

Timor-Leste: Country Environmental Analysis

July 2009



Sustainable Development Department
East Asia & Pacific Region
World Bank



The World Bank

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All dollar amounts are United States dollars.

Abbreviations and Acronyms

ADB	Asian Development Bank
ALRI	acute lower respiratory infections
ARI	acute respiratory infections
CEA	Country Environmental Analysis
COI	cost of illness
COPD	chronic obstructive pulmonary disease
DALY	disability-adjusted life year
DHS	Demographic and Health Survey
DNSAS	National Directorate for Water and Sanitation
DNMA	National Directorate for Environment
EDTL	Timor-Leste Electricity
EEZ	exclusive economic zone
EIA	environmental impact assessment
EKKN	Elang Kakatua, and Kakatua North
FAO	Food and Agriculture Organization
F-FDTL	Timor-Leste Defense Force
FY	Fiscal Year
GDP	gross domestic product
GoTL	Government of Timor-Leste
GNI	gross national income
HCA	human capital approach
IAP	indoor air pollution
IDPs	internally displaced persons
JICA	Japan International Cooperation Agency
JPDA	Joint Petroleum Development Area
LLP	Land Law Program
LPG	liquefied petroleum gas
MAF	Ministry of Agriculture and Fisheries
MDG	Millennium Development Goals
NAP	National Action Program
NCSA	National Capacity Self Assessment
NDES	National Directorate for Environmental Services
NDP	National Development Plan
NGO	nongovernmental organization
NP	National Priority
PM	particulate matter
PNTL	Policia Nacional de Timor-Leste
SDS-SEA	Sustainable Development Strategy for the Seas of East Asia
SEMA	State Secretariat for the Environment
SERN	Secretary of Natural Resources
SFU	solid fuel use
SIP	Sector Investment Programs
SSEP	State Secretary for Energy Policy

TFET	Trust Fund for East-Timor
TLEA	Timor-Leste Exclusive Area
TLCLS	Timor-Leste Standard of Living Survey
UNCBD	United Nations Convention on Biodiversity
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNTAET	United Nations Transitional Administration
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
VSL	value of statistical life
WHO	World Health Organization
WSS	water supply and sanitation
YLL	years of life lost

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Executive Summary

The Country Environmental Analysis (CEA) for Timor-Leste identifies environmental priorities through a systematic review of environmental issues in natural resources management and environmental health in the context of the country's economic development and environmental institutions. Lack of data has been the main limitation in presenting a more rigorous analysis. Nevertheless, the report builds on the best available secondary data, presents new data on the country's wealth composition, and derives new results on the costs of water and air pollution. The CEA calls for urgent attention to gaps in the environmental management framework, the lack of capacity to implement the few regulations in place, and the high cost of indoor air pollution and poor water, sanitation, and hygiene.

Timor-Leste is a young country that regained independence in 2002, and it has emerged from a bitter past burdened by colonialism and violent conflicts. It is still a fragile state facing enormous challenges. The Human Development Index for Timor-Leste in 2006 was 0.547, with a rank of 141 out of 179 countries. Timor-Leste is now classified as a lower middle-income country with a gross national income (GNI) per capita in 2007 of more than \$1,500. However, the non-oil per capita income is less than \$400, which gives a better perspective of the living standard facing most Timorese. Timor-Leste is a market economy, democratically governed, and richly endowed with natural resources—primarily oil and gas. A sound system of financial management of these assets is in place to prevent a sudden burst of spending from crowding out other sectors of the economy. Much of its nature—world class coral reefs, untouched forests, and scenic vistas—remains relatively unspoiled and could be the basis of a thriving tourism sector. Tourism is currently marginal but well managed. These are tremendous assets, which could provide for much needed employment to a rapidly growing population. Many nations have started out with a worse balance sheet.

Both the constitution and the current government of Timor-Leste (GoTL) have recognized the importance of environmental protection. However, the country lacks a comprehensive **environmental management framework** in terms of legislation, regulation, and adequately resourced institutions. The existing environmental legislation is a legacy of the past and is not well recognized in current day Timor-Leste. The GoTL made some progress in the development of two important draft environmental laws (on environmental impact assessment and pollution control) in 2006, but they were not approved. In the second part of 2008 the Ministry of Economy and Development, which is responsible for the environmental area, decided to return to the subject. With support from the World Bank, a new draft was prepared that integrated the two diplomas and created the environmental license system. The draft was presented to the Council of Ministers in February 2009. It will be important to complete this process in order to lay the ground for the challenges that future growth and investment will pose to the environment.

While many of the environmental problems today are the result of too little economic growth, the problems of tomorrow will increasingly become the problems of increased economic activity. Human capital with skills in environmental management is quite scarce, and insufficient information makes their task formidable. There is a severe lack of data and public records that can promote environmental awareness. Hence, building an appropriate legal and regulatory

framework and building modest but adequate capacity for environmental management emerge as a first-rate priority.

The CEA draws attention to **indoor air pollution** as an environmental priority. Many young children and women die prematurely or get sick because of breathing polluted air while cooking with firewood. Using statistics on related diseases and the associated income losses and medical costs, the economic cost of indoor air pollution is estimated at approximately \$13 million per year. This amounts to about 1.4 percent of the Timor-Leste GNI or 3.5 percent of the gross domestic product (GDP) in 2006. This is a significant burden, but too little has been done to address it. The situation can be mitigated by a combination of simple measures, including improved stoves, better ventilation, cleaner fuels, and increased health awareness and basic education. Timor-Leste has significant oil and gas reserves, and the potential for a much larger liquefied petroleum gas market in urban areas should be investigated. These measures have been shown to be cost-effective in other countries. They do require collaboration across institutional boundaries and adaptation to local culture.

The report also points out the **lack of clean water, appropriate sanitation, and hygiene** as an environmental priority. The CEA estimates that this imposes an economic cost of about \$17 million per year by way of illness and premature death. This amounts to about 2 percent of Timor-Leste GNI or 5 percent of GDP in 2006. While the government is trying to address this problem, most of the efforts have been concentrated on water supply rather than on water treatment and sanitation. Again, interventions can be simple, effective, and low-cost: hygiene education, hand-washing with soap, building of latrines, disinfection of water at the household level, and so on. All these measures have been shown to strongly reduce the incidence of disease and will reduce mortality, particularly among children.

The CEA also looks at outdoor air pollution and at natural resource management for land, forestry, and coastal and marine resources. Outdoor air pollution is not a serious problem for the time being, but it could become so in the long run if the economy grows rapidly, urbanization continues, heavy industry emerges, and motorization increases rapidly. This underlines the need for good forward territorial and development planning.

Data are quite deficient when it comes to land degradation and forestry. A pioneering study on land management, soil conservation, and invasive alien species has been undertaken as part of the CEA process. This survey of over 1,800 households indicates that fallow, residue management and tree planting are widely practiced. Siam weed is a widespread nuisance, affecting about one-fifth of all cropland. Forestry data are being collected through a multidonor effort in collaboration with the government, and this information will make a thorough assessment possible. Existing information indicates that deforestation due to fuelwood gathering is a local problem around Dili but not yet a national issue. However, slash-and-burn agriculture and a rapidly growing population put strong pressure on the forests. Finally, the marine environment is poorly documented, but informal evidence indicates that coral reefs and fisheries are in relatively good shape. Prudent management of these resources represents an important source of future income.

In conclusion, much good work has already been done to enhance the quality of the environment in Timor-Leste. Efforts are under way to improve the data base for environmental management. Meanwhile, several areas of importance call for urgent attention:

- The gaps in environmental legislation and regulations and the very limited human resources available for effective implementation
- The need to address indoor air pollution
- The need to address deficient water-quality and sanitation

In each of these areas, the CEA gives examples of what can be done to effectively and efficiently address the problems.

Sumáriu Ejekutivu

Nasaun nian Análize Ambiental (AAN) ba Timor-Leste identifika prioridades ambiental liuhusi revizaun sistemátika ida konabá asuntus ambientais iha jestaun rekursus naturais no saúde ambiental iha kontestu dezenvolvimentu ekonómiku nasaun nian no instituisaun ambiental. Dadus nebé kuran, sai limitasaun prinsipal atu prezenta análize ida nebé rigorozu liu. Maske nune'e, relatóriu ne'e halo bazeia ba dadus sekundáriu diak nebé iha, prezenta dadus foun konabá kompozisaun riku-soin nasaun nian, no lori resultadu foun konabá be-folin no poluisaun-ar. AAN apela atu fo atensaun urjente ba haketan(gap) iha enkuadramentu jestaun ambiental, kuran kapasidade atu implementa regulamentus balun nebé iha nanis ona, no kustu-bo'ot poluisaun-ar iha uma laran no be qualidade ladiak, ijiene no saneamentu.

Timor-Leste nudar nasaun foun nebé manan hikas fali ninia independénsia iha 2002, no sai husi pasadu ida nebé moruk ho kolonilaizmu no konfliktus violentus. Timor-Leste sei hanesan estadu frájil nebé sei hasoru dezafius wa'in. Indikador Dezenvolvimentu Umanu ba Timor-Leste iha tinan 2006 maka 0.547, no nia ranking 141 husi nasaun 179. Timor-Leste agora ne'e klasifikadu hanesan nasaun ida ho rendimentu médiu ki'ik no rendimentu nasional bruto (GNI) per kapita iha tinan 2007 bo'ot liu \$1,500. Maibé, rendimentu per kapita non-oil ki'ik liu \$400, nebé fo perspetiva ida diak-liu ba padraun-moris nebé Timor-oan barak hasoru. Timor-Leste nia ekonomia maka ekonomia-merkadu, nia ukun ho demokrasia, no haksoin ho rekursus naturais – Ulukwa'in ho óleo no gas. Sistema Jestaun Finansial ida tenki iha ba patrimóniu hirak ne'e atu prevene despezas wa'in husi setor ekonomia sira seluk. Patrimóniu hirak ne'e barakliu husi natureza – ah'hu-ruin klase mundial, florestas virgens no paizajens furak – nebé sei orijinal bele sai baze ba setor turismu nebé buras wa'in. Turismu oras ne'e dadaun sei marjinal hela maibé nia jestaun diak. Buat hirak ne'e sai patrimóniu bo'ot, nebé bele fo servisu (kampu-de-traballu) ba populasaun nebé buras lais presija tebes. Nasoens barak mak hahú ho balansete nebé aat liu ita.

Konstituisaun no mos Governo Timor-Leste agora daudaun ne'e rekoñese tiha ona importánsia protesau ambiental. Maibé, nasaun laiha **enkuadramentu jestaun ambiental** ida nebé kompriansivu hanesan lejislasaun, regulamentus no insituisoens ho rekursus adekuaudu. Lejislasaun ambiental nebé agora iha ne'e legadu ida husi pasadu nebé ladun rekoñese iha Timor-Leste tempu agora. GoTL halo progresu balun hanesan halo esbosu lei-ambiental importante rua (konabá avaliasaun impaktu ambiental no kontrole poluisaun) iha tinan 2006, maibé lei sira ne'e la-hetan aprovasaun. Iha segunda metade 2008 Ministériu Ekonomia no Dezenvolvimentu, nebé responsavel ba área ambiental, desidi atu fila hikas ba asuntu ida ne'e. Ho apóiu husi Banku Bundial, prepara ona esbosu foun ida nebé integra diploma rua no kria sistema ba lisensa-ambiental. Esbosu refere prezenta tia-ona iha Konsellu-de-Ministrus iha Fevereiru tinan 2009. Importante atu tuir-mai kompleta prosesu ida ne'e atu harí baze ba dezafius nebé dezenvolvimentu no investmentus oin-mai sei hatau ba méiu-ambiente.

Enkuantu problemas ambientais agora barak tanba resultadu husi kresimentu ekonómiku nebé ki'ik liu, problemas aban-bainrua nian sei aumenta ba-beibeik sai hanesan problemas atividades ekonómikas avansadas nian. Kapital Umanu ho habilidades iha jestaun ambiental uit'oan tebes, no informasaun nebé la-suficiente halo sira nian knar todan [estraordináriu] tebes. Mukit tebes ba dadus no koñesimentus públikus nebé bele hamoris konsiensialisasaun ambiental.

Nune'e, harí enkuadramentu regulatóriu no legal nebé apropriadu no harí kapasidade ida ke simples maibé adekuaudu ba jestaun ambiental sai hanesan prioridade-da-primeira-instánsia.

AAN foka nia atensaun ba **poluisaun-ar uma laran** nian hanesan prioridade ambiental. Labarik no feto barak mate sedu ka hetan moras tanbá dada-i'is ar-poluídu wain'hira tehin ho ai- sunu. Haré ba estatística konabá moras nebé relasionadu no rendimentu-asosiadu nebé lakon no folin ba tratamentu/konsulta, kustu ekonómiku poluisaun-ar uma laran nian hetan estimativa besik dolares (\$) millaun 13 tinan ida. Ida ne'e konta bá pursentu (+/-) 1.4 husi Timor-Leste nia GNI eh pursentu 3.5 husi produktu doméstiku bruto (GDP) iha tinan 2006. Ida ne'e naha todan bo'ot ida, maibé buat hotu nebé halo tiha ona, sei uit'oan liu, atu resolve problema ne'e. Situasaun ne'e bele hamenus ho kombinasauun sasukat simples balun, inklui hadiak fugaun, hadiak ventilasaun, uza kombustivel nebé moos, no haburas konsiensialisaun konabá saúde no edukasaun básika. Timor-Leste iha rezerva óleo no gas barak, no iha kbi'it ba merkadu (luan liu tan) gas no petróleo-líkidu nian iha áreas urbanas nebé tenki hetan investigasaun. Sasukat hirak ne'e hatudu tiha ona folin baratu iha nasoens sira seluk. Sira presija kolaborasaun entre instituisoens no adaptasaun ba kultura lokal.

Relatóriu ne'e mos hatudu katak **falta bee-mos, saneamentu apropriadu no ijiene** hanesan prioridade ambiental ida. AAN halo estimativa katak ida ne'e obriga kustu ekonómiku dolares (\$) millaun 17 tinan-tinan husi moras no mate sedu. Ida ne'e konta ba pursentu 2 husi GNI Timor-Leste nian eh pursentu 5 husi GDP iha tinan 2006. Bain'hira Governu koko atu rezolve problema ida ne'e, esforsus barak-liu konsentradu ba fornesimentu bee duke tratamentu bee ho saneamentu. Dala ida tan, intervensaun bele sai simples, efetivu, no baratu: edukasaun ijiene nian, fase liman ho sabaun, halo sintina, desinfetasaun bee iha nivel umakain, nsst. Sasukat hirak ne'e hotu hatudu tiha ona kata sira hamenus maka'as teb-tebes insidénsia konabá moras no sei hamenus mortalidade, liu-liu entre labarik sira.

AAN mos haré ba poluisaun-ar iha li'ur no jestaun ba rekursu natural ba rai, floresta, área kostal no mariña. Poluisaun-ar iha li'ur la'os problema bo'ot ida agora ne'e dadaun, maibé bele sai problema bo'ot iha tempu naruk se ekonomia buras lalais, urbanizasaun kontinua, mosu industria bobo'ot no motorizasaun aumenta lalais. Ida ne'e fo émfaze ba nesesidade atu antisipa ho planu territorial no dezvoltamentu nebé diak.

Degradasaun rai no florestas nia dados mak kurang tebes. Estudu pioneiru nebé hala'o ona ba jestaun rai, konsersasaun rai, no atakes husi espésies [insetus] estrañus hatau tiha ona hanesan parte husi prosesu AAN. Peskija ida ne'e halo ba umakain liu 1,800 nebé hatudu katak rai-mamuk, jestaun rai-restu no arborizasaun pratika ona iha fatin barak. Aihoris-fuik [sizánus] sira hasusar iha fati-fatin, sira okupa no afeta (+-)1/5 rai agrikultura nian. Dadaun ne'e doadores oioin servisu hamutuk ho governu halibur hela dados florestrais; resultadu husi dados florestais ne'e sei fo informasaun atu posibilita avaliasaun ida nebé komprensivu no detalladu. Informasoens nebé iha hatudu katak tesi aihoris atu halo ai-sunu sai hanesan problema lokal iha Dili no arredores daeit maibé seidauk sai hanesan problema nasional ida. Maibe, agrikultura ta-ai-sunu-rai no kresimentu populasaun nebé lais sei haka'as no hamohu aihoris [florestas] sira. Finalmente, ambiente tasi (mariña) nia dokumentasaun mak kuran liu, maibe evidénsias informais hatudu katak ah'hu-ruin no ikan sira mais-ou-menus sei iha kondisaun diak. Hala'o jestaun diak ida bá rekursus hirak ne'e sei fo rendimentu iha futuru.

Konkluzan, servisu diak barak tebes mak halo tiha ona atu aumenta kualidade meiu-ambiente iha Timor-Leste. Esforsu sei halo dadaun atu hadiak baze-de-dadus ba jestaun ambiental. Enkuanu ne'e, áreas importantes barak sei hein atu hetan atensaun urjente. Áreas sira ne'e mak hanesan:

- Separasaun [haketan] entre lejislasaun ambiental ho regulamentu no rekursu umanu nebe limitadu atu halo implementasaun efektivu.
- Presiza atu resolve poluisaun ar uma laran.
- Presiza atu hadiak kualidade bee-mos no saneamentu.

Iha áreas sira ne'e ida-idak, AAN fo ezemplu konaba sa'ida mak bele halo atu resolve problemas sira ne'e ho diak (ho efesiencia no efetividade).

Chapter 1: Background and Rationale

Timor-Leste regained independence in May 2002. It has a current population of approximately 1 million.¹ The country consists of the eastern portion of the island of Timor and includes the enclave of Oecussi (also known as Ambeno; 2,500 square kilometers) and the islands of Atauro (144 square kilometers) and Jaco (8 square kilometers). Timor is part of the Malay Archipelago, representing the largest and easternmost of the Lesser Sunda Islands. The area of Timor-Leste is approximately 14,874 square kilometers, or 1,487,000 hectares (larger than Cyprus or Jamaica but smaller than Fiji), with a total length of approximately 265 kilometers and a maximum width of 97 kilometers (Sandlund et al. 2001).

Timor-Leste is a young democracy struggling to build and strengthen the institutions of state. Independence has been restored after 24 years of Indonesian control and three years of U.N. administration, and Timor-Leste has experienced a series of riots and civil unrest that have tested the government. The Human Development Index for Timor-Leste in 2006 was 0.547, with a rank of 141 out of 179 countries (UNDP 2008). Timor-Leste is now classified as a lower middle-income country, with a gross national income (GNI) per capita in 2007 of more than \$1,500 (World Bank 2009b). However, the non-oil per capita income is less than \$400, which gives a better perspective of the living standard facing most Timorese (GoTL 2008).

Agriculture is the main employer of the country, while oil production is the main growth sector. The geographic characteristics of Timor-Leste make it less than ideal for agricultural production: rugged, erosion-prone terrain, poor soils, and varying, often unpredictable rainfall. Nonetheless, the economy is predominantly agricultural, with more than 70 percent of the population living in rural areas (World Bank 2009a). Petroleum production constitutes the largest growth sector in the country. Production in the Bayu Undan petroleum field began in early 2004, dramatically increasing the country's GNI. This income is prudently managed through a Petroleum Fund, discussed further later.

The country has experienced economic hardship since it has regained independence. The gross domestic product (GDP) fell during 2002 and 2003 due in part to a drought that adversely affected crop yields. In 2004, non-petroleum GDP started a slow recovery, reaching a 2.3 percent growth rate in 2005, but real non-oil GDP declined by 5.8 percent in 2006 (World Bank 2007a). With the buildup of the new United Nations mission and higher government spending, non-oil GDP growth rebounded to about 8 percent in 2007. Total economic growth was estimated to have reached 12 percent in 2008 (GoTL 2009). The country now faces the challenge of building on its early progress in the context of very limited human resources, embryonic institutions, and high levels of poverty and unemployment.

The sustainable management of natural resources is a major challenge for Timor-Leste.

With the rural population relying heavily on renewable natural resources for their livelihood and the beginning of hydrocarbon extraction, Timor-Leste's dependence on natural wealth is clear. How effectively and efficiently natural wealth is managed and transformed into financial assets, produced assets, and human capital is a key policy issue.

Against this background, the objectives of the Timor-Leste Country Environmental Analysis (CEA) were to:

- Measure the wealth of Timor-Leste, including nonrenewable natural wealth, renewable natural wealth, produced capital, and intangible (i.e., human, institutional) capital
- Identify and when possible quantify the country's environmental priorities
- Establish the relevant linkages between environmental and natural resource management policies and the development agenda, including specific policy instruments where feasible
- Assess the institutional capacity within the country for sound environmental management
- Provide policy advice and contribute to building capacity on environmental issues linked to growth and development
- Assist the Country Assistance Strategy process

Chapter 2: The Policy and Institutional Context

2.1 Country Context

Timor-Leste was colonized by Portugal in the sixteenth century and invaded by Indonesia in 1975. In the sixteenth century it was known as Portuguese Timor until Portugal's decolonization of the country. In late 1975 Timor-Leste declared its independence, but it was invaded and occupied by Indonesia later that year and became Indonesia's 27th province, known as East Timor.

In 1999 the population voted overwhelmingly for the restoration of independence from Indonesia, but the outcome of the referendum was met with an orchestrated campaign of violence and destruction. More than a thousand people lost their lives, and the country's infrastructure was left in ruins. An estimated 75 percent of the population was displaced and nearly 70 percent of all buildings, homes, schools, etc. were destroyed by a campaign of violence carried out by militia groups. Bridges and power lines were demolished, and the telecommunications system was rendered inoperable. Valuable files, including land and property titles, civil registry, and education records were destroyed. Following the ballot, most Indonesian citizens left the territory, causing a severe shortage of qualified and experienced professionals (World Bank 2005a).

Major steps have been taken to build the nation, but peace and political stability are still major challenges. After three years of United Nations Transitional Administration (UNTAET), elections were held in April 2002. Commander Ray Kala (Xanana) Gusmao won the election to become the first democratically elected president of the country. Soon after, Timor-Leste was recognized as a sovereign nation by the United Nations. In April 2006, the country slid into a complex crisis sparked by the dismissal of nearly half the soldiers in Timor-Leste's army (F-FDTL). The crisis was accompanied by fighting between the army and police, widespread communal violence in Dili, and the displacement of over 100,000 people.² The United Nations took on a renewed executive policing mandate. More than 2,500 foreign troops and police remained in Timor-Leste in 2008, though a decrease in troop numbers was expected in mid-2009. In some posts, control of policing responsibilities has been transferred to the Policia Nacional de Timor-Leste (PNTL), and the U.N. expects that 70 percent of the sites will be managed by the PNTL by mid-2009.

Presidential and parliamentary elections were held in April/May and June 2007, respectively, and were generally judged free and fair. Following a second-round run-off election, José Ramos-Horta became the country's new president. While no single party gained

² As of May 2009, most of the camps had been dismantled and the people resettled.

enough seats to form a government on its own, the president invited a coalition, the Parliamentary Majority Alliance, to establish a government. With former President Gusmao as Prime Minister, the IV Constitutional Government took office on August 8, 2007. Soon after, the program of the new IV Constitutional Government acknowledged that the environment occupied a marginal position in the previous governments and stated that the newly elected government will give a strategic position to the environment in the development plans of the country (Barreto 2008).

Significant progress has been made with demilitarization. The two most pressing risks to national stability, the Petitioners and Alfredo Reinado and his supporters, have been addressed. The Petitioners—a breakaway group of the armed forces—have been financially compensated and largely disbanded, although there is some concern that many grievances have been left unresolved. Alfredo Reinado was killed during an assassination attempt on the president on February 11, 2008, and his armed supporters have either surrendered or been captured. There has been a significant reduction of the number of small arms in circulation in the community. The armed forces have largely absorbed the former resistance fighters. As a result, the F-FDTL retains much of its character from the resistance years, including a decentralized power structure.

2.2 National Wealth³

Timor-Leste total wealth per capita is among the highest in the region. Natural resources can be valued by taking the present value of resource rents over an assumed lifetime and calculating the net present value of such rents using a discount rate—in this case, 4 percent (World Bank 2008a). Using this method, Timor-Leste’s total wealth per capita (\$56,000) is more than three times higher than the average for the region and is comparable to upper middle-income countries like Malaysia. (See Table 2.1 and Annex A for a technical discussion of the estimation of Timor-Leste national wealth.)

