JAPAN INTERNATIONAL COOPERATION AGENCY

STATE SECRETARIAT OF PLANNING, SCIENCE AND TECHNOLOGY
THE STATE OF SERGIPE, THE FEDERATIVE REPUBLIC OF BRAZIL

THE STUDY
ON
WATER RESOURCES DEVELOPMENT
IN THE STATE OF SERGIPE
IN
THE FEDERATIVE REPUBLIC OF BRAZIL

FINAL REPORT
SUPPORTING
(VOLUME I)
MASTER PLAN STUDY

[K] ENVIRONMENT

MARCH 2000

YACHIYO ENGINEERING CO., LTD. (YEC)

THE STUDY ON WATER RESOURCES DEVELOPMENT
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IN THE FEDERATIVE REPUBLIC OF BRAZIL

SUPPORTING REPORT (K)
ENVIRONMENT

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CHAPTER 1 INTRODUCTION

This Study was implemented over two phases, the Master Plan Study and the Feasibility Study for Priority Project. This report mentions results of environmental study at the Master Plan Study.

Most of information on the existing environmental conditions was provided by ADEMA (Administracao do Meio Ambiente) as local environment management organization. Moreover several field surveys conducted to identify present environmental situation of the study area.

The Initial Environmental Examination is a preliminary environmental impact assessment. The Initial Environmental Examination is conducted at the early stage to identify possible environmental effects and guide further project planning. The general objectives of this supporting report related Initial Environmental Examination are as follows:

1) To provide a baseline information of the existing environmental conditions in the Study Area.
2) To indicate the potential environmental impacts and issues associated with individual water resources development projects in Sergipe State.
3) To point out the key environmental conservation and management plan associated with water resources development projects in Sergipe State.
4) To carry out Initial Environmental Examination on the projects selected in this master plan study.

CHAPTER 2 ENVIRONMENTAL LEGISLATION

2.1 Environmental Laws

The governments of Federal Republic and Sergipe State provide many laws and regulations on environmental conservation and environmental impact assessment. Major environmental enactment related to water resources conservation or development is shown in Table-2.1.

Table-2.1 Environmental Laws and Regulations

Federal/ Stare	Law and regulation	Subject
Federal Law	Constitution Art.225	Federal Environment Basic Law
	Law No.6938, Decree No.99274	National Environmental Policy
	Resolution No.237	National Environmental Policy
	Law No.5197, Law No.6902	Ecosystem (Fauna and Flora) Preservation
	Law No.4771, Law No.7803	Forest Code
	Resolution CONAMA No.01, 09	Environmental Impact Assessment System
	Resolution CONAMA No.20	Water Quality Standard
State Law	Constitution Art.232	State Environmental Basic Law
	Law No.2683	Mangrove Protection
	Law No.2795, Decree No.13468, 13713	State Protected Area
	Law No. 2825	Landscape Control
	Law No.3195, Decree No.2441	Control of Agricultural Toxicant
	Decree No.5371	Protection of Springs, Cultural Property
	Resolution No.01	Environmental Consideration of Construction
	Resolution No.07/92	Water Standard of Vaza-Barries River Estuary
	Resolution No.05/98	Cost Table for EIA (RIMA)
	Resolution No.13/98	Noise Control

State Resolution No.16/79 is to provide the classification of river water, but the execution has not been realized.

2.2 Environmental Impact Assessment System

The Environmental Impact Assessment (EIA) is required in the Federal Law No.6938. The EIA System was enacted under the Resolution CONAMA No.1 on 23 Jan. 1986. The system mandates that all government agencies, government-owned corporations and private companies prepare an Environmental Impact Assessment for any project or activity that affects the quality of the environment. With regard to water resources development, the EIA is necessary for major projects such as construction of dams, pipelines, opening canals, dikes and major reservoirs.

Sergipe state government does not enact the state original decree, the EIA system therefore observes the federal regulations. ADEMA of Sergipe State Secretariat for Environment is the government agency implementing the EIA system and to judge the EIA reports (RIMA: Relatorio de Impact Ambiental) on any project in the state. IBAMA (Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renovaveis) is responsible for projects extending two states more. In case of the projects of rivers controlled by the Federal Government in Sergipe State, the EIA reports will be judged by both ADEMA and IBAMA. The General Flow of Environmental Impacts Assessment System is shown in Figure-2.1.

