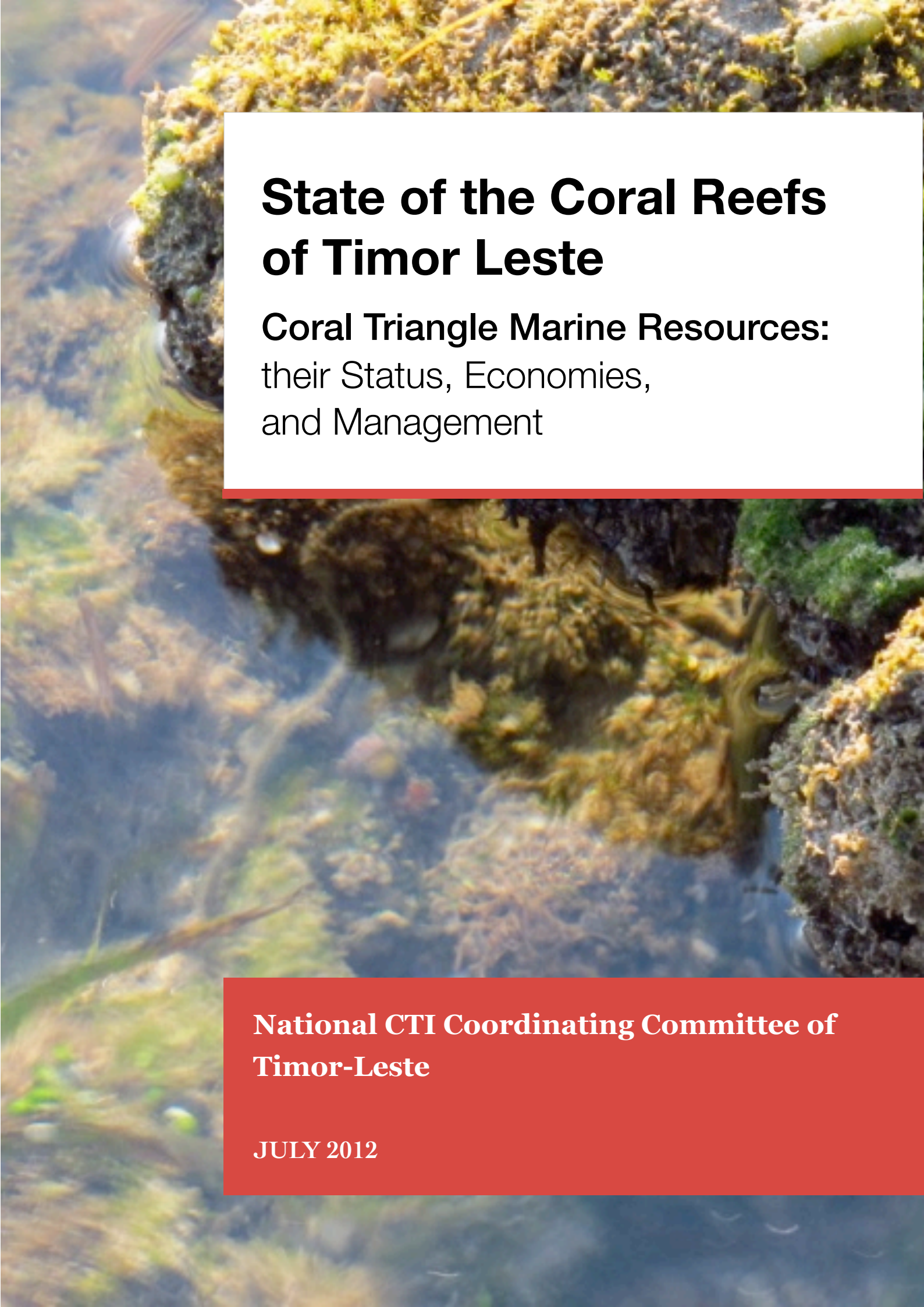

State of the Coral Reefs of Timor Leste

Coral Triangle Marine Resources: their Status, Economies, and Management

National CTI Coordinating Committee of Timor-Leste

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Extracts of the Timor-Leste State of the Coral Triangle Report (SCTR) is available at the ***Coral Triangle Learning Resource Network***
http://www.coraltriangleinitiative.net/SCTRlaunch

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I.Executive Summary

Introduction

Timor-Leste is the youngest country in the Coral Triangle (CT), achieving 10 years of independence in 2012. It is located in an important transitional region of the CT, the Wallacea between Asia and Australia, and is considered a biodiversity hotspot . Timor-Leste has several ongoing projects with the FAO (Food and Agricultural Organization) Regional Fisheries Livelihoods Programme (RFLP), Coral Triangle Support Partnership (CTSP), Arafura Timor Seas Expert Forum (ATSEF), Partnerships in Environmental Management for the Seas of East Asia (PEMSEA), Charles Darwin University of Australia, and the U.S. National Oceanographic and Atmospheric Administration (NOAA), among others. These initiatives have helped begin the work towards meeting the higher level goals of food security, sustainable fisheries, and securing critical services from coral reefs and related ecosystems. Knowledge gaps present challenges as evidenced in Timor-Leste's State of the Coral Triangle Report. It is expected that, as Timor-Leste is able to more systematically establish and collect baseline datasets, tracking progress will become easier and more accurate.

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The National Plan of Action (NPOA) is complete, with initial goals focusing on establishing key policy and legislative frameworks, collecting baseline data for ecological and socio-economic monitoring, and knowledge management.

Biophysical Characteristics

Timor-Leste is a small island state of just about 14,874 km^2. Most of the country's land area is located in the eastern part of Timor Island, which is shared with Indonesia, in between the Timor Sea to the south and the Banda sea to the north. The two coastlines, measuring 706 km, are dramatically different in terms of oceanography and coastal geography and, therefore, support quite different marine habitats.

The Banda Sea to the north has the largest areas of coral reefs, seagrass meadows, and mangroves. The reef flats are narrow (20-100 m), dropping off sharply to the deep sea. Species and habitat surveys are not comprehensive, and reports of the potential habitat area differ. The total fringing reef area is around 146 km^2. The reefs are likely to be rich in biodiversity, as with other reefs in the region, but little detailed data are presently available. Mangrove cover was around 18 km^2 in 2008, a steep decline from 90 km^2 in the earlier part of the last century.

Timor Sea to the south is shallower with wider coastal plains. This probably facilitates the retention of riverborne sediments and nutrients, stimulating pelagic and benthic productivity in an area adjacent to where most of the oil and gas of Timor-Leste is found. Timor-Leste has experienced few or no tropical cyclones since 1970, although its coral reefs in the south are exposed to heavy seas from frequent cyclones from the Indian Ocean and the Timor Gap. Mangrove forests on the south coast are sparse and small.

The country also has two islands: Atauro Island of about 144 km^2 and the smaller uninhabited Jaco Island of 8 km^2. Seaweed culture in Atauro Island is the major income-generating activity, bringing in a total revenue of about US$ 19,130 from seaweed export in 2009.

Governance

The State Government owns all natural resources in Timor-Leste. Fisheries and protected area management is the responsibility the Ministry of Agriculture and Fisheries (MAF). A range of laws and policies to regulate fishing has been passed since Timor-Leste's independence in 2002. An integrated fisheries policy, *The Future for Fisheries: A Policy and Strategy for the Responsible Development and Management of Fisheries in Timor-Leste,* is currently being prepared, covering the following areas: (i) optimal use and management of living resources; (ii) habitat conservation; (iii) fishing industry development; (iv) aquaculture industry development; and (v) development of fisheries institutions. While this

emerging policy framework is a strong foundation, the limited capacity of MAF to effectively implement these policies and regulations is a challenge.

The Constitution of Timor-Leste recognizes traditional natural resource management practices, such as *Tara Bandu* or the establishment of season taboos, which is part of the *Adat* system. Alongside the construction of state-based resource management, CTI development partners, such as the Coral Triangle Support Program (CTSP), are recommending a community-based framework for the management of Timor-Leste's proposed marine protected area (MPA) network, starting with Nino Konis Santana National Park, Timor-Leste's declared National Park.

Socioeconomic resources

Socioeconomic data on the contribution of coral reefs and fisheries to the livelihoods and food security are sparse.

Fishing and other marine activities were common from the earliest human settlements in Timor-Leste. Now, except for Dili, few urban settlements are on the coast. Despite its long coastline and apparent abundant marine resources, the fisheries sector is still underdeveloped. Timor-Leste has no commercial fisheries, although a few semi-industrial licenses have been issued. In 2010, agriculture (including fisheries) contributed up to 94% of the income of communities dominated by subsistence farming systems (i.e., up to 85% of the total population). However, with the current growth rates of 3-4% per annum, the population (including subsistence fishers) will grow significantly, thus resulting in more pressure on the country's natural resources.

Estimates of the number of artisanal fishers in Timor-Leste have fluctuated widely. A 2002 study estimated 20,000, whereas recent surveys calculated 5,415 fishers nationwide, although it is possible that including the number of part-time subsistence fishers would increase the latter figure. With about 30% of the Timor-Leste population estimated to be experiencing hunger and nearly half living in poverty, it is likely that poverty and hunger exist at relatively high rates in fishing communities.

Despite the lack of commercial fisheries and the prohibitive prices of seafood in local markets, fisheries probably play a critical role in food security for subsistence households. Women and children collect juvenile fishes, crabs, molluscs, and sea urchins through shoreline activities known as "*meti*" or use of rotenone-based pesticides derived from derris root. Catch from artisanal fishers is usually sold in roadside markets at an average price of US$5 per kg.

Aquaculture and associated activities are beginning to take hold in Timor-Leste. CTI projects, such as the FAO's Regional Fisheries and Livelihood Program, are helping with livelihood diversification in coastal communities. Seaweed culture is playing an increasing role as a result of a successful project of the National Directorate for Fisheries and Aquaculture (NDFA). Other seafood products are also being tested through a US Government-funded project. In addition, The WorldFish Center is assisting Timor-Leste in devising a national aquaculture strategy and action plan for the development of sustainable aquaculture.

The CTI is the first program to introduce the concept of payment of ecosystem services (PES) in Timor-Leste as a means of managing and generating incentives for the management of the country's marine and coastal resources.

Threats, Vulnerabilities, and Emerging Issues

Erosion resulting from deforestation, particularly of mangroves and riparian vegetation, has impacted many of Timor-Leste's tropical marine ecosystems. Mangroves continue to be harvested for fuel and food, despite some localized attempts at rehabilitation.

Illegal fishing is another major threat to Timor-Leste's fish stocks, particularly from encroaching fishers using destructive techniques such as blast fishing. Estimates of the loss to the Timorese economy from illegal fishing may reach US$40 million a year. Monitoring and surveillance levels are very low.

Transmigration in Timor-Leste is part of the policy of the Indonesian Government to "go east." Transmigrants brought with them various fishing practices. Fisher communities close to main fishing ports have linked the arrival of transmigrants to the introduction of blast fishing, cyanide fishing, use of compressors for *Trochus* (top shells), and sea cucumber harvest.

Population growth and density along the north coast, where the largest areas of coral reefs and associated ecosystems are found, is an emerging issue. Over time, this will exacerbate pressure on marine resources, either

directly, through increased harvesting, or indirectly through increased erosion resulting from peasants moving to steeper and more marginal land.

The impact of these threats is likely to be difficult to contain, given the limited management capacity to implement the programs and policies devised under the National Plan of Action (NPOA).

National Plan of Action

Timor-Leste's responses to date fit in with the overall goals of establishing baseline data and key policies and legislation to support fisheries and protected area management. Ongoing mapping and habitat assessment exercises, which are being carried out in conjunction with international scientific institutions, will also provide Timor-Leste with invaluable baseline data to assess its progress in future State of the Coral Triangle Reports. Assessment of threatened species and the formulation of fisheries policies and management plans for the proposed MPA network are also in progress. Implementing these policies and plans is the next big challenge for Timor-Leste.

Signs of historical overfishing, including low abundance of valuable commercial and upper trophic-level species like snappers and groupers, as well as the emergent threat of destructive fishing, mean that effective management is vital to the protection of Timor-Leste's reefs through fishing regulations and the proposed MPA network. Similarly, managing upland threats through integrated catchment management and the rehabilitation of mangrove forests are emergent priorities for Timor-Leste.

Food security for coastal populations as well as for the general Timor-Leste population is an ongoing concern. As mentioned earlier, about 30% of the Timor-Leste population is experiencing hunger, and many live in poverty. Small site-based projects, such as PEMSEA's integrated coastal management demonstration sites and other livelihood projects, will provide valuable lessons for rolling out more systematic measures to sustainably and inclusively manage Timor-Leste's rich marine resources, both for sustainable fisheries and improved food security.

Seizing opportunities to derive payments for ecosystem services from offshore oil resources should be considered to help fund resource management and enhance access and use rights by the impoverished sectors and make food available as part of corporate social responsibility.

I. Introduction

The Government of Timor-Leste is actively engaging with a series of development and aid agencies to ensure that the development of the fisheries sector in done in a sustainable and participatory manner. This report starts by presenting some of the programs currently ongoing or in the pipeline and provides contact details for each one of them to facilitate communication and coordination of efforts.

Regional Fisheries and Livelihood Programme (RFLP)

http://www.fao.org/fileadmin/templates/rap/files/epublications/TimorLesteedocFINAL.pdf

Key contact: Henrique Alonzo
Government Focal Point: Pedro Rodrigues

The FAO-supported RFLP aims to improve livelihood opportunities and sustainable fisheries resources management. It assists in the development of a cold chain for fisheries products to allow improved market chains, the enhancement of postharvest and handling practices, as well as the introduction of improved preservation techniques. The RFLP helps to improve co-management mechanisms, ensuring the long-term conservation of fisheries resources. Safety at sea is addressed through specific training and the development of an accident reporting system. Alternative livelihoods and microfinance are planned to be addressed in the future. In 2005 and 2007, a project to gather information on the fisheries sector in Timor-Leste was implemented.

