

1. 調査の目的と概要

2. 調査の方法と対象

3. 調査の結果

4. 考察と結論

社会開発調査部報告書

**DEMOCRATIC REPUBLIC OF MADAGASCAR
MINISTRY OF INDUSTRIES, ENERGY AND MINES**

**GROUNDWATER DEVELOPMENT STUDY
IN
SOUTH-WESTERN REGION
OF
THE DEMOCRATIC REPUBLIC OF MADAGASCAR**

**VOLUME 2
MAIN REPORT**

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JULY 1991

JAPAN INTERNATIONAL COOPERATION AGENCY

GROUNDWATER DEVELOPMENT STUDY
IN
SOUTH-WESTERN REGION
OF
THE DEMOCRATIC REPUBLIC OF MADAGASCAR

LIST OF REPORT

- VOLUME 1 SUMMARY REPORT
- VOLUME 2 MAIN REPORT
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- VOLUME 4 SUPPORTING REPORT (2) -- DATABASE MANUAL
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Preface

In response to a request from the Government of the Democratic Republic of Madagascar, the Government of Japan decided to conduct a Study on Groundwater Development in South-Western Region and entrusted the study to the Japan International Cooperation Agency(JICA).

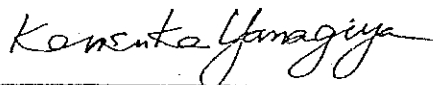
JICA sent to Madagascar a study team headed by Dr. Masaichi Nakayama, Kokusai Kogyo Co., Ltd., on four occasions between September 1989 and March 1991.

The team held discussions with the officials concerned of the Government of Madagascar, and conducted field surveys at the Study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

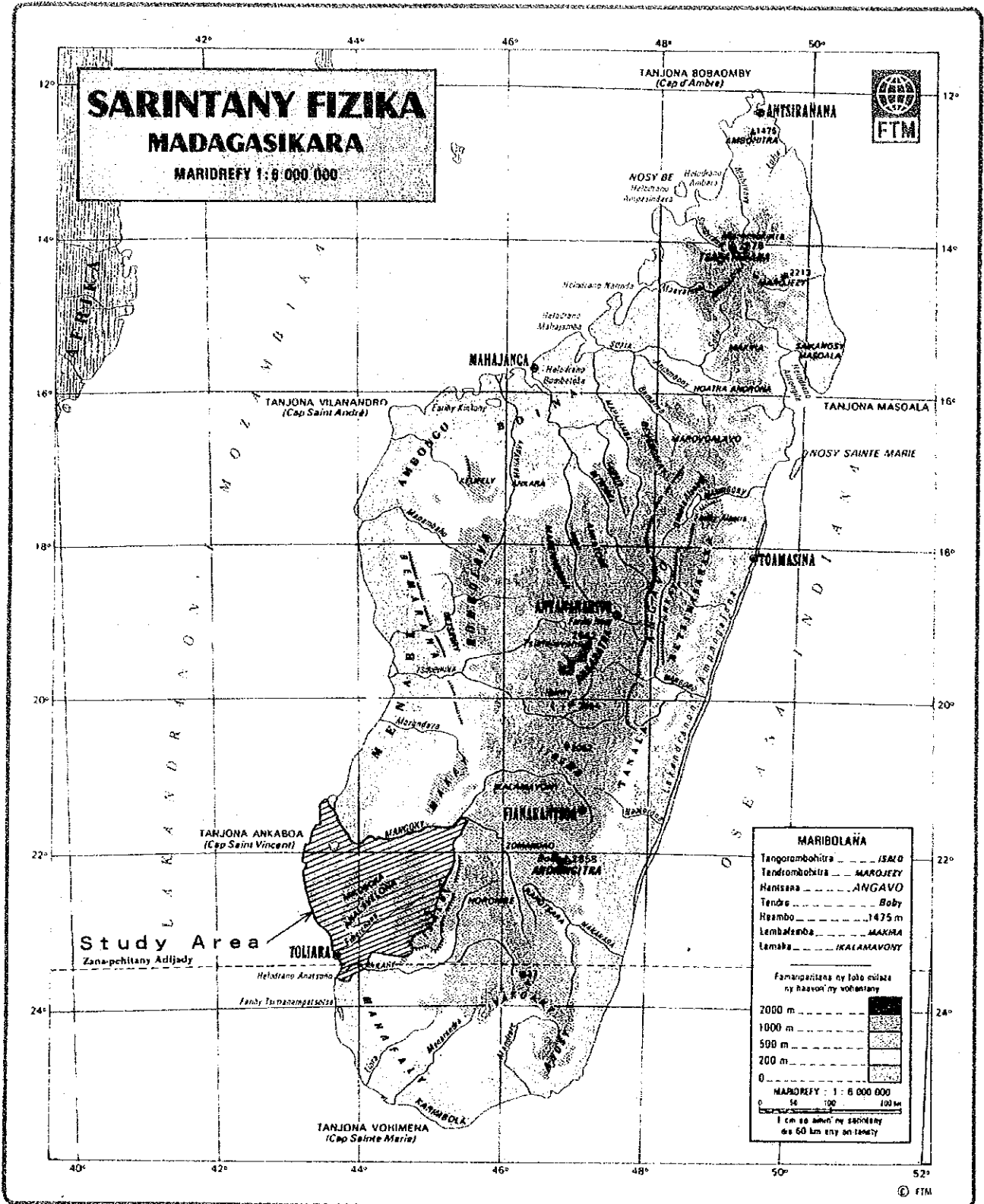
I wish to express my sincere appreciation to the officials concerned of the Government of Democratic Republic of Madagascar for their close cooperation extended to the team.

July, 1991

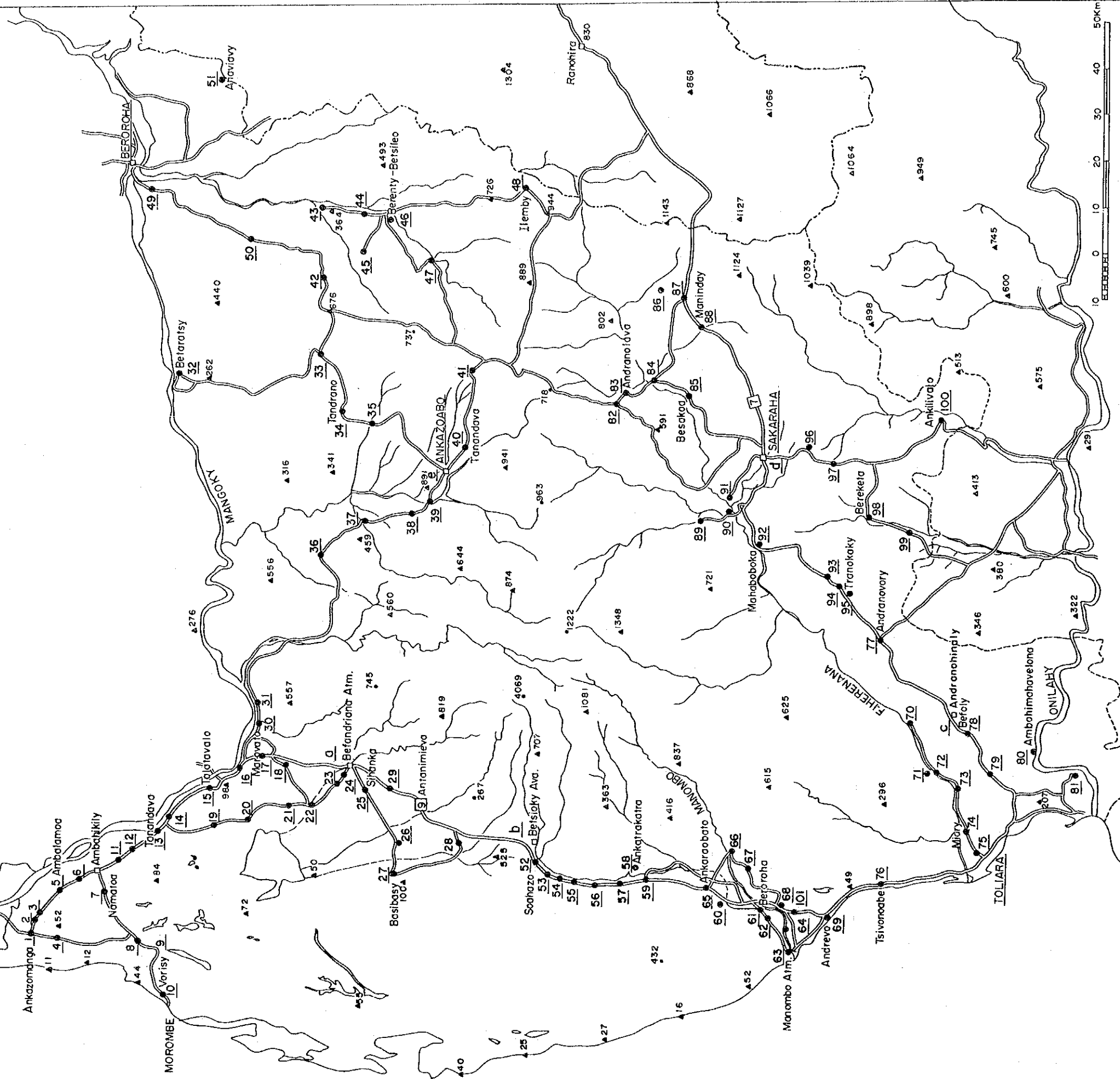


Kensuke Yanagiya
President
Japan International Cooperation Agency

LOCATION MAP OF STUDY AREA



Location Map of Candidate Villages



- No Villages
- 1 Ankazomanga
 - 2 Besadabo
 - 3 Befasy
 - 4 Ankilifolo(1)
 - 5 Ambalamoa
 - 6 Tsianihy
 - 7 Namafoa
 - 8 Mangolovolo
 - 9 Ankida
 - 10 Vorisy
 - 11 Andranomanintsy
 - 12 Berantala
 - 13 Tanandava
 - 14 Antsakoabe

- 15 Talatavalo
- 16 Ambiky
- 17 Marovato
- 18 Andranoboka
- 19 Satrambondro
- 20 Mahavozokely
- 21 Antranosatra
- 22 Manoy
- 23 Ampoza
- 24 Ankilifolo(2)
- 25 Sihanaka
- 26 Bemoka
- 27 Basibasy
- 28 Aniatelo
- 29 Mangotroka
- 30 Nosy-Ambositra
- 31 Tsiarimploke

- 32 Betaratsy
- 33 Andranomanintsy
- 34 Tandrano
- 35 Ampandranitsetaky
- 36 Andranomafana
- 37 Manakiala
- 38 Berenty-Ankilimasy
- 39 Betsinefo
- 40 Tanandava
- 41 Ampoza
- 42 Ipetsa Atm
- 43 Mandabe Atm
- 44 Soatanimbary
- 45 Sahanory Atm
- 46 Berenty-Betsileo
- 47 Ankilivaokely

- 48 Ilemby
- III. Fiv. BEROROKA
- 49 Tanandava-Antaifasy
- 50 Anjamitikitra
- 51 Anaviavy
- IV. Fiv. TOLJARA I / II
- 52 Soahazo
- 53 Analamisampy
- 54 Belitsaka
- 55 Ampasikibo
- 56 Namaboha
- 57 Antseva
- 58 Ankilivaotoka
- 59 Ampihany

- 60 Ambondro
- 61 Beroroka
- 62 Antsomarifidy
- 63 Manombo-Atm
- 64 Antandroka
- 65 Ankarabato
- 66 Andoharano
- 67 Tsefanoka
- 68 Betetsy
- 69 Andrevo
- 70 Anjanala
- 71 Ampihailia
- 72 Behompy
- 73 Ambolonkira
- 74 Miary
- 75 Befanamy
- 76 Tsvionoabe
- 77 Andranovory

- 78 Befoly
- 79 Ankororoka
- 80 Ambohimahavelona
- 81 Manoroka
- 101 Ankilimalinika
- V. Fiv. SAKARAHIA
- 82 laborana
- 83 Andranolava
- 84 Lambokandro
- 85 Besakoa(1)
- 86 Besakoa(2)
- 87 Ampandra
- 88 Maninday
- 89 Bevoalavo
- 90 Tanambo
- 91 Ambahimaittsy

- 92 Mahaboboka
 - 93 Mahasoa
 - 94 Andamasiny-Vineta
 - 95 Tranokaky
 - 96 Analatary
 - 97 Antanimora
 - 98 Bereketa
 - 99 Ankilimitraoka
 - 100 Ankilivaio
- a Befandriana
b Betsioky Nord
c Andranohinainy
d Sakaraha
e Ankazoabo

LISTE D'ABREVIATIONS

<i>AEP</i>	Alimentation en Eau Potable
<i>AEPA</i>	Alimentation en Eau Potable et Assainissement
<i>BAD</i>	Banque Africaine de Développement
<i>CNEA</i>	Comité National de l'Eau et de l'Assainissement
<i>DGBDE</i>	Direction Générale de la Banque de Données de l'Etat
<i>FED</i>	Fonds Européen de Développement
<i>FISE</i>	Fonds International de Secours à l'Enfance
<i>FNDE</i>	Fonds National de Développement Economique
<i>FJKM</i>	Fiangonan'i Jesosy Kristy eto Madagasikara
<i>FLM</i>	Fiangonana Loterana eto Madagasikara
<i>GREA-AE</i>	Groupe Régional de l'Eau et l'Assainissement - Afrique de l'Est et Australe
<i>JIRAMA</i>	Jiro sy Rano Malagasy
<i>MEP</i>	Ministère de l'Economie et du Plan
<i>MI</i>	Ministère de l'Intérieur
<i>MIEM</i>	Ministère de l'Industrie, de l'Energie et des Mines
<i>MPARA</i>	Ministère de la Production Agricole et de la Réforme Agricole
<i>MPCSJS</i>	Ministère de la Population, de la Condition Sociale, de la Jeunesse et des Sports
<i>MRSTD</i>	Ministère de la Recherche Scientifique et Technologique pour le Développement
<i>MSP</i>	Ministère de la Santé Publique
<i>MTMT</i>	Ministère des Transports, de la Météorologie Nationale et du Tourisme
<i>OAA</i>	Organisation pour l'Alimentation et l'Agriculture
<i>OAES</i>	Opération de l'Alimentation en Eau dans le Sud
<i>OMS</i>	Organisation Mondiale de la Santé
<i>ORSTOM</i>	Office de la Recherche Scientifique et Technique d'Outre-Mer
<i>PNUD</i>	Programme des Nations Unies pour le Développement

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1. INTRODUCTION

1. INTRODUCTION

1.1 General

This Draft Final Report was prepared in accordance with the stipulations contained in the Scope of Work as agreed upon between the Ministry of Industries, Energy & Mines (MIEM) and the Japan International Cooperation Agency (JICA) for the conduct of the "Groundwater Development Study in Southwestern Region of the Democratic Republic of Madagascar".