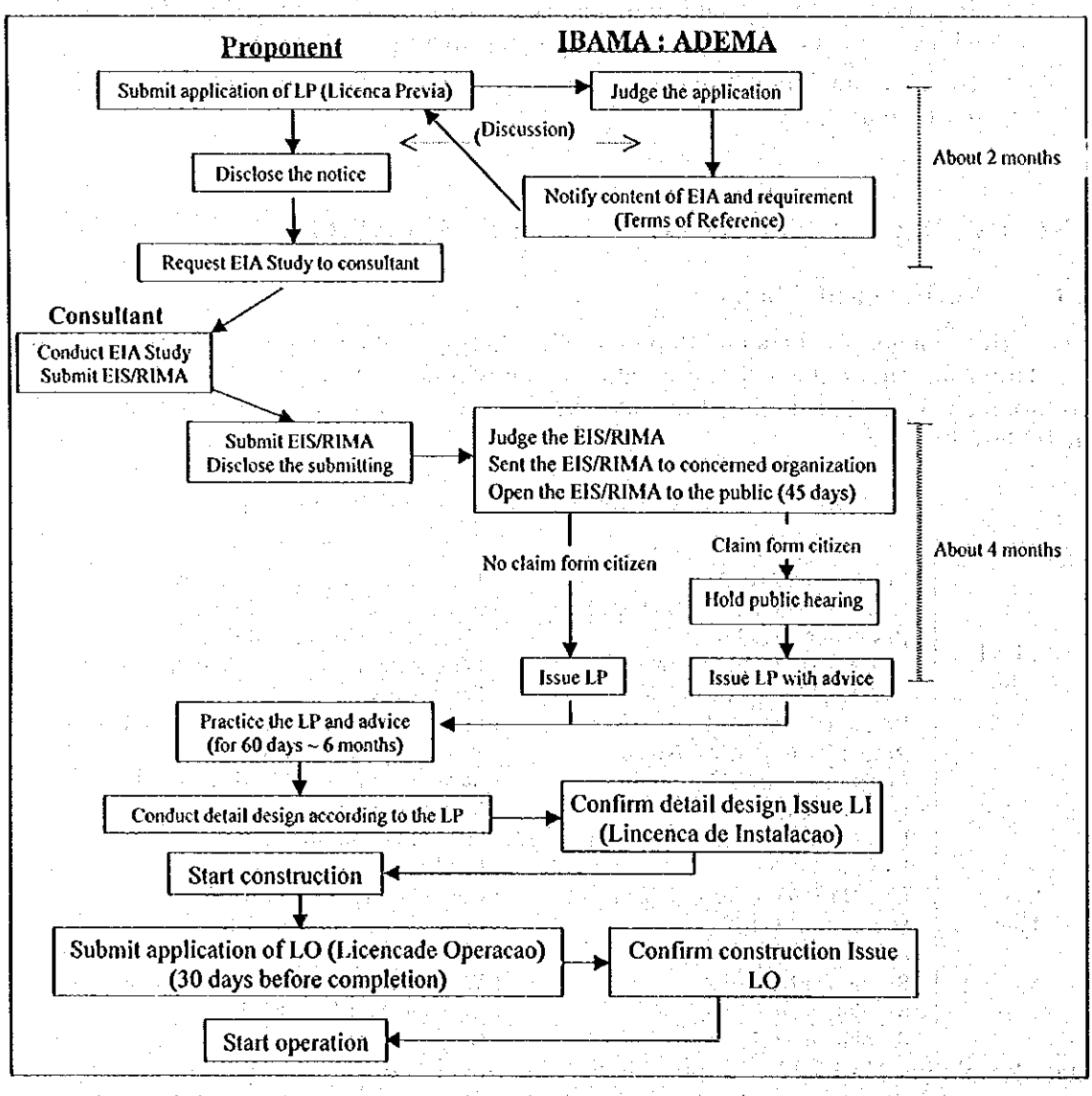

Figure-2.1 General Flow of Environmental Impacts Assessment System

After the approval of the EIS (RIMA), the License of Preparation (LP: Licenca de Previa) is issued. In progressing of the project, moreover, the judgments of License of Instruction (LI: Licenca de Instalacao) and License of Operation (LO: Licenca Operacao) are needed.

CHAPTER 3 ENVIRONMENTAL CONDITIONS OF SERGIPE STATE

3.1 Environmental Issues

Main environmental issues currently occurred in Sergipe Sate are as follows:

1) River water pollution due to untreated domestic and industrial wastewater, and inflow of agricultural chemicals, in particular Sergipe River and Japaratuba River.
2) High salt concentration of groundwater and surface water due to meteorological and geological characters in areas from the center to the northwest of the state.
3) Population concentration from rural areas to cities owing to water shortage and poverty.
4) Uncontrolled solid waste disposal in the whole area of the state.

3.2 Land Use

Dominant land use in Sergipe State is pasture land. Intensive agricultural lands are only small areas. The natural vegetation of inland area is thicket or shrub, which are called Cerrado or Caatinga. Undisturbed Cerrado or Caatinga remain only in limited areas such as mountainous district or hill area because of grazing and/or agricultural activity. The natural vegetation of coastal areas is characterized by mangrove, or evergreen forest called Mata Atlantica. The mangrove forests have thrived well. Small old growth forests are scattered from the coastal area to the middle east part. There are no major inland wetlands and deserts.

A major built-up area is located only in Aracaju urban area. The agricultural land is dominated by sugarcane plantation and small plots cultivated for fruits, cassava, corn, bean and vegetables. Irrigated farmlands are mainly located near Xingo dam and Sao Francisco River mouth because of intake from Sao Francisco River. The stock farming is mostly extensive in semi-arid or arid zone.

Areas of each land use category estimated from satellite image by each drainage basin or municipality are shown in Table-3.1 and Table-3.2.

Table-3.1 (1/2) Area of Each Land Use Category by Each Drainage Basin

Drainage Basin	Sub Drainage Basin No.	Area (km²)	Town	Forest Area			Wood Land			Pasture (Vegetation density > 20%)		
				Plain	Hill	Mountain	Plain	Hill	Mountain	Plain	Hill	Mountain
Sao Francisco	101	258.05		5.91	4.47	1.59				136.68		
	102	925.77	0.57	0.96		36.06	0.39	0.02		583.96		
	103	236.72				25.30	4.06			76.54		
	104	294.23		1.31	26.65		15.96	36.00	2.44	80.70	30.29	
	105	1448.38	1.43		13.61	41.26	205.79	99.72	95.97	449.86	220.69	
	106	536.24	0.26	6.54	9.52	1.34	8.17	255.39		171.91	39.95	
	107	430.20			6.70	3.11		333.20		43.48	28.56	3.12
	108	319.21	0.58		7.04		21.18	51.29	28.41	161.32	22.82	
	109	309.31	0.23	5.52	2.70		30.93	25.38		82.22	95.63	
	110	645.12		13.29	59.02		179.01	72.83		36.91	54.43	
	111	107.69		0.78	17.08		33.81			1.05	26.38	
	151	149.80	0.48	4.07	34.24					60.47		
	152	361.72	0.94	13.24	4.24	35.89	1.53			161.90		
	153	81.07				20.63		7.95		28.35		
	154	288.45		0.89	6.57	17.63	4.60	5.12		90.32	31.15	
	155	29.01	0.01		5.29			4.71			6.30	
	156	87.11	0.16		1.19	10.24		33.63		7.97	10.16	
	157	174.27	0.42	0.85	6.33	4.02		11.42			79.65	
	158	47.97			5.42		0.32	15.67		12.79	0.23	
	159	195.12	0.64		17.51	0.40	7.85	23.81		24.35	28.74	
	160	350.86		32.41			82.32			17.36		
	Sub-total	7276.30	5.72	85.77	227.58	197.47	595.92	976.14	126.82	2231.14	674.98	3.12
Japaratuba	201	365.62	0.08		11.48			84.38	2.41	205.42	2.99	
	202	36.03			9.97					26.06		
	203	233.19	0.67		8.34		3.06	34.08	6.47	156.68		
	204	196.69	1.30	9.34	7.81		13.83			148.34		
	205	362.26	0.22	8.37	15.44		61.87	4.41	32.59	97.14	11.34	
	206	19.25		1.93			0.21			12.81	2.05	
	207	414.72	1.72	17.46	21.67		14.73	55.92		99.37	24.64	
	208	94.24	0.19	8.19	3.72		13.87	0.31		7.89	7.35	
	Sub-total	1722.00	4.18	45.29	78.43		107.57	179.10	41.47	753.71	48.37	
Sergipe	301	476.07		7.83	0.59		104.98	93.25		23.95	59.35	
	302	375.55	0.12	10.54			92.34	9.67		186.65		
	303	468.87	0.85		0.08		6.76	125.85		313.86	0.75	
	304	222.18	1.06	5.98				37.54		162.72		
	305	501.52	0.66	0.76	25.06		3.66	153.00		171.10	59.13	
	306	499.85	3.23	0.81	17.43	5.71	0.24	106.76		118.70	47.00	
	307	88.87	0.57		1.47		9.81	7.37		42.12		
	308	645.73	36.99	33.78	16.59		30.14	3.75		164.69	41.16	
	309	394.36	30.95	7.19	52.80		1.11	44.29		94.40	1.82	
	Sub-total	3673.00	74.43	66.89	114.02	5.71	249.04	581.48		1278.19	209.21	
Vaza Barris	401	436.93	0.80	8.55	7.57		99.74	38.84		59.74	22.68	
	402	274.00	0.16		25.19			62.13	26.22	14.03	57.13	
	403	521.00	1.05	7.52	6.93	6.18	0.44	29.69	24.81	165.19	107.05	
	404	188.97	0.27		3.43	20.24			55.92	64.39	0.16	
	405	173.80	0.38		5.82	2.50		15.79	30.62	59.65	13.03	
	406	233.81	0.35		0.63	0.32		36.16		121.30		
	407	274.07	0.23	2.36	26.03	1.57	4.47	132.00		79.40	0.02	
	408	456.42	1.79	37.79	25.95		24.48	14.80		52.70	58.09	
	Sub-total	2559.00	5.03	56.22	101.55	30.81	129.13	329.41	137.57	616.40	258.16	
Piaui	501	338.61	0.07		67.37	13.07		2.62		199.87	14.76	
	502	743.54	2.55	10.17	103.07	52.77	0.20			300.70	47.21	6.83
	503	698.54	0.39	11.98	158.58	11.51		79.99	0.50	255.69	20.43	
	504	702.63	0.94	28.25	225.96	0.56		6.00		54.59	10.65	
	505	84.17	0.16	0.26	18.99						1.88	
	506	423.02	2.46	14.70	48.43		0.99	34.99		11.19	119.76	
	507	1271.49	2.32	84.31	147.68		78.66	22.35		62.36	118.13	
	Sub-total	4262.00	8.89	149.67	770.08	77.91	79.85	145.95	0.50	884.40	332.82	6.83
Real	601	174.84		7.38						130.67		
	603	937.08	1.11	2.60	108.78	117.62	139.20	2.88		516.86		
	604	424.89	0.54	17.86	59.66	48.91				270.61	3.46	
	605	413.30	0.41	0.02	95.13		2.04			190.02	8.98	
	606	466.43	0.68	9.52	49.33			0.87		80.01	87.86	
	607	125.48	0.25	5.29	31.13			10.18		3.57	1.08	
	609	15.98								0.80		
	Sub-total	2558.00	2.99	42.67	344.03	166.53	141.24	13.93		1192.54	101.38	
Total		22050.30	202.48	893.02	3271.38	956.86	2605.50	4452.02	612.72	13912.76	3249.84	19.90