Coral Triangle Support Partnership (CTSP)

www.usctsp.org

Key contact: Niall Byrne
Government Focal Point: Celestino da Cunha Barreto

CTSP supports the governments of Indonesia, Malaysia, Papua New Guinea, Philippines, Solomon Islands, and Timor-Leste (referred to as the CT6) in their regional commitment to ensure that the world's most precious marine areas are sustained well into the future. Made up of a unique consortium of the world's leading conservation NGOs – World Wildlife Fund (WWF), Conservation International (CI), and The Nature Conservancy, CTSP is a five-year, $32-million project supported by the United States Agency for International Development (USAID). The collaborative nature of this partnership encourages the development of transformational policies on natural resource management, strengthens the capacity of institutions and local communities, and builds decision support capacity. CTSP is part of the US support to the Coral Triangle Initiative (USCTI), which also involves the National Oceanic and Atmospheric Administration (NOAA), the Program Integrator (PI), the Department of Justice (DOJ), and the US State Department. The Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (CTI-CFF) is a multilateral partnership of six countries formed in 2009 to address the urgent threats facing the coastal and marine resources of one of the most biologically diverse and ecologically rich regions on earth.

Strengthening Coastal and Marine Resources Management in the Coral Triangle of the Pacific, Phase 2 (CTI-Pacific)

Government Focal Point: Aleixo Leonito Amaral

This regional technical assistance (RETA) project funded by the Asian Development Bank (ADB) is part of ADB's commitment to the CTI-CFF, a regional effort to preserve and manage Asia-Pacific's marine resources. One of three subprojects under the ADB-funded CTI program, this RETA is aimed at supporting the introduction of more effective coastal and marine resource management, especially those associated with coral reefs, threatened by human and climate change impacts. A climate change adaptation program is built into the project, which will include conducting climate vulnerability assessments, developing climate adaptation measures, and creating public awareness of climate change challenges. The project will also help ensure food security for the populations in Pacific countries through the increased resilience of their marine and coastal ecosystems. The RETA is being

implemented in Fiji Islands, Papua New Guinea (PNG), Solomon Islands, Timor-Leste, and Vanuatu.

Arafura Timor Seas Expert Forum (ATSEF)

Government Focal Point: Augusto Fernandes

ATSEF provides opportunities to improve informationsharing arrangements between the littoral states of the Arafura and Timor Seas. It provides an opportunity to identify cooperative research agendas and arrangements to enhance the capacity to sustainably manage the Arafura and Timor Seas. The Forum promotes effective information exchange and development of policy, scientific, and institutional linkages to augment existing arrangements between littoral states and strengthen and extend intergovernmental regional cooperation. Expected results include: (i) development of agreements or protocols concerning information exchange; (ii) identification of agreed management priorities for the Arafura-Timor Seas; (iii) identification of research and information requirements to support agreed management priorities; and (iv) identification and development of opportunities for progressing sustainable development through the exchange of information on practical institutional and policy approaches.

Partnerships in Environmental Management for the Seas of East Asia (PEMSEA)

Government Focal Point: Roberto Lemos

The Government of Timor-Leste signed the Haikou Partnership Agreement for the implementation of the Sustainable Development Strategy for the Seas of East Asia (SDS-SEA). PEMSEA is a joint initiative between the Global Environment Facility (GEF), the United Nations Development Programme (UNDP), and the International Maritime Organization (IMO).[1] It aims at building interagency, intersectoral, and intergovernmental partnerships to achieve sustainable development of the Seas of East Asia. It has developed a range of methodologies, techniques, working models, and standards that help improve coastal management including the integrated coastal management (ICM) framework (Weber, 2008).

ACDI/VOCA

http://www.acdivoca.org/site/ID/easttimorMudCrabandMilkfishCultivation/

Key contact: Elizabeth Weber (eweber@acdivoca.org)

Government Focal Point: Dani do Carmo

ACDI/VOCA was recently awarded a grant from the United States Department of Agriculture for a Mud Crab and Milkfish Cultivation Project in the northern coastal villages of Timor-Leste. The project will be developed in collaboration with the Fisheries Department of the Ministry of Agriculture and Fisheries (MAF) and with the Ministry of Tourism, Commerce, and Industry (MTCI). The project will establish fisheries cooperatives in 20 villages along Timor-Leste's north coast to develop and manage crab and fish nurseries. Families wishing to raise crabs or fish will be selected by the cooperatives. Most of the participants will be women, because crab and fish cultivation activities are not dependent on a fixed schedule and allow for the flexibility women need to accommodate other household responsibilities, and the cages and tanks will be located in the villages, close to their homes.z Technical assistance will be provided by the project in forming and managing the cooperatives and in the technical aspects of crab and fish cultivation. Solar-powered tanks will be installed in each village, and members of the cooperatives will be taught in their maintenance and use. Crab cages and fish pens will be made from local materials, and locally woven baskets will be used to transport the crabs to a central holding tank facility in Dili, the capital. A receipt system will be designed and implemented so that individual producers can be accurately compensated for the crabs sent to market. The project will enter a close-down phase at the end of the third year. Because of the high demand for crabs, and the consequently high return for them, the project will become a sustainable new industry for Timor-Leste.

[1] PEMSEA is now an intergovernmental organization composed of member countries with headquarters at the Department of Environment and Natural Resources (DENR) in the Philippines.

II. Biophysical Characteristics

A. Physical Geography

Geography

Timor-Leste is situated in an important transition region of the Coral Triangle Initiative known as Wallacea. This region between Australia and Asia is marked by the Wallace Line to the west and the Weber/Lydekker Line to the east (Fig. 1). The Wallacea transition region, where Timor-Leste sits, covers the region east of Bali and west of New Guinea, including the island groups of Sulawesi, the Lesser Sundas, and Maluku. Biologically speaking, Wallacea is a biodiversity hotspot where species from Asia and Australia mingle (Fig. 2). Not only is Timor-Leste located in the southeastern boundary of Wallacea,[2,3] but it is found inside a global centre of marine diversity known as the Coral Triangle.

Timor-Leste covers an area of approximately 14,874 km^2, with most of the country's land area located in the eastern part of the island of Timor with the exception of the Oecusse enclave (2,500 km^2). The country has a coastline of 706 km.[4] It has two islands, Atauro Island (144 km^2) and the smaller uninhabited Jaco Island (8km^2).(Fig. 3)

Timor-Leste is bathed by two distinct seas, the Timor Sea (South) and the Banda Sea (North). Both seas converge at the eastern part of Timor-Leste, resulting in an interesting area supporting diverse biota. Part of this area is

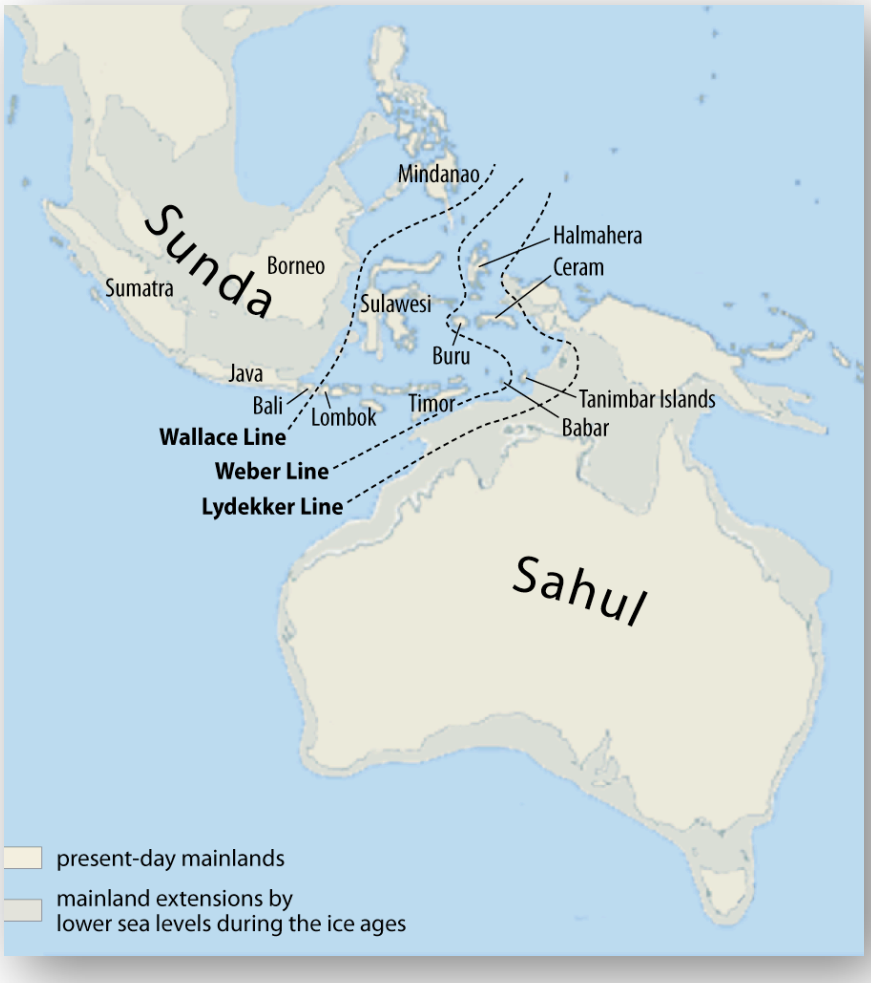

Figure 1 – Map of showing the Wallace, Weber and Lydekker lines

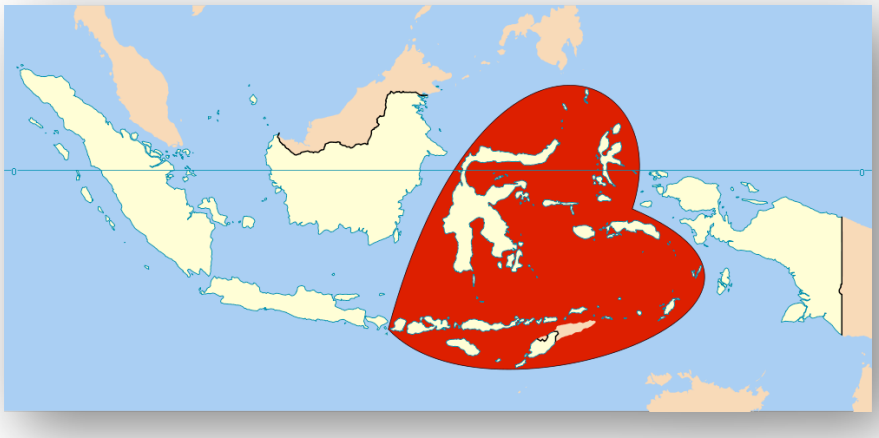

Figure 2 – Map of highlighting the Wallacea region (Source)

[2] Weber's Line roughly coincides with the Timor Trough.
[3] Interestingly the Wallace line seems to coincide with the Timor trough, an important bathymetric feature as will be explained in coming section of this report.
[4] CIA Factbook, 2007.

Figure 3 – Map of Timor-Leste with District names (Wikicommons)

Figure 4 (a, b) – Examples of Timor-Leste's North coast (Source: Wikipedia [first] Rui Pinto [second])

captured in the Nino Konis Santana National Park, Timor-Leste's first declared national park. Timor-Leste's north coast is rocky and steep, and arid woodlands tend to be the dominant vegetation type (Figs. 4a and 4b). When present, coastal plains moving towards the Banda Sea tend to be very narrow. There are two exceptions to this rule, the first being the Dili District and the second the Manatuto District, where the coastal plains are slightly wider than elsewhere in this coast (Boggs *et al*., 2009).

The North Coast hosts numerous white sandy beaches with interspersed rocky outcrops. The waters are deeper, calmer, and more transparent than those off the south coast. An important feature of the North Coast is the marine trench that runs 3 km deep all the way to the Wetar Strait. The nearshore littoral zone of the North Coast is very narrow, and the sea floor drops off sharply to the deep sea (Boggs *et al*., 2009).

Figure 5 – Spinifex grass a common grass found in drier sandy beaches of the North coast © Rui Pinto

Research on the biological and ecological aspects of seashores is presently not available in Timor-Leste. There has been no attempt thus far to ascertain the morphology and type of beaches in Timor-Leste. *Pes caprae* (beach morning glory) formation is found in many of the sandy beaches in the North Coast. Grasses such as *Spinifex* are also common in the drier more seasonal parts of the North Coast (Fig. 5).

Most of the rivers in the North Coast are choked with gravel to the coast, and there are few deltas. This is due to the very steep offshore gradient mentioned earlier. In the north coast, the sediments that reach offshore are deposited in deep water (Sandlund *et al*., 2001).

The South Coast of Timor-Leste is, in comparison to the country's North Coast, shallower with wider coastal plains extending towards the Timor Sea. The slopes in these coastal plains often range from 3%-6% (GERTIL, 2002), making river deltas, lagoons, floodplains and swamps characteristic features on this coast (Fig. 6 and Fig. 7).

Long stretches of sandy beach with heavy waves and surf are also common in the South Coast. The nearshore waters are turbid most of the time (Sandlund *et al*., 2001). The entire South Coast sits in an important sedimentary and hydrogen producing basin(Patmosukismo *et al.*, 1989 as cited in Tomascik *et al.*, 1997), and it is where most of the oil and gas of Timor is found.

