4.4.9 Water Resources

1. Policy

Water resources in Timor-Leste at present has not been optimally managed, both as raw water sources for clean water and irrigation and as sources of energy that can be utilized for various activities. The phenomenon of water scarcity also happens in Timor-Leste, which can be observed from the lack of accessible clean water to meet the demand and the many non-irrigation areas found across the country.

Figure 4.26 - Annual Rainfall

From the geographical condition of Timor-Leste, this country is a relatively desiccated country with an unstable balance between dry season and wet season, where the dry season is relatively longer than the wet season. This is also supported by the general condition of Timor-Leste geology which is formed from Karst rocks which is porous in nature. The ability of the soil to hold water is very low, a phenomenon which can be observed from the shrivelled rivers in dry season and the flooding in rainy season. From December to March northwest to southwest winds prevail, bringing the principal wet season for the year to most parts of the island. From May until October southeast to northeast winds prevail, bringing mostly dry season, except for the south coast and southern slopes where the wet season persists until July. The average annual rainfall totals vary from 565 millimetres at Manatuto along the north coast to 2,837 millimetres at Lolotai in the central-western mountains

In common with most tropical locations, extremely heavy rainfalls occasionally occur over East Timor during relatively short time intervals. As is characteristic of the tropics, there is little temperature variation on either a diurnal or a seasonal basis. The most striking temperature variations occur depending on the altitude. Average annual temperatures typically decrease

from 27°C at sea level to 24°C at 500 metres elevation, 21°C at 1,000 metres, 18°C at 1,500 metres and 14°C at 2,000 metres elevation.

Relative humidity usually follows a diurnal cycle with a maximum around dawn and a minimum during the mid-afternoon. Relative humidity varies between 70% and 80%, which makes the climate humid in general, but pleasant. Annual average evaporation varies from 1,805 millimetres along the north coast at Laga to 607 millimetres at Fatu-Bessi, located at 1,120 metres. Evaporation is at a minimum during the first half of the year, rising to a peak around September.

Moreover, river sedimentation can be found in many places as a result of sediment deposition which comes from the upstream. Therefore, an intensive study with special condition needs to be carried out in order to manage water resources in Timor-Leste.

Such a phenomenon must be supported by the government through its policies on the management of water resources, which essentially enables the utilization of the resources optimally to fulfil water demand for the people as well as to make use of the energy. Another equally important policy is to preserve natural conservation in order to safeguard hydrology cycle, by protecting the forest, land use, soil water, etc.