Table-3.1 (2/2) Area of Each Land Use Category by Each Drainage Basin

Drainage Basin	Sub Drainage Basin No.	Pasture (Vegetation density < 20%)			Mangrove	Salt Marsh	Dunes Vegetation	Cultivation Area			Exposed Rock/Soil	Water
		Plain	Hill	Mountain				Dense	Plane	Hill		
Sao Francisco	101	17.09						87.77	0.06	0.90	0.09	3.49
	102	82.48						207.81	5.36		8.15	0.01
	103	58.14						67.88	4.80			
	104	41.78	22.58					18.03	18.49			
	105	139.98	148.16					10.61	7.31	3.62	9.60	0.77
	106		29.02					0.47	8.41	3.61	0.33	1.32
	107		7.10					0.58	3.46		0.31	0.58
	108							4.82	19.23	1.23	0.09	1.20
	109							47.82	11.01	7.32	0.51	0.04
	110	18.39			0.39	41.36	7.74	86.94	23.59	42.47	6.65	2.10
	111	3.94				0.93				7.58	15.60	0.54
	151	14.59						19.43		1.55	1.02	13.95
	152	4.39						121.53		0.40	4.38	10.28
	153	3.65						15.71				4.78
	154	36.11						52.36	30.86		1.10	11.74
	155		5.59					0.95				6.16
	156		2.82						8.19		1.80	10.95
	157		35.19					2.05	1.81	13.17	1.79	17.57
	158							2.77	1.91		0.78	8.08
	159	0.61						48.29	12.50	4.62	5.13	20.67
	160	77.02			35.78	6.02	3.69		28.64		38.07	29.55
	Sub-total	498.17	250.46		36.17	48.31	11.43	795.82	185.63	86.47	95.40	143.78
Japaratuba	201							38.50		20.36		
	202											
	203							11.97	0.62	11.30		
	204							5.94	5.63	4.02	0.24	0.24
	205							74.48	1.14	54.66	0.60	
	206					2.20		0.05				
	207					10.76		95.46	51.44	21.42		0.13
	208	7.97			13.75	7.70	0.08	0.54	13.57	0.98	7.37	0.76
	Sub-total	7.97			13.75	20.66	0.08	226.94	72.40	112.74	8.21	1.13
Sergipe	301	36.34	2.29					43.80	103.69			
	302	14.08	7.45					10.53	44.17			
	303							8.30	10.75		1.67	
	304							12.03	2.68			0.17
	305		11.27	2.60				61.33	7.97	4.90		0.08
	306		9.13	11.61				170.34	7.06	0.01	0.70	1.12
	307		6.60		3.52			8.24	7.95			1.22
	308	11.03	2.44	3.00	69.01	0.45	41.74	95.09	39.16		16.52	40.19
	309	10.43	69.85	4.99	8.58		16.08	31.28	8.13	0.60	8.07	3.79
	Sub-total	71.88	109.03	22.20	81.11	0.45	57.82	440.94	231.56	5.51	26.96	46.57
Vaza Barris	401	0.66	23.95					0.77	173.58			0.05
	402		78.06					5.79	5.01		0.28	
	403		7.65					17.10	142.18		5.06	0.15
	404	9.49	4.12					13.13	6.69		11.13	
	405		8.88	2.76				33.60			0.77	
	406			8.94				61.49	2.85			1.77
	407	4.35	6.21					16.47	0.54		0.42	
	408	14.90	16.95		73.24	2.46	46.27		36.53		4.22	46.25
	Sub-total	29.40	145.82	11.70	73.24	2.46	46.27	148.35	367.38		21.88	48.22
Piaui	501								7.83	33.02		
	502	20.05						103.43	72.90	18.33	3.09	2.24
	503							73.39	18.11	67.17	0.80	
	504							30.63	27.27	317.78		
	505								0.71	62.17		
	506		5.81					52.23	10.79	121.67		
	507	144.64	13.08		99.75	11.52	67.45	3.39	39.38	290.10	33.85	52.52
	Sub-total	164.69	18.89		99.75	11.52	67.45	263.07	176.99	910.24	37.74	54.76
Real	601	16.13							20.66			
	603	2.70							40.44	0.13	4.76	
	604								12.24	11.61		
	605	22.71						25.32	8.45	60.22		
	606	1.87						41.20	39.68	155.41		
	607				8.13				7.29	56.00		2.56
	609				1.67				7.37			6.14
	Sub-total	43.41			9.80			66.52	136.13	283.37	4.76	8.70
Total		1631.04	1048.40	67.80	627.64	166.80	366.10	3883.28	2340.18	2796.66	389.90	606.32