The Study Area is located in Toliara Province (about 160,000 km²), and the candidate villages are shown in the attached location map. A total of 106 villages were selected between the Mangoky and Onilahy rivers in the southwestern region of the country, as proposed by the Government of Madagascar.

1.2 Outline of the Study

1.2.1 Background of the Project

The Madagascar Government, in its continued commitment to ensure the economic well-being of its people, has formulated and implemented the Third Five-Year National Development Plan covering the period 1986-1990. The objectives of the Plan are the achievement of self-sufficiency in food supply, the promotion of exports, and the increase in agricultural productivity, leading to an improved standard of living.

Being an agricultural country where 80% of the population is rural, the Plan focuses attention upon these rural farming communities to effect a more balanced and sustainable economic growth.

A major thrust of the country's development efforts is the provision of potable water to the population by the year 2000. Toward this end, the Government has created a public corporation, the Jiro and Rano Malagasy (JIRAMA), as the agency responsible for the development, implementation and management of urban potable water systems and electrification projects. On the other hand, drinking water supply in

rural areas is under the jurisdiction of MIEM.

While notable progress has been made with regards to the water sector, much work has yet to be done. At present, only 18% of the total population has access to potable water supply. Of this, almost 91% are in urban areas. In rural areas, therefore, water-borne and water-related diseases continue to take their toll upon the residents, particularly among the younger generation, hindering agricultural productivity and causing problems in the development of this sector.

A number of bilateral and multilateral aid agencies have provided assistance to the Madagascar Government in installing potable water supply systems in rural areas. Still, a large number of rural communities remain unserved, particularly the communities located between Onilahy River and Morondava City where the need for potable water is most acute, and thus given priority consideration.

Accordingly, the Government of Madagascar formulated a project idea designed to develop groundwater as a source of domestic water supply and to construct simple water supply systems for villages located between Onilahy River and Morondava City, targeting communities with a population between 500 and 3,000 people. The project would be implemented by the Department of Energy and Water of MIEM, depending on the results of a detailed study.

In August 1988, therefore, the Madagascar Government requested the assistance of the Japanese Government to carry out a study with the purpose of assessing the development potential of groundwater resources and preparing a groundwater development plan in the southwestern region of the country, specifically the region between Onilahy River and Morondava City.

On this basis, the Japanese Government through its development assistance arm, the Japan International Cooperation Agency, sent a preliminary study team in May 1989 to Madagascar and this mission drew up the Scope of Work for the execution of this Study.

1.2.2 Objectives of the Study

The objectives of the Study are to evaluate the groundwater potential in the Study Area, to formulate a groundwater development plan for priority areas, and to implement technology transfer to counterpart engineers in the course of the Study.

1.2.3 Study Team

The Study is practically implemented by a joint study team composed of JICA Study Team members and MIEM personnel. JICA has organized a study team consisting of a team leader and 16 professionals and experts. The team leader, Dr. Masaichi Nakayama, is responsible for maintaining close liaison between JICA and the Government of Madagascar and other agencies concerned in this Study. As a groundwater development specialist, he is also responsible for formulating the development plan and for monitoring and managing the progress of the Study. For the smooth conduct of the Study and effective transfer of technology, MIEM provided the JICA Study Team with a team of counterparts from its personnel. The JICA Study Team members and MIEM counterparts are listed below.

JICA Study Team

Name	Specialization/Designation
1. NAKAYAMA Masaichi	: Team Leader
2. KANDA Atsuo	: Co-Team Leader/Hydrogeologist
3. SUGIYAMA Akira	: Hydrogeologist
4. OMORI Shoichi	: Geologist/Remote Sensing Expert
5. SETOJIMA Masahiro	: Remote Sensing Expert
6. YAMAGUCHI Masahiro	: Hydrologist/Computer modeling Expert
7. MEDINA Reynaldo Real	: Hydrologist
8. HIROZU Takayoshi	: Water Quality Expert
9. TANAKA Masatoshi	: Geophysicist/Survey Expert
10. KAJIWARA Susumu	: Geophysicist
11. TANABE Yoshitaka	: Drilling Supervisor/Geologist
12. NOMURA Shinji	: Drilling Supervisor/Geologist
13. FUJIWARA Kunio	: Pilot Facilities/Rehabilitaion Expert
14. NARITA Hiroatsu	: Water Supply Planner
15. ARAKAWA Shuji	: Water Supply Facility Expert
16. OBARA Masaru	: Project Economist
17. AOKI Hirochika	: Translator/Interpreter

MIEM Counterparts

Name	Specialization/Designation
1. RANDRIANARISOA NHELSON	: Team Leader
2. RANDRIANARISON Justin	: Vice Team Leader
3. MELY CHRISTINE	: Vice Team Leader
4. RAJOELISAONINA Alfred	: Geophysical Prospecting
5. RABEMANANTSOA Boniface	: Water Quality Analysis
6. RAKOTONARIVO Solonirina	: Remote Sensing and Geology
7. TOGNIHAGNITSE (HANGY)	: Water Supply Engineering and Socio-economics
8. RAZAFINDRABETSIAVALONA Ndriana:	Hydrology
9. RABENANDRASANA Emmanuel	: Hydrology and Database
10. RALAIARIVONY Solofo Joel	: Water Quality Analysis
11. RAKOTOMAVO Marcel	: Chief Driller
12. RANDRIANANTOANDROHARISOANARIVO:	Water Quality Analysis
13. RASOLOMAMONJISOA Nathanael	: Mechanic
14. RAKOTOVAO Bernard	: Assistant Chief Driller
15. RANDRIANARISOA Solo Christophe:	Hydrology, Chief Driller
16. RANDRIAMANALINA Jacques	: Chief Driller
17. RAKOTOFIRINGA Justin	: Electrician
18. RANAIVOSON Albert	: Geophysical Prospecting
19. RAMANATOANINA Gilbert	: Water Supply Engineering
20. RAZAFINDRABE Pierre	: Rehabilitation Survey
21. RAKOTOMALALA	: Rehabilitation Survey
22. RAMILIJONA Albert	: Rehabilitation Survey
23. BOTO Francois	: Geophysical Prospecting
24. RAKOTONDRAMANGA Jean Honore	: Mechanic

25.	RANDRIANARISOA Patrice	:	Geophysical Prospecting
26.	RAKOTO ANDRIANALY Jules	:	Water Supply Engineering
27.	RANDRIAMANANJARA H. Joseph	:	Administrator
28.	RAZAFINDRATSIRA WILLIAM	:	Driller
29.	RANDRIAMORASATA Jean de Dieu	:	Assistant Driller
30.	RAMAROLAHY Jean Chrisostome	:	Assistant Driller
31.	RAKOTONANDRASANA Jerome	:	Assistant Driller
32.	RAMILISON Martin	:	Assistant Driller
33.	RANDRIANABININA Louis	:	Assistant Driller
34.	RAKOTONIRINA Victor	:	Assistant Driller
35.	RAFARALAHISOA Honore	:	Rig Driver
36.	RAKOTOARISOA Robelle	:	Assistant Driller
37.	RAVELONARIVO Jhonson	:	Assistant Driller
38.	RANDRIAMARO	:	Assistant Driller
39.	RANAIVO Alfred	:	Assistant Driller
40.	RAKOTOMARIA	:	Driller
41.	RAMANANTSARA Olivier	:	Assistant Driller
42.	RAKOTONIRINA Etienne Bruno	:	Assistant Driller
43.	RAKOTOARISOA	:	Assistant Driller
44.	MARAVELO	:	Assistant Driller
45.	RAMARO ANDRIAMBOLOLONA	:	Assistant Driller
46.	RAKOTOZAFY Jean Baptiste	:	Assistant Driller
47.	RANDRIAMARO Samuel	:	Assistant Driller
48.	RAKOTOMAVO Paul	:	Driller
49.	RANDRIAMANEVA Edmond	:	Assistant Driller
50.	RAKOTOZAFY III	:	Assistant Driller
51.	RASOLONJATOVO Ignace Victor	:	Assistant Driller
52.	RAZANAKOLONA Rolland	:	Assistant Driller
53.	RALIJAONA Joseph	:	Assistant Driller
54.	RAZAFINDRANAIVO Eursele	:	Assistant Driller
55.	RAKOTONDRANAIVO Florent	:	Assistant Driller
56.	RAZAKARIMANANA Serge	:	Assistant Driller
57.	RAMANGASON Jose	:	Assistant Driller
58.	ANDRIAMANGA Rakotondrazafy	:	Water Supply Engineering and Administrator

1.3 Study Area

1.3.1 Location

The Study Area is situated in the southwestern region of Madagascar. It is bounded in the north by the Mangoky River, in the south by the Onilahy River, in the east by the Tangorombohitr Isalo Mountains and in the west by the Mozambique Strait. Elevations range from 0 to 1300m above sea level. It has a coastal region and an elevated area known as the Madagascar High Plateau. Besides Mangoky and Onilahy Rivers, the Study Area is traversed from east to west by the Fiherenana River and by the Manombo River in its coastal region.

1.3.2 Climate

The Study Area has a warm and dry tropical semi-arid climate. The annual rainfall varies from 350mm in the coastal area to 900mm in the mountainous area. Wet and dry seasons are very pronounced, that is, about 95% of the annual rain fall is concentrated in the four-month rainy season from December to March. The mean maximum temperature is about 35°C, highest in October and November, and the mean minimum temperature is about 10°C in June and July. Evapotranspirations vary from the coastal area to the inland area: from 1200 to 1700mm for potential evapotranspiration and from 400 to 900mm for real evapotranspiration.

The low annual rainfall in the region leaves rivers with a scant flow, if any, during the dry season, thereby causing this region to have the poorest surface water resources in the country.

1.3.3 Geology

The general geology in the Study Area is characterized by two types of areas:

- the coastal sedimentary basin area, i.e., the Morondava Sedimentary Basin
- the elevated and altered Precambrian Complex area known as the Madagascar High Plateau

The Morondava Sedimentary Basin covers the whole Study Area and consists of consolidated and semi-consolidated Jurassic, Cretaceous to Quaternary period deposits.

The principal aquifers in the Morondava Sedimentary Basin are found within the unconsolidated Quaternary deposits, the limestone and marly limestone of the Jurassic to Eocene period deposits, and the sandstone in the Isalo formations.

The geological map of the Study Area is shown in Fig. 1.3.1.

1.3.4 Population

In the Study Area, the population density is 5.4 persons per square kilometer on the average. More than 95% live in villages of 100 to 3000 inhabitants and subsist principally by raising cattle and goats and by cultivating rice, corn and cash crops like cotton and sugar cane.

Because of lack of water, village people in some areas had to abandon fertile lands and move to other villages or rural centers with readily available but often polluted water. This was the case in areas like Sakaraha, Ankazoa-bo and the Befandriana plain. Also, livestock is affected from water-borne parasitic and bacterial maladies because of inadequate watering places.

1.4 Study Description

1.4.1 Study Components and Sequence

The Study components described in the Scope of Work agreed upon between MIEM and JICA is presented below.

"The Study comprises following three (3) phases:

Phase I : Preliminary Analysis and Field Reconnaissance

The Study in this Phase I shall comprise a review and analysis of existing studies and data, and analysis of satellite image and aerial photos as well as conduct of the first field survey for the study area.

The results of survey and analysis mentioned above shall lead up to a revised hydrogeological map and to identified potential areas for the groundwater development.

Phase II : Analysis and Evaluation on Groundwater Resource

This Phase shall comprise conduct of the second field survey including geological survey, groundwater leveling, water quality analysis, geophysical survey, test drilling and pumping test, for the evaluation of groundwater resource potential and selection of priority areas for rural water supply development.

Phase III : Formulation of Rural Water Supply Development

This Phase shall comprise project formulation of rural water supply in the priority areas from the socioeconomic, technical and institutional aspects."

In addition to the above mentioned components, the Study activities included preparation of Inception Report, Progress Report (1), Interim Report, Progress Report (2), Draft Final Report, and Final Report.

The flowchart shown in Fig. 1.4.1 was prepared to fulfill the requirements of the above described Scope of Work.

1.4.2 Technical Survey Methods

The following technical methods were used in this Study.

(a) Preliminary Hydrogeological Investigation

- LANDSAT and SPOT image data analysis
- Aerial photograph interpretation
- Field geological reconnaissance survey (on faults and lineament, geological boundary and weathering condition)
- Geophysical Prospecting (electrical resistivity sounding and VLF-magneto-telluric method)

(b) Detailed Hydrogeological Investigation

- Detailed hydrogeological field reconnaissance in areas with a high potential for groundwater development using results of aerial photo interpretation
- Detailed geophysical prospecting at candidate sites to determine location and depth of test wells
- Test well drilling and pumping tests to determine hydraulic parameters of aquifer

(c) Hydrological Investigation

- Rainfall and discharge measurements
- Simultaneous groundwater leveling in the wet and dry seasons
- Continuous groundwater level observations
- Water balance analysis

