No.

The Republic of Cape Verde
Ministry of Tourism, Industry and Energy (MTIE)

Preparatory Survey Report
on
The Water Supply System
Development Project
in
The Republic of Cape Verde

January 2011

Japan International Cooperation Agency

Toyo Engineering Corporation
INGEROSEC Corporation
UNICO International Corporation

GED
CR(3)
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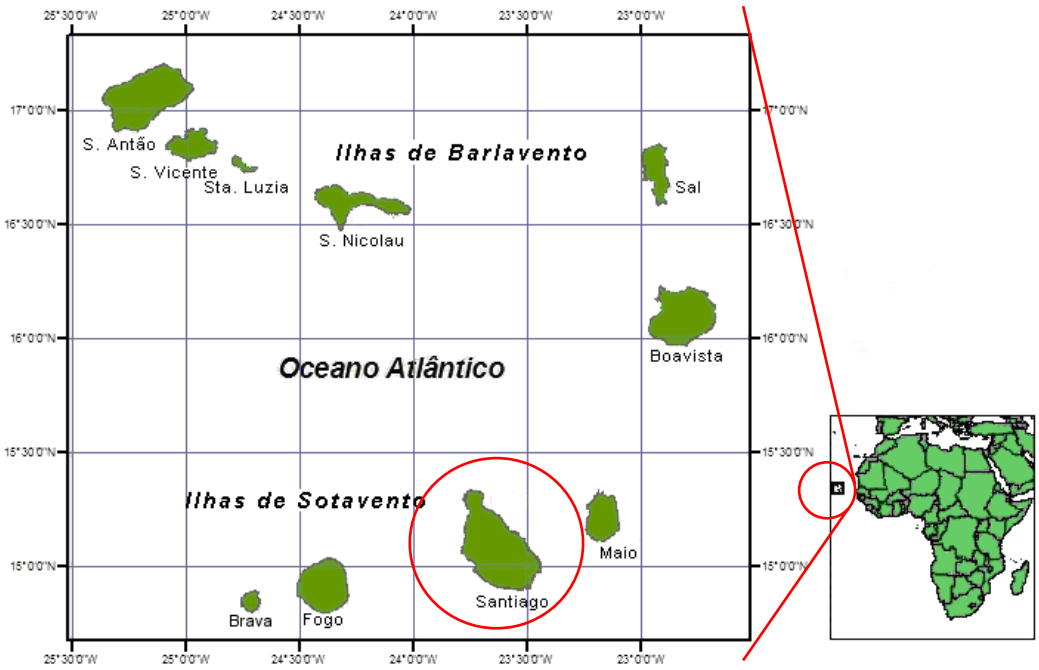

Location of the Republic of Cape Verde

Map of the Santiago Island

Photo

Counter Part:Ministry of Economy Growth and Competitiveness,

Now MTIE (Ministry of Tourism, Indstry and Economy)

Meeting with MTIE (From left; Mr.Pedro, Mr.Lopez, DG of MTIE)

From right; Mr.Suzuki, survey team leader, Mr.Kojima, JICA)

Steering Committee (center : Mr. Lopez, DG of MTIE)

Meeting with Sao Miguel (Center : Mayor)

Ribeira Grande, Cape Verde

Tarrafal, Cape Verde

Near Picos (between Praia and Assomada)

（around 400m from sea level）

Near Malagueta (between Assomada and Tarrafal)

（around 800m from sea level）

Reservoir (Praia)

Reservoir (Santa Cruz)

Reservoir (Tarrafal)

Reservoir under construction (Ribeira Grande）

Water tanker truck (Picos)

Water Tanker truck & Reservoir (Porto Mosquito)

Tap water measurement meter

ELECTRA SWRO plant site (Palmarejo, Praia)

ELECTRA SWRO plant site sea coast (Palmarejo, Praia)

Intake for old MED (Palmarejo, Praia)

Praia SWRO (5,000m^3/d x 1 unit)

Praia container type SWRO (1,200m^3/d x 2 units)

Santa Cruz SWRO plant site

Santa Cruz SWRO　(500m^3/d)

High pressure pump with energy recovery device (Praia)

High pressure pump with energy recovery device（Sal island）

Intake beach well (Praia)

Intake beach well (Sal island)

Candidate desalination plant site in Palmarejo (Praia)

Candidate desalination plant site in Calheta (Sao Miguel)

Dam donated by China (Sao Lourenco)

Port Praia

Abbreviations

(P)：Português (E)：English (J)：Japanese

ACV	Águas de Cabo Verde (P) カーボヴェルデ水道会社 (J)
ADA	Agência de Distribuição de Água (P) Agência de Distribuição de Água 社 (J)
ADC	Cooperação de Desenvolvimento da Áustria (P) Austrian Development Cooperation (E) オーストラリア開発庁 (J)
ADP	Águas de Portugal (P) ポルトガル水会社 (J)
AFD	Agência de Desenvolvimento Francesa (P) French Development Agency (E) フランス開発庁 (J)
AfDB	Banco de Desenvolvimento Africano (P) African Development Bank (E) アフリカ開発銀行 (J)
APD(P) ODA(E)	Ajuda publica ao desenvolvimento (P) Official Development Assistance (E) 政府開発援助 (J)
ARE	Agência de Regulação Económica (P) 経済監督庁 (J)
BADEA	Banco Árabe para Desenvolvimento Económico na África (P) Arab Bank for Economic Development in Africa (E) アラブ銀行 (J)
BQ	Facturas de construção (P) Bill of quantity (E)
BOT	Construir, Operar e Transferir (P) Built, Operate, and Transfer (E)
CAPEX	Gasto de Capital (P) Capital Expenditure (E) 資本支出 (J)
CNAG	Conselho Nacional de Águas (P) 国家水資源協議会 (J)

CPI	Indice de Preços do Consumidor (P)
	Consumer Price Index (E)
	消費者物価指数 (J)
CVE	Escudo de Cabo Verde (P)
	Cape Verde escudo (E)
	カーボヴェルデエスクード (J)
D/D	Desenho Detalhado (P)
	Detailed Design (E)
	詳細設計 (J)
DGA	Direcção Geral do Ambiente (P)
	Direction General of Environment (E)
	環境総局 (J)
DGE	Direcção Geral da Energia (P)
	Direction General of Energy (E)
	エネルギー部 (J)
DGIC	Direcção Geral da Indústria e Comércio (P)
	Direction General of Industry and Commerce (E)
	産業・商業部 (J)
DGPOG	Direcção Geral do Planeamento, Orçamento e Gestão (P)
	Direction General of Planning, Budget and Management (E)
DGT	Direcção Geral do Turismo (P)
	Direction General of Tourism (E)
	観光部 (J)
DICL	Ferro dúctil com revestimento de cimento (P)
	Ductile Iron Cement Lining (E)
	ダクタイル鋳鉄管 (J)
DoP (P) WoP (E)	Direito de Passagem (P)
	Right of Way (E)
	道路境界線 (J)
DSCR	Taxa de Cobertura do Serviço de Débito (P)
	Debt Service Coverage Ratio (E)
DSS	Dodecil de Sulfato de Sódio (P)
	Dodecyl Sodium Sulfate (E)
EAI (P) IEE (E)	Exame Ambiental Inicial (P)
	Initial Environmental Examination (E)
	初期環境調査 (J)

EDA	Empresa de Electricidade de Portugal (P) ポルトガル電力会社 (E)
EIA	Estudo do Impacto Ambiental (P) Environmental Impact Assessment (E) 環境影響評価 (J)
EIB	Banco de Investimento Europeu (P) European Investment Bank (E) 欧州投資銀行 (J)
ERD	Dispositivo de recuperação de energia (P) Energy Recovery Device (E) エネルギー回収装置 (J)
FIC	Zona Franca Comercial (P) Commercial Free Zone (E) 国際見本市 (J)
FMD (P) DCF (E)	luxo Monetário de Desconto (P) Discount Cash Flow (E)
F/F	Fact-finding (E) ファクトファインディング (J)
F/S	Estudo de Viabilidade (P) Feasibility Study (J) 予備調査 (J)
GIRH (P) IWRM (E)	Gestão Integrada de Recursos Hídricos (P) Integrated Water Resources Management (E) 統合水資源管理 (J)
Governo de Cabo Verde (P) GoCV (E)	Governo da República de Cabo Verde (P) Government of Cape Verde (E) カーボヴェルデ政府 (J)
GPRSP	Crescimento e a Redução da Pobreza (P) Growth and Poverty Reduction Strategy Paper (P) 成長と貧困削減戦略 (J)
GTC	Termos e Condições Gerais (P) General Terms and Conditions (E) 一般条件書 (J)
HDPE	Polietileno de Alta Densidade (P) High Density Polyethylene (E) 高密度ポリエチレン管 (J)

IBRD	International Bank for Reconstruction and Development (E) 国際復興開発銀行 (J)
ICB	licitação competitiva internacional (P) International Competitive Bidding (E) 国際競争入札 (J)
IDA	Associação de Desenvolvimento Internacional (P) International Development Association (E) 国際開発協会 (J)
IEC	Informação, Educação e Comunicação (P) Information, Education and Communication (E)
IGEA	Inspectoria Geral de Actividade Económica (P) Inspectorate General of Economic Activities (E) 経済活動監査部 (J)
INE	Instituto Nacional de Estatística (P) 国家統計 (J)
INGRH	Instituto Nacional de Gestão de Recursos Hídricos (P) 水資源管理公社 (J)
IRR	Taxa Interna de Retorno (P) Internal Rate of Return (E) 内部収益率 (J)
ISO	Organização Internacional para Padronização (P) International Organization for Standardization (E) 国際標準化機構 (J)
JDC (P) IDC (E)	Juros durante a construção (P) Interest during Construction (E) 建設中金利 (J)
JICA	Agência de Cooperação Internacional do Japão (P) Japan International Cooperation Agency (E) 国際協力機構 (J)
LA	Acordo de Empréstimo (P) Loan Agreement (E) 借款契約 (J)
LDCs	Países Menos Desenvolvidos (P) Least-developed countries (E) 後発開発途上国 (J)
MADRRM	Ministério do Ambiente, do Desenvolvimento Rural e dos Recursos Marinhos (P) Ministry of Agriculture, Rural Development and Maritime Resources (E) 農業・農村開発・海洋資源省 (J)

MDGs	Desenvolvimento do Milénio (P)
	Millennium Development Goals (E)
	ミレニアム開発目標 (J)
MECC	Ministério da Economia, Crescimento e Competitividade (P)
	Ministry of Economic Growth and Competitiveness (E)
	経済成長競争力省 (J)
MPD	Movimento para a Democracia (E)
	民主運動 (J)
MTIE	Ministério do Turismo, Indústria e Energia (P)
	Ministry of Tourism, Industry and Energy (E)
	観光・産業・エネルギー省 (J)
O&M	Operação e Mintenance (P)
	Operation and Mintenance (E)
ONG (P) NGO (E)	Organizações não Governamentais (P)
	Non-Governmental Organizations (E)
	非政府組織 (J)
OMC (P) WTO (E)	Organização Mundial do Comércio (P)
	World Trade Organization (E)
	世界貿易機関 (J)
OMS (P) WHO (E)	Organização Mundial da Saúde (P)
	World Health Organization (E)
	世界保健機関 (J)
OPEX	Custos gerais de manutencao (P)
	Operational Expenditure (E)
	運転費用 (J)
PAGIRH	Plano de Acção na Gestão Integrada de Recursos Hídricos (P)
	Plan on Integrated Management of Water Resources (E)
	統合的水資源管理とアクションプラン
PAIS	Planos Ambientais Intersectoriais (P)
	Inter-sector Environmental Plants (E)
	横断型環境計画 (J)
PAICV	Partido Africano da Independência de Cabo Verde (P)
	カーボヴェルデ独立アフリカ党 (J)
PANA-II	Plano Nacional do Ambiente – II (P)
	National Action Plan for the Environment – II (E)
	国家環境アクションプラン II (J)

PAR (P) RAP (E)	Planos de Ações de Reassentamento (P) Resettlement Action Plans (E) 住民移転計画書 (J)
PCR	Relatório de Conclusão do Projecto (P) Project completion report (E) プロジェクト完成報告書 (J)
PDM	Plano de Desenvolvimento Municipal (P) Municipality Development Plan (E) 郡開発計画 (J)
PEAD	Polietileno de Alta Densidade (P)
PIB (P) GDP (E)	Produto Interno Bruto (P) Gross Domestic Product (E) 国内総生産 (J)
PIC	Programa de Cooperação Indicativa (P) Indicative Cooperation Program (E) 協力プログラム指針 (J)
PPP	Parceria Público-Privada (P) Public Private Partnerships (E) 官民パートナーシップ (J)
PRB	Escritório de Referência Populacional (P) Population Reference Bureau (E) 人口調査局 (J)
RBS	Estructura Analítica dos Riscos (P) Risk Breakdown Structure (E) リスク分析構造 (J)
RGS	Ribeira Grande de Santiago (P) リベイラグランデ (J)
RO	Osmose Reversa (P) Reverse Osmosis (E) 逆浸透膜 (J)
SAAS	Serviços Autónomos de Água e Saneamento (P) 水・衛生オートノーム・サービス (J)
SBS	Bissulfito de Sódio (P) Sodium bisulphite (E) 重亜硫酸ソーダ (J)
SD	São Domingos (P) Sao Domingos (E) サオドミンゴス (J)

SDI	Silt Density Index
SDTIBM	Sociedade de Desenvolvimento Turístico das Ilhas de Boa Vista e Maio (P) Boa Vista and Maio islands Touristic Development Company, SA (E) ボアビスタ島及びマイオ島観光開発公社 (J)
SEPA	Secretaria Executiva para o Meio Ambiente(P) Executive Secretary for the Environment (E) 環境局 (J)
SPC	Empresa de Objectivo Específico (P) Specific Purpose Company (E) 特別目的会社 (J)
SSM	São Salvador do Mundo (P) Sao Salvador do Mundo (E) サオサルバドールドムンド (J)
STEP	Condições Especiais para a Parceria Económica (P) Special Terms for Economic Partnership (E) 本邦技術活用条件 (J)
SWRO	RO de dessalinização da água do mar (P) Sea Water Desalination RO (E) 逆浸透膜法 (J)
TDS	Total de Sólidos Dissolvidos (P) Total Dissolved Solids (E) 塩分濃度 (J)
TIFR (P) FIRR (E)	Taxa Interna Financeira de Rentabilidade (P) Financial Internal Rate of Return (E) 財務内部収益率 (J)
TMOR (P) SWRO (E)	Tecnologia da Membrana da Osmose Reversa (P) Reverse Osmosis membrane technology (E)
TOR	Termos de Referência (P) Terms of Reference (E)
UBC	Código Uniforme de Edificação (P) Uniform Building Code (E) ユニフォームビルディングコード (J)
UNDP	Programa de Desenvolvimento das Nações Unidas (P) United Nations Development Program (E) 国連開発計画 (J)

WB	Banco Mundial (P)
	World Bank (E)
	世界銀行 (J)
ZDTI	Zonas de Desenvolvimento Turístico Integral (P)
	Integral Tourism Development Zone (E)
	総合観光開発地区 (J)

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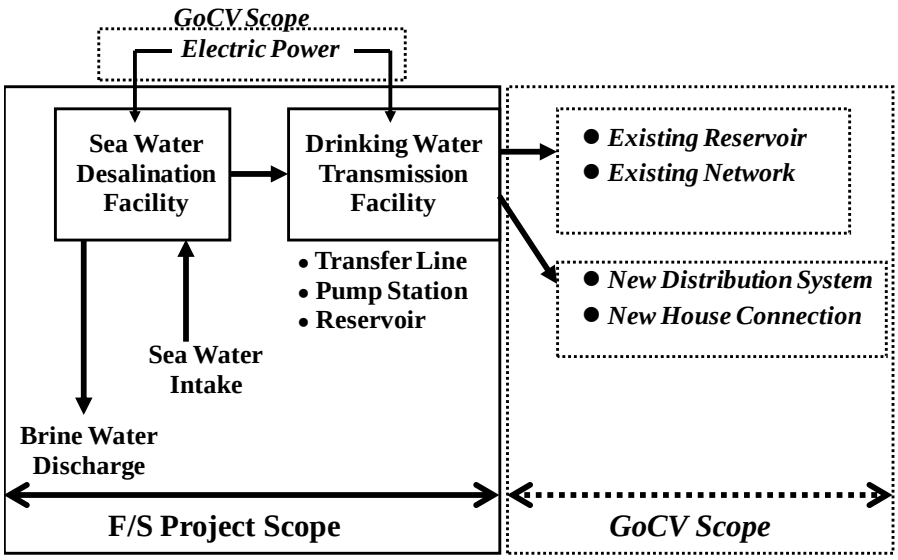
Executive Summary

Executive Summary

The Survey was conducted as a Preparatory Survey (hereinafter referred to as "the Survey") to realize Japan's ODA (Official Development Assistance) loan project on the Water Supply System Development Project (hereinafter referred to as "the Project") with the aim to develop a new drinking water supply system consisted of Sea Water Desalination Facility and Water Transmission Facility upon the request from the Government of the Republic of Cape Verde (hereinafter referred to as "GoCV") from October 2009 to December 2010.

The objectives of this survey, in consideration of the present shortage of drinking water and the increase in water demand related to economic development in Santiago Island, are to execute a feasibility study (hereinafter referred to as "the F/S Project") in order to build a wide area water pipe network as well as increasing drinking water production through the utilization of sea water desalination and building a distribution and supply network in target regions with a view to formulating Japan's ODA loan project.

The project scope is illustrated as below:



The estimated population in 2020, the target year of the project, in Santiago Island was estimated at 355,319 by the latest study by the Institute Nacional de Estatistics (INE).

Based on the population estimation for 2020, survey of drinking water utilization conditions, survey of affordability to pay, discussions of Project Steering Committees and discussions with related organizations in GoCV, the F/S Project drinking water production capacity is set at 40,000m^3/day.

The drinking water quality supplied by the project basically follows WHO guidelines for Drinking Water, 3rd edition, 2008.

Continuous ground water utilization was studied and discussed from the viewpoints of investment cost reduction, boron content reduction in drinking water, and drinking water quality improvement. Because of the GoCV policy that ground water will be utilized for irrigation purposes after completion of an adequate amount of the network for desalinated water, it was concluded that there would be no utilization of ground water for the study.

Additionally it was concluded that 2 stage RO system can clear the boron content in the WHO guidelines.

3 water supply system cases (case 1/2/3) were developed, and the additional case (case 4), which was modified from cases 2 and 3, was developed from the main viewpoints of water supply service and operation and maintenance flexibility. From a view point of economical reason, the system was divided into the north area and the south area of the Santiago Island. From another view point of drinking water demand increasing, the south area and the north area were further divided into two phases. The system concept drawing is shown below:

CABO VERDE - Water Supply System of Santiago Island

Altitude levels are indicative
Pumps location and reservoirs locations are indicative

An economics study was conducted using the discounted cash flow method, and its Financial Internal Rate of Return (FIRR) with a drinking water tariff of US$5/m^3 was calculated as below:

Project		S1	S2	N1	N2
		South Phase 1	South Phase 2	North Phase 1	North Phase 2
Production capacity	(m^3/day)	15,000	5,000	15,000	5,000
Sales capacity	(m^3/day)	13,500	3,000	13,000	5,000
Total capital requirement	(million US$)	72.0	26.0	77.6	32.7
Plant construction cost	(million US$)	68.0	25.0	74.0	31.0
Others	(million US$)	4.0	1.0	2.6	1.7
Sales	(million US$/year)	24.6	5.5	23.7	9.1
Direct cost (note)	(million US$/year)	11.5	3.7	13.6	3.6
Gross profit	(million US$/year)	13.1	1.8	10.1	5.5
FIRR, before tax	(%)	16.2	2.9	10.9	14.7
FIRR, after tax	(%)	13.6	2.5	9.2	12.4
Benefit population*	(thousand)	67	29	116	53

(*) Total benefit population is 265 thousand.

S1 shows the highest FIRR value, and N2, N1 and S2 follow accordingly.

The economic analysis was conducted in consideration of the entire island benefit.

The following benefit was tentatively set:

- Release from water collection work, and increase the opportunity to join the other social job
- Use of underground water to agriculture
- Decrease of medical expenditure by improving sanitary conditions

The EIRR was calculated to be 19.2%. This project was also concluded to be a beneficial project for the Santiago Island.

Project risk study was conducted, and no critical risk was found.

Water transmission line construction, stable and ample power supply, and beach well sea water intake are listed as the medium technical risk. Operation and maintenance are also listed as the medium risk.

The Initial Environmental Examination (IEE) of the F/S Project was conducted by JICA during this survey period, and no critical issue was found.

The Environmental Impact Assessment (EIA) will be conducted by GoCV in accordance with the Cape Verde laws and regulations.

From the view points of this project characteristic, the application of Special Terms for Economic Partnership (STEP) might be expected, and GoCV accepted the application.

It is concluded that the project is technically, environmentally and financially viable.

Chapter 1. Outline of the Survey

Chapter 1. Outline of the Survey

1.1 Introduction

The Survey was conducted as a Preparatory Survey (hereinafter referred to as "the Survey") to realize Japan's ODA (Official Development Assistance) loan project on the Water Supply System Development Project (hereinafter referred to as "the Project") with the aim to develop a new drinking water supply system including a Sea Water Desalination Facility and Water Transmission Facility.