The oceanography of the South Coast, more specifically of the Timor Sea, seems to be different from that of the other seas in the Indonesian Archipelago. Surveys of the South Coast have shown that it has a unique topography. While the water in the coastal areas is somewhat deep, they abruptly become shallower offshore (TDCA, 2004). It is believed that the wider, shallower shelf along the South Coast facilitates retention of river-borne sediments and nutrients and stimulates pelagic and benthic productivity (Alongi *et al*., 2009).

The persistent onshore currents and wave action of the South Coast has resulted in the development of beach ridge plains which run parallel to the shore. These beach-ridge plains form lagoons and are important areas for mangrove colonization. Unlike the distribution of mangrove forests in the North Coast, mangroves of the South Coast are sparse and small (Alongi *et al*., 2009).

The Island of Timor has been described as a 'tectonic chaos' due to its extraordinary formation and ongoing geomorphological processes. While Timor-Leste is frequently hit by earthquakes covering a range of magnitudes (Fig. 6), most of the "focus" or hypocenters in the island of Timor are found below 100 km (Katili, 1985 as cited by Tomascik *et al*., 1997). The Island of Atauru and the enclave of Oecusse are prone to tsunami events. It is estimated that tsunami events in these areas could potentially generate waves of up to 4 m in high (GERTIL, 2002). Approximately 10% of the world's seismicity occurs in the Indonesian Archipelago (Tomascik *et al*., 1997) (Fig. 7).

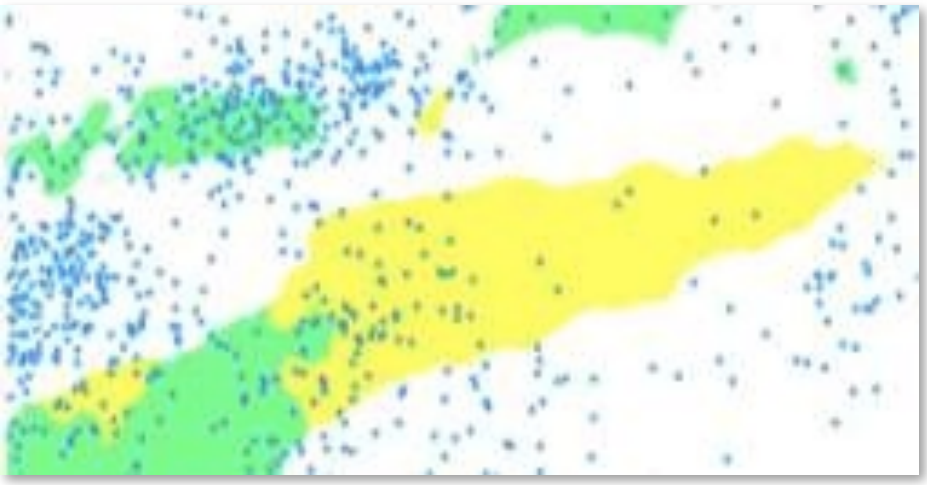

Figure 6 – Map of earthquakes with epicentres occurring in and around Timor-Leste

Figure 7 – Map of areas of Indonesian archipelago that are prone to experience tsunami events

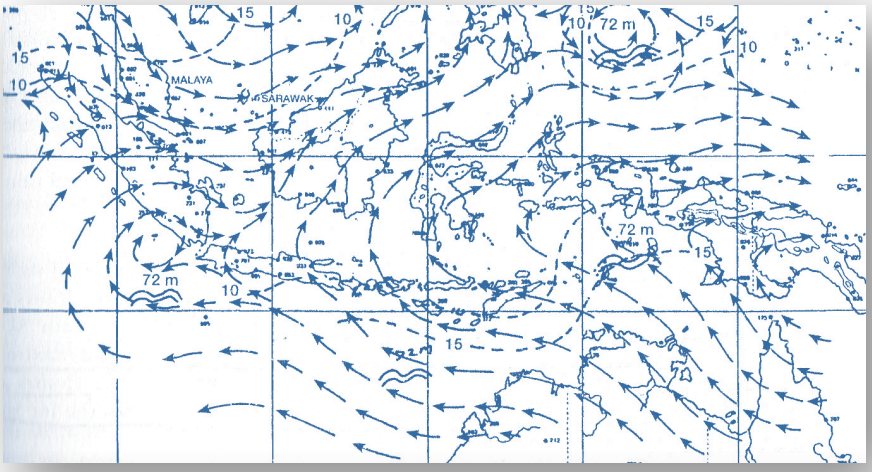

Figure 8 - General wind patterns under normal condition for July (Southeast Monsoon), averaged over a 30 year period. Arrows indicate windflow; dashed lines are isotachs in knots and ~ is the wave height in meters. (Tomascik, 1997)

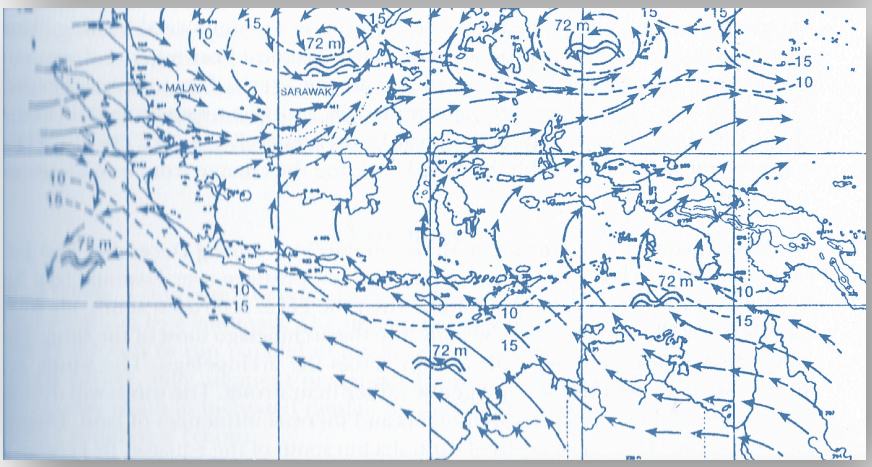

Figure 9 General wind patterns under normal condition for October (transition period), averaged over a 30 year period. Arrows indicate windflow; dashed lines are isotachs in knots and ~ is the wave height in meters. (Tomascik, 1997)

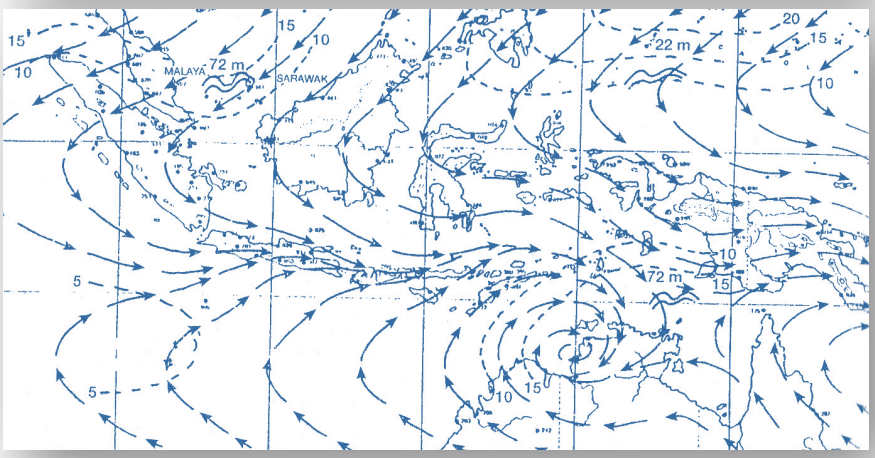

Figure 10 - General wind patterns under normal condition for January (Northeast), averaged over a 30 year period. Arrows indicate windflow; dashed lines are isotachs in knots and ~ is the wave height in meters. (Tomascik, 1997)

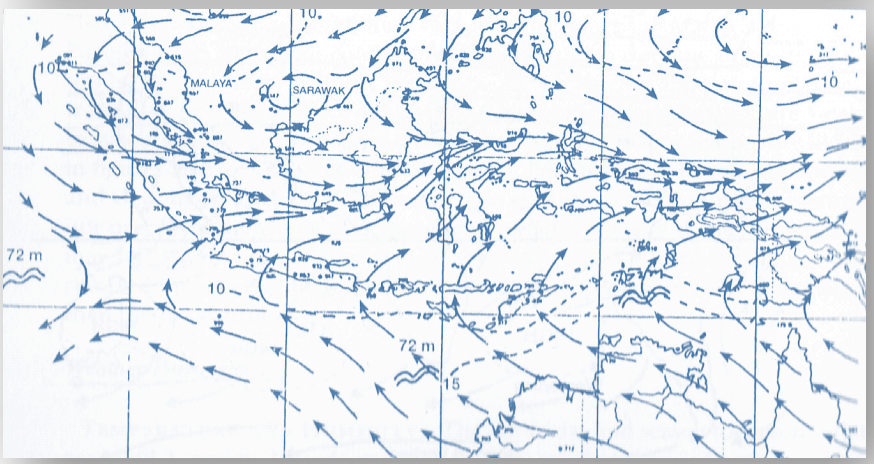

Figure 11 - General wind patterns under normal condition for October (transition period), averaged over a 30 year period. Arrows indicate windflow; dashed lines are isotachs in knots and ~ is the wave height in meters. (Tomascik, 1997)

At a regional scale, Timor-Leste is strongly influenced by the Inter-Tropical Convergence Zone (ITCZ), the Asian and Australian land masses, and the Indian and Pacific Ocean air masses. Given its position in the Indonesian Archipelago, with its many mountainous islands, Timor-Leste experiences some deviations to the wind field (Figs. 8-11).

The annual weather is marked by two seasons, wet and dry. These two seasons may or may not be separated by a transition period. The dry season, which runs from June to September, is mainly influenced by the Australian continent air masses coinciding with the southwest monsoons. The wet season, which runs from December to March, is influenced by the Pacific Ocean and Asian Continent air masses. The wet season coincides with the time of the northeast monsoon.

The El Niño-Southern Oscillation (ENSO) affects the wet season in Timor-Leste. During El Niño, the monsoon onset is delayed, and the wet season ends earlier, leading to less rainfall overall. During La Niña, the wet season is extended, with an increase in rainfall and floods. While Timor-Leste has experienced few or no tropical cyclones since 1970, its coral reefs in the south coast are exposed to heavy seas from frequent cyclones in the Indian Ocean and the Timor Gap.

The prevalence of cyclones in Timor-Leste is known to be associated with La Niña years, although the chance of a direct hit is still fairly low (Da Silva and Moniz, 2010). Strong winds in Timor-Leste usually occur between March-April and September-October.

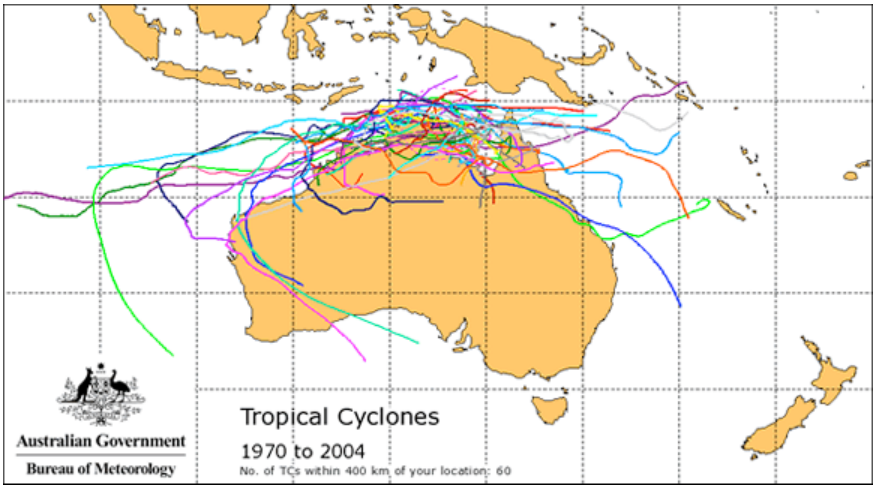

Figure 12: Tropical Cyclones, 1970-2004

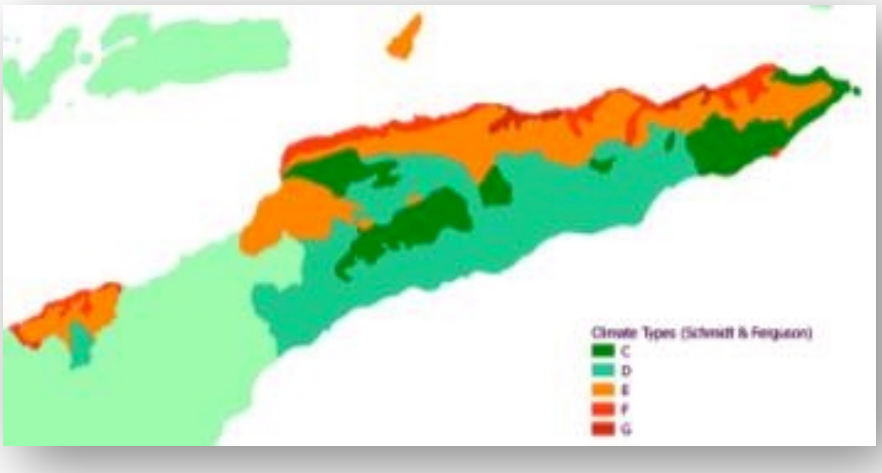

Figure 13: Map of Climatic Zones.