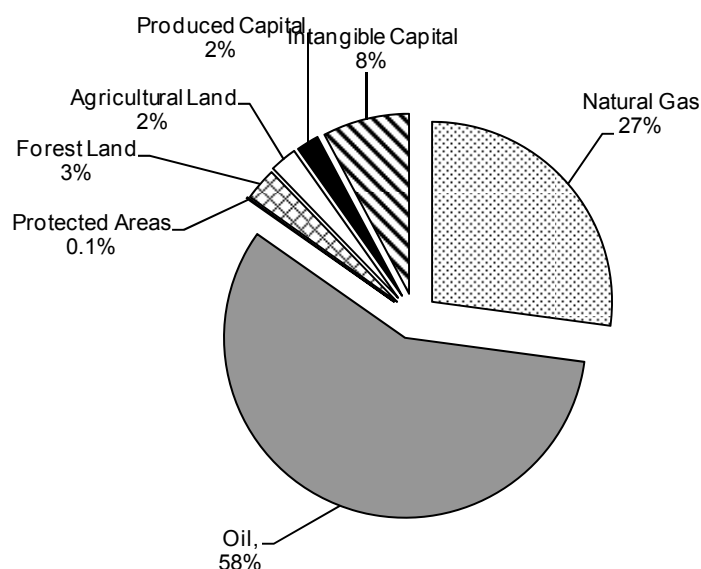
³ This section draws heavily on notes prepared by Giovanni Ruta (Economist, World Bank), which appears in edited form in Annex A.

Table 2.1. Wealth per Capita in Selected East Asian and Pacific Countries, 2005

Assets	Timor-Leste	Indonesia	Malaysia	East Asia and Pacific
	(2000 dollars)			
Produced Capital	1,124	3,125	13,500	4,030
<i>Crop</i>	1,304	2,471	908	2,339
<i>Pasture Land</i>	53	72	26	223
<i>Forest – Timber</i>	1,262	916	491	316
<i>Forest – NTF</i>	356	143	384	109
<i>Protected Areas</i>	66	298	756	226
Non-mineral natural assets	3,040	3,900	2,564	3,214
Intangible capital	4,331	3,940	22,275	6,962
Non-mineral wealth	8,495	10,965	38,339	14,206
Energy and mineral wealth	47,165	2,385	16,987	2,034
Total wealth	55,660	13,350	55,326	16,240

The Timorese wealth is mainly composed of nonrenewable natural resources wealth. The definition of total wealth used in this report includes not only produced capital, but also natural and intangible capital. Timor-Leste wealth is mainly composed by oil and natural gas reserves (85 percent). Forestland and agricultural land correspond to 3 percent and 2 percent of total wealth respectively. (See Figure 2.1.)

Figure 2.1. Total Wealth per Capita in Timor-Leste, 2005 (in 2000 dollars)



The management of nonrenewable natural resources represents a significant challenge for the country. Since most of the wealth consists of natural assets and mainly nonrenewable natural resources, this represents a peculiar challenge for the country economic management. In order to sustain and increase per capita consumption levels over time, it is necessary to have non-declining wealth. From a practical perspective, this calls for natural resource rents to be invested rather than consumed. The Petroleum Fund established in 2005 has this very objective, as it allows oil wealth to be transformed into financial wealth and preserves the value of Timor-Leste's petroleum wealth for future generations. The fund held assets of \$4.8 billion as of March 2009 (BPA 2009).

2.3 Economic Development

The initial years after the violence in 1999 were marked by high rates of growth as the country rebounded from widespread destruction. Following a 35 percent drop in GDP, precipitated by the civil violence, growth recovered to reach 15 percent in 2000 and 17 percent in 2001. Although impressive, these initial growth rates were largely a result of the massive aid flows and large international presence (World Bank 2005a).

GDP growth rate fell to around -6 percent per year in 2002 and 2003, due in part to a drought that adversely affected crop yields. In 2004, non-petroleum GDP started a slow recovery, reaching a 2.3 percent in 2005, but real non-oil GDP declined by 5.8 percent in 2006 (World Bank 2007a). With the buildup of the new United Nations mission and higher government spending, non-oil GDP growth rebounded to about 8 percent in 2007. Inflation spiked to 7.6 percent in the same year, reflecting supply disruptions and higher transport costs. Following improved stability and better government budget performance, it was estimated that real

economic growth reached 12 percent in 2008 and would decrease to 8 percent in 2009 (GoTL 2009). Inflation has risen to an estimated 9 percent mainly due to food prices. This growth rate should be seen in the context of the explosive population growth (3 percent per year), which is among the highest in the world. About half of the population is below the aged of 18 (GoTL 2008).

Poverty is pervasive and has recently increased. The national upper poverty line for Timor-Leste is defined for 2007 as about \$27 per person per month. The national line defining extreme poverty is set to about \$22 per month. Half of the Timorese population lives below the upper poverty line and about one-third are below the lower poverty line. A comparison of the two poverty assessments available (for 2001 and 2007) shows a significant increase in poverty levels over time. (World Bank, MoF, and DNS 2008). Whereas poverty rates are especially high in rural areas, many people in urban areas suffer from unemployment. Unemployment in Dili, where about a quarter of the formal labor force resides, is a particular problem that appears to have exacerbated the intensity of the recent conflicts. Unemployment rates in the rest of the country are much lower, with the national rate estimated at 3.5 percent, reflecting the prevalence of self-employed and subsistence workers. However, it should be noted that more than one-third of the population is registered as outside of the labor force and therefore not counted among the unemployed. (World Bank, MoF, and DNS 2008).

Even though the agriculture sector contributes to only 30 percent of the GDP, it is estimated that it provides subsistence to 80 percent of the population. Households rely heavily on the cultivation of staple crops such as maize, rice, cassava, and sweet potato. Crop yields are well below the average for East Asia, leading to problems of food security in many communities. These low crop yields are devastating for communities during the country's dry seasons.

As described in the previous section, petroleum production constitutes the largest source of growth, yet it is an exhaustible resource that requires cautious management. In light of high oil prices and expanding production, the gross national disposable income in Timor-Leste is expected to grow rapidly. Non-petroleum sectors have unfortunately lagged behind (World Bank 2006).

2.4 National Development Planning

Since the country has regained independence, the government has articulated its vision for the development of the country and, with the help of the donor community, has set about the pursuit of this vision. The National Development Plan (NDP) set out the strategy for the period 2002–07. In August 2007, however, the new government suspended the NDP framework and six National Priorities Working Groups, which became fully operational in June 2008 and started a National Priorities 2009 process. The government's National Priorities 2009 have been grouped into seven areas: agriculture and food security; rural development; human resources development; social protection and social services (including health); security and public safety; clean and effective government; and access to justice. (See Annex E for a more detailed description.) These reflect the government's priorities as approved by the Council of Ministers and reflect detailed work developed by the Working Groups formed for each priority.

The preparation of the Medium-Term Strategic Plan has already commenced. Given the scope of this exercise, it is expected that a strategic framework will be developed by June 2009 and that in July the preliminary sector and national priorities will be defined and presented to the Council of Ministers. After public consultations, this will be presented to the National Parliament for approval in September 2009.

The medium-term strategy will focus on human resources development, rural development, private sector participation, and infrastructure development. The objectives will be to lift the majority of the poor out of poverty, with a particular emphasis on rural development; to develop the private sector through enabling a more conducive business environment, and to develop core infrastructure, including in regard to roads and bridges, ports and airports, dams, irrigation schemes and water supplies, electricity, and telecommunications.

2.5 Environmental Institutions

Environmental Administrative Framework

The State Secretariat for the Environment (SEMA), under the Ministry of Economy and Development, and the Ministry of Agriculture and Fisheries (MAF) are the two government agencies with primary responsibilities for the environment. SEMA deals with the environmental issues in the sectors, and MAF deals with resource management, including forests, fisheries, and biodiversity conservation. The MAF has three Secretaries of State: the Secretary of State of Agriculture and Forestry, the Secretary of State of Fisheries, and the Secretary of State of Livestock. MAF has about 235 staff, with 4–10 staff in each district, but with insufficient qualified personnel.

SEMA has responsibility for environmental monitoring, control, and protection. Its sectors cover a wide range of environmental issues, such as environmental impact assessment (EIA), pollution control, environmental law and enforcement, biodiversity conservation, environmental awareness, environmental databases, environmental laboratories, and international environmental affairs.⁴ Staffing has recently increased significantly, up to a total of 73 staff, with 39 of them based in districts.⁵ However, only three of these staff have a master's degree, and only four are assigned to manage EIAs. There is no adequate infrastructure to perform monitoring activities. There is just one laboratory to conduct very basic water analysis. SEMA is composed of the Chief of Cabinet of the Secretary of State and two Directorates: the National Directorate for Environmental Services (DNMA), with most of the employees, and the National Directorate of Environmental Issues.

Environment is a cross-cutting topic, and therefore other Secretaries of State share responsibilities in this area. The two main secretaries are the Secretary of Natural Resources (SERN) and the State Secretary of Energy Policy (SSEP).

SERN is responsible for mineral and natural resources, including oil and gas, as well as related industries. This department is under the Prime Minister and has a total of 36 employees. Its budget has increased considerably from \$500,000 (FY07) to \$4.5 million (FY08). It plans to

⁴ More information is available in Leitão (2007).

⁵ Augusto Pinto, Director of Environment, personal communication, May 2009.

recruit 5 more staff and to carry out some important assessment studies, including a Timor-Leste pipeline and gas hub option study, a supply base study, and a geological mapping of natural resources (oil, gas, and minerals) (GoTL 2008b).

SSEP is responsible for implementing the 2008 development program that promotes the use of renewable and alternative energy sources throughout the country. It has a total of 17 staff and its 2008 budget amounted to \$3.3 million to undertake the 2008 development program, which includes databases and studies on renewable energy sources; biogas pilot power plants; thermoelectric plants; hydropower plants, including Iralalaro and Ainaro; and communication (e.g., seminars to promote renewable energy) (GoTL 2008b).

The National Directorate for Water and Sanitation (DNSAS, Direccao Nasional Serbisu Aguas e Saneamento) is the agency responsible for most of the water and sanitation sector activity and is under the Ministry of Infrastructure. This agency is responsible for the national management of water resources. It formulates sector policy, manages the distribution of water for human consumption, and monitors water quality through the DNSAS laboratory.

Two other government stakeholders share part of these responsibilities with DNSAS: the DNMA is in charge of water issues related to the agricultural and fishery sectors (i.e., irrigation and aquaculture), and the Ministry of Health sets standards, codes of practice, and enforces legislation.

Land management and forestry are under the current jurisdiction of the MAF. Forestry management is currently handled by National Directorate of Agriculture and Forestry of MAF. However, the Secretary of State of Environment and Reforestation is under the Ministry of Economy and Development. There are only 26 forest guards in the country, and the forestry staff have few resources available. Currently district officers are being instructed, and it is expected that they will be trained by the end of 2009.

Land, water, and coastal zones provide many functions for many users, and therefore there are potential conflicts that require an integrated approach. The GoTL recognizes that an integrated approach to managing these resources is essential (GoTL 2006c), and it will help to allocate resource more optimally while taking advantage of the inter-sectoral measures and synergies. At present, Timor-Leste does not yet have an integrated management system for land, water, and coastal zones.

Even though the Constitution of Timor-Leste has clearly established the importance of protecting the environment, this has not yet been translated into legislation. The Constitution of Timor-Leste enshrines a healthy environment as a constitutional right. Also in the Constitution, the concept of environmental protection includes the idea to “preserve and rationalize natural resources” and the responsibility of the state to promote the sustainable development of the economy. The Constitution prescribes that:

- 1. 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 the future generations.*
- 2. The State shall recognize the need to preserve and rationalize natural resources.*
- 3. The State should promote actions aimed at protecting the environment and safeguarding the sustainable development of the economy.*

Timor-Leste needs to develop the legal framework in many areas including the environment. The country does not have a law that defines the generic legal and institutional framework for the protection of the environment. The environmental laws from the Indonesian period were sought as the framework to follow until a new one is gradually developed and promulgated. This was clear during the UNTAET period, when environmental regulations were promulgated only in the areas where there were legal gaps. However, the Indonesian laws lost their political legitimacy after a legal battle in July 2003 that led to a Supreme Court decision against their application and in favor of the Law of Portugal. Despite subsequent regulatory clarification, supporting the position that the Indonesian legislation and UNTAET regulations are part of the legal system until they are revoked, the legitimacy of the Indonesian laws is still questioned.

During the UNTAET period, only a few regulations were promulgated in the environmental area. As such, without the legitimacy of the previous Indonesian legal framework, Timor-Leste has almost no environmental regulations or dispositions. Moreover, there is some evidence to suggest that environmental protection is considered as a luxury for the newly developing country.

The few regulations in force consist of two Guidelines from the Secretary of State of Tourism (2001) and the Protected Areas Regulation from the UNTAET period (2000). The main objectives of Guideline 1 (Environmental Requirements for Development Proposals) and Guideline 5 (On Prescribed Activities for Pollution) are to define a simplified and incremental process for environmental assessment evaluation and approval and to provide a framework for environmental inspections and license issuing. The actual legal value of the Guidelines is also in question, as the regulations associated with the Guidelines date from the Indonesian period.

In reference to the protected areas regulation 19/2000 from UNTAET, the act has the advantage of being very simple and clear in its objective to protect specific areas or sites, but unfortunately this regulation was not complemented by an appropriate management system for protecting more broadly the different ecosystems of Timor-Leste. As a result, the legislation is limited to creating

⁶ This section draws heavily on a special report commissioned for the CEA; see Barreto (2008) for a more detailed discussion.

only one category of protected areas—Wild Protected Areas.⁷ This regulation allows the application of Indonesia Law No 23/1997 until domestic legislation is completed.⁸

There are two important draft environmental laws, but despite those efforts, the environmental management of Timor-Leste lacks several important elements. The government has made some progress in the development of two important draft laws related to Environmental Impact Assessment and Pollution Control. These were initiated in 2006 but never were approved. In 2008 SEMA returned to the subject with the goal of developing a new draft that would simplify and consolidate the two proposed systems into one environmental license system. The draft was finished in the end of 2008 with the work of a national counterpart (a national lawyer and a SEMA environmental engineer adviser) and an international environmental lawyer supported by the World Bank. The draft decree-law was presented to the Council of Ministers in February 2009. Further work is now being done on the standards for EIAs, after which the draft will once again be presented.

In 2009 SEMA planned to continue the development of the environmental legal framework. The priorities are the development of the National Environmental Policy Law (Lei de Bases do Meio Ambiente) and the completion of the necessary legal package for the implementation of the decree-law for the environmental license system.

Overall, inconsistent language and lack of human technical capacity are important obstacles for the development of the Timor-Leste legal framework. Even though the official languages in the Country are Portuguese and Tetum, the constitution also recognizes Indonesian and English as working languages in public administration. As a result, there are challenges related to translation, legal vocabulary, and interpretation of laws.

There is no specific legislation of the protection of coastal and marine resources. The Protected Areas Regulation of Timor-Leste includes some of the coastal and marine resources in the list of Wild Protected Areas, but it does not adequately protect all the main ecosystems of the country. A great deal of attention has been given to the development of the regulations for fishing sector, but the main problem identified by the study in the fishing sector is the illegal fishing activities that in most cases are related to boats of other nationalities fishing in Timor-Leste waters (Barreto 2008). This could constitute a threat to marine resources, including reefs and coral ecosystems, because of the harmful methods and techniques used for fishing. This type of problem could be more effectively resolved through bilateral agreements between Timor-

⁷ The Wild Protected Areas are: (a) the total land area of Jako Island together with surrounding rocks, reefs, and other surface and sub-surface features; (b) Tutuala Beach together with forest adjacent to the beach; (c) Cristo Rei Beach and the hinterland; (d) the summit of Tata Mailau Mountain, all elevations on Tata Mailau Mountain above 2,000 meters and the surrounding forest; (e) the summit of Sadoria Mountain, all elevations on Sadoria Mountain above 2000 meters and the surrounding forest; (f) the summit of Malobu Mountain, all elevations on Malobu Mountain above 2000 meters and the surrounding forest; (g) the summit of Mount Diatuto and the surrounding forests; (h) the summit of Mount Fantumasin and the surrounding forests; (i) the Riverlet Clere Sanctuary; (j) the Tilomar Reserve; (k) the Lore Reserve; (l) the Monte Mundo Perdido and the surrounding forest; (m) the summit of Monte Matebian and all elevations on Monte Matebian above 2000 metres and the surrounding forest; (n) the Monte Cablaque and the surrounding forest; and (o) the Manucoco Reserve.

⁸ Augusto Pinto, Director of Environment, personal communication, May 2009.

Leste and the home countries of the boats involved in illegal fishing. These bilateral agreements could also include joint patrols in national waters of both countries involved in the problem.

In the water sector, a National Water Policy has been formulated but not yet approved. The GoTL has been working with the Asian Development Bank (ADB) on a National Water Policy that incorporates the key principles of integrated water resource management. According to their assessment, the implementation of the policy requires strengthening the capacity of water resources management, and coordination with DNSAS, MAF, DNMA, and others. The approval of this policy has been delayed, and this had implications for the development of the institutional and legal frameworks.

There is no specific or independent water and sanitation sector regulation of service provision. Currently the activities of the sector are guided by the strategic plan for service delivery developed during the UNTAET period and the standards and code of practices set by the Ministry of Health and the previous Secretary of Environmental Coordination, Territorial Zoning and Physical Development (GoTL 2006e). Donors through the Trust Fund for East-Timor (TFET) and AusAID have assisted policy and planning through preparation of investment strategies, legislation, and guidelines. Although there is no regulation of service, a rural water and sanitation and hygiene sector strategy was developed and signed in 2008 by the Ministries of Health and Infrastructure with support from the Rural Water Supply and Sanitation Program. As dictated by the strategy, separate water and sanitation policies are now under way. Under the plan, they are scheduled to become law by 2010–11.⁹

Timor-Leste has concentrated legislative efforts in the development of regulations for sanitation and water for public consumption. In the sanitation area, one decree of law was approved on Sanitary Surveillance Authorities, and two additional legal acts are in the process of being approved: One is in relation to multi-village water supply systems and the other is on the management of sanitation services, septic tanks, and wastewater treatment systems, with provisions for health and environmental issues. The World Health Organization (WHO) has been working on water standards.

In terms of water consumption, two regulations were promulgated: Decree-Law 04/2004 on Water Supply for Public Consumption and Ministerial Order 1/2004 on Fees and Charges for Water Supply. The Decree-Law is a standard regulation except in the creation of two systems for water supply: one for urban areas managed by the government and another for rural areas managed by the community.¹⁰ The fees policy is an attempt to balance the need to charge user fees for financial and environmental reasons with the reality of the economic situation of the population and their right to have access to water.

There is no specific legislation on air quality. The only environmental legislation related to emissions standards for stationary sources is the Ministerial decree 13/1995 from the Indonesian period.

⁹ Jesse Shapiro, Sanitation Adviser, personal communication, May 2009.

¹⁰ The approach to community water management explicitly recognizes the advantages of using traditional laws in the management of rural water supplies. The role of the Water and Sanitation Service in assisting the communities in dispute resolution can be very important, particularly for disputes outside the community where the traditional structures have less ability to be effective.

Timor-Leste has a very complex situation related to land rights and tenure. This situation is a historical legacy of the successive processes of dispossession and resettlement during Portuguese and Indonesian rule, a lack of official recognition of traditional land rights, and finally the destruction of the existing land records and registries in the last days of Indonesian occupation.

The Timor-Leste Land Reform was done in phases, using a participatory approach, but the most important land laws have not yet been approved. The reform included the formulation of a package of laws based on field research carried out under the Timor-Leste Land Law Program (LLP) and supported by the U.S. Agency for International Development (USAID). The LLP drafted the following laws/decrees that can support new legislation on land tenure in the country: decree law on leasing of state property and on land dispute mediation (already approved by the National Parliament), and acts on property system, land transfer and registration, pre-existing land rights, and title restitution (not yet enacted). The latter are the most important in terms of completing the creation of a legal system of land property in Timor-Leste and solving the uncertainty about land property.¹¹ However, they have been in the approval process since 2005.

MAF drafted the National Forest Policy, but the legislation and regulations to support this policy is still pending. MAF and the NDCF, supported by the Food and Agriculture Organization (FAO) and the Netherland Partnership Programme, drafted the National Forest Policy. This was approved following public hearings involving a broad range of stakeholders. The aim of the National Forest Policy is to provide a framework for the development of an appropriate Forest Law and Regulations. Supporting forest legislation is being formulated. A concept for implementing participatory forestry practices has also been drafted and is under decentralized review (Heino 2006). At present, there are only two regulations, formulated during the UNTAET period, that are in effect: Regulation 2000/17 prohibits logging and Protected Areas Regulation 2000/19 (described previously) defines the majority of the remaining forest cover in Timor-Leste as protected areas.

Timor-Leste has been very active in developing the institutional and legal framework for oil and gas and has created two systems: the Joint Petroleum Development Area (JPDA) and the Timor-Leste Exclusive Area (TLEA) regimes. The JPDA regime is based on the Timor Sea Treaty. It is supported by several legal diplomas that were promulgated in the areas of exploration, drilling, development and production, fiscal regime, and institutional arrangements. In addition to the JDPA, the TLEA has regulatory conditions for oil and gas operations. It has promulgated a law governing petroleum activities and a model production sharing contract, as well as rules for taxation and the dedicated use of petroleum revenues through the creation of a petroleum fund.

The law governing petroleum activities does not have a specific chapter on environmental protection, but it does have a generic set of environmental principles. Despite the clear acknowledgement within the Timor Sea Treaty of the importance of the environmental

¹¹ Public estimates suggest that there approximately 50,000 land titles have been issued since the Portuguese colonial era: about 2,000 by the Portuguese administration and approximately 48,000 during the Indonesian regime (GoTL 2008b).

dimensions of oil and gas production, the subsequent regulations (which include the Interim Petroleum Mining Code and the Petroleum Act), do not address these issues. The approach relies on a “Good Oil Field Practices” concept as a standard or solution for achieving environmental protection, as well as on the best management of the oil and gas resources.

In terms of policy and regulation in the mining sector, the government is now giving attention to the drafting of the regulatory framework for mining operations. The framework, plus building sectoral knowledge and internal capacity, are the emphasized priorities. The initial law for the mineral sector was drafted in 2002, but it did not appear to meet the expectations and needs of the government. As a result, a new law proposal is being drafted. The first draft had a chapter on the environment, but it did not recognize the variability in capacity across the range of small and large mining projects. Some key elements of value in the existing draft include requirements for an ecological and social baseline survey, an EIA, a mine feasibility study, and the establishment of a mine reclamation guarantee trust fund. Clearly, some of these requirements only make sense for big mining projects, and a less rigorous approach would be more appropriate for the smaller projects that are expected to be exploited first in Timor-Leste.

There is no specific environmental legal framework for electricity projects. At the regulatory level the government has successfully promulgated the basis for the national electricity system. The emphasis of the regulation is on the creation of an electricity system that is efficient, integrated, flexible, and economically sustainable. In terms of implementation, important measures did not get beyond the initial recommendations, e.g. the creation of Water and Electricity Regulatory Authority and the drafting of regulations associated with the new policy related with fees and tariffs, as defined in the decree-law 13/2003.

Chapter 3: Priority Environmental Problems

This chapter reviews a selection of environmental issues that have been chosen on the basis of their impacts on human health and ecosystems. Even though these impacts can be translated into economic terms, the lack of reliable data has limited the analysis. The two main sections concern environmental health and natural resources management analysis.

3.1 Environmental Health

This section looks at the environmental health damages related to outdoor air pollution, indoor air pollution, and lack of appropriate water and sanitation services and hygiene. Technical discussions of indoor air pollution and water and sanitation services and hygiene are presented in Annexes 2 and 3.

Outdoor Air Quality

At present, outdoor air pollution is a minor problem. It is mainly limited to Dili, but the situation nevertheless needs attention considering the rapid urban population growth rate that Timor-Leste is experiencing and the potential economic growth of the country. Dili already accounts for 20 percent of the population. The urban population is growing much faster than the rural population. Other secondary urban centers should also grow, but growth in Dili is expected to be faster than average due to high urban fertility as well as migration from the countryside and from other smaller urban centers. If population growth is accompanied by economic growth, it is expected that the number of vehicles will significantly increase in Dili.

The Timor-Leste vehicle fleet is very small and mainly concentrated in Dili. Louis Berger Group and Kmaneck (2005) estimate that the operational vehicle fleet in Timor-Leste in mid-2004 was 22,150 vehicles, which was approximately 24 vehicles per 1,000 people. The number has probably increased significantly since then. The fleet consisted of 11,000 motorcycles, 3,600 private cars and taxis, 1,800 four wheel drive vehicles, 1,800 pickups and vans, 1,750 buses, and 2,200 trucks. Small vehicles dominate the bus fleet (90 percent), with micro and mini-buses having up to 20 seats. More than three-quarters of the vehicles are registered in Dili District.

Emissions of greenhouse gases and other pollutants from road transport are modest, given the small number of motor vehicles in use in Timor-Leste. Growth in the number of road vehicles that is expected to accompany economic and population growth will increase the seriousness of vehicle emissions. At the same time, rising income will allow people to purchase better quality vehicles, to replace old vehicles, and to maintain vehicles in better condition, which will reduce emissions. In reaching the balance between these two opposite forces, the government plays a key role on the enforcement of traffic regulations, including the requirement for regular inspection of vehicles.