The Survey was conducted by Japan International Cooperation Agency (hereinafter referred to as "JICA") and the Survey Team, which is composed of a consortium with Toyo Engineering Corporation as leader, Ingérosec Corporation and Unico International Corporation, in accordance to the request by the Government of the Republic of Cape Verde (hereinafter referred to as "GoCV") and the agreed minutes between the Ministry of Economic Growth and Competitiveness (MECC, presently succeeded by the Ministry of Tourism, Industry and Energy as MTIE), JICA and the Survey Team on 27th February, 2009.

1.2 Background of the Survey

Cape Verde is a group of islands off the west coast of Africa. The GNI per person is US$2,130 and it is ranked as a Middle Income Country. However, since the country is located in the tropical Sub-Saharan dry region, the yearly average rainfall is very low, less than 300mm, thus resulting in a chronic shortage of water.

The country, as stipulated in its government manifestation "Strategic Development and Poverty Reduction in 2004-2007 (GPRS)", places great emphasis on the improvement and development of its infrastructure as one of the strategies to reduce poverty through the country's economic growth. Furthermore, according to its five-year national strategy (2006~2011), sustainable growth and improvement of average life expectancy are placed as the main theme; in addition, the strategy aims at the development of society and poverty reduction through infrastructure reinforcement. The water sector has a significant position in this reinforcement plan. From the third state development plan (1991-1995) to the seventh plan (2006-2011), the Water sector has been one of the most important development targets.

In addition, the government drew up "The master plan of development of water resource 1993-2005" with the target of "An increase up to 100% of the safe and stable drinking water supply ratio by the year 2005" with the support of the United Nations Development Program (UNDP) in 1992. Although the water supply ratio increased up to 65% in the latter half of 1990, the safe drinking water supply remains insufficient, as seen in the number of victims in the cholera

outbreak in 1990 and other years.

In consideration of these conditions, at present, the country is aiming for an increase in the water supply ratio from 84.9% (national average 2006) to 100% by 2020 in accordance with “The integrated activity plan of state water resources” stipulated by the National Institute for Water Resources Management (INGRH).

The water supply ratio of Santiago Island remains low in comparison with the countrywide average, for example, in 1994 staying under 40%. The supply of drinking water in the island depends greatly upon sea water desalination. The capital city, Praia, depends upon desalination about three-quarters of its potable water resources. The stable supply of drinking water is positioned as a crucial issue, as is the reinforcement of the water supply network.

1.3 Objectives of the Survey

The objectives of this survey, in consideration of the present shortage of drinking water and the increase in water demand related to economic development in Santiago Island, are to execute a feasibility study (hereinafter referred to as “the F/S Project”) in order to build a wide area water pipe network as well as increasing drinking water production through the utilization of sea water desalination and building a distribution and supply network in target regions with a view to formulating Japan’s ODA loan project.

1.4 Outline of the F/S Project

1.4.1 F/S Project Site

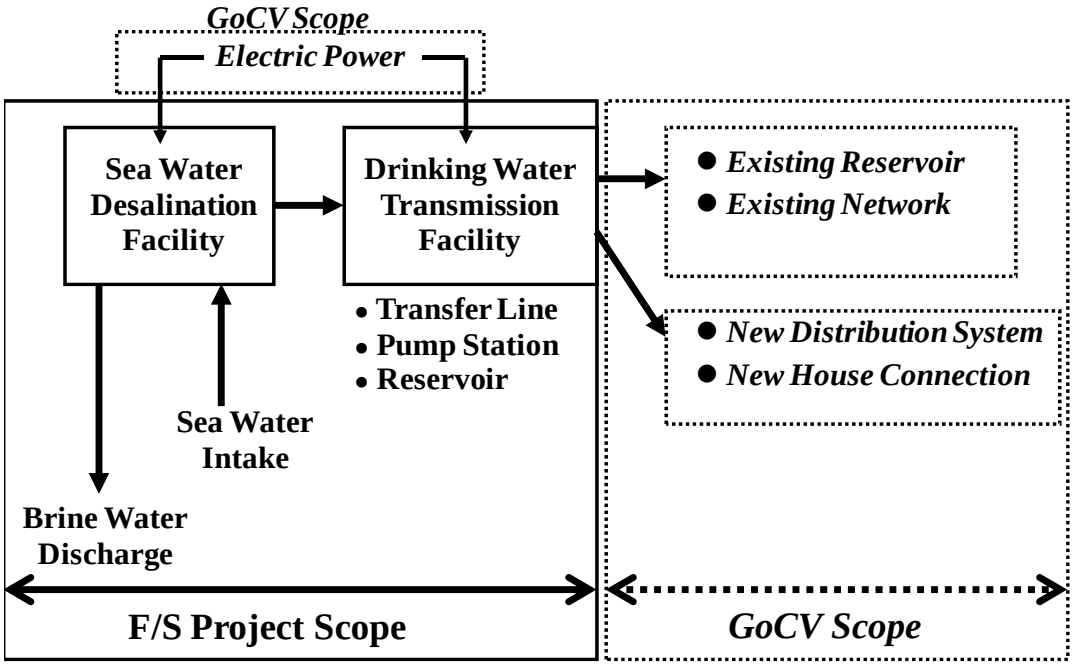
The Study was conducted in Santiago Island. The sites for two Sea Water Desalination Facilities are located in Palmarejo and Calheta. The Water Transmission Facility, including primary water reservoirs, will be located in urban areas and their surroundings in each municipality, including Praia city. Transmission pipe lines and pump stations will be constructed along the existing major roads linking desalination facilities and water reservoirs.

1.4.2 Scope of the F/S Project

The project consists of four (4) major components as summarized below.

Table 1.4-1: F/S Project Components

Component	Summary
1. Desalination Plant(s)	Construction of new plants for increase of water supply
2. Transmission Pipe Line	Construction of new water supply network and pipe line from desalination plants to each municipality
3. Reservoirs, Distribution Tanks, Pump Stations, Electrical Facilities, etc.	Construction of new facilities
4. Consulting Services	Planning and Detail Design Bidding Assistance Construction Supervision Initial Operation Soft Component



Note: Neither new distribution system nor new house connection system is applied to Japan's ODA loan.

1.5 Terms of Reference (TOR) of the Survey

1.5.1 Phase 1 (Preliminary Survey) : October 2009 ~ March 2010

Preparation Stage (In the beginning of October 2009)

(1) To identify items to be examined during the field survey and set-up the Survey plan.

(2) To prepare a Questionnaire and Inception Report and to submit them to the GoCV.

1st Mission (October 2009 ~ November 2009)

Through the 1st Mission, the Survey Team shall conduct the following:

(1) Meetings with the GoCV to discuss the Project scope and the Survey plan

i. To collect the answers to the questionnaire from the GoCV, and to discuss and confirm the contents of the Inception Report with the GoCV.

ii. To confirm the Project scope and to discuss the criteria for site selection of the Project.

iii. To confirm the GoCV's national program and projects with other donors in the water sector, and to confirm the relevance between the Project scope and the above program on water sector development in Cape Verde.

(2) Preparatory Survey

i. To collect and analyze the existing documents and reports regarding topographical data, geotechnical data, natural conditions and water resources in Santiago Island.

ii. To collect and analyze the existing documents and reports regarding socioeconomic, demography, industries and land development in Cape Verde.

iii. To collect and analyze the existing documents and reports regarding national development programs, water sector development plan, etc., in Cape Verde.

iv. To examine completed and on-going projects on the drinking water sector.

v. To examine relevant laws, bylaws, regulations, institution concerning the drinking water sector.

vi. To examine current status of water supply to users, and drinking water consumption by users.

vii. To analyze the existing documents and to identify drinking water demand and required quantity by conducting hearing survey to users, such as willingness to pay and affordability.

viii. To examine the current status of drinking water facilities, such as desalination facilities, transmission pipe lines, reservoirs, pumping stations, etc.

ix. To collect and analyze data on the current status of drinking water loss, including leaked and stolen water, and existing measures against water loss.

x. To examine the possibility of mixing groundwater to desalinated water (locations, quantity and quality)

xi. To analyze and confirm quality of feed sea water near the candidate desalination facility sites. *(The real analysis was conducted during Phase 2.)*

xii. To examine socioeconomic conditions, willingness to pay the water tariff, affordability of users and possible amount of drinking water tariffs for users in the project target areas.

(3) Examination through comparing the following alternative options

i. Single drinking water service network which supplies drinking water from new desalination facility or the up-graded existing desalination facility in Praia to each municipality.

ii. Several/Independent drinking water service network which supplies water from new desalination facilities in each municipality (e.g., Sao Miguel, Tarrafal, etc.), including water service network in Praia which supplies water from new facility or the up-graded existing desalination facility.

2nd Mission (January 2010 ~ February 2010)

Through the 2nd Mission, the Survey Team shall conduct the following:

(1) Preparatory Survey

To confirm the current situation of relevant agencies such as ELECTRA (city of Praia), ADA (municipality of Praia) and SAAS (another five local municipalities) from the viewpoints of capability regarding the operation and maintenance of the existing water supply facilities. In particular, to confirm the institutional structure and capability regarding operation and maintenance through the examination of improvement plans about the financial situation with the raising of the drinking water tariff and countermeasures against water loss.

(2) Forecast of water demand and setting-up of unit quantity of drinking water production per day/hour

To forecast water demand and to set a unit quantity of water production per day/hour according to the examination of the current production status of the existing facilities, forecasts of water demand in each municipality and a development plan for the water supply.

(3) Basic plan development on the drinking water supply in the Project targeted area

To establish the basic plan development on the water supply in the Project target area, such as target municipalities and wards covered by the project, water supply systems constructed by the Project (reservoirs, distribution pipes, etc.) and assumed ratio of water loss.

(4) Confirmation of the project's basic plan

To discuss and confirm the following items with the GoCV to formulate the Project:

i. To identify the Project target area.

ii. To determine the Project target year for planning the facilities to deal with the expected demand.

iii. To examine the possibility of groundwater to be used as mixing water with desalinated water.

iv. To examine the specifications and design of desalination facilities, equipment and related facilities of the water supply.

1.5.2 Phase 2 (Feasibility Study; F/S): April 2010 ~ December 2010

3rd Mission (May 2010 ~ June 2010)

Through the 3rd mission, the Survey Team shall conduct the following survey:

(1) Natural Condition Survey

To collect the necessary information and to conduct a natural condition survey as follows to prepare the basic design for adequate desalination facilities and water transmission facilities that were identified through the Phase 1 Survey.

a) Water quality analysis on desalinated water in Praia and Santa Cruz from the existing desalination facilities.
b) Water quality analysis on feed water from a beach well before filtering at the existing desalination facilities in Praia and Santa Cruz.
c) Water quality analysis of groundwater from wells on the island.
d) Water quality analysis of sea water around the candidate new desalination facility construction site for the new desalination facilities design.
e) Boring and soil investigation for desalination facilities design
f) Soil investigation for water transmission facility design

(2) Basic Design for desalination facilities in Santiago Island

To prepare the basic design for desalination facilities and water transmission facility, including the plans of facilities/buildings, alignment of pipe lines and specifications of equipment (e.g., quantity of water production, diameter of pipe, etc.).

(3) Basic design for water transmission facility at the F/S Project target municipalities

To prepare the basic design for the water transmission facility (e.g., reservoirs, water tanks, pumping stations, and electrical facilities) according to the above designed desalination facilities in Santiago Island.

(4) Preliminary cost estimation and implementation schedule development of the F/S Project

To develop the implementation schedule of the F/S Project, and to estimate the F/S Project cost based on the above basic design.

(5) Recommendations for institutional reform to implement the F/S Project

To identify a bottleneck in the institutional structure and to prepare recommendations for countermeasures based on the analysis of sustainability and capabilities of the relevant agencies regarding project implementation, operation and maintenance (e.g., organization structure, number of staff, technical training, etc.).

(6) Preliminary economic and financial analysis

To conduct an economic analysis of the financial condition and the sustainability of the F/S Project implementation agency based on an examination of the annual audit report, revenue from water tariffs and the required cost to operate and maintain the Project.

(7) Environmental and social considerations survey

To conduct an “Initial Environment Examination (IEE)” based on the “Japan Bank for International Cooperation Guidelines for Confirmation of Environmental and Social Considerations – Japan Bank for International Cooperation; April 2002 -” to identify and confirm the negative impact from the Project and to propose mitigation measures compared with the alternative options.

(8) Examination of socioeconomic conditions for the basic design of desalination facilities and equipment

To examine the socioeconomic condition, development plan, current situation of water consumption on the Project target site, regulations and guidelines for planning and design of the water facilities in Cape Verde, similar projects by other donors, etc., to prepare an adequate basic design for required facilities.

(9) Examination of conditions for procurement of construction

To confirm the availability of construction materials, considering local procurement and procurement from third countries, and to examine the conditions of local contractors, including labor conditions, related laws, availability of construction materials, and capability of contractors for execution of the Project.

(10) Preparation of construction plan of the F/S Project

To prepare the construction plan of the F/S Project based on past records and experiences of contractors, accessibility to the F/S Project site, meteorological and natural conditions, etc.

4th Mission (August 2010)

Through the 4th mission, the Survey Team shall conduct the following survey:

(1) Explanation of Interim Report

(2) Discussion on Preliminary Economics Study

(3) Discussion on Japan's loan application for the F/S Project

Post 4th Mission (September to November 2010)

Post 4th mission, the Survey Team shall conduct the following survey:

(1) Examination of CAPEX and OPEX estimation

To examine the Capital Expenditure (CAPEX) and Operational Expenditure (OPEX) estimation of the F/S Project cost.

(2) Identification of focal points to ensure the F/S Project formulation of Japan's ODA loan and the F/S Project implementation

To identify actions conducted by the GoCV after the Survey and focal points to ensure the F/S Project implementation.

(3) Examination of scale, components, financial arrangement and efficiency of the F/S Project based on technical and economic appropriateness

To examine the F/S Project from the point of view of adequate scale and components for Japan's ODA loan to ensure the objectives of the F/S Project and to identify demarcation of JICA and the GoCV such as financial arrangement of both sides of each component of the F/S Project.

(4) Examination of operation and maintenance organization establishment, and impact and sustainability of the F/S Project

i. To prepare recommendations for financial arrangements according to the examination of financial sustainability of the executing agency and adequate water tariffs to be decided based on affordability of the residents in the target area.

ii. To prepare an operation and maintenance plan considering a bottleneck and countermeasures to be assumed on the operational stage based on the capabilities of the executing agency (e.g., organization structure, number of staff, technical level and feasibility of countermeasures against water loss).

(5) Operational and effect indicators

To set operational and effect indicators and to calculate Internal Rate of Return (IRR)

5th Mission (November 2010)

The Survey Team shall conduct an Explanation and Discussion on the Draft Final Report prepared by The Survey Team

i. To explain the Draft Final Report to GoCV, and to have follow-up discussions.

ii. To discuss the activities and conditions which should be followed by GoCV, regarding environmental and social considerations and institutional reform for operation and maintenance, and to ensure technical and financial sustainability of the F/S Project.

1.6 Implementation Framework of the Survey

The Survey Team will include the following experts:

- Water supply system planning specialist (Team leader)
- Socio-economic condition survey/Economics analysis specialist

- National condition survey/Socio-environment assessment specialist
- Hydrology/geology study specialist
- Organizational/Institutional study specialist
- Water treatment facility/Planning specialist A (Desalination plant)
- Water treatment facility/Planning specialist B (Transmission pipe, Storage tank)
- Water treatment facility/Planning specialist C (Distribution network)
- Water treatment facility/Planning specialist D (Pump, electricity, costing)
- Hydraulic analysis/Facility planning assistant

Chapter 2. Current Situation of Cape Verde

Chapter 2. Current Situation of Cape Verde

2.1 General Information of Cape Verde

2.1.1 Political Situation

Cape Verde became independent in 1975 and stayed under rule by a single party, PAICV (Partido Africano da Independência de Cabo Verde), till the adoption of a multi-party system in 1991. After that, power has changed regularly and peacefully between PAICV and MPD (Movimento para a Democracia). In May 2008, GoCV prepared the country's second Growth and Poverty Reduction Strategy Paper (GPRSP-II), with five strategic aims: government reform, human capital, competitiveness, infrastructure building, and social cohesion. Cape Verde is regarded today as one of Africa's most stable democratic countries.

2.1.2 Population

The Population Reference Bureau (PRB) estimated the population of Cape Verde at 509,000 for Mid-2009. 38% are younger than 15 years old and almost half of the population lives in Santiago. The population data for Cape Verde is as per Table 2.1-1:

Table 2.1-1: Population Data

Item	Number	Unit
Population mid-2009	0.5	million
Rate of natural increase (general)	2.1	%
Rate of natural increase in urban areas (1980-2000)	6.8	%
Rate of natural increase in rural areas (1980-2000)	-1.6	%
Births per 1,000 people	26	people
Deaths per 1,000 people	5	people
Net migration rate per 1,000 people	-5	people
Projected population 2025	0.7	million
Projected population 2050	0.8	million
Projected population change 2009-2050	53	%
Infant mortality rate	29	for 1,000 live births under age 1
Total fertility rate	3.1	children per woman
Population under 15	38	%
Population above 65	6	%
Life expectancy (whole population)	71	years (at birth)
Life expectancy (males)	68	years (at birth)
Life expectancy (females)	73	years (at birth)
Urban population	59	%
GNI PPP per capita*	3,450	US$
Density	126	people/m^2
People living under $2 a day in 2005	40	%

Note: GNI PPP per capita: Is the gross national income in purchasing power parity divided by population in international dollars.

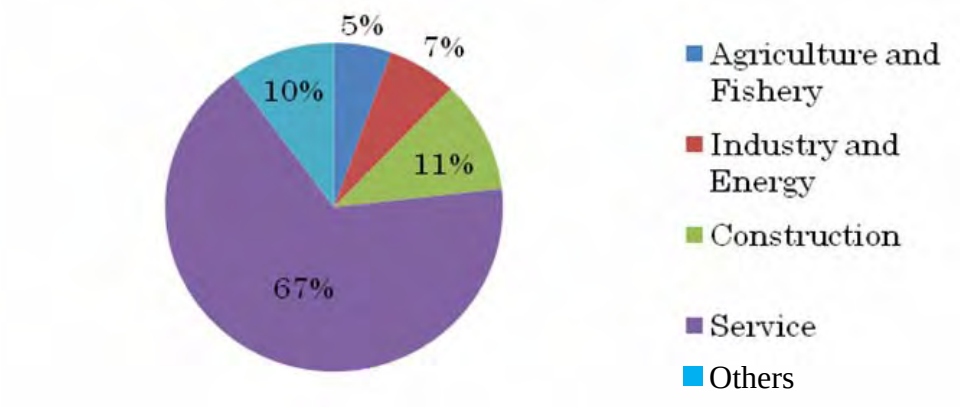
Source: 2009 World Population Data Sheet, Population Reference Bureau

Since the creation of the country, difficult social and economic conditions have forced many Cape Verdeans to emigrate to other countries, mostly to Europe, the US or other African countries. Their remittances have contributed greatly to the economy of their homeland, representing about 8% of GDP (2008).

2.1.3 Economy and Industry

The economy of Cape Verde is characterized by a structural imbalance between national production and consumption needs. About 80% of food is imported and the country's high trade deficit is covered mostly by foreign aid and remittances from emigrants.

Industry is dominated by the service sector, especially tourism, representing 66.6% of GDP in 2008. Agriculture is hampered by the lack of rain and land, fish resources are not fully exploited, and the manufacturing sector is still at a very early stage. For international trade, Cape Verde mainly exports fuel (re-export for vessels), shoes, garments, fish and imports food, industrial products, transport equipment and fuel. As for energy, the country is highly dependent.



Source: Bank of Cape Verde 2008 Annual Report

Figure 2.1-1: Composition of Industries in GDP 2008

However, despite its natural and structural problems, Cape Verde has succeeded in achieving robust economic growth in recent years. GDP in 2008 was 1,182 million Euro, a 13.1% increase from 2007 (1,045 million Euro), in spite of a strong downturn in the world economy, especially that of EU countries to which Cape Verde has been strongly connected.

Table 2.1-2: GDP

Indicator	2006	2007	2008
GDP (nominal)	954 million Euro	1,045 million Euro	1,182 million Euro
GDP - per capita (USD)	2,463 USD	2,893 USD	3,428 USD
GDP - real growth rate	15.3 %	9.5 %	13.5 %

Source: Report of Bank of Cape Verde, Calculations of Chamber of Commerce and Tourism Portugal Cape Verde

Notes: GDP (nominal) at market prices

Inflation increased by 6.8% in 2008. CPI in recent years (2005-2008) is as per Table 2.1-3, with an average increase of 4.1%.

Table 2.1-3: CPI

Year	CPI (2007=100)	Increase Rate
2008	106.8	6.80 %
2007	100.0	4.38 %
2006	95.8	4.81 %
2005	91.4	0.44 %
Average Increase Rate		**4.10 %**

Source: INE, Bank of Cape Verde, Ministry of Finance of Cape Verde, IMF

Cape Verde has been adopting a sound monetary policy, with the pegging of the Cape Verde escudo (CVE) to the Euro since 1999. An agreement of parity between the CVE and the Euro was made, so the exchange rate is fixed at 110.265 CVE per one Euro. Portugal and other EU countries have been and will remain the main partners of Cape Verde, but the country is also strengthening South-South cooperation, especially with Brazil and China. Cape Verde's major multinational partners are the World Bank (WB, International Development Association (IDA)), African Development Bank (AfDB, Le Fond africain de developpement (FAD)), European Investment Bank (EIB), and Arab Bank for Economic Development in Africa (BAEDA). As for bilateral partners, in addition to traditional European partners such as Portugal and Germany, China and Kuwait are cooperating closely.