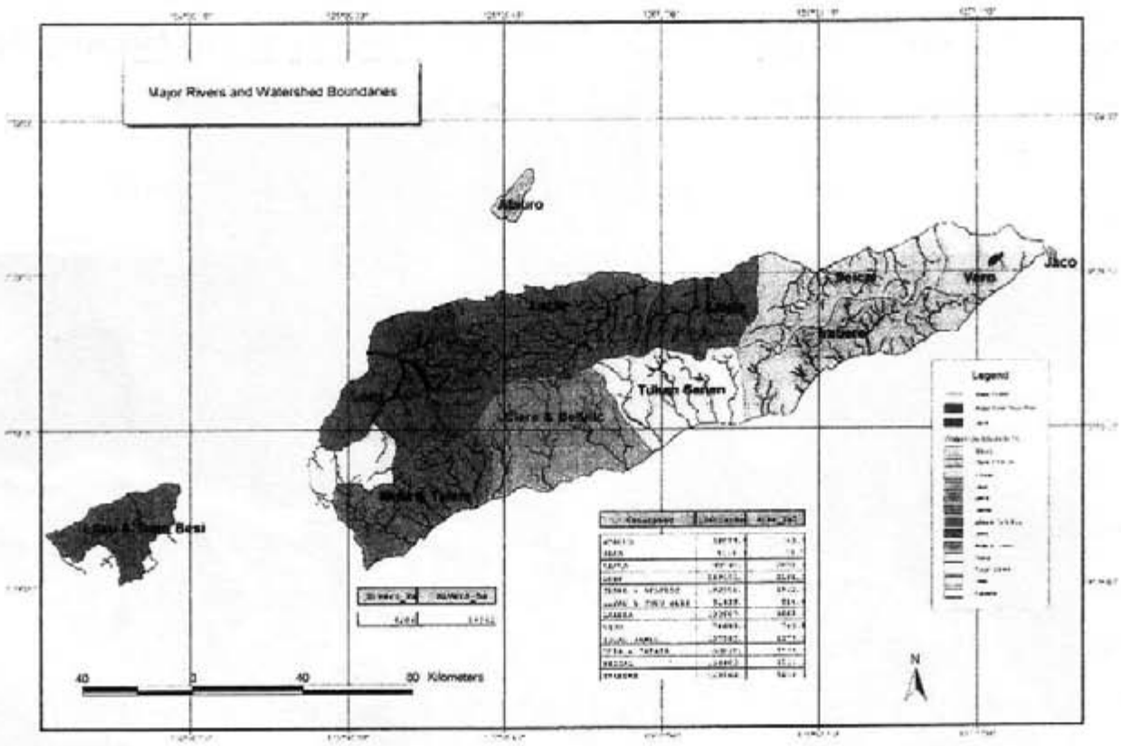
The hydrology condition in one area can be seen from several things, namely vegetation, type of soil, total watershed area, topography, rainfall, and climatological condition. In Timor-Leste, there are several river systems which contain certain catchment areas, from which the potential of watershed areas can be seen. There are 10 (ten) river systems (major river and watershed) in Timor-Leste, and there are also some river systems which cover Indonesian area, especially in the border area and Oe-Cussi. The total length of the river in Timor-Leste is about 4,286 km with a total river surface area of around 18,342 ha.

Table 4.54 - Watershed Area

Watershed	Area (Km^2)
Atauro	140,7
Jaco	11,1
Laclo	2031,4
Loes	2191,3
Clere & Belulic	1923,6
Lifau & Tono Besi	814,4
Laleia	1009,9
Vero	746,8
Tukan Sanen	1379,8
Mola & Tafara	1538,8
Seical	1514,8
Irabere	1619,6

Source: MAF

Figure 4.27 - Major Rivers and Watershed Boundaries



Source: MAF

From obtained data, the largest river system is Loes with a total area of 2,191.3 km^2, while the smallest would be Jaco with a total area of 11.1 km^2.

By considering the population growth and its accompanying water needs, the future of water balance, availability of infrastructure, and water resources services tend to be especially uneven and sensitive.

Generally, water resources infrastructure development does not stand alone but related to the development of other sectors since infrastructure is a support or could sustain the development of these other sectors. Water resources infrastructure development provides a lot of great support such as for the development of agriculture, plantation, flood control, urban raw water supply and industrial, and hydroelectric (hydropower).

In the meantime, the utilization of water resources in Timor-Leste is still suboptimal, since there are a lot of water constructions for irrigation and reservoir which are not functional. Water exploitation for electricity has also yet to be massively developed, and there is only quite a few micro-hydro power plants, one of which is the micro-hydro power plants in Gariuai with a capacity of 326 KW. In order to thoroughly identify with water resources potential which can be developed in Timor-Leste, the following figure depicts the condition.