(d) Preparation of Database System

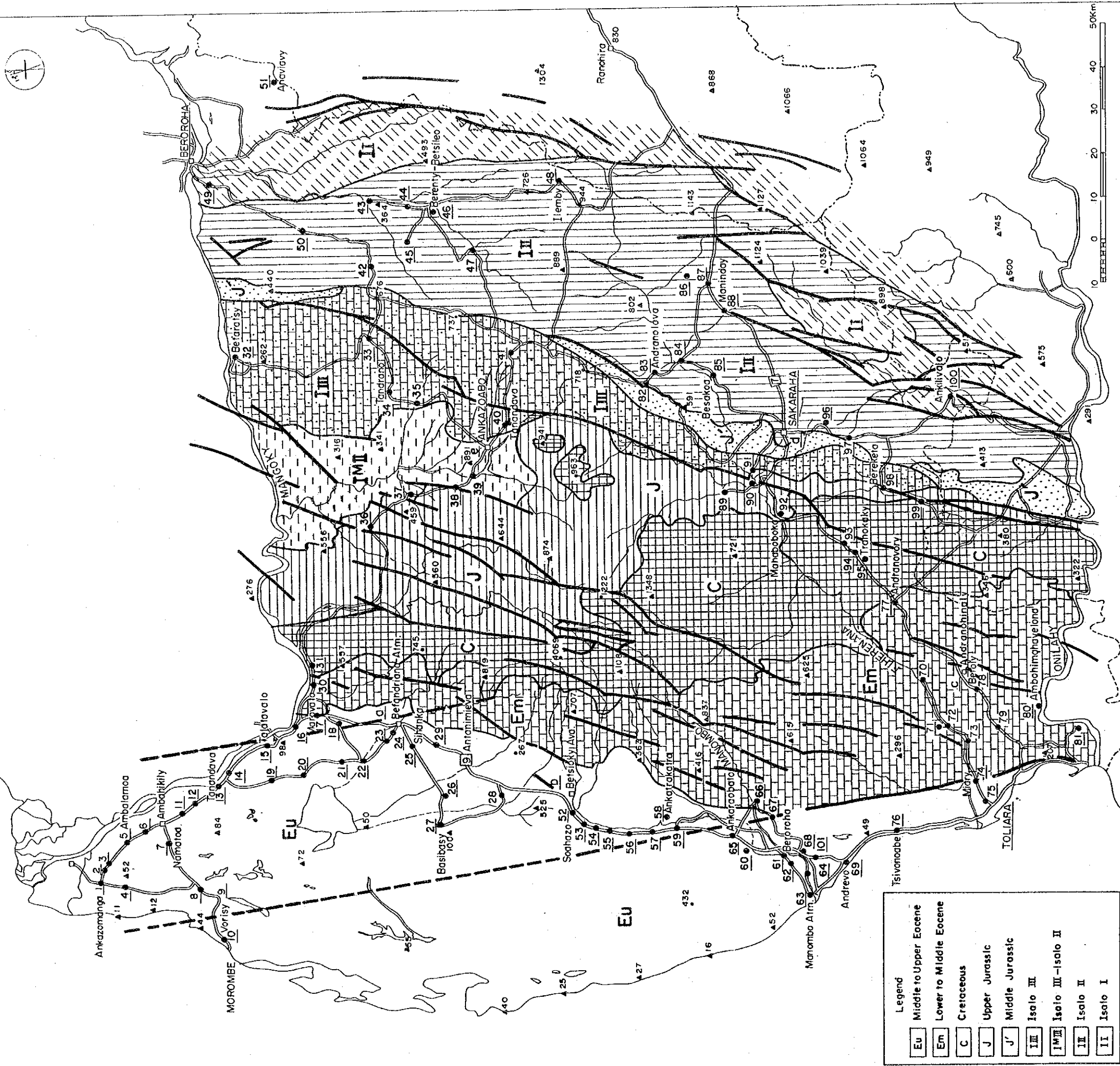
- Collection and arrangement of existing groundwater data
- Design and coding of a database program and processing of data

(e) Computer Simulation of Groundwater Flow and Formulation of the Groundwater Development Plan

1.4.3 Study Schedule

The Study was conducted in three phases of field work, preceded by preparatory work and followed by analytical work in Japan. Phase I activities were performed between August 1989 and March 1990, while Phase II and Phase III activities took place between May 1990 and March 1991. Fig. 1.4.2 presents the general work schedule covering the entire study period.

Fig. 1.3.1 Geological Map of the Study Area



Legend	
Eu	Middle to Upper Eocene
Em	Lower to Middle Eocene
C	Cretaceous
J	Upper Jurassic
J'	Middle Jurassic
III	Isalo III
III	Isalo III-isalo II
II	Isalo II
II	Isalo I

No Villages	II. Fiv. ANKAZOABO ATM	48 Ilemby	60 Ambondro	78 Befoly	92 Mahaboboka
15 Talatavalo	32 Betaratsy	III. Fiv. BEROROHA	61 Beroroha	79 Ankorofoka	93 Mahasa
16 Ambiky	33 Andranomanintsy		62 Anisomarify	80 Ambohimanavelona	94 Andamasiny-Vineta
17 Marovato	34 Tandrano		63 Manombo-Atm	81 Manoroka	95 Iranokaky
18 Andranoboka	35 Ampandramitsetaky	49 Tandava-Antaifasy	64 Antandroka	101 Ankilimalinika	96 Analamary
19 Sattrambondro	36 Andranomafana	50 Anjamitikitra	65 Antakaobato		97 Antanimora
20 Mahavozokely	37 Manakiala	51 Anaviavy	66 Andoharano	V. Fiv. SAKARAHA	98 Bereketa
21 Antranosatra	38 Berenty-Ankilimasy		67 Tsefanoka		99 Ankilimitraloka
22 Manoy	39 Betsinefo	IV. Fiv. TOLJARA I/II	68 Benetsy		100 Ankilivalo
23 Ampoza	40 Tanandava		69 Andrevo	82 Laborana	
24 Ankilifofo(1)	41 Ampoza		70 Anjamaia	83 Lambomakandro	
25 Sihanaka	42 Ipetsa Atm		71 Ampihalia	84 Besakoa(1)	
26 Bemoka	43 Mandabe Atm		72 Behomy	85 Besakoa(2)	
27 Basibasy	44 Soatanimbary		73 Ambolonkira	87 Ampandra	
28 Analatelo	45 Sahanorany Atm		74 miary	88 Maninday	
29 Mangotroka	46 Berenty-Betsileo		75 Befanamy	89 Bevoalavo	
30 Nosy-Ambositra	47 Ankilivalokely		76 Tsvonoabe	90 Tanambao	
31 Tsiarimpioke			77 Andranovory	91 Ambahimalitsy	

I. Fiv. MOROMBE	92 Mahaboboka
1 Ankazomanga	93 Mahasa
2 Beadabo	94 Andamasiny-Vineta
3 Befasy	95 Iranokaky
4 Ankilifofo(1)	96 Analamary
5 Ambalamoa	97 Antanimora
6 Tsiainihy	98 Bereketa
7 Nanatoka	99 Ankilimitraloka
8 Mangolovofo	100 Ankilivalo
9 Ankida	
10 Vorisy	a Befandriana
11 Andranomanintsy	b Betsioky Nord
12 Berantala	c Andranohinaly
13 Tanandava	d Sakaraha
14 Antsakoabe	e Ankazoabo

Fig. 1.4.1 Flowchart of the Study

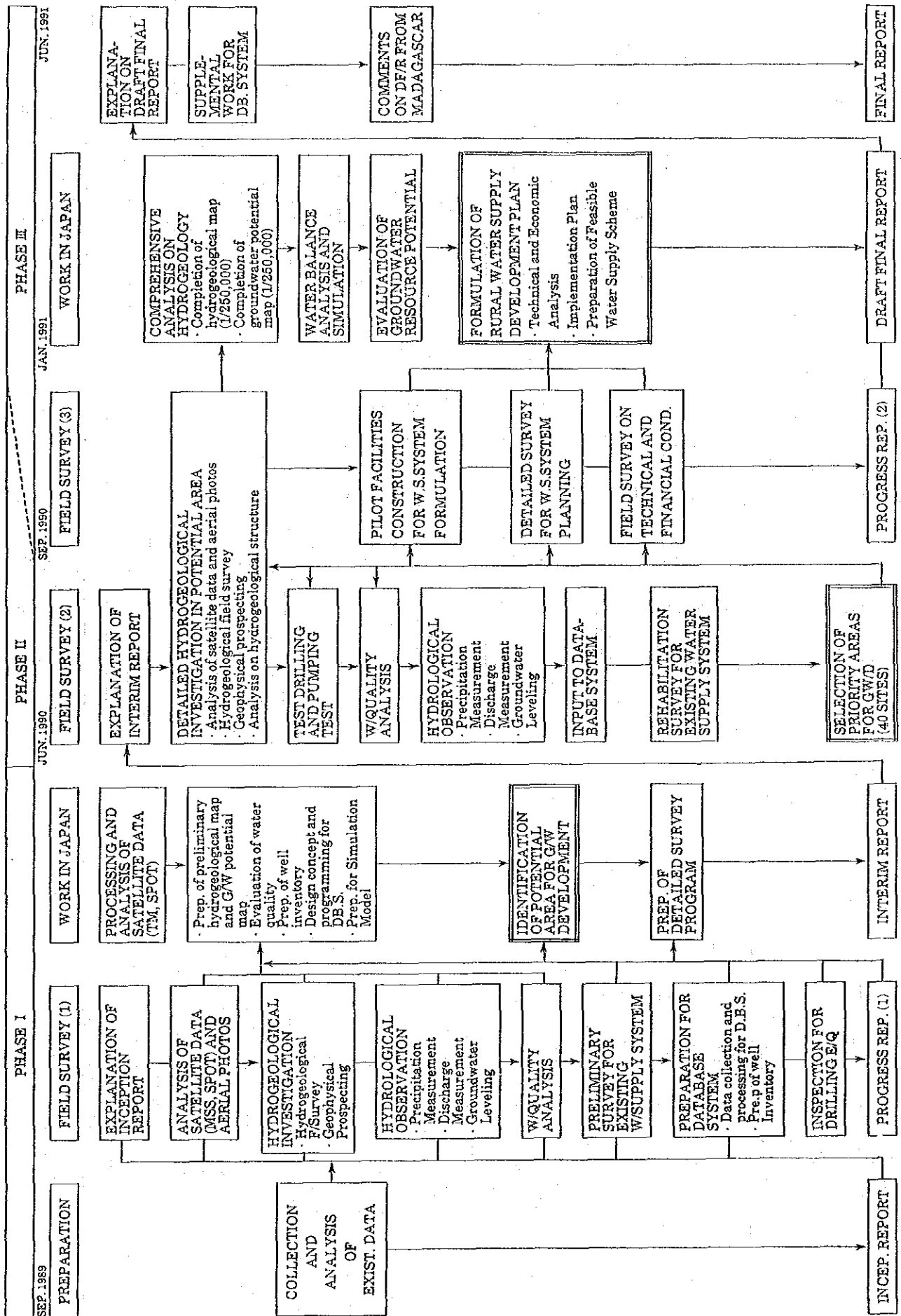


Fig. 1.4.2 Work Schedule

Work Item	Month No.	1989												1990												1991					
		Year												Year												Year					
		Season												Season												Season					
		Month												Month												Month					
Phase I Field Survey	Preparatory work in Japan (Preparation of ICR)																														
	Explanation of ICR, Data collection																														
	Interpretation/analysis of satellite/aerial photos																														
	Hydrogeological field reconnaissance																														
	Geophysical prospecting (VES/VLF-MT)																														
	Preparation for DB/System and WB/analysis																														
	Hydrological observation, WQ/analysis																														
	Preliminary survey for existing WS/system																														
	Preparation/explanation of P/R-1																														
	Processing/analysis of satellite data (TM/SPOT)																														
	Analysis/arrangement of survey results, Prep. of ITR																														
Phase II Field Survey	Explanation of ITR, Suppl. data collection																														
	Detailed hydrogeological reconnaissance																														
	Detailed geophysical prospecting																														
	Hydrological observation, WQ/analysis																														
	Test drilling and pumping test																														
	Rehabilitation survey for existing WS/system																														
	Preparation/Input to Database System																														
	Selection of priority areas for GW/develop.																														
	Detailed/Supplemental survey of priority areas for GW/D																														
	Pilot facilities construction for WS/system formulation																														
	Phase III Field Survey	Detailed survey for WS/planning																													
Field survey on technical/financial conditions																															
Preparation/explanation of P/R-2																															
Explanation on DE/R and database system																															
Comprehensive anal./arrang on survey results																															
WB/analysis and evaluation of GWR/potential																															
Completion of hydrogeological map																															
Formulation of rural WS/development plan																															
Preparation of Draft Final Report (DF/R)																															
Preparation of Final Report																															
Reporting Schedule																															
Inception Report (IC/R) Progress Report (P/R-1) Interim Report (IT/R) Progress Report (P/R-2) Draft Final Report (DF/R) Final Report (F/R)																															

2. SOCIOECONOMIC AND SECTORAL BACKGROUND

2. SOCIOECONOMIC AND SECTORAL BACKGROUND

2.1 Madagascar

2.1.1 General

Madagascar, an island country, is located off the coast of southeastern Africa, between 11° and 25° latitude south, and between 43° and 50° longitude east. The island is surrounded by the Indian Ocean in the east and the Mozambique Channel in the west.

The country covers 592,000 km² and, the island being 1,500 km long and 600 km wide, presents a great variety of climatic characteristics:

northeast: markedly dry
east coast: subequatorial, mean temperature 21°C-27°C,
rainfall 3,000 mm a year
west: tropical, a pronounced dry season, mean temperature 24°C-27°C
south: semi-arid, mean rainfall 350 mm a year
central plateau: temperate, mean rainfall 1,200-1,900 mm a year.

Administratively, the country is organized in four hierarchical levels of decentralized or autonomous communities, which in descending order are: FARITANY (Province), FIVONDRONAM-POKONTANY (Prefecture), FIRAISANA (District) and FOKONTANY (Village). There are six Provinces, 111 Prefectures, 1,252 Districts and 13,476 Villages in the country. The six Provinces are Antananarivo, Antsiranana, Mahajanga, Toamasina, Fianarantsoa and Toliara.

Politically, the President of the Republic is the Chief of State, while the Chief of Government is the Prime Minister who heads a group of 21 Cabinet Ministers. Other government institutions are the Supreme Council of the Revolution, the National Popular Assembly, the Military Committee for Development, and the High Constitutional Court (Fig. 2.1.1).

2.1.2 Population

The last population census was taken in 1975, turning as a result 7,603,000 inhabitants for the whole country. According to Inventaire Socio-Economique 1976-1986 by the Banque des Donnees de L'Etat, projections based on the 1975 population census are 9,985,000 for 1985 and 11,443,000 for 1990. The average population growth rate is 2.76% per year, resulting from 44.2 per thousand gross birth rate and 16.6 per thousand gross mortality rate. The overall population growth rate is a composite reflecting a faster growth rate in urban areas than in rural areas.

The following table shows that urban population grew absolutely and also increased relatively from 16.3% in 1975 to 19.1% in 1985 and 20.7% in 1990. Conversely, rural population, although larger in absolute terms, decreased relatively between 1975 and 1990.

Year	Total population	Urban pop.	Rural pop.
1975	7,603,000	1,240,000	6,363,000
1985	9,985,000	1,910,000	8,075,000
1990	11,443,000	2,366,000	9,077,000

Source: Guide des Affaires a Madagascar,
Edition 86/87

In 1990, population younger than 15 years was estimated to comprise around 43.3%, while the population aged 65 years and over comprised around 3.6% (Table 2.1.1). Hence, about 53% of the total population, or roughly 6 million people fell into the economically active age category. The high proportion of rural population suggests that the vast majority of the economically active population is engaged in productive activities in the primary sector.

2.1.3 Economy

A marked deterioration of the economy during the early 1980's prompted the Government of Madagascar to take a series of corrective measures, formulating an economic policy designed to achieve a gradual transformation of the centrally planned economy into an economy ruled by market forces. These corrective measures included domestic and

foreign trade measures (lifting of price controls and restrictions on exports, simplifying export and import procedures), public sector measures (withdrawal of the State from productive activities, closing down unprofitable State owned enterprises), liberalization of the financial sector and periodic adjustment of the exchange rate. The economic policy implemented by the Government revitalized the economy as reflected in recent economic indicators.