Following up on its steady development, Cape Verde joined the World Trade Organization (WTO) in December 2007, and graduated from the list of least-developed countries (LDCs) in January 2008.

Table 2.1-4: Balance of Payments

(Million CVE)

Item	2005	2006	2007	2008	2009
1. Current Account	**-3,568**	**-7,214**	**-15,787**	**-16,158**	**-25,113**
Trade Balance	-30,960	-40,694	-53,243	-53,470	-61,558
Exports	7,881	8,429	6,545	8,643	7,221
Imports	-38,851	-49,123	-59,788	-62,113	-68,779
Service Balance	5,438	11,612	15,762	16,804	16,017
Income Balance	-2,995	-3,515	-2,530	-3,499	-4,387
Current Transfer	24,949	25,383	24,224	24,008	24,814
2. Capital and Financial Account	**8,619**	**13,015**	**22,735**	**22,626**	**22,986**
3. Errors and Omissions	**30**	**-758**	**172**	**-4,541**	**0**
4. Total Balance (1+2+3)	**5,080**	**5,044**	**7,120**	**1,927**	**-2,127**

Source: Bank of Cape Verde 2008 Annual Report

Note: The amount for Exports includes the re-export amount for fuel for vessels

Table 2.1-5: External Debt in 2008

(Million USD)

Creditors	Contract Amt	Disbursed Amt	Reimbursement	Remaining Amt
Multilateral	N/A	**567**	**170.5**	**396.5**
BM/IDA	296.11	247.82	14.32	233.49
FAD	132.83	124.74	22.61	102.13
BEI	81.01	12.84	12.33	0.51
FIDA	29	26.93	15.74	11.19
BADEA	84.55	71.5	46.4	25.1
OPEC	44.67	35.95	26	9.95
NDF	2.9	3.25	0.3	2.95
NTF	10.4	9.42	5.53	3.89
BAD	16.5	17.66	16.5	1.16
SAUDI FUND	4	4.28	4.07	0.21
KFW	N/A	10.82	6.7	4.12
CEDEAO	N/A	1.79	0	1.79
Bilateral	**270.92**	**159.4**	**56.33**	**103.07**
China	40.54	10.28	10.28	0.01
Kuwait	19.6	17.15	8.93	8.22
Portugal	156.9	116.82	32.85	83.98
South Africa	1.6	1.93	1.93	0
Abu Dhabi	0.2	0.21	0.21	0
Germany	12.1	12.95	2.14	10.81
Denmark	2.07	0.05	0	0.05
Japan	37.92	0	0	0
Financial Institutions	**210.65**	**48.47**	**42.11**	**6.36**
CGD	173.32	16.8	18.11	-1.3
ICO (Spain)	15.63	14.45	6.61	7.83
CACEX (Brazil)	5.9	3.96	1.39	2.57
Banco Espirito Santo	15.8	13.26	16	-2.74

Creditors	Contract Amt	Disbursed Amt	Reimbursement	Remaining Amt
Private	13	12.95	9.87	3.08
MSF	1	1.07	0.64	0.43
SOMEC (Portugal)	12	11.88	9.23	2.65
Others	0	0	0	0
Total	N/A	**787.82**	**278.81**	**509.01**

Source: Direction General of Treasury, Bank of Cape Verde

2.2 Natural Conditions in Santiago Island

2.2.1 Climate

(1) Climate type and seasonal characteristics

Santiago is the largest island of Cape Verde, with an area of 991 km^2. It is one of the ten islands of the Cape Verde archipelago located approximately 640 km west of Africa and 1,500 km southwest of the Canary Islands. Due to its geographical location, its climate is strongly influenced by the masses of warm, dry air from Africa, namely from the Sahara Desert.

The climate is arid to semi-arid, dry tropical tempered by an oceanic influence alternating with the winds from the northeast (October to June) characterized by a strong desiccant and erosive action on the archipelago, which may cause precipitation on the slopes exposed to the northeast. Also, the very uncertain "monsoon" from the south (July to September) may be responsible for precipitation.

That being so, the climate is characterized by a long dry season (8 to 10 months) and a short rainy season, largely determined by the Intertropical Convergence Zone's position over the years, which is characterized by very scant and irregular rainfall causing long periods of drought.

The archipelago is volcanic in origin, and the corresponding lithology and morphology combined with the climate, heavily influence water availability in the archipelago. Despite the limited hydrogeology of volcanic rocks, the groundwater resources are the main natural source of fresh water. Its proper characterization is vital for the strict management and integrated development of the region.

The average annual rainfall in Santiago Island is 265 mm and the potential evapotranspiration is high. Rainfall is usually very intense and irregular and tends to be concentrated in the months between July and October. In the interior of the island the incidence of rainfall is greater (321 mm/year in Pico da Antonia, altitude about 1,390 m) than on the coastline (170 mm/year in Praia).

Also, a marked inter-annual irregularity leads to long periods of drought and almost no

precipitation. Periods of intense rainfall are usually accompanied by large surface runoff along the slopes and streams (dry most of the year because there are no retention systems that prevent water flowing into the sea). The low vegetation cover and little soil thickness form a fragile ecosystem, unable to retain the surface flowing water.

In summary, the climate is tropical with two seasons: a dry season from December to July and a warm and wet season between August and November. Temperatures are high throughout the year; rainfall is scarce, irregular and concentrated in a short period of time.

In consequence, water availability is low causing a permanent exploitable water resources shortage.

(2) Climate evolution in the past years

Global climate changes have already been demonstrated, evidenced, and supported by scientists. The last decade of the twentieth century was the warmest on record and there is expected to be a global temperature increase of 1 to 6 ºC by 2100. It is further observed that the snow cover has globally declined by about 10% since the late 60s; mountain glaciers are retreating, nature and biodiversity are being threatened and wildlife continues to decline.

Half of the mammals and a third of the number of reptiles, birds and fish species are endangered. Such changes will lead to the transformation of the agro-ecological zones, disturbance of water regime-based crops, land degradation and public health, which may be particularly harmful in vulnerable regions, particularly the coastal areas of Cape Verde.

According to studies conducted by the Direcção Geral do Ambiente (General Directorate for Environment), under the following projects: Climate Change, Biodiversity Conservation, Combat against Desertification and PANA-II, all of the Cape Verde islands are vulnerable to climate change, in particular the coastal areas, with high population levels and economic investment, including port facilities, airports, trade, tourism and agriculture.

Little is known about the effects of global climate change on Cape Verde’s ecosystems. Although some observed phenomena reveal a relationship between global climate change and changes in plant and animal biodiversity, the information is not very accurate.

Droughts will probably be more intense, but its exact consequences on the species of plants and animals and on public health are still unclear. The increase in global mean temperature may cause a decline of the marine ecosystem, including the plant and animal population.

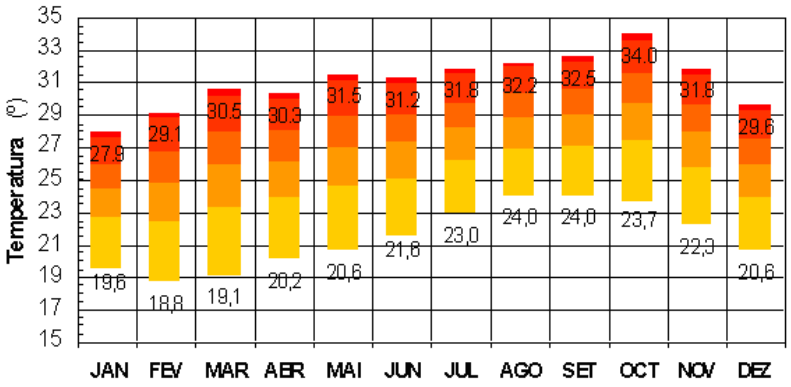
Cape Verde is historically known for some natural disasters in Africa's Sahel, with a large impact on humans. The combined impact of floods, wind and droughts has already caused losses.

Deser and Blackmon (1993) observed in the winter, "a warming from 1920 to 1950, and a cooling from 1950 to the present day" as well as a concurrence between "sea temperatures cooler than normal and stronger winds than normal" off West Africa, particularly in the vicinity of the Canary Islands and of the Cape Verde Islands (Nouaceur, 1999; Sagna, 2001).

(3) Monthly temperatures and evolution

Temperature data used to develop the present the report was essentially from the Praia-Airport Station in the period ranging from 1999 (with data gaps in some months) to 2008.

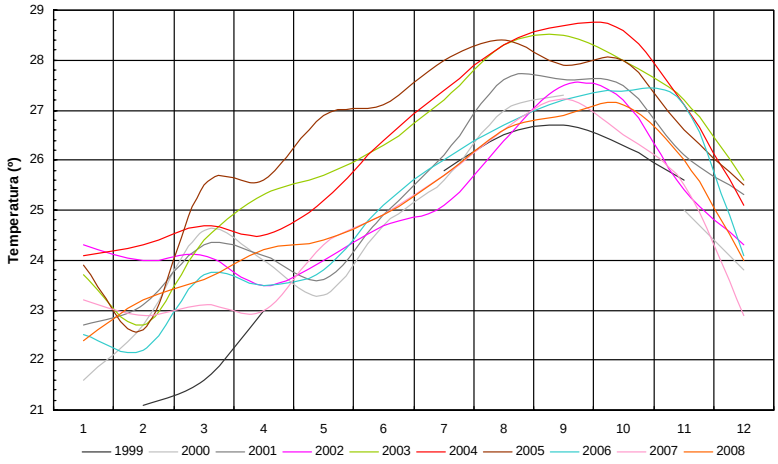
Values range from a minimum of 18.8 ºC to a maximum of 34.0 ºC, as shown in figure 2.2-1.



Source: National Institute of Meteorology and Geophysics

Figure 2.2-1: Mean Monthly Temperature Variation, 1999-2008

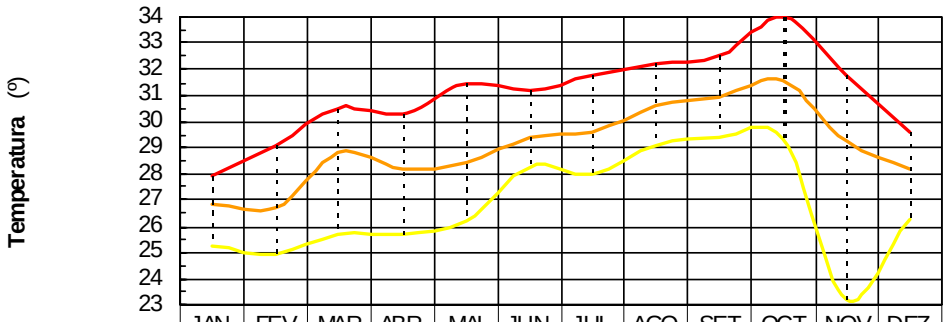
Inter-annual variation show some irregularities in the first half (no precipitation period), while the second half shows a more regular basis, as can be seen in figure 2.2-2.



Source: National Institute of Meteorology and Geophysics

Figure 2.2-2: Inter-Annual Mean Monthly Temperature Evolution, 1999-2008

Figure 2.2-3 shows the maximum values of the mean monthly temperature evolution from 1999 to 2008.

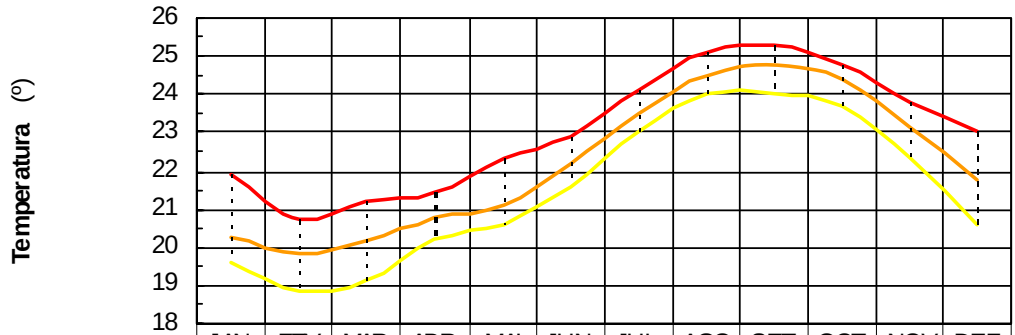


	JAN	FEV	MAR	ABR	MAI	JUN	JUL	AGO	SET	OCT	NOV	DEZ
máxima	27,9	29,1	30,5	30,3	31,5	31,2	31,8	32,2	32,5	34,0	31,8	29,6
média	26,8	26,7	28,8	28,2	28,4	29,4	29,6	30,6	30,9	31,5	29,2	28,2
minima	25,2	24,9	25,7	25,7	26,2	28,3	28,0	29,1	29,4	29,3	23,2	26,3

Source: National Institute of Meteorology and Geophysics

Figure 2.2-3: Maximum Values of Mean Monthly Temperature Evolution

Figure 2.2-4 shows the minimum values of the mean monthly temperature evolution from 1999 to 2008.



	JAN	FEV	MAR	ABR	MAI	JUN	JUL	AGO	SET	OCT	NOV	DEZ
máxima	21,9	20,7	21,2	21,4	22,3	22,9	24,1	25,1	25,3	24,8	23,8	23,0
média	20,2	19,8	20,2	20,8	21,1	22,2	23,5	24,5	24,8	24,4	23,1	21,7
minima	19,6	18,8	19,1	20,2	20,6	21,6	23,0	24,0	24,0	23,7	22,3	20,6

Source: National Institute of Meteorology and Geophysics

Figure 2.2-4: Minimum Values of Mean Monthly Temperature Evolution

2.2.2 Rainfall

(1) Monthly rainfall for 10-year and 100-year return periods

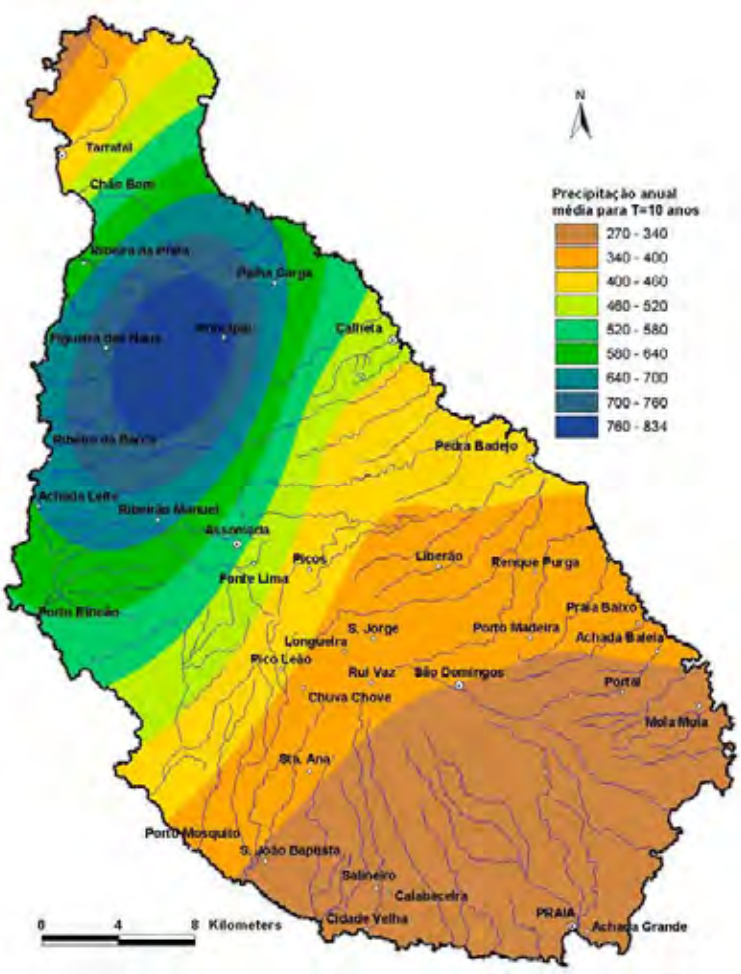
Table 2.2-1 shows monthly rainfall values for the 10-year and 100-year return periods for the eight analyzed stations in Santiago Island.

Table 2.2-1: Monthly Rainfall, mm, for 10-year and 100-year return period

Return Period (T)	Month	Stations							
		Assomada	Chão Bom	Flamengos	Praia-Aeroporto	Ribeirão Manuel	Santa Cruz	São João Baptista	Serra Malagueta
10 Years	Jan	22.2	16.2	6.4	9.9	12.7	15.6	9.7	29.6
	Feb	0.5	7.2	8.0	2.4	6.1	8.8	0.0	5.5
	Mar	2.1	0.0	0.0	0.3	0.0	0.0	0.0	0.0
	Apr	0.7	0.0	0.0	0.1	0.0	0.1	0.0	0.0
	May	0.7	2.6	3.2	2.5	1.0	6.3	0.8	0.7
	Jun	0.0	0.0	0.0	0.2	15.9	0.2	0.0	0.5
	Jul	81.4	45.2	55.2	26.9	51.5	30.1	26.6	91.4
	Aug	217.3	149.3	224.3	123.5	240.3	186.1	138.2	349.0
	Sep	273.9	200.3	228.8	115.3	332.6	151.6	178.5	329.2
	Oct	151.5	99.2	133.0	78.6	155.0	128.8	70.5	224.0
	Nov	19.9	28.1	27.1	11.5	8.1	77.0	10.4	55.6
	Dec	11.4	4.2	8.4	23.2	0.0	19.3	2.4	20.5
100 Years	Jan	53.4	35.6	23.0	27.2	40.4	38.5	30.6	65.0
	Feb	2.8	37.0	30.6	9.9	31.8	40.0	0.0	27.7
	Mar	11.1	0.0	0.0	1.6	0.0	0.0	0.0	0.0
	Apr	3.7	0.0	0.0	0.4	0.0	0.6	0.0	0.0
	May	3.7	13.3	9.0	8.6	5.4	28.6	3.6	3.7
	Jun	0.0	0.0	0.0	1.2	82.6	1.1	0.0	2.8
	Jul	173.2	124.3	133.6	69.8	94.4	65.0	80.5	164.0
	Aug	296.8	264.6	374.5	247.4	377.1	315.3	230.3	529.0
	Sep	372.3	377.9	379.6	201.4	572.9	242.0	353.4	444.8
	Oct	264.2	217.0	267.1	170.0	318.8	252.1	163.8	389.0
	Nov	49.9	104.4	77.7	36.2	28.4	228.3	42.9	167.4
	Dec	53.2	18.7	21.8	111.7	0.0	66.6	8.8	66.4

Source: National Institute of Meteorology and Geophysics

The spatial distribution of 10-year return period mean annual rainfall listed in the above table is shown in figure 2.2-5.



Source: JICA Study Team

Figure 2.2-5: Spatial distribution of 10-year return period mean annual rainfall

(2) Delimitation of main hydraulic basins

The attachment areas, for which the average monthly and annual rainfalls have been assessed, are the following:

- Achada Bilim; Curral Velho; Furna; Molha Cinza; Palmarejo Grande; Porto Formoso; Rib.ª Angra; Rib.ª Canio Grande; Rib.ª da Barca; Rib.ª da Cuba; Rib.ª da Cumba; Rib.ª do Charco; Rib.ª dos Engenhos; Rib.ª dos Picos; Rib.ª Flamengos; Rib.ª Fondura; Rib.ª Fontão; Rib.ª Grande C. Velha; Rib.ª Grande Tarrafal; Rib.ª Mangue; Rib.ª Praia Formosa; Rib.ª Principal; Rib.ª S. Francisco; Rib.ª S. Martinho; Rib.ª S. Miguel; Rib.ª S. Domingos; Rib.ª Saltos; Rib.ª Santa Ana; Rib.ª Santa Clara; Rib.ª Santa Cruz; Rib.ª Seca; Rib.ª Selada; Rib.ª Trindade; Rib.ª Vaqueiro.

The location of the hydraulic basins is shown in Figure 2.2-6.

Source: JICA Study Team

Figure 2.2-6: Hydraulic Basins

(3) Annual rainfall of the main hydraulic basins

Annual rainfall (mm) for a 10-year return period of the main hydraulic basins is presented in Table 2.2-2.