Table-3.2 (1/2) Area of Each Land Use Category by Each Municipality

Municipality Code	Name	Area (km²)	Town	Forest Area			Wood Land			Pasture (Vegetation density > 20%)		
				Plain	Hill	Mountain	Plain	Hill	Mountain	Plain	Hill	Mountain
01-0120	CANIDE DO SAO FRANCISCO	908.20	1.35	24.37	43.32	30.83	1.54			497.52		
01-0220	FEIRA NOVA	189.30	0.29				0.40	33.99		152.18	0.49	
01-0240	GARARU	640.40	0.81	0.97	12.89	37.94	3.48	177.72	23.82	159.82	91.32	
01-0260	GRACHO CARDOSO	236.20	0.20					131.39		101.89	1.27	
01-0310	ITABI	202.90		6.46	1.97	3.07	5.06	126.35		34.90	5.51	1.58
01-0420	MONTE ALEGRE DE SERGIPE	418.50	0.56		3.86		115.88	22.31	8.98	84.73	77.24	
01-0450	NOSSA SENHORA DA GLORIA	745.40	0.31	6.65	3.61	1.54	88.04	125.78	8.47	223.90	146.87	
01-0540	POCO REDONDO	1220.00	1.07			107.17	23.06	9.77		596.65		
01-0560	PORTO DA FOLHA	895.10	0.56	2.04	40.15	31.99	30.52	48.14	67.77	271.10	75.30	
02-0140	CARIRA	634.60	0.71	17.23			204.43	12.41		109.73	8.54	
02-0230	FREI PAULO	406.80	0.91	7.56	1.16	5.28		10.54		175.00	68.17	
02-0445	NOSSA SENHORA APARECIDA	347.10	0.27	5.05	5.00		33.33	26.86		236.44	5.40	
02-0500	PEDRA MOLE	79.00	0.15		2.18			26.07			44.26	
02-0520	PINHAO	152.70	0.11		6.27			33.90		8.69	29.76	
02-0600	RIBEIROPOLIS	263.00	1.96	2.07	2.06			26.04		214.07	4.90	
03-0020	AQUIDABA	370.20			6.61		0.01	165.30	12.07	165.35	0.03	
03-0190	CUMBE	131.40			13.35			18.72		59.43	2.39	
03-0380	MALHADA DOS BOIS	59.30			0.16		4.02	4.56	22.30	13.44	11.58	
03-0430	MUPIBECA	82.00		0.45	2.05		23.44	2.84	0.77	12.45	2.96	
03-0460	NOSSA SENHORA DAS DORES	482.60	1.24		17.73			157.83		166.59	23.61	
03-0700	SAO MIGUEL DO ALEIXO	143.30	0.23					62.36		70.61		
04-0050	AREIA BRANCA	129.00	0.75		18.81	1.30		17.97		1.02	50.26	
04-0100	CAMPO DO BRITO	200.80	0.33		11.24			51.34	13.20	71.28	10.46	
04-0290	ITABAIANA	338.40	2.35		0.02	1.08		15.34		169.13	1.86	
04-0370	MACAMBIRA	137.40	0.17		12.44			16.58	34.37	21.40	20.28	
04-0390	MALHADOR	102.20	0.84		3.79	2.34		56.22		0.92	9.92	
04-0410	MOITA BONITA	95.70	0.29	0.77	4.58	0.66		6.15		42.76		
04-0680	SAO DOMINGOS	102.30	0.21		1.58	12.29		0.03	24.32	15.28	11.72	
05-0550	POCO VERDE	380.70		8.62	2.06	27.12	18.57			249.50		
05-0710	SIMAO DIAS	560.80	0.97	7.82	27.04	34.97		38.83		144.40	65.29	6.93
05-0740	TOBIAS BARRETO	1119.10	1.54	22.07	168.38	123.78	134.25	2.76		613.36	10.54	
06-0350	LAGARTO	962.50	1.64	5.86	131.82	28.68		107.77	51.62	396.89	17.51	
06-0580	RIACHAO DO DANTAS	528.40	0.40	12.36	91.96	26.12		14.90		319.06	18.82	
07-0010	AMPARO DE SAO FRANCISCO	39.80			8.45			21.56		4.43	2.12	
07-0070	BEIJO GRANDE	149.20		3.95			35.17			0.58		
07-0110	CANHOBA	165.80			7.11			103.73		0.77	32.76	1.44
07-0160	CEDRO DE SAO JOAO	73.00			0.40		3.86	24.70	1.66	32.65	6.28	
07-0270	ILHA DAS FLORES	57.60		5.92			16.15			15.79		
07-0440	NEOPOLIS	249.90	0.23		23.97	0.40	7.69	70.82		15.99	45.70	
07-0470	NOSSA SENHORA DE LOURDES	80.60			0.61			21.49		2.86	35.77	
07-0570	PROPRIA	95.50	0.84				12.84			40.11	0.02	
07-0730	TELHA	56.50			3.34		1.56	1.43		34.01		
07-0999	SANTANA DO SAO FRANCISCO	47.00			0.92		1.43				12.76	
08-0130	CAPELA	431.90	1.51	5.31	21.13		18.92	48.28	37.01	207.90		
08-0200	DIVINA PASTORA	93.00	0.26	0.32	6.52		12.73	13.52		30.94	6.70	
08-0650	SANTA ROSA DE LIMA	66.20	0.12		7.01			22.42			22.86	
08-0720	SIRIRI	167.10	0.38		10.03		4.04	53.37		7.04	37.53	
09-0330	JAPARATUBA	374.00	0.42	10.94	13.10		62.45	2.39		156.11	32.27	
09-0340	JAPOATA	397.40	0.24	19.28	10.48		90.21	21.18		55.86	83.55	
09-0390	PACATUBA	407.30		24.13	36.84		94.00	26.00		14.94	30.68	
09-0530	PIRAMBU	199.20	0.12	1.61	32.59		76.70	0.20		0.86	25.09	
09-0690	SAO FRANCISCO	86.80		0.09			10.88	4.01		58.41		
10-0150	CARMOPOLIS	40.00	0.41	0.45			8.02			28.36		
10-0250	GENERAL MAYNARD	18.10		0.20						16.65		
10-0360	LARANJEIRAS	163.40	0.97	2.93	2.10		17.05			39.23	8.18	
10-0400	MARUIM	95.20	1.49	1.53	1.36					51.54		
10-0590	RIACHUELO	78.60	1.09		0.07		5.33	34.54		10.86	1.69	
10-0610	ROSARIO DO CATETE	103.80	0.66	10.13	6.23		5.20			59.00		
10-0660	SANTO AMARO DAS BROTAS	237.90	0.52	41.25			10.30	0.16		83.52	1.67	
11-0030	ARACAJU	181.80	44.21	1.41	0.12		0.31	3.47		12.89	4.87	
11-0060	BARRA DOS COQUEIROS	87.90	0.64	1.89			0.35					
11-0480	NOSSA SENHORA DO SOCORRO	157.20	15.62	1.96	4.81		5.19	0.90		57.20	0.40	
11-0670	SAO CRISTOVAO	432.40	3.40	8.66	60.88		0.77	27.68		132.21	49.28	
12-0040	ARAUA	194.60	0.03		92.48						2.03	
12-0067	BOQUIM	213.60			83.58			25.49		1.80	1.62	
12-0170	CRISTINAPOLIS	251.30	0.43	0.02	91.62					11.09	41.39	
12-0300	ITABAIANINHA	480.00	0.92	27.44	87.65			5.75		78.91	29.96	
12-0510	PEDRINHAS	39.90	0.30		14.58							
12-0620	SALGADO	255.80	0.46	1.16	70.31			3.22			111.95	
12-0750	TOMAR DO GERU	337.10	0.40		27.79		1.89			144.90	17.12	
12-0760	UMBAUBA	124.10	0.23	5.82	15.57			0.82		0.01	12.25	
13-0210	ESTANCIA	649.60	3.95	35.40	52.43		64.06	4.75		45.14	98.99	
13-0280	INDIAROBA	311.40	0.24	18.27	74.73			9.73		5.49	10.62	
13-0320	ITAPORANGA D' AJUDA	757.30	0.63	60.03	48.90	1.87	49.62	123.63		80.01	39.63	
13-0630	SANTA LUZIA DO ITANHY	336.20	0.30	26.06	81.89					18.83	2.92	
Total		22050.30	101.24	446.51	1635.69	478.43	1302.75	2226.01	306.36	6956.38	1624.92	9.95