In real terms, gross domestic product (GDP) at constant 1984 prices grew from 1,400 billion FMG in 1985 to 1,522 billion FMG in 1989, for an average growth rate of 2% per year (Table 2.1.2). However, the growth rate from 1988 to 1989 was a remarkable 3.82%, fueled by a strong 7% growth rate in the primary sector where rice production jumped from 2,149,000 ton in 1988 to 2,380,000 ton in 1989. The 1989 GDP breakdown showed the primary sector comprising 44%, the secondary sector 16% and the tertiary sector 40%. The World Bank reported the per capita gross national product of Madagascar as US\$180 in 1988.

- Agriculture, Livestock and Forestry

The primary sector accounted for the largest share of the GDP in 1989 and has traditionally supplied most of the export products. Domestic consumption crops include rice 2.4 million ton, manioc 2.3 million ton, sweet potato, corn, potato and beans. Cash crops consist of export products and raw materials for agroindustry such as coffee, pepper, vanilla, clove, sugar and cotton (Table 2.1.3).

Cattle breeding is by far the most important livestock activity in terms of economic value and social prestige. In 1989, each of Toliara Province and Mahajanga Province concentrated about one-third of the 9.6 million heads of cattle estimated to exist in the country. Other types of livestock in 1989 included 1.4 million pigs (56% in Antananarivo Province), 1.9 million sheep and goats (95% in Toliara Province), and 20 million chickens (Table 2.1.4). Shrimp has become an important export product amounting to 5,300 ton exported out of 7,300 ton produced in 1989. Also, lobster and crabs have been steadily growing as export products.

Madagascar is estimated to be covered by 12,000,000 ha of natural forests and 264,000 ha of reforested areas (Table 2.1.5). Natural forests are composed of tropical rain forests (50%), tropical dry forests (25%), and bush and mangrove (25%). Firewood and charcoal are widely used for cooking, and the yearly production is estimated at 47,000 m³ of firewood and 15,000 m³ of charcoal.

- Manufacturing and Mining

The manufacturing sector of Madagascar consists essentially of processing agricultural products such as sugar 120,000 ton, vegetable oil 7,000 ton, condensed milk, cotton textiles, blankets, twine and rope. Other industries include soap, petroleum and cement. Mining production in 1989 included 14,700 ton of graphite and 170,000 ton of chromium (Table 2.1.6).

An estimated 60% or more of the manufacturing plants are located in Antananarivo Province. The manufacturing sector is still weak, accounting for only 16% of GDP and 14% of exports in 1989. However, this sector will necessarily have to grow as the country proceeds further with its economic development efforts, and to the extent that the required infrastructure is completed in other areas of the country.

- Transportation

The transportation network of Madagascar includes land, air, sea and river systems. Land transportation is the main mode, but only around 10% of the estimated 50,000 km road network is paved (Table 2.1.7). Insufficient maintenance and unequal distribution make inter-regional road communication difficult. The railroad network comprises two independent systems, north and south, totaling 883 km.

Air transportation comprised 57 airports in 1984, of which 27 with paved runways. Air transportation is the only means to reach some remote areas, but runways are in general unsatisfactory and equipments insufficient. Sea transportation serves as the main mode for foreign trade, and it also permits domestic exchange between enclave coastal regions. The port system includes one main port (Toamasina) and

three secondary ports for ocean going vessels (Antsiranana, Toliara, Mahajanga), as well as eleven ports for coastal navigation vessels.

- Foreign Trade

Exports in 1989 amounted to 506,000 million FMG, of which 47% were comprised by three products (coffee, vanilla, clove), 8% by sugar and cotton textiles, 11% by shrimp and fish, and 9% by chromium and graphite (Table 2.1.8). The heavy reliance of exports on the primary sector and extractive industries is easily seen in the above export data.

Imports, on the other hand, amounted to 545,000 million FMG in 1989, of which 35% were comprised by equipments, 27% by raw materials, 17% by consumption goods, 11% by energy and 10% by food, mostly rice to set up a buffer stock (Table 2.1.8).

Incentive measures to promote export diversification have been implemented to lessen reliance on traditional exports, and appear to be reflected in the high proportion of equipments and raw materials as import items.

2.1.4 Health and Education

Health care facilities in 1989 included 7 general and principal hospitals, 13 medical-surgical hospitals, 108 medical centers and 1,086 primary health care centers. These facilities were staffed by 1,143 medical doctors, 40 pharmacists, 75 dentists, 1,680 midwives and 4,670 nurses (Table 2.1.9).

The top three causes of morbidity in 1987 were reported to be malaria, respiratory illness, and diarrhea. Likewise, the top three causes of mortality in hospitals were reported to be malaria, malnutrition, and diarrhea. Gastrointestinal diseases appear to be the third most important cause of morbidity and mortality, requiring some 206,000 people to seek medical care, and causing 690 deaths in 1987 (Table 2.1.10). Infant mortality was estimated at 68 per thousand and life expectancy at 49.5 years for males and 51.1 years for females.

Education infrastructure in 1989 comprised 13,672 elementary schools, 1,478 secondary schools and 23 higher level facilities (Table 2.1.11). The student/teacher ratio depended on the Province varying from 33 to 67 in elementary schools, 38 to 46 in secondary schools, and 19 to 71 in universities.

Schooling rate was estimated to be only 53% for elementary school age children (1,534,142 out of 2,917,629), and 28% for secondary schools (345,302 out of 1,214,365).

2.1.5 Water Supply Sector

(1) Present Situation

According to a MIEM document on water policy in Madagascar, only 18% of the population is estimated to be served with potable water supply, of which 16.5% in urban areas. Population centers of more than 2,000 inhabitants are classified as urban areas, 83% of which have their water supply facilities, even though 36% are in bad conditions. In reference to towns of less than 2,000 inhabitants, or rural areas, 16% are served with water supply but 12% are in bad conditions. Further, about 80% of water supplied to the rural population was estimated to be of unsatisfactory quality, giving rise to a significant incidence of water-borne diseases, especially among children.

Water supply facilities in urban areas are composed of impounding works, treatment plants, and conduction, storage and distribution systems. In cities of over 2,000 inhabitants and capital cities of Prefectures, these facilities are under the responsibility of JIRAMA, and in certain cases under the District government. On the other hand, water supply systems for rural areas basically consist of wells with or without handpumps, directly from rivers, pumping from wells or rivers, collection and storage of rain water. These facilities are under the jurisdiction of MIEM or local governments.

As the needs of the water sector are generally accorded high priority, different government and non-government organizations have been taking cooperative actions to solve the most urgent problems. However, due to limited re-

sources, the program has been rather modest in scope, centering around repair and rehabilitation of water supply facilities.

(2) National Policy

The three objectives of the 1986-1990 National Development Plan are food self-sufficiency, increase of exports, and improvement of living standards. The strategy to attain these objectives was outlined through six measures, one of which being the improvement of the social situation. Priority areas identified in the social aspect are health, quality of education, housing, potable water supply and sanitation.

The country has been striving to implement a coherent action geared toward accomplishing the objectives of the International Drinking Water Supply and Sanitation Decade. Within this framework, a World Bank/WHO mission conducted a study in 1982 and made recommendations for rural water supply and sanitation.

Within the water sector, the policy of the country has been to supply drinking water to all urban population centers by 1992, and to make water accessible to the rural population by the year 2000, so that one round trip to the water source takes no more than 15 minutes. The country recognizes the need for beneficiary communities to participate in the construction of water supply facilities according to their possibilities, that is, contributing construction materials, labor, etc. Also recognized is the need for users to pay water charges, to cover at least operation and maintenance costs.

The Government of Madagascar is in the process of formulating an updated water supply policy. To this effect, a World Bank mission visited the country in October 1990 to provide its invaluable assistance. Having set the procedure and timetable, an updated water supply policy for Madagascar is expected to be completed in 1991.

(3) Organizations and Institutions

1) National Committee for Water and Sanitation (CNEA)

Established by Decree 89-017 of January 18, 1989, CNEA is the official organization responsible for direction and coordination of all actions on the water and sanitation sector. The CNEA took over the functions of the Ad-hoc Committee for the International Drinking Water Supply and Sanitation Decade.

Functions of the CNEA include formulation of national policy on water and sanitation, overseeing all water and sanitation projects from conception to reception of works, participation in preparation of requests for financing and ensuing negotiations, and ensuring coherence between national and regional programs.

The CNEA is presided by the Director General for Planning and composed of representatives from Ministries with activities in the water/sanitation sector, and from the following: JIRAMA, Water Supply to the South, Microrealization, Microhydraulics, and Directorate General of Data Bank of the State.

2) Ministry of Economy and Planning (MEP)

MEP is responsible for coordinating all activities carried out in the water and sanitation sector by different Ministries. It also coordinates all foreign aid programs.

3) Ministry of Industries, Energy and Mines (MIEM)

MIEM, through its Directorate of Energy and Water, Bureau of Water and Hydrogeology, is in charge of formulating detailed policy on the water sector. In the study phase, it is in charge of carrying out general hydrogeologic studies, test drilling, pumping test, and creation of hydrogeologic data bank. In the implementation phase, it is in charge of scheduling impounding works, ensuring observance of legislation on water impounding, overseeing water supply companies, and undertaking maintenance of water supply facilities in rural areas (Fig.2.1.2 to Fig. 2.1.6).

4) Ministry of Transport, Meteorology and Tourism (MTMT)

MTMT, through its Directorate of National Meteorology, is in charge of implementing national hydrologic and meteorologic networks, and collection and analysis of hydrologic and meteorologic data.

5) Ministry of Scientific and Technological Research for Development (MRSTD)

MRSTD, through its Hydrology Department, is in charge of research on water resources and hydrology.

6) Ministry of the Interior (MI)

MI oversees Districts, some of which are in charge of water supply systems.

7) Ministry of Health (MH)

MH finances and implements water supply works for rural medical centers.

8) Presidency of the Republic

Operation Microrealization and Operation Water Supply to the South implement water supply works mostly in rural areas, using financing from the European Development Fund (FED) and African Development Bank (BAD).

9) Non-Governmental Organization (NGO)

Fikrifama, is the most active NGO in the water sector and constructs essentially gravity systems in the high plateau.

Caritas is active in the high plateau, the Toliara area and around Fort Dauphin, constructing gravity systems and water points.

FLM (Malagasy Lutheran Church) is active mostly in the south, in the construction and rehabilitation of water points.

FJKM constructs gravity systems in the high plateau.

(4) Recent Projects

Water supply projects in Madagascar are implemented mostly with technical and financial assistance from foreign sources. The following are some projects for which foreign assistance has been assured or is being negotiated: improvement of water supply in Antananarivo, groundwater development between Onilahy and Morondava, strengthening water supply in Antsiranana, improvement of water supply in Mahajanga, improvement of water supply in Ambositra, and low cost water supply systems for rural areas.

Some of the specific water supply projects undertaken by MIEM in the past 5 years are the following.

- * Rehabilitation and extension of the water supply system of Ambatondrazaka, in 1986, at a cost of 500 Million FMG financed by FNDE (National Economic Development Fund).
- * Rehabilitation, extension and strengthening of the water supply system of Ambositra in 1989, at a cost of 1,100 Million FMG financed by MIEM and FED (European Development Fund).
- * Rehabilitation and extension of the water supply system of Antsiranana, in 1989, at a cost of 11,500 Million FMG financed by the Government of Italy.
- * Construction of a new water supply system in Tangainony, in 1990, at a cost of 265 Million FMG financed by MIEM.
- * Rehabilitation of existing water supply facilities in Mahanoro, in 1990, at a cost of 445 Million FMG financed by MIEM.

(5) Financing

According to a World Bank report on the water and sanitation sector of Madagascar, of 1,705 billion FMG for public investments during the 1989-1991 period, the water and sanitation sector comprises 120.8 billion FMG (7.1%), broken down into 19.6 billion FMG (4.2%) in 1989, 58.5 billion FMG (9.0%) in 1990, and 42.7 billion FMG (7.2%) in 1991, as shown in Table 2.1.12. Investment funds for the water and sanitation sector are expected to come 15% from local sources and 85% from foreign sources. Further, the water sub-sector is overwhelmingly favored with 96.5%, of which 63.8% in urban areas and 32.7% in rural areas. All of the 3.5% investment in the sanitation sub-sector is planned for urban areas.

The high proportion of foreign financing for water supply projects underscores the importance of foreign aid for the sector. Bilateral and multilateral assistance to the water sector has in recent years been forthcoming from the following sources: France, Japan, Italy, Germany, European

Development Fund (FED), African Development Bank (BAD), UNICEF, UNDP and the World Bank.

According to the above mentioned report, a Swiss cooperation program financed US\$ 2.6 million of water supply projects through various NGO's during the 1986-1989 period. The Swiss Cooperation foresees for the 1990-1992 period an investment of around 6.6 billion FMG for rural water supply. This amount represents around 17% of public investments planned for rural water supply by the Government of Madagascar for the 1989-1991 period.