Industrial emissions are also limited since the industrial sector represents a small proportion of the economy of Timor-Leste. The industrial sector represents 15 percent of GDP, and it is expected to increase as the economy grows (World Bank 2007b). (Agriculture is 32 percent and services, 54 percent). The minimal production in the minerals and petroleum sectors has kept their environmental impacts small and localized. Shipping, petroleum exploitation and energy exploitation, and energy generation are likely to be the main large-scale source of industrial pollution (GoTL 2006c).

Open burning is also contributing to outdoor air pollution. Open burning of small amounts of waste takes place along the roads of Dili, and this lowers urban air quality. The practice was inherited from the Indonesian occupation, but it still goes on daily all over the country and includes the burning of both organic and inorganic waste. In addition, people in the outskirts of the city have the custom of burning the hillsides in the dry season to produce new vegetation for cattle and farmable area (Leitao 2007).

Air quality is not currently monitored in Timor-Leste, and the country does not have technical capacity to provide monitoring. According to DNMA, this responsibility falls on its Environmental Laboratory. This laboratory possesses a particulate matter (PM₁₀) analyzer, but the equipment is not working properly and there are neither trained people nor the equipment needed to conduct reliable air quality monitoring (Leitao 2007).

Indoor Air Quality

Although outdoor sources often dominate air pollution emissions, indoor sources frequently dominate air pollution exposures. Exposure is a function of both the pollutant concentration in an environment and the person-time spent in the environment. The household combustion of biomass (such as dung, charcoal, wood, or crop residues) or coal is the main factor behind of indoor air pollution (IAP) (Desai et al. 2004).

In Timor-Leste, approximately 98 percent of the households and nearly all rural households use solid fuels for cooking (DHS 2003). (See Table 3.1.) These percentages were lower before the end of the subsidy to kerosene (in place during the Indonesian period) and the increase on the international price of kerosene. Prices went from 5¢ per liter during the Indonesian occupation to 50¢ immediately after they left (UNDP 2004b). The price has increased even more since then.

Table 3.1. Household Fuel Use in Timor-Leste

Fuel Type	Share (%) of Household Use
Electricity	0.3
Gas	0.0
Kerosene	1.3
Charcoal	0.3
Firewood	98.0

Source: DHS, 2003

Cultural factors also contribute to increased air pollution exposure. There is a traditional belief that if mothers and their newborn stay inside an enclosed hut where a pot with slow-

burning fuel creates an atmosphere of smoke and warmth, both will be protected from possible sickness (Leitao 2007).

Solid fuel use (SFU) generates substantial emissions of many health-damaging pollutants, including respirable particulates and carbon monoxide when it is burned in inefficient simple stoves or used in houses without ventilation. Cooking facilities are generally quite simple, using three stones as the foundation (UNDP and GoTL 2008).

The health outcomes that have *strong* association with SFU include acute lower respiratory infections in young children and chronic obstructive pulmonary disease and lung cancer (from exposure to coal smoke) in adult women (more than 30 years old). It is these population groups who suffer the most from indoor air pollution because they spend much more of their time at home and more time cooking than older children and adult males do.

The methodology used by Desai et al. (2004) and international best practice were followed in order to calculate the burden of disease from household SFU for Timor-Leste. (See Annex 2 for a technical discussion of the estimation of the cost.)

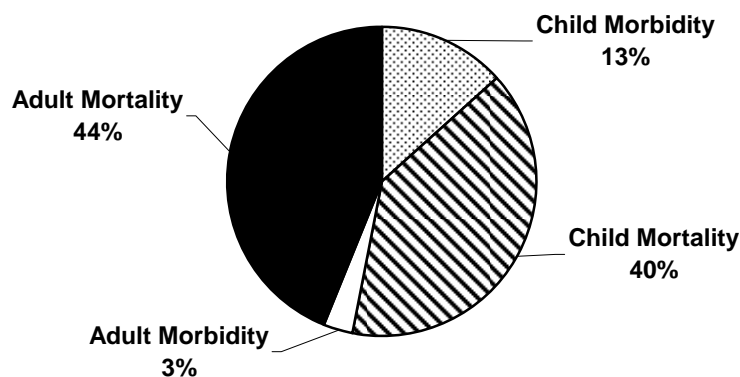
Children bear most of the estimated attributable burden from SFU. (See Figure 3.1.) The burden is about 8,000 disability-adjusted life years (DALYs)¹² lost and some 300 deaths, which respectively represent 5 percent and 4 percent of the national total in 2002.

The annual value of the damage of indoor air pollution is estimated by taking into account both mortality (early death) and morbidity (sickness). There are different methods of estimating this cost in dollars (see Annex 2). In principle, we estimate the cost of lost income due to poor health or early death, and the cost of treatment.

The annual morbidity and mortality cost of health effects from indoor air pollution associated with the use of solid fuel is estimated at some \$12.5 million. The lower bound is \$5 million and the upper bound is \$20 million. The mean estimate is equivalent to about 1.4 percent of Timor-Leste GNI, or 3.5 percent of GDP in 2006.

¹² See Annex 2 for the definition of DALY.

Figure 3.1. Distribution of Mortality and Morbidity Cost of Indoor Air Pollution between Children and Adult Women



Water, Sanitation, and Hygiene

Poor water quality continues to pose a major threat to human health. Diarrheal disease alone amounts to an estimated 4.1 percent of the total DALY global burden of disease and is responsible for 1.8 million deaths every year (WHO 2004). It was estimated that 88 percent of that burden is attributable to unsafe water supply, sanitation, and hygiene, with most of that burden attributed to children in developing countries.

About 58 percent of the Timorese population has access to an improved water source, while only 36 percent have access to adequate sanitation.¹³ According to *World Health Statistics* (WHO 2007), 58 percent of the population of Timor-Leste (77 percent of the urban and 56 percent of the rural population) had access to an improved water source in 2004. Around 36 percent of the population had access to adequate sanitation facilities (66 percent of the urban population and 33 percent of the rural). These values are below the average for the East Asia-Pacific region and closer to those reached by low-income countries.

Urban centers are a priority for the country to respond adequately to rapid urbanization and high urban natural growth rates.¹⁴ Average daily per capita consumption in Dili is

¹³ See Annex 3 for the definition of improved water and adequate sanitation.

¹⁴ The annual rate of natural increase was estimated to be 3.3 percent for the period 2000–05 (the third highest in the world) and urban fertility levels have hardly declined (World Bank 2007d). Population growth, including net migration, was 5.2 percent for the same period. The annual growth rate for 2000–05 was 6.75 percent for urban areas and 4.82 percent for rural areas (UNPD 2006).

estimated at 208 liters, with water losses estimated at 40 percent (JICA/TEC 2001).¹⁵ Currently, less than half of the daily demand for water in Dili is satisfied from the water treatment plant; the rest is supplied by 10 deep wells that provide adequate quality water without treatment other than chlorination (GoTL 2006e).

In Dili, the provision of drinkable water faces many challenges. First, the sector has a high record of households connected to the network informally. This deteriorates the water quality within the distribution system due to low pressures and a lack of adequate water main maintenance, allowing the intrusion of contaminated groundwater and thus increasing the probability for waterborne diseases. Unfortunately, the level of service available to the substantial areas of “informal” urban settlements is not well documented.

The second issue is the lack of proper sanitation. Currently, no sewerage system exists in Timor-Leste (GoTL 2008b). Even though 36 percent of the population has access to toilets or adequate excretal disposal facilities, the waste is generally left untreated. In the absence of proper facilities, many households use drains, rivers, fields, or gardens. This is leading to biological, chemical, and physical pollution of the water, where the shallow wells are often contaminated by nearby domestic sewage treatment systems that in the main have a very low degree of effectiveness. This problem is particularly important in Dili, where half the households rely on shallow wells for their water supply.

Inadequate solid waste management is also contributing to the lack of proper sanitation. Solid waste is collected in Dili by commercial operators, but there is not complete coverage, and much waste is not collected, left lying on the streets, dried up streams, and the sea. Moreover, there are no formal systems for collecting and disposing of waste outside Dili (GoTL 2008b).

The third issue is the impact of agriculture and animal activities. The water is supplied to the city through three rivers on the outskirts. This makes the system very vulnerable to activities such as animal herding, agriculture, or slash-and-burn that take place upstream and influence both the quality of the water and the physical integrity of the treatment system downstream. Moreover, the high levels of sedimentation for erosion and turbidity make the water treatment more costly.

Another problem brought up by the DNMA is the issue of waste oil and its infiltration into the soil and groundwater. A great number of small workshops and also a few larger activities, such as Electricity of Timor-Leste (EDTL), produce waste oil. Most of this oil is going into the city drainage and/or soil, which presents a problem regarding water contamination with heavy metals such as lead, chromium, and cadmium, with naphthalene, with chlorinated hydrocarbons, and with other toxic materials (Leitao 2007). SEMA has initiated a project to collect waste oil from Dili and surrounding districts. Waste oil will start to be collected in 2010.¹⁶

¹⁵ This includes technical and commercial losses and it varies from 25 to 70 percent, depending of the area.

¹⁶ Augusto Pinto, Director of Environment, personal communication, May 2009.

These problems not only increase the cost of water treatment and are obstacles to the provision of clean water to the population, they also have adverse impacts on the biological diversity of local waterways and coastal ecosystems. For example, high concentrations of nutrients from wastewater can damage corals reefs and their internal ecosystems. The environmental contamination reduces productivity and revenues in fisheries, agriculture, and tourism (Green 2006).

In its effort to respond to those issues, Timor-Leste subscribes to the Millennium Development Goals (MDGs). Timor-Leste is committed to reach MDG7, ensure environmental sustainability, and its target 10: reduce by half the proportion of people without sustainable access to safe drinking water. This target involves both the proportion of the population with sustainable access to an improved water source and the proportion with access to improved sanitation.

To measure progress toward these goals, Timor-Leste adopted 2001 as its baseline. While most countries have been able to define their targets, Timor-Leste has recently regained independence and therefore it does not have such historical information. The major disruption suffered by Timor-Leste in 1999 also means that any information on the country's situation in 1990 would probably be meaningless. Hence, the baseline year used in the first MDG Report is 2001. A direct implication for Timor-Leste is the need to adjust the targets according to the shorter time frame allowed to attain the goals (UNDP 2004a). Following this adjustment, the GoTL has shown commitment to achieve target 10 in MDG7.

The agreed targets in the sector require substantial and sustained programs to overcome important challenges recognized by the GoTL. These include low service coverage, rapid population growth, increasing expectations on government and community, and limited human and financial resources (GoTL 2006e). Even though Timor-Leste has improved the access to safe drinking water and sanitation significantly, many people are still left without access to those services. Moreover, those who have access to sanitation are not connected to a sewerage system or to adequate isolation of human excreta.

Timor-Leste is performing better, in relative terms, than other low-income countries. While diarrheal illness is generally not as severe as other water-related illness, it is more common and affects a larger number of people. The statistics show that Timor-Leste is performing better than very-low income countries, such as Sierra Leone. Moreover, it is even doing better than a country like Lao PDR that has the same per capita income level. In absolute terms, however, the death and DALY rates of diarrheal disease are high, and they impose a significant economic cost on the country.

A rough estimate of the health impact of diarrheal illness cases attributable to inadequate water supply, sanitation and hygiene indicates that a cost of approximately \$16.9 million. This central estimate corresponds to 2 percent of the Timor-Leste GNI or 5 percent of GDP in 2006.

This economic cost is limited to health effects; however, other important welfare impacts are associated with lack of adequate water supply, sanitation, and hygiene. A recent study by the World Bank (2007f) analyzes the economic impacts of poor sanitation on health, water,

external environment, tourism, and other welfare measures such as time loss for toilet access. The study was limited to Cambodia, Indonesia, the Philippines, and Vietnam. The estimated total cost was 1.3 percent of GDP in the Philippines and Vietnam, 2.3 percent in Indonesia, and 7.2 percent in Cambodia.

A rough extrapolation from this study indicates that the total cost of poor sanitation in Timor-Leste could be around \$17 million per year. Timor-Leste has a rate of access to improved sanitation below Indonesia's level but much higher than Cambodia's. Timor-Leste has a GDP per capita similar to Vietnam but much lower than Indonesia's. Considering those variables, a rough extrapolation indicates that the total cost of poor sanitation in Timor-Leste could be around 5 percent of GDP, or 2 percent of GNI in 2006.

3.2 *Natural Resources Management*

Most people in Timor-Leste are directly dependent for their livelihood on cultivating the land, using forest products, and, to a lesser extent, harvesting marine life. In addition, marine ecosystems contain an important potential source of protein to combat malnourishment and possibly significant income from nature-based tourism.

This section on natural resources management covers three areas of interest: land management, with a focus on crop production and land degradation; forestry, with a discussion of the main factors behind forest degradation; and coastal zone and marine ecosystems management, with an emphasis on coral reefs and fisheries. Biodiversity is discussed as an integral part of the two latter ecosystems in particular. All areas suffer from a lack of quantitative data.

Land Management

Information on land use and land cover in Timor-Leste is sparse and inconsistent. The most recent aerial photographic survey was conducted by the Royal Australian Air Force in 2001. The Land and Property Unit of the Ministry of Justice is undertaking an analysis of these photographs with the eventual goal of creating a comprehensive land cover database (GoTL 2006c).

There are currently major discrepancies in land cover categories and estimates. The World Bank Country Assistance Strategy (World Bank 2005a:51) reported that “[76] percent of the land area is covered by secondary (mostly scrub) forest and 10 percent by grassland.” However, UNDP (2001), using 1999 satellite images, concluded that 16 percent of Timor-Leste is dense forest; 19 percent is sparse forest, woodland, or mixtures of small fields and secondary forest; and 65 percent contains no forest cover of any sort.

The GoTL (2006c) provides the most recently published land cover estimates. However, because of a lack of comprehensive information they defer to the 2001 MAF assessment that used Indonesian aerial photography from 1993. (See Table 3.3.)

Table 3.3. Areas of Land Use, by Category

Land Use	Area (hectares)	Distribution (percent)
Forest		
Lowland	761,486	51.0
Highland, coastal & other	92,768	6.2
Agricultural land		
Estate crops	74,578	5.0
Food & other	336,400	22.5
Non-productive land	203,152	13.6
Cities, towns villages	19,934	1.3
Lakes	5,080	0.3
Total	1,493,398	100.0

Source: GoTL 2006c.

The Table indicates that more than half of the land is forest, but according to the GoTL study this is in fact grassland, savanna, or secondary forest, which has been increasing since 1993 at the expense of primary forests.

Land suitable for rainfed agriculture is in short supply, and irrigation schemes are inadequate. Some 450,000 hectares of land, about 30 percent of the country, is devoted to agricultural production. (The prevalence of swidden agricultural practices is likely skewing the reported figures on cultivated land downwards; some fallow tracts may not be counted even though they constitute an important component of the swidden cultivation system.)

Approximately 600,000 hectares of land are suitable for crop and livestock production; almost two-thirds of this land cannot support rainfed agriculture (GoTL 2006d). The total irrigated design area covers 41,092 hectares, with a functional area of 21,000 hectares and a total of 19 large and 346 small irrigation schemes scattered throughout the country. Due to the damages inflicted during 1999, almost all schemes needed rehabilitation, but almost 50 percent of the area has already been rehabilitated (World Bank 2004).

Crop productivity is very low in Timor-Leste. There is a significant productivity gap between Timor-Leste and other East Asian countries. The main food crops are rice, maize, and cassava. Coffee, vanilla, candlenut, and coconuts are grown commercially in small quantities. The two staple cereals, maize and rice, both suffer from comparatively low crop yields. The productivity of maize in Timor-Leste is 1.3 ton per hectare, while for Indonesia it is 3.5 tons and for East-Asia it is 5.3 tons per hectare. The productivity of rice (paddy) in Timor-Leste is 1.4 tons per hectare, while for Indonesia it is 4.8 tons and for East-Asia it is 6.2 tons (FAO 2007a).

Land degradation is one of the many factors limiting agricultural productivity. The low productivity is a combination of factors, including constraints on fertile soil and cultivable terrain; poor access to and low application of quality seeds, fertilizer, and pesticides; limited irrigation; lack of farming mechanization; non-existent credit institutions; scarce market access; and inefficient markets (FAO 2007a). Unfortunately, the magnitudes of those effects are not quantifiable due to lack of information.

Post-harvest losses are high. According to FAO, post-harvest loss of rice in Timor-Leste can be as much as 30 percent in some areas, while loss of maize is 30 percent on average (MAF 2008). A large percentage of harvested crops are devoured by rodents because the grain storage

facilities tend to be unsecured. Protective measures like rodent traps are seldom used because they are deemed too costly by many farmers (GoTL 2006d).

Invasive species threaten agriculture. In recent years Siam weed (*Chromolaena odorata*), one of the world's worst tropical weeds, has become a widespread nuisance in Timor-Leste, causing difficulties with plantation establishment and for agriculture generally. The expansion of this weed may be facilitated by the frequent fires, as regrowth occurs rapidly after burning, giving it an advantage over plants that recover more slowly. Additionally, deforestation also favors the weed, which does not do well in shaded forest (Mcfadyen 2003). Although it has not been quantified, the direct and indirect economic losses due to Siam weed are likely to be significant. The only effective control is natural predators such as gall fly (*Cecidochara connexa*), and an experiment with this method was started in Timor-Leste in 2005.

The combination of geological and climate conditions, slash-and-burn agriculture, overgrazing (by goats), and deforestation have contributed to the partial/severe degradation of one-third of the land area of Timor-Leste (World Bank 2005). In addition to decreasing agricultural productivity, high levels of erosion disrupt the hydrological cycle needed to absorb and release water throughout the year. Erosion also yields additional problems through increased sedimentation in lowland areas, estuaries, and reefs. Once deposited in lowland areas, the eroded sediments silt up agricultural fields and damage irrigation systems and water storage facilities. In coral reefs and estuaries the accumulation of sediments can lead to eutrophication, choking aquatic vegetation and disrupting ecosystem functioning (Sandlund et al. 2001).

The geological condition of the country makes it susceptible to land degradation.¹⁷ The island is characterized by a dramatic topography. The Ramelau mountain range stretches across the island from east to west to form a central backbone. Relatively short, steep slopes run down from the Ramelau Mountains to the island's north and south coasts. The mountainous nature of the island decreases the availability of arable land, and the abundance of steep inclines contributes to high levels of erosion. Nearly half of the country is estimated to have a slope of 40 percent or more. The steep slopes, with shallow soils, are very susceptible to erosion. Timor Island is derived from limestone and metamorphosed marine clays. This geologic composition contributes to rather thin, fragile soils with low levels of fertility. The fertility of the soils is further reduced by the rapid decomposition of organic matter induced by the tropical climate (GoTL 2006c).

Climatic conditions contribute to erosion. The country has distinct wet and dry seasons, with a climate that can be broadly characterized as "hot and humid." Timor-Leste's climate is tropical, but drier than that of many of the surrounding islands. A significant characteristic of the precipitation is that it comes in torrential downpours. The hard driven rains cause a high degree of surface runoff, increasing the risk of soil erosion. The northern regions are likely the most

¹⁷ Land degradation is defined here as a process that lowers the productivity of the land, assuming other factors such as technology, management, and weather are held constant. A subset of this is soil degradation, which can manifest itself as water erosion (sheet, rill, gully erosion, mass movements), wind erosion, biological degradation (decrease in humus), physical degradation (increase in bulk density, decrease in permeability), chemical degradation (acidification, toxicity), and excess of salts (salinization, alkalization).

susceptible to erosion because of their longer dry periods and more concentrated rainfalls (Green 2006).

Agricultural practices induce land degradation. High rates of population growth and the high dependence on agriculture have speeded up the conversion of forested land to agricultural use. In Timor-Leste, land degradation stems largely from swidden agricultural practices and the overharvesting of forest products. Swidden (or “slash-and-burn”) agriculture is a widespread agriculture practice (Sandlund et al. 2001). It involves rotating fields in a cycle of cropping and fallowing. It can be a viable system when population is low and fallow periods are sufficient for rejuvenation of vegetation. But the system becomes environmentally problematic in higher density communities, either because agricultural land is not given the time to replenish its nutrients or because forest land is cleared—often through burning.

Even though the level of land degradation cannot be measured accurately in Timor-Leste due to lack of data, it is considered an environmental priority. The high dependence on agriculture makes land degradation an important environmental concern.

Land rights in Timor-Leste are being redefined, but even basic data about land management are hard to come by. Hence, the World Bank organized a new survey in collaboration with the Government’s Statistical Services. The study covered more than 1,800 households and looked at the linkages between their land management decisions and welfare indicators. It focused on both investments in sustainable land management and practices leading to land degradation, such as slash-and-burn deforestation. Annex 4 contains the details of the study.

The main conclusions of this study are:

- Rural households practice sustainable land management practices such as residue management and tree planting to a very high degree. However, slash-and-burn is widely used to clear land, which is inexpensive and provides short-term fertilization but can be very destructive, in particular if fires run amok.
- There are only marginal differences between the poor and non-poor households in terms of land management and investment patterns.
- The predominance of slash-and-burn plot clearing methods is reinforced by the large prevalence of the Siam weed in the plots held by most households. However, this is not an effective means of eradication, and biological methods would need to be implemented to combat this infestation.
- Clearing forests for agricultural use is small in relative terms. There appears to be no significant difference between poor and non-poor households in this regard.
- Firewood is universally used as cooking fuel, though a surprisingly low share of households collect their own wood. Relatively more poor households collect firewood.

Forestry

There is no up-to-date and comprehensive information on the forests of Timor-Leste. Maps for forest cover produced by the Australian Government–funded ALGIS project continue to rely on information collected during the Indonesian period for the 1993 inventory. It is generally believed that the forests have been severely overharvested and degraded in recent times.

However, it is not likely that all the open and poor quality forests are the result of degradation, especially on steep land. Skeletal soils and poor moisture have produced extensive areas of natural savannah formations.

Using remote sensing data, FAO estimated that the country's total forest area fell from 966,000 hectares in 1990 to 798,000 hectares in 2005 (FAO 2005). These estimates suggest that Timor-Leste lost about 17 percent of its total forest area in 15 years. FAO calculated an annual deforestation rate of 1.16 percent during 1990–2000 and 1.31 percent during 2000–2005 (Green 2006).

Forestry has always been important in the economy of Timor-Leste. Very valuable sandalwood has been harvested for centuries and—at other times—honey, beeswax, and timbers such as teak and kayu merah have been significant. According to GoTL (2006c), a very simplified grouping of the main natural forest types of Timor-Leste is as follows:

- **Savannah formations** dominated by *Eucalyptus alba*, where the tree component has value only for fuelwood
- **Open or moderately dense forest** dominated by *Eucalyptus urophylla*, but with several associated species; used for fuelwood and for poles
- **Tropical dry monsoon forest** carrying a mixture of species, some with timber production potential, the most important of which is kayu merah (*Pterocarpus indicus*)

Timber is produced from species of the native trees suren (*Toona sureni*), sandalwood (*Santalum album*), and aina (*Pterocarpus indicus*). Teak is not a native timber tree of Timor-Leste but has been planted for more than a century. During the Indonesian period, some extensive plantations of teak and fast-growing species such as gmelina were established. Suren was only ever available in small quantities but is a keenly sought after furniture timber, with export potential.

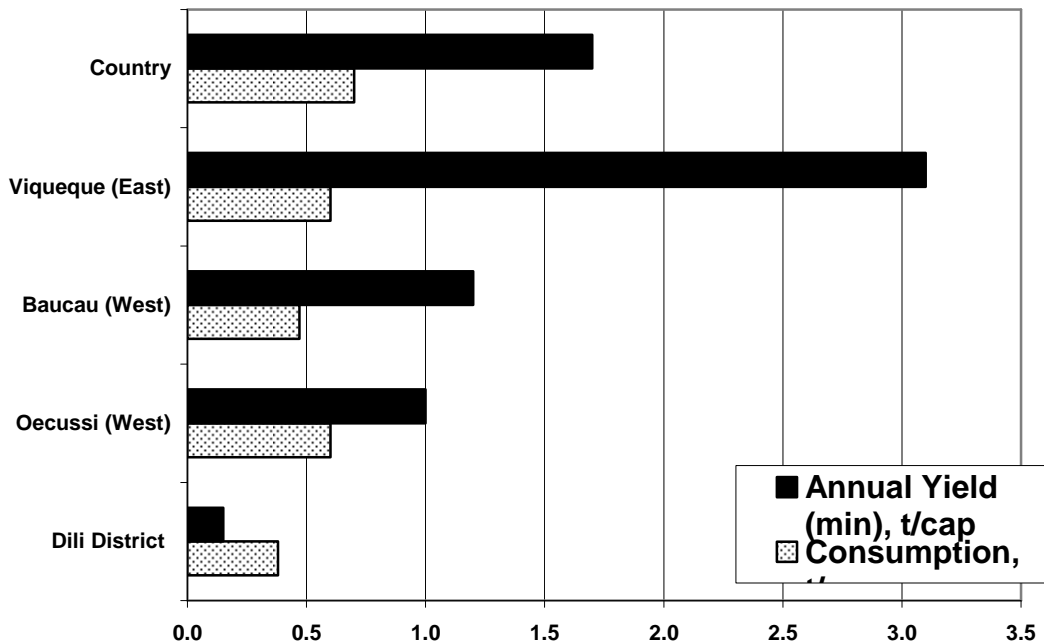
Sandalwood is one of the most valuable of timbers, with a strong overseas market. It is so valuable that control of its harvest is a major problem wherever it occurs. Sandalwood has been harvested from Timor for a millennium. Of all the forest products of Timor-Leste, sandalwood offers the best prospect for profitable commercial activity. Currently, this resource is said to be in a very poor state, but its reestablishment would provide rural employment in the short term and good financial returns in 20–40 years. Sandalwood was found widely distributed in the more favored savannah sites and especially in old gardens and ladang in the other types. Key resources like sandalwood are much reduced, and illegal harvesting remains a problem (GoTL 2006c).

