Motor vehicle registry Only 11 East Timorese civil engineers Only 55 percent of roads paved Only 12 buses Port improvement Rehabilitation of navigation systems Rehabilitation of roads	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 preferences and needs Road network maps with attributes, transit route maps
Treaties	
Convention on International Trade in Endangered Species (CITES)	Location of sites that fall under treaties
Urban issues	
Crime and 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 and causes stress High migration from rural to urban areas Sewage	Cadastre Census Crime data and programs Epidemiological maps Location of infrastructure capacity and services Location, capacity, and waste flow of sewage facilities Migration data Waste management and dump plans
Waste management	
Garbage truck fleet management Garbage smell, transportation in the rain, toxic smoke, lack of a collection system Road network	Inventory of waste sites, capacity, type of waste
Water	
Access to fresh water Agricultural runoff causing eutrophication Coastal zone Domestic sewerage, 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	Geophysical data Irrigation and water diversion needs Land-use maps Location of water users Location of sewage treatment facilities Location of water bodies and courses with flow and condition data Location and capacity of dams Meteorological data, precipitation Mosquito vector data Water consumption data Groundwater mapping

Sources: UNPDA 2002, ETTA 2000, ICRC 2001, WHO 2000 and 2001, Internews 2002, Phillips 1999, Sandlund et al. 2001, Tais Timor No. 8 2000, TaisTimor August 2000b, TimorAid 2001, UN Secretary General 2001, UN-CCA 2000, UNDP 2002, United Nations and World Bank 1999, UNTAET 2000a, UNTAET 2000/27, UNTAET 2000b update, UNTAET 2001.

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