Table 2.2-2: Mean Annual Rainfall (mm) for 10-year Return Period

Hydraulic Basins	Area (m^2)	Min	Max	Mean	Std
ACHADA BILIM	9,300,625	307.1	423.6	362.2	29.61
CURRAL VELHO	9,132,225	274.7	295.2	285.1	5.67
FURNA	27,193,600	392.3	647.3	512.1	62.58
MOLHA CINZA	36,707,176	305.1	348.9	324.6	9.12
PALMAREJO GRANDE	17,134,800	271.3	290.7	279.6	4.44
PORTO FORMOSO	8,084,900	636.7	750.3	681.1	25.03
RIB. ANGRA	18,176,850	475.3	570.2	533.1	21.61
RIB. CANIO GRANDE	27,800,550	287.6	348.0	313.7	13.74
RIB. DA BARCA	25,382,324	652.1	830.6	748.7	44.46
RIB. DA CUBA	36,898,624	521.9	833.5	714.3	78.28
RIB. DA CUMBA	13,777,850	341.5	387.0	366.2	11.32
RIB. DO CHARCO	35,569,276	598.3	799.3	699.9	37.29
RIB. DOS ENGENHOS	40,397,700	437.2	679.5	576.6	65.50
RIB. DOS PICOS	50,541,724	380.6	544.6	419.0	30.37
RIB. FLAMENGOS	32,923,600	442.4	831.3	594.0	117.22
RIB. FONDURA	15,557,575	363.5	431.4	399.6	16.11
RIB. FONTAO	16,734,750	322.4	505.2	399.3	42.51
RIB. GRANDE C.VELHA	21,230,350	278.5	366.3	309.6	25.42
RIB. GRANDE TARRAFAL	28,563,576	393.2	824.4	614.7	119.70
RIB. MANGUE	9,624,075	338.3	372.4	350.8	8.01
RIB. PRAIA FORMOSA	17,346,224	333.1	372.6	346.7	8.80
RIB. PRINCIPAL	38,422,552	534.2	828.9	684.4	70.34
RIB. S. FRANCISCO	27,514,300	292.3	326.2	309.0	8.25
RIB. S. MARTINHO	34,266,824	274.3	374.5	310.0	22.59
RIB. S. MIGUEL	29,119,924	470.7	753.3	557.1	64.33
RIB. S.DOMINGOS	30,633,600	323.1	357.5	335.7	6.62
RIB. SALTOS	21,651,400	417.9	547.3	444.6	21.76
RIB. SANTA ANA	57,780,176	315.5	449.5	370.7	28.05
RIB. SANTA CLARA	37,898,376	407.3	539.2	461.7	28.26
RIB. SANTA CRUZ	41,852,448	400.3	624.3	456.3	60.14
RIB. SECA	75,695,376	337.1	411.9	372.8	16.54
RIB. SELADA	31,262,950	555.4	655.8	599.7	22.25
RIB. TRINDADE	69,266,376	278.1	345.5	305.6	14.02
RIB. VAQUEIRO	11,337,825	632.0	790.0	699.9	34.84

Source: JICA Study Team

Annual rainfall (mm) for a 100-year return period of the main hydraulic basins is presented in Table 2.2-3.

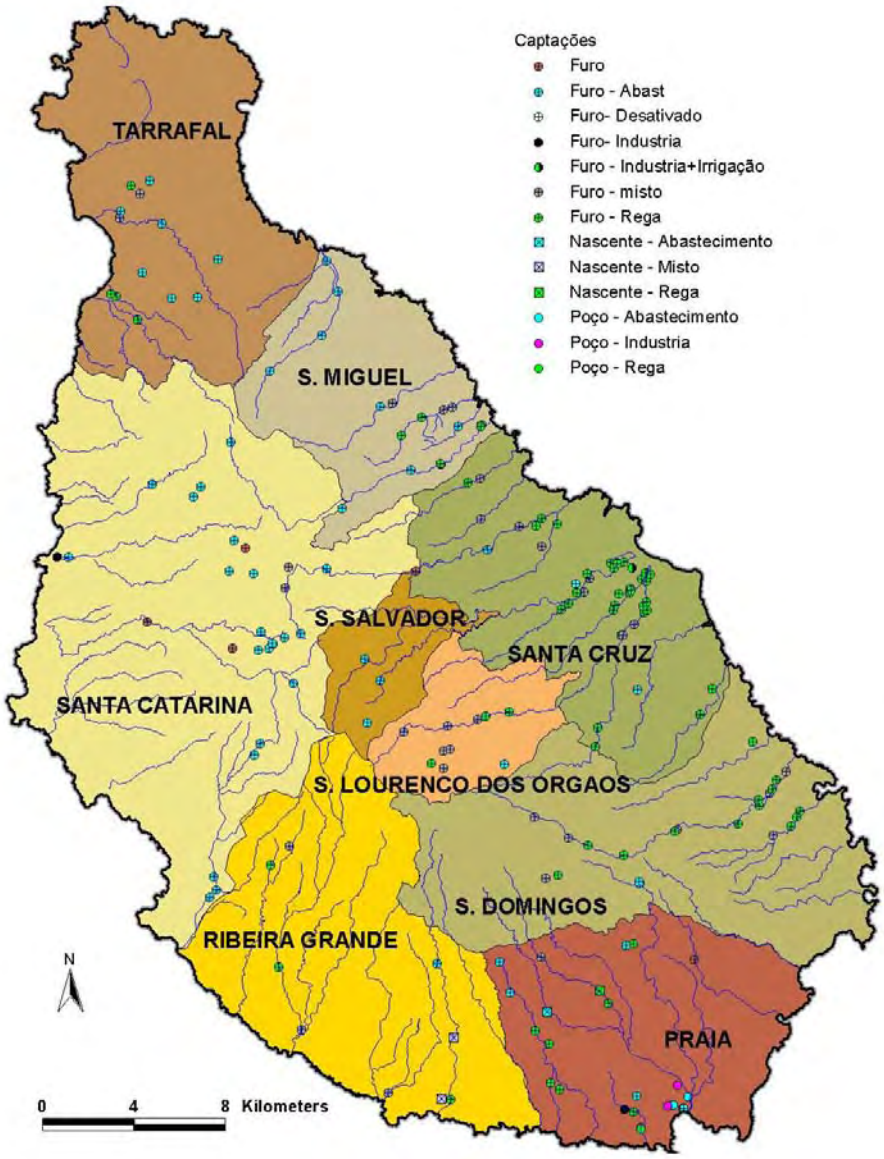
Table 2.2-3: Mean Annual Rainfall (mm) for 100-year Return Period

Hydraulic Basins	Area (m^2)	Min	Max	Mean	Std
ACHADA BILIM	9,300,625	508.9	600.3	551.0	22.03
CURRAL VELHO	9,132,225	394.0	468.6	426.8	20.17
FURNA	27,193,600	558.7	848.1	688.7	71.08
MOLHA CINZA	36,707,176	509.0	664.2	577.3	34.10
PALMAREJO GRANDE	17,134,800	380.6	429.7	402.5	11.13
PORTO FORMOSO	8,084,900	795.2	955.1	858.0	34.25
RIB. ANGRA	18,176,850	873.7	1,125.0	993.9	62.82
RIB. CANIO GRANDE	27,800,550	445.3	559.0	500.9	24.79
RIB. DA BARCA	25,382,324	1,057.2	1,236.6	1,194.1	33.53
RIB. DA CUBA	36,898,624	797.0	1,173.8	1,035.2	89.18
RIB. DA CUMBA	13,777,850	581.3	752.5	681.5	42.65
RIB. DO CHARCO	35,569,276	770.7	1236.9	1,114.7	120.99
RIB. DOS ENGENHOS	40,397,700	554.9	1,228.8	904.4	209.11
RIB. DOS PICOS	50,541,724	463.4	789.7	556.1	87.51
RIB. FLAMENGOS	32,923,600	466.4	1,111.6	690.4	179.98
RIB. FONDURA	15,557,575	631.7	823.0	706.4	37.85
RIB. FONTAO	16,734,750	543.3	706.9	613.6	36.57
RIB. GRANDE C.VELHA	21,230,350	411.1	527.8	465.5	33.20
RIB. GRANDE TARRAFAL	28,563,576	646.1	1,069.1	850.6	117.61
RIB. MANGUE	9,624,075	560.3	721.4	644.1	36.17
RIB. PRAIA FORMOSA	17,346,224	554.6	722.7	640.1	39.53
RIB. PRINCIPAL	38,422,552	647.6	1,074.4	818.4	106.97
RIB. S. FRANCISCO	27,514,300	446.2	548.9	501.0	22.40
RIB. S. MARTINHO	34,266,824	393.6	513.2	459.1	30.80
RIB. S. MIGUEL	29,119,924	504.2	907.2	627.5	74.70
RIB. S.DOMINGOS	30,633,600	494.3	669.2	549.8	43.46
RIB. SALTOS	21,651,400	459.7	748.4	554.4	75.28
RIB. SANTA ANA	57,780,176	508.0	694.4	585.5	41.46
RIB. SANTA CLARA	37,898,376	618.1	932.4	789.7	69.66
RIB. SANTA CRUZ	41,852,448	459.7	813.1	614.7	102.71
RIB. SECA	75,695,376	486.6	787.3	587.2	85.87
RIB. SELADA	31,262,950	937.5	1,212.8	1,129.9	54.15
RIB. TRINDADE	69,266,376	398.5	524.0	462.9	27.76
RIB. VAQUEIRO	11,337,825	1,064.8	1,199.4	1,149.4	30.87

Source: JICA Study Team

2.2.3 Groundwater

Of the 220 points between water holes, wells and springs, only 173 are geo-referenced. Figure 2.2-7 and Figure 2.2-8 shows the location of these 173 water points and the spatial distribution of water points by municipalities, respectively.



Source: JICA Study Team

Figure 2.2-7: Localization of Water Points with GPS References

Source: JICA Study Team

Figure 2.2-8: Distribution of Water Points by Municipality

According to past studies, about 68.3% of water is superficial waters (rivers, lakes…) and about 31.7% of water is groundwater. From this observation, and from the data of production established by INGRH for the years 2006 to 2008, we calculated the available groundwater production for each municipality.

Table 2.2-4: Production of Groundwater in m^3/day for 2006

Year 2006

Municipality	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Praia+ Ribª Grande	975	1,117	1,118	1,124	1,088	1,006	1,008	792	669	885	1,000	999	11,780
S. Domingos	418	479	479	482	466	431	432	340	287	379	428	428	5,049
S. Catarina	592	678	679	683	660	611	612	481	406	537	607	606	7,152
Tarrafal	313	359	359	361	350	323	324	255	215	284	321	321	3,787
S. Miguel	331	379	379	382	369	341	342	269	227	300	339	339	3,997
S. Cruz	923	1,057	1,058	1,064	1,030	952	954	750	633	838	946	945	11,149
Orgãos	226	259	259	261	253	233	234	184	155	205	232	232	2,735
Total	**3,779**	**4,327**	**4,331**	**4,357**	**4,215**	**3,897**	**3,907**	**3,070**	**2,592**	**3,429**	**3,873**	**3,870**	**45,649**

Source: JICA Study Team

Table 2.2-5: Production of Groundwater in m^3/day for 2007

Year 2007

Municipality	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Praia+ Ribª Grande	1,057	1,082	1,048	1,120	1,105	1,031	968	966	626	750	993	1,000	11,746
S. Domingos	453	464	449	480	473	442	415	414	268	322	426	429	5,034
S. Catarina	642	657	636	680	671	626	588	587	380	456	603	607	7,132
Tarrafal	340	348	337	360	355	331	311	311	201	241	319	321	3,776
S. Miguel	359	367	356	380	375	350	328	328	213	255	337	339	3,985
S. Cruz	1,000	1,024	992	1,060	1,046	976	916	914	593	710	940	947	11,117
Orgãos	245	251	243	260	256	239	225	224	145	174	231	232	2,727
Total	**4,096**	**4,192**	**4,061**	**4,340**	**4,281**	**3,995**	**3,750**	**3,744**	**2,427**	**2,908**	**3,848**	**3,875**	**45,517**

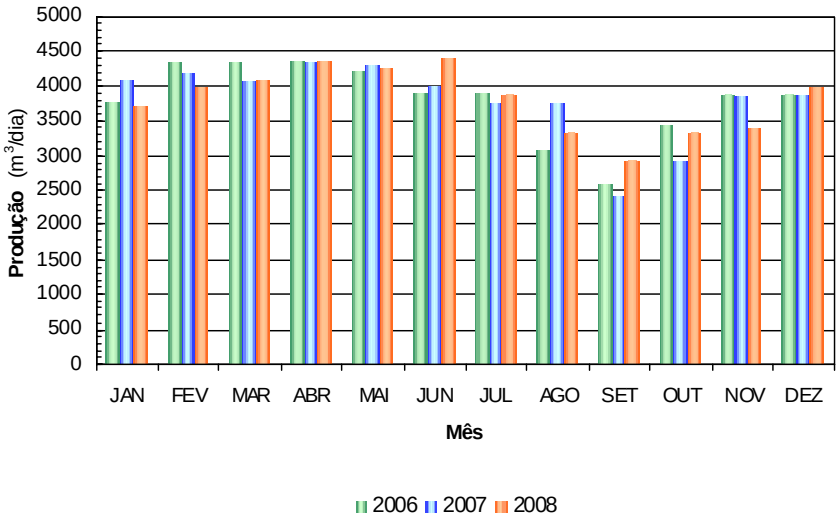
Source: JICA Study Team

Table 2.2-6: Production of Groundwater in m^3/day for 2008

Year 2008

Municipality	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Praia+ Ribª Grande	955	1,022	1,059	1,124	1,097	1,136	1,001	863	751	857	875	1,023	11,764
S. Domingos	409	438	454	482	470	487	429	370	322	367	375	438	5,042
S. Catarina	580	620	643	683	666	690	608	524	456	520	531	621	7,142
Tarrafal	307	328	340	361	353	365	322	277	242	276	281	329	3,781
S. Miguel	324	347	359	381	372	386	339	293	255	291	297	347	3,991
S. Cruz	903	967	1,002	1,064	1,039	1,076	947	817	711	811	828	968	11,134
Orgãos	222	237	246	261	255	264	232	200	174	199	203	237	2,731
Total	**3,699**	**3,960**	**4,103**	**4,357**	**4,253**	**4,404**	**3,877**	**3,344**	**2,912**	**3,322**	**3,391**	**3,964**	**45,585**

Source: JICA Study Team



Source: JICA Study Team

Figure 2.2-9: Monthly Production of Groundwater in m^3/day 2006-2008

2.2.4 Geology

The facilities will be installed on geological formations between 2 and 13 million years old that include material, both explosive and effusive, derived from volcanic activity. The survey has been done at the site of the project including for new desalination plants, pump stations and reservoirs.

Santiago Island has a contrasting relief, alternating between the mountainous area in the interior and the flatter zones near the coast. The relief is dominated by the two mountain ranges that rise in the central area—Serra de Pico da Antónia, with an altitude of 1,394 meters (the highest point on the island), and Serra da Malagueta, which fluctuates between 700 and 850 m. These mountain ranges, with sky-pointing crests and other formations that erosion has not smoothed, are separated by gorges and deep valleys with steep sides causing the rapid draining of rainfall.

Some of the lower-lying areas along the coast are constituted by structural surfaces designated as plateaus (“achadas”), which are the product of basaltic drainage, interspersed with deep valleys whose features are evidence of torrential runoff.

2.3 Socio-Economy

2.3.1 Population (Santiago)

Santiago Island is the most populated island, with about 54% of the population of Cape Verde. Population growth in Cape Verde in recent years is characterized by certain areas

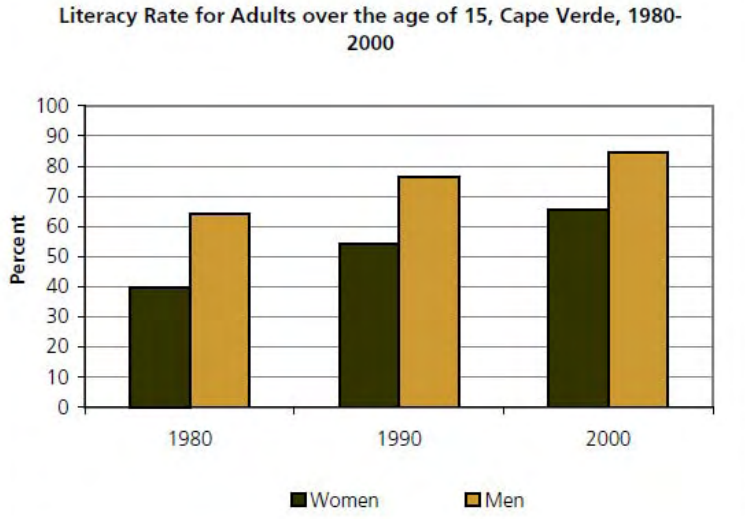
suddenly becoming very attractive, the most obvious example being the municipality of Praia. While the growth rate of the population per year in Cape Verde was 1.57% in the period from 2000-2008 (the population grew from 436,823 inhabitants in 2000 to 499,796 in 2008), the municipality of Praia grew 2.67% over the same period, rising from 97,232 to 123,741 inhabitants.

2.3.2 Education

The extremely high literacy rate of 79% in 2007 is the direct result of 32 years of sustained investment in education, amounting to 20.4% of the national budget between 2004 and 2006. Although the situation varies considerably from one municipality to another, the outcome of this human capital investment strategy is a net enrolment rate of about 96% at the national level. Primary education is free, universal (98% net enrolment) and compulsory until age 11; 83% of primary school pupils finish without repeating and only 2.7% drop out.

Since 1980, however, the quality of education has gradually decreased, mainly as a result of an insufficient number of qualified teachers. The decline is also partly due to a lack of educational planning and professional management and to a failure to evaluate student performance at the end of basic education. The enrolment rate in secondary schools for all children aged 12-17 years is a commendable 70% (77% for girls and 75% for boys).

UNICEF reports that many girls drop out of secondary school due to sexual abuse and teenage pregnancy. Nevertheless, substantial progress is being made in reducing gender inequality, with women becoming increasingly empowered and their rights formally established.



Source: 2003 Earth Trends, http://earthtrends.wri.org

Figure 2.3-1: Literacy for Adults over the Age of 15 (1980-2000)

2.3.3 Family Structure

In Cape Verde, the family structure is a dual one, basically with the predominance of large families in rural areas and nuclear families in urban areas. According to the "Caracteristicas Socio-Demograficas 2001-2002" based on the census in the year 2000 and 2002 about 43.8% of heads of family are women, of which 39.19% live in rural areas, 41.23% in urban areas.

The average family-size is around 4.9 per family (4.8 for urban areas and 5.2 for rural areas). Various economic, social and cultural factors along with emigration provide families with certain fragility, followed by instability for both women and younger children. In 2002, 52% of the population in Cape Verde was female and 41.6% of the population was less than 15 years old.

2.3.4 Employment

The labour market operates under restrictive employment regulations, which together with relatively high personnel costs has led to a structurally high unemployment rate (26% in 1998). According to the INE, the unemployment rate fell to 18% in 2008 due to an increase in labour demand associated with the rapid economic growth in labour-intensive sectors.

The national unemployment rate masks wide geographical variations across the islands. To overcome the lack of opportunity in Cape Verde, the poor still turn to migration and the 'informal' sector. It is estimated that 'informal' employment accounts for about 40% of total employment.

The government expects FDI-funded projects to create at least 15,000 new jobs in the construction, transport, hotel and tourism sectors. Moreover, rapid private sector growth has generated a need for skilled professionals.

2.3.5 Poverty

Rapid growth since the early 1990s has sharply reduced poverty, although inequality remains high. The share of the population in absolute poverty decreased from 49% in 1988-89 to 37% in 2001-02 and to 27% in 2007. This is an important achievement, driven by rapid growth in real income per capita. At the same time, inequality rose sharply during the 1990s and has remained high since then, with a Gini coefficient for consumption of 0.49 in 2007. Progress in reducing poverty has been slower in rural areas, where 72% of the poor live and where 30% of the population lives in absolute poverty, compared to 12 percent of the urban population. It has also varied across islands and socioeconomic groups: The islands with the

largest rural populations (Santo Antão, Santiago, São Nicolau and Fogo) have experienced the highest rates of poverty and food insecurity.

Cape Verde is on track to achieve most of the Millennium Development Goals (MDGs) by 2015. The country ranks 102 out of 177 countries in the UNDP's 2008 Human Development Index, which is the third-highest ranking in Africa. The sharp reduction in poverty since 1990 has been complemented by significantly increased access to education and health care. The net primary enrollment rate in elementary education rose from 72% in 1990/91 to 95% in 2005/06, while net secondary enrollment reached nearly 60% in 2005/06. Adult literacy rates are high (approximately 79% in 2006, 97% among minors), and life expectancy at birth (71 years) is the third highest in Africa. Cape Verde has now achieved parity for girls and boys in school enrollment. Infant mortality has been reduced from 45 to 25 per 1,000 live births since 1990; maternal mortality has also declined as births attended by skilled health personnel have raised sharply from 54% in 1995 to around 90%. Cape Verde has made important efforts to contain the spread of infectious diseases.

At the same time, Cape Verde faces important social challenges with unemployment among vulnerable groups. Though the proportion of the labor force unable to find formal work fell from 26 to 18% between 1998 and 2008, unemployment remains high, particularly among the young, women and rural populations, and there are sharp differences across islands, reflecting a misalignment between skills and job opportunities and constraints in domestic migration, even though there has been significant movement towards urban areas that has put pressure on basic services.

The annual GNI PPP per capita is estimated at US$3,450 (2009), but according to the "Perfil de Pobreza em Cabo Verde 2001-2002" based on the latest census 2000, 172,727 individuals are considered as poor and they have an annual consumption expense of less than 43,250 CVE. Representing 36.7% of the total population, the poor live mostly in rural areas (62%). Among the poor, those who are considered to among the very poor (92,828 individuals with an annual level of expenditure equal to or less than US$288.33) represent 86% of the poor, which equates nationally to 20% of the total population. It also can be seen that they reside mostly in rural areas (68%).

Considering the distribution of poor in each island, it appears that the incidence of poverty in Santo Antao Island is greater than the others, with 54% of the population living below the poverty line. It is also noted that 64% of these are considered very poor; as a proportion, this is equivalent to 35% of the population of this island. But the poor of Santo Antao represent only 16% of the total poor in Cape Verde.