Harvesting of wood for local construction and furniture manufacturing contributes to deforestation, but it also provides important livelihoods. There is high demand for sawn timber for construction purposes and for value-added products such as local furniture manufacture. Excessive logging by Indonesian companies has been blamed for the apparent acceleration of forest loss in the last decades (Bouma and Kobryn 2004). Imports of sawn timber are said to be meeting most of the local demand at the present time. Local resources of suitable timber trees, especially teak and kayu merah, are reported to have been severely overharvested in the past, so that relatively little is currently available. There appears to be little prospect for local timber supplies meeting local demand in the near future. However, the proposed national forest resource assessment will clarify this situation. One potential source of sawlogs in the short term (although of poor quality) is salvage of Albizzia (*Paraserianthes falcataria*) trees in coffee

plantations that have been killed or severely damaged by the rust disease or where coffee plantations are to be rehabilitated (GoTL 2006c).

Fuelwood collection contributes to deforestation but is not a major source of it. Fuelwood use for cooking has increased strongly with the elimination of kerosene subsidies that prevailed during the Indonesian rule (Palmeirim 2007). However, a Household Energy Study commissioned by the World Bank showed that, except for the Dili District, a positive fuelwood supply/demand balance is indicated for most of the country (World Bank 2007c). (See Figure 3.2.) The analysis is supported by findings of a demand survey and by field observations that found that fuelwood is widely and easily available for collection or purchase and that market prices are low and affordable to the lowest income groups. The study also indicated that, except in highly localized cases, overcutting of trees for fuel purposes is not the major cause of deforestation in Timor-Leste. The use of charcoal is not common in Timor-Leste (UNDP and GoTL 2008).

Figure 3.2. Fuelwood Supply/Demand Balance, Selected Districts



Source: World Bank 2007c.

Even though there is a positive fuelwood supply/demand balance for most of the country except Dili, there are other good reasons to curtail fuelwood use. Tremendous amounts of country’s biomass resources are being wasted by inefficient use in traditional cook stoves, population growth will gradually erode the current overall positive supply/demand balance, and overcutting for fuelwood extraction is occurring already around Dili.

Clearing of land for agriculture is a major force behind deforestation. The practice of shifting cultivation puts pressure on forested land, as noted earlier. In addition, the pressures to produce more food for a rapidly increasing population are manifested by the continued growth in

land areas for both arable agriculture and shifting cultivation practices. It has been estimated that each new person would need about 0.24 hectares planted of rice or maize to meet a 2,000 calories a day food requirement (World Bank 2007c). Hence if the population of about 1 million increases with about 3 percent per year, this implies an increased demand for more than 7,000 hectares of land just for rice cultivation each year.

Deforestation has significant consequences for the environment since the forest is important for protecting watersheds, reducing flood peaks, stabilizing soil cover, and preserving biodiversity. Deforestation threatens the flora and fauna of cleared land (through species destruction or habitat destruction and fragmentation). All the threatened bird species of the territory are forest-dependent (Trainor et al. 2007), and this is likely to be the case for most other plants and animals. Deforestation also leads to increased erosion by decreasing the amount of vegetation that anchors the soil. The country's steep terrain and monsoonal rains makes the need for protective vegetation even more crucial. Without sufficient vegetative cover, soil nutrients are washed away, soil fertility is reduced, and landslides and flashfloods become more frequent and devastating. Upstream forests and land naturally regulate the hydrological cycle, releasing water to aquifers and rivers over a period of time, thereby reducing floods and providing water in dry season. Destruction of forests and the related land degradation damages the hydrological cycle, leading to an increased frequency and severity of floods and droughts.

Deforestation provides short-run income but is not sustainable in the long run. The forest is also an important source on non-timber products such as fuelwood, medicinal plants, honey, rattan, bamboo, animals for meat, and spiritual values (GoTL 2006d). The preparation, distribution, and marketing of fuelwood is a highly important source of employment, especially in rural areas (World Bank 2007c). Without clear and enforced property rights, these assets are open access property sources of income that will be harvested without regard to sustainability.

A rust epidemic of the albizia coffee shade trees is expected to result in a significant reduction in coffee yield. Albizia currently shades 53,000 of the total 55,000 hectares of coffee grown in Timor-Leste, but unfortunately the infestation incidence is estimated at 95 percent (USDA 2006). The three districts most affected are Ermera, Liquica, and Manufahi. Coffee is the primary non-petroleum export, and approximately 28 percent of households earn some income from coffee. Part of the harvest is certified organic and marketed through fair-trade channels, capturing prices on the high end of the coffee market (World Bank 2008). Since the use of fungicides will make Timor-Leste lose its market niche as an organic product, Old (2002) and the U.S. Department of Agriculture (USDA 2006) recommend the establishment of a formal national coffee rejuvenation program that replace dead and diseased albizia coffee shade trees. Currently, the Cooperativa Cafe Timor's USAID funding supports a tree nursery program to provide replacement shade tree seedlings to coffee farmers.

Coastal and Marine Management

The majority of the people live on or near the coast, and all significant urban areas are located in the coastal zone. Timor-Leste has a coastline approximately 700 kilometers in length,

and a potential exclusive economic zone¹⁸ of approximately 75,000 square kilometers, although the precise boundaries of this zone have not yet been determined (GoTL 2006d).

There is high diversity along the coastal zone of Timor-Leste. It includes marine, inter-tidal, and shorelines areas that contain a vast diversity of interconnected ecosystems, including coral reefs, deep-sea bottoms, mangrove forests, beaches, and river estuaries. The interconnectedness of these systems is demonstrated by the essential roles played by mangroves and reefs in the life and feeding cycles of most marine fish species (GoTL 2006c). The habitats vary along the coastline because of the local influences of seasonal rainfall, local geology and topography, river discharges, and regional offshore oceanographic features, as well as the impact of human occupation. This results in spatial difference in marine habitats, with the north coast being different from the south coast and with the eastern edge of the island having attributes that differ from those to the west (GoTL 2006d).

Timor-Leste is one of the Coral Reef Triangle countries, along with Indonesia, Malaysia, Papua New Guinea, the Philippines, and Solomon Islands. The Coral Triangle is a marine biodiversity hotspot of global significance. It contains 75 percent of all coral species known to science, over 3,000 species of reef fish, and the largest tuna fisheries in the world (WWF 2008).

Coastal marine resources are poorly documented in Timor-Leste.¹⁹ Data from the Indonesian period are highly aggregated, and there are legitimate concerns as to their accuracy (Stockwell 2003). The National Department of Fisheries and Aquaculture, in charge of the management, monitoring, and control of marine resources, lacks reliable and up-to-date information on the distribution and abundance of the major species and on the various marine habitats throughout the country. Some estimates of the nature and size of the offshore resource will be made with ongoing AusAID assistance.

The coastal and marine resources represent a significant source of economic value. The marine resources are valuable for their contribution to national food sources (mostly subsistence use), as a potential income generation activity, and as a potential basis for tourism. Commercial species such as snappers and groupers are in the near shore of Timor-Leste, and mackerel and tuna are in the offshore, along with other pelagic and midwater species. During the Indonesian rule, there was an influx of better-equipped fisherfolk from other parts of the archipelago, and fishing pressure extended further offshore than previously. The limited data available on fishing activities prior to 1999 indicate that some 630 vessels with outboard motors and 11,387 canoes were active in fishing. Control over operations was rather loose, and on occasion destructive methods such as explosives and poisons were used, resulting in damage to the marine habitat in some regions (GoTL 2006d).

¹⁸ Under the United Nations Convention on Law of the Sea, the exclusive economic zone (EEZ) is covered by Articles 56, 58, and 59. The EEZ is defined as that portion of the seas and oceans extending up to 200 nautical miles in which coastal states have the right to explore and exploit natural resources as well as to exercise jurisdiction over marine science research and environmental protection. Freedom of navigation and overflight, laying of submarine cables and pipelines, and other uses consented to on the high seas are still allowed.

¹⁹ However, several surveys are under way through MAF, with support from JICA. These will cover both artisanal and commercial fisheries (interviews with MAF spokespersons, World Bank mission, February 2008).

Following the withdrawal of Indonesia, fishing activity fell dramatically, both as a result of a number of Indonesian fishers leaving the country and from the serious damage inflicted on fishing boats, gear, and infrastructure. Fisheries contribute approximately 1 percent of Timor-Leste's GDP. Replacement of vessels and gear and rehabilitation of infrastructure have been a major focus in recent years, and catch levels have increased, especially in areas close to urban centers. Subsistence fishing has largely recovered since the Indonesian withdrawal and continues to be focused on local requirements as an important element of food security. Commercial fisheries appear not to have recovered, and legally registered activity is quite limited.²⁰ The Fisheries Management Capacity Building Project financed by AusAID is undertaking a preliminary survey of the country's fish resources, which was expected to be released by mid-2008.

The available information suggests that coastal and marine resources are in good condition and internationally competitive. The scarce data suggest that the coastal zone resources are largely unspoiled compared with other countries in the region (GoTL 2006c).²¹ Nature-based tourism is seen as having great potential for growth and employment generation. A national tourism policy is under development, but tourism statistics are not available. Informal estimates by staff dealing with tourism in the ministry put the number of annual tourism arrivals in the area of 1,500. International marketing is being improved, but no major infrastructure is expected to be constructed in the coming years to respond for the growing demand. If the security situation improves, tourism could be a major potential market, particularly given the proximity to Australia (only 500 kilometers away). The GoTL has been supporting the development of the sector, and the country is a member of the World Tourism Organization. Since the tourism industry is in its very early stage, the environmental impact of the sector is minimal.

The country's coral reefs are in good condition. Shallow inshore reef flats are used extensively by women and children in the coastal communities of Timor-Leste for harvesting small fish and invertebrates. These activities involve walking out during low tides and also using intertidal traps. According to GoTL (2006c), resources are being harvested within their capacity. There is not enough data to quantify overfishing in reefs, particularly in the Dili area. There is physical evidence of explosive fishing having occurred in a number of reefs, and this evidence is also supported by local fishers and people in the coastal communities. However, it appears that these destructive activities have been reduced since the Indonesian period (Stockwell 2002). With respect to sedimentation, it is not very clear what effects the sediments entering the marine environment are having on coral reefs. Large volumes of sediments are transported to coastal areas by rivers during the rainy season, and it is clear that this periodically prevents the marine tourism industry from operating.

Several mangroves areas were damaged in the past. In particular, the stand at Tibar, just West of Dili, was severely damaged during Indonesian times when aquaculture ponds were constructed in the intertidal zone. These ponds are currently lying dormant and would require

²⁰ Timor-Leste lacks resources to monitor any illegal commercial fisheries. However, the four commercially licensed trawlers that operate in its waters have on-board dedicated staff to monitor catches (personal information from MAF spokesperson, interview with World Bank mission, February 2008). Anecdotal evidence indicates that there are illegal fishing activities.

²¹ Data are lacking on any pollution from oil and gas fields and from international shipping.

substantial renovation. A minor amount of mangrove cutting took place on the inner margin of most of the mangrove stands during the Indonesian period.

The impact of small-scale cutting of mangroves by family groups in the north coast of Timor-Leste was found to be substantial. Alongi and Carvalho (2008) found that approximately one year after the start of the harvesting, the forest experienced a 30–50 percent decline in live stems and a 46–86 percent loss of above-ground biomass, with more canopy gaps between dense, smaller trees. Soil chemistry has also deteriorated to a condition where mangrove regrowth is slow and establishment difficult.

Illegally harvested wood from the mangrove forests around Metinaro is sold for firewood and building material. There are informal reports of substantial illegal cutting, for example near Metinaro (Haburas Foundation 2008). This is one of the few economic activities available to the marginalized communities in the area, but it represents a serious threat to fish stocks and livelihoods in the long run.

The coastal community survey reported that there is a relatively high level of awareness in coastal communities regarding the ecological importance of mangrove habitat. Unfortunately, many of the mangroves are used as dump grounds for solid waste, particularly in the areas adjacent to the coastal highways. Although they are not a threat to the health of the mangrove, there are potential pollution issues in the long run (Stockwell 2002).

3.3 Climate Change

Currently, there is little information and analysis on the likely impacts of climate change in Timor-Leste. Flooding is already a significant problem and may be aggravated by climate change. In the longer term, the greatest threat to the coastal zone may come from climate change (GoTL 2006c). Coral reefs are very sensitive to changes in water temperature and chemical composition.

Barnett et al. (2007) found that Timor-Leste is vulnerable to climate change and that its climate may become hotter and drier in the dry season and increasingly variable. They considered three natural resources—water, soil, and the coastal zone—and found all to be susceptible to changes in climate and sea level. These changes could have consequences in agriculture production and food security; if sea level rises, it is likely to damage coastal areas, including Dili.

Timor-Leste is a minor emitter of greenhouse gases, and therefore mitigation is not currently an important issue in the country but adaptation will be. Timor-Leste emits 0.2 tons of carbon dioxide per capita (World Bank 2007b). This value for 2005 has not changed since 2000, which is the earliest information available. Carbon dioxide emissions are low compared with Indonesia (1.4 tons) but at the same level as Lao PDR.

Timor-Leste is in the process of building capacity and increasing its technical and financial support for adaptation and transfer of technology. The National Adaptation Plan of Action and an Initial National Communication plan are the starting points for shaping this process.

The GoTL has recently joined the Rio Conventions. In January 2007, Timor-Leste has acceded to all three Rio Conventions: the United Nations Convention to Combat Desertification (UNCCD), United Nations Framework Convention on Climate Change (UNFCCC), and the United Nations Convention on Biodiversity (UNCBD) (GoTL 2008b). Timor-Leste obtained access to the Clean Development Mechanism fund for adaptation, mitigation, and technology transfer projects after the National Parliament ratified the Kyoto Protocol.

Timor-Leste has already completed the National Capacity Self Assessment (NCSA). As a result of its accession to the UNCCD, Timor-Leste completed the NCSA project in November 2005 (GEF et al. 2007). The NCSA is a development action plan for global environmental management that examines the country's capacity and identifies barriers in the implementation of multilateral environmental agreements.²² The assessment included an inception report, stocktaking, thematic capacity assessment, cross-cutting capacity assessment, and a capacity action plan.

Insufficient legislation, ineffective implementation of existing legislations and policies, lack of coordination among institutions, and lack of human capacity were the main constraints identified. The assessment found that some aspects of the Rio conventions are covered in sectoral policies and regulation, but they have not directly addressed the issues of biodiversity, climate change, or land degradation. Implementation of existing legislation was also found to be ineffective due to lack of public awareness and political will to finance awareness programs. Another challenge identified was the lack of coordination among institutions. Responsibilities for the implementation of the Rio conventions are currently shared among different government agencies, and this could generate conflicts of interest. The assessment also found that lack of enough skilled human resources is one of the most significant capacity gaps in the country.

The NCSA identified six cross-cutting capacity areas as priorities: capacity to prepare national reports for the respective convention secretariats; capacity to develop policy and legal frameworks to enable effective implementation of the UNCBD, UNFCCC, and UNCCD; capacity to access national and international financial resources to implement programs and projects under each convention; capacity to plan and implement public awareness programs; capacity to conduct research and monitoring; and capacity to obtain and share information and adopt new and clean technology.

The NCSA action plan consists of six project concepts with the identified implementing agency. The projects are to develop and review national environment education curriculum to

²² The capacity needs identified were as follows: to develop the National Action Programs (NAPs) for Climate Change and Land Degradation; to develop the National Biodiversity Strategy and Action Plan, an obligation under the UNCBD; to establish an effective administrative mechanism to oversee and coordinate implementation of the obligations under the conventions, including the NAPs (reporting, accountability, coordination, performance targets); to establish a harmonious legal and policy framework to achieve the objectives of conservation, adaptation, mitigation, and sustainable utilization of natural resources; to incorporate the NAPs into corporate plans and work programs of government agencies; to establish a comprehensive yet integrated public awareness program to create awareness at all levels of the community and within schools; and to establish an effective and coordinated structure for the collection and distribution of financial resources available under the conventions.

incorporate environmental issues and the Rio conventions;²³ to strengthen the National Public Awareness Programme;²⁴ to organize an annual international conference on environmental issues, management, and policies in Timor-Leste;²⁵ to gain access to financing and financial and project management training; to build capacity for research, monitoring, and evaluation in order to establish an institutional structure and plan to deliver training and skills upgrading for officers in various related agencies, so that they can draft project proposals, oversee the implementation of projects, and effectively manage the budget and financing of the proposal; and to develop and strengthen capacity for conducting research, monitoring, and evaluation across the three conventions.

²³ The Ministry of Education, Directorate for National Curriculum will be the lead agency. The Directorate will seek the assistance and collaboration of the National Directorate for Environmental Services (NDES), Ministry of the Interior/National Disaster Management Office, nongovernmental organizations (NGOs), Ministry of Development/Industry Unit, Convention National Focal Points, United Nations Development Programme (UNDP), and the Capacity Development Coordination Unit.

²⁴ The NDES Public Awareness Unit will lead the Working Group, which will include officers from MAFF, MI/NDMO, CDCU, MPW, UNDP, and NGOs.

²⁵ The lead agency is the National University of Timor-Leste, with secretariat support from NDES Multilateral Environmental Agreement Secretariat. The key agencies will be NDES, MFAC, Tourism, UNDP, and NGOs, with support and contribution from line Ministries such as MAFF and MI/NDMO.

Chapter 4: Operational Responses

The previous chapters have described the environmental situation in Timor-Leste. This chapter briefly reviews the responses to those problems thus far. It also identifies several areas that have been neglected.

In terms of environmental management, the country lacks a comprehensive approach. The current approach does not include several important elements: an environmental policy and associated institutional framework law; environmental management plans and standards; a comprehensive protected areas system and endangered species laws; systems for environmental information and reporting, and a plan for environmental education. The environmental impact assessment and environmental licenses regulation are draft laws not yet approved. The forest management policy was approved, but the legislation and regulations to support it are still pending.

The government of Timor-Leste and its constitution recognize the importance of environmental protection. However, many of the regulations promulgated and the proposals in process to date (with the exception of land tenure regulation) have been inspired by other jurisdictions and require a critical analysis of their applicability to Timor-Leste. Hence, the country needs to quickly develop basic environmental legislation that has full legitimacy and is adapted to its specific needs and constraints. In a country that already imposes severe restrictions on private investments, it is also important that new regulations do not present an unnecessary obstacle to economic development. Importantly, the 2008–2012 Development Program of the IV Constitutional Government of Democratic Republic of Timor-Leste includes specifically the development of an environmental policy and the elaboration and consolidation of the environmental legislation.

The lack of human resources and data in the country are important impediments. There is a severe lack of databases and public records that can promote environmental awareness. The 2008–2012 plan includes a program for the provision of adequate information on environment and campaigns and programs of environmental education, inside and outside the educational system (GoTL 2008b). The approach to address the lack of human capital capacity has been to invest in one-on-one mentoring and skills transfer programs. This was an important start, but it proved to have limitations both in terms of coverage of the adequate numbers of civil service staff and cost-effectiveness of program delivery. In terms of environmental information and databases, there are development plans but no significant concrete progress has been made on this front.

The United Nations Development Programme (UNDP) provides laudable support for capacity building for environmental management. From 2006/2007 national budget point offices in 13 districts have been rehabilitated and they have had the opportunity to take courses overseas on environmental management and technical capabilities. DNMA is seeking

international funding to train staff in specific areas such as water and air quality testing, environment and biodiversity monitoring, etc. Even though those have been important steps, much more needs to be done in collaboration with the donor community.

With respect to human and financial resources, the government of Timor-Leste has made important progress in this area. It has increased significantly the budget for the State Secretariat for the Environment in 2008, allocating \$2.2 million²⁶ to implement its 2008 programs, and it aims to recruit 82 national staff for SEMA in order to implement its plan. The major components of the program are: improved management; regulation and environmental law; environmental education awareness; evaluation, monitoring, investigation, and permitting of environmental pollution license; reduced environmental impact; protection and conservation of biodiversity and natural resources; enhanced participation in multilateral environmental agreements program; knowledge and quantification of environmental data; data analysis and sampling of environmental pollution in Timor-Leste; and regional and districts focal point for environmental conservation and monitoring (GoTL 2008b).

This report draws attention to indoor air pollution as an environmental priority. Its economic cost is estimated to be approximately 1.4 percent of the Timor-Leste GNI, or 3.5 percent of GDP in 2006. Even though this is a significant burden, very little has been done to address it. Several local NGOs have been developing and promoting various types of improved stoves since 2001. NGOs such as the Haburas Foundation, the ETADEP Foundation, and the Permatil Foundation, with funding from external donors, have implemented improved stove projects. They mainly produce portable clay stoves for fuelwood and agricultural residues. Some small commercial stove producers are operating in Dili and sell portable ceramic stoves with a metal cladding for \$5–12, depending on size. They have had little formal training and few tools, and the efficiency of the stoves is unknown. The impression is that these efforts lack critical mass; only a few hundred improved stoves at the most have been disseminated so far, and there is little documentation on the effectiveness of the stoves or the programs. It is by no means an easy task. The two biggest barriers in Timor-Leste are the still relative abundance of fuelwood supplies at low prices (compared with relatively expensive alternative sources such as kerosene), and the absence of a culture of purchasing household stoves (World Bank 2007c).

The substitution away from fuelwood toward alternative fuels is still in a very early stage. Access to electricity is very low in Timor-Leste. Electricity supply in rural areas consists of 58 isolated grids, powered by diesel generators, of which only some are still operational (UNDP and GoTL 2008). The World Bank has concentrated funds in two projects to improve the supply of electricity, mainly in Dili. The Energy Service Delivery Project (International Development Association grant of \$2.5 million) will finance the repair of the Comoro power station and the rehabilitation of the power distribution system in Dili. It includes a technical assistance component for the policy strengthening of the power sector. The second one, the Power Sector Priority Investments Project, seeks to improve the capacity and efficiency of the generation, and distribution of Timor-Leste Electricity.

²⁶ According to the Budget Execution Report up to Second Quarter 2008 produced by the Ministry of Finance of Timor-Leste, the aggregate budget for the Office of the Secretary of State for Environment, the National Directorate of Environment Services, and the National Directorate of International Environmental Affairs was \$585,000 at June 2008.

In order to contribute to the knowledge of the energy sector of Timor-Leste, the World Bank has recently completed two analytical pieces: *Options for Renewable Energy Technologies* (Clouston 2006) and *Timor-Leste Issues and Options in the Household Energy Sector* (World Bank 2007c). The latter is a scoping study that analyzes the fuelwood supply-demand patterns in the country and underlines the need to address indoor air pollution also from a natural resources management perspective. However, there has not been any follow-up of this study. The former study concludes that “the potential exists to produce a significant energy supply in forms useful to most of the Timorese population at an affordable cost” (Clouston 2006:1). It contains a detailed review of options, including biogas, biomass briquettes, coconut oil as substitute for diesel, solar power, biodiesel, and the introduction of better stoves. The study focuses on small to medium-scale energy production, with some discussion of more-intensive systems, energy conservation, and efficiency. Clouston (2006) shows that these technologies are often suitable to be built and managed by the local consumers at a very low cost, but he points out that the success of any program to introduce renewable energy will depend on the ability to train qualified local technicians and to enable them and educational institutions to train more people.