While no studies have been conducted in Timor-Leste for sunshine and cloud coverage, it appears that the average cloud cover ranges between 5-6 oktas, with maximum cloud cover occurring in the afternoon. At a regional scale, atmospheric pressure from December to March is low, a pattern that is reversed from May to October (southwest monsoon).

Timor-Leste has a distinct mountainous spine, which traverses the territory from west to east, creating different rainfall patterns in the north and south coast.[5] Climate-wise, Timor-Leste can be grouped into five distinct types using the Schmidt and Ferguson Q values, C, D ,E, F, G.[6] (Fig. 14 and 15)

Diverse microclimates occur at altitudes with low temperature and available sunlight, resulting in an adaptive agriculture production system. Rice is commonly cropped in warmer lowland areas, while maize is grown in the medium altitudes and root crops at higher altitudes.

[5] State of the Nation Report, 2008.
[6] Lains and Silva, 1956.,

Figure 14: Paddy Field in Coastal Area. © Rui Pinto

Figure 15 – Abrupt Fall into the Ocean View from Subaun Ki'ik ©

Figure 17- Mota Maloa rivulet (Dili) highlighting an alluvial filled intermittent riverchannel, high levels of sedimentation and erosion © Rui Pinto

Figure 16 – Map of rainfall

An analysis of the average temperature values in Timor-Leste indicates that the country's mountainous areas have the lowest temperatures, while temperatures increase as one moves towards the lowland coastal areas (see Fig. 9).

Rainfall in Timor-Leste is heterogeneous, with the highest rainfall values being found in the central to the western parts of the country. The eastern tip of Timor-Leste tends to be drier, especially along the north coast. The mountainous area (Ermera, South of Bobonaro, East of Covalima, and some areas of Ainaro and Manufahi district) is where the rainfall values for the country reach their highest. There are some pockets of high rainfall in the region of Baguia (Baucau) and Iliomar (Lautem) (Fig. 16).

The Government of Indonesia has estimated that 67% of the total area of the island of Timor (including Timor-Leste) is prone to landslides and 6% to flooding.[7]

Slopes associated with flash flooding events are known to cause landslides and significant damage to agricultural land and infrastructure. In 1999, landslides affected nearly 30% of the country's road system (2332 km).[8] This same combination (rainfall and steep slopes) alongside deforested catchment areas leads to significant considerable flood events in Timor-Leste's coastal areas (Fig. 17)

Physical Oceanography

Timor-Leste lies south of the equator, and its surface currents are influenced by the southeast monsoon (May to November) and the northwest monsoon (November to March) A weak drift current flows through the Arafura Sea throughout the year. In the Timor Sea, a southwest current prevails all year round, with its axis running close

[7] Indonesia Regional Physical Planning Project for Transmigration (RePPProT), 1989

[8] GERTIL

to the coast of the island of Timor (Salm and Halim, 1984 as cited in Tomascik, 1993).

There are two main currents influencing the waters surrounding Timor-Leste: the Indonesian monsoon current[9] and the Indonesian throughflow (Fig. 17) (Wagey and Arifin, 2008). Timor-Leste is influenced by the Indonesian throughflow, which plays a significant role in mid-latitude circulation in the Pacific. The throughflow is highest during the southeast monsoon (June to August) and lowest during the northwest monsoon (December to February). The prevailing motion of the throughflow is from the Pacific to the Indian Ocean. While there is some movement of Indian Ocean water from the south into the eastern seas, most of this water ends up being recycled southward as it goes through the island of Timor and back into the Indian Ocean. The deep flow through the Timor Trough originates from the Indian Ocean and contributes to the formation of a recirculation pattern into the Seram Sea, North Banda Sea, and back into the South Banda Sea before getting back into the Indian Ocean. The links to the Indian Ocean are provided by flows through Timor Straits.

Throughflows characterized by large internal waves and tides have been suggested to be responsible for the intermittent high production events experienced in the predominantly oligotrophic sea (McKinnon *et al.*, 2011).A swell originating from the Indian Ocean is detectable in Timor-Leste. This swell gets stronger as one moves westward to the south coast of Sumatra and Java. In Timor-Leste, local winds appear to determine most of the wave action. The north coast of Timor-Leste tends to experience low-energy waves, while the south coast displays bigger waves in the months between April and November (Wyrtki, 1961 as cited in Tomascik, 1997). It appears that river inputs to the coastal zone along the north coast are limited to rapid wet season pulses that extend as a relatively confined plume perpendicular to the mouths of the rivers. Nutrients in these plumes probably lead to limited plankton blooms and to reproductive synchrony by some fish and epibenthic organisms, such as prawns and gastropods (Alongi et al., 2009). On the whole, most marine productivity appears to be centered in the surf zone ecosystems where fish and other edible items are easily caught (Alongi et al., 2009).

Upwelling results experienced in Timor-Leste appear to occur in response to the seasonal development (Kailola, 1993) of the Asian monsoons and the southeast trade winds with upwelling occurring from around May to September (Wagey and Arifin, 2008). It is interesting to note that all of the seven upwelling sites occur within the Wallacea area (Fig. 2) of the Indonesian archipelago (Wagey and Arifin, 2008). The lowering of sea level during the months of August and September marks the end of the upwelling season.

Variations in the temperature-salinity (T-S) plots occur in Timor Sea during the southeast monsoon (June to August). During the northwest monsoon (December to February), sea surface temperatures are known to be warmer (3ºC warmer), and sea surface salinity of the Timor Sea has been shown to reach 35.1 psu[10] (Tomascik, 1997).

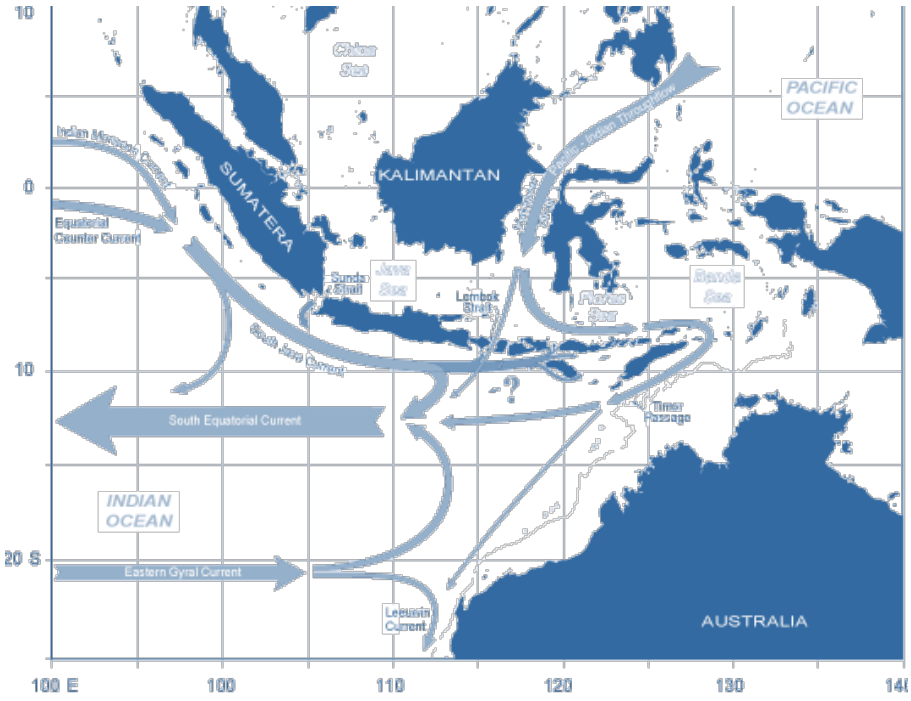

Figure 18 – The Indonesian Throughflow *(Source: http://tryfan.ucsd.edu/woce_ioe/images/iab_p.gif)*

[9] http://en.wikipedia.org/wiki/Indian_Monsoon_Current

[10] Reference and datasets for analysis can be freely download from NOAA coast watch website: http://coastwatch.pfeg.noaa.gov/erddap/search/index.html?page=1&itemsPerPage=1000&searchFor=Indonesia

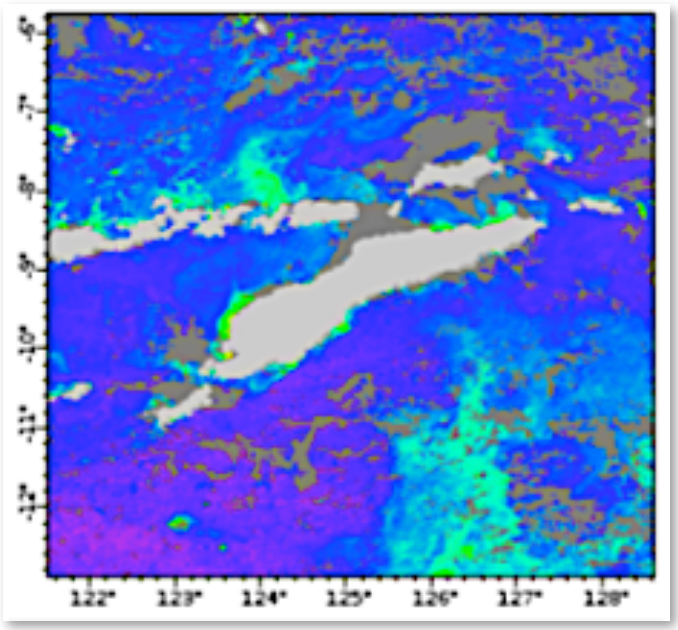

Figure 19- General chlorophyll concentration (mg m3) for January 2009 (Northeast monsoon period)

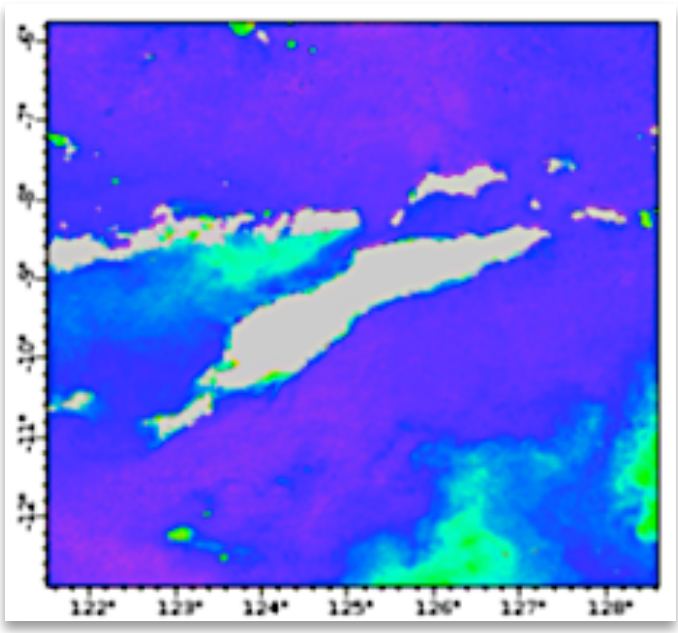

Figure 20 - General chlorophyll concentration (mg m3) for April 2009 (transitional period)

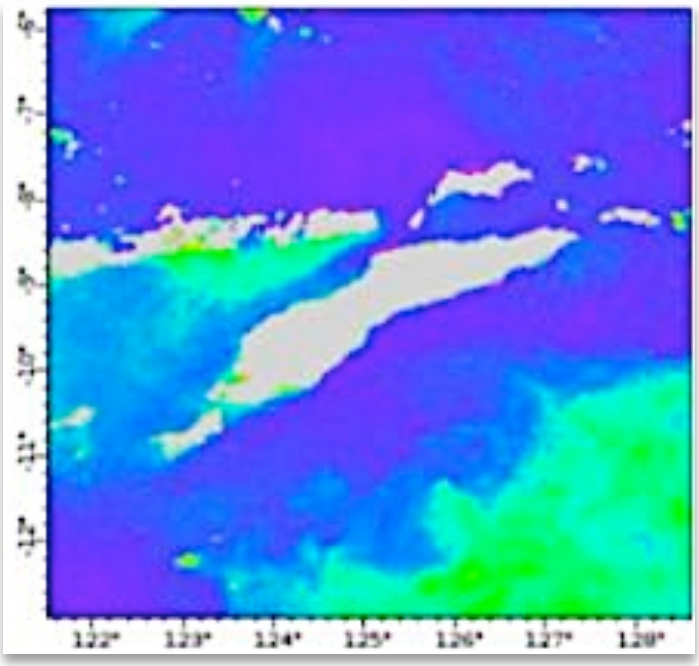

Figure 21 General chlorophyll concentration (mg m3) for July (Southeast monsoon period)

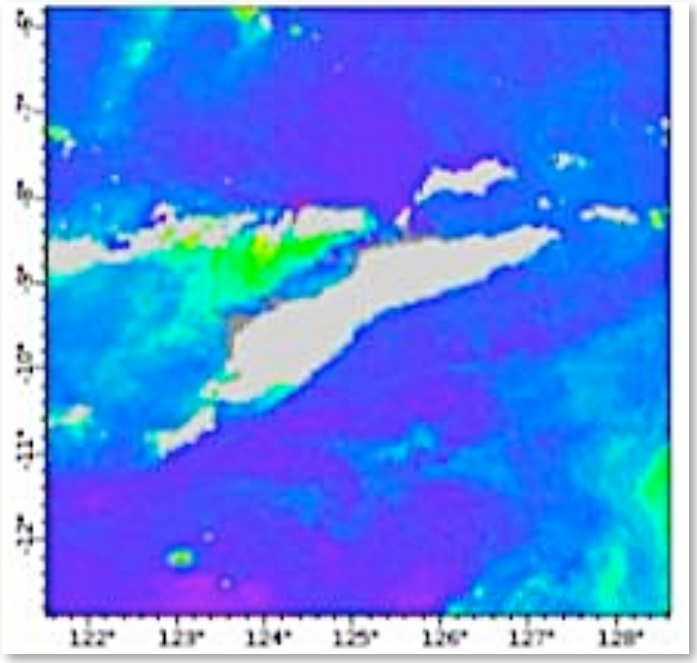

Figure 22 General chlorophyll concentration (mg m3) for October 2009 (transitional period)

Concentration of Chlorophyll in Sea Water (mg m-3)

Chlorophyll concentration maps (Figure 21-23) show significant differences in concentration number and location between seasons

At the end of Timor-Leste's dry season (from June to September), interstitial salinities at high tidal elevations were found to be less than those of normal seawater due to input from freshwater wetlands and bare tidal flats that are sometimes found behind the mangroves (Alongi *et al*., 2009).