Table-3.2 (2/2) Area of Each Land Use Category by Each Municipality

Municipality Code	Name	Pasture (Vegetation density <20%) Plain	Hill	Mountain	Mangrove	Salt Marsh	Dunes Vegetation	Cultivation Area Dense	Plane	Hill	Exposed Rock/Soil	Water
01-0120	CANIDE DO SAO FRANCISCO	36.37		1.61				235.61	1.01	2.87	5.53	26.27
01-0220	FEIRA NOVA							1.95				
01-0240	GARARU		60.41					0.54	22.80	23.88	3.90	20.10
01-0260	GRACHO CARDOSO											1.45
01-0310	ITABI		14.47						3.53			
01-0420	MONTE ALEGRE DE SERGIPE	60.86	36.37						5.09		2.45	0.17
01-0450	NOSSA SENHORA DA GLORIA	20.54	86.60					10.84	16.26		5.48	0.51
01-0540	POCO REDONDO	151.97						306.40	5.89		9.34	8.68
01-0560	PORTO DA FOLHA	135.54	29.23					90.63	50.20	3.84	1.78	16.31
02-0140	CARIRA	26.03						31.93	223.59			
02-0230	FREI PAULO							15.90	122.13			0.15
02-0445	NOSSA SENHORA APARECIDA	10.97	8.76					6.24	8.78			
02-0500	PEDRA MOLE		2.95						3.39			
02-0520	PINHAO		7.41						66.56			
02-0600	RIBEIROPOLIS		5.10					6.52				0.28
03-0020	AQUIDABA									20.83		
03-0190	CUMBE							33.48		4.03		
03-0380	MALHADA DOS BOIS							3.21	0.03			
03-0430	MUPIBECA							11.05	0.38	25.61		
03-0460	NOSSA SENHORA DAS DORES		9.02	0.59				83.38	14.87	5.88	1.68	0.18
03-0700	SAO MIGUEL DO ALEIXO								10.10			
04-0050	AREIA BRANCA		4.23	12.72				21.37			0.57	
04-0100	CAMPO DO BRITO			11.02				30.40	0.13			1.40
04-0290	ITABAIANA			0.45				135.95	10.41			1.81
04-0370	MACAMBIRA		21.17					8.15	2.71		0.13	
04-0390	MALHADOR		4.99	0.82				22.36				
04-0410	MOITA BONITA							39.07	1.42			
04-0680	SAO DOMINGOS		3.40					20.69	0.06		12.72	
05-0550	POCO VERDE	22.01							52.82			
05-0710	SIMAO DIAS	13.85	65.97					75.44	70.32	8.61	0.31	0.05
05-0740	TOBIAS BARRETO								11.74	23.20	7.48	
06-0350	LAGARTO	8.91	25.84					140.55	27.48	14.83	1.13	1.97
06-0580	RIACHAO DO DANTAS								8.73	36.05		
07-0010	AMPARO DE SAO FRANCISCO		0.30					0.12			0.31	2.51
07-0070	BREJO GRANDE	31.37			24.36	3.93	1.75		28.37		2.20	17.52
07-0110	CANHOBA		6.94					2.35	3.50	0.48	0.69	6.03
07-0160	CEDRO DE SAO JOAO							0.39	2.26		0.23	0.57
07-0270	ILHA DAS FLORES	13.33				1.84	0.16					4.41
07-0440	NEOPOLIS	3.15				0.47		48.27	16.30	8.81	0.79	7.31
07-0470	NOSSA SENHORA DE LOURDES		17.43					0.02		0.18		2.24
07-0570	PROPRIA							15.54	12.10		3.25	10.80
07-0730	TELHA							3.16	7.69		0.28	5.03
07-0999	SANTANA DO SAO FRANCISCO							18.78	7.48		1.10	4.53
08-0130	CAPELA							51.58	7.46	32.55		0.25
08-0200	DIVINA PASTORA		0.94		0.12			1.85	12.00	7.10		
08-0650	SANTA ROSA DE LIMA		1.05	3.62				7.79		1.33		
08-0720	SIRIRI							5.25	35.05	14.37		0.04
09-0330	JAPARATUBA					0.97		61.20	5.60	25.38	3.17	
09-0340	JAPOATA	0.67				1.84		71.25	21.27	20.68	0.89	
09-0490	PACATUBA	47.19			11.56	34.15	8.73	11.27	3.42	20.94	35.18	8.27
09-0530	PIRAMBU	7.66			3.32	5.30		4.71	3.41	11.12	25.48	1.03
09-0690	SAO FRANCISCO							12.66	0.75			
10-0150	CARMOPOLIS					2.76						
10-0250	GENERAL MAYNARD					0.47			0.78			
10-0360	LARANJEIRAS	4.84	0.13		10.18			63.22	4.88	2.00	1.36	6.33
10-0400	MARUIM		7.04		5.80			21.78	3.88			0.78
10-0590	RIACHUELO		2.09		1.71			19.64	1.58			
10-0610	ROSARIO DE CATETE					1.02		17.29	4.27			
10-0660	SANTO AMARO DAS BROTAS	3.02			28.06	14.67		13.14	26.85		5.48	9.26
11-0030	ARACAJU				23.43		51.41	1.58	9.53		5.62	22.95
11-0060	BARRA DOS COQUEIROS	6.95			22.58	0.44	39.66		0.58		8.95	5.86
11-0480	NOSSA SENHORA DO SOCORRO	11.71			13.96			15.26	14.74		4.74	10.71
11-0670	SAO CRISTOVAO	3.47	85.53		29.59			15.38	0.96	0.55	1.41	12.63
12-0040	ARAUA							1.71	9.42	88.93		
12-0067	BOQUIM							25.66	6.58	68.87		
12-0170	CRISTINAPOLIS							21.74	28.07	56.94		
12-0300	ITABAIANINHA								12.20	237.17		
12-0510	PEDRINHAS							16.59	5.12	3.31		
12-0620	SALGADO		2.56					5.14	9.41	51.59		
12-0750	TOMAR DO GERU	18.65						41.70	22.05	62.60		
12-0760	UMBAUBA									89.40		
13-0210	ESTANCIA	50.14	9.10		50.17	2.63	38.89		21.28	119.28	19.09	34.30
13-0280	INDIAROBA	1.06			24.62				30.53	119.83	0.34	15.94
13-0320	ITAPORANGA D' AJUDA	125.26	5.17	3.07	39.80	12.91	42.45	13.96	50.29	11.00	21.89	27.18
13-0630	SANTA LUZIA DO ITANHY				24.56					174.29		7.35
Total		815.52	524.20	33.90	313.82	83.40	183.05	1941.64	1170.09	1398.33	194.95	303.16