Figure 4.28 - Potential for Water Resources Development

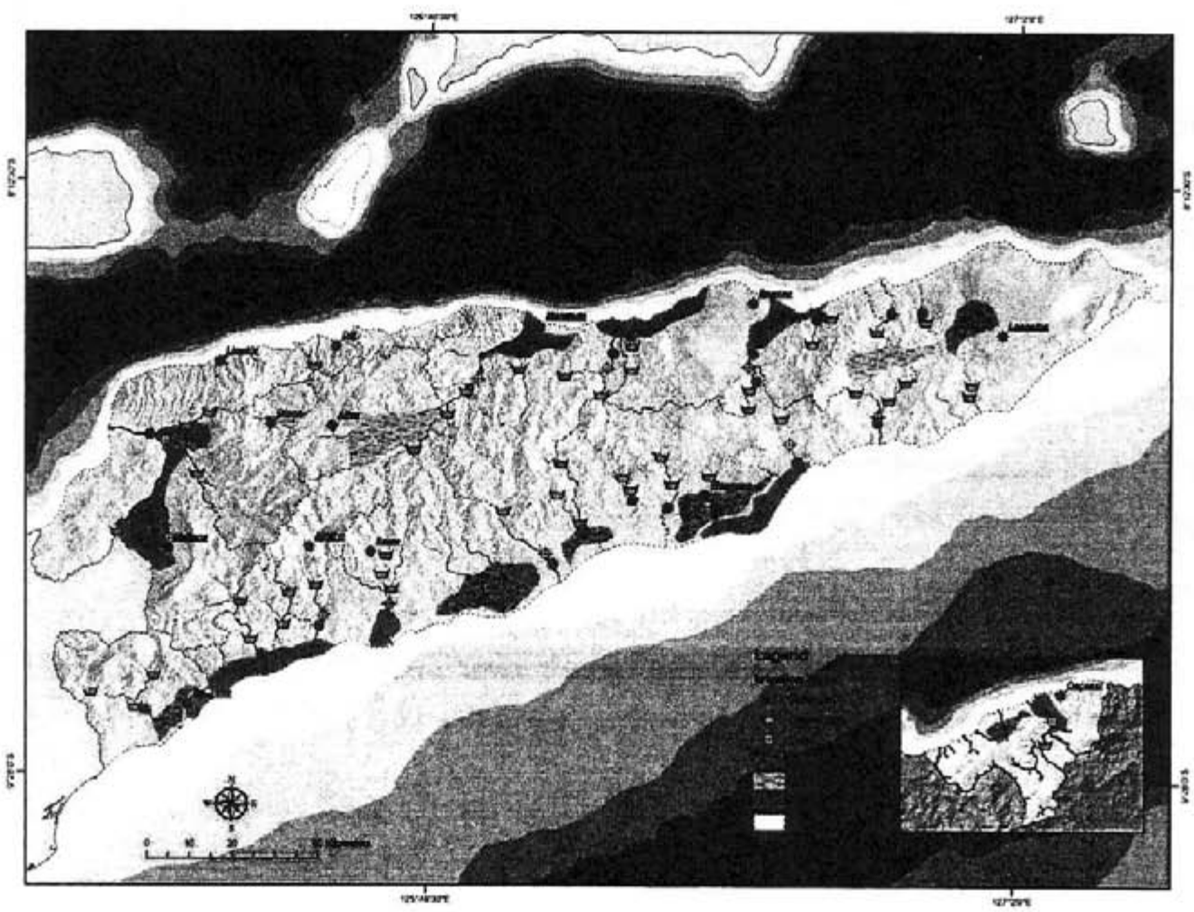


Figure 4.30 - Dam Ilustration 1

Figure 4.28 above presents the potential for water constructions development to increase the benefit and impact of water resources. There are several water resources potentials which can be utilized in a large scale is the watershed area of Laclo and Sahen in districts of Manatuto and Aileu, in which the watershed contains a fairly spacious catchment area which results in a relatively high water availability. In these regions, it is possible for multipurpose dams to be built in order to fulfil raw water and electricity (hydropower) needs. There are several identified locations in which hydropower can be built. One of the locations that has been assessed is in Daisoli region.