Tides are known to influence the vertical water structure. Tides in the Indonesian archipelago, where Timor-Leste is located, are caused by wave propagation across the shelves and into the basins from the Pacific and Indian Oceans (Fig. 23).

Timor-Leste appears to have mixed tides with prevailing semi-diurnal tides (Fig. 15). Tides, together with currents, play an important role in providing a continuous supply of oxygen to reef communities. The most obvious effect of tides on coral reefs is the cyclic nature of sub-aerial exposure and inundation of reef flat areas (Tomascik *et al*., 1997). Some large waves occur in Timor-Leste's south coast, which is known to experience ocean swells of usually lower than two meters.

B. Biodiversity of Coastal and Marine Ecosystems

There are limited studies on biodiversity of the eastern part of the Island of Timor. Sandlund et al. (2001) provided one of the first, and arguably the most complete, synthesis produced in Timor-Leste's post- independence era. Wagey and Arifin (2008) conducted the first marine biodiversity review of the Arafura and Timor seas, a publication which had restricted circulation in Timor-Leste.

Sandlund et al. (2001) based a significant part of their work on Monk et al. (1996) and classified Timor's coastal and marine ecosystems into the four biotopes:

1. **Oceanic** and **sub-tidal marine environment** (including pelagic water columns, deepsea bottoms, shallower rocky bottoms, sandy-muddy bottoms, seagrass beds, and coral reefs);
2. The **intertidal zone**, including rocky intertidal shelves, sandy-muddy tidal flats, and mangrove forests;

Figure 23 – Geographic distribution of tides types in Southeast Asian seas (from Tomascik et al. 1997)

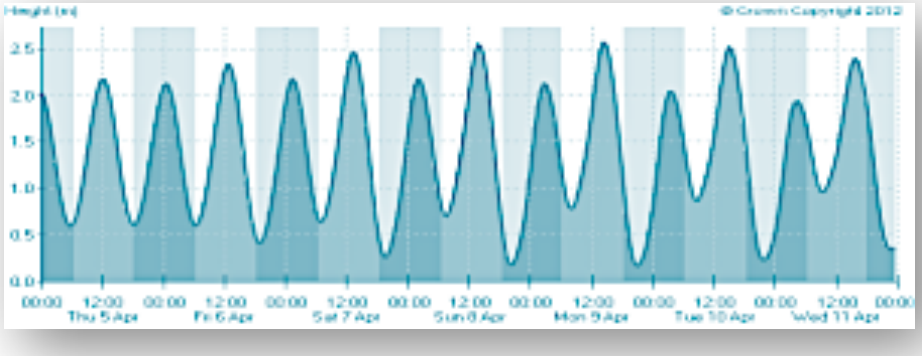

Figure 24 – Dili Port tide prediction for one week of April http://easytide.ukho.gov.uk/easytide/EasyTide/ShowPrediction.aspx?

3. **Shorelines**, including sandy beaches, dunes, rocky outcrops, limestone cliffs, river estuaries, and brackish lagoons; and
4. **The nearshore zone** including coastal drylands, natural forests, and wetlands.

Further studies conducted through the Arafura Timor Sea Expert Forum (ATSEF) have allowed the Government of Timor-Leste to gain a better understanding of the species assemblages and composition of coastal and marine habitats found in the country's north coast. However, despite this program's pioneering mapping efforts, a significant area of the north coast is yet to be mapped (Fig. 25).

Figure 25 – North coast of Timor-Leste highlighting surveyed and un-surveyed areas © Rui Pinto

Timor-Leste's north coast, as will be explained in the demography section of this report, has the highest population densities alongside the largest areas of mangroves, seagrass meadows and coral reefs. As population grows at a staggering rate, pressure on these ecosystems is expected to increase.

The coastal and marine habitat classification system used by Boggs et al. (2009) in the ATSEF study introduced the first marine and coastal habitat classification system to be used for Timor-Leste. This classification incorporated rugosity, relief, and height of corals as well as a benthic habitat classification adapted from English et al. (1997).

The most recent training on mapping exercises conducted by the Government of Timor-Leste, with the help of the Government of Southern Australia and CTSP, has started the discussion with the Government of Timor-Leste to set up a standard marine and habitat classification system to ensure standardized map classification for the entire country.

Despite such efforts, there are significant information gaps for the country's south coast. While some data are available for part of the south coast (Fig. 24), much of its extensive coastline (350+ km) and habitats remain poorly understood.

Charles Darwin University (CDU), in partnership with the Australian Institute of Maritime Science (AIMS), initiated a project aimed at completing broad-scale mapping of the marine and coastal habitats in Timor-Leste's south coast. The idea is to use Landsat satellite imagery to target current existing gaps in habitat mapping and fill these data gaps.

The CTSP, working with the Timor-Leste Agricultural and Land Use Global Information Systems Unit (ALGIS), has reshaped one of the Government's donor proposals to ensure that mapping exercises cover one of the missing areas of the north coast and that there is no overlap with other donor-funded mapping activities.

Coordination between the Government of Timor-Leste, donors, and supporting agencies is critical to optimize resources and funding to best measure and monitor the biodiversity within the coastal and marine habitats of Timor-Leste. Increased capacity building within the government would facilitate these co-ordination activities and aid Timor-Leste in meeting its national and international biodiversity targets and commitments.

It is hoped that all the studies will complement each other and feed into the CTI Atlas. Furthermore, there is great potential to incorporate socioeconomic and biological datasets in these efforts (Table 1).

Coral Reefs

The Indonesian archipelago is known to have a wide range of euphotic zones (Gieskes *et al*., 1989) ranging from 100 m (Banda Sea) to 60 m or more (Flores) to depths of less than 15 m. Most of the reef surveys in

Table 1: Data sets that may help improve current mapping efforts

Future Data Sets	Program	Description	Key Contact Person (Government)
Socio-economic	CTI-Pacific	Socioeconomic survey (6,000 coastal households); Questionnaire (waiting to be designed) Funding: GEF Agency: ADB Proposed implementation arrangements: Bureau of Statistics	Aleixo Leonito Amaral
Biological	CTI-Pacific	Productivity of the South Coast Design finalized Funding: GEF and AIMS (in-kind) Agency: AIMS and ADB Implementation: Partnership between AIMS and Timorese scientists	Aleixo Leonito Amaral

Timor-Leste have been confined to depths between 15-25 m.

Fringing reefs are the most visible type of coral reefs found in Timor-Leste. They seem to persist in the most stressed coastal environments in the north coast. In places with strong coastal currents, fringing reefs may be found in riverfront environments.

The reefs in Timor-Leste, much like the reefs in Eastern Indonesia, have a narrow reef flat (20-100 m) with a steep drop-off (40-60 m depth). An interesting feature of some of the fringing reef systems in Timor-Leste is the existence of a rubble zone located immediately below the reef crest (2-3 m in depth). This is often taken as evidence of serious fish bombing in the area. A brief study cited by Tomascik *et al.* (1997) postulated that the rubble area may be the result of high bio-erosion rates in rapid growing branching corals (*Porites cylindrica*, *P. nigrescens, Acropora aspera,* and *A. nobilis*) that produce high fragment levels that are then deposited at the base of the upper reefs.

While Timor-Leste's fringing reefs have been classified as **oceanic fringing reefs** alongside fringing reefs from Sulawesi and Flores (Tomascik *et al.*, 1997), little quantitative information is currently available to make meaningful comparisons between Timor-Leste's fringing reef type and other fringing reef types found elsewhere in the Indonesian Archipelago (e.g., Sumatra, Java, Borneo).

In Timor-Leste, most of the reefs appear to be found in the north coast, which is characterized by karst geology and uplifted ancient coral reefs (Audley-Charles, 2004; Hamson, 2004; Keep *et al*., 2009). Fringing coral reefs and seagrass meadows are known to occur in this coast. There have been some localized studies of coral reefs in country (Hodgson, 1999; Deutsch, 2003; Wong and Chou, 2004; Dutra and Taboada, 2005). However, Boggs and colleagues (2007) remain the only study which tried to capture and map corals in Timor-Leste.

Shallow coral reefs in the north coast have been estimated to occupy an area of not more than 3,000 hectares (ha). Boggs *et al.* (2007) mapped more than 60,000 ha of potential coral habitat in the deeper waters of the north coast. However, more studies and surveys in deeper water should be conducted to map these deeper water corals.

Most of the zooxanthelate corals found in the **deep fore-reef slope** tend to be of platy or encrusting morphology to maximize their surface area and exposure to light. There, a diverse assemblage of sponges (Appendix 1: Table x) and gorgonians (Appendix 1: Table x) and whip corals (Appendix 1: Table x) can be found.

Reef slopes appear to be more diverse than the fore-reef slopes in terms of number of species and growth-form diversity (branching, massive, and encrusting).

Reef crests, where wave energy is a dominant environmental effect, tend to be marked by fast-growing branching and tabulate corals. *Acropora* tends to be the dominant group of reef-crest scleractinians in fringing reefs with moderate to high wave exposure, and *Porites*

Figure 26 – Timor-Leste's karst geology and uplifted ancient coral reefs and its diverse coral reefs © Rui Pinto

for those fringing reefs with low wave exposure. Encrusting coralline algae are found on reef flats.

North coast corals tend to have a higher cover of *Acropora* corals (Appendix 1: Table x), poritid corals, *Heliopora, Millepora, Xenia,* and *Briarium* (Appendix 1: Table x)(Ref).

As pointed out by Tomascik *et al*. (1997), runoff appears to be a key factor responsible for the absence of major reef development in many islands of the Indonesian Archipelago. Recent studies have shown that some of Timor-Leste's catchment areas have naturally high rates of erosion and sediment yield (Alongi *et al*., 2009). Given that most of the rivers are located in the south coast (GERTIL, 2002), this naturally high sediment yield may be one of the determinant factors in coral reef development in Timor-Leste's south coast.

It would be naive to pinpoint runoff as the main determining factor for reef zonation patterns in Timor-Leste. Zonation is likely to be influenced by a combination of other variables such as rainfall, evaporation and surface current patterns, and substrate type.

As shown in previous maps (Figures 12 and 15), the south coast is not climatically homogenous. There are some areas of the south coast that experience high rainfall values. High rainfall is known to impact water salinity, which is known to impact fertilization success in corals. This may also be a factor limiting coral distribution in certain areas of the south coast.

Despite this, coral reefs in Timor-Leste appear to be able to withstand high temperatures without any observed damage. This may be because of tidally induced upwelling events, which are known to lower water temperature and play an important role in the overall productivity of Timor-Leste's coastal waters.

South coast coral reefs appear to have a higher cover of sponges, hydroids, algal groups, ascidians, and *Montipora* corals. *Montipora* colonies with black line disease have been recorded on the south coast of Jaco Island alongside some partially damaged coral colonies by *Drupella* grazing (Ayling and Ayling, 2009).

Maps generated by the Defence Mapping Agency Topographic Center in August 1976 show some of the areas of the south coast where corals are known to occur (Fig. 28).

Figure 27 – Google earth imagery ©2012 Cnes/Spot Image, Digital Globe, GeoEye showing of Suco Tachilin, Suai (South coast) located between Loumea and Mola river. The arrows highlight sedimentation into marine habitats © Rui Pinto

Figure 28 – Map highlighting the possible sites where coral reefs could occur in the South Coast© Rui Pinto

Mangroves

Mangrove forests are important habitats along tropical coasts, including the northern and southern coasts of Timor-Leste (Alongi et al., 2009). Timor-Leste's mangrove forests are thought to occupy an area smaller than 1000 ha, 750 ha of which are found in the country's north coast (Boggs et al., 2008).

Previous coastal mapping exercises (Boggs et al., 2008) revealed significant ongoing coastal habitat loss in Timor-Leste. The total mangrove forest extent was reduced from 9,000 ha in 1940 to 3,035 ha in 2000 (FAO, 2003) to just 1,802 ha in 2008 (Boggs et al., 2009), for a 40% loss between 2000-2008, or more disturbingly, an approximate 80% loss of total mangrove habitat since 1940.

Mangrove trees in Timor-Leste, much like elsewhere, are harvested for timber and fuelwood, and there is evidence that hinterland mangroves have been removed for brackishwater shrimp and/or fish ponds.

Mangrove forests are known to provide valuable ecological and economic resources as nursery grounds for many commercially important fish, shellfish, and crustaceans, and to prevent coastal erosion as well (Alongi, 2009b).

As noted by Alongi *et al.* (2009), mangroves along the north coast are, sparse and located in small, "quiescent embayments." Mangroves in the north coast do not appear to be directly influenced or impacted by river runoff and sedimentation rates.

n the seaward area, most of the mangroves tend to be dominated by

Figure 29 – Mangrove forest hinderlands converted for brackish water fish ponds in Hera © Rui Pinto

one or more species of *Avicennia*, which form a usually narrow fringe with species of *Sonneratia* being commonly associated in this fringe. The *Rhizophora* zone follows, and then, the *Bruguiera* zone. Mangrove forests may also display a *Ceriops* zone, which may have associated *Heritiera* and *Lumnitzera*. *Nypa fruticans* stands can sometimes be found growing in estuaries interspersed with other genera (*Avicennia, Sonneratia*, or *Rhizophora*) (Cinatti, 1987).