Renewable energy is a priority in the 2008–2012 Development Plan. A renewable energy assessment for preparation and formulation of energy policy was undertaken by SSEP in January 2008, and a proposal for renewable energy development in rural areas is being formulated. SSEP has been undertaking an integrated rural energy development program in various places since 2005, covering projects of solar power, biogas, mini hydropower, and cooking stoves (GoTL 2008b). The 2008 SSEP Development Program covers research, maps, and databases on reserves and on potential and renewable energy sources; the establishment of pilot biogas project plants; reform of EDTL and reduction of imported fuel dependency; construction and monitoring of the hydro-power plants in Iralalaro and Ainaro; and promotion of renewable and alternative energy. A special plan for energy development in rural areas has recently been developed by UNDP and the Government of Timor-Leste (UNDP and GoTL 2008). It features an ambitious program for energy efficiency and renewable energy development.

Hydropower seems to be a sector that may in some cases come into direct competition with other water-users. The Iralalaro Hydropower project in the eastern tip of the island is predicted to supply electricity by means of water use from the Iralalaro Lake. The international bidding process for this project has already begun. To add to this particular project, other projects, like hydroelectric schemes with mini-hydros in bigger catchments areas that also supply irrigation schemes, are under study (Leitao 2007).

This report also points out the lack of appropriate sanitation as an environmental priority. The GoTL attaches a very high priority to achieve sustained progress towards the NDP targets (and MDGs) through a significant but still insufficient program. That includes urban and rural water supply and sanitation (WSS) projects, policy, planning, and administration projects and community awareness programs. The expenditure for the period 1999–2005 totaled \$79.1 million, with 85 percent of the funding coming from donors, mainly Japan (38 percent), Australia (18 percent), and TFET (14 percent). The allocation of the expenditure was mainly for urban water services (58.3 percent), with only 1.3 percent for urban sanitation. Rural WSS captured 32.4 percent of the expenditure, and 7.8 percent was assigned to policy, planning, and administration. The GoTL increased the overall level of spending to a third higher from the

period FY05/06 to FY09/10. It also significantly shifted the allocation toward urban water, sanitation, and drainage.

The percentage of people who have access to safe drinking water has not yet reached the level targeted by the MDG, but many donors, the UNDP, and the ADB has been actively participating in the sector, mainly in urban areas. Current projects include the Urban Water Supply and Sanitation Project (\$6.5 million) and the Dili Water Supply Performance Improvement (technical assistance \$1 million), which will support the improvement of performance of DNSAS in managing and operating its Dili city water supply services. The ADB also has completed the Integrated Water Resources Management Project (\$600,000) and a technical assistance to create the National Water Policy. Other key donors investing in the sector are Japan, AusAID, CARE Canada, UNICEF, and Portugal.²⁷ The World Bank does not have any specific project in the WSS sector.

The CEA also looks at outdoor air pollution and at natural resource management comprising land, forestry and coastal and marine resources. These areas are very important for the sustainable development of Timor-Leste, and the lack of adequate legal and regulatory framework places them under risk.

Land management is a very important factor for sustainable development in an agricultural country such as Timor-Leste. The Timor-Leste Land Reform was done in phases, and it includes a package of laws based on field research. However, the most important land laws are not yet approved. UNDP has made some efforts in this area, with two projects on land management: one ongoing on capacity building for sustainable land management that is investing \$400,000 in Timor-Leste (Mainstreaming and Capacity Building of Sustainable Land Management in Timor-Leste) and the other a small one on land degradation in Timor-Leste (\$24,000). USAID, building in its past Land Law Program, started in October 2007 a new project to strengthening property rights in Timor-Leste (\$10 million). The project is implemented by ARD, and it includes an awareness component, an activity to support the Land Policy Laws and the implementation of regulations, and a component to support a National Land Commission, a Land Administration, and a Dispute Resolution system. After one year of being effective, they have hired staff, commenced pilot activities in two areas (Liquica and Manatuto), and started collecting data to demark all areas/parcels in the country. They have also facilitated the promulgation of a Ministerial Regulation on the Cadastre and have been behind a policy

²⁷ The projects funded by Japan are Improve Water Supply in Same and Ainaro (\$5.3 million) and Improve Water Supply in Ermira/Gleno & Maubess (\$2 million). AusAID funded the Rural Water Supply and Sanitation Project that helped re-establish the community-based water supply and sanitation systems in rural districts and the provision of technical experts (www.ausaid.gov.au). UNICEF is supporting the Rural Water for Households & School (in five districts) (\$1.2 million), and it has supported the major water supply projects for district town water supply system in Dili (2000–04) and in Liquica, Manatuto, and Lospalos (2002–03), for irrigation such as the rehabilitation of Laclo Irrigation Scheme (2002–03), and for rural WSS services in Aileu and Baucau (2001–03). Portugal is funding four small projects in the sector (total \$1.5 million): update urban drainage master plan, Oeccusi District Water and Sanitation Improvement, Technical Training for DNSAS staff, and Atauro Family Sanitation (1,000 household toilets). CARE Canada has also been involved in the sector; during 2001–04 is has implemented a project focused on poor rural areas covering almost 24,000 people (www.care.ca).

statement for the development of a Transitional Land Law that has been distributed to the Council of Ministers.²⁸

Lack of data is still the main barrier to understanding the magnitude of the cost of land degradation in Timor-Leste. A first attempt to analyze land management in the Comoro and Laçlo watershed was undertaken with funds from the Japan International Cooperation Agency (JICA) (2008). However, a more comprehensive national study is needed.

The World Bank has been involved in the rural sector, and it has completed two projects on agriculture rehabilitation, with the third currently on implementation. The Third Agriculture Rehabilitation Project (\$11.4 million) has a component to strengthen the capacity of MAF to continue developing key national policies and to strengthen the Ministry's managerial and technical capacity.

The CEA has launched a study of land management, soil and water conservation, and invasive species. Gathering new information from more than 1,000 households, this study will throw new light on how farmers perceive and act on tenure, conservation practices, and invasive threats. Results from the survey were expected toward the end of 2008. They will underpin more specific proposals for operational follow-up.

Forestry is an area that has received the attention of many donors. Between 1999 and 2005, \$5.6 million were spent in programs of forestry for Timor-Leste. Three quarters of the total were contributions from donors mainly into small-scale reforestation programs, and related training for local communities. The Trust Fund for East-Timor (TFET) has been the main donor (17 percent). The World Bank is the TFET trustee, and ADB and the World Bank administer the projects. Canada and Japan were also important donors, with Australia as a minor contributor.

The Forestry program includes Forestry Policy regulation funded by FAO (\$280,000), Reforestation I and II funded by Australia (\$13,000), plantation programs financed by Japan (\$600,000), and Oecussi Community Activation Project by UNDP (\$4 million). Finally, the TFET has supported the Agricultural Rehabilitation Project (\$2 million) to include a component on community development and forestry training. USAID has a small grants program to assist in sustainable agricultural practices, such as the use of organic fertilizer. They are also assisting in the distribution of improved varieties of seeds and seedlings.

In terms of data, the Ministry of Agriculture with support from the European Community, FAO, the German aid agency, and Portuguese Aid will carry out a nationwide Forest Resource Assessment using satellite imagery. The study is expected to be completed in four years. Current data are insufficient to propose any specific programs at this point, but this situation is about to be remedied.

Another important natural resource for Timor-Leste is its very rich coastal and marine area. The value of this asset is not yet determined due to scarce data. A research project, including mapping of coral reefs in the north coast of Timor-Leste, is under way with the collaboration of the National Directorate of Fisheries, the Northern Territory Government of

²⁸ The information on the USAID strengthening property rights in Timor-Leste project was provided by Nigel Thompson (ARD Inc.)

Australia, and the Charles Darwin University. JICA is sponsoring a Fisheries Advisor for MAF, and several surveys are under way to map out both commercial and artisanal fisheries. The overall impression is that both coral reefs and fisheries are in relatively good condition but in need of ensured protection in the future. Well managed, they present an excellent basis for employment and a thriving tourism industry.

During the U.N. climate change conference in Bali in December 2007, leaders from the six coral countries agreed to develop a plan of action, which includes establishment of marine protected areas, management of sustainable fisheries, protection of threatened species, and adaptation to climate change. The U.S. government pledged \$4.35 million to launch the process. The Global Environment Facility (GEF) expects to focus at least \$25 million on the program, and ADB committed \$2 million in designing funds for 2008. Specifically in Timor-Leste, GEF has allocated \$270,000 (GoTL 2008b). WWF, The Nature Conservancy, and Conservation International also made financial commitments (WWF 2008). The CTI Arafura and Timor Seas Ecosystem Action Programme, under the Coral Triangle Initiative (\$8 million with \$2.5 million from GEF), is a regional project to be implemented in 2008–09.

Timor-Leste also joined 10 other countries in East Asia on 15 December 2006 in signing the Haikou Partnership Agreement for the implementation of the Sustainable Development Strategy for the Seas of East Asia (SDS-SEA), through the Global Environment Facility/UNDP/Partnerships in Environmental Management for the Seas of East Asia Project on the Implementation of the SDS-SEA (PEMSEA 2008).

Chapter 5: Tackling Environmental Priorities

As the previous chapter has shown, much good work has already been done to enhance the quality of the environment in Timor-Leste. However, several areas of importance call for urgent attention. This chapter selects just a few of them to focus on issues where problems are significant but where clear actions can also be identified:

- The gap in environmental legislation and regulations and the very limited human resources available for effective implementation
- The need to address indoor air pollution
- The need to address deficient water-quality and sanitation

5.1 Enacting New Environmental Legislation and Regulations and Enhancing Human Resources

The World Bank has provided environmental legal advice as part of the CEA process. This report clearly identifies the legislative and regulatory framework as one of the priority areas for improvement. At the request of the Secretary of Environment of Timor-Leste for support, the World Bank provided environmental legal advice focused on the environment policy framework law, the EIA, and environmental licenses.

The support had been mainly concentrated in capacity building through short workshops, advice about the process of engaging relevant stakeholders in the development of laws, and advice to the national legal counterpart through comments and recommendations on specific draft regulations. Initially the following priorities were identified: the environmental policy framework law (Lei de Bases do Meio Ambiente), the EIA and environmental licenses, the environmental penalties act, and the law on protected areas.

Despite the previous identification of priorities, the environmental legal advice that the World Bank provided during 2008 concentrated on the development a new draft decree-law to create an environmental license system. This responds to a Timor-Leste need to create an incremental system that deals with projects that have the potential to generate environmental impacts through environmental evaluation and pollution controls using instruments like environmental assessment, environmental licenses, and management plans and closure plans.

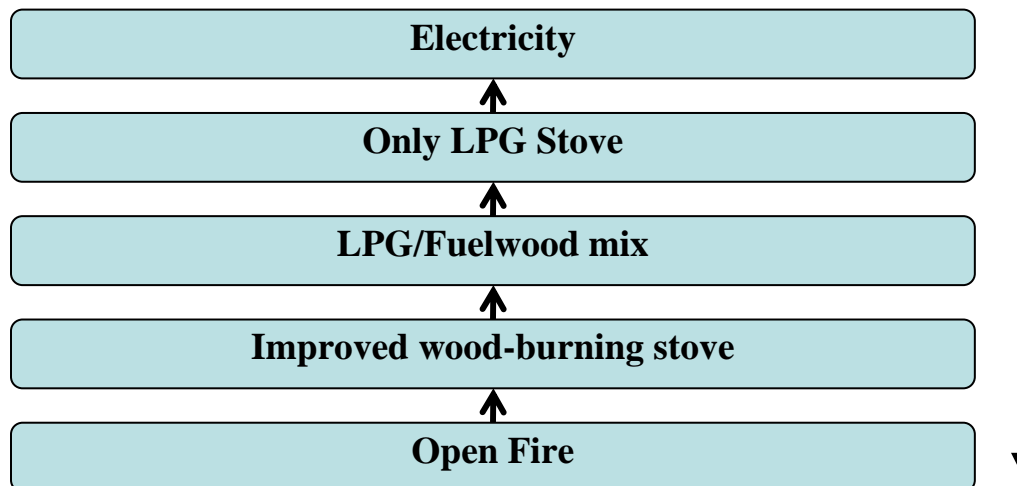
The advice also concentrated on capacity building activities, especially for the team that is responsible for drafting the decree-law, and on building recommendations for the internal and external processes of consultation.

One direct consequence of this advisory work was the formation of a legal advice office in SEMA that will be run by a national lawyer. This is considered a step forward in the creation of proper conditions for development of an environmental legal framework. This office still needs a lot of environmental technical legal support in the process of drafting laws, as the plans for 2009 include the drafting of the environmental policy framework law (Lei de Bases do Meio Ambiente) and the delivery of the legal packet for the implementation of the environmental license system, as mentioned earlier.

5.2 Addressing Indoor Air Pollution

The literature and experiences from various countries indicate that tackling IAP requires that households move up the energy ladder (see Figure 5.1).

Figure 5.1. Energy Options, ranked by increasing effectiveness in mitigating the health impacts of IAP



Source: World Bank 2005.

Hutton et al. present results for the cost-benefit analysis of eight energy interventions scenarios at the global and regional level (Hutton et al. 2006). The intervention scenarios cover three different interventions: liquefied petroleum gas (LPG), biofuels (ethanol), and an improved stove (chimneyless “rocket” stove) at two levels of population coverage by 2015 (50 percent or 100 percent) and at two levels of poverty focus (pro-poor or general population). Table 5.1 shows the benefit-cost ratio²⁹ for region SEAR B, where Timor-Leste belongs, and for the three main scenarios:

- Scenario I: 50 percent of the population switches from solid fuel to LPG.
- Scenario II: 50 percent of the population switches from solid fuel to biofuel.

²⁹ The intervention costs include: the cost of the stoves and their installation, program costs that are assumed to be borne by the government or a donor, fuel recurrent costs, and maintenance costs assumed to be zero (stove are replace every three years). The benefits include: health benefits, health care cost saving, productivity gains due to morbidity, value of deaths averted, time saving (fuel collection time and cooking time), and short-term local and global level environmental impacts (fewer trees being cut down, more fertilizer compounds being available, economic value of averting greenhouse gas emissions).

- Scenario III: 50 percent of the population switches from traditional to improved stove.

Table 5.1. Benefit-cost Ratios (\$ return per \$1 invested)

By 2015, reduce by 50% population without access to a cleaner fuel or an improved stove						
	Scenario I (LPG)		Scenario II (Biofuel)		Scenario III (Improved Stove)	
	Urban	Rural	Urban	Rural	Urban	Rural
SEAR B	1.8	1.5	0.7	0.6	32.1	28.3

Note: Ratios are expressed with interventions cost saving included as an economic benefit.

Source: Hutton et al. 2006.

The results indicate that LPG and improved stoves are potentially highly efficient for region SEAR B to undertake. The biofuel intervention was not found to be profitable for the SEAR B region. All interventions have a greater effect for urban than rural areas. Assuming these regional results could be extrapolated to Timor-Leste, the improved stove interventions is the most cost-beneficial intervention, particularly in urban areas, follow by access to LPG.

The exercise also indicates that private households receive the majority of the benefits. They include immediate fuel saving, lower health care expenditures, less morbidity and mortality, and the time saving in relation to less illness, fuel collection, and cooking. The government benefits from averting health system costs. The society shares the impacts on local and global environment.

There is no cultural barrier to the use of improved stoves. The switch is expected to be widely accepted since, before the arrival of subsidized kerosene fuel in Indonesian times, clay stoves were commonly used in the country. Moreover, no small-scale stove projects undertaken have faced cultural resistance (Clouston 2006).

Financial constraints are the main challenge. Even though households may know or learn about the benefits, they may face constraint to actually switch to cleaner fuels or improved stoves. Local solutions adequate to each targeted audience need to be tested (Hutton et al. 2006). Where there are market distortions, the government usually intervenes through subsidizing stoves, running high-profile subsidy schemes for clean fuels, facilitating micro-credits to purchase efficient appliances, and enabling the environment for the private sector to function.

In order to spread adoption of efficient stoves, scaling up is required. Much work has been done, but it is piecemeal fashion by individuals and organizations. The government does not have a program ready or available expertise. To broaden adoption requires implementing educational and practical demonstrations. The participation of micro-credit providers could ease the household financial constraints. Funding could also be used to encourage manufacturers to design more efficient and affordable stoves (Clouston 2006).

Spreading awareness is an important tool to encourage the adoption of safer practices. Making people aware of the problem to promote behavioral change was found to be important. For example in Guatemala, women were not aware of the link between health and smoke, and behavioral changes were observed when information was disseminated (World Bank 2005b).

The source of information and the form it is presented in are crucial. The information should be readily understandable and delivered by a reliable source. Medical practitioners and other health workers are perceived to be the most credible, according to surveys done around the world.

Changes in cooking habits can reduce exposure to IAP. Women should be encouraged to keep children away from smoke when cooking, to dry the wood before use, to push the wood deeper in the stove so there will be less smoke, and to keep lids on pots to reduce cooking time (WHO 2000). Timorese women can be guided by experts in thinking of better ways to improve their cooking practices, taking into account the cultural norms and beliefs to avoid resistance.

5.3 *Improving Water Supply and Sanitation*

Effective interventions to improve human health are well documented. In a comprehensive international survey, Fewtrell and Colford (2004) review five type of interventions: hygiene (health education and encouragement of specific behaviors such as hand-washing); sanitation (means of excreta disposal, often a latrine); water supply (provision of a new source or improved distribution system, such as hand-pump or household installation); water quality (treatment to remove pathogens, either at the source or in the household); and multiple interventions (hygiene, sanitation, and water combined). The study confirmed that all these interventions were broadly effective in improving health. Health education and hand-washing promotion were found to reduce disease risk by 37 percent. Treating water in the household (boiling, chemical, or solar disinfection) reduces diarrhea risk by 35 percent, while treating water at the source reduces risk by only 11 percent. Surprisingly, multiple interventions were not found to be more effective than single interventions.

Household-based chlorination is the most cost-effective intervention. Cost-efficient interventions to mitigate health impacts of poor sanitation and polluted water are documented in Clasen and Haller (2008). This study shows that household-based chlorination is the most cost-effective intervention among the seven analyzed.³⁰ This result holds in all WHO regions examined. For the particular case of SEAR D region, the cost per DALY averted is \$125 for household chlorination. Solar disinfection is only slightly less cost-effective (\$144). Traditional source-based interventions have about the same mean cost per DALY averted (\$143) as solar disinfection. Household-based ceramic filtration follows in rank (\$336) because of the additional investment required. Combined flocculation-disinfection is at the bottom of the list, with a cost per DALY averted of about \$1,116. Even though these cost-effectiveness ratios cannot be directly applied to Timor-Leste, the level is indicative, and the rank of intervention is expected to hold. Hence, it is vital that efforts be made to implement a cost-efficient program for better environmental health in Timor-Leste.

³⁰ The cost-effectiveness was computed for conventional improvements of water quality at the source (well, borehole, and communal stand post) and at the household level (chlorination, filtration, solar disinfection, and combined flocculation/disinfection). Chlorination uses sodium hypochlorite following the Safe Water System, with safe storage and behavior change techniques to promote adoption of consistent use. Gravity filtration uses commercial “candle” or pot-style filters. Solar disinfection uses the “Sodis” method, in which clear two-liter PET bottles are filled with raw water and then exposed to the sun’s ultraviolet and infrared radiation for 6–48 hours in order to kill microbes. Flocculation-disinfection uses Procter & Gambles PUR® sachets, which combine an iron-based flocculent with a chlorine-based disinfectant to treat water in 10-liter batches.

In Asia, the construction of a borehole is the less expensive way to supply water, while simple pit latrine is the cheapest sanitation facilities to construct. Cairncross and Valdamanis (2006) estimated the cost of constructing water supply in facilities in Africa, Asia, and Latin America. They compared house connection, standpost, borehole, dug well, and rainwater facilities. In Asia, they estimated that borehole has a median construction cost of \$17 per capita while the most expensive is the construction of a house connection, which amounts to \$92 per capita. The study also found that the mean construction cost of simple pit latrines is \$26 per capita while sewer connections are the most expensive, at approximately \$154 per capita. While the estimated cost may not be extrapolated directly to Timor-Leste, the categorization of facilities according to their cost is expected to hold.

Emphasis should be placed on interventions likely to accelerate health gains for children who bear the most of the burden. Disinfection at the point of use has a relative low cost and a high health impact in a region with high child mortality, such as Timor-Leste. Using this type of technology combined with better hygiene appears to be one of the most cost-effective water-related health interventions in many developing countries. This would complement the continued expansion of coverage and upgrading of piped water and sanitation services, which is a long-run goal for the country (WHO 2002b).

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Annex A: Estimation of National Wealth

Economic development can be likened to a process of portfolio management in which a country's authorities decide how to use up, invest on, or conserve its endowments of available resources or wealth to generate consumption possibilities over time. Wealth here refers to a concept that is broader than commonly used in economic sector work. Following a long tradition that starts with Adam Smith, the measure of wealth here includes produced assets such as buildings and machinery, human capital, institutional assets, and natural wealth in the form of land, forests, and subsoil assets.

Total wealth in Timor-Leste is calculated at nearly \$56,000 per capita. (See Box A.1.) Oil and natural gas reserves are predominant, accounting for 85 percent of total wealth. Intangible capital—an aggregate including human, social, and institutional capital—and non-oil natural assets follow in importance.

Box A.1. Estimating Wealth

Natural capital

Following the methodology that underpins the wealth estimates of the World Bank (2008a), natural capital encompasses nonrenewable resources (including oil, natural gas, coal, and mineral resources), cropland, pastureland, forested areas (including areas used for timber extraction and non-timber forest products), and protected areas. Most commercial natural resources are valued by taking the present value of resource rents—the economic profit on exploitation—over an assumed lifetime and calculating the net present value of such rents using a discount rate of 4 percent. While forests can, in principle, yield benefits forever if sustainably managed, overexploitation is accounted for by calculating the effective lifetime of the resource given current harvest rates. Agricultural land rents are estimated calculating profits from different types of crops, assuming that the products of the land are sold at world prices. The values for non-timber forest resources and protected areas are estimated only crudely. In the case of non-timber forest products, world average values of benefits per hectare, distinguishing industrial and developing countries, are applied to a share of the country's forested area. Protected areas are valued using country-specific per hectare values for cropland or pastureland (whichever is lower).

Produced capital

Produced capital includes physical infrastructure and urban land and is estimated by cumulating investment time series using an appropriate depreciation rate (assumed to be 5 percent per year). Investment time series of at least 20 years of data are needed to obtain a robust estimate of physical capital (investments older than that have a negligible remaining value today owing to depreciation).

Intangible capital

The methodology underpinning the wealth estimates by the World Bank (2008a) allows estimation of intangible assets as the difference between total wealth and tangible assets. Total wealth is computed as the present value of current and future consumption (following Fisher (1906) and Hamilton and Hartwick (2005)). The computation is typically done by including nonrenewable resources such as oil and natural gas in the natural capital aggregate. Oil revenues have, however, begun to accrue in the Petroleum Fund only recently.

A note on discounting and time horizon used to estimate rents

The estimates of natural assets and total wealth are obtained by calculating the discounted value of rents and consumption levels 25 years into the future. Given the high uncertainty about rents and consumption beyond 2030, this choice of capping the future seems reasonable, but any choice will necessarily be ad hoc. With respect to discounting, the rate used is the social rate of discount—that is, the one a government would choose in allocating resources across generations. Consistent with World Bank (2008a) estimates, the rate chosen is 4 percent. This is only one of a range of possible rates available in the literature.

A.1 Non-oil Wealth

The average Timorese has a non-oil wealth—consisting of physical assets, agricultural land, forest assets, and intangible assets—of \$8,500 per capita (see Figure A.1). The country shares many features of low-income economies, namely a level of total (non-oil wealth) that is several orders of magnitudes lower than that of middle-income economies, a very low level of produced capital (hovering around \$1,000 per capita), and a relatively large share of natural capital in the wealth composition.³¹

Produced capital, computed by cumulating gross capital formation over time, accounts for \$1,124 per capita (13 percent of total non-oil wealth). This is the second smallest value recorded in the region (after Lao PDR).³² Given the lack of recorded data prior to 1999, the estimates here rely on a hypothetical flow of investments for the period 1986-1998 that is assumed to be equal to investments in the year 1999. This is likely to overestimate produced capital, owing to the fact that the turmoil that preceded the restoration of the independence was likely to be characterized by low, or even negative, investment levels.