Figure 4.29 - Dam Ilustration 2

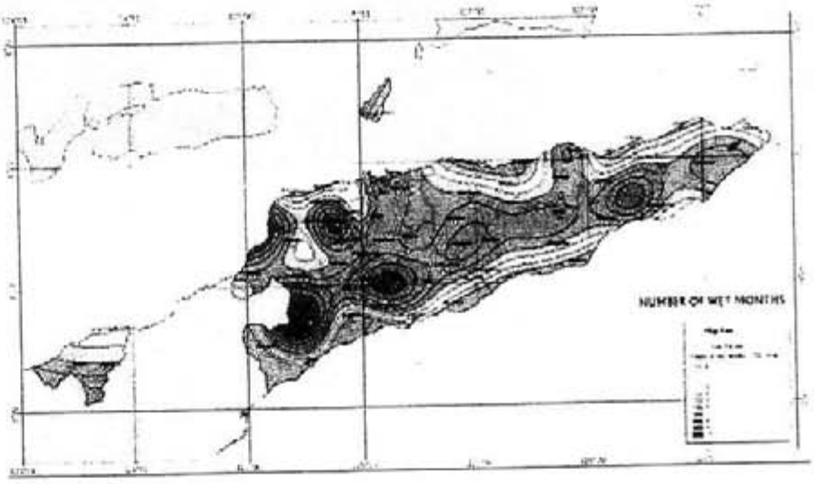
Other than Laclo and Sahen watershed, other watersheds which can be developed is the Loes watershed in Bobonaro and Ermera District. There are also other locations which are potential for dam establishment, but their potentials are not as promising as the ones found is Laclo and Loes watershed.

For other potentials, Barragem can also be developed to meet water demand as well as to be used for drinking water, by collecting water in the wet season to be used during the dry season. The Barragem potential can be seen in the pictures, in which the location of the reservoir is situated near residential areas, while for irrigation water is located close to the rice fields. Such an effort is done to prevent water loss. Water utilization in the reservoirs is built by use gravity principle.

2. Problems and Challenges

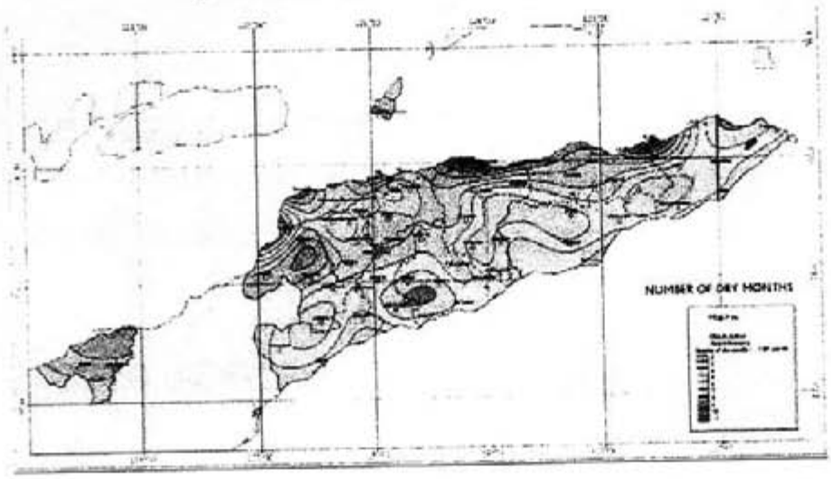
With the existing geographical conditions, it would require an appropriate technical approach which is suitable to the condition in Timor-Leste, both in terms of government policy and technical aspect, given the condition in Timor-Leste that is still lacking of water, both clean water and irrigation water, in addition to the fact that water resources have not been fully utilized and there is no large hydro power plant had been developed.

Figure 4.31 - Number of Wet Months



During the wet season, wet areas are mostly located in the highlands of Ermera, Lolotoe, Same, and in Los Palos. This can be observed from a relatively high rainfall in these regions. A low rainfall occurs in lowlands along the coast, which is understandable considering that thick vegetations mostly occur in higher grounds, while in the lowlands, the land use is typically intended for residential purpose. In the wet season, water availability is not much of an issue, but the actual problem lies in the exploitation and distribution of water.

Figure 4.32 - Number of Dry Months



During dry months, it is likely for water scarcity to come about, both for raw water and clean water. The driest region especially in the southern coastal area especially in the Betano region. The dry months take place not only in the southern part but also in the northern coast of Tutuala region. Generally speaking, during the dry months, the whole of

Timor-Leste dries up which effectively causes water crises for irrigation and clean water.