The greatest impact on mangrove forests in Timor-Leste is the extensive use of wood for fuel. This is known to be the case in the Metinaro mangrove forest, where an internally displaced people's camp has contributed to a noteworthy decrease in Timor-Leste's biggest mangrove forest cover.

The majority of the mangroves in Timor-Leste do not appear to be associated with seaward coral reefs. Seagrass/coral fringing reef associations seem to be more common. Despite this, exceptions to this general rule may exist in sites less surveyed (e.g., Lamsana, SucoMa'abat, Manatuto District) (Cliff Maralessy, pers. comm., 2012). Table x in Appendix provides a checklist of the mangrove species found in Timor-Leste.

Seagrass Meadows

Seagrasses are recognized for their ability to help stabilize coastlines and provide shelter to an array of economically important marine organisms. Furthermore, they are a critical habitat for a number of endangered marine species (*Dugong dugon* and *Cheloniamydas*) and support a rich and diverse fauna (Tomascik *et al*., 1997).

Seagrasses grow in sheltered, soft-bottom, shallow, sub-littoral water in the euphotic zone (Monk *et al.,* 1997), making a broad zone on the shore between the

Figure 30 – Mangrove remnants in the North coast © Rui Pinto

beach or mangroves and the edge of the coral reefs. While there are limited publications on seagrasses, it is believed that members of the genera *Halodule, Halophila, Enhalus, Cymodocea, Syringodium, Thalassia,* and *Thalassodendron* are found in Timor-Leste.

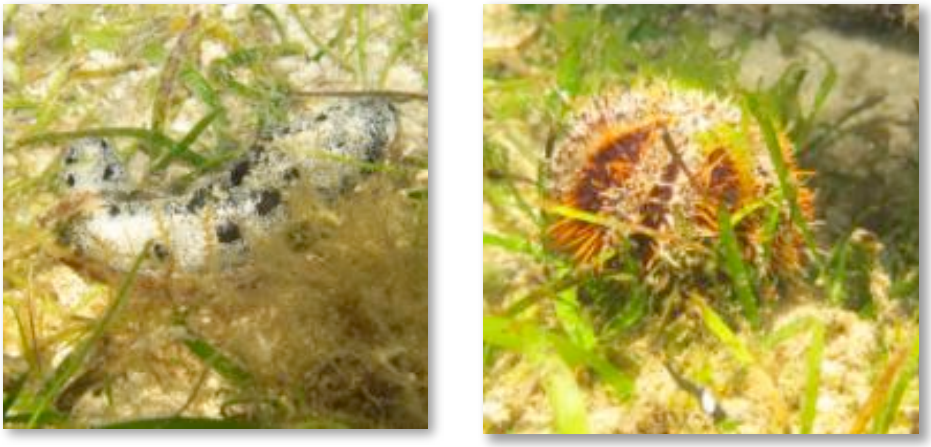

Figure 31 – Some of the sea cucumbers and sea urchins found in Timor-Leste's seagrass beds © Rui Pinto

Seaweeds (or macroalgae) are known to occur in the country and are increasingly becoming an important source of livelihood diversification for coastal communities.

The north coast hosts the most extensive seagrass meadows (2,200 ha) alongside 1,266 ha of mixed corals and seagrasses and open reef flats. Mixed seagrass communities in Timor-Leste appear to be composed of seven species and are often associated with fringing reefs (Tamascik *et al*., 1997; Wagey and Arifin, 2008).

They tend to reach their peak density in shallow water back reef environments (reef flats) and lagoons. This estimate appears to be similar to the results of previous surveys conducted on islands nearby, such as Lombok (Kiswara and Winardi, 1994) and Komodo and Sumbawa (Suharsono *et al.*, 1993 as cited in Tomascik, 1993), as well as studies conducted in Northern Australia (Roelofs *et al*., 2005).

The relative low seagrass species diversity appears to be partly related to the relatively homogenous seawater temperatures found in the island of Timor. Monospecific seagrass meadows are known to occur. The species that are known to form monospecific meadows appear to be *Thalasia hemprichii, Halophila ovalis,* and *H. uninervis* (Nienhuis *et al*., 1989).

Echinoderms (sea cucumbers and sea urchins) are the most noticeable and economically important components of benthic seagrass communities (Appendix 1, Checklist of sea cucumbers).

The CTSP has helped the Timor-Leste Government to gain a better understanding of the species assemblages found in Nino Konis Santana National Park (NKS). Although the national park hosts a relatively small area of seagrass meadows, the rapid survey has shown the presence of *Syringodium isoetifolium, Cymodocea rotundata, Halophila ovalis,* and *Halodule uninervis* in the National Park (unpublished Program technical update).

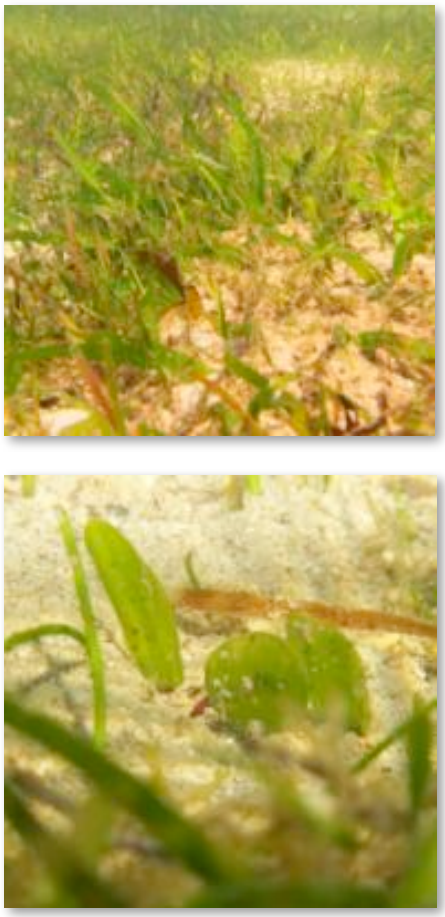

Figure 32 – Com's seagrass meadows © Rui Pinto

III.Governance

The National Directorate of Fisheries and Aquaculture (NDFA) under the Ministry of Agriculture and Fisheries (MAF) is responsible for the development and management of the fisheries industry. The organization chart of the agency is presented below.

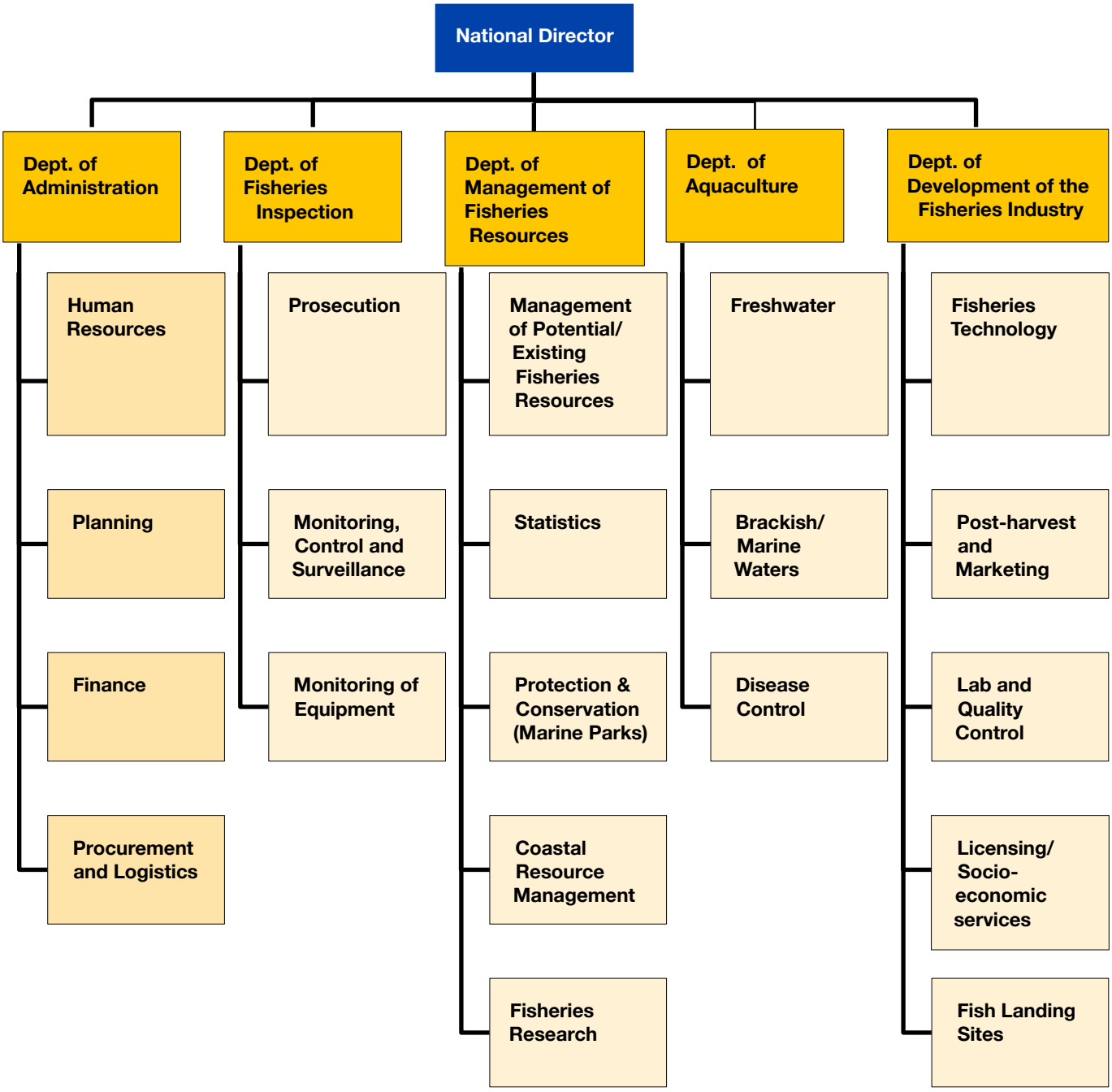

Figure 33: Organization Chart of the National Directorate for Fisheries and Aquaculture (NDFA) (Pinto and Cunha Barreto, 2011)

The NDFA is working with the CTSP to encourage and facilitate community-based fisheries management initiatives and establish a network of locally managed marine areas. This work focuses in Timor-Leste's CTI Priority Geography, which is Nino Konis Santana National Park, Timor-Leste's declared National Park.

A.Policy and Legislation

MAF's policy objectives focus on increasing the level of food security, improving animal production and fish production, as well as supporting the development of agricultural industries for increasing the value of agriculture, forestry, and fisheries products through fostering output processing and marketing as well as export revenue and employment creation. MAF underlines the importance of sustainability, capacity development, and private sector involvement as important elements in its policy (MAF, 2004).

The first Constitutional Government (2002-2007) sought partnerships with aid agencies to (i) improve marine resource planning and management; (ii) develop fisheries policy and legal and regulatory framework; (iii) encourage and support the involvement of private sector and to develop basic infrastructure; and (iv) capacity development of staff. Such partnerships and support from aid agencies did not come to fruition because of the civil unrest in 2006 that resulted in the abrupt halt to the few ongoing programs.

Most of the fisheries laws and policies have been prepared by the first Constitutional Government, but the implementation of such laws and regulations needs further improvement. The biggest challenge faced by

MAF is its capacity to translate these policies and regulations into effective implementation.

The World Bank Agricultural Rehabilitation Project (ARP) facilitated the development of a Law decree and general fishing regulations, draft legislation for fishing crimes, and a decree for marine parks.

Deepsea fishing and management capacity building activities have been financed by AusAID. The AusAID-funded Fisheries Management Capacity Building Project, which ended in 2006, helped build some management skills in this sector. There has been considerable progress in the preparation for the implementation of the *Fisheries Decree Law and Regulations*, including the licensing system for offshore fisheries, with the first offshore tuna license issued in January 2005.

The first offshore tuna license and the subsequent licenses proved to be disastrous for licensed vessels, which encountered many armed illegal fishers targeting similar fishing grounds. (Illegal fishing will be covered in the Threats and Vulnerabilities section of this report.)

The Hera fishing port was rehabilitated with assistance from the Asian Development Bank (ADB)-funded Agricultural Rehabilitation Project (ARP II). Despite being a fishing port, it has become the country's first army F-

Table 2: Timor-Leste's Fisheries Legislation

Title	Type of Legislation and Date Approved
General basis of the legal regime for the management and regulation of fisheries and aquaculture.	Decree Law No 6/2004 of 21 April 2004.
General regulation on fishing	Government Decree No 5/2004 of 28 July 2004
Altering Government Decree No 5/2004 of 28 July 2004. Government Decree No 3/2005 of 6 July 2005	
Crimes related to fisheries.	Law No 12/2004 of 29 December 2004
Establishment of tariffs for fisheries licences, inspection, related activities and services of fisheries.	Government Decree No 2/2005
Definition of fishing zones.	Ministerial Diploma No 01/03/GM/I/2005
Percentages of by-catch tolerated	Ministerial Diploma No 03/05/GM/I/2005
List of protected aquatic species.	Ministerial Diploma No 04/115/GM/IV/2005
Minimum sizes of fish species that can be caught.	Ministerial Diploma No 05/116/GM/IV/2005
Penalties for fisheries infringements.	Ministerial Diploma No 06/42/GM/II/2005

Figure 34 – Typical CTSP classroom setting showing some of the visual aids used to explain fishing zones, minimum catch sizes and the importance of managing spawning aggregation sites (Valu Sere Beach, Tutuala) © Rui Pinto

Figure 35 – Turtle captured by a Fishermen is returned to the ocean in Com's fisheries harbour by community members © Rui Pinto

FDTL naval port. Presently, the only port used as fishing port is Com-Lautem.