Natural assets include cropland and pastureland (\$1,356 per capita, 16 percent of the total), timber and non timber forest assets (\$1,618 per capita, 19 percent), and protected areas (\$66 per capita, less than 1 percent). The value of agricultural land is calculated as the present value of agricultural rents over the next 25 years using a 4 percent discount rate. Current agricultural rents are estimated using information on land area, production, and export values from FAO (2007). Rental rates are estimated regionally using data in FAO (2007) and Dimaranan (2006). Timber extraction data are not available for Timor-Leste. The estimates here are based on the average

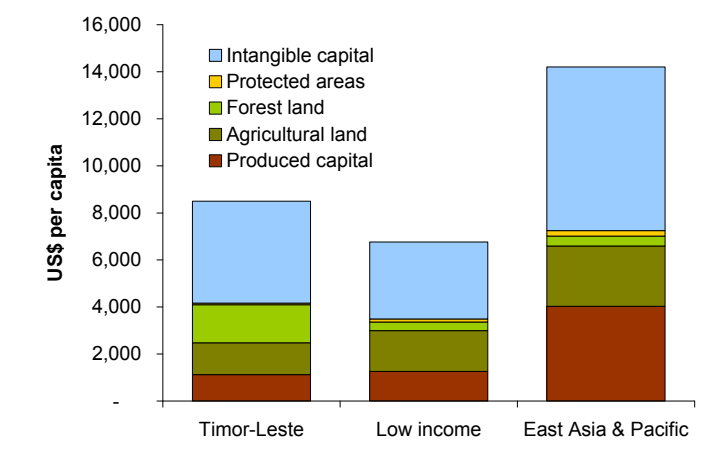
³¹ The World Bank estimates (2008a) show that as countries rise on the development ladder, natural resource wealth becomes less important in relative terms (although not necessarily on absolute terms, owing to increasing productivity of natural assets).

³² For comparison, Indonesia has \$3,125 per capita in produced assets.

regional timber wealth value of \$1,543 per hectare. Likewise, non-timber forest wealth is based on a regional average value of \$435 per hectare.

Intangible capital, which includes assets ranging from human and social capital to the quality of institutions, is estimated at \$4,300 per capita. World Bank (2006c) shows that intangible capital tends to capture the returns to human capital abroad (the effect comes through remittances from nationals living abroad). In the case of Timor-Leste, the relatively high intangible wealth may be due more to the transfers from international donors than to human capital returns.

Figure A.1. Non-oil Wealth per capita in Timor-Leste, East Asia and Pacific, and Low-income Countries, 2005 (in 2000 dollars)



A.2 Oil, Natural Gas Assets, and Total Wealth

The Timorese economy is in a real way shielded from the influence of its substantial nonrenewable natural resource wealth. For this reason, oil and natural gas are treated separately. Following a procedure similar to the one for agricultural and forest land, oil wealth is estimated by projecting current oil depletion figures 25 years into the future and by computing the present value of the depletion stream (using a 4 percent discount rate). Depletion for the years 2005 and 2006 is reported in Table A.1. Depletion is calculated for the two wells currently in production: Elang, Kakatua, and Kakatua North (EKKN) and Bayu Undan. Estimating future extraction and prices is a very difficult exercise owing both to a high uncertainty about actual oil reserves in Timorese territory and to volatile energy prices. The estimates presented here are likely to be conservative.

Depletion is estimated as quantity extracted times unit rents. Unit rents in Table A.1 are estimated by subtracting the average cost of extraction from the average revenue (i.e., the price of oil or natural gas). This is likely to overestimate the value of scarcity rents (i.e., marginal revenues minus marginal costs), which is the theoretically appropriate measure to use.³³

³³ The marginal cost of extraction is very difficult to estimate. This estimate of average costs is based on information from IMF's *World Economic Outlook* (for an average cost of extraction for the region) and

Table A.1. Oil and Natural Gas Depletion in Timor-Leste, 2005 and 2006

<i>Well</i>	<i>Item</i>	<i>Product</i>	<i>Unit</i>	<i>2005</i>	<i>2006</i>
EKKN	Production	LPG	barrels	954,782	833,700
Bayu Undan	Production	Cond	barrels	21,325,467	25,902,672
Bayu Undan	Production	Propane	barrels	6,035,911	7,238,877
Bayu Undan	Production	Butane	barrels	4,878,968	5,993,518
Bayu Undan	Production	LPG	barrels	32,240,346	39,135,067
Bayu Undan	Production	LNG	Mm3		4,130
	Production	LPG	barrels	33,195,128	39,968,767
	Production	LNG	m3	0	4,130,030,000
	Unit Rent	LPG	\$/barrel	46.63	56.49
	Unit Rent	LNG	\$/m3	0.19	0.26
	TL share of rent		Percent	90	90
	Depletion	LPG	\$	1,393,094,771	2,031,917,908
	Depletion	LNG	\$	0	958,833,664
	Depletion	Total	\$	1,393,094,771	2,990,751,572

Note: EKKN stands for Elang, Kakatua, and Kakatua North. This is a mature project with production now well into decline. The development of the Greater Sunrise project is likely, however, to more than compensate for the decline in EKKN.

Sources: Production levels from TSDA 2006; unit rents from TSDA 2006, IMF 2005:165, and OPEC 2006.

The value of oil and natural gas swamps all other measures of wealth with a share that is nearly 85 percent of the total. This technology-intensive industry, however, has done little to create jobs for the unemployed. In June 2005, the National Parliament unanimously approved the creation of a Petroleum Fund to serve as a repository for all petroleum revenues and to preserve the value of Timor-Leste's petroleum wealth for future generations. The fund held assets of \$4.8 billion as of March 2009 (BPA 2009).³⁴

A.3 Sustainable Development in Timor-Leste—Insights from the National Accounts

Timor-Leste is relatively well endowed in nonrenewable natural resources. This represents a peculiar challenge for the country's economic management. In order to sustain and increase per capita consumption levels over time, it is necessary to have non-declining wealth. From a practical perspective, this calls for natural resource rents to be invested rather than consumed. The Petroleum Fund established in 2005 has this very objective, as it allows transforming oil wealth into financial wealth.

Saving is a key element of sustainable development. Figure A.2 provides a picture of Timor-Leste's income and saving situation. Some key peculiarities of Timor-Leste's economy are evident. First, gross national disposable income (GNI, the income the country has available for

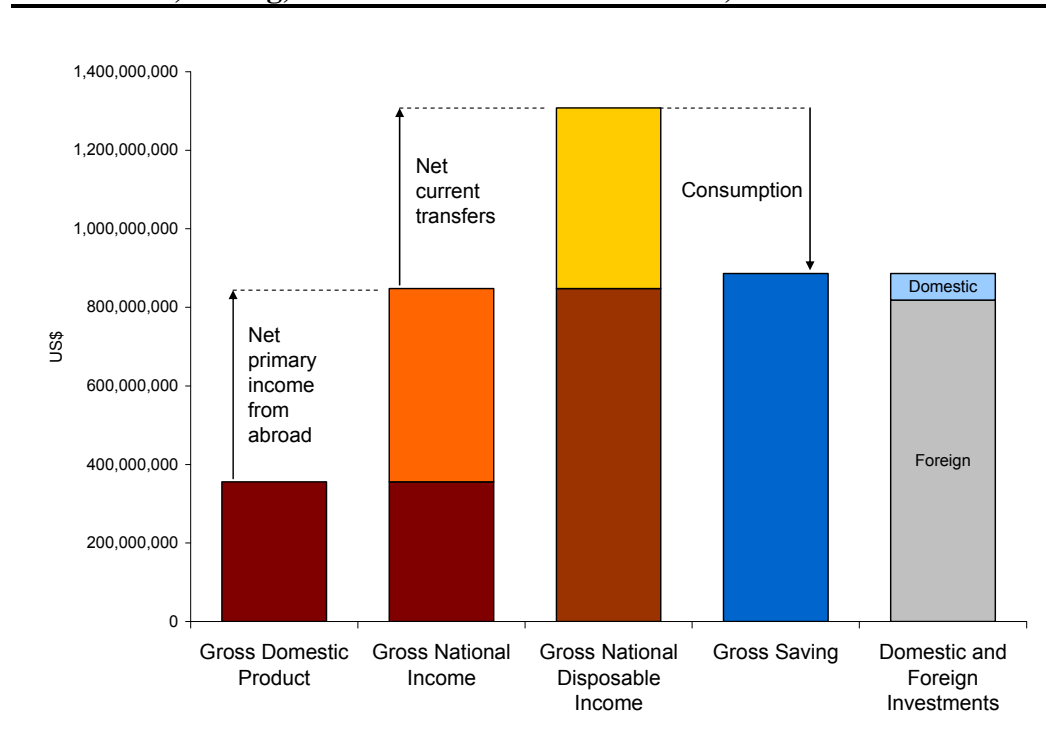
from the OPEC *Annual Statistical Bulletin* data (for the annual change in average costs). The information is combined to obtain an average cost in 2005.

³⁴ Note incidentally that depletion as calculated in Table A.1 does not necessarily correspond to the flow of resources into the government's coffers via the Petroleum Fund. The reason for this discrepancy is that depletion is estimated using an annualized flow of costs of extraction, whereas actual net government revenues reflect the share of profits retained by oil companies as cost recovery of earlier exploration and drilling.

current consumption) is much higher than gross domestic product (GDP, the sum of all value added produced in the economy). National income is currently being boosted by net primary income coming from abroad—mostly in the form of revenues from the offshore petroleum sector—and by net current transfer in the form of international aid. While net primary income from abroad is likely to be sustained over time, net current transfers are more volatile.

A second important feature is the high savings rate in Timor-Leste, which is more than two times larger than household and government consumption. This is by and large an effect of the Petroleum Fund, which explicitly imposes a savings rule on the country’s income account. A third key feature, which again is inherently linked to the Petroleum Fund, is that a very small share of savings (8 percent) is invested in physical infrastructure. The lion’s share of savings is invested in foreign assets. Owing to increasing oil prices, the share of savings invested abroad increased in 2007, a trend that likely continued in 2008.

Figure A.2. Income, Saving, and Investment in Timor-Leste, 2006



As a way of comparison, Figure A.3 depicts the 2005 wealth composition for Malaysia, a natural resource-rich economy. Notice in particular the large share of produced capital: 24 percent of total wealth. Domestic investments in Malaysia hovered around 23 percent of GDP in the 1970s, 28 percent in the 1980s, and 36 percent in the 1990s. In 2005 GNI per capita in real terms was more than four times higher than in 1960. Table A.2 provides produced, natural and intangible capital estimates by region for 2005.

Figure A.3. Total Wealth per Capita in Malaysia, 2005 (in 2000 dollars)

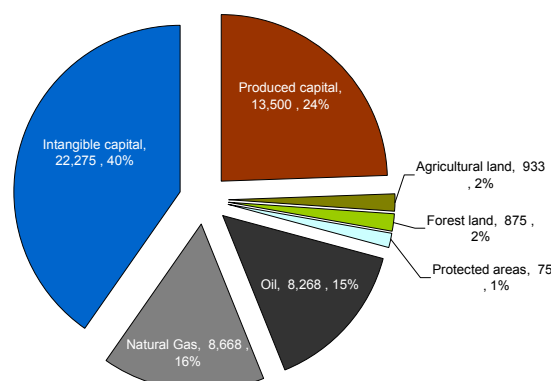


Table A.2. Wealth Estimates, by Region, 2005

WEALTH IN THE YEAR:	2005				Percent				
	2000 USD per capita				Percent				
	Total wealth	Produced	Natural ca	Intangible c	Produced c	Natural ca	Intangible capital		
<i>East Asia & Pacific</i>	16,240	4,030	5,248	6,962	25%	32%	43%		
<i>Europe & Central Asia</i>	47,998	8,594	4,597	34,807	18%	10%	73%		
<i>Latin America & Caribbean</i>	68,197	10,048	14,988	43,161	15%	22%	63%		
<i>Middle East & North Africa</i>	26,240	4,306	7,315	14,619	16%	28%	56%		
<i>South Asia</i>	8,358	1,500	2,573	4,285	18%	31%	51%		
<i>Sub-Saharan Africa</i>	10,043	1,273	3,615	5,155	13%	36%	51%		
<i>Low income</i>	7,376	1,264	2,847	3,265	17%	39%	44%		
<i>Lower middle income</i>	17,895	4,102	5,472	8,321	23%	31%	47%		
<i>Upper middle income</i>	74,331	11,449	12,862	50,020	15%	17%	67%		
<i>High income</i>	471,373	80,046	16,218	375,108	17%	3%	80%		
<i>World (non oil)</i>	97,908	16,893	7,165	73,850	17%	7%	75%		
<i>High oil producers</i>	23,978	7,659	23,805	-7,486	32%	99%	-31%		
<i>World</i>	91,311	16,069	8,650	66,592	18%	9%	73%		
WEALTH IN THE YEAR:	2005				Percent				
	2000 USD per capita				Percent				
	Natural capital	Agricultur	Timber an	Protected a	Sub-soil as	Agricultur	Timber an	Protected	Sub-soil as
<i>East Asia & Pacific</i>	5,248	2,562	425	226	2,034	49%	8%	4%	39%
<i>Europe & Central Asia</i>	4,597	2,819	248	468	1,062	61%	5%	10%	23%
<i>Latin America & Caribbean</i>	14,988	4,740	2,646	680	6,922	32%	18%	5%	46%
<i>Middle East & North Africa</i>	7,315	2,407	92	38	4,778	33%	1%	1%	65%
<i>South Asia</i>	2,573	1,631	217	135	590	63%	8%	5%	23%
<i>Sub-Saharan Africa</i>	3,615	1,938	743	160	774	54%	21%	4%	21%
<i>Low income</i>	2,847	1,733	366	133	615	61%	13%	5%	22%
<i>Lower middle income</i>	5,472	2,591	567	248	2,066	47%	10%	5%	38%
<i>Upper middle income</i>	12,862	4,324	1,636	625	6,277	34%	13%	5%	49%
<i>High income</i>	16,218	5,301	1,092	2,005	7,819	33%	7%	12%	48%
<i>World (non oil)</i>	7,165	2,934	699	548	2,983	41%	10%	8%	42%
<i>High oil producers</i>	23,805	1,436	679	869	20,822	6%	3%	4%	87%
<i>World</i>	8,650	2,800	697	577	4,575	32%	8%	7%	53%

Note: region and income group aggregates exclude high oil-producing countries.

Annex B: The Cost of Indoor Air Pollution

Desai et al. (2004) reviewed research studies from around the world that have assessed the magnitude of health effects from indoor air pollution from solid fuels. Solid fuels are commonly burned in inefficient simple stoves, as in most of the households of Timor-Leste. In such situations, solid fuel use (SFU) generates substantial emissions of many health-damaging pollutants, including respirable particulates and carbon monoxide.

The health outcomes that have strong association with SFU include acute lower respiratory infections (ALRI) in young children and chronic obstructive pulmonary disease (COPD) and lung cancer (from exposure to coal smoke) in adult women (more than 30 years old). It is these population groups who suffer the most from indoor air pollution because they spend much more of their time at home and more time cooking than older children and adult males do. For males older than 30, COPD and lung cancer are considered to have a moderate association with SFU. “Moderate” indicates a relatively small number of suggestive findings and that additional, carefully conducted studies are needed to strengthen the evidence base and to pinpoint risks (Desai et al. 2004).

This annex is limited to evaluating health outcomes that have strong association with SFU. It also excludes lung cancer from exposure to coal smoke in adult women, since the number of households using coal is insignificant. When estimating morbidity cost for children younger than 5, the cost of acute respiratory infections (ARI)—that is, both ALRI and acute upper respiratory infections—is included. In a study from Kenya, Ezzati and Kammen (2001) documented a statistically significant and increasing relationship between daily exposure to indoor PM₁₀ and both ARI and ALRI.

Table B.1 presents the relative risks for strong health outcomes. It shows the central estimate as well as lower and upper bounds. These ratios represent the risk of illness for those who are exposed to household SFU compared with the risk for those who are not exposed. According to Desai et al. (2004), they are widely applicable, since they are based on a broad evidence base.

Table B.1. Relative Risk for Health Outcomes Strongly Related to Solid Fuel Use

Health Outcome	Relative risk		
	Low	Central	High
ALRI (Children <5)	1.9	2.3	2.7
COPD (Women ≥30)	2.3	3.2	4.8

Source: Desai et al. (2004)

In order to calculate the burden of disease from household SFU for Timor-Leste, the methodology and international best practice of Desai et al. (2004) are followed. First, attributable fractions from SFU are estimated using population exposure and relative risks for each disease, age, and sex group.

According to the Timor-Leste DHS (2003), 98 percent of the households in Timor-Leste use solid fuels (firewood) as their main fuel source for cooking (see Table B.2). Similar results were found in a recent survey conducted by the World Bank (2007c).³⁵

Table B.2. Household Fuel Use in Timor-Leste (percent)

Fuel Type	Estimate of Household Use
Electricity	0.3
Gas	0.0
Kerosene	1.3
Charcoal	0.3
Firewood	98.0

Source: DHS, 2003

Exposure to SFU is modified by ventilation-related factors, including outdoor cooking and improved stoves. The World Bank (2007c) survey found that 76 percent of Dili households, 87 percent of Baucau households, and 89 percent of rural household normally prepare their meals outdoors. It is unclear whether this practice is based on cultural preferences or the fact that most of the houses surveyed were small and indoor space was at a premium. Cooking outdoors only reduces but does not eliminate exposure to pollutants from wood smoke. Dasgupta et al. (2004) showed that in Bangladesh, cooking outdoors with biomass fuel decreases PM₁₀ concentrations on average approximately one-third compared with cooking inside, but the level of concentrations remain high. It should also be noted that cooking “outdoors” often implies the use of a simple shelter from rain and wind, which also captures some of the fumes emitted.

With respect to cooking stoves, the World Bank (2007c) survey indicated that of the 865 households surveyed, only 9 used traditional clay stoves and 12 used “improved stoves” of various types. The remainder use open three-stone stoves they made themselves. However, their heating efficiency is only around 15 percent; most of the energy from fuelwood is simple wasted during cooking (World Bank 2007c).

Desai et al. (2004) recommend applying a ventilation coefficient of 0.25 to the population that uses improved stoves or cooks outdoors. Since on average 80 percent of the people who use solid fuel prepare their meals outdoors, this study applies the 0.25 ventilation coefficient to these households to adjust the level of exposure to SFU. In other words, it is assumed that they have a 75 percent lower risk of health effects than households that cook indoors. The estimated adjusted population exposure to SFU is therefore 0.38.³⁶

The next step is to calculate the number of disability-adjusted life years (DALYs)³⁷ and deaths due to ALRI and COPD in Timor-Leste (see Table B.3). National data on the burden of these

³⁵ While the DHS (2003) is representative at the national level, the survey conducted by the World Bank (2007c) had some limitations and therefore has to be used cautiously when reporting national data.

³⁶ Percent of population exposed to SFU = (% of households using solid fuels with traditional stove indoors)*1 + (% of households using solid fuels and either improved stoves or cooking outdoors)*0.25 = 0.18*1+0.80*0.25 = 0.38.

³⁷ The DALY is a health gap measure that extends the concept of potential years of life lost due to premature death to include equivalent years of “healthy” life lost by virtue of being in states of poor health or disability. The DALY combines in one measure the time lived with disability and the time lost

diseases were not available, therefore this study uses the burden of disease estimated for World Health Organization (WHO) subregion SEAR D³⁸ for 2002 (revised data). Assuming that Timor-Leste is representative of SEAR D, the subregional estimates were adjusted by population weight (WHO 2001)³⁹ to estimate the number of DALYs and deaths for Timor-Leste.

For the particular case of ALRI mortality in children younger than 5, there is national information on all-cause mortality rate under 5,⁴⁰ and therefore the percentage of ALRI deaths for region SEAR D was applied to the Timor-Leste mortality data for this specific age group in 2006. Unfortunately, due to lack of data, this type of adjustment was not possible for the other indicators.

Table B.3. Timor-Leste Estimated Burden of Disease from Selected Diseases, 2000

Disease, sex, age group	DALYs lost	Death
ALRI, Children <5	20,033	577
COPD , Women ≥30	3,085	251

Source: WHO (2002 Revised)

It is important to notice that only a fraction of the total cases is attributable to SFU. Table B.4 shows attributable fractions from SFU taking into account the levels of exposure of the Timor-Leste population—that is, the relative risk estimation from table B.1 is adjusted by the level of exposure in Timor-Leste (0.38).⁴¹

Table B.4. Attributable Fractions from SFU for Timor-Leste

Disease, sex, age group	Attributable fractions		
	Low	Central	High
ALRI, Children <5	0.25	0.33	0.39
COPD , Women ≥30	0.33	0.46	0.59

The total all-cause number of cases of ALRI and COPD are multiplied by the attributable fraction from SFU to get the attributable burden from SFU (see Table B.5). The estimated burden is 8,029 DALYs lost and 305 deaths, which represent 5 percent and 4 percent of the national totals in 2002 respectively. These percentages are in line with those found by Desai et al. (2004) for India (3.4 percent).

Table B.5. Attributable Burdens from SFU for Timor-Leste

due to premature mortality. One DALY can be thought of as one lost year of “healthy” life, and the burden of disease can be considered a measurement of the gap between current health status and an ideal situation where everyone lives into old age free of disease and disability (WHO 2008).

³⁸ This region includes Bangladesh, Bhutan, Korea (DPR), India, Maldives, Myanmar, Nepal, and Timor-Leste.

³⁹ Timor-Leste is home to 0.1 percent of the population of SEAR D.

⁴⁰ The mortality rate under 5 is 55 per 1,000.

⁴¹ Attributable fraction = $[(\% \text{ population exposed} * \text{relative risk} + \% \text{ population unexposed} * 1) - 1] / (\% \text{ population exposed} * \text{relative risk} + \% \text{ population unexposed} * 1)$.

Disease, sex, age group	Attributable burden					
	DALYs lost			Deaths		
	Low	Central	High	Low	Central	High
ALRI, Children <5	5105	6624	7862	147	191	226
COPD , Women ≥30	1020	1405	1822	83	114	148
Total	6125	8029	9685	230	305	375

The total number of DALYs and deaths attributable to SFU are good indicators of the impact on health. The annual value of the damage of indoor air pollution is then estimated computing mortality and morbidity costs of the health outcomes that have a strong association with SFU. The cost of mortality for adults is based on the value of statistical life (VSL) as a higher bound and on the human capital approach (HCA) as a lower bound and on HCA for child mortality. The cost of morbidity is estimated using the cost of illness (COI) approach—i.e., the annual medical treatment cost and value of lost time from COPD and ARI are calculated for the people suffering from those illnesses in a given year. For the case of COPD, since it is a long-term illness, the present value of the years of life lost (YLL) for new cases of COPD is also included.

B.1 Mortality Cost

VSL is based on valuation of mortality risk estimated through revealed or stated preferences. It is important to note that this study is not putting a value of any particular person’s life or the suffering and grievance that is associated with death. However, people’s behavior and statements reveal something about the economic benefits of reducing the statistical risk of death. This is important for rational social decision-making. Mrozek and Taylor (2002) provide a meta-analysis of VSL estimates from labor market studies from around the world. The study concludes that a range for VSL of \$1.5–2.5 million can be reasonably inferred from labor market studies when “best-practice” assumptions are invoked. The sample of countries used in Mrozek and Taylor (2002) has an average GNI per capita of \$30,000.⁴²

Since there are no studies of VSL conducted in Timor-Leste, the benefit transfer approach is applied using an income elasticity of one as a conservative estimation—i.e., it is assumed that willingness to pay for mortality risk reductions is proportional to the income level across countries. Table B.6 below presents the estimates of VSL for Timor-Leste, indicating a lower bound of \$42,000 and an upper bound of \$70,000.

⁴² Atlas methodology—i.e., market-based exchange rates are used as opposed to purchasing power parity.

Table B.6. Estimated Value of Statistical Life in Timor-Leste

	High	Low	Source
Avg. VSL in high-income countries (million US\$)	2.5	1.5	Mrozek and Taylor (2002)
Avg GNI per capita in high-income countries (US\$)	30,000	30,000	World Bank(*)
GNI per capita in Timor Leste (\$ in 2006, Atlas method)	840	840	World Bank(2007)
Income elasticity	1	1	
Estimated VSL in Timor-Leste	70,000	42,000	Benefit Transfer

(*) Weighted avg. GNI per capita, based on the sample of countries in Mrozek and Taylor (2002)

The HCA is based on the economic contribution of an individual to society over the lifetime of the individual. Death involves an economic loss that is approximated by the loss of all future income of the individual. Just as in the case of VSL, this is not a judgment of the value of the life of an individual but an estimation of the economic value of the “statistical life.” Following WHO standard practice, a discount rate of 3 percent is applied. An annual growth of real income of 2 percent is assumed, following the example of Larsen (2006). Average annual income is approximated by GNI per capita. In the case of children, it is assumed that the lifetime income on average starts at age 20 and ends at expected length of life of 57 years (World Bank 2007b). For adults, the YLL for COPD are assumed to be 7.5 years (Larsen 2006). (See Table B.7.)

Table B.7. Cost of Mortality (per Death) Using HCA

	Avg. number of years of lifetime income lost	US\$(2005)
ALRI, Children <5	37	26,541
COPD , Adults ≥ 30	7.5	6,433

The lower and upper bound estimations of the cost of mortality (per death) using the estimates from HCA and VSL methodologies are presented in Table B.8.