Clean water demand, irrigation water, and power demand will gradually increase in proportion to the population and economic growth of the Timor-Leste people. The challenge that must be overcome is to tap into the whole Timor-Leste water potentials in an optimal way to fulfil society needs with regards to ecosystem balance. Other challenge to be solved is the impact of surface-water runoff, its call flood. In this regard, flood management needs to be further considered.

3. Framework and Policy Direction

The framework and policy direction of the development of Timor-Leste water resources in the future must be done gradually as follow:

a) Short Term – Formulating policy regarding natural conservation to preserve water cycle balance.

b) The short term purpose and objectives is to protect the hydrology cycle in Timor-Leste in order to safeguard natural conservation balance, especially conservation of forest, river, watershed, sea, and coastal area. This is done in order to conserve environmental balance in the future; in which on-going development must consider the environmental conservation factor.

c) Middle Term – Water resources utilization to meet water demand of the society and to fulfil energy demand.

d) The middle term purpose and objectives is to exploit water resources with appropriate technological use such as for new water sources, Barragem, and micro-hydro centre, with the intention of fulfilling water and energy demand of the society as the number of population grows.

e) Long Term – Reduce dependency on diesel power generator to be replaced with hydropower.

f) The long term purpose and objectives is to reduce the burden of diesel power generator uses, since the use of such power generator is

uneconomical and environmentally unfriendly for natural conservation compared with micro-hydro.

4. Strategy

The main strategy in the management of water resources is by tapping into the whole potential be it surface water as well as soil water for the interest of the society while managing the impact of water run-off. This can be described as follow:

a) Conduct review study for all of water resources potential, in terms of capacity and quality.

b) Improve existing water constructions so that they could optimally function.

c) Implement technology which is related with the utilization of water resources management.

d) Discover new water sources alternatives to meet the growing demand.

5. Working plan

a) Short Term:

i) Prepare hydrology and climatology data which have already been measured in the past, for the sake of planning;
ii) Procurement and rejuvenation of hydrology measurement tools to be used as supporting data for the planning of water resources management activity;
iii) Inventarisation of water constructions which are still operational or not.
iv) Conduct potential review for every watershed;
v) Conduct soil water potential review as a new source alternative.

b) Middle Term:

i) Increase capacity of clean water availability;
ii) Increase the number of irrigated areas in conjunction with the increase of raw water sources;

iii) Rejuvenation of existing Barragem so that they could perform more optimally and establish new reservoirs in potential areas to be used for the fulfilment of drinking water demand as well as irrigation water;

iv) Development of micro-hydro power plant;

v) Improvement and expansion of flood control check dams;

vi) Establishment of multipurpose dams to meet clean water, irrigation, and power plant demand.

c) Long Term:

i) Realization of water demand which is evenly spread across the region;

ii) Improvement of electricity availability with the establishment of the micro-hydro;

iii) Realization of a flood-free Timor-Leste.

6. Project Implementation

a) Short Term:

i) Water resources potential study in Timor-Leste;

ii) Master plan preparation of the multipurpose dams;

iii) Master plan preparation of the drainage system in Timor-Leste;

iv) Design and rehabilitation of irrigation networks and existing Barragem;

v) Supervision of the rehabilitation of irrigation networks and existing Barragem;

b) Middle Term:

i) Determination of water resources and its implementation;

ii) Detailed Engineering Design for the multipurpose dams;

iii) Development of new Barragem;

iv) Improvement of raw water capacity;

v) Development of drainage construction;

vi) Development of Micro hydro Power Plant.

c) Long Term: Establishment of multipurpose dams in Timor-Leste.

The project is prepared for the short term until the year 2015, primarily intended for equipment procurement and inventory of hydrology equipment, water resources master plan study, detailed design and rehabilitation of existing constructions. Total cost of investment for short term water resources projects is USD 92,050,000. Work began with studies conducted in the first year and then in the second year concentrated on the procurement activities several hydrology tools and design detail. For the following years there will be a rehabilitation of existing constructions and the commencement of Barragem and new irrigation networks development.