A new policy, "The Future for Fisheries" (A Policy and Strategy for the Responsible Development and Management of Fisheries in Timor-Leste), 2014 has yet to be approved by the Government. Despite remaining a draft, the document presents five main policy objectives:

1. **Optimal use and management of Timor-Leste's living aquatic resources** resulting in increased sustainable production, consumption and export of fishery products providing long-term social and economic benefits;
2. **Conservation and rehabilitation of Timor-Leste's aquatic habitats** helping to sustain the productivity of fisheries resources;
3. **Sustainable, efficient, and profitable industry** meeting the needs of the population for the ready availability of affordable, quality fish and supplying export markets mainly from offshore resources;
4. **Development of a viable aquaculture industry** meeting the needs of the population for the availability of affordable quality fish and supplying export markets; and
5. **Development of fisheries institutions and associations** staffed by capable individuals serving the needs of the fishing and aquaculture industries.

These five policy objectives cover five areas: (i) optimal use and management of living resources; (ii) habitat conservation; (iii) fishing industry development; (iv) aquaculture industry development; and (v) development of fisheries institutions.

B.Compliance

Despite the lack of information on government regulations, Baticados (2005) found that most (97%) fishers were inclined to comply with the new regulations as long as they are consulted and explained. With a smaller percentage (16%) looking at enforcement as a joint effort between the government and the fishing community. Despite this, the aforementioned survey found that all the fishermen interviewed wanted to have a role in resource management.

The Coral Triangle Initiative, through the CTSP, has helped community members in selected sites gain a better understanding of the biology behind the laws and the management purposes behind some basic restrictions presented in the laws presented before. The program has had some success and led to the voluntary establishment of community-based management groups that engage in information sharing and conservation activities (Fig. 35).

IV. Socioeconomic Characteristics

Timor-Leste's coastal area has been inhabited by humans for thousands of years, with strong archaeological evidence of human and sea interactions. Sprigg et al. (2003) describe the inhabitants of coastal Timor as mobile hunter-gatherers. Oliveira (2007) suggests that coastal resources played an important role in the subsistence economy of Timor-Leste's first inhabitants.

Figure 36: Traditional palm wine distillery in Valiana, Lori, Lore I, South Coast of Timor-Leste © Rui Pinto

The findings of O'Connor and Veth (2005) of two fishing hooks in association with remains of pelagic fish species suggest that fishing in the open sea was part of the economy of Timor-Leste from the very early stages of human occupation, and that sometime in this long history, these strong links to the sea became weaker (Cinnati, 1988).

Nowadays, Timorese are no longer seaward-oriented people (McWilliam, 2002). The reasons behind moving from a sea orientation to a land orientation remain unknown.

Timor-Leste's highest population density is found in upland sucos (group of villages) and aldeias (villages) in the northern part of the Island. This trend clearly contradicts the generalization used by by Monk et al. (1997) to describe Timor-Leste.

The 2002 Census estimated that, while approximately 66% of the population live below 500 m aabove sea level (asl), few urban settlements are actually located on the actual coast with the exception of Dili –a trend that remained unchanged in subsequent census exercises (2010).

Timor-Leste's household survey (2001) found agriculture (including fisheries) to be the main source of income for 94% of villages (Drysdale, 2007). Similar results were found in the 2010 household census. Despite such, one-third of the country's population is known to experience food shortages, notably towards the end of the two lean seasons between harvests, October-November and February-March (IRIN, 2012).

Coastal communities in Timor-Leste, much like highland communities, are dominated by subsistence or semi-subsistence farming systems, with up to 85% of the total population being dependent on agriculture. It is thought that farmers engage in fishing, gathering of natural resources like collection and sale of firewood, palm wine brewing, and honey collection as complementary income-generating activities (Fedele and Horjus, 2006). Communities inhabiting most remote areas of the country (south coast), remote from services and markets, tend to be even more subsistence-based and rank highly in food insecurity and vulnerability (Fedele and Horjus, 2006).

The poverty rate in rural areas (46%) is higher than in urban areas (26%), and lowland rural residents report lower levels of poverty than other rural areas. The extent to which fisheries is contributing to household income in lowland rural Timor-Leste still unknown. Despite the uncertainties over how much fisheries contribute to household income, fisheries appear to be crucial to food security (Baticados, 2005).

The CTSP has helped the Department of Fisheries, Resource Management, and Aquatic Research to track down how much revenue comes from inland fisheries in Lake Iralalaru, the biggest freshwater lake in Timor-Leste. Preliminary results showed that the freshwater fishery contributes more that 75% to household revenue (CTSP, unpublished report).

Current growth rates of 3-4% per annum (Census 2010) will result in the doubling of Timorese population in 18-20 years (UniQuest, 2010). The unstable cash economy cannot absorb the current population growth rate and, in the short to medium term, the number of people dependent on the subsistence sector will grow significantly, putting more pressure on the country's natural resources.

The limited extent of coral reef, seagrass, and mangrove habitats in Timor-Leste's north coast limit the available marine resources and levels of harvest, particularly in the reef fisheries and mangroves. In the light of the current population growth and increasing human resource use, it is urgent to improve the management of marine and coastal resources using precautionary principles and to strive for effective conservation management.

A.Fisheries Sector

Despite its long coastline and apparent abundant fishery resources, this sector is deemed underdeveloped. There are currently no large-scale, commercial activities, with only a couple of semi-industrial licenses being issued to single company.

Previous surveys of the Timor Sea (TDCA, 2004) found stocks of economically important fish species of Lutjanidae, Lethrinidae, and Serranidae. A group of snappers (Lutjanidae) was found to be the most common fish, contributing 49.32% of the total catch by weight. Within this group, there are three species of high economic importance, namely: *Pristipo moidestypus*, *P. mutidens,* and *Lutjanus vitta*. *Pristipo moidestypus* and *P. multidens* are recognized tropical and deepwater snappers.

Most of the fishing in Timor-Leste is done at the subsistence and artisanal levels and is commonly supplemented by other livelihood activities such as agriculture (de Carvalho *et al*., 2007).

It was estimated in 2002 that Timor-Leste had over 20,000 fishers, half of whom were dependent on fishing as their main source of food and income (Jasarevic, 2002). These numbers have been reviewed by MAF, and recent figures place the figure at about 5,500 (Baticados, 2005). Most fishing activities are limited to low-technology inshore fishing (Wever, 2005).

Table 3: Number of fishers in Timor-Leste (Baticados, 2005)

District	Number of Fishing Centers	Number of Fishers
Ainaro	2	25
Ambeno	13	370
Baucao	10	252
Bobonaro	11	315
Covalina	10	254
Dili		
Mainland	13	1527
Atauro Island	18	512
Lautem	12	460
Liquica	31	541
Manufahi	5	121
Manatuto	18	370
Viqueque	8	217
Total	**151**	**5415**

Figure 37 – Some of the catch being sold next to the road © Rui Pinto

FAO, through its Regional Fisheries and Livelihood Program (RFLP), has supported the Government of Timor-Leste in generating an online database of artisanal fishers (www.peskador.org), which provides the most up-to-date information on registered boats.

Artisanal fishers target demersal species, such as snapper, croaker and bream; pelagics like tuna, mackerel, scad and sardines; and a variety of prawns, crabs, lobsters, bivalves, and cephalopods (McWilliam, 2002), which are often sold in roadside markets at an average price of US$5 per kilo. The diversity of species found in these markets is astonishing, ranging from eels to triggerfishes.

Figure 38 – Meti in Com © Rui

Figure 39 – Mr. Tomé, Sea weed farmer and main supplier for the Lautem District © Rui Pinto

Strong winds and waves in the months of December, January, July, and August cause a drop in fishing activities and poorer fish catch in nearshore waters. The reduction of activities is more evident in the south because of the more exposed shoreline.

Women and children engage in a fisheries practice known as "*meti*". Women and children appear to target juvenile fishes, crabs, molluscs, and sea urchins during their fishing activities. Rotenone-based piscicides derived from Derris root is known to be used during *meti* (Pinto, 2011).

B.The Aquaculture sector

Mariculture in Timor-Leste (sea weed farming) started in 2003-2004. It started with relatively small number of farmers (20 farmers in 2004) who engaged in pilot trials developed by the National Directorate for Fisheries and Aquaculture. Given the success of the pilot testing, the number of sea weed farmer has steadily since then and has reached nearly 1,500 farmers in 2010. (NDFA & WFC, 2011)

The geographical focus of seaweed farming has been in Atauro Island, a small island situated in the north of Dili with a population of 10,000. Unlike freshwater aquaculture, which tends to cater to local markets, seaweed production targets foreign markets with a small proportion used domestically. Seaweed culture has been identified by the Government as a major income-generating activity in Atauro Island, with the total revenue from seaweed export in 2009 estimated to be in the order of US$19,130 (NDFA, 2010 cited in NDFA and WFC, 2011).

While NDFA has presently four freshwater fish hatcheries with modest facilities, their seed production capacity is very low due to logistics and financial constraints in managing the hatcheries which are in need for urgent rehabilitation. Sector development is greatly constrained by the capacity of government hatcheries and nurseries to supply seed (NDFA and WFC, 2011).

Aquaculture appears to have been government-led with a significant military input. Timor Timur Dalam Angka (1997) cites inland fishery production increasing from 18.8 tons (t) in 1986 to 401.5 t in 1995 and 379.4 t in 1997. However, these numbers appear to have been greatly miscalculated (Cook, 2000) as the numbers reported by the Bureau of Statistics were in some cases ten times the value registered figures in Timor logbooks.

Aquaculture development has been identified by the Government of Timor-Leste as a means of improving the food and nutrition security situation and increasing household revenues in both inland and coastal communities (NDFA and WFC, 2011). The National Directorate of Fisheries and Aquaculture is currently being assisted by the WorldFish Center (WFC) to devise a national aquaculture strategy and action plan for the development of sustainable aquaculture to address the problem of poverty and food security in the country. The project is jointly funded by the FAO-funded RFLP and CTSP.

C.Coastal Tourism

Timor-Leste has a small, developing tourism sector based on natural assets such as diving. The major attractions are diving and fishing linked to the Nino Konis Santana National Park and Atauro Island. Atauro and Com have developed a reputation for ecotourism. There is potential for increased tourism activities associated with whale watching and marine megafauna in the eastern coastal area, and the proposed Nino Konis Santana National Park may create more demand (Edyvane et al., 2009).

Infrastructure and quality of accommodations and tourist services in Timor-Leste are limited and generally of poor quality. There are many sites and opportunities for ecological and cultural tourism and for development in both the north and south coasts. The north coast seems to be favored by tourists over the south coast mainly due to the easier access to the sites and due to the presence of saltwater crocodiles in the south coast.

There are also several sites of cultural significance, which complement the sites of recognized natural significance (Edyvane *et al.*, 2009). Religious and political tourism are strong potential themes that are likely to be explored by Timor-Leste's cultural ecotourism packages. Strong political tourism sub-themes, including sites of Portuguese colonization, Indonesian occupation, and FRETILIN-led struggle for independence have the potential to attract tourists (Edyvane *et al.*, 2009).

Coastal-marine biodiversity, especially diving and snorkeling, as well as interactions with marine wildlife also offer significant potential for ecotourism development. Community-based ecotourism has the potential to provide significant opportunities for local economic development through a combination of nature-based tourism and cultural tourism (Edyvane *et al*., 2009).

Tourism offers potential solutions to food security and livelihood objectives. However, at the same time, poorly managed tourism could lead to a significant loss of food security from coastal environments. The scale of food insecurity highlights the necessity to develop tourism revenues and jobs for local coastal communities. As such, it is imperative that the tourism sector adopt best management practices and guidelines for the sector development while in its formative stages (UniQuest, 2009).

D.Minerals, Oil, and Gas

Timor-Leste has been blessed with oil and gas, which contribute most of the country's revenues. However, these finite resources are projected to rapidly decline in production from 2020.

Government injection of oil funds into the economy appears to be targeted at consumption growth and not at production stimulation, and significant improvement in the capacity of the economy in the short to medium term is considered unlikely (Veloz, 2009).

E. Transportation and Shipping

The port in Dili is the main and only international port of entry to Timor-Leste. Dili port is located near the center of town. It has a wharf length of 300 m and can concurrently accommodate two large vessels with a draft of up to 7 m (World Bank, 2011).

Roll-on, roll-off facilities are available for front-loading vessels. Improvement works to Dili Port port were undertaken by the United Nations Peacekeeping Force (wharf extension), with US$5.7 million of bilateral aid from the Government of Japan and the Emergency Infrastructure Rehabilitation Project (US$1.3 million) (World Bank, 2011).

The Dili port is complemented by a fuel terminal located towards the western end of Dili, which is currently operated by the Indonesian State Company (Pertamina). Small wharfs or jetties are located at Hera, Tibar, Com, Caravela, the enclave of Oecussi, and the island of Atauro, with the latter two providing the only means of access to the localities from other parts of Timor-Leste (World Bank, 2011).