It should be noted that more than half of the poor in Cape Verde are concentrated in

Santiago Island, with 43% outside the city of Praia and 13% in the city of Praia. Outside the city of Praia, 49% of the population is considered as poor.

Regarding the water supply, every 9 out of 100 poor households only have access to public water.

Table 2.3-1: Population of Cape Verde according to the poverty status by residence and island

	Total	Very Poor	Poor	Not Poor (Low Income)	Not Poor (Medium Income)	Not Poor (High Income)
Cape Verde	470,687	92,828	79,899	227,197	47,141	23,622
Urban	259,321	29,739	35,043	134,542	38,509	21,488
Rural	211,366	63,089	44,856	92,655	8,632	2,134
S. Antiao	50,623	17,553	9,861	I9,993	2,442	774
S. Vicente	71,446	7,372	10,868	38,909	8,482	5,815
Fogo	41,235	10,262	7,101	20,873	2,237	762
Santiago (Praia)	106,595	8,246	13,391	54,866	19,375	10,717
Santiago (Except Praia)	149,379	42,083	31,306	64,576	9,249	2,165
Other Island	7,312	7,372	27,980	5,356	3,389	51,409

Source: Instituto nacional de Estatistica/World Bank/ Perfil Pobreza em Cabo Verde 2001-2002

2.3.6 Public Health

In the health sector, efforts are being made to step up the campaign against non-contagious diseases; to control tuberculosis, HIV/AIDS and malaria; and to improve reproductive and child health. As regards access to health services, Cape Verde has reached a national rate of 74%, while in urban areas the rate is 85%. There has been an evident improvement in public health, reflected in lower rates of maternal and under-five mortality and a marked increase in life expectancy at birth. In contrast, performance on other health-related indicators has deteriorated in recent years. For example, the incidence of some highly contagious diseases such as HIV/AIDS and tuberculosis has increased. According to the UNAIDS' 2006 Report on the Global AIDS Epidemic, the HIV prevalence rate in Cape Verde was around 0.8%.

The Ministry of Health is in charge of public health management in Cape Verde. A cholera epidemic began at the end of 1994, peaking in 1995. According to the data provided by the Ministry of Health in 1995, 12,955 cases of cholera were registered nationwide. But in 1996, there was a significant reduction to no incidences, and in the following year, only two cases were reported.

In terms of morbidity, the distribution of diarrhoea per island reveals that Santiago Island has about two-thirds (2/3) of registered cases. Deficient conditions for sanitation and water supply in the island are the main causes of the occurrence of diarrhoea. In addition, parasitic and infectious diseases constitute the three main causes of death among children younger than five years old.

Malaria does not constitute a major threat; however, a dengue epidemic has developed in recent years. Between the end of September to the beginning of November 2009, the Ministry of Health in Cape Verde reported more than 13,000 suspected cases of dengue. Some 3,000 cases have been confirmed and about 68 are suspected with Dengue Haemorrhagic Fever, with six deaths. At the beginning of the epidemic, many cases were clinically diagnosed as H1N1, since Cape Verde is also currently being hit by this pandemic flu. The reported cases of Dengue have seen a sharp increase from the beginning of November and around 80% of cases have been reported in Praia, mainly in Santiago where about 150,000 out of the 350,000 total population of Praia live. Other islands such as Brava, Fogo and Maio are also affected by the outbreak.

According to an interview with the Director of Health at the Ministry of Health, dated 3rd February, 2010, there is a strong relationship between the lack of water and the spread of diseases like malaria and dengue. Indeed, the lack of water has resulted in a shortage in tap water services. To overcome the times without tap water services, people are stocking up water in their own tanks. These tanks increase the ways for mosquito to reproduce and spread the abovementioned diseases within the island, especially in Praia, where there is a high concentration of the population.

The health infrastructure in Cape Verde is as follows:

Table 2.3-2: Health Infrastructure in Cape Verde

Description of facility	Number of Doctors	Number of Nurses	Number of Sanitary Agents
Dr. Agostinho Neto Hospital (Santiago) (326 beds)	81	150	-
Dr. Batista de Sousa Hospital (220 beds)	47	101	-
Regional Ribeira Grande Hospital	8	25	-
Regional S. Filipe Hospital	5	21	-
Regional Santiago Norte Hospital	14	27	-
Health Centers (26)	89	153	-
Sanitary Points (34)	-	34	-
Basic Sanitary Units (112)	-	-	112

Source: Health Ministry Statistical Report 2007, in Journal “Comunicar” May 2009

2.3.7 Power availability on Santiago Island, and development project

There is a close link between the water system development project and the availability of power to make the installations run well. One basic assumption of the project is the availability of necessary power. However, we will try to evaluate in the following whether this assumption is reasonable or not, regarding the current situation concerning power availability and future development projects.

(1) Power demand – actual and forecasted

The actual and forecasted power demand in Santiago Island is evaluated as follows:

Table 2.3-3: Actual and Forecasted Power Demand in Santiago Island

	Actual and forecasted power demand in Santiago		
Year	2009	2015	2018
Power demand	28,470	51,695	64,731

Source: JICA Study "Power Transmission and Distribution System Development Project", Chubu Electric Power

(2) Actual situation concerning power availability

At present, there are two main power stations in operation: the power station of Palmarejo, 3km from the city of Praia, which is a fuel-powered power station of 26,036 kW, and the Gamboa power station, in the city of Praia, which is a diesel-powered power station of 7,426 kW. Producing power from diesel is very expensive; the Gamboa power station is thus scarcely used when there is peak demand. An additional wind power farm of 900 kW capacity has also been built; however, because of maintenance problems only 350 kW of power are available.

In conclusion, the authorities are generally considering actual power availability of 26,036 kW as of 2010.

The desalination plant needs about 12% of the power capacity which is about 3,124 kW.

(3) Power capacity development projects on Santiago Island

There are several power capacity development projects on Santiago Island:

Table 2.3-4: Power Capacity Development Projects on Santiago Island

Project description	Financing	Start of operations (tentative)
Increasing capacity of Palmarejo power plant +20,000kW	JICA (JBIC) - AfDB	2010-2011
Increasing capacity of Palmarejo power plant +10,000kW	World Bank	2010-2011
Wind farm close to Praia +10,000kW	InfraCo	—

Source: MTIE

There is the strong probability that in the following years (until 2015), the available power capacity on Santiago Island will reach 66,036 kW.

As a first approximation, the JICA F/S project will ask for about 11,700 kW, which will be about 17% of power capacity.

It is thus reasonable to assume the power for the proposed water supply system project will be available.

2.4 Water Supply Management in Cape Verde

2.4.1 Development Policies and Plans Regarding Water Supply

(1) Government Program VII for Legislature, 2006-2011 (March 2006)

The Government Program 2006-2011 is positioned at the uppermost level for Cape Verde, which indicates the national priority and the development direction and challenge. The program emphasizes the further enhancement of desalination in Chapter 1, “New paradigms for growth and competitiveness of the economy”. The government committed itself to foster new technology and renewable energy for improving people’s access to safe water and an adequate price for water. The main issues relevant to desalination are shown as below:

- To double the existing production capacity of desalinated water by 2010 mainly in the Boavista, Sal, Maio islands and the city of Praia in Santiago Island
- To integrate the desalination of seawater and wastewater regeneration in the planning of water resource management for ensuring people’s access to safe drinking water, and ensuring the water supply for modern farms.

- To promote the assembly of Public Private Partnerships (PPP) to solve the problem regarding investment and operation of desalination plants for water production and regeneration.

(2) Growth and Poverty Reduction Strategy Paper - II (GPRSP-II) (May 2008)

The GoCV developed an integrated strategy for poverty reduction known as the Growth and Poverty Reduction Strategy Paper I (GPRSP-I) in November 2004. Recently, the second GPRSP-II targeting 2008-2011 was made by the GoCV. The GPRSP-II focuses on five strategic issues: 1) Good governance, 2) Human capital, 3) Competitiveness, 4) Infrastructure and 5) Social cohesion.

In water and sanitation areas, the four actions were recognized as important triggers in order to ensure economic growth in agricultural, industrial and tourism sectors. The four key actions were: (1) Integrated Water Resources Management (IWRM), (2) an increase of desalination capacity, (3) sufficient water use, (4) an expansion of the water treatment system and reutilization of wastewater. To translate the aforementioned actions into practice, the detailed governmental actions were also indicated in the GPRSP-II as below:

- Development and implementation of the "Action Plan on Integrated Management of Water Resources (PAGIRH)"
- An establishment of public private partnerships (PPP) for mobilizing financial resources for water production and water supply
- Development of infrastructure to capture and reserve water by constructing new dams and large reservoirs
- Strengthening and upgrading of infrastructure for the distribution of drinking water, the collection of wastewater and promotion of household connections for water and sewage, periphery urban and rural areas

(3) National Vision on Water, Life and the Environment up to 2025 (February 2000)

Due to the significant growth of water demand, the scarcity of water tends to be a serious threat for socio-economical development. In this context, the National Vision acknowledged that the development and the implementation of the policies and programs on the IWRM were increasingly essential. An outline of the vision is summarized as follows:

- To increase the availability of water, considering the priority use of surface water
- To improve the use of existing resources

- To ensure close links between the problems of quantity and quality of water
- To increase the coverage rate of access to the sewerage system in urban areas
- To promote the participation of people in design, construction, operation and maintenance of hydraulic works

(4) Action Plan and Integrated Management of Water Resources – PAGIRH (July 2009)

In the context of the current national strategic framework based on GPRSP, the PAGIRH was prepared by the INGRH as a new approach, which is the guideline and strategy related to water sector development until the year 2020 in order to ensure the new requirements of economic and social development in Cape Verde. This plan reviews the constraints of the current water sector and proposes actions for overcoming and the strategy including the reform of the current institutional framework for the water sector.

The PAGIRH regards desalination of seawater as an alternative resource and comprehensive solution for future demand of potable water in Cape Verde under the situation of limited natural resources and increased demand between various economic sectors. Cape Verde has experience of water desalination since the 1960s, and currently desalinated water for drinking is supplied to the islands of Sao Vicente, Sal, Boa Vista and the city of Praia in Santiago Island.

On the other hand, to ensure the sustainability of the utilization of desalination as an alternative option instead of natural water resources, PAGRH points out that low cost technologies with lower energy consumption and lower capital intensity to cope with increased demand are necessary.

The main focus issues on water supply and desalination are indicated in the following.

1) Technologies for Desalination

Three types of technologies are used for desalination: 1) Multi vapor compression, 2) Reversed osmosis and 3) Multi-effect distillation. The evaporation system is practically out of service and “reversed osmosis” has been applied to existing equipment working in Cape Verde as modern technology.

The technology still highly depends on electricity and it will have a direct impact on production costs and the water tariff paid by consumers. The use of renewable energy for water production seems to be important to minimize costs.

2) Strategy for Desalination and Integration between the PAGIRH and Energy Policy

Water production in Cape Verde partly depends on energy not only for desalination but also for wells and other items. In fact, the cost of energy directly or indirectly reflects the cost of water production. The issue of water supply in Cape Verde should be viewed together with the issue of energy. The PAGIRH suggests the integration of the National Energy Plan into National Integrated Water Resource Management.

3) Water Loss

Significantly, a large portion of water production is not utilized efficiently due to water loss. In Cape Verde, there are many opportunities to save water loss for potable water and for agricultural water; the PAGIRH mentions that this inefficiency cost accounts for 0.64% of Gross Domestic Product. Great potential for saving water remains in reducing its use in toilets, showers and baths and in reducing water loss.

2.4.2 Institutional Framework

Water supply entities in Cape Verde are shown as below.

(1) CNAG

The "Concelho Nacional de Águas" (CNAG) is a national council to coordinate inter-governmental policy on long-term integrated water resources management in Cape Verde, chaired by the MADRRM. The CNAG is composed of the governmental members responsible for agriculture, energy, health, sanitation and others exercising supervision over local authorities, which are currently the MADRRM, the MTIE, Ministry of Health, Ministry of Infrastructure, Ministry of Finance and Ministry of Decentralization, Housing and Land Management. The basic task of the CNAG is to ensure the development and optimal use of water resources through discussion, consultation and integration at the national level. The modified Water Code (Decreto-Legislativo No.5/99) defined the main tasks of the CNAG as follows:

- To propose to the Government policy on management and exploitation of water resources
- To approve the national plan for water resources
- To adopt programs and plans for development, protection and optimal use of water resources
- To propose to the Government legislative measures

- To declare hydraulic works of public interest
- To approve mandatory directives for implementation by all entities responsible for specific functions relating to water in different sectors

The CNAG meeting is held at least once a trimester. It is stated that the activities of all agencies responsible for water resource issues should be followed by the decisions and resolutions by the CNAG.

(2) INGRH

The "Instituto Nacional de Gestão de Recursos Hídricos" (INGRH) is a public institution under the MADRRM; however, INGRH has administrative and financial autonomy from the central government and has its own assets. Its main task is to exercise its own attributions and functions delegated by the National Water Council (CNAG). INGRH is charged with the actual management of ground and surface water resources and allocates water for drinking water and agriculture. Its main tasks are defined as below:

1) Planning and management of water resources
   - To prepare and execute the decisions of the National Water Council with regard to supervising, coordinating, planning and managing all activities related to the management of water resources
   - To proceed with hydrologic studies in order to utilize groundwater resources for IWRM
   - To promote, implement and support new technologies on water resources
   - To make statements regarding licenses or authorizations for usage of groundwater resources
   - To set technical standards for construction, modification, maintenance and operation of groundwater exploitation
2) Use, Development and Conservation of Water Resources
   - To promote inventorying, protection and conservation of water resources
   - To authorize the allocation of hydraulic properties used or administrated by public or private entities
   - To develop studies, projects and trials aimed at defining and exploiting new sources of water supply

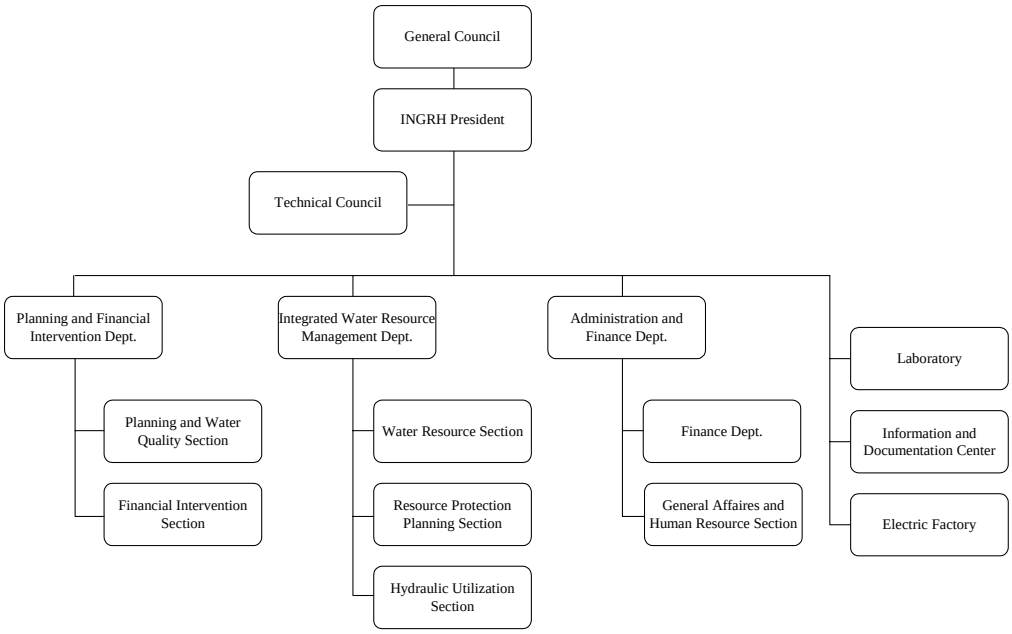
- To elaborate studies on the behavior of groundwater resources and check the quantity available

3) Water Quality

- To control the quality of water
- To establish allowable limits of concentration of harmful substances contained in water
- To develop plans and programs in order to avoid deterioration of water quality and to promote improvement of water quality

4) Supervision and Control

- To oversee the policy actions that contravene the Water Code
- To authorize restrictions on the use of water resources in certain areas that are in danger of exhaustion, degradation or contamination



Source: INGRH

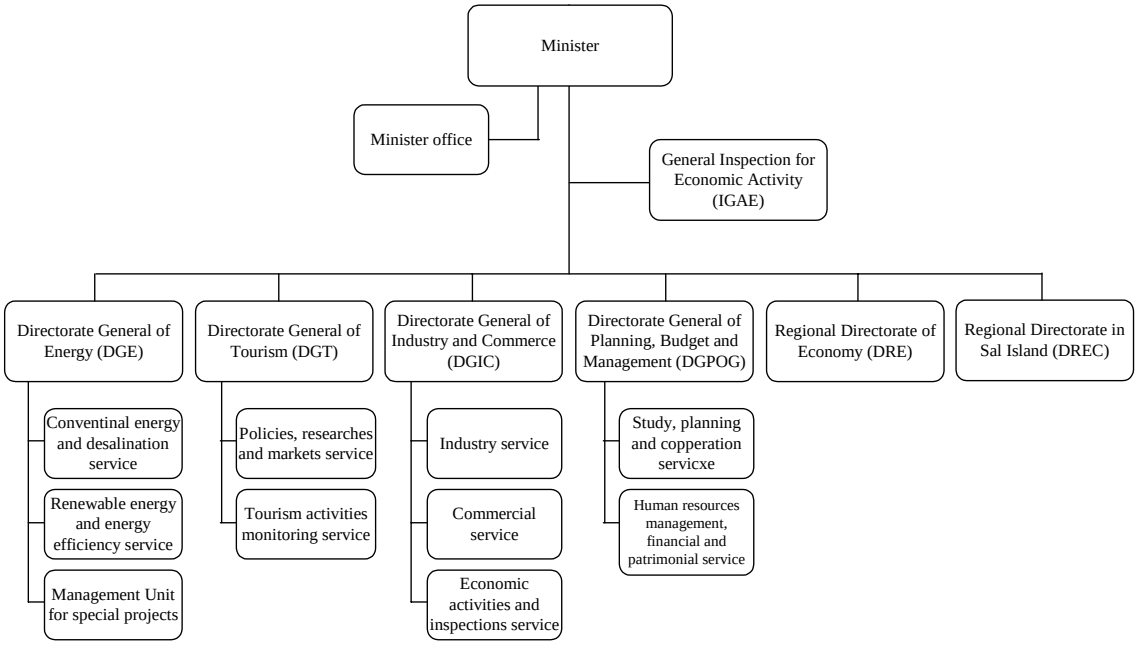
Figure 2.4-1: Organizational Chart (INGRH)

(3) MTIE

The “Ministerio do Turismo, Industria e Energia” (MTIE, Ministry of Tourism, Industry and Energy) is a government organization in charge of defining, executing and appraising public policies for the production of goods and services, in particular, in the field of industry, energy,

commerce, tourism and company-related services. The total annual budget in 2010 is 1,084,123,138 ECV. Total number of employee accounts for 64 persons as of 2010. The ministry is composed of the Minister's office with 9 persons, Directorate General of Planning, Budget and Management (DGPOG) with 4 persons, Directorate General of Energy (DGE) with 8 persons, Directorate General of Industry and Commerce (DGIC) with 21 persons, Directorate General of Tourism (DGT) with 4 persons, Inspectorate General of Economic Activities (IGEA) with 9 persons, Regional Directorate of Economy for Northern and Southern Regions with 8 persons, and Regional Directorate of Sal Island (DREC) with 1 person. There are public institutions and autonomous services such as ELECTRA, Boa Vista and Maio Islands Touristic Development Company, SA (SDTIBM), Commercial Free Zone of Cape Verde (FIC), etc.

The DGE is the department responsible for the design, implementation and evaluation of energy and desalination as well as the submission of proposals for growth, improvement and increasing productivity and competitiveness. The DGE undertakes services related to (1) Conventional Energy and Desalinization, (2) Renewable Energy and Energy Efficiency, and (3) services by a Management Unit for Special Projects that is in charge of the present water project in Santiago Island.



Source: MTIE

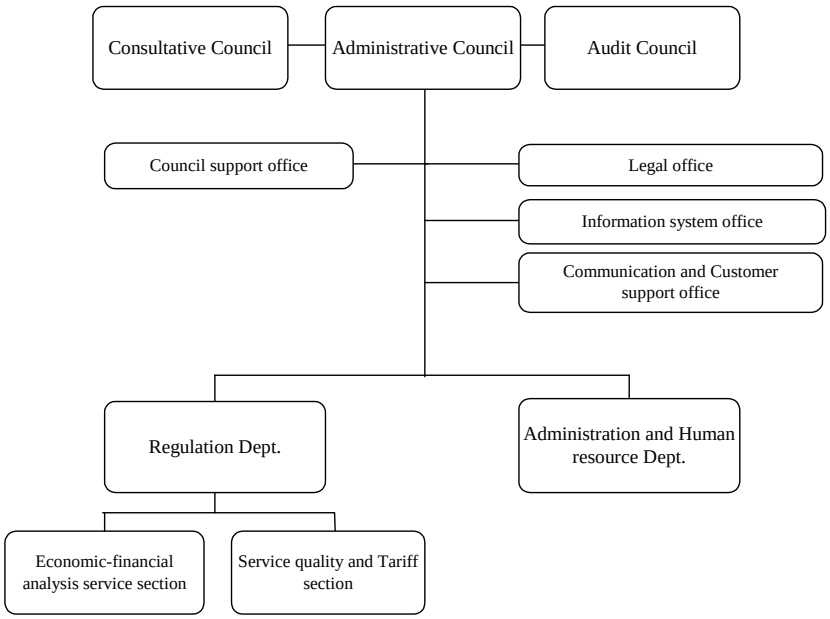
Figure 2.4-2: Organizational Chart (MTIE)

(4) ARE

The "Agência de Regulação Económica" (ARE) is an independent regulatory agency

established by Decree No.26/2003, starting its activities in February 2004. The ARE is aimed at administrative work for economic regulations and supervising in the sectors of water, energy, telecommunications, urban public transport and ferry transport services. The mission of ARE is to promote the economic efficiency and financial stability of the different sectors and to serve the public interest for the benefit of society. ARE's assignment also includes protecting the rights and the interests of customers, in particular on prices and the quality of service provided.