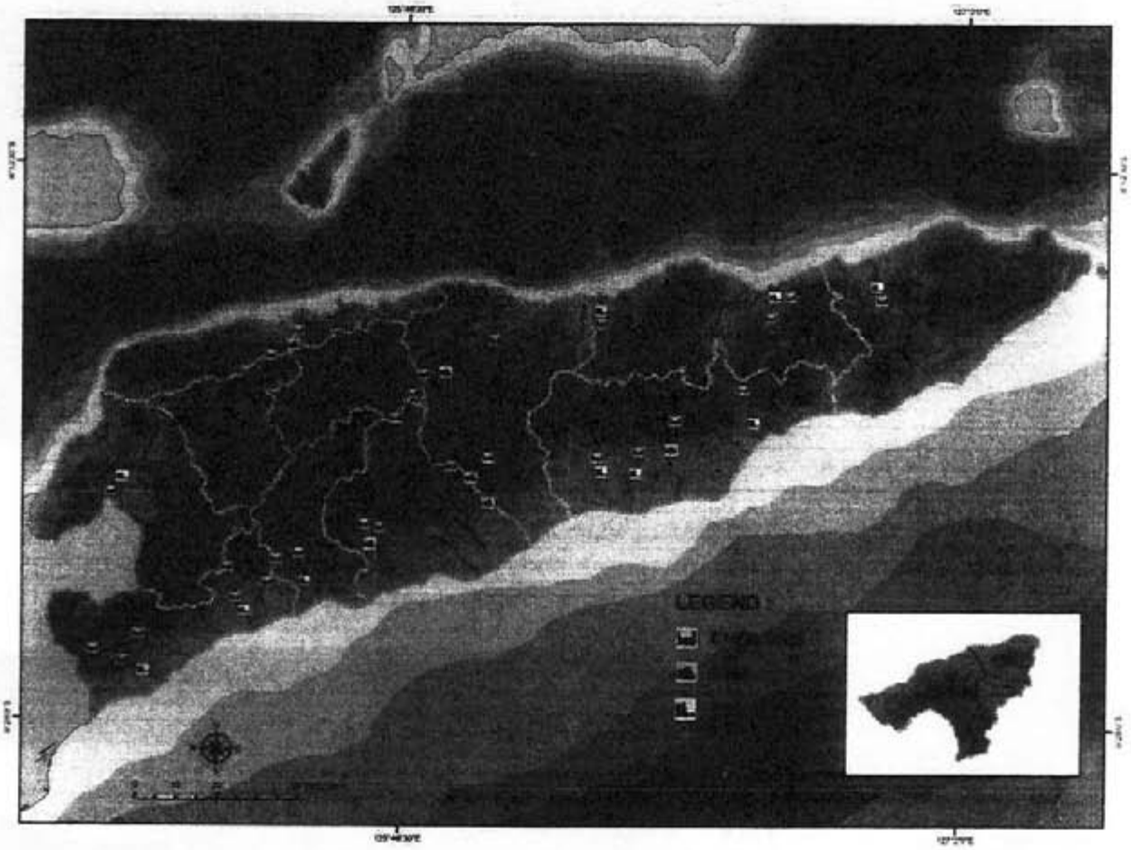
Table 4.55 - Cost Estimation for the Sub-Sector of Water Resources Projects 2010 – 2015

No	DESCRIPTION	SHORT TERM					
		2010	2011	2012	2013	2014	2015
A	**WATER RESOURCES STUDY**						
1	Hydrological and Climatological Data Inventory	√					
2	Hydrological and Climatologycal Measurement		√	√			
3	Water Resources Study in Timor-Leste	√					
4	Potential Dam Study	√					
5	Potential Barragem Study		√				
6	Design and Rehabilitation Irrigation System	√					
9	Design and Rehabilitation Existing Barragem	√					
10	Master plan of Multipurpose Dam					√	
11	Detail Design of Multipurpose Dam						√
12	Detail Design of Irrigation System		√				
13	Detail Design of Barragem		√				
14	Supervisions		√	√	√	√	√
B	**IMPROVEMENT EXISTING WATER CONSTRUCTIONS**						
1	Rehabilitation of Irrigation System		√	√	√	√	√
2	Rehabilitation of Existing Barragem		√	√	√	√	√
C	**CONSTRUCTIONS**						
1	Multipurpose Dam Constructions						
2	Barragem Constructions			√	√	√	√
3	Constructions of Irrigation System			√	√	√	√