Table 2.1.1 Age distribution of Madagascar population in 1990

Age group	Male (%)	Female (%)	Total (%)
0 - 4	8.3	8.1	16.4
5 - 9	6.8	6.8	13.6
10 - 14	6.7	6.6	13.3
15 - 19	5.6	5.6	11.2
20 - 24	4.5	4.6	9.1
25 - 29	3.8	4.2	8.0
30 - 34	3.1	3.4	6.5
35 - 39	2.6	2.7	5.3
40 - 44	1.7	1.9	3.6
45 - 49	1.5	1.6	3.1
50 - 54	1.2	1.4	2.6
55 - 59	1.2	1.3	2.5
60 - 64	0.9	0.3	1.2
65 - 69	0.8	0.8	1.6
70 - 74	0.5	0.5	1.0
Over 74	0.5	0.5	1.0
Overall	49.7	50.3	100.0

Source : Investir a Madagascar!, MIEM, 1990

Table 2.1.2 Gross Domestic Product of Madagascar at Constant 1984 Prices

GDP	Unit: Billion FMG					
	1984	1985	1986	1987	1988	1989
GDP by Sector	1369	1400	1411	1443	1466	1522
Primary Sector	581	592	605	617	625	669
Secondary Sector	214	223	220	235	234	247
Tertiary Sector	574	585	586	591	607	606
National Accounts						
Consumption	1058	1071	1082	1092	1111	1135
Government	185	190	190	192	193	193
Investment	186	189	198	186	191	207
Exports	214	223	232	239	229	253
Imports	(274)	(273)	(291)	(266)	(258)	(266)
GDP	1369	1400	1411	1443	1466	1522

Source : -Inventaire Socio-Economique 1976-1986, Tome II, DGBDE, 1988

-Investir a Madagascar!, MIEM, 1990

Table 2.1.3 Production of Selected Crops in Madagascar

Crop	Unit: ton				
	1985	1986	1987	1988	1989
Rice	2,177,680	2,230,205	2,296,132	2,149,000	2,380,000
Corn	140,200	152,890	158,100	156,400	168,475
Beans	41,500	48,560	46,060	45,000	45,113
Potato	263,600	263,900	266,640	270,100	271,000
Manioc	2,142,000	2,190,000	2,178,400	2,186,300	2,277,000
Sweet Potato	450,000	467,140	466,760	466,900	483,260
Sugar cane	1,744,150	1,950,000	1,990,660	1,985,000	1,990,000
Peanuts	31,500	32,540	32,500	30,200	32,300
Cotton	42,700	41,000	27,000	31,400	41,500
Coffee	78,500	78,500	80,500	83,500	88,200
Pepper	2,800	2,880	3,000	3,500	3,700
Vanilla	7,000	3,300	7,800	7,800	7,800
Clove	13,500	7,100	7,100	10,100	7,100
Sisal	19,800	19,800	19,700	19,500	19,900
Banana	224,500	225,200	225,900	226,000	217,341

Source : Rapport Economique et Financier Annee 1989, MEP

Table 2.1.4 Livestock Production in Madagascar

	Unit: head			
	Toliara Province		Madagascar	
	1985	1989	1985	1989
Cattle	2,236,437	3,100,000	7,461,114	9,638,500
Pig	78,742	111,000	648,387	1,427,800
Sheep & goats	1,273,002	1,761,200	1,418,920	1,861,860
Chicken	n.a	2,292,000	14,500,000	20,072,000

Source : Inventaire Socio-Economique 1976-1986, Tome I, DGBDE, 1988
 Investir a Madagascar!, MIEM, 1990
 Guide des Affaires a Madagascar, Edition 86/87

Table 2.1.5 Forest Area of Madagascar

Unit: 1,000ha

Type of forest	Toliara Province	Madagascar
Natural forests	4,322	12,058
Tropical rain forest	294	6,159
Tropical dry forest	1,150	2,798
Bush	2,831	2,831
Mangrove	47	270
Reforested area	12	264

Source : Investir a Madagascar!, MIEM, 1990

Table 2.1.6 Industrial Production of Madagascar

Product	Unit	1985	1986	1987	1988	1989
Sugar	ton	92,994	92,462	101,216	114,708	120,407
Vegetable oil	ton	1,178	4,520	7,956	6,913	6,950
Condensed milk	ton	3,535	3,380	3,476	3,324	2,705
Cigarette	ton	2,368	2,188	2,669	1,817	1,700
Beer	he	241,491	255,364	240,257	201,371	232,411
Cotton textiles	km	64,856	67,355	62,492	56,468	57,858
Blankets	ton	935	1,045	1,541	1,985	1,921
Twine & rope	ton	1,241	1,378	1,501	1,610	1,665
Paper	ton	16,571	16,786	12,863	13,984	15,441
Soap	ton	12,321	13,494	14,563	12,594	16,200
Paint	ton	2,000	553	2,477	2,594	2,376
Gas oil	m ³	95,046	32,988	84,837	101,758	53,910
Fuel oil	m ³	115,874	49,819	127,108	153,728	90,172
Cement	ton	28,383	32,213	44,490	32,820	25,787
Graphite	1000t	14.7	16.2	13.6	14.6	14.7
Chromium	1000t	127.3	89.3	106.8	171.5	170.0

Source : Rapport Economique et Financier Annee 1989, MEP

Table 2.1.7 Road Network of Madagascar in 1985

Unit:km

Road classification	Paved road	Improved road	Dirt road	Total
National road	4,345	4,260	-	8,605
Provincial road	546	1,000	9,483	11,029
Unclassified	-	-	30,000	30,000
Total	4,891	5,260	39,483	49,634

Source : Guide des Affaires a Madagascar, Edition 86/87

Table 2.1.8 Exports and Imports of Madagascar in 1989

	Volume	Value	%
	ton	Million FMG	
<u>Export products</u>			
Coffee	58,403	115,927	22.9
Pepper	1,417	5,051	1.0
Vanilla	596	67,779	13.4
Clove	16,449	51,408	10.2
Shrimp & fish	7,067	55,857	11.0
Sugar	72,128	38,594	7.6
Petroleum products	61,288	8,693	1.7
Graphite	15,049	15,394	3.0
Chromium	152,591	31,083	6.2
Others	99,266	116,407	23.0
Total	484,254	506,193	100.0
<u>Import products</u>			
Food	107,777	61,381	11.3
Energy	302,806	53,308	9.8
Equipment	17,380	193,236	35.4
Raw materials	174,453	144,606	26.5
Consumption goods	12,246	92,868	17.0
Total	614,662	545,399	100.0

Source : DGBDE

Table 2.1.9 Health Care Facilities and Personnel in 1989

	Toliara Province*	Madagascar
<u>Health care facilities</u>		
General hospital	0	2
Specialized health care center	0	8
Principal hospital	1	5
Medical-surgical hospital	3	13
Secondary hospital	6	55
Medical centers	20	108
Urban dispensary	6	42
Health center	61	475
Birth center	7	59
Infirmery	17	116
Primary health care center	193	1,086
<u>Health care personnel</u>		
Medical doctors	90	1,143
Pharmacists	2	40
Dentists	5	75
Midwives	173	1,680
Nurses	659	4,670

* 1985 data

Source : - Investir a Madagascar!, MIEM, 1990

- Guide des Affaires a Madagascar, Edition 86/87

Table 2.1.10 Top Causes(Ranking)of Morbidity and Mortality in 1987

Cause	Toliara Province		Madagascar	
	Number	%	Number	%
<u>Outpatient consultation</u>				
Malaria	33,566(1)	18.7	293,772(1)	16.2
Respiratory system infection	33,206(2)	18.5	203,216(2)	11.2
Diarrhea	16,071(3)	9.0	152,829(3)	8.4
Influenza	13,636(4)	7.6	150,880(4)	8.3
Other respiratory ailments	5,999(5)	3.3	83,337(5)	4.6
Total	179,525		1,818,457	
<u>Hospitalization</u>				
Malaria	2,037(1)	17.4	16,610(1)	14.3
Respiratory system infection	626(2)	5.3	3,546(3)	3.1
Diarrhea	612(3)	5.2	5,400(2)	4.6
Tuberculosis	525(4)	4.5	3,283(4)	2.8
Bilharziasis	327(5)	2.8	989	0.9
Other digestive ailments	317(6)	2.7	2,270(10)	2.0
Total	11,714		116,153	
<u>Mortality in hospitals</u>				
Malaria	61(1)	10.2	1,481(1)	15.1
Malnutrion	50(2)	8.4	802(2)	8.2
Diarrhea	32(3)	5.4	690(3)	7.0
Tuberculosis	30(4)	5.0	323(5)	3.3
Respiratory system infection	22(5)	3.7	245(7)	2.5
Other digestive ailments	12(10)	2.0	-	-
Total	596		9,829	

Source : Bulletin Semestriel de Statistiques Sanitaires,
2^o semestre 1987, Ministere de la Sante

Table 2.1.11 Education in Madagascar in 1989

Indicators	Elementary	Highschool	College
Madagascar			
No. of education centers	13,672	1,478	23
No. of students	1,534,142	345,302	37,096
No. of school age persons	2,917,629	1,214,365	-
Student/Teacher ratio	41	41	39
Toliara Province			
No. of education centers*	1,390	108	3
No. of students*	127,125	22,957	2,082
Student/Teacher ratio	36	39	21

* 1985 data

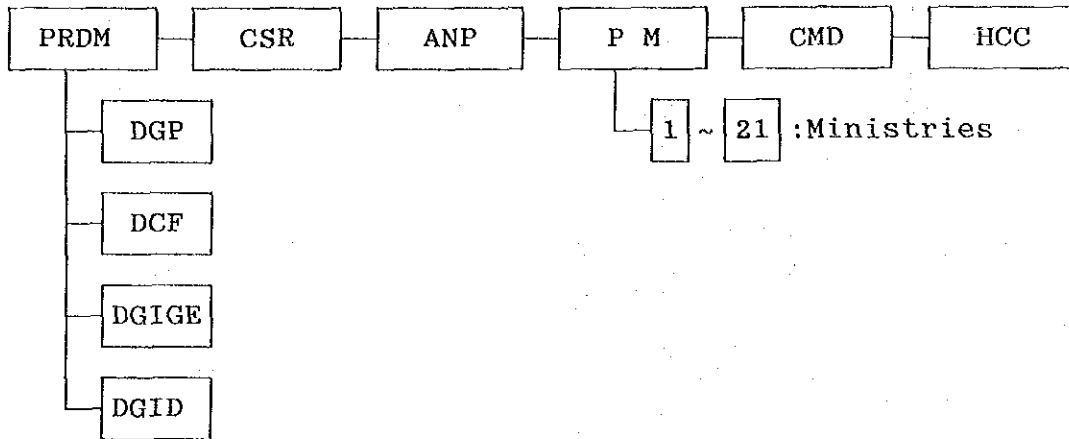
Source : Investir a Madagascar!, MIEM, 1990
 Guide des Affaires a Madagascar, Edition 86/87

Table 2.1.12 Public Investment Program 1989-1991 for
the Water and Sanitation Sector
Unit: Billion FMG

	1989		1990		1991		Total		%
	For.	Loc.	For.	Loc.	For.	Loc.	For.	Loc.	
Urban water	6.7	2.6	9.3	5.5	36.8	4.2	31.0	77.1	63.8
Rural water	9.2	1.1	10.3	1.7	18.7	8.9	10.5	39.5	32.7
Water subsector	15.9	3.7	19.6	7.2	55.5	35.7	41.5	116.6	96.5
Urban sanitation	0	0	0	2.2	3.0	0.8	1.2	4.2	3.5
Rural sanitation	0	0	0	0	0	0	0	0	0
Sanitation subsector	0	0	0	2.2	3.0	0.8	1.2	4.2	3.5
Water&Sanitation Sector	15.9	3.7	19.6	8.0	58.5	36.5	42.7	120.8	100.0
All Sectors	324.9	145.7	470.6	466.1	199.7	645.8	395.6	588.6	1,705.0

Source : Secteur Eau et Assainissement, Rapport sur la situation actuelle,
GREA-AE/PNUD/Banque Mondiale RAP/86/038, 1989

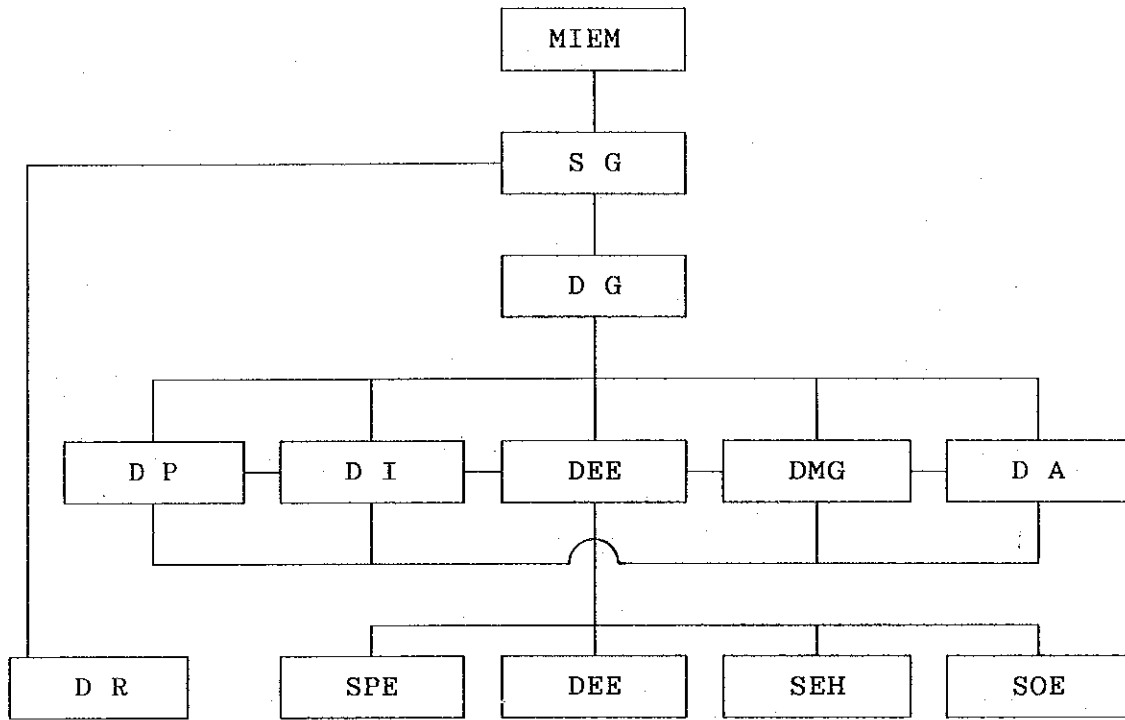
Fig.2.1.1 Organization Chart of
the Democratic Republic of Madagascar



Legend

- PRDM : President of the Democratic Republic of Madagascar
- CSR : Supreme Council of the Revolution
- ANP : National Popular Assembly
- PM : Prime Minister
- CMD : Military Committee for Development
- HCC : High Constitutional Court
- DGP : Directorate General for Planning
- DCF : Directorate for Financial Control
- DGIGE : Directorate General for the General Comptroller of the State
- DGID : Directorate General for Investment and Development