In the water sector, ARE is theoretically responsible for authorizing and determining the water tariff for the water supply service, managed by each water supply entity such as ELECTRA and SAASs.



Source: ARE

Figure 2.4-3: Organizational Chart (ARE)

(5) ELECTRA

The "Empresa de Electricidade e Água SARL" (ELECTRA) was founded by the Decree-law No.37/82 as a public utility, and later changed into a limit liability company by the Decree-law No.68/98. This company operates in the generation, distribution and sales of electricity for all 9 islands and water for Praia City in Santiago Island, Sao Vincente Island, Sal Island, and Boavista Island.

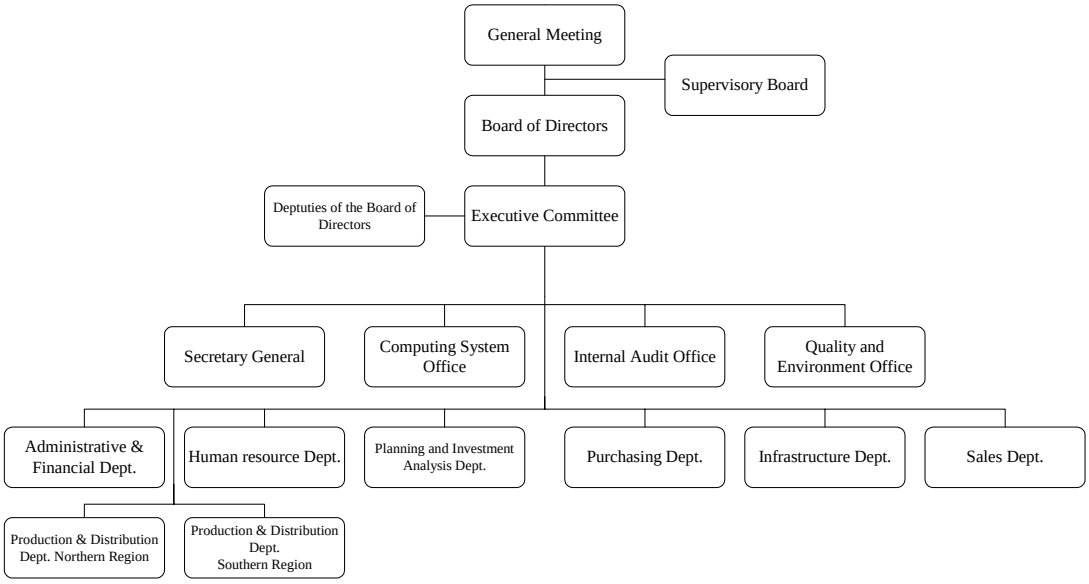
In 2000, 51% of ELECTRA's equity was owned by private companies – Empresa de Electricidade de Portugal (EDA) and Águas de Portugal (ADP) – and a concession contract on the generation, distribution of electricity and water for 36 years was signed. In 2006, however,

after three years of private management, the GoCV increased its share from 35% to 51%, and later to 85% in 2008.

The ELECTRA is allowed to carry out the abovementioned service under transfer agreements with local municipalities. In Praia city, the ELECTRA is responsible for the production and distribution of water, mostly provided by the desalination plant at Palmarejo. Their water service has mainly focused on water supply by household connections in the Praia municipality since 1999.

1) Current organizational structure

The ELECTRA has established offices in all the islands, with its head office located in Mindelo City in São Vincente Island. The organizational upper structure consists of the General Meeting, the Board of Directors with 5 members, the Executive Committee with 3 members, and the Supervisory Board with 2 members. Under the Board of Directors, there are 12 sections, as follows:



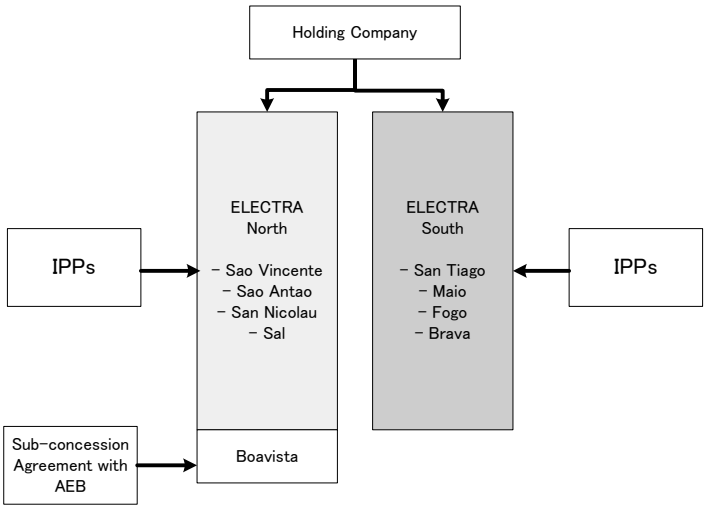
Source: ELECTRA Annual Report 2008

Figure 2.4-4: Current Organizational Chart of ELECTRA

2) Future organizational restructuring

The institutional restructuring of ELECTRA has been assisted and studied by the IBRD since July 2009, and five options for the restructuring were proposed to the MTIE. Currently, the MTIE favors option 3, which is (1) to establish a holding company for the electricity, water supply and sanitation service and (2) to divide ELECTRA into ELECTRA

North (S. Vincente, S. Nicolau, S. Antao and Sal) and ELECTRA South (Santiago, Maio, Fogo, Brava) and Aguas de Cabo Verde (ACV) for water production and supply. It is confirmed that this restructuring is the governmental view according to the interview with the MTIE in the third fieldwork survey and is on-going.



Source: JICA Study Team

Figure 2.4-5: Future Organizational Restructuring

3) Number of employee and training

The number of employee accounted for 709, permanent staffs 612, part-time staffs 97, as of December 2009. The average age of employees was 41 years old, and the averae years of continuous employment was 12.1 years.

As for trainings for employees, 28 trainings courses, 18 internal trainings and 2 external trainings, were held in 2008, and the number of trainees accounted for 149 in total.

4) Business management

Financial situation of ELECTRA was negative with about 700 million CVE deficit in 2009, including both electric power supply and water supply services. According to the available data in fiscal year 2008, electric power supply service shared 77% of the total revenue, and water supply service had 17% of that. With regard to operating cost, the largest cost was direct activity cost shared 65%, followed by amortization cost with 13% and personnel cost with 12%. Total sales accounted for about 6.2 billion CVE with 13% increase to the previous year, however the sales amount was not sufficient to cover total expenditure. The increase of revenue attributed to mainly the tariff revision of electricity and water supply, on the other hand the growth of fuel price influenced on the increase of the direct cost in operating cost.

During recent three years, ELECTRA achieved 27% increase of the total revenue, the difference between profit and loss was steadily decreasing. The financial situation has been, however, in deficit since 2004 except for 2006, and the improvement is still a large challenge of ELECTRA.

The main financial indicators and the trend of operating cost are shown as below.

Table 2.4-1: Main financial indicators (ELECTRA)

(thousand CVE)

	2006	2007	2008	2009	2007-2009 Change	2007-2009 %
Sales Amount	4,254,797	4,869,602	5,479,342	6,196,225	1,326,623	27%
Sales of Electricity	3,045,753	3,669,768	4,203,699	N.A.	1,157,946	38%
Sales of Water	883,361	912,460	927,001	N.A.	43,640	5%
Service Rendered	242,157	230,982	289,359	N.A.	47,202	19%
Company own works	30,071	28,880	27,875	N.A.	-2,196	-7%
Others	53,455	27,512	31,408	N.A.	-22,047	-41%
Net Results	-1,156,216	-1,298,496	-969,249	-698,661	599,835	-46%
Net Asset	10,014,087	4,813,691	10,507,262	10,014,087	5,200,396	108%
Net Liability	8,794,673	10,634,498	11,316,703	9,506,523	-1,127,975	-11%

Source: ELECTRA Annual Report 2008, 2009

Table 2.4-2: Trend of Operating Cost (ELECTRA)

(thousand CVE)

Operating cost	2006	2007	2008	2006-2008 Change	2006-2008 %
Direct Activity Cost	3,302,567	3,970,672	4,096,027	793,460	24%
Sub-contract	53,916	16,540	0	-53,916	-100%
Supply and Service	392,578	460,790	420,548	27,970	7%
Personnel Cost	704,880	721,324	742,290	37,410	5%
Amortization	705,154	692,947	795,049	89,895	13%
Taxes	31,188	34,351	38,056	6,868	22%
Provisions for the year	186,711	244,578	198,630	11,919	6%
Other operational cost	53,455	27,512	31,408	-22,047	-41%
Total	5,411,013	6,168,098	6,294,385	883,372	16%

Source: ELECTRA Annual Report 2008, 2009

(6) ADA (Agência de Distribuição de Água)

The "Agência de Distribuição de Água" (ADA) was established in 1999 when the water supply service in Praia was transferred from Praia municipality to both ELECTRA and ADA. ADA is an organization independent from Praia municipality without subsidies. ADA has been responsible for the water supply service, such as by public fountain and by tank truck, in

order to meet the demand of households without water connections in Praia municipality. ADA purchases desalinated water from ELECTRA and sells it to customers because it does not produce water. Currently, the ADA's Board of Directors appointed by the City Council consists of the president, chief executive and director, and the total number of employees amounts to 75 people.

(7) SAAS (Serviços Autónomos de Água e Seneamento)

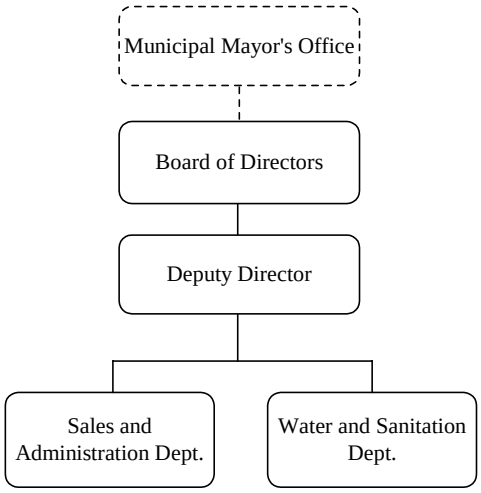
The "Serviços Autonomos de Agua e Seneamento" (SAAS) was created in the context of the policy of decentralization by Law No.132/IV/95, aimed to efficiently manage waterworks. The first SAAS was established in Santa Cruz in 1995, followed by Tarrafal in 1999 and Sao Miguel, Sao Domingos and Santa Catarina in 2000. The institutional building of the latter 5 municipalities had been supported by the Austrian Development Cooperation (ADC) from 1998-2001.

SAAS has administrative and financial autonomy focusing on the management of production and distribution of water for drinking and in some cases for irrigation. A sanitation service has not really been launched yet. 3 SAASs, Ribeira Grande de Santiago SAAS, Sao Salvador do Mundo SAAS and Sao Lourenco dos Orgaos SAAS, however, are still not independent administratively and financially; their SAASs still belong to the Mayor's office in each municipality.

SAAS is directed by a Board of Directors, and the Deputy Director in many cases is responsible for the actual management of the service including financial and commercial affairs and technical matters, and the Mayor has the power to appoint and dismiss Board members. SAAS has a sales and administration department and a technical department. The number of employees of SAASs is varied between Ribeira Grande de Santiago SAAS with 16 persons and Santa Catarina SAAS with 96 persons. From the viewpoint of a performance indicator, the number of employee per 1,000 connections, Santa Cruz SAAS at 4.6 employees/1,000 connections could be doing the most efficient management of waterworks.

Table 2.4-3: Number of Connections and Employees (SAAS)

	S.Domingos	Sta. Cruz	S.Miguel	Tarrafal	St Catarina	Ribeira Grande	SLD Orgaos	S. Salvador
No. of connections	800	5,000	N.A.	3,724	4,906	782	860	276
Number of Employee	93	23	N.A.	57	96	16	31	18
Staff/ 1,000 connections	116	4.6	N.A.	15	20	20	36	65



Source: JICA Study Team

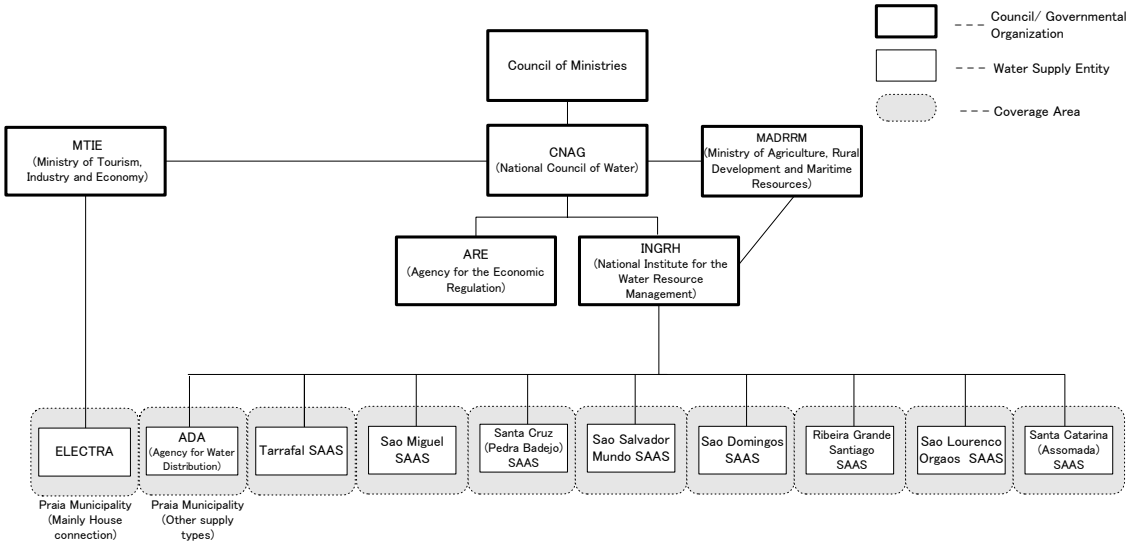
Figure 2.4-6: Organization Chart (SAAS)

(8) Institutional Framework for Waterworks

There is no single national entity which comprehensively manages and supervises waterworks in the whole country.

SAASs are responsible, in general, for each waterworks in their municipal areas, except for the SAAS of Ribeira Grande de Santiago, Sao Salvador do Mundo and Sao Lourenco dos Orgaos, which still belong to each respective mayor's office. CNAG is a coordination body between the relevant ministries for water resource management. INGRH is a technical regulatory organization for water resources and also manages intake facilities, including groundwater sources in the municipalities. MTIE (former MEGC) is in charge of the planning, development, control and management of the desalinated water, including establishing public-private partnerships with concession contracts.

The current institutional framework for water supply is shown as below:



Source: JICA Study Team

Figure 2.4-7: Institutional Framework for Water Supply in Santiago island

2.4.3 Legal Framework for Water Supply

The "Código de Águas (Water Code)" promulgated in 1984 defined the legal basis on the legal ownership, protection, conservation, development, administration and use of water resources in Cape Verde. The law described that all water resources in the soil, atmosphere and others are public property; the law can be applied to inland maritime water and the territorial sea, including desalinated water. The Code described that the first priority for water use should be placed on drinking water for people and that the order of priorities for the other uses be determined by CNAG. It also states that the management of water resources is governed by a centralized national body such as CNAG, INGRH and the Regulatory Agency, and stipulates the role and function of these organizations.

The licensing of desalinated water is described in the Decree-law No.36, promulgated in November 2008, which defines the basic concept of concession including project, construction, financing, maintenance of the infrastructure and desalination plants for public water use and irrigation. Water supply by desalination plants is to be undertaken by public-private companies based on the concession contract for 30 years that grants a license for producing and selling desalinated water. The concessionaire should be a joint stock company with a minimum share capital of 25 million CVE. It is also mentioned that the public works will be conducted under a BOT (Built, Operate, and Transfer) scheme. Municipalities are permitted to be shareholders of the company as the concessionaire, and the company signs the contract for water supply with each municipality and with users. The private partner is chosen by the MECC and approved by the Council of Ministries.

Order No.47 in 2008 issued by the minister of MECC indicated that the state selected Lachesis SRL as a public-private company, and provided the license for production and sales of desalinated water to Santa Catarina, Santa Cruz, Sao Miguel, San Lourenco dos Orgaos, and Sao Salvador do Mundo municipalities, in accordance with Law No.36.

Table 2.4-4: Main Legislation and Regulations on Water Sector

Name	Contents
General Water Sector Issues	
Law No.41/II/84, July 18	- To approve the Water Code (Código de Águas) - To define the legal ownership of water resources, protection, conservation, development, management and usage of water resources, etc.
Decree-law No. 5/99, December 13	- To amend a part of the Water Code（Código de Águas）
Decree-Law No.75/99, December 30	- To define a legal framework of concessions and licenses for water supply and sanitation
Decree No.82/87, August 1	- To define regulations in order to prevent scarcity, obstruction of water and water-borne diseases
Decree No.84/87, August 8	- To define the regulation on registration of water usage
Decree No.165/87, December 31	- To define the implementation of survey, project, construction, development, conservation, modification, and interruption of water facilities, referred to in Article 21 of the Water Code
Decree No.166/87, December 31	- To define the contents of Chapter 4 in the Water Code
Decree No.167/87, December 31	- To define the regulation on determination of tax for using water resources and water tariff, payment, collection, fines, etc., which are directly related to water resource use
Decree No.168/87, December 31	- To define the regulations on water supply and sewerage service
Decree-law No.7/04, February 23	- To define standards on discharge water quality by human activities from households, communities and business.
Decree-law No.7/2004, February 23	- To authorize the responsibility of the Directorate General for Environment, which covers all sewerage discharge in water and soil
Decree-law No.8/2004, February 23	- To define standards and regulations, classifications, management systems, and penalty systems for the purpose of conserving water environment and improving water quality.
MEGC Order, No.44/19, November 2008（Series II）	- To approve access to fuel with a special price for the purpose of desalinated water production
CNAG and INGRH	
Decision No.1/02, April 22	- To approve regulations of CNAG
Decree-regulation No.1/02, June 3	- To approve INGRH's articles of incorporation
Ordinance No.20/03, September 8	- To approve the new organizational structure of INGRH
Decree-law No.56/05, August 22	- To approve the establishment of the Ministry of Agriculture, Rural Development and Maritime Resources.

Public-Private Partnership and Concession Contract	
Decree-law No.36/2008, November 10	- To define the basic concept of concession contracts on water supply for drinking and irrigation produced by desalination plants, covering Santa Catarina, Santa Cruz, Sao Lourenco dos Orgaos, Sao Miguel and San Salvador do Mundo.
Official Gazette (BO) No.12, April 2005	- General concession contract on transmission and distribution of energy and water, and collection and treatment of residual water for reuse between the State of Cape Verde and ELECTRA SARL
Official Gazette (BO) No.12, April 2005（Series III）	- Special concession contract on transmission and distribution of energy and water, and collection and treatment of residual water for reuse between the State of Cape Verde and ELECTRA SARL
Despacho MEGC, no 47/10 de Dezembro de 2008 （II Série）	- To determine the Lachesis SRL as a public-private partner with a license for producing and selling desalinated water to Santa Catarina, Santa Cruz, San Miguel, Sao Lorenco dos Orgaos and Sao Salvador do Mundo municipalities.
ARE and Water Tariff	
Decree-law No.20/VI/03, April 21	- To approve the establishment of ARE
Decree-law No.26/03, August 25	- To define the legal status, functions, duties and responsibilities of ARE
Decree-law No.27/03, August 25	- To approve ARE's articles of incorporation
ARE Order No.4/08	- To approve a new water tariff (ELECTRA)
ARE Order No.4/09	- To approve the modification of a parameter value for calculating water charges in Porto Novo city
ARE Order No.8/09	- To approve the modification of a parameter value for calculating water charges in Porto Novo city (Águas de Porto Novo)
Instruction No.2/08	- To define a formula for calculating a water tariff for Porto Novo city (Águas de Porto Novo)
Others	
Law No.86/IV/93, July 26 de: Law on Environment Policy	- To establish the basic law on environmental policy, which provides a framework for environmental policies
Decree-law No.14/97, July 1: Law on Environment Policy	- To indicate the fundamental principles for environmental protection in accordance with the orientation of the basic environmental law
Resolution No.29/2003, December 29	- To approve the national policies on sanitation

Source: JICA Study Team based on information from the MTIE, ARE and INGRH

2.5 Current Situation of Water Supply in Santiago Island

2.5.1 General Situation

For the analysis of drinking water use, it is necessary to take into consideration the fact that the situation is different between urban and rural areas and also consider the different use of water with special reference to agricultural use, which has a major influence on the availability of the limited ground water resources of the island. The deficit in terms of availability against needs implies the need to find or create complementary water resources as shown in Table 2.5-1.