For the middle term program between 2015 and 2020, the total amount of estimated investment costs for the sector development of water resources projects are around USD 296,000,000. This amount is larger than the budget for short term period due to the many

construction projects, particularly to establish multipurpose dams and for further development of new Barragem.

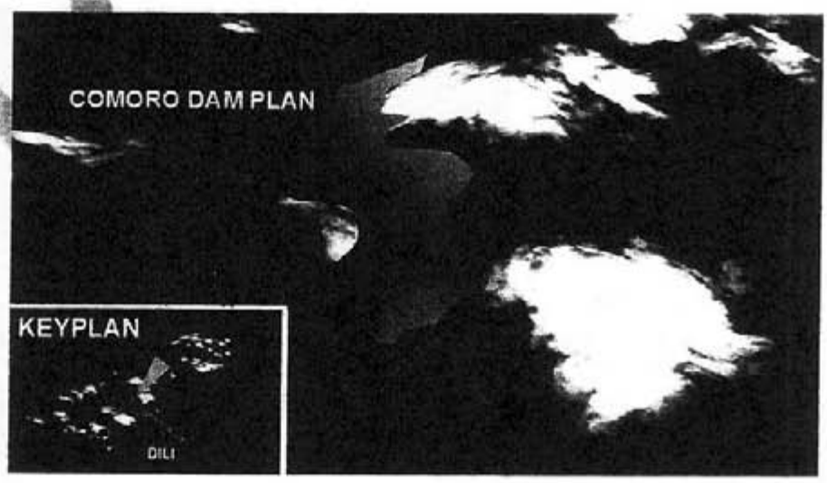
Figure 4.33 - Water Resources Planning 2011-2015



For illustration purpose, the following are some perspective images for several potential locations of the planned dams during the short term period of 2011-2015, as follow:

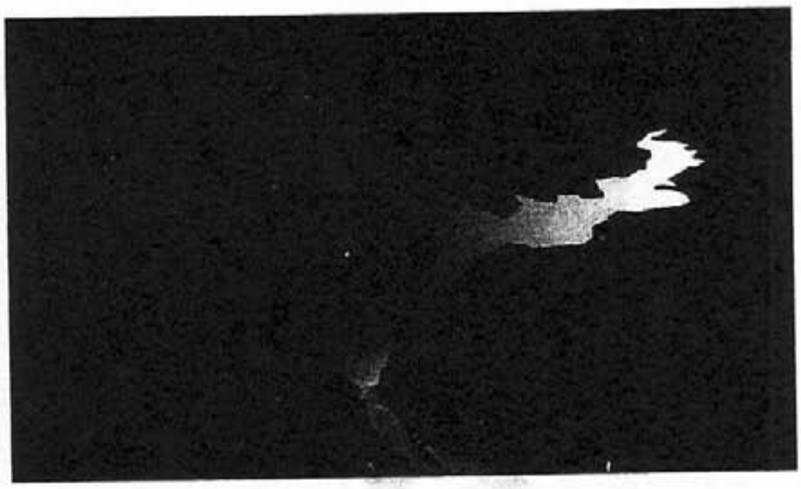
i) Comoro Dam (Dili)

Figure 4.34 - Comoro Dam Plan



ii) Laclo Dam (Manatuto)

Figure 4.35 - Laclo Dam Plan



iii) Sahen Dam (Manatuto)