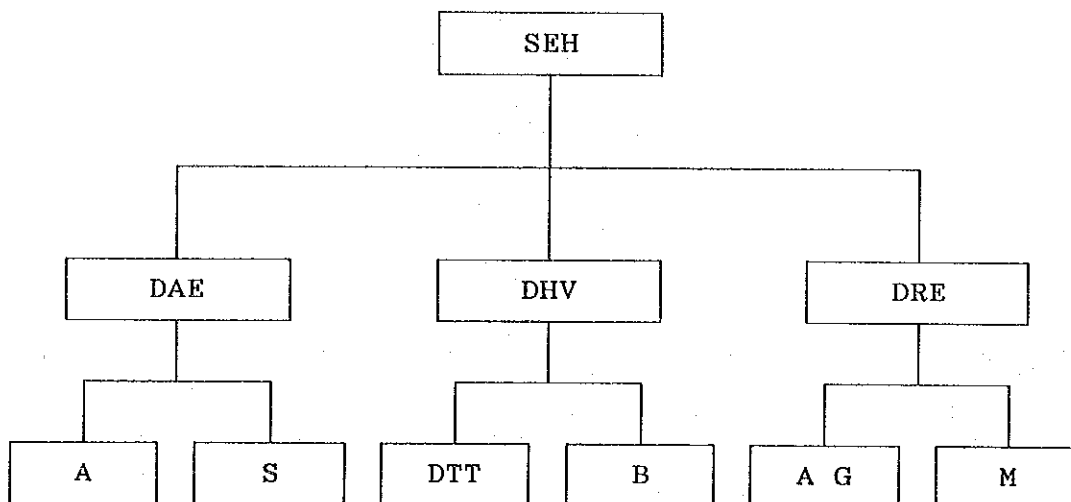
Fig.2.1.2 Organization Chart of MIEM



Legend

- MIEM : Ministry of Industries, Energy and Mines
- SG : General Secretariat
- DG : Directorate General
- DP : Directorate for Planning
- DI : Directorate for Industries
- DEE : Directorate for Energy and Water
- DMG : Directorate for Mines and Geology
- DA : Directorate for Cottage Industry
- DR : Regional Bureau
- SPE : Energy Planning Bureau
- SRO : Resource Opportunities Bureau
- SOE : Energy Operations Bureau
- SEH : Water and Hydrogeology Bureau

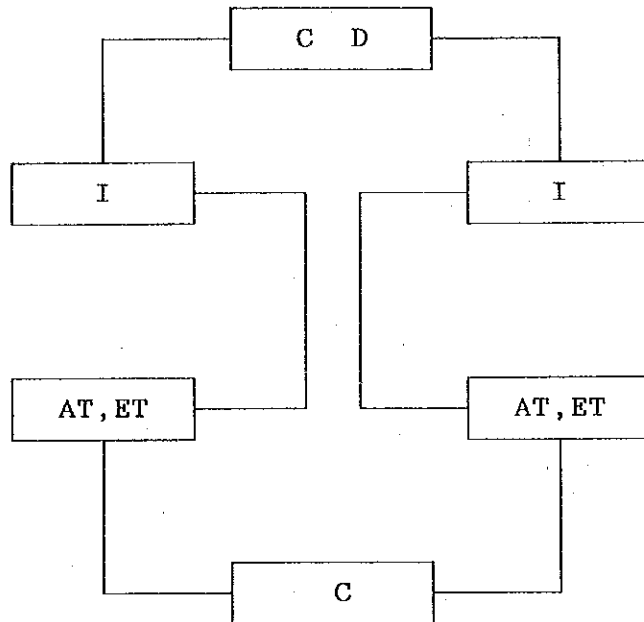
Fig.2.1.3 Organizagion Chart of Water and Hydrogeology Bureau



Legend

SEH : Water and Hydrogeology Bureau
DAE : Water Supply Division
DHV : Village Water Supply Division
DRE : Water Resources Division
A : Accounting
S : Secretariat
DTT : Dessign-Printing-Topography
B : Library
AG : Workshop-Garage
M : Warehouse

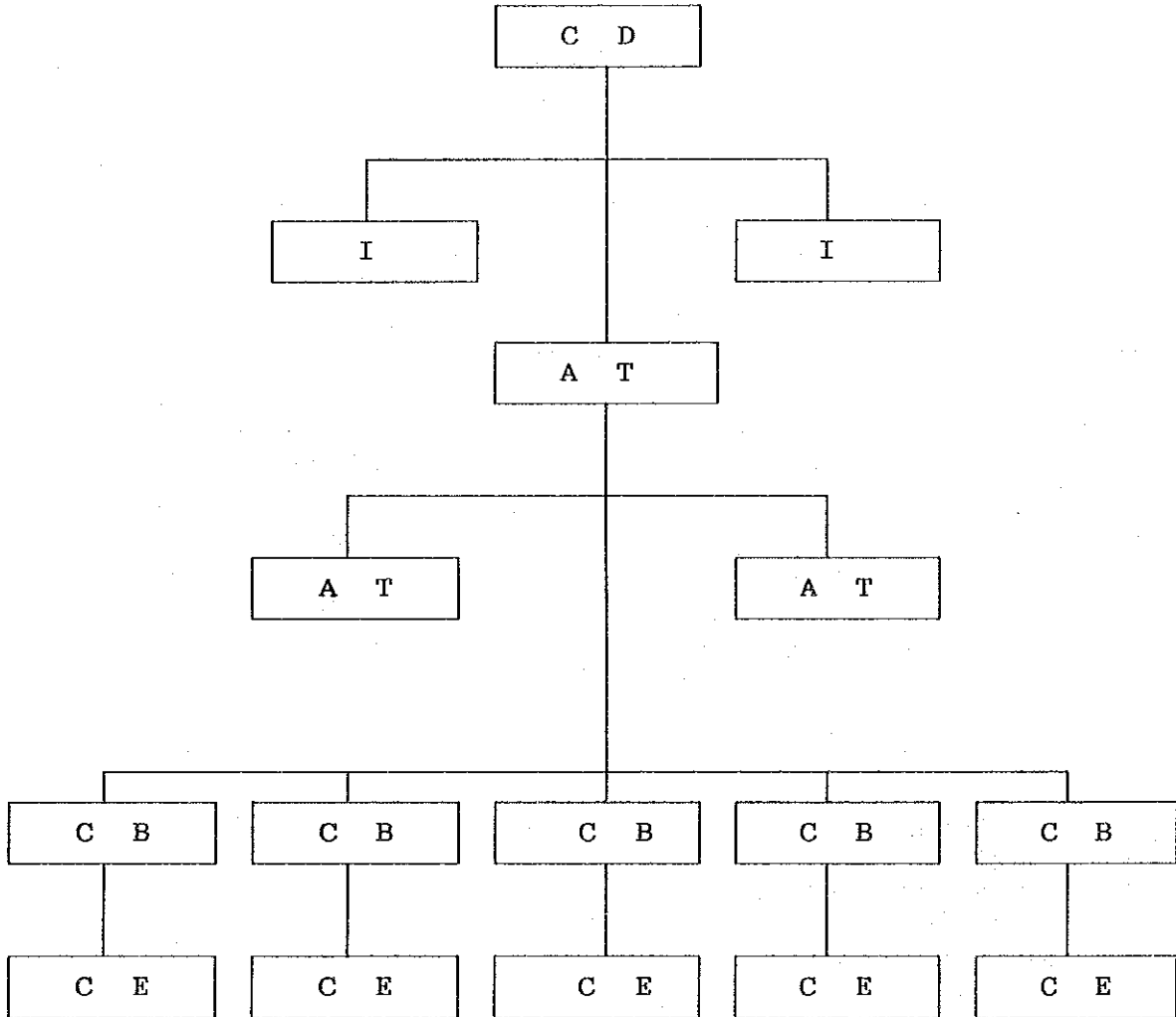
Fig.2.1.4 Organization Chart of Water Supply Division



Legend

CD : Division Chief
I : Engineer
AT : Technical Assistant
ET : Technical Clerk
C : Driver

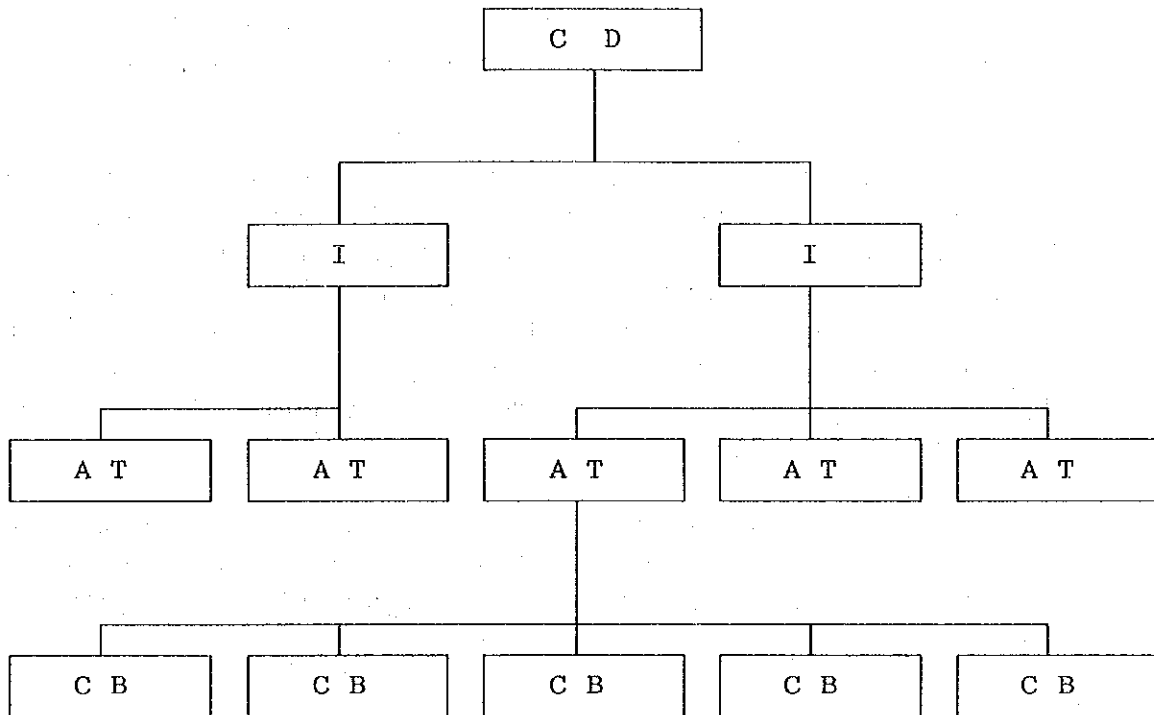
Fig.2.1.5 Organization Chart of Village Water Supply Division



Legend

- CD : Division Chief
- I : Engineer
- AT : Technical Assistant
- CB : Supervisor
- CE : Foreman

Fig.2.1.6 Organization Chart of Water Resources Division



Legend

CD : Division Chief
I : Engineer
AT : Technical Assistant
CB : Supervisor

2.2 Toliara Province

2.2.1 General

Toliara Province is located in southwestern Madagascar, covering an area of 161,405 km², or roughly 27% of the country total area, under a predominantly semi-arid climate.

Toliara Province is organized according to the typical pattern of political and administrative organization of a Faritany (Province). Political bodies are the Executive Committee, the Popular Council, and the Administrative Committee. The President of the Executive Committee is the highest authority of the Province and is elected indirectly by the Presidents of the Prefectures comprising Toliara Province.

Administratively, Toliara Province is divided into 21 Prefectures, 210 Districts and 2,027 Villages, which are hierarchical levels of decentralized or autonomous communities.

2.2.2 Population

According to "Guide des Affaires a Madagascar, Edition 86/87", the 1985 population of Toliara Province was estimated at 1,440,000 inhabitants, roughly 14% of the country total population.

Although no data were available on the Toliara Province economically active population and its sector distribution, observations during the field survey indicated prevalence of the rural population, suggesting that the population is engaged basically in farming activities. In addition, noticeable service activities are micro-businesses such as road side stall merchants, street vendors, and transportation service operators.

2.2.3 Economy

As a reflection of the economic situation of the country, the economy of Toliara Province is heavily dependent on the primary sector. However, activities in the primary sector

are hampered by the long dry season lasting from May to October. This situation is aggravated in the case of small farmers without irrigation infrastructure which could offset, at least partially, the adverse effect of the harsh climate on small scale farming.

Farming activities, which are made possible mostly during the rainy half of the year, and the scarce development of the manufacturing sector appear to push people into the informal service sector, not only in urban areas but also along the main road in rural communities. However, even these service activities are hampered by the predominantly poor state of the road network, which restricts the traffic volume.

As the process of economic development advances, the shift of the rural population to urban areas will inevitably accelerate, and the manufacturing sector will necessarily have to be developed. Urbanization places a heavy demand on basic services like water supply, and manufacturing in general requires a reliable water source. From these viewpoints, the study to determine the development potential of groundwater resources in the southwestern region will undoubtedly have high potential benefits for the economy of Toliara Province.

- Agriculture, livestock and forestry

Important crops in Toliara Province in 1985 were rice 150,000 ton, cassava 215,000 ton, sugar cane 64,000 ton, sweet potato, corn and peanuts (Table 2.2.1). During the field survey, it became apparent that cotton was an important cash crop in the Province, being cultivated by both small farmers and by mechanized plantation-type farms, but no data were available on cropped area and production volume. Also, large scale rice cultivation was seen in some localized areas. In general, however, crop production in the Province seemed to use rather rudimentary techniques, suggesting that crop yields were not high.

As for livestock, Toliara Province in 1989 accounted for 3,100,000 heads of cattle (32% of the country), 111,000 pigs (8% of the country), 1,761,000 sheep and goats (95% of

the country) and 2.3 million chickens (11% of the country), as indicated in Table 2.1.4. During the field survey, freely grazing cattle could be seen everywhere, but there are some areas specializing in cattle ranching. A few heads of sheep and goats were seen in any village, either freely roaming or confined in small pens, but they seem to be concentrated in the Ampanihy area, where handwoven wool articles are reportedly being produced.

In 1989, Toliara Province was estimated to be covered by 4,322,000 ha of natural forests (36% of the country), of which tropical rain forests comprised 294,000 ha (5% of the country), tropical dry forests 1,150,000 ha (41% of the country), bush 2,832,000 ha (100% of the country), and mangrove 47,000 ha (17% of the country), as shown in Table 2.1.5. On the other hand, reforested area in Toliara Province covered 12,000 ha or 5% of the country.

Charcoal production appears to be growing in Toliara Province, especially along roads crossing the bush covered dry and rocky land. There is no question that charcoal production is an important and one of the few available sources of cash income for people who live on this dry and barren land. However, the environmental implications on this already fragile ecosystem, if denuded of its bush cover, are clearly worrisome.

- Manufacturing and mining

In 1985, food processing industries comprised the majority in Toliara Province, followed by textiles, chemicals, wood and metal works. Food processing industries included several bakeries and vegetable oil refineries, as well as a slaughterhouse, a sugar mill, a beverage bottling plant and a salt mine. Textile industries included several sisal processing plants, a rope industry, and a spinning and weaving plant. Chemical industries consisted of several soap making plants, while wood and metal work industries included cabinet and furniture, as well as farming equipments.

Types and locations of minerals mined in Toliara Province are the following: mica (Amboasary, Betroka, Ambovombe,

Bekily, Tsihombe), graphite (Tranoroa), copper (Vohibory), lime (Soalara) and titan (Taolagnaro). However, no data were available concerning production levels of the manufacturing and mining sector in Toliara Province.

- Transportation

The road network within Toliara Province in 1985 was estimated at 4,027 km, or 25 m per km², which compared favorably with the national average of 15 m per km². Also, paved roads, comprising 14% of the road network in the Province, compared favorably with the national average of 10%.