(1) Limited natural water resources

A deficit of approximately 5 million cubic meters of water per year is the balance for natural water resources of Santiago Island as shown in Table 2.5-1 below.

Table 2.5-1: Summary of Water Needs and Availability (m^3/year)

	2007	%
Annual Water Needs		
Population (Residents)	11,277,223	23.9%
Temporary population (Tourists, etc.)	311,962	0.7%
Agriculture	32,685,120	69.3%
Others / Industry	2,914,500	6.1%
Total	47,188,804	100%
Availability of Water *1		
Holes	6,676,560	
Wells and Springs	33,658,840	
Poilão Dam	1,700,000	
Total	42,035,400	

Source: INGRH

*1: Without desalinated water

The priority is given to drinking needs but the situation for the distribution of potable water is very different in each municipality. In addition to the problem of availability of resources, there is usually a lack of infrastructure for storage, an insufficient distribution through pipeline networks, and as a consequence a non-continuous service.

Table 2.5-2 shows that about 30% of wells are not equipped with meters. Among these wells, some are dedicated to potable water supply and some are mixed. The mixed use means that the well produces for both agricultural needs and for potable water production by adding chlorination treatment.

Table 2.5-2: Ratio of wells with water measurement meters

Municipalities	Well with meters		Well without meters		Total quantity of wells
	#	(%)	#	(%)	
Praia	15	71.43	6	28.57	21*
Ribeira Grande	10	83.33	2	16.67	12*
São Domingos	8	38.10	13	61.90	21
São Lourenço	7	70.00	3	30.00	10
São Miguel	13	100.00	0	0.00	13
Santa Cruz		74.29		25.71	35
Tarrafal	13	81.25	3	18.75	16
Santa Catarina	20	68.97	9	31.03	29**
Total	**112**	**71.34**	**45**	**28.66**	**157**

* including wells, holes and springs whose water is billed

** 8 not working

Source: December 2007 (INGRH)

(2) Potable water coverage

1) Urban areas[1]

According to the results of the census, "*Integrated questionnaire of basic indicators 2007*", 98.6% of the urban population in Santiago Island had access to serviced potable water, 62.1% through public pipes (individual and collective), 27.8% through fountains and 8.7% through water tankers. The rate of household connections is up to 58.2%.

2) Rural areas

According to the latest census in 2007, 75.8% of the rural population had access to serviced water, 58.2% through household connections, 36.8% through public pipes (individual and collective), 35.0% through fountains and 4.0% by water tankers.

However, the average figures for Santiago Island hide a wide diversity in the situation and the big gap between municipalities.

The following Table 2.5-3 illustrates the situation regarding water supply coverage in Santiago Island by municipality:

[1] Urban areas/Rural areas: The data is defined by Instituto Nacional de Estatistica (INE)

Table 2.5-3: Source of Water in Santiago Island (in %)

Main Source of Water	Cape Verde (Average)	Santiago Island		Ta	SM	SSM	SCz	SD	Pr	RGS	SLO	SCa
		Urban	Rural									
1. Serviced Water	89.5	98.6	75.8	93.0	74.0	43.2	89.1	81.0	98.4	65.2	68.3	80.9
Public Pipe (Individual)	46.9	55.4	34.2	62.3	51.6	11.7	70.3	8.2	45.4	8.0	42.9	42.9
Public Pipe (Collective)	5.0	6.7	2.6	6.2	2.8	1.6	4.9	1.2	3.7	0	5.4	4.5
Fountain	30.7	27.8	35.0	23.9	18.2	23.4	9.8	61.3	45.2	55.3	16.0	30.9
Water Tanker	6.8	8.7	4.0	0.7	1.4	6.5	4.1	10.4	4.0	1.9	3.9	2.6
2. Non-Serviced Water	10.5	1.4	24.2	7.0	26.0	56.8	10.9	19.0	1.6	34.8	31.7	19.1
3. Rate of House Connections	50.1	58.2	38.1	64.1	53.7	15.4	76.9	9.9	47.3	10.9	43.9	48.8

Source: Instituto Nacional de Estatistica/Integrated questionnaire of basic indicators 2007, Summary of main results

On the one hand, we can see that Sao Domingos (SD), Sao Salvador do Mundo (SSM) and Ribeira Grande de Santiago (RGS) have the lowest rate of coverage by individual public pipes and therefore particular attention shall be given to these municipalities to evaluate the feasibility of the projected distribution.

On the other hand, Praia, which has the highest rate of coverage, is actually half supplied by fountains and not by individual public pipes.

In order to have an efficient distribution of water, and to meet the requirement of needs, it will be necessary to have better coverage by public pipes in terms of transmission lines and distribution networks.

3) Typical existing network distribution system

The typical structure of a water supply system is as follows:

A deep well pump that fills a square reservoir (capacity from 10-1000 m^3 or more) through PVC or steel pipes, and the distribution is done through a gravity distribution network made of PVC, cast iron, steel or HDPE. The electricity for the pumps is supplied by the existing electric grid or by diesel generators. In both cases the energy supply is neither continuous nor stable so the supply of water is inevitably discontinuous (sometimes several hours per day or less). The raw water chlorination is done between the well and the reservoir in order to be distributed as potable water. There is no other type of treatment processing facility operated in Santiago Island.

The use of solar energy exists but is not widespread.

Except for Praia and Sao Domingos, there is no reliable and accurate map of the existing distribution network. So it becomes impossible to quantify the length, diameter or material of the pipelines buried for transmission lines or distribution lines. It can only be supposed that the hilly relief of the island and consequently the important pressure variations added to the rocky soil condition will accelerate the ageing process of pipelines.

2.5.2 Water Production

Table 2.5-4 presents the current capacity for water production in Santiago Island in 2006.

Table 2.5-4: Current Capacity for Water Production in Santiago Island

Municipality	2006			
	Potable Water (m^3/year)	Industrial (m^3/year)	Total (m^3/year)	Total (m^3/day)
Tarrafal	237,011	—	237,011	649.35
São Miguel	89,512	—	89,512	245.24
São Salvador do Mundo	—(*1)	—	—	—
Santa Cruz	299,623	7,856	307,479	842.41
São Domingos	128,665	1,670	130,335	357.08
Praia	2,723,248(*2)	74,387	2,797,635	7,664.75
Ribeira Grande de Santiago	—(*1)	—	—	—
São Lourenço dos Orgaos	—(*1)	—	—	—
Santa Catarina	563,492	—	563,492	1,543.81
Total (Santiago Island)	4,041,551	83,913	4,125,464	11,302.64

(*1): Included in Santa Catarina

(*2): INGRH supplied 599,530 (m^3/year) and ELECTRA supplied 2,123,718 (m^3/year).

The JICA Survey team conducted the analysis of water from different resources in Santiago Island. The resources are 1) desalinated water from existing desalination facilities in Praia and Santa Cruz, 2) feed water from a beach well before filtering at the existing plants in Praia and Santa Cruz, 3) ground water near the candidate sites of the planned water distribution and 4) sea water around the candidate sites for the planned and future desalination facility.

(1) Water analysis items and sampling location

In Cape Verde, no water quality standard exists. The Ministry of Health of Cape Verde is drafting standards which shall be based on WHO standard. Therefore, this analysis items follow to WHO guidelines.

The parameters of water analysis are as follows, and the water sampling locations are also described in Figure 2.5-1.

1) Desalinated water from existing desalination facilities in Praia and Santa Cruz

pH
Electric Conductivity
Total Dissolved Solid, TDS
Total Hardness, $CaCO_3$
Chloride, Cl^-
Boron
Coliform Bacteria Count

2) Beach well water to the existing desalination facilities in Praia and Santa Cruz

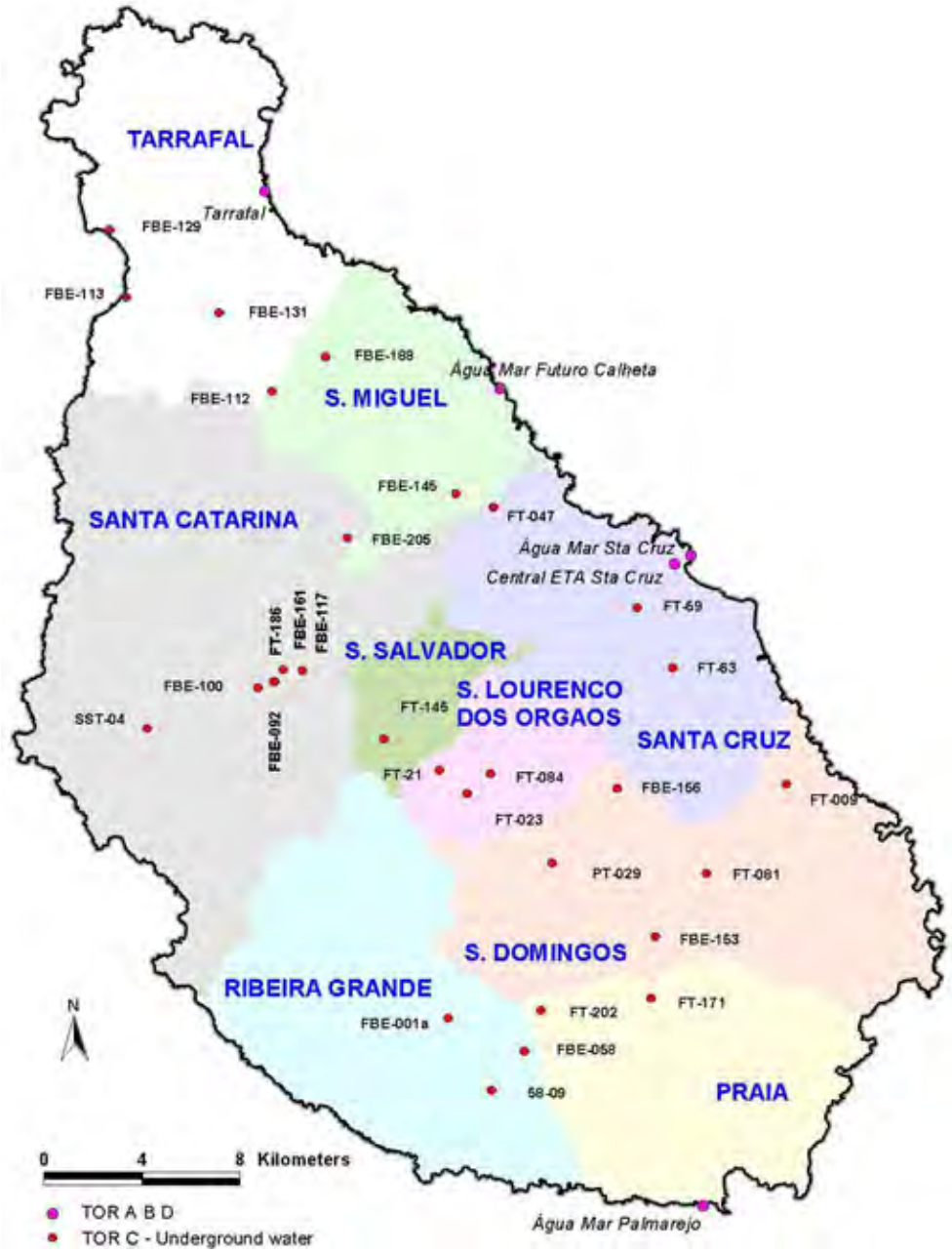
Water Temperature, ℃
pH
Electric Conductivity
Total Dissolved Solid, TDS
Turbidity
Total Hardness, $CaCO_3$
Nitrate, NO^-_3
Nitrite, NO^-_2
M-Alkalinity, $CaCO_3$
Chloride, Cl^-
Total Phosphorus, PO_4^{-3}
Boron
Coliform Bacteria Count
Dissolved Oxygen, DO
Chemical Oxygen Demand, COD

3) Ground water near the candidate sites of the planned water distribution

Water Temperature, ℃
pH
Turbidity
Total Hardness, $CaCO_3$
Nitrate, NO^-_3
Nitrite, NO^-_2
Chloride, Cl^-
Iron, Fe
Arsenic
Cadmium
Mercury
Cr^{+6}
Lead
Fluorine
Manganese
Standard Plate Count Bacteria
Coliform Bacteria Count
Fecal Coliform Bacteria Count

4) Sea water around the candidate sites of the planned desalination facility

Water Temperature, ℃
pH
Electric Conductivity
Total Dissolved Solid, TDS
Turbidity
Calcium, Ca^{2+}
Total Hardness, $CaCO_3$
Nitrate, NO^-_3
Nitrite, NO^-_2
Sulfate, SO_4^{-2}
M-Alkalinity, $CaCO_3$
Chloride, Cl^-
Silica, SiO_2
Total Phosphorus, PO_4^{-3}
Sodium, Na^+
Boron
Coliform Bacteria Count
Dissolved Oxygen, DO
Chemical Oxygen Demand, COD



Source: JICA Study Team

Figure 2.5-1: Location of sampling sites concerning TOR 1), 2), 3) and 4)

(2) Analysis results summary

Results of analysis of the collected water samples from each resource are summarized in Table 2.5-5 through Table 2.5-8, from which the results are mentioned below.

1) Desalinated water from existing desalination facilities in Praia and Santa Cruz

The quality of the water is generally within or close to the allowable level for drinking

water; however, the following items should be pointed out for Praia;

- Total Dissolved Solids: Quality 790 mg/l exceeds Japanese Standards 500~200 mg/l, though it is within WHO Standards.
- Chloride: Quality 320~8,00 mg/l exceeds Japanese, EU and WHO standards of 200, 250 and 250 mg/l, respectively.
- Boron: Quality 0.69 mg/l exceeds slightly WHO guidelines 0.5 mg/l though it is within Japanese and EU guidelines.

2) Beach well water for the existing desalination facilities in Praia and Santa Cruz

The difference in quality of the well water is observed between Praia and St. Cruz: the first seems to be concentrated sea water (by 10%) and the second seems to be rather diluted sea water (by 10%).

3) Ground water near the candidate sites of the planned water distribution

The water qualities seem generally within the allowable level for drinking water from the analyzed figures of pH, turbidity, nitrite, chloride, boron, fluorine, iron and other very little substances, i.e., arsenic, cadmium, mercury chromium, lead and manganese.

However, the following points should be investigated:

(Refer to part in Table 2.5-7, which exceed the guideline figure.)

- Nitrate: The ground water in some areas in Sao Miguel, St. Cruz, Assomada & Picos, Sao Lorenco and Sao Domingos contains more nitrate than the level specified in the Standards in Japan, EU and WHO. Especially, it should be carefully checked some of those figures reach seven (7) times the Japanese Standard. The reason for the higher content of nitrate is assumed to be the influence of agriculture practices, namely the use of nitrate fertilizers.
- Total Coliform: The ground water in some area in Assomada & Picos and Tarrafal contains more than 3,000ufc/100ml. Punctual bacteriological contamination is probably due to the influence of sewage contamination.
- Total Hardness: The ground water in some areas in Sao Miguel, St. Cruz, Sao Lorenco and Sao Domingos show more total hardness (up to 770 mg/l) than the Japanese Standard of 300 mg/l. The reason for the

higher contamination is assumed to be due to the specific soil composition of the area.

4) Sea water around the candidate sites of the planned and future desalination facility

Some difference in salinity (presented by TDS) is observed among Palmarejo, Sao Miguel and Tarrafal as follows:

Total Dissolved Solid (mg/l)

- Palmarejo (two samples) : 41,000 & 42,000
- Sao Miguel (two samples) : 38,000
- Tarrafal (two samples) : 39,000 & 40,000

Sea water samples in Palmarejo were collected at the sea surface in the vicinity of the existing four (4) desalination facilities and, therefore, their higher salinity is assumed due to the influence of discharged brine from existing desalination facilities under operation, namely, two (2) 1,200 m^3/day facilities located just close to the candidate site.

The sea water of other areas, namely, Sao Miguel and Tarrafal, also shows higher salinity than generally understood as standard sea water with TDS around 35,000 mg/l, which is assumed to be due to the characteristics of Santiago Island.

Table 2.5-5: Analysis of Desalinated Water (Praia and St. Cruz)

Sample Location / Sampling No. / Analysis Item		Praia	St. Cruz	Drinking Water Regulation		
		SP 1-1 SP 1-2 1-1 1-2	SS 1-1 SS 1-2			
		Range	Range	WHO	EU	Japan
Item	Unit					
Temperature	℃	16.4 ~ 19.1	24.1 ~ 24.2			
pH	-	6.4 ~ 7.4 at 21 ℃	6.0 a 20 ℃	-	6.5 ~ 9.5	5.8 ~ 8.6
Conductivity	µS (cm)	940 ~ 1,100 at 25 ℃	220 ~ 230 at 25 ℃		2,500	
TDS	mg/l	770 ~ 790	160 ~ 180	1,000		200~500
Turbidity	NTU	<0.3 (LQ)	-	1 (Max 5)	-	<2 deg
Total Hardness	mg($CaCO_3$)	71.1	<9.6 (LQ)	-	-	<300
Chloride	mg (Cl^-)/l	320 ~ 800	64	<250	<250	<200
Boron	mg (B)/l	0.65 ~ 0.69	<0.05(LQ) ~ 0.51	<0.5*	<1.0*	<1.0*
Total Coliform Bacteria Count	ufc/100ml	0	0			

Source: JICA Study Team

Table 2.5-6: Analysis of Beach Well Water (Praia and St. Cruz)

Sample Location / Sampling No.		Praia	St. Cruz
		SP 1-1 SP 1-2 1-1 1-2	ES 1-1 ES 1-2
Analysis Item		Range	Range
Item	Unit		
Temperature	°C	15.1 ~ 15.2	23.6 ~ 24.0
pH	-	7.7 ~ 7.8 at 20 °C	7.5 at 20 °C
Conductivity	µS (cm)	52,000 ~ 53,000 at 25 °C	44,000 ~ 45,000
TDS	mg/l	38,000	31,000
Turbidity	NTU	<0.3 (LQ)	<0.3(LQ) ~ 0.35
Total Hardness	mg($CaCO_3$)/l	1,100	1,200
Nitrate	mg(NO_3)/l	2.6 ~ 2.8	4 ~ 4.2
Nitrite	mg(NO_2)/l	<0.01 (LQ)	<0.01 (LQ)
Alkalinity	mg($CaCO_3$)/l	84 ~ 103	130
Chloride	mg (Cl^-)/l	20,000 ~ 21,000	17,000 ~ 19,000
Total Phosphate	mg (P)/l	<0.08	<0.08
Boron	mg /l	4 ~ 5	3
Total Coliform Bacteria Count	ufc/100ml	0	0 ~ 130
Oxygen	mg (O_2)/l	4 ~ 5	8 ~ 9
Organics	mg (C)/l	<2	<2

Source: JICA Study Team

Table 2.5-7: Analysis of Ground Water (Sao Miguel, St. Cruz, Assomada & Picos, Sao Lorenco, Tarrafal, Sao Domingos, Ribeira Grande and Praia)