Figure 4.36 - Sahen Dam Plan 1

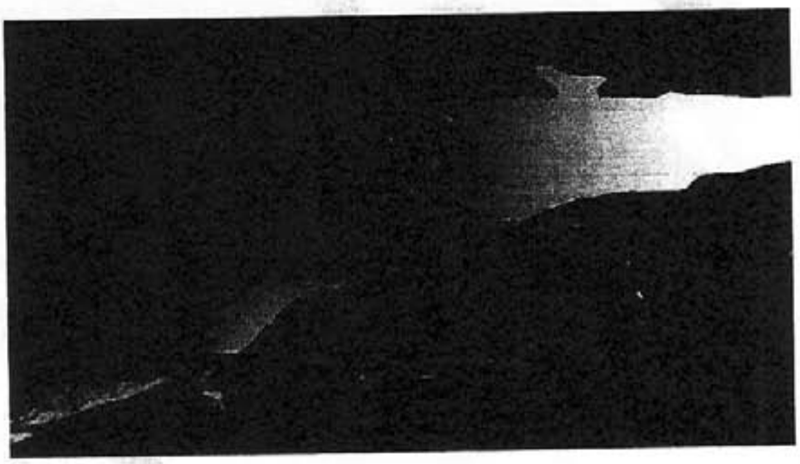
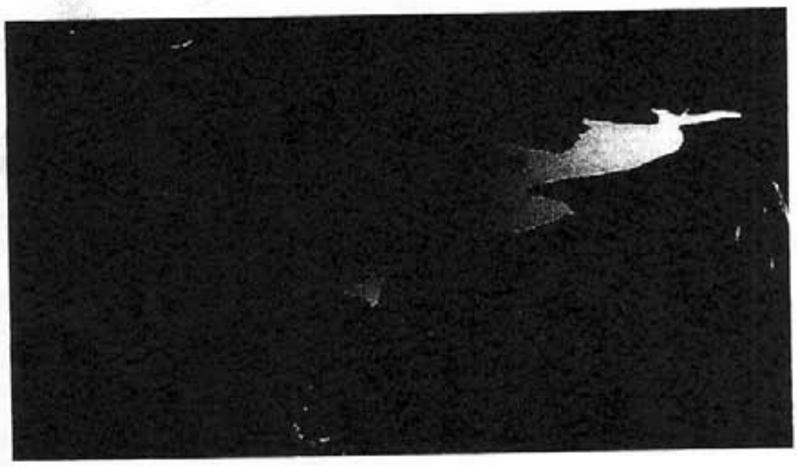


Figure 4.37 - Sahen Dam Plan 2



iv) Irabele Dam (Viqueque)

Figure 4.38 - Irabele Dam Plan

v) Caraulun Dam (Manufahi)

Figure 4.39 - Caraulun Dam Plan

The establishment of dam is expected to be implemented in the watershed area of Laclo River and Sahen River in Manatuto district with an estimated construction cost of about USD 250,000,000 which is done gradually over the course of 5 years, with the anticipation that the new dams could improve power demand by about 30 MW, supply irrigation water and clean water demand, especially for Dili and Manatuto.

Table 4.56 - Cost Estimation for Water Resources Sector Projects 2016 – 2020

No	DESCRIPTION	MID TERM				
		2016	2017	2018	2019	2020
A	**WATER RESOURCES STUDY**					
1	Hydrological and Climatologycal Data Inventory					
2	Hydrological and Climatologycal Measurement					
3	Water Resources Study in Timor-Leste					

4	Potential Dam Study					
5	Potential Beragem Study					
6	Design and Rehabilitation Irrigation System					
9	Design and Rehabilitation Existing Beragem					
10	Masterplan of Multipurpose Dam					
11	Detail Design of Multipurpose Dam					
12	Detail Design of Irrigation System					
13	Detail Design of Barragem					
14	Supervitions	√	√	√	√	√
B	**IMPROVEMENT EXISTING WATER CONSTRUCTIONS**					
1	Rehabilitation of Irrigation System					
2	Rehabilitation of Existing Barragem					
C	**CONSTRUCTIONS**					
1	Multipurpose Dam Constructions	√	√	√	√	√
2	Barragem Constructions	√	√	√	√	√
3	Constructions of Irrigation System	√	√	√	√	√

Figure 4.40 - Water Resources Planning 2016 – 2020