As for water transportation, Toliara Province has a secondary port for ocean going vessels (Toliara), two main ports for coastal navigation (Morondava and Taolagnaro), and a secondary port for coastal navigation (Morombe). The volume handled by the Toliara port in 1985 was 4,900 ton loaded and 26,000 ton unloaded for ocean going vessels, as well as 8,700 ton loaded and 26,200 ton unloaded for coastal navigation vessels (Table 2.2.2).

Concerning air transportation, Toliara Province has three airports (Toliara, Morondava and Taolagnaro) and many landing strips. Passenger traffic handled by these airports in 1985 were Toliara 12,641, Morondava 9,694 and Taolagnaro 7,549 (Table 2.2.3).

2.2.4 Health and Education

Health care facilities in Toliara Province in 1985 included one principal hospital, 3 medical-surgical hospitals, 20 medical centers and 193 primary health care centers. Health care facilities in Toliara Province in 1985 were staffed by 90 medical doctors, 5 dentists, 2 pharmacists, 173 midwives and 659 nurses (Table 2.1.9).

The top three causes of morbidity in Toliara Province in 1987 were the same as those for the whole country, i.e., malaria, infection of the respiratory system and diarrhea. However, people seeking medical care for these three causes comprised higher proportions of outpatients and hospitalized patients relative to the percentages for the whole

country. In addition, bilharziasis (schistosomiasis) patients accounted for 2.8% of hospitalizations in Toliara Province, while comprising only 0.9% in the whole country (Table 2.1.10).

With respect to mortality in hospitals, the top three causes in Toliara Province in 1987 were also the same as those for the whole country, i.e., malaria, malnutrition and diarrhea. In Toliara Province, diarrhea accounted for 5.4% of deaths in hospitals, in addition to 2% for "other digestive ailments", as compared with 7% for the whole country (Table 2.1.10).

Education infrastructure in Toliara Province in 1985 included 1,390 elementary schools, 108 secondary schools and 3 higher level facilities. The number of students in 1985 was reported to be 127,125 in elementary schools, 22,957 in secondary schools and 2,082 in universities. The 1989 student/teacher ratio was 36 in elementary schools, 39 in secondary schools and 21 in universities.

Table 2.2.1 Agricultural Production in Toliara Province

Crop	Area(ha)			Production(ton)		
	1983	1984	1985	1983	1984	1985
Rice	109,300	91,250	100,000	208,440	135,860	150,000
Cassava	40,458	51,159	36,852	186,443	245,517	214,688
Sweet potato	18,486	9,807	6,347	107,070	56,999	26,786
Beans	3,872	1,155	1,410	3,955	2,118	1,016
Corn	29,641	12,181	17,004	35,908	10,443	9,937
Sugar cane	n.a	2,824	2,702	n.a	40,250	63,631
Peanuts	5,189	3,682	4,090	3,638	3,382	2,058
Coffee	n.a	3,635	4,050	n.a	1,340	1,380

Source : Guide des Affaires a Madagascar, Edition 86/87

Table 2.2.2 Cargo Handled by Toliara Province Ports

Port	Unit:ton			
	1984		1985	
	Ocean	Coastal	Ocean	Coastal
Loading				
Toliara	11,322	5,853	4,886	8,747
Taolagnaro	17,886	796	8,501	1,170
Morondava	5,087	2,308	5,797	11,488
Morombe	5,702	649	3,083	5,428
Unloading				
Toliara	21,558	28,311	26,034	26,168
Taolagnaro	311	13,565	2,505	11,428
Morondava	20,237	8,534	19,589	15,433
Morombe	-	4,328	-	2,592

Source : Guide des Affaires a Madagascar, Edition 86/87

Table 2.2.3 Air Traffic in Toliara Province

Airport	1984		1985	
	Passenger	Cargo (ton)	Passenger	Cargo (ton)
Loading				
Toliara	n.a	n.a	12,641	71
Morondava	n.a	n.a	9,694	87
Taolagnaro	n.a	n.a	7,549	95
Morombe	n.a	n.a	1,584	13
Unloading				
Toliara	13,150	487	12,295	142
Morondava	7,900	114	9,524	92
Taolagnaro	7,472	144	7,418	127
Morombe	1,118	16	1,499	19

Source : Guide des Affaires a Madagascar, Edition 86/87

2.3. Study Area

2.3.1 General

The local administration system in Madagascar, operating under the principle of decentralization, is constituted by FIVONDRONANA (Prefecture), FIRAISAMPOKONTANY (District) and FOKONTANY (Village). Smaller communities, KOMITY and FOKONOLONA, are recognized but those communities cannot be regarded as administrative units. The overwhelming majority of the candidate villages proposed for the Study consists of FOKONTANY, the rest distributed between FIRAISAMPOKONTANY and KOMITY.

FOKONTANY, which from the viewpoint of the rural water supply program is the most important unit, is a spontaneously formed community of considerable concentration.

FOKONTANY, with a leader elected by villagers, forms the lowest stratum of local autonomy. However, with the many constraints encountered, such as lack of institutional and financial capacity, its administrative capability remains limited. The official role of the head of FOKONTANY is also confined to a rather limited scope, for example, issuance of pass for cattle, tax collection, etc. It is entirely rare to find a village office and full-time staff even in a larger FOKONTANY with population above 1,000. An official FOKONTANY budget with detailed source and application of funds is hardly available.

Heads of FIVONDRONANA and FIRAISAMPOKONTANY are indirectly elected.

Table 2.3.1 shows the number of local administrative units in the Study Area.

2.3.2 Population

The Study Area is almost flat with some rolling plains, where rural inhabitants have traditionally formed small and concentrative settlements. As individual settlement, a FOKONTANY exhibits in most cases the characteristics of a self-sufficient society with its own minimum social infrastructures such as a primary school, a church, water sources, etc.

Given these circumstances, it is worth stressing that statistics on overall population and population density in a prefecture does not provide any useful information to grasp the real village population and its distribution, thus presenting a data gap in the design of individual rural water supply systems.

Since the official records of the latest FOKONTANY population census were not available, the actual number of inhabitants in FOKONTANY or KOMITY have been estimated based on the information obtained in the field from community leaders and validated by an actual count of the number of houses.

The survey shows the population of FOKONTANY to vary from around 500 to 2500. On the average, about 8 to 10 persons constitute a standard family, with such a family owning one to three small houses with an aggregate floor space of 10 to 20 square meters.

Change in FOKONTANY population due to immigration or emigration may be generally regarded as minor when compared with the natural growth rate. However, social causes may account for some cases where a FOKONTANY was composed of only a few families, or where an entire FOKONTANY had disappeared, due possibly to a mass migration to some other location.

The statistical data on population of FIVONDRONANA are presented in Table 2.3.2.

2.3.3 Rural Economy

- Economic activities

Most inhabitants in the Study Area are engaged in farming and livestock breeding. Cotton and rice are the main cash crops and the basic source of farmers income. Other principal products in the region are cassava, maize and beans. With regards to livestock, cattle-raising is the most popular as it yields better economic returns and adds prestige to the owner, as cattle occupies an important place in the culture of Madagascar.

Small-scale cattle-raising is done in some villages, particularly in ANKAZOABO and BEROROHA. This activity, however, is severely affected by the frequent forays of cattle rustlers. The problem is of such magnitude as to warrant the government to initiate a self-defense cooperation between small and large FOKONTANY against cattle-rustlers. The number of cattle raised in the region in 1988 can be found in Table 2.3.3.

In agriculture, while irrigation farming has considerably been developed in the western and southern areas, farming remains largely rain-fed. Although numerous irrigation facilities were rehabilitated in recent years, no integrated rural development projects, which could include drinking water supply as one component, have been planned nor executed in the Study Area.

The production of food crops is gradually increasing but has yet to reach the self-sufficiency level, particularly for rice which is the nation's staple food.

Commercial activities are mainly small-scale and characterized by small retail shops trading basic consumer goods. These enterprises are mostly found in FIRAISAMPOKONTANY and are located along the main roads. To further improve commerce and distribution, emphasis should be on developing and improving road networks.

As to the levels of income among rural inhabitants, no reliable record or information was available.

- Infrastructure

Existing network of roads in the Study Area is unsatisfactory, both in coverage and in surface condition, to support and sustain sound social and economic activities in the region. The main roads traversing TOLIARA-SAKARAHHA-IHOSY and TOLIARA-MOROMBE can hardly be regarded as all-weather type roads with their damaged pavement and bumpy surfaces. Secondary and tertiary (feeder) roads, which occasionally pass through river beds and swampland, have worse surfaces without any kind of regular maintenance.

Although the rehabilitation and extension of main roads are among the main objectives of the 1986-1990 Five-Year National Development Plan, very little progress in this respect can be observed.

Electrification of the region remains low and its real improvement in terms of capacity and coverage is hardly expected in the short term. At present, mini-power stations with engine generators are installed in TOLIARA City (15,000 KVA), BEZAHA (100KVA), MANJA (100KVA), MOROMBE (100KVA), and SAKARAHHA (out of order). Any expectation for a future expansion of the power supply in the area has no realistic basis and can not be used in preparing the rural water supply program.

Telephone and telecommunication systems are not yet sufficiently developed in the Study Area. Modern microwave relay stations for telephone and television channels are installed in the southern area to connect TOLIARA to ANTANANARIVO and other cities. Some of the relay stations are operated on power generated by photo-voltaic cells (solar cells).

2.3.4 Public Health

Due to scarcity of reliable information, the actual state of public health in the Study Area could not be accurately ascertained. The description that follows is, therefore, meant to provide the gist of the above subject.

Because of the short-supply of safe water, water-borne and water-related diseases were expected to be widespread in the Study Area. As a matter of fact, the Study Team observed that, on the whole, the rural people in the Study Area showed low levels of health and widespread symptoms of diseases caused by water shortage and by unsatisfactory sanitation practices. Subsequent interview conducted among rural inhabitants confirmed the high incidence of diarrhea, parasitism, and malaria.

The vital role played by safe water and sanitation in primary health care, although duly recognized in the country, has yet to be translated into effective measures

before benefits can be enjoyed, especially by the rural people. In addition, the highly skewed distribution of medical facilities (e.g., hospitals, medical centers, dispensaries, maternity clinics, etc.) provide rural inhabitants very little opportunity to receive competent medical treatment. Table 2.3.4 shows the distribution of the medical facilities in the Study Area.

2.3.5 Water Supply Sector

(1) Status of the sector

Water supply services are rendered by public entities and private entrepreneurs. Two public sector entities are responsible for the provision of potable water in the Study Area. MIEM takes on the task of supplying safe water to the rural areas, while JIRAMA, a public corporation which operates within the purview of MIEM, takes charge of waterworks in the urban area of TOLIARA.

There are at present a few urban-type water supply systems in the Study Area, with the one in TOLIARA as the typical and the biggest. For the southern part of the Study Area, that is, along the main road from TOLIARA to SAKARAH, water is provided by water vendors and seasonal rainwater. Water vendors are private entrepreneurs who sell water by the bucket or by the 200 liter drums carried on tractor trailers or trucks, and also in tank lorries.

The water source of TOLIARA is groundwater in MIARY and ANDRANOMENA. Water from four (4) deep tubewells in MIARY is immediately conveyed to two (2) elevated tanks having storage capacities of 1,000m³ and 600m³. In ANDRANOMENA, the water collected is sent to a distribution system by-passing an extant old tank. Quality-wise, the groundwater in ANDRANOMENA has high calcium and salt contents. Except for disinfection with hypochlorite, no water treatment is undertaken in TOLIARA's waterworks.

Both JIRAMA and MIEM (TOLIARA) currently operate under difficult circumstances. The waterworks of TOLIARA consist of pumps and storage tanks with capacities too small to meet even present demand. This problem is further aggravated by a distribution main which is over twenty years old

and which needs immediate replacement. MIEM (TOLIARA Office) is saddled by insufficient budget, machinery, spare parts, equipment, and technical staff. Shortage of transportation means and qualified personnel preclude MIEM from channeling and putting to optimal use the rural villagers' willingness to participate in maintenance work.

Worth noting at this point is the role international agencies can play to support the public sector's activities in technical and financial terms, as well as the difficulties involved in such cooperations. The U.S. AID, for instance, supported the construction of tubewells in the region in 1963 but had the experience of finding many of the handpumps turned into useless scraps after only a few years.

A listing of government and other agencies concerned with water supply systems in the region, together with a description of their functions, is shown in Table 2.3.5.

(2) Water usage

For drinking purposes, the distinctive taste of water takes precedence over its chemical or biological quality for most people in the Study Area. This was evidenced by their preference to use the turbid river water rather than the comparatively cleaner groundwater, in cases where the well water was salty. Infrequently practiced is the boiling of water for drinking. Insufficient awareness on sanitation could account for these practices.

Water consumption per capita appears to be higher among rural inhabitants nearer water sources. By reason of proximity, it has become habitual for them to consume more water for a variety of domestic uses. This seems to be the case especially when the region under the Study is compared with other African rural regions. A wide variation on per capita consumption exists, however, among the rural inhabitants of the Study Area, i.e., 10 liters to 30 liters.

The results of an investigation made by the Study Team on actual water use is summarized in Fig. 2.3.1. A well with a handpump was selected for the investigation.

(3) Water supply system

Water Sources

The traditional sources of water for domestic use of the rural people in the Study Area are:

- Shallow well (unconfined aquifer)
- Underflow water in dry river bed
- Spring
- Surface water from rivers, brooks, and irrigation canals

These water sources are usually only a few hundred meters away from settlements. In some villages along the TOLIARA-SAKARAHHA road, water is provided by water vendors and rainfall.

As is customary in the region, the individual FOKONTANY enjoys exclusive right over all point source(s) within its domain. However, natural water sources like rivers and irrigation canals are regarded usually as public water sources.

Intake facility and distribution system

Water supply structures in the Study Area are fairly simple and may be summarized as follows:

- one or more water points, simply dug wells (unprotected) mainly, or a few protected dug wells without pumps
- tube wells with handpumps
- simple water supply systems consisting of tubewells (or protected dug wells) equipped with powered pumps and a distribution system characterized by a few public faucets

The most popular means to collect shallow-depth groundwater or underflow water in river beds is the dug well. This is a shallow hole dug manually and is usually without protective measures such as inner wall lining (or casing) and solid covering on the surface area around the hole. The water inside the well, despite its being of better quality

by nature, cannot therefore be regarded as safe water, given its susceptibility to contamination from both the inside and the outside.

Only a few protected wells equipped with handpumps are still in use in the region. In many FOKONTANY, the operation of such type of wells has ceased, notwithstanding the better quality of water.