F. Traditional Knowledge Management

Timor-Leste's Constitution recognizes traditional natural resource management practices such as *tara bandu,* or the establishment of season taboos, which are part of the *adat* system. Programs such as RFLP and CTSP have worked to capture local knowledge. The CTSP program provides some guidance to fisheries managers

on how to capture local knowledge and make the best use of this knowledge in data-deficient environments. Pinto (2011)[11] is one of a few published resources providing guidelines to help fisheries managers navigate through the nuances of working with different epistemologies.

G.Gender Issues

The only report ever produced on fisheries and gender in Timor-Leste was that of De Carvalho et al. (2007). The fisheries sector is Timor-Leste, much like elsewhere in the region, is dominated by men. Unlike elsewhere, where women take a role in selling, in Timor-Leste, most of the fish markets are run by men. Women appear to play a role in post-harvesting (drying and salting) but, given the limited available training on this topic, often confine their engagement in fisheries-related activities to intertidal fishing. Donors such as JICA have provided crucial training and facilitated the establishment of women's cooperatives. As this training covered only a small group in different districts, there is a need to expand this program and provide more and better training to women interested in getting more involved in the sector.

H.Payment for Ecosystem Services

The CTI is arguably the first program to introduce this concept in Timor-Leste. It is expected that this program will help Government to explore creative ways of managing and generating incentives for the management of the country's marine and coastal resources.

[11] http://unesdoc.unesco.org/images/0021/002145/214540tet.pdf

V. Threats and Vulnerabilities

Overpopulation in islands such Java, Sulawesi, and Bali meant that most of the transmigrant Indonesian population inhabiting Timor-Leste's transmigration zones came from these islands. Transmigration was part of an Indonesian Government policy to "go east". Transmigrant people brought with them a series of fishing practices and new uses of some of the natural resources found in Timor-Leste.

Fishermen communities in sites, such as Tibar, Hera, and Com, sites close to the country's main fishing ports, link the arrival of the transmigrants and other Indonesian people, namely people from Celebes, with the introduction of blast fishing, cyanide fishing, and the use of compressors for trochus and sea cucumber harvest. These unsustainable fishing practices have left the coastal and marine environment vulnerable. While there are some anecdotal evidences of improvement, it will take more than a decade for the country to recover from the damage caused by blast fishing in the country's north coast.

Furthermore, as postulated by Monk *et al.* (1997), the hasty attempt by the Indonesian Government to force local Timorese communities to shift from subsistence-based practices to a market economy appeared to have generated some confusion and clashes between the local belief system and its valuation of nature and a predominantly economic valuation of natural resources being imposed by the Indonesian Government.

Moreover, traditional natural resource management practices and customary laws, which helped ensure the sustainability of several subsistence practices, were stopped, giving rise to a natural resource management gap that seems to have contributed to the accentuated exploitation and misuse of Timor-Leste's natural resources, such as mangrove forests and coral reefs.

The current lack of knowledge and absence of ecological data about the marine and coastal ecosystems in Timor-Leste makes the process of developing coastal areas particularly challenging. Furthermore, decisionmakers' lack of understanding and underestimation of the importance of coastal ecosystems, short-term thinking, and the lack of a sense of accountability on the part of developers enhanced the potential for destruction of these ecosystems.

Illegal fishing is a major threat to Timor-Leste's fish stocks. The level of surveillance by the relevant Timorese relevant forces of law and order is still very low. Current estimates suggest that illegal fishing causes significant losses to the Timorese economy in the order of US$40 million a year.[12]

Most of the illegal fishing vessels operating in Timor-Leste's economic exclusive zone (EEZ) appear to be Indonesian. Illegal vessels ranging from 7-14 gross tons (GT) are often reported by artisanal fishers to operate in

Figure 40 – Nine illegal boats seen in Iliomar (Source: http://odanmatan.blogspot.com/2009/04/ro-ahi-ilegal-naok-ikan-iha-tasi-mane.html)

[12]Source: http://www.oreporter.com/Timor-Leste-sofre-com-pesca-ilegal-por-parte-de-estrangeiros,1450698970.htm

their traditional fishing grounds and come to as close as 200 m from the shoreline.

Results from previous fishery resource surveys using pelagic longlines and drift gill nets revealed that pelagic fish are mostly distributed along the coastal areas in the northern part of Timor Sea, 15-20 miles offshore (TDCA, 2004). The fact that such boats are now fishing increasingly closer to shore may be an indicator that fishing grounds found 15-20 miles offshore have been exploited by illegal fishers who have now moved closer to the shore.

Most of the illegal fishing appears to be in the eastern part of the south coast, with a substantial number of boats being spotted and reported to local authorities.

A. Current Issues in Marine Resource Management

The major issues in coastal and marine resources management in Timor-Leste appear to be associated with (i) rapid population growth and the direct demands on the natural resources for nutrition and income; (ii) pressures that result in land use moving onto increasingly steep and marginal land creating downstream impacts to the marine environment; (iii) short supply of land suitable for agriculture and inadequate irrigation schemes, which may result in further deforestation; (iv) increasing coastal populations, resulting in higher demand on the marine resources, and (v) climate change (UniQuest, 2009).

Population Growth

In Timor-Leste, population growth is a major underlying cause of increased risk to coastal and marine resources. Increased demands are projected to be significant, with a 150% increase in demand for fish resources expected by 2030. The forecast growth in demand is such that many question the ability of natural resource endowments to sustain such levels of demand in the long run (UniQuest, 2009).

Excessive Nutrients and Other Pollution Sources

Population growth and inadequate infrastructure to supply water and remove sewage in the country's main urban centers is leading to increased nutrients entering coastal environments through the local drainage systems (UniQuest, 2009). Increasing urbanization brings added challenges to coastal and marine management, such as (i) water and air pollution, (ii) intensified use of the natural resources in the surrounding areas, and (iii) loss of agricultural and vegetated land due to urban sprawl (UniQuest, 2009).

Land Degradation

Unsustainable agricultural practices (through traditional slash and burn agricultural methods and cultivation of steep upland hillsides), illegal logging of native wood species, fire, firewood extraction, and cultivation on marginal land are thought to be the leading causes of land degradation in Timor-Leste. These unsustainable practices lead to an increase in runoff and sediment movement into Timor-Leste coastal environments. This movement is particularly high during torrential rain events and flash floods that are known to occur in almost all districts, causing severe soil erosion and landslides in the uplands and disastrous floods in the lowland areas (UniQuest, 2009).

Overfishing

Monk *et al.* (1997) reported that fish populations are being overexploited in the Nusa Tenggara and Mollucas regions. Despite this, there are limited in-country studies to substantiate these claims. One of the first studies conducted after the independence (Deutsch, 2003) showed evidence of overfishing and its impact in fish assemblages in Timor-Leste. This study identified lower median family richness, lower mean number of snapper, and lower median number of parrotfish for sites in Dili, indicating that fishing is impacting on fish abundance in fishing grounds in and around Dili District.

Destructive Fishing Practices

While destructive fishing techniques, such as dynamite and cyanide fishing, are common in the Indonesian archipelago, these destructive fishing techniques were not as prevalent in Timor-Leste as in other parts of the Lesser Sunda Ecoregion. Fishers have identified a greater concentration of blast fishing craters along the Laivai to Mehara transect, with some of the craters been relatively recent as the result of IUU fishing by Indonesian vessels.

An increase in fishing effort and the number of people relying on coastal and marine resources for protein is seen during the two lean seasons between harvests, October-November and February-March. During this time, community members engage in many destructive

practices, such as the use of derris root and crow bars to dislodge corals to create fish traps.

Climate change and climate variability and crop failure has led to more pressure on coastal and marine habitats.

Climate Change

Timor-Leste is drier today than it was some 30 years ago, and there has been an increase in sea surface temperatures at a rate of 0.12oC per decade over the period 1981-2008 (Kirono, 2010).

The most up-to-date projection for Timor-Leste shows that there is a tendency for (i) stronger tropical cyclones, (ii) a decrease in evaporation (iii) an increase in sea surface temperature (0.6-0.8oC by 2030), and (iv) an increase in sea level (3.2-10 cm by 2020). While extreme rainfall events are expected to decrease in number, they are thought to increase in their intensity, and ocean acidification is also expected to increase (Kirono, 2010)

The aforementioned changes in weather pattern (prolonged drought, extended rains) make Timorese subsistence farmers and fishers extremely vulnerable to climate change.

Threatened Species

Timor-Leste's fauna, excluding birds, is characterized by low overall species richness but with relatively high levels of endemism (Monk *et al*., 1997). Of the 168 resident birds, 32 are endemic to the Lesser Sundas and 8 are endemic to the Island. At least two mammals (of the 35 native species) and one reptile (of 40 species) are currently known to be endemic. The country's fauna include a number of endemic species like the Timor shrew and Timor rat. There are about 250 species, of

Table 4: Threatened Species in Timor-Leste *(Source: ASEAN Centre for Biodiversity)*

Taxa	Number	Number threatened
Vertebrates		
Amphibians	10	-
Freshwater fishes	48	1
Marine fishes	264	6
Freshwater and marine fishes	22	-
Terrestrial birds	151 ?	4?
Marine birds	16 ?	-
Terrestrial and marine birds	91 ?	3 ?
Terrestrial mammals	69 ?	2 ?
Marine mammals	28	3
Freshwater reptiles	3	-
Terrestrial reptiles	47	-
Marine reptiles	13	6
Invertebrates		
Freshwater molluscs	2	-
Marine molluscs	278	2
Marine crustaceans	39	-
Coelenterates	2	-
Hexacorals	12	-
Insects	488	-
Plants		
Terrestrial	807	4
Marine	28	-
Freshwater	30	-
Total	**2,448**	**31**

which 24 are endemic. The five threatened species are Slaty Cuckoo Dove, Wetar Ground Dove, Timor Green Pegion, Timor Imperial Pigeon, and the Iris Lorikeet.

According to the IUCN, three species of trees, four species of birds, three species of mammals, and one butterfly species in Timor are considered threatened with extinction. Table 5 below summarizes the list of Timor-Leste's endangered plants and animals.

Table 5: Timor Leste's Endangered Plants and Animals

Common Name	Scientific Name	IUCN Status	Threats
Trees			
Sandalwood	*Santalum album*	VU	Habitat loss, fires, agriculture, extraction
Borneo teak	*Intsia bijuga*	VU	Habitat loss, selective logging
Burmese rosewood	*Pterocarpus indicus*	VU	Habitat loss, agriculture, selective logging
	Mangifera timorensis	EN	
Birds			
Timor green pigeon	*Treron psittaceus*	EN	Habitat loss, agriculture, hunting
Timor imperial pigeon	*Ducula cineracea*	EN	Habitat loss, agriculture, hunting
Wetar ground dove	*Gallicolumba hoe*	EN	Habitat loss, agriculture, hunting
Yellow crested cockatoo	*Cacatua sulphurea*	EN	Habitat loss, harvest for pet trade, agriculture
Mammals			
Thin shrew	*Crocidura tenuis*	VU	Habitat loss, degradation, restricted range
Western baked-backed bat	*Dobsonia peronei*	VU	Habitat loss, extraction, restricted range
Mentawai palm civet	*Paradoxurus hermaphrodites*	VU	
Long-tailed macaque	*Macaca fascicularis*	LR/nt, CITES	
Northern common cuscus	*Phalanger orientalis*	CITES	
Timor leaf-nosed bat	*Hipposidero scrumeniferus*	DD	
Greater long-eared bat	*Nyctophilus timorensis*	VU	
Philippine horseshoe bat	*Rhinolophus philippinensis*	LR/nt	
Papuan pipistrelle bat	*Pipistrellus papuanus*	LR/nt	
Schreibers' bent-winged bat	*Miniopterus schreibersii*	LR/nt	
Timor monitor lizard	*Varanus timorensis*	CITES	
Estuarine crocodile	*Crocodylus porosus*	CITES	
Timor python	*Python timorensis*	CITES	
Snake neck turtle	*Cheloni amcordii*	CR	
Southeast Asian box turtle	*Cuora amboinensis*	VU	

Common Name	Scientific Name	IUCN Status	Threats
Insect			
Timor Yellow Tiger	*Parantia timorica*	EN	Severely fragmented population with ongoing decline
Marine Species			
Green turtle	*Chelonia mydas*	EN, CITES	
Hawksbill turtle	*Eretmochely simbricata*	CR	
Leatherback turtle	*Dermochely scoriacea*	CR	
Loggerhead turtle	*Caretta caretta*	EN	
Olive turtle	*Lepidochely solivacea*	EN, CITES	
Dugong	*Dugong dugon*	VU	
Sperm whale	*Physeter catodon*	VU	
Killer whale	*Orcinus orca*	LR/ed, CITES	
Spinner dolphin	*Stenella longirostris*	LR/ed, CITES	
Bottlenose dolphin	*Tursiops truncates*	DD	
Basking shark	*Rhincodon typus*	VU	
Southern giant clam	*Tridacna derasa*	VU	
Giant clam	*Tridacna gigas*	VU	
Small giant clam	*Tridacna maxima*	LR/ed	
Fluted giant clam	*Tridacna squamosa*	LR/ed	
Bear paw Clam	*Hippopus hippopus*	LR/ed	
China clam	*Hippopus porcellanus*	LR/ed	
Giant coconut crab	*Birgus latro*	DD	

CR- critically endangered; EN – endangered; VU – vulnerable; LR – lower risk; (nt – near threatened, ed – conservation dependent), DD- data deficient Sources: FAA 118/119 Report; Sandlund et al, 2001

B.Emerging Issues for Marine Resource Use

Mariculture

Please refer back to the section on Aquaculture.

Climate change impacts

Refer back to the section on current issues for marine resource management.

Harmful algal blooms

There are no records that the author is aware of of harmful algal blooms in Timor-Leste

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