3.3 Social Environment

(1) Ethnic Group

There are no specific areas with original culture or tradition, such as the Indio Park, in Sergipe State.

(2) Cultural and Historical Property

Potsherds and rock wall paintings of indigenous people have been excavated at the suburbs of Itabaiana City and the upper valley of Xingo Dam respectively. There is an excavation site of fossils in Canhoba. Sao Cristovao City, Laranjeiras City and Salgado City are designated as historic or cultural area by the state decree.

(3) Endemic Disease

There are schistosomiasis and dengue fever as an endemic disease in the whole area of Sergipe State. However, because local governments have conducted the campaign, education program and sprinkling of pesticides, the patients, especially dengue fever's, have been decreasing considerably. Increases of the patients caused by water development projects have not been identified in Sergipe State.

(4) Fishery

Main fishery activities in Sergipe State are divided into two distinct categories. They are estuary fisheries and marine fisheries. In inland rivers, economical fishery activities are hardly practiced. The estuary fisheries use canoes with oar or sail, and are almost a day trip in according with the tides. Shrimps account for about 60 % of the total production. The fishing production by class in 1997 is shown in Table-3.3. The fishing production by municipality and month in 1997 is shown in Table-3.4.

Table-3.3 Fishing Production by Class in 1997

Class	Production (ton)	%
Fish	842.2	24.8
Crustaceans	2,397.2	70.5
Mollusks	162.1	4.7
Total	3,401.5	100.0

Source: Statistical Bulletin of Marine and Estuary Fishery -1997- Sergipe

Table-3.4 Fishing Production by Municipality and Month in 1997

Unit: ton

Municipality	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Ilha das Flores	11.4	17.8	17.7	13.4	10.1	1.2	1.0	18.2	17.7	13.7	19.1	19.9	161.3
Brejo Grande	5.6	2.8	2.2	4.2	3.2	4.9	3.9	7.9	3.5	3.1	4.6	9.8	55.6
Pirambu	74.3	64.1	48.5	58.0	31.4	50.9	106.9	119.9	91.3	59.3	90.7	88.8	884.0
Maruim	5.8	9.0	2.3	3.0	8.6	8.5	6.3	9.7	1.4	0.6	16.1	13.6	84.9
S. A. das Brotas	6.1	9.3	2.8	3.2	6.4	10.1	6.9	12.1	2.5	4.4	15.3	11.7	90.8
N. S. do Socorro	7.2	10.3	14.4	13.9	12.9	6.3	18.2	12.0	16.7	24.0	27.0	24.4	187.6
Aracaju	99.3	70.5	103.1	94.4	68.8	96.1	167.9	150.4	68.0	63.5	140.5	101.1	1223.8
Sao Cristovao	18.1	9.9	9.9	13.1	13.0	14.7	15.3	20.6	16.1	18.5	15.2	12.3	176.6
Estancia	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.1
S. L. do Ltanhy	46.1	28.1	48.2	61.1	19.5	35.1	43.1	61.4	62.2	35.5	47.3	35.5	523.1
Indiaroba	0.5	0.5	0.6	0.5	0.5	0.6	1.3	1.2	1.6	1.9	1.7	1.8	12.7
Total	274.5	222.4	249.9	264.9	174.6	228.5	370.9	413.5	281.1	224.5	377.6	318.9	3401.5
%	8.1	6.5	7.3	7.8	5.1	6.7	10.9	12.2	8.3	6.6	11.1	9.4	

Source: Statistical Bulletin of Marine and Estuary Fishery -1997- Sergipe

3.4 Natural Environment

(1) Vegetation

The natural vegetation can be divided into five types: They are mangrove and coastal forest zone called Mata Atlantica, evergreen or deciduous forest zone, deciduous forest and Cerrado zone, and two types of Caatinga zones (drought resistant and high drought resistant). Caatinga is found in more arid zone than Cerrado.