As for tube wells equipped with powered pumps, only a few have been in actual operation in the region and almost all of these are now inoperative because of mechanical troubles in the pumps or in the engine generators.

Water distribution systems depending upon simple point sources and utilizing an elevated tank and a few public faucets are not promoted yet in the Study Area. An exception is the two FOKONTANY near TOLIARA which have installed distribution pipes and a few public faucets.

No treatment process of any type is undertaken in the region.

Maintenance

Of the numerous technical and financial constraints on the operation and maintenance of water supply systems in the Study Area, the one having the most decisive effect is the absence of a water organization at the FOKONTANY level. This problem implies shortage of trained manpower at each level of the maintenance system hierarchy. This observation may best be illustrated by the fact that even for a simple tubewell equipped with a handpump, no maintenance program is implemented. Also, the water users have not been involved and their assistance has not been tapped for the required maintenance. The MIEM (TOLIARA Office) is severely hampered by shortage of skilled personnel and transportation means.

Fig. 2.3.2 shows the organization of MIEM (TOLIARA Office), the sole organization in the region involved in rural water supply.

Power source for prime mover

As mentioned above, electrification of the region in the near future is improbable. Alternative power sources may be required either in the form of solar or wind power, and conventional internal combustion engines as well. Since some experience in using these alternative sources have already been accumulated in the region, it would be worthwhile to evaluate past examples.

Solar power use includes a successful utilization for microwave relay stations and a failed utilization for pumping water in TSIOMBE (southern area). Another example is the considerable number of failed installations of diesel generators. Whatever may be the choice for the power source, the factor that shall essentially govern the life of equipment is its "maintenance free" characteristic.

Table 2.3.1 Number of Local Administrative Units in the Study Area

Fivondronana	Firaisampokontany	Fokontany
Toliara I	6	21
Toliara II	17	93
Sakaraha	9	67
Ankazoabo-Sud	4	38
Beroroha	5	44
Morombe	8	55

Table 2.3.2 Population Distribution in the Study Area

FIVONDRONAMPOKONTANY (Prefecture)	FIRAISAMPOKONTANY (District)	POPULATION	
		Total	Density
TOLIARA I	MAHAVATSE I	20,699	
	MAHAVATSE II	30,028	
	BETANIA	23,928	
	TANAMBAO I	33,468	
	TANAMBAO II	28,657	
TOLIARA II	MITSINJO	15,177	233.5
	MIARY	10,265	45.2
	SAINT AUGUSTIN	12,187	73.4
	MANOMBO SUD	11,726	27.0
	ANKILILOAKA	10,360	17.4
	ANALAMISAMPY	8,290	9.1
	ANKARAOBATO	8,310	16.0
	MAROFOTY	8,260	51.6
	AMBOLOFOTY	8,440	78.2
	ANKILIMALINIKA	7,747	32.3
	TSINISIHA	6,663	12.5
	BELALANDA	4,470	79.0
	ANDRANOVOVORY	7,142	7.2
	ANATANIMIHEVA	5,935	8.2
	AMBOHIMAHAVELONA	6,750	10.5
MAROMIANDRA	4,416	16.9	
BETSINJAKA	7,612	20.3	
SAKARAHA	SAKARAHA	14,718	12.57
	AMBORONABO	4,342	6.73
	ANDAMASINY-VINETA	5,033	9.98
	MAHABOBOKA	4,522	4.53
	BEREKETA	4,435	4.56
	ANDRANOLAVA	4,698	3.10
	AMBINANY	2,554	2.59
	MIKOBOKA	4,316	4.88
ANKAZOABO-SUD	MIARY-LAMATIHY	3,195	7.74
	ANKAZOABO	16,351	7.8
	ANDRANOMAFANA	3,018	2.3
	BERENTY	13,702	5.0
BEROROHA	TANDRANO	6,644	2.5
	BEROROHA	18,113	6.8
	MARERANO	4,544	1.8
	MANDRONARIVO	2,756	2.0
	FANJAKANA	2,211	29.5
	BEHISATSE	2,666	23.4

Table 2.3.2 Cont.

FIVONDRONAMPOKONTANY (Prefecture)	FIRAIAMPOKONTANY (District)	POPULATION	
		Total	Density
MOROMBE	MOROMBE I	10,886	
	MOROMBE II	13,305	
	AMBAHIKILY	19,987	
	ANTONGO VAOVAO	4,238	
	BEFANDRIANA SUD	9,348	
	ANTANIMIEVA	6,205	
	NASINASY	5,945	
	NOSY-AMBOSITRA	5,676	

Table 2.3.3 Number of Cattle in the Study Area in 1988

FIV. SAKARAH

P.V. Sakaraha

Firaisana de :

Sakaraha	:	-----	11,728
Miary Lamatihy	:	-----	6,422
Mahaboboka	:	-----	9,588
Andamasiny Vineta	:	-----	9,023
Amboronabo	:	-----	5,615
Bereketa	:	-----	6,630
TOTAL	:	-----	49,006

P.V. Andranolava

Firaisana de :

Andranolava	:	-----	14,140
Ambinany	:	-----	5,880
Mikoboka	:	-----	15,139
TOTAL	:	-----	35,159

FIV. MOROMBE

P.V. Morombe

Firaisana de :

Ambahikily	:	-----	7,082
Atongo	:	-----	7,110
Morombe	:	-----	2,847
TOTAL	:	-----	17,039

P.V. Befandriana-Sud

Firaisana de :

Antanimieva	:	-----	7,120
Basibasy	:	-----	12,645
Befandriana-Sud	:	-----	24,828
Nosy Ambositra	:	-----	8,274
TOTAL	:	-----	52,867

P.V. Ankililoaka

Firaisana de :

Manombo-Sud	:	-----	1,658
Marofoty	:	-----	915
Ankilimalinika	:	-----	1,993
Tsianisiha	:	-----	2,897
Ankaraobato	:	-----	2,663
Analamisampy	:	-----	8,160
Ankililoaka	:	-----	9,902
TOTAL	:	-----	28,188

Table 2.3.3 Cont.

FIV. TOLIARA IIP.V. Toliara IIFiraisana de :

Betsinjaka	:	-----	1,482
Belalanda	:	-----	1,114
Mitsinjo-Betanimena	:	-----	1,039
Maromiandra	:	-----	1,538
Miary	:	-----	1,010
Andranovory	:	-----	13,685
TOTAL	:	-----	20,168

P.V. AmbohimahavelonaFiraisana de :

Ambohimahavelona	:	-----	2,495
Antanimena	:	-----	4,495
Ambolofoty	:	-----	1,280
Saint-Augustin	:	-----	1,710
TOTAL	:	-----	9,980

FIV> ANKAZOABO-SUDP.V. Ankazoabo-SudFiraisana de :

Ankazoabo-Sud	:	-----	40,074
Andranomafana	:	-----	4,761
Tandrano	:	-----	17,341
TOTAL	:	-----	62,176

P.V. BerentyFiraisana de :

Berenty	:	-----	20,898
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FIV. BEROROHAP.V. BerorohaFiraisana de :

Mandranarivo	:	-----	12,702
Marerano	:	-----	16,511
Behisatra et Fanjakana	:	-----	2,847
Beroroha	:	-----	17,813
TOTAL	:	-----	59,706

Table 2.3.4 Medical Facilities in the Study Area

Facilities	Number	Service level
Hospital	1	Full service
Medical Center	5	One doctor stationed
Dispensary	21	One nurse stationed
Maternity Hospital	6	
Primary Health Center	30	First aid

Note: Doctor 15
 Nurse 40
 Midwife 20
 Helper 50-70

Table 2.3.5 Government and International Agencies and Organizations Concerned with Water Supply

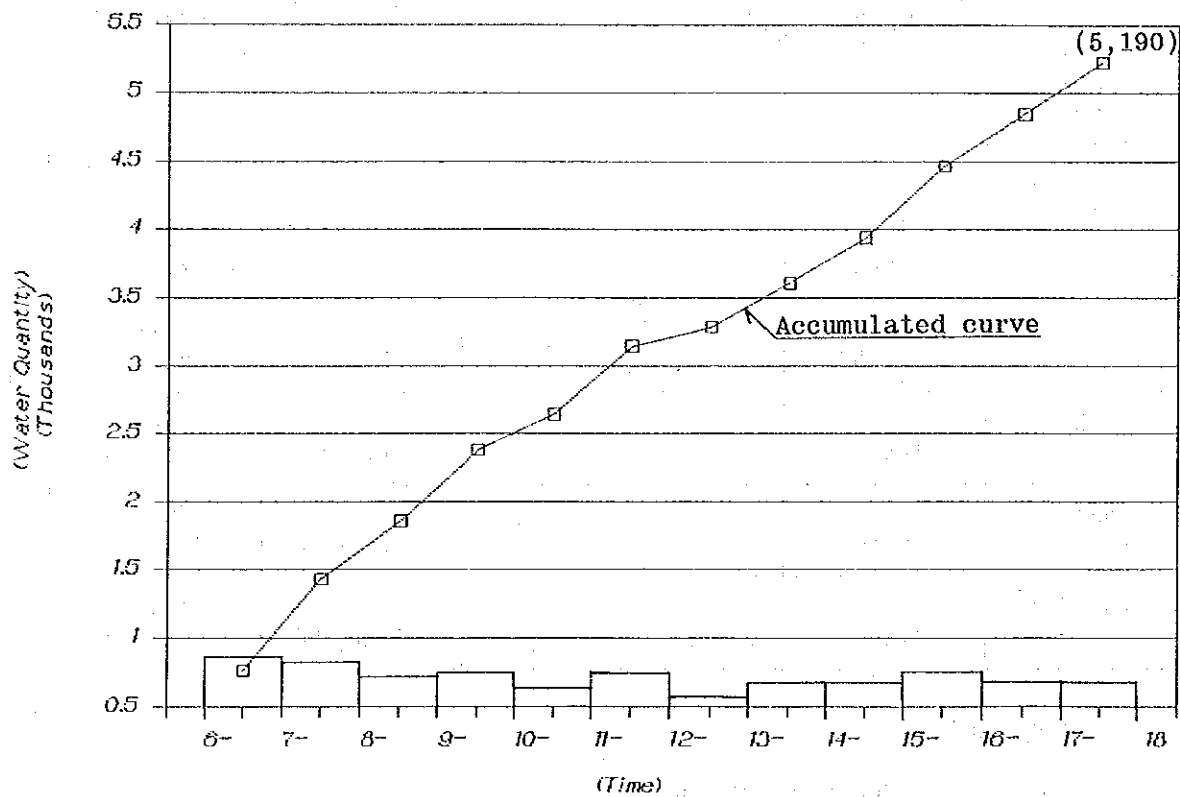
ORGANIZATION	CONSTRUCTION AND CONTROL	MANAGEMENT	MAINTENANCE	EXPLOITATION	NATURE OF INVESTMENT
I. MINISTRY AND PUBLIC CORP.					
1. MIEM (URBAN)	JIRAMA	JIRAMA R.O.	ditto	JIRAMA R.O.	- Local - External
2. MIEM (DEE/SEH, RURAL)	ditto	ditto	ditto	villages	- Local - External
3. JIRAMA (URBAN)	ditto	ditto	ditto	ditto	- Local - External
4. MPARA (DIR)	ditto	R.O.		villages	- Local - External
5. MINSAN (DIR)	ditto	R.O.		villages	- Local - External
6. MIN INT (R.O)	ditto	R.O.	-	villages	- Local - External
7. MPCSJS (DCEE)	Contractors	-		villages	- Local - External
II. ORGANIZATION UNDER CONTROL OF PRESIDENTIAL CABINET					
1. MICROREALISATION	ditto	ditto	-	villages	- Local - External
2. OAES	ditto	ditto	ditto	villages	- Local - External

Table 2.3.5 Cont.

ORGANIZATION	CONSTRUCTION AND CONTROL	MANAGEMENT	MAINTENANCE	EXPLOITATION	NATURE OF INVESTMENT
<u>III. NON GOVERNMENTAL ORGANIZATIONS</u>					
1. FLM	ditto	-	-	villages	- Local - External
2. FIKRIFAMA	ditto	-	-	villages	- Local - External
3. FJKM	ditto	-	-	villages	- Local - External
4. CARITAS	ditto			villages	- Local - External
5. FAFIFAMA	ditto	ditto	-	villages	- Local - External

Abbreviations

- R.O : Regional Office
MIEM : Ministère de l'Industrie de l'Énergie et des Mines
MININT : Ministère de l'Intérieur
MPARA : Ministère de Production Agricole et de la Réforme Agraire
MINSAN : Ministère de la Santé
MPCSJS : Ministère de la Population, de la Condition Sociale, de la Jeunesse et du Sport.

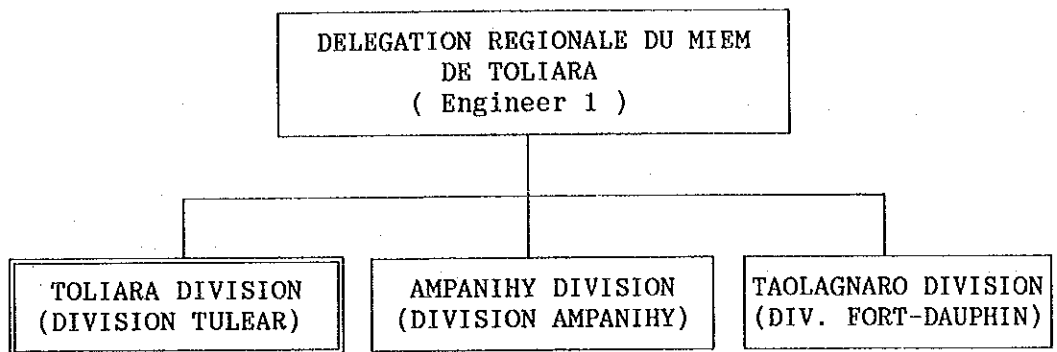


Note

Place : AMPASIKIBO
 Type : well with a hand pump
 Date : Nov. 24. 1989
 Population : 1,500
 Estimated : 3.48 lcd
 consumption per capita per day

The observed total amount of water is obviously less than real consumption of the day since the observation period did not fully cover the real water intake period.

Fig. 2.3.1 Water Consumption Curve



Personnel :
(Staff)

- Engineer 1		
- Assistant engineer.2	- Assistant engineer.1	- Assistant engineer.1
- Office staff.....3	- Office staff.....2	- Office staff.....2
- Skilled labor.....2	- Skilled labor.....2	- Driver.....1
- Mechanics.....2	- Mechanics.....1	- Labor.....2
- Driver.....3	- Driver.....2	
- Labor.....10	- Labor.....21	
- TOTAL.....24	- TOTAL.....30	- TOTAL.....7

Fig. 2.3.2 Organization chart of MIEM TOLIARA