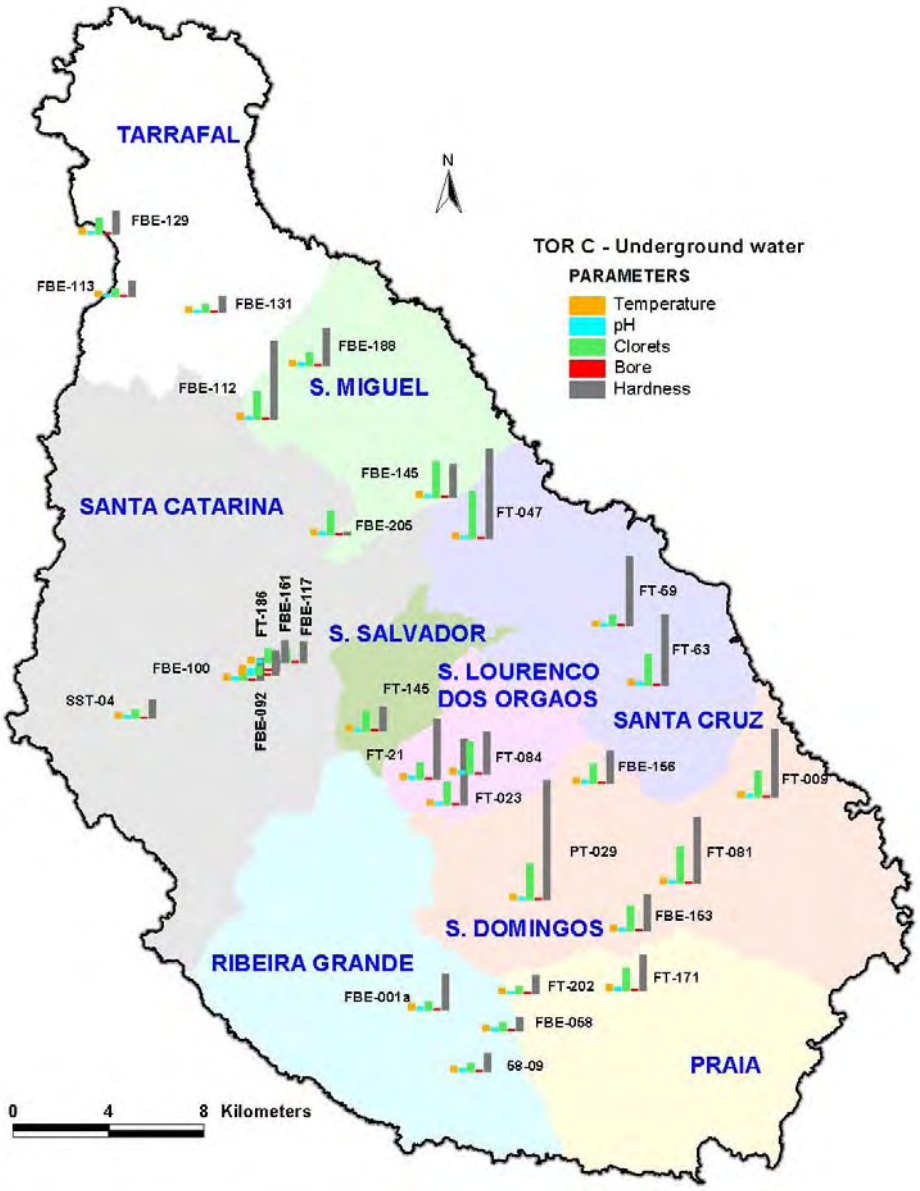
Sample Location / Sampling No. / Analysis Item		1)Sao Miguel	2) St. Cruz	3) Assomada and Picos	4) Sao Lourenco dos Orgaos	5) Tarrafal	6) Sao Domingos	7) Ribeira Grande de Santiago	8) Praia	Dringking Water Regulation		
		FBE-145 FBE-205 FBE-188 FBE-112	FBE-146 FT-09 FT-47 FT-59 FT-63	FT-186 FBE-116 FBE-161 FBE-100 FBE-117	FT-145 FT-21 FT-23 FT-80 FT-84	FBE-129 SST-04 FBE-131 FBE-113 FST-24	FBE-153 FBE-156 FT-81 PT-29 FT-208	58-09 58-01	FBE-58 FT-202 FBE-1A FT-171			
Item	Unit	Range	Range	Range	Range	Range	Range	Range	Range	WHO	EU	Japan
Temperature	℃	26.1~26.8	24.3 ~ 28.8	26.0 ~ 28.7	26.2 ~ 28.1	26.0 ~ 28.4	25.5 ~ 28.2	27.5 ~ 27.8	26.8 ~ 30.6			
pH	-	7.5 ~ 8.5 at 22 °C	7.2 ~ 7.8 at 20 °C	7.2 ~ 8.1 at 20 °C	7.4 ~ 7.7 at 22 °C	7.9 ~ 8.2 at 25 °C	7.0 ~ 8.0 at 23 °C	8.0 ~ 8.2 at 22 °C	8.2 ~ 8.4 at 24 °C	-	6.5~9.5	5.8~8.6
Turbidity	NTU	0.3(LQ) ~ 1.55	<0.3(LQ) ~ 0.62	<0.3 (LQ)	<0.3(LQ) ~ 0.68	<0.3(LQ) ~ 0.79	<0.3(LQ) ~ 0.72	<0.3 (LQ)	<0.3(LQ) ~ 0.41	1(Max 5)	-	<2 deg
Nitrate	mg(NO_3)/Ll	1.0(LQ) ~ 73.9	5.6 ~ 54.4	31.0 ~ 71.6	<1.0 ~ 54.4	12.4 ~ 16.6	<1(LQ) ~ 54	12.3 ~ 16.1	10.6 ~ 24.8	<50	<50	<10
Nitrite	mg(NO_2)/l	<0.01(LQ) ~ 0.02	<0.01 (LQ)	<0.01 (LQ)	<0.01(LQ) ~ 0.21	<0.01 (LQ)	<0.01 (LQ)	<0.01 (LQ)	<0.01 (LQ)	<3	<0.5	<0.05
Chloride	mg (Cl^-)/l	78 ~ 220	59 ~ 300	37 ~ 85	96 ~ 200	43 ~ 92	120 ~ 230	42 ~ 85	42 ~ 130	<250	<250	<200
Boron	mg (B)/l	0.05 ~ 0.14	0.06 ~ 0.13	0.05	<0.05 ~ 0.09	<0.05 ~ 0.06	0.07 ~ 0.12	<0.05(LQ)	<0.05(LQ) ~ 0.07	<0.5*	<1.0*	<1.0*
Fluorine	mg (F)/l	<0.5(LQ) ~ 2.2	<0.5(LQ) ~ 0.6	<0.5 (LQ)	<0.5 (LQ)	<0.5 (LQ)	<0.5 (LQ)	<0.5 (LQ)	<0.5 (LQ)	<1.5	<1.5	<0.8
Total Coliform Bacteria Count	ufc/100ml	0 ~ 130	0 ~ 610	92 ~ 3,400	0 ~ 576	0 ~ 3,600	0 ~ 16	38 ~ 1,200	31 ~ 36			
Standard Plate Count Bacteria	ufc/ml	0 ~ >300	0 ~ >300	0 ~ 36	0 ~ 28	0 ~ >300	0 ~ 40	83 ~ 89	0 ~ 82			
Fecal Coliform Bacteria Count	ufc/100ml	0	0 ~ 119	0 ~ 5,800	0 ~ 19	0 ~ 140	0 ~ 35.2	11 ~ 83	0 ~ 40			
Iron	µg (Fe)/l	<60 (LQ)	<60(LQ) ~ 130	<60 (LQ)	<60(LQ) ~ <93(LQ)	<60(LQ) ~ 100	60(LQ) ~ 1,900	<60 (LQ)	<60 (LQ)	<300	<300	<300
Total Hardness	mg($CaCO_3$)	11.7 ~ 497.7	189.7 ~ 575	98. ~ 148	149 ~ 418	96 ~ 138	200 ~ 770	111 ~ 136	84.1 ~ 217.1	-	-	<300
Arsenic	µg (As)/l	<1(LQ) ~ 12	<1 (LQ)	<1 (LQ)	<1 (LQ)	<1 (LQ)	<1 (LQ)	<1 (LQ)	<1 (LQ)	<10	<10	<10
Cadmium	µg (Cd)/l	<0.5 (LQ)	<0.5 (LQ)	<0.5 (LQ)	<0.5 (LQ)	<0.5 (LQ)	<0.5 (LQ)	<0.5 (LQ)	<0.5 (LQ)	<3	<5	<10
Mercury	µg (Hg)/l	<0.1 (LQ)	<0.1 (LQ)	<0.1 (LQ)	<0.1 (LQ)	<0.1 (LQ)	<0.1 (LQ)	<0.1 (LQ)	<0.1 (LQ)	<1	<1	<0.5
Cr+6	µg (Cr)/l	<2 (LQ)	<2 (LQ)	<2(LQ) ~ 4	<2 (LQ)	<2 (LQ)	<2(LQ) ~ 6	4	3 ~ 7	<50	<50	<50
Lead	µg (Pb)/l	<5 (LQ)	<5 (LQ)	<5 (LQ)	<5 (LQ)	<5 (LQ)	<5 (LQ)	<5 (LQ)	<5 (LQ)	<10	<10	<10
Manganese	µg (Mn)/l	<4(LQ) ~ 48	<4 (LQ)	<4 (LQ)	<4(LQ) ~ 80	<4 (LQ)	<4 (LQ)	<4 (LQ)	<4 (LQ)	<400	<50	<50

Source: JICA Study Team

Table 2.5-8: Analysis of Sea Water (Praia-Palmarejo, Tarrafal and Sao Miguel)

Sample Location / Sampling No. / Analysis Item		Palmarejo	Tarrafal	Sao Miguel
		PX 1-1 PX 1-2	PT 1-1 PT 1-2	PC 1-1 PC 1-2
		Range	Range	Range
Item	Unit			
Temperature	°C	24.6 ~ 25.1	26.3 ~ 26.4	26.7
pH	-	8.2 a 24 °C	8.2 a 21 °C	8.2 a 22 °C
Conductivity	µS (cm)	58,000 at 25 °C	54,000 at 25 °C	54,000 at 25 °C
TDS	mg/l	41,000 ~ 42,000	38,000	39,000 ~ 40,000
Turbidity	NTU	<0.3	0.96 ~ 1.06	1.77
Total Hardness	mg($CaCO_3$)/l	1,300 ~ 1,400	1,100	1,100
Nitrate	mg(NO_3)/l	<2 ~ 2.1	1.9	2.1
Nitrite	mg(NO_2)/l	<0.01	0.011 ~ <0.01(LQ)	0.011
Alkalinity	mg($CaCO_3$)/	128 ~ 129	120	122
Chloride	mg (Cl^-)/	23,000 ~ 25,000	21,000	20 x 103
Total Phosphate	mg (P)/	<0.08	<0.08	<0.08
Boron	mg /	5	5	5
Total Coliforms	ufc/100ml	0	0	0
Oxygen	mg (O_2)/	8	9	9
Calcio	mg/	517 ~ 519	444 ~ 454	446
Sulfate	mg(SO_4^{-2})/	3,200	2,700 ~ 2,800	27 x 102
Silica	mg/	1.7	<0.3 (LQ)	<0.3 (LQ)
Sodium	mg/	13,000	11,000 ~ 12,000	12,000

Source: JICA Study Team



Source: JICA Study Team

Figure 2.5-2: Bar chart for each groundwater site with the results concerning the parameters of temperature, pH, Chlorides, Boron and hardness

2.5.3 Water Treatment Facility

The water source is both well water and desalinated sea water. Well water is treated only by chlorination for sterilization. Sea Water Desalination facilities with Reverse Osmosis membrane technology (SWRO) are operated on the island as follows:

- 5,000 m^3/d x 1 train and 1,200 m^3/d x 2 trains in Praia
- 500 m^3/d x 1 train in Santa Cruz

(1) SWRO facilities in Praia (Refer to Figure 2.5-3)

These facilities were constructed using Spanish assistance.

- Production capacity : Nominal 5,000 m^3/d, Actual 4,660 m^3/day
- Location : Praia (4 km west from Praia city)
- Plant supplier : Pridesa, Spain
- Container type SWRO : 2 units of 1,200 m^3/d with 11 PV each, are equipped
- Additional 5,000 m^3/d unit will be delivered soon with Spanish funds.

  Plant has been commissioned since 2002 by ELECTRA.

  Operation and maintenance, etc., are also managed by ELECTRA.

- Major specifications

  - Intake : Beach well. 3 wells
  - Dual media filter : 2 units, space is already available for one additional unit
  - Cartridge filter : 2 units
  - High pressure pump with energy recovery : 3 units, Sulzer product, max 70 kg/cm^2
  - RO train : 2 trains, with 80 Pressure Vessels (71 Pressure Vessels in operation)
    Each PV contains 7 pieces of 8-inch element SW30HR-370, DOW product
  - Product water tank : 1,500 m^3 common with water from 1,200 m^3/d x 2 plant

- Operator

  - 2 operators/shift x (3+1) = 8, plus 2 substitutes for emergency cases, total 10 workers, plus manager, etc.
  - General affairs person : Co-work with power station
  - Maintenance : Coming from ELECTRA head office, when needed

- Operating Condition

  - 40.9% recovery (= Product 194 m^3/h/ Feed 474 m^3/h)
  - Feed salinity : 52,300 μS/cm, Product salinity: 1,030μS/cm
  - Feed pressure : 68.8 kg/cm^2, Differential pressure across PV: 1.99 kg/cm^2
  - Electricity : 800 kW for SWRO plant supplied from nearby power plant which has the capacity of 25 MW
  - Electric consumption : 4.27 kWh/m^3

    (note) Electric consumption of 1,200 m^3/d temporary desalination plants which are located at same plant site is 2.60 kWh/m^3 due to new type of energy recovery device.)

- Sea water temperature: Generally 19-22 deg C, depending on the season.

ELECTRA recognizes that the membrane was fouled and needed cleaning. Indeed, the cleaning is usually done 1-2 times a year and all of the membrane was to be replaced in June 2010. In fact, after being commissioned in 2002, 12% of the membranes were replaced each year. The corresponding cost was born by Spanish funding.

- For the output water quality, as no official drinking water standard is available in Cape Verde, the WHO guidelines are followed for drinking water quality, especially concerning Electric Conductivity and pH. As after-treatment, pH and hardness are monitored, which are adjusted at each production water reservoir. No sterilization is done at these reservoirs because chlorination affects the corrosion of transmission pipes. The sterilization is done at the reservoir near the city.

(2) SWRO plant in Santa Cruz (Refer to Figure 2.5-4)

This facility were constructed by the Government of Cape Verde.

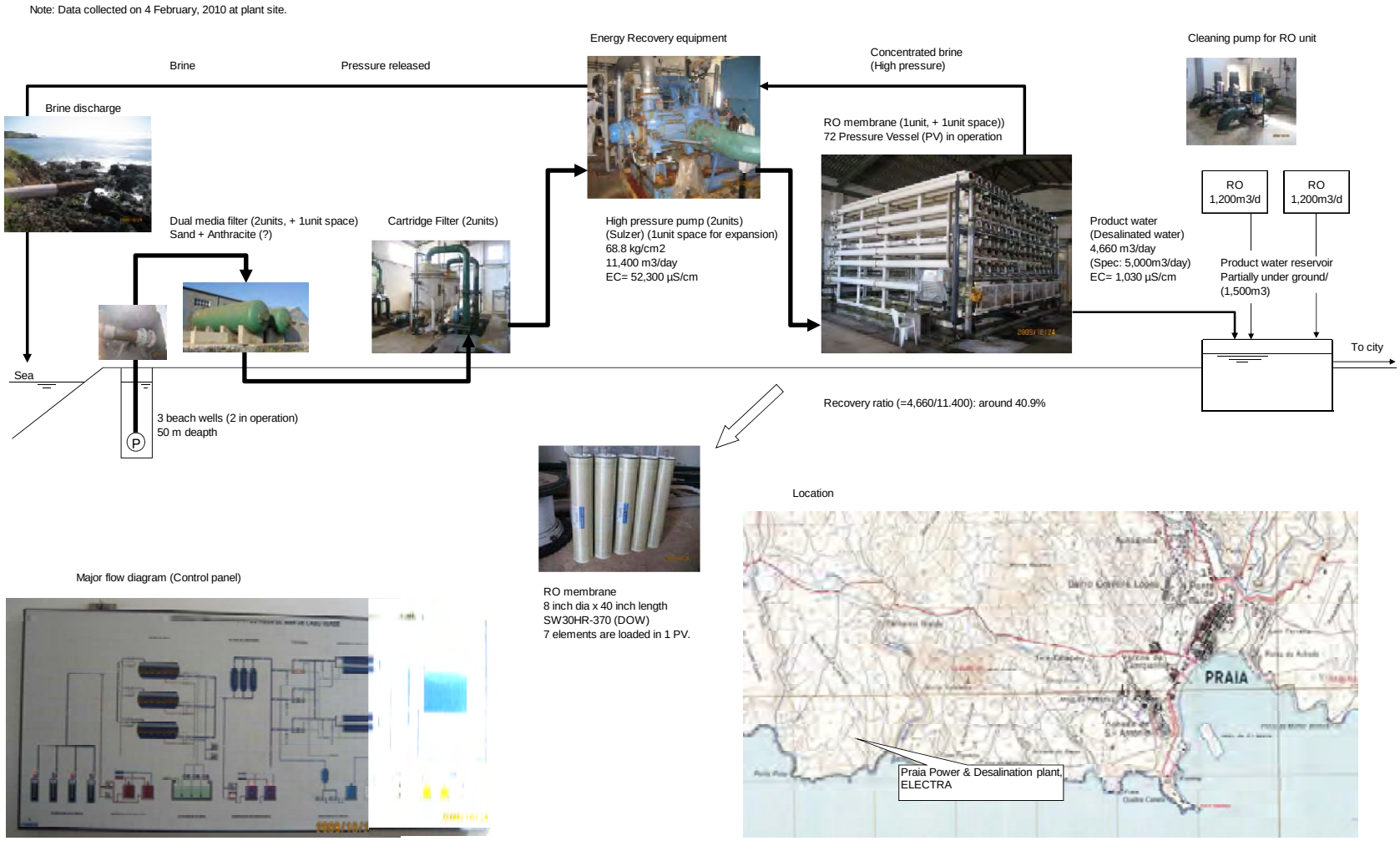
- Production capacity : 500 m^3/d
- Location : Achada Ponta (5 km South East from Pedra Badejo)

The site location was selected by the Ministry of Infrastructure.

The plant was planned and constructed by the government and was commissioned in May 2009. Operation and maintenance are managed by SAAS of Santa Cruz.

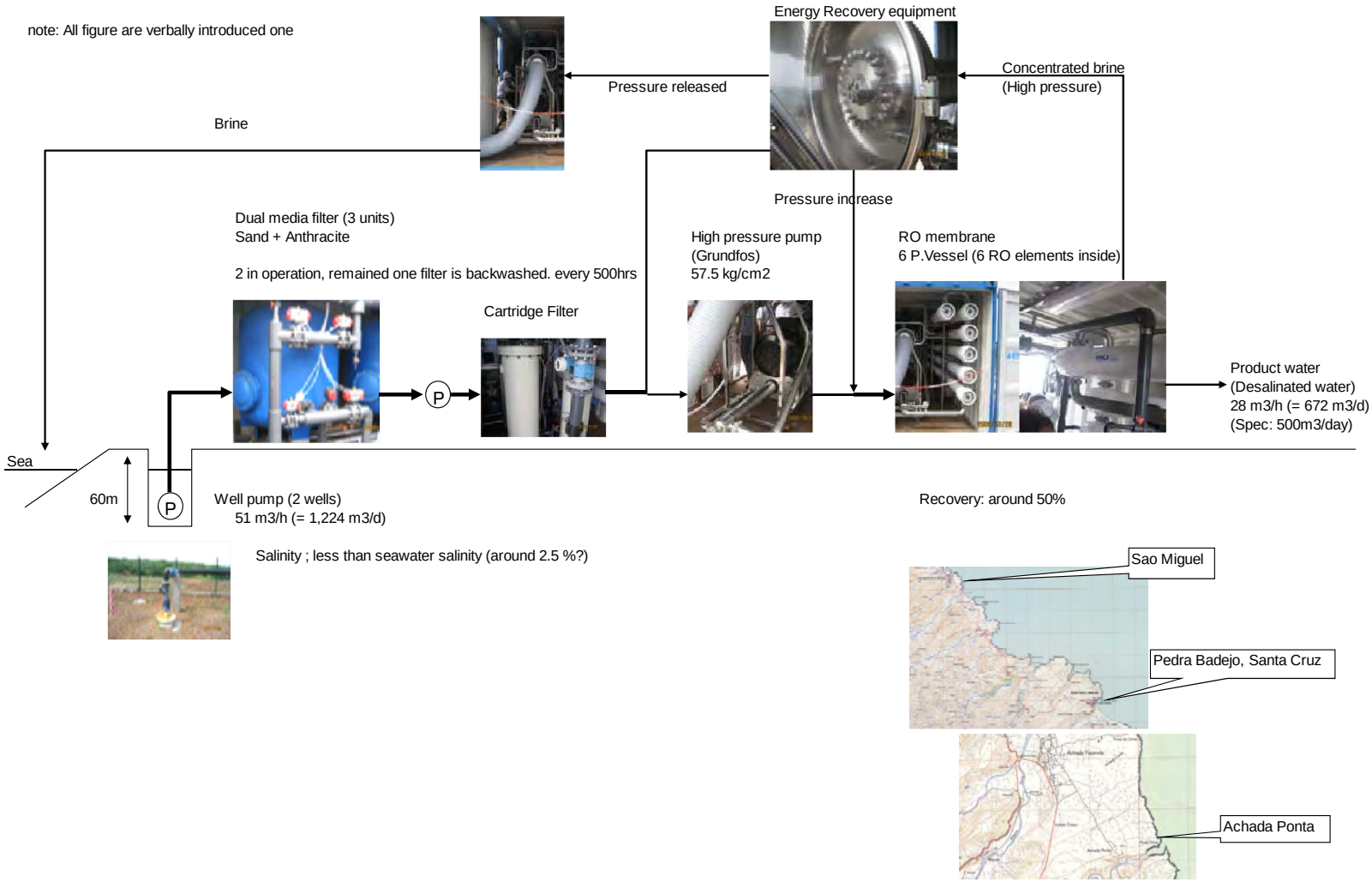
- Major specifications
  - Intake : Well pump (2 wells), each 51 m^3/h, 60 m depth
  - Dual media filter : 3 units (2 in operation and 1 in backwash)
  - Cartridge filter : 2 units
  - High pressure pump, with energy recovery: 1 unit, Grundfos product, 55 m^3/h x 575m x 83 kW with energy recovery equipment
  - RO train : 1 train, with 6 Pressure Vessels, each PV contains 6 pieces of 8-inch element, PROTEC product
  - Product water tank : small tank is installed
  - Diesel Engine Generator: 200 kW
  - Operator : 3 shifts (1 operator/shift, plus night work), total 6 operators
- Operating Condition

Electricity is not supplied from the grid to this plant site, though construction of the grid line is completed. It is equipped with a 200 kw diesel engine generator. 600 liters/day of diesel oil is consumed. The production cost is estimated to be around 185 CVE/m^3.



Source: JICA Study Team

Figure 2.5-3: Praia SWRO major process



Source: JICA Study Team

Figure 2.5-4: Chada SWRO major process