Cerrado : Woods composed of stunted and twisted trees (height 3 to 6 m), growing on cattle-grazing land.

Caatinga: Stunted sparse forest found in the drought areas; dominated by trumpet bush, *Bignoniaceous Caesalpiniaceous* and *Cereus*. The typical dominant species are *Mimosa bo*stilis and *Caesalpinia pyramydalis*.

Mangrove forests in the coastal areas have thrived well. The dominant mangrove species are *Rhizophora mangle, Avicennia spp., Laguncularia racemosa and Conocarpus erectus*. The natural vegetation of the inland remains only in limited areas such as mountainous district, hill area and riverside because of grazing and/or agricultural activity.

(2) Wildlife

The information on the fauna is based on interviews of the local people, therefore the data are very poor. Most of the endemic fauna species have disappeared because of reforestation. However, amphibian and aquatic animals have thrived relatively well, caimans have been identified in the residual forests of Cerrado and Mata Atlantica zone. Large-sized carnivorous mammals such as jaguar have not been identified in the State. Rock cavy (*Kerodon rupestris*) is a well-known endemic specie in the Cerrado zone.

Aquatic life of rivers in Sergipe State can be divided two types roughly depend on the salinity level of the river water. Because of low salinity level of river water, aquatic life in Sao Francisco River and Japaratuba River is similar. Curimbata (*Prochilodus argentlees*) that swim up river from the sea to spawn have been identified in these two rivers. In the other four rivers, aquatic life with salinity tolerance is dominant.

Although surveys on the habitats of the endemic or endangered fauna and flora have not been conducted in the whole state yet, these species inhabit only limited areas such as sizable mangrove forests or undisturbed forests scatted in southern part of Sergipe State. The small amount of remaining riverside forest provides some habitat for wildlife too.

List of fauna species likely to occur in Sergipe State is given in the Data Report.

(3) Protected Area

There are seven protected areas in Sergipe State. They are shown in Table-3.5. These locations and the other environmental information are shown in Figure-3.1.

Table-3.5 Protected Areas in the State

Name	Category	Location	Remark
Santa Isabel Biological Reserve	Federal	Pirambu Pacatuba	Protection of turtle coast and ecosystem
Itabaiana Ecological Habitat	Federal	Itabaiana, Areia Branca	Protection of ecosystem in Itabaiana mountain
Vaza-Barris River Estuary Environmental Protection Area	State	Itaporanga, Aracaju Sao Cristovao	Protection of permanent natural character
Southern Coast Environmental Protection Area	State	Itaporanga, Estancia Sta. Luzia, Itanhy	Protection of permanent natural character
Morro do Urubu Environmental Protection Area	State	Aracaju	Protection of residual Atlantic forest
Sergipe River Environmental Protection Area	State	Aracaju, Barra dos, Coqueiros	Protection of natural landscape and environment
Taramanday Municipal Ecological Park	Municipal	Aracaju	Protection of mangrove forest

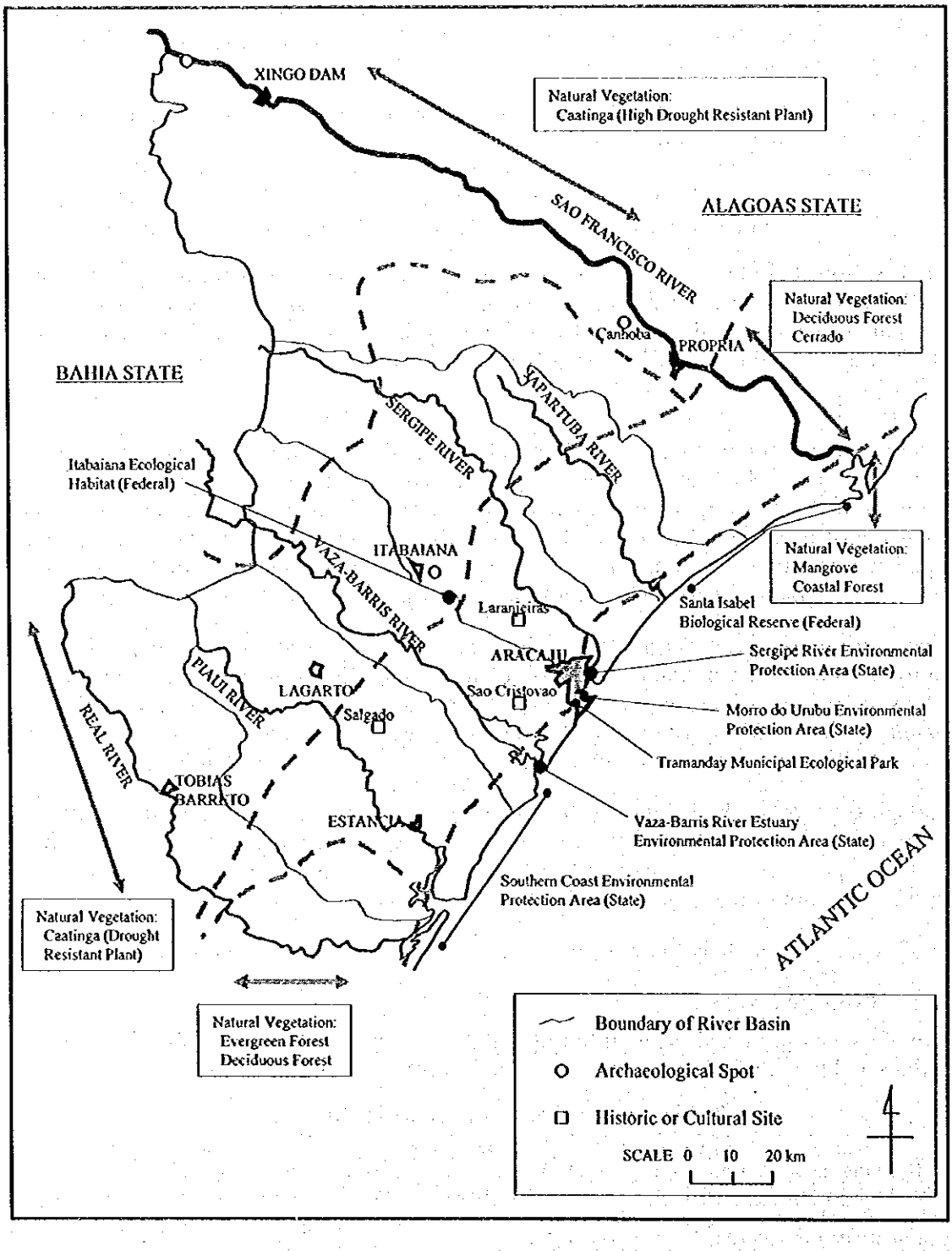

Figure-3.1 Environmental Characteristics in Sergipe State

3.5 Environmental Characteristics of Each Drainage Basin

(1) Sao Francisco River Basin

The natural vegetation is mangrove or coastal forest in the coastline and Cerrado or Caatinga in the inland. However, the natural vegetation remains only in limited areas because of grazing and/or agricultural activity. In the northwestern and southeastern part of the basin, the vegetation has thrived relatively well. According to Xingo Dam EIA report, a few endemic reptilian species have been identified.