Table B.8. Cost of Mortality (per Death) Using HCA and VSL

	Lower Bound		Higher Bound	
	\$ (2006)	Method	\$ (2006)	Method
ALRI, Children <5	26,541	HCA	26,541	HCA
COPD , Adults ≥30	6,433	HCA	70,000	VSL

Finally, the total cost of mortality from SFU is calculated by multiplying the attributable number of deaths by the cost per death. Table B.9 indicates that the total cost was approximately between 0.5 percent (lower bound) and 1.9 percent (upper bound) of the GNI of Timor-Leste in 2006.⁴³

⁴³ Timor-Leste GNI (Atlas method, 2006 dollars) is \$865 million (World Bank 2007b).

Table B.9. Total Cost of Mortality from Solid Fuel Use

	Lower Bound			Higher Bound		
	Attributable number of deaths	Cost per death \$ (2006)	Total (\$)	Attributable number of deaths	Cost per death \$ (2006)	Total (\$)
ALRI, Children <5	147	26,541	3,900,059	226	26,541	6,006,206
COPD , Adults ≥30	83	6,433	533,901	148	70,000	10,380,966
TOTAL			4,433,960			16,387,172

Note: Lower and upper bound for ALRI and lower bound of COPD are estimated using HCA and higher bound of COPD is estimated using VSL.

B.2 Morbidity Cost

In order to measure the cost of morbidity, the COI is used to estimate the cost of ARI and COPD. The COI is composed of medical cost and the value of time losses, with no provision for the human suffering. Hence, it is certainly an underestimate of the full cost. COPD is a long-term illness and therefore—in principle as with mortality—the present value of YLL for new cases of COPD is also included.

Table B.10 presents the baseline data for the estimation of morbidity cost of ARI for children less than 5 years old.

Table B.10. Baseline Data for the Morbidity Cost Estimation of ARI for Children Under 5

			Baseline	Source
Percent of ARI cases treated at medical facilities (children < 5 years)			63.0	World Bank, 2006b based on DHS and LSMS
Average cost of examination and treatment per consultation including transport cost (\$)	Lower Bound	With usual health care provider	0.4	TL DHS 2003
	Central	Average	17.0	
	Higher Bound	Doctor in private clinic	33.6	
Average duration of ARI in days			7	Larsen (2006)
Average hours per day of care giving per case of ARI			2	Larsen (2006)
Avg. value of one hour of time for care giving adults(\$)		75% of avg hourly minimum wage (effective minimum wage \$2/day)	0.2	Larsen (2006) and World Bank (2007e)

Unfortunately, DHS data only show the average cost of examination and treatment per consultation without distinguishing among diseases. Therefore it is assumed that the average applies for ARI and COPD. Importantly, most of the average cost when using the usual care provider is driven by the subsidized cost of consulting a doctor in a government health facility (2¢ per examination). To obtain a better measure of the economic cost of this type of service, the cost per consultation with a doctor in a private clinic (\$33.61) is used as an upper bound in the sensitivity analysis. Since the quality of care provided by doctors in a private clinic exceeds that

provided by the usual health provider, the actual cost may lie within this range (\$17). Unfortunately, there are no data available on average wages for Timor-Leste and therefore the effective minimum wage is used as a proxy.

The annual ARI cost per case including treatment, transport, and time lost is estimated to be approximately \$3 (lower bound), \$13 (central), and \$24 (upper bound), depending on the assumptions used.

According to the Timor-Leste DHS (2003), ARI two-week prevalence in children under 5 is 0.143 (i.e., 14.3 percent of children were estimated to have ARI starting or continuing into the two-week observation period). To convert the two-week prevalence to two-week incidence,⁴⁴ the first number is multiplied by 0.67.⁴⁵ The two-week ARI incidence rate is 0.095—i.e., 9.5 percent of children younger than 5 were estimated to have had ARI starting in the two-week period. To convert this number to annual incidence, it is multiplied by 26. The annual ARI incidence rate is calculated to be 2.48 cases per child per year. Total annual cases of ARI in children under 5 per year are estimated to be approximately a third of a million.

Attributable risk fractions from Desai et al. (2004) are applied to obtain a lower, central, and higher bound of the number of cases of ARI attributable to SFU.

The total annual morbidity cost of ARI from SFU for children less than 5 years old is estimated to be between \$300,000 and \$3.5 million, depending on the assumed attributable risk fraction and the cost of treatment. This cost represents between 0.03 percent and 0.4 percent of Timor-Leste GNI in 2006 (see Table B.11).

Table B.11. Total Morbidity Cost of ARI for Children Under 5

	Low	Central	High
Attributable risk fractions	0.25	0.33	0.39
Annual total number of children with ARI	373,644	373,644	373,644
Attributable number of cases	95,221	123,548	146,643
Annual COI for ARI (US\$)	2.91	13.37	23.83
Total annual cost of ARI (US\$)	277,283	1,651,832	3,495,129

Table B.12 presents the baseline data for the estimation of morbidity cost of COPD for adult women. COI estimation includes cost of treatment and time lost as well as cost of hospitalization (1.5 percent of the population diagnosed with COPD are hospitalized on average 10 days). The daily cost of hospitalization varies between \$17.36 when using public hospitals to \$48.09 when using private hospitals. For the cost of treatment and time lost, the same assumptions as for ARI are used.

⁴⁴ Two-week incidence is the number of episodes starting during a two-week period.

⁴⁵ Two-week incidence rate = two-week prevalence rate*[14/(14+average duration of the episode)]. It is assumed that the average duration of an ARI episode is seven days.

Table B.12. Baseline Data for the Morbidity Cost Estimation of COPD for Women Older than 30

			Baseline	Source
Percent of COPD patients being hospitalized per year			1.5	Assumption based on Schulman et al (2001) and Niederman et al (1999)
Average length of hospitalization for COPD (days)			10	Larsen (2004b)
Daily cost of hospitalization + transportation (\$)	Lower Bound	Public Hospital	17.4	World Bank, 2006b
	Central	Average	32.7	
	Higher Bound	Private Hospital	48.1	
Percent of COPD patients with an emergency doctor/hospital outpatient visits per year			15	Larsen (2006)
Average number of doctor visits per COPD patient per year			1	Larsen (2006)
Average cost of examination and treatment per consultation (regular or emergency) including transport cost (\$)	Lower Bound	with usual health care provider	0.4	TL DHS 2003
	Central	Average	17.0	
	Higher Bound	Doctor in private clinic	33.6	
Estimated lost workdays (including household work days) per year per COPD patient			2.6	Larsen (2006)
Avg. value of lost workday (\$)		75% of avg hourly minimum wage (de facto minimum wage US\$2/day)	1.5	Larsen (2006) and World Bank (2007e)

The annual cost per case of COPD including treatment, hospitalization, transport, and time lost is estimated to be \$6.56 (lower bound), \$11.36 (central), and \$16.15 (upper bound), depending on the assumptions used.

Table B.13 shows the COPD female prevalence rate per 1,000 individuals for subregion SEAR D (Shibuya et al. 2001). Combining this information with the female population distribution in Timor-Leste, it is estimated that 873 adult women suffer from COPD.

Table B.13. Estimated Total Number of Cases of Females with COPD

Age groups	COPD Female Prevalence per 1000 (Region SEARO D)	Female Population in TL	Total number of cases of Female with COPD
30-44	3.87	77,522	300
45-59	7.65	42,980	329
60-69	8.35	15,697	131
70+ (*)	11.44	9,918	113
TOTAL			873

Source: Shibuya et al. (2001) & Timor-Leste Census 2004

(*) the prevalence rate for the group age 70-79 is applied to the population 70+

The attributable risk fractions of Desai et al. (2004) are applied to obtain lower, central, and higher bounds of the number of cases of COPD attributable to SFU. Table B.14 presents the total annual morbidity cost of current cases of COPD from SFU using the COI approach.

Table B.14. Total Morbidity Cost of Current (Prevalence) Cases of COPD from SFU for Women Older than 30

	Low	Central	High
Attributable risk fractions	0.33	0.46	0.59
Annual total adult women with COPD	873	873	873
Attributable number of cases from SFU	288	402	515
Annual COI for COPD (\$)	6.6	11.4	16.2
Total annual cost of COPD (\$)	1,891	4,561	8,321

Since COPD is a long-term illness, the present value of YLL for new cases is included. Table B.15 presents the estimation of new cases of COPD using the incidence rate from Shibuya et al. (2001). The present value is calculated using the Timor-Leste GNI per capita as a proxy for average annual income, assuming a discount rate of 3 percent, and a real income growth rate of 2 percent.

Table B.15. Estimated Present Value of YLL for New Cases of Females with COPD

Age groups	COPD Female Incidence per 1000 (Region SEARO D)	Female Population in TL	Total Number of female new cases with COPD	Average duration of COPD (yrs)	Present Value of Years of life lost (YLL)
30-44	0.35	77,522	27	23.4	474,703
45-59	0.45	42,980	19	13.2	200,386
60-69	1.11	15,697	17	5.0	71,492
70+ (*)	3.17	9,918	31	2.6	68,240
TOTAL			95		814,822

Source: Shibuya et al. (2001) & Timor-Leste Census 2004

(*) the incidence rate for the group age 70-79 is applied to the population 70+

The present value is estimated to be approximately \$800,000, but it needs to be adjusted by the attributable risk fraction. After applying those, the morbidity costs of new cases of COPD attributable to SFU are estimated to be, on average, \$380,000 (see Table B.16).

Table B.16. Morbidity Cost of New Cases (Incidence) of COPD from SFU for Females Older than 30

	Low	Central	High
Attributable risk fractions	0.33	0.46	0.59
PV of YLL for new cases	814,822	814,822	814,822
Total annual cost Attributable to YLL from SFU	268,891	374,818	480,745

The total annual morbidity cost of COPD for adult women from SFU, including both current and new cases, is estimated to be between \$270,000 and \$500,000, depending on the assumed attributable risk fraction and the cost of treatment (see Table B.17).

Table B.17. Total Morbidity Cost of COPD from SFU for Females Older than 30

	Low	Central	High
Morbidity cost of current (prevalence) cases	1891.02	4561.15	8320.96
Morbidity cost of new (incidence) cases	268,891	374,818	480,745
Total annual cost Attributable to YLL from SFU	270,782	379,379	489,066

As indicated in Table B.18, COPD morbidity cost in adult females accounts for approximately 20 percent of the total morbidity cost of indoor air pollution (central estimate). The annual total morbidity cost from SFU including both ARI and COPD is estimated at \$550,000–\$4 million with a mean estimate of \$2 million—equivalent to nearly 0.17 percent of Timor-Leste GNI in 2006.

Table B.18. Estimated Total Cost of Morbidity from SFU for both ARI and COPD

	Lower Bound	Central	Higher Bound
ARI, Children <5	277,283	1,651,832	3,495,129
COPD, Adults ≥30	270,782	379,379	489,066
TOTAL	548,065	2,031,211	3,984,195
% of GNI	0.06%	0.23%	0.46%

B.3 Total Cost to Health

In summary, the annual morbidity and mortality cost of health effects from indoor air pollution associated with the use of solid fuel is estimated at some \$12.5 million, with a lower bound of \$5 million and an upper bound of \$20 million (see Table B.19). The mean estimate is equivalent to about 1.4 percent of Timor-Leste GNI, or 3.5 percent of GDP⁴⁶ in 2006. This percentage is in line with the one found by Larsen (2006) for Ghana (1.4 percent of Ghana's 2004 GDP).

⁴⁶ Timor-Leste GDP (2006 dollars) is \$356 million (World Bank 2007b).

Table B.19. Total Cost to Health from SFU (dollars per year)

		Lower Bound	Central	Higher Bound
ARI, Children <5	Morbidity	277,283	1,651,832	3,495,129
	Mortality	3,900,059	4,953,133	6,006,206
Total ARI		4,177,342	6,604,965	9,501,336
COPD , Adults ≥30	Morbidity	270,782	379,379	489,066
	Mortality	533,901	5,457,434	10,380,966
Total COPD		804,684	5,836,813	10,870,031
TOTAL		4,982,025	12,441,777	20,371,367
% of GNI		0.58%	1.44%	2.35%

Annex C: The Cost of Inadequate Water Supply, Sanitation, and Hygiene

Water-related diseases are typically placed in four classes: waterborne, water-washed, water-based, and water-related insect vectors (Gleick 2002). The first three are most clearly associated with lack of improved domestic water supply.⁴⁷ Box C.1 lists the diseases associated with each class.

Box C.1. Water-related Diseases

Waterborne diseases are caused by the ingestion of water contaminated by human or animal feces or urine containing pathogenic bacteria or viruses; they include cholera, typhoid, amoebic and bacillary dysentery, and other diarrheal diseases.

Water-washed diseases are caused by poor personal hygiene and skin or eye contact with contaminated water; they include scabies, trachoma, and flea, lice, and tick-borne diseases.

Water-based diseases are caused by parasites found in intermediate organisms living in contaminated water; they include dracunculiasis, schistosomiasis, and other helminths.

Water-related diseases caused by insect vectors, especially mosquitoes that breed in water, include dengue, filariasis, malaria, onchocerciasis, trypanosomiasis, and yellow fever.

Source: Gleick 2002.

⁴⁷ According to the United Nations Statistics Division (United Nations 2005), a household is considered to have access to an improved water supply if it uses improved drinking water sources or delivery points. Improved drinking water sources include piped water into dwelling, plot, or yard; public tap/standpipe; tube well/borehole; protected dug well; protected spring; and rainwater collection. Unimproved drinking water sources include unprotected dug well; unprotected spring; cart with small tank/drum; bottled water; tanker-truck; and surface water (river, dam, lake, pond, stream, canal, irrigation channels). A household is considered to have access to improved sanitation if it uses improved sanitation facilities, which includes flush or pour-flush to piped sewer system, septic tank, or pit latrine; ventilated improved pit latrine; pit latrine with slab; and composting toilet. Unimproved sanitation facilities include flush or pour-flush to elsewhere; pit latrine without slab or open pit; bucket; hanging toilet or hanging latrine; and no facilities or bush or field.

A rough estimate of the health impact of diarrheal illness cases attributable to inadequate water supply, sanitation, and hygiene indicates that this is approximately 2 percent of the Timor-Leste GNI for 2006. The analysis is limited to the mortality (children under 5) and morbidity costs associated with the percentage of diarrheal disease cases that can be attributed to inadequate access to water, sanitation, and hygiene.

The relationship between lack of adequate water supply, sanitation, and hygiene conditions and water-related diseases has been well documented. Tables C.1 and C.2 present death rates and estimated DALY rates of water-related diseases, and they place Timor-Leste in an international context. Unfortunately, due to lack of information the Tables only include diarrheal diseases, malaria, and dengue. (There is information on trypanosomiasis, schistosomiasis, lymphatic filariasis, and onchocerciasis but since these diseases were eradicated in the countries selected for comparison, they are not included in the Tables.)

Table C.1. Death Rates* from All Causes and Water-related Diseases

	Timor-Leste	Same Income Level Lao PDR	High-Income Country Sweden	Low-Income Country Sierra-Leone
GNI per capita(PPP)	2,000 (**)	2,050	35,070	850
All Causes (age-standarized)	1,490.4	1,627	429	2,892
Diarrhoeal diseases	19.1	98.5	0.6	271
Malaria	3.8	22.2	0	199
Dengue	0.3	3.3	0	0.1

Sources: World Health Report 2004, WHO and World Bank 2007b.

(*) Estimated deaths per 100,000 population by cause, and Member State, 2002.

(**) Data from CIA(2007) since this country is not covered in World Bank 2007b.

Table C.2. DALY Rates* from All Causes and Water-related Diseases

	Timor-Leste	Same Income Level Lao PDR	High-Income Countries Sweden	Low-Income Country Sierra-Leone
GNI per capita(PPP)	2,000(**)	2,050	35,070	850
All Causes (age-standarized)	20,876	35,301	8,783	73,362
Diarrhoeal diseases	616.2	3,181.2	9	8,772
Malaria	124	832.3	0	7,146
Dengue	12	112.3	0	3

Sources: World Health Report 2004, WHO and World Bank 2007b.

(*) Estimated DALYs per 100,000 population by cause, and Member State, 2002.

(**) Data from CIA(2007) since this country is not covered in World Bank 2007b.

C.1 Mortality Cost

First, the total number of annual diarrheal deaths in children younger than 5 is estimated by multiplying the percentage of diarrheal disease deaths over all-cause deaths from WHO sub-region SEAR D for 2002 (revised data) by the number of deaths to those under 5 from Timor-Leste national data. Since only a fraction of the total cases is attributable to substandard potable

water supply, sanitation, and hygiene practices, an 88 percent attributable rate is applied.⁴⁸ The total number of cases is estimated to be 478 per year.

The human capital approach is used to estimate the cost of mortality for children under 5. The value estimated in Annex B is applied here—i.e., a cost of \$26,541 per child is used to calculate the total annual cost of mortality attributable to inadequate water supply, sanitation, and hygiene. Table C.3 indicates that this total cost represents approximately 1.5 percent of the Timor-Leste GNI in 2006.

Table C.3. Annual Mortality Cost Attributable to Inadequate Water Supply, Sanitation, and Hygiene

		Source
Mortality rate, under-5 (per 1,000) in TL	55.2	World Bank 2007 WDI
Annual u5 child mortality (approx)	2883	
Diarrheal mortality in children < 5 (as a % of child mortality) in SEAR D Region	19%	WHO Data 2002 Revised
Estimated annual diarrheal deaths in children < 5 in TL	544	
Percent of diarrheal cases attributable to inadequate water supply, sanitation and hygiene.	88%	WHO 2002
Estimated annual diarrheal deaths in children < 5 in TL attributable to inadequate water supply, sanitation and hygiene	478	
Cost of mortality(per death) using HCA (\$2006)	26,541	
Total annual cost of mortality attributable to inadequate water supply, sanitation and hygiene	12,694,690	
As a % of TL GNI 2006	1.5%	

C.2 Morbidity Cost

In order to measure the cost of morbidity, the cost of illness approach is used. This is composed of medical costs and the value of time losses, with no provision for human suffering. Table C.4 presents the baseline data for the estimation of the morbidity cost of diarrheal illness.

Table C.4. Baseline Data for the Morbidity Cost Estimation of Diarrheal Disease for Children Under 5

⁴⁸ This rate was estimated by WHO (2002a) for developing countries.

			Baseline	Source
Percent of diarrheal cases treated at medical facilities (children < 5 years)			15%	World Bank, 2006b based on DHS and LSMS
Average cost of examination and treatment per consultation including transport cost(\$)	Lower Bound	With usual health care provider	0.4	TL DHS 2003
	Central	Average	17.0	
	Higher Bound	Doctor in private clinic	33.6	
Percent of diarrheal cases treated with oral re-hydration salt (ORS) among mothers (children < 5 years)			60%	World Bank (2006b)
Average cost of oral re-hydration salt (ORS) per treatment (days) (\$)			0.4	Assumption (one ORS packet per day during 4 days)
Average duration of diarrheal illness in days			4	Larsen (2006)
Average hours per day of care giving per case of diarrheal in children <5			2	Larsen (2006)
Avg. value of one hour of time for care giving adults(\$)		75% of avg hourly minimum wage (effective minimum wage US\$2/day)	0.2	Larsen (2006) and World Bank (2007e)

The annual diarrheal disease cost per case is estimated to be approximately \$1.81 (lower bound), \$4.31 (central), and \$6.80 (upper bound), depending on the assumptions used.

The next step is to calculate the total annual cases of diarrhoeal disease. According to the Timor-Leste DHS 2003, diarrheal disease two-week prevalence in children under 5 is 0.101 (i.e., 10.1 percent of children were estimated to have diarrhea starting or continuing into the two-week observation period). Timor-Leste MICS reports a higher rate of 0.254. The large difference between the two surveys could be explained in part by the timing of data collection,⁴⁹ and they are used in this section as the lower and higher bounds.

To convert the two-week prevalence into a two-week incidence,⁵⁰ the first number is multiplied by 0.78.⁵¹ The two-week diarrheal incidence rate is 0.198 (and 0.786)—i.e., 19.8 (and 7.86) percent of children younger than 5 were estimated to have had a diarrheal episode starting in the two-week period. To convert this number to annual incidence, it is multiplied by 26. The annual diarrheal incidence rate is calculated to be 5.14 (and 2.04) cases per child per year. The total annual cases of diarrheal disease in children under 5 attributable to inadequate water supply, sanitation, and hygiene are estimated to be approximately half a million.⁵²

Combining information on the number of annual cases and COI, the total annual morbidity cost of diarrheal illness for children younger than 5 attributable to inadequate water supply,

⁴⁹ Timor-Leste MICS 2002 data were collected during August-September 2002, while the DHS 2002 data were collected during April-August 2002.

⁵⁰ Two-week incidence is the number of episodes starting during a two-week period.

⁵¹ Two-week incidence rate = two-week prevalence rate*[14/(14+average duration of the episode)]. It is assumed that the average duration of a diarrheal episode is four days.

⁵² The lower bound figure is 270,940 and the higher bound is 681,374.

sanitation, and hygiene is estimated to be between \$500,000 and \$4.6 million (see Table C.5). This represented between 0.06 and 0.5 percent of Timor-Leste GNI in 2006.

Table C.5. Total Morbidity Cost of Diarrheal Illness, Children Under 5

	Low	Central	High
Attributable number of cases to inadequate WSS	270,940	476,157	681,374
Annual COI for diarrhea (\$)	1.82	4.31	6.80
Total annual cost of diarrhea (\$)	493,111	2,052,236	4,634,363

There is no national information on diarrheal illness for the population older than 5. Following Larsen (2006), international evidence is used. These data indicate that diarrheal incidence in the population over 5 years old is one-fifth of the incidence rate for children under 5. The estimated COI for children under 5 is also applied here, using the same assumptions but assuming that two working hours per day are lost to illness per case in adults. Using this information, the total annual morbidity cost of diarrhea for the population over 5 years old attributable to inadequate water supply, sanitation, and hygiene is estimated to have been between 0.06 and 0.5 percent of Timor-Leste GNI in 2006 (see Table C.6).

Table C.6. Total Morbidity Cost of Diarrheal Illness, Population Over 5 Years of Age

	Low	Central	High
Attributable number of cases to inadequate WSS	277,674	487,992	698,309
Annual COI for diarrhea (\$)	1.82	4.31	6.80
Total annual cost of diarrhea (\$)	505,367	2,103,245	4,749,551

C.3 Total Cost of Health Effects

In summary, the annual morbidity and mortality cost of health effects from inadequate water supply, sanitation, and hygiene is estimated at some \$16.9 million (see Table C.7). The mean estimate is equivalent to about 1.9 percent of Timor-Leste GNI, or 4.8 percent of GDP in 2006. Table C.8 provides some estimates of the cost of poor sanitation in other countries for comparison.

Table C.7. Total Cost to Health from Inadequate Water Supply, Sanitation, and Hygiene (dollars)

	Low	Central	High
Mortality			
Children under age 5	12,694,690	12,694,690	12,694,690
Morbidity			
Children under age 5	493,111	2,052,236	4,634,363
Population over age 5	505,367	2,103,245	4,749,551
TOTAL	13,693,168	16,850,170	22,078,604
% of TL GNI 2006	1.6%	1.9%	2.6%

Table C.8. Cross-country Comparison of Cost of Poor Sanitation

Variable	Timor-Leste	Cambodia	Indonesia	Philippines	Vietnam
GNI per capita, Atlas method (current US\$)	750	440	1260	1270	620
GDP per capita, PPP (constant 2005 International \$)	2224	1440	3209	2956	2143
Sanitation					
% Improved rural	33	15.7	40	59	50
% improved urban	66	56.1	73	80	92
% improved total	36	24	55	72	61
% urban sewerage connection treated	0	28.9	2	3.3	14
Economic cost of poor sanitation (% Country GDP)		7.2	2.3	1.3	1.3

Source: World Bank 2007a, 2007f.

Annex D: Land Management Survey

The land management survey was conceived as an extension of the Timor Leste Survey of Living Standards (TLSLS) carried out in 2007. The TLSLS collected detailed household living standards data from a nationally representative sample. This survey contained a brief section on agricultural plots managed by the households. However, it did not collect land management practice data.

The extension to TLSLS allowed detailed data collection aimed at meeting needs of diverse areas of research, such as finance, vulnerability, justice, and land management. The land management module of the extension focused on plot and forest clearing practices, long-term land management, and investment practices. The extension also looked at the extent of the Siam weed infestation at the plot level and various coping strategies. The design of the extension survey followed the original survey closely. A nationally representative random subset of households in the original sample was selected to be visited again for the extension. This survey design method allowed the merging of household-level data from the original survey with that from the extension for a richer analysis.

The first round of the extension survey took place in May-August 2008 and collected data from 1,559 households previously surveyed in the TLSLS from 13 districts. Initial review of the data indicated errors in the data collection. As a result, the complete survey was implemented to about 300 additional households in the districts where errors had been uncovered. The field work was undertaken by the end of 2008. This analysis uses data from both the original and the replacement households.

The land management module was initially intended to collect very detailed information on specific types of land management practices. Some of the details were lost in the translation during the implementation of the survey. Preliminary analysis showed that respondents tended to answer one way or the other for broad groups of land management questions. Thus, it was concluded that the respondents grasped a variety of land management practices, such as crop rotation and crop residue management, but details of specific methods of these practices may have been lost in translation. To compensate for these difficulties, the data from related practices were aggregated. For example, detailed information about improved fallow, stripped fallow, and fallowing of whole plots were aggregated to indicate whether households practiced any type of fallowing.

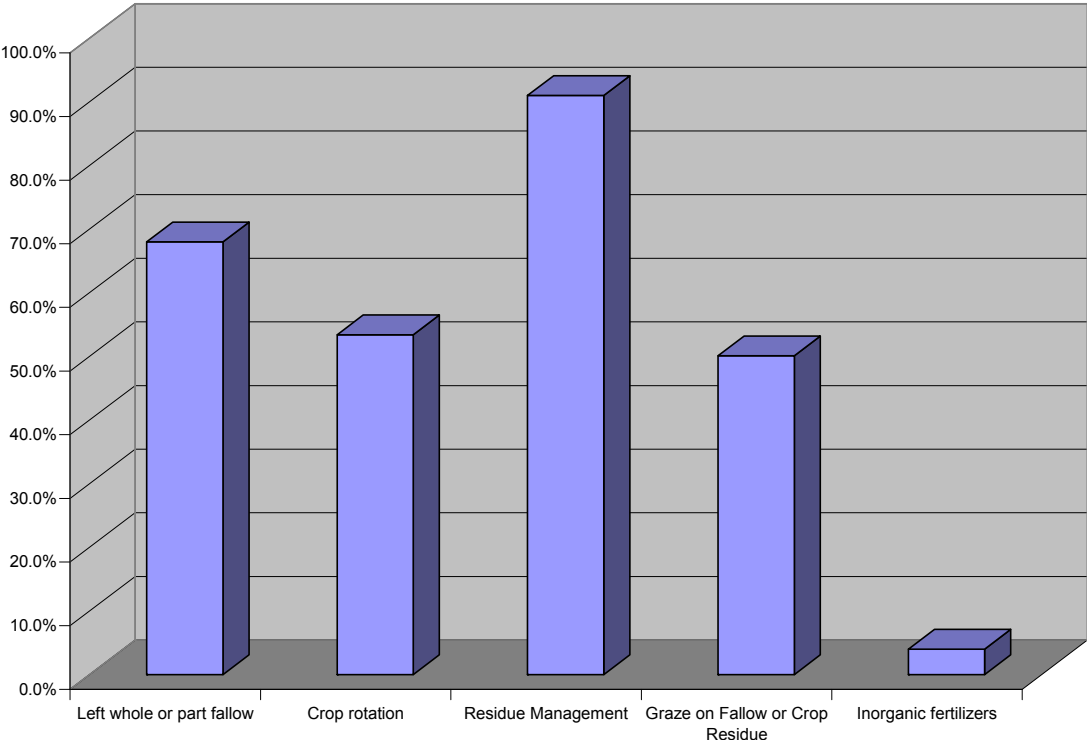
The survey included both urban and rural households. About 75 percent of the population in the country is rural. Preliminary analysis indicated that both urban and rural households were involved in agriculture and actively managed agricultural plots. As a result, this study uses all the households in the sample, though different weights were used for urban and rural households to account for their representativeness in the national population.

The study looked at the linkages between various sustainable and unsustainable land management decisions by households and welfare indicators. It focused on two types of practices: investments in land and practices leading to land degradation such as slash-and-burn deforestation. The study defined poor households as those with per capita consumption expenditures of less than \$27 per month adjusted for regional differences in prices. An average rural household holds two plots. Though the average number of plots is not different for poor and non-poor households, the poor households have significantly smaller holdings.

D.1 Land Management Practices

Both poor and non-poor households use a mix of land management practices on their holdings (see Figure D.1). Keeping a plot fallow and crop rotation are practiced by a majority of households. However, almost all households practice some kind of crop residue management. Keeping a plot fallow and crop residue management allow moisture and fertility retention in the soil. Almost half the households also allow livestock to graze on the fallow and crop residue. Grazing reduces the soil management benefits of fallow plots and residue management, but it does entail some natural fertilization. As expected, the rate of inorganic fertilizer and other chemical use is very low in rural Timor-Leste.

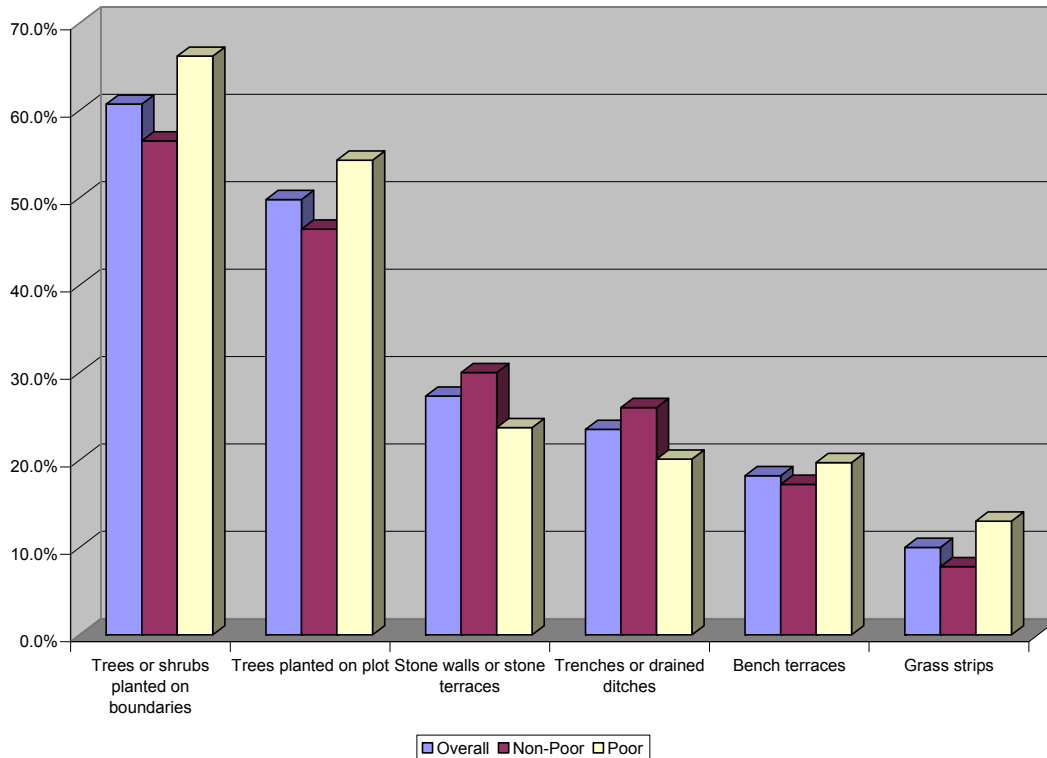
Figure D.1. Land Management Practices, by Percent of Households



Structural Investments

The most prevalent investment in sustainable plot management is planting shrubs or trees along plot boundaries, followed by trees within plots in about half of the households (see Figure D.2). Relatively fewer households and particularly fewer poor households invested in other enhancements in their plots.

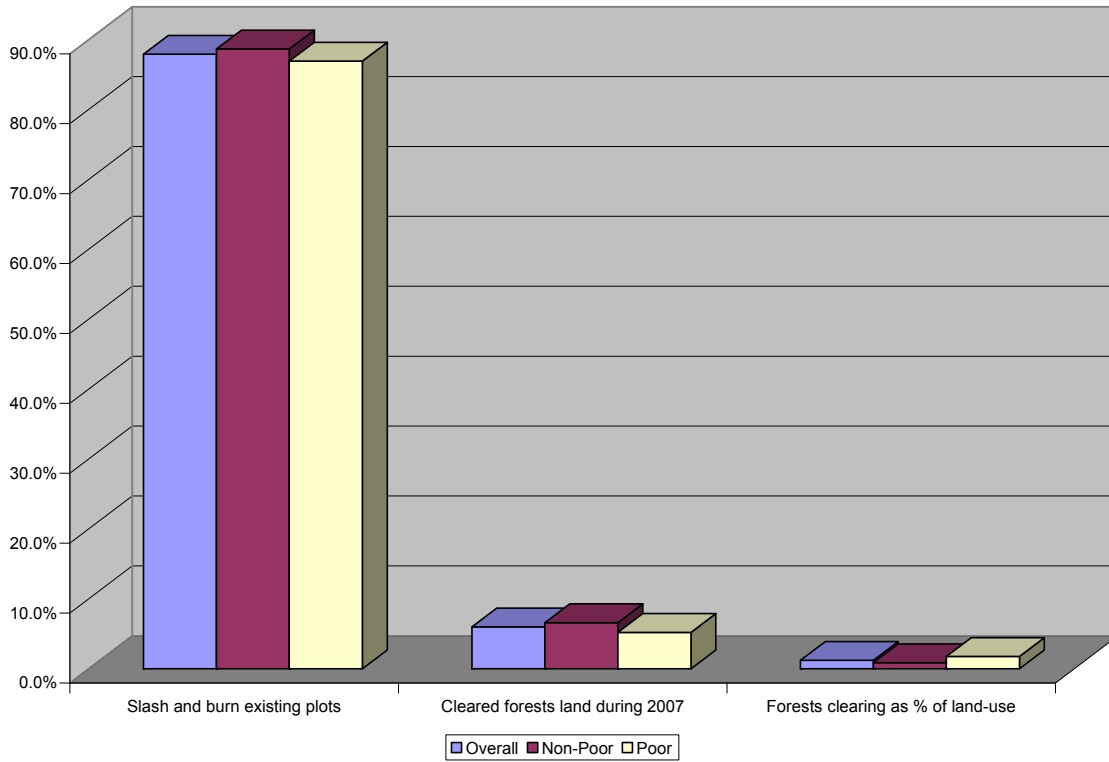
Figure D.2. Physical Investments in Plots, by Percent of Households



Slash and Burn

Slash and burn is widely used for clearing existing plots. A very high percentage of both non-poor and poor households reported to have used slash and burn to clear their plots (see Figure D.3). However, only about 6 percent of the households reported to have cleared forests in 2007. The total area cleared was about 1 percent of the all the land holdings surveyed.

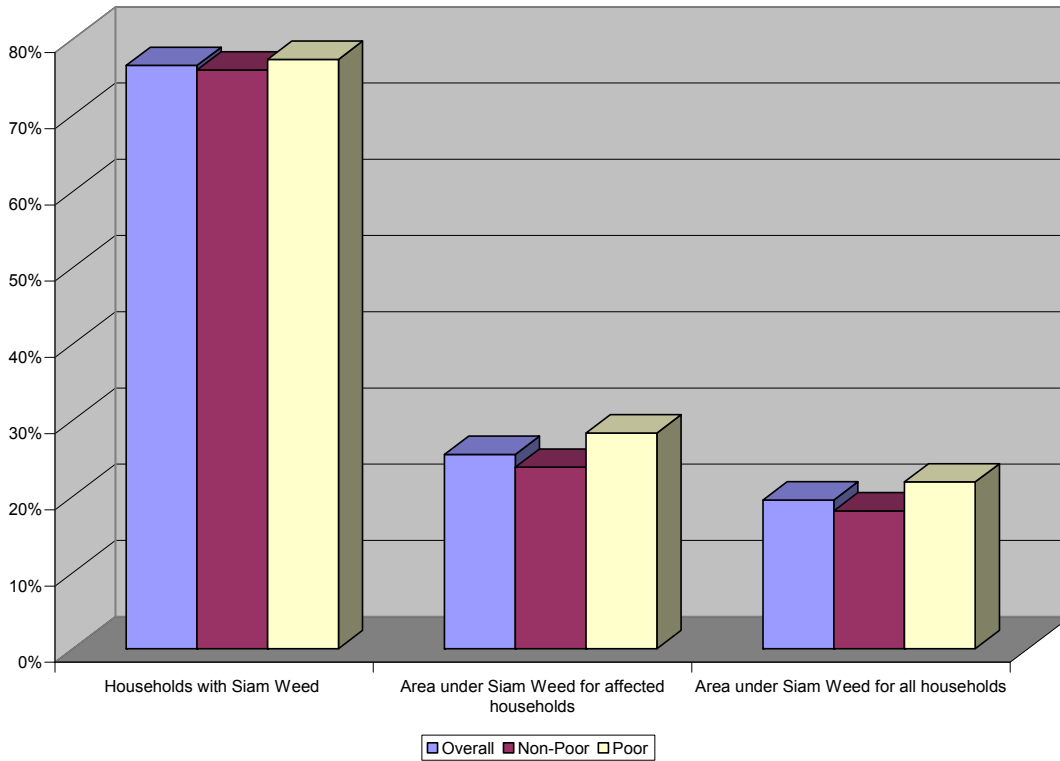
Figure D.3. Slash and Burn of Existing Plots and Forests



D.2 Siam Weed

About 77 percent of the households reported to have Siam weed in their plots, and on average about 25 percent of their plot areas were affected (see Figure D.4). Thus about 20 percent of all the land surveyed was affected by Siam weed. A slightly higher proportion of poor households than non-poor households reported these problems. A high degree of Siam weed infestation may be one of the reasons for the popularity of slash-and-burn plot clearing. This is not an effective means of eradication, however.

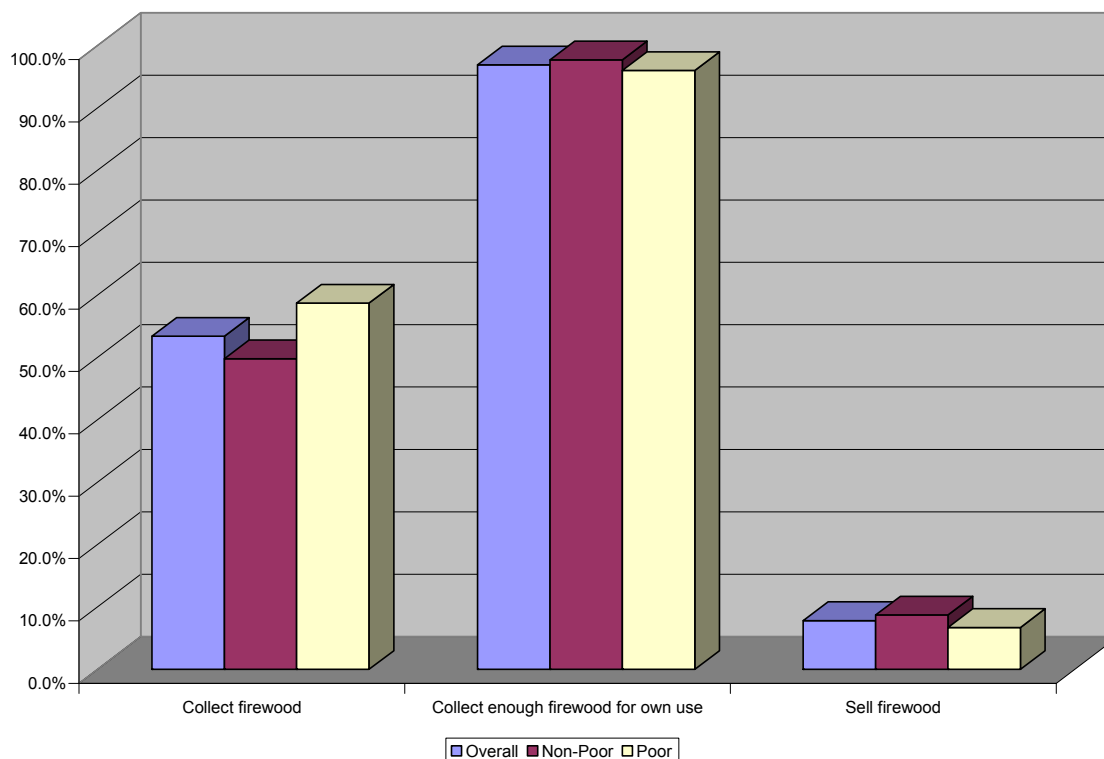
Figure D.4. Households and Plot Areas under Siam Weed Infection



D.3 Firewood Use

Almost all rural households in the sample used firewood as their main cooking fuel (see Figure D.5). However, only 50 percent of non-poor households and 59 percent of poor households reported collecting firewood. Almost all households reported that they were able to collect a sufficient quantity of firewood for their own use. Nine percent of the non-poor firewood collecting households also sold firewood, compared with 7 percent of the poor households.

Figure D.5. Firewood Collection and Selling, by Household



D.4 Conclusions

- Rural households practice sustainable land management practices such as residue management and tree planting to a very high degree. However, slash and burn is widely used to clear land, which is inexpensive and provides short-term fertilization but can be very destructive, in particular if fires run amok.
- There are only marginal differences between the poor and non-poor households in terms of land management and investment patterns.
- The predominance of slash-and-burn plot clearing methods is reinforced by the large prevalence of the Siam weed in the plots held by most households. However, this is not an effective means of eradication, and biological methods would need to be implemented to combat this infestation.
- The clearing of forests for agricultural use is small in relative terms according to this study. There appears to be no significant difference between poor and non-poor households in this regard.
- Firewood is universally used as cooking fuel, though a surprisingly low share of households collect their own wood. Relatively more poor households collect firewood.

Annex E: National Development Planning

This annex describes the National Priority (NP) areas identified by the six National Priorities Working Groups that became fully operational in June and the investment programs prepared to set detailed policies by the previous government.

The government's National Priorities 2009 are grouped into seven areas: agriculture and food security, rural development, human resources development, social protection and social services (including health), security and public safety, clean and effective government, and access to justice.

Agriculture and Food Security. This NP area is co-led by the Ministry of Agriculture and the Ministry of Commerce, Tourism and Industry. For its primary goal of boosting food production, the government sets out to increase the area under paddy cultivation and the second paddy crop, along with a higher percentage of high-yielding seeds, agricultural mechanization, and crop intensification systems delivered by trained extension workers.

Rural Development. Jointly led by the Ministry of Economy and Development and the Ministry of Infrastructure, this NP area undertakes to alleviate poverty through both the promotion of business initiatives and the improvement of infrastructure targeted for rural development, mainly focused on the promotion of agribusiness.

Human Resources Development. This NP priority area has three distinct targets: improve the quality of basic and technical professional education; prepare young people for the labor market, and ensure participation of young people, under the joint leadership of the Ministry of Education, the Secretary of State for Vocational Training and Employment, and the Secretary of State for Youth and Sports.

Social Protection and Social Services. This priority area is led by the Ministry of Social Solidarity and the Ministry of Health. Continued emphasis is placed on the sustainable reintegration of internally displaced persons (IDPs) through delivering relocation assistance, including recovery packages for IDPs, and the completion of an exit strategy for IDPs in transitional shelters. Social stabilization programs in conflict-prone communities will be run by a dedicated Ministry of Social Solidarity peace building unit. A multi-pronged approach will be used to protect vulnerable groups.

Security and Public Safety. This NP area is jointly led by the Secretary of State for Defense and the Secretary of State for Security. Establishing an overarching reform framework for the Timor-Leste Defense Force and the Policia Nacional de Timor-Leste has highest priority. This will be

accomplished through submission of a revised National Security Policy to the Council of Ministers, as well as drafts of a National Security Law and an Internal Security Law. Drafting of a Maritime Strategy with a model integrated maritime administration is intended to promote this reform framework.

Clean and Effective Government. Under the leadership of the Ministry of Finance, continued emphasis will be placed on aid effectiveness as an objective to harmonize official development assistance with government priorities. Government accountability, transparency, and integrity will be promoted through improved government efficiency and transparency in handling funds as well as an Expenditure Review Unit with trained staff. A performance budgeting module will be introduced for the FY 2010 budget preparations.

Access to Justice. This important new NP segment is led by the Ministry of Justice, in cooperation with the General Prosecutor's Office and the Office of the President of the Court of Appeal. Three distinct priority areas are foreseen in order to realize access to justice, including for vulnerable groups: strengthening the justice system, bringing justice to citizens, and promoting private sector development. A policy on gender justice will be developed for implementation. The Ministry of Justice will promote private sector development through implementation of land and property registration (as land laws and Properties Registry Code package solution) as well as through proposals and recommendations from an expert Working Group that are approved and implemented.

The main focus areas for the different sectors can be described based on the *State of the Nation Report for Natural Resources and the Environment Sector* (GoTL 2008b) and on Sector Investment Programs (SIPs) elaborated by the previous government.

SIPs were prepared as action plans by the previous government. Subsequent to the preparation of the National Development Plan (NDP), the government recognized the need for a mechanism by which the longer-term goals and aspirations of the nation could be translated into action. By mid-2005, a total of 17 individual SIPs were prepared to set detailed policies, programs, and expenditure requirements for each sector for the period FY2005/06 to FY2009/10 (GoTL 2006a).

The SIP for the natural resources and environment sector and for the agriculture, forestry, and fisheries sector are the two most relevant action plans for environmental issues. The SIP on natural resources and the environment (GoTL 2006c) describes four priority themes: capacity building (there is still a very serious shortage of trained individuals with the necessary knowledge and technical and managerial skills in each of these sectors); further development of institutional capacities; building a better understanding of the resource base of the country (the development of appropriate plans, policies, and legislation ultimately relies on reliable, comprehensive, and up-to-date information); and enabling the environment for the private investment (this will be needed for commercial development of natural resources in a sustainable manner).

The SIP for the agriculture, forestry, and fisheries sector (GoTL 2006d) includes the Policy and Strategic Framework for the sector developed by the Ministry of Agriculture, Forestry, and Fisheries (currently the Ministry of Agriculture and Fisheries). The agriculture and livestock

sector continues to be the most important source of livelihood for the majority of the population of Timor-Leste and therefore it makes an important contribution to the objectives of the NDP and the Millennium Development Goals. The plans for the sub-sector include measures to increase food production, improve food quality, improve animal production, support the development of agricultural industries for domestic and export markets, design effective agricultural planning based on improved data, provide an appropriate legislative and regulatory framework, and increase the amount and quality of information services to farmers.

The forestry sector policy was approved by the government in 2007. The purpose of the community forestry policy is to operationalize the government's agenda for decentralization and devolution of authority for the management of natural resources to lower levels of government and to civil society. It will enable, rather than enforce, rural communities to improve their livelihoods and the condition of the forests in their vicinity by removing any constraints that inhibit them from doing so. Government agencies and other service providers will adopt a supportive and facilitative role to support communities in these efforts. There are two categories of forests for community management. All traditional community lands (*rai adat*) can be allocated to communities for community forestry management to the extent that communities are able and willing to carry out sustainable forest management; and communities can make application for public land (*rai estado*) to be allocated for community forest management if they can demonstrate that they can carry out sustainable forest management (FAO 2007b).

The 2008–2010 development plan includes a reforestation and a capacity building program. The plan includes the creation of tree nurseries with trees for domestic use, trees for human and environmental rehabilitation, and trees for commercial use in all districts, but with a particular focus on dry/arid and waste lands. The program also includes capacity building for foresters, the creation and protection of Forest Centers supported by the creation of adequate legislation, and civic education programs (GoTL 2008b).

The National Department of Fisheries and Aquaculture has focused its plan on improving information and on creating a monitoring system. The plan aims to: continue institutional capacity building, including policy and legislative development; enhance the capacity of staff to undertake their core functions; gather data to determine sustainable production levels for fish resources and to base local and national management planning to maintain a healthy marine environment; work with coastal communities to develop effective inshore/near-shore catch monitoring systems; encourage and facilitate private sector investments, first in an offshore fishery and second in better facilities for storage, processing, and distribution of local fish supplies; and implement regulatory measures and enforcement (GoTL 2006d).

The water and sanitation sector considers that adequate land use, sanitation, and other pollution prevention measures need to be adopted to protect the environment (GoTL 2006e). The primary sector key results areas are: adequate, safe, and sustainable water supplies; safe disposal of sewerage and wastewater in urban areas; the collection and safe disposal of nuisance surface waters from major urban areas; the collection and safe disposal of solid and hazardous wastes from major urban areas; management of water resources for the purpose of water supply and sanitation in cooperation with other relevant ministries; and adoption of safe

water supply and sanitation practices that contribute to improved human health and environmental protection.

The main policy objective of the energy sector is to gradually substitute imported with indigenous energy resources, including renewable energy. The strategy for the sector is less clear since further evaluation and assessment of the alternative sources are needed.

In the mining sector, the government plans to develop geological information and institutional capacity and to draft regulations for mining. The mining sector in Timor-Leste is currently restricted to sand and gravel operations. An inventory of the on-shore potential for Timor-Leste was carried out in 2002–03 (UNESCAP 2003) to improve the information on mineral reserves. The inventory suggested that a limited number of larger-scale operations may develop, but it also indicated that there is some potential for mineral extraction in relatively small-scale mining projects.