There is leishmaniasis (schistosomiasis transmitted by mosquitoes), an endemic disease, in the basin. The main environmental issues currently facing the basin are river water pollution due to untreated domestic and industrial wastewater, and uncontrolled solid waste disposal. The shortage of sanitary facilities has caused waterborne diseases such as polio, typhoid fever, hepatitis and cholera.

Potsherds and rock wall paintings of 1200 to 8000 years old have been excavated at the upper valley of Xingo Dam. There is an excavation site of fossils in Canhoba. The coastline is designated as Santa Isabel Biological Reserve to protect turtles and the ecosystem.

(2) Japaratuba River Basin

The natural vegetation is coastal forest, Cerrado and Caatinga. However, the natural vegetation remains only in limited areas because of human economic activity. Along the coast, the coastal forest have thrived relatively well, small forest areas are scattered in the inland.

There is schistosomiasis, an endemic disease, in the basin. The main environmental issues currently facing the basin are river water pollution due to untreated industrial, mining and domestic wastewater, and uncontrolled solid waste disposal. In particular, water pollution of Japaratuba River due to untreated industrial wastewater is a serious problem.

There are many kinds of fish in the Siriri River; therefore, fishery is flourishing in the river. However, the fishermen use a poison to catch the fish and shrimp. The coastline is designated as Santa Isabel Biological Reserve to protect turtles and the ecosystem.

(3) Sergipe River Basin

The natural vegetation is mangrove or coastal forest in the coastline and Cerrado or Caatinga in the inland. However, the natural vegetation hardly remains because of human economic activity. Only mangrove forests have thrived in the coastal area well.

The main environmental issues are water pollution due to industrial wastewater, air pollution and uncontrolled industrial solid waste disposal in the lower part. In particular, water pollution of Sergipe River due to industrial wastewater and industrial solid waste is a serious problem.

Shrimps are framed in the Pomanga River. Potsherds of indigenous people have been excavated at the suburbs of Itabaiana City. Laranjeiras City is designated as historic or cultural area by the state decree.

There are Sergipe River Environmental Protection Area and Taramanday Municipal Ecological Park in Aracaju.

(4) Vaza Barris River Basin

The natural vegetation is mangrove or coastal forest in the coastline and Cerrado or Caatinga in the inland. However, the natural vegetation hardly remains because of human economic activity. The major natural forests are found only in and around Vaza Barris River estuary.

There is schistosomiasis, an endemic disease, in the basin. The main environmental issues currently facing the basin are river water pollution due to untreated domestic and agricultural wastewater, and uncontrolled solid waste disposal. Vaza Barris River water has high salt concentration due to meteorological and geological characters.

There are many shrimps in the Vaza Barris River estuary, therefore fishery is flourishing and very important activity around the estuary. Sao Cristovao City is designated as historic or cultural area by the state decree.

Mangrove forests in the estuary are protected by the state decree. And there are Itabaiana Ecological Habitat, Vaza-Barris River Estuary Environmental Protection Area and Southern Coast Environmental Protection Area in the basin.

(5) Piaui River Basin

The natural vegetation is mangrove or coastal forest in the coastline and evergreen forest or Cerrado or Caatinga in the inland. However, the natural vegetation remains only in limited areas such as mountainous districts or the estuary because of human economic activity. In the southeastern part of the basin, the vegetation has thrived relatively well. Small forest areas are scattered in the middle and northwestern part.

The main environmental issues currently facing the basin are river water pollution due to untreated industrial and domestic wastewater, and uncontrolled solid waste disposal. In particular, water pollution around industrial areas due to industrial wastewater and uncontrolled solid waste is a serious problem.

Fishery is flourishing and very important economic activity in the estuary. Salgado City is designated as historic or cultural area by the state decree. The coastline is designated as Southern Coast Environmental Protection Area.

(6) Real River Basin

The natural vegetation is evergreen forest or Cerrado or Caatinga. However, the natural vegetation remains only in limited areas such as mountainous districts or the estuary because of human economic activity. In the southeastern and southeastern part of the basin, the vegetation has remained relatively well.

The main environmental issues currently facing the basin are river water pollution due to untreated domestic and industrial wastewater, and uncontrolled solid waste disposal. There are no major industrial areas in the basin but the dumping of industrial organic solid waste has caused the river water pollution.

The coastline is designated as Southern Coast Environmental Protection Area.

CHAPTER 4 INITIAL ENVIRONMENTAL EXAMINATION

4.1 Potential Environmental Impacts

4.1.1 Change of River Flow and Wastewater Discharge

River development projects with direct intakes or dam reservoirs and well development projects will cause change of the flow regime. In general, the developed water does not completely return into the rivers. Therefore, surface water developments will decrease the river flow even if the developed water returns into the same river basin. New water resources developments lead to increase in wastewater discharge. Change of river flow and wastewater discharge by each basin after project implementation identified in this Master Plan Study is shown in Table-4.1. The numerical analyses are carried out based on the following two assumptions:

Case-I: Water used for irrigation does not return to a river at all.
Water used for other purposes completely returns into a river.
Case-II: Half of developed water including groundwater returns into a river.

These analyses ignore amount of evaporation from newly constructed reservoirs and change of groundwater recharge caused by well development projects.

Table-4.1 Change of River Flow and Wastewater Discharge in 1997 - 2020

Item	S. Francisco R. Basin	Japaratuba R. Basin	Sergipe R. Basin	Vaza Barris R. Basin	Piaui R. Basin	Real R. Basin	Total or Average
Average Flow (m^3/day) : 1997 at River Mouth	153,792,000	915,840	1,195,776	1,351,296	1,980,288	1,767,744	161,002,944
Total Developed Surface Water (m^3/day)	1,660,568	79,196	111,583	344,457	107,267	8,832	2,311,903
Developed Surface Water Rate to Surface Flow at River Mouth	1.1%	8.6%	9.3%	25.5%	5.4%	0.5%	1.4%
Case-I: Average Flow (m^3/day): 2020 at River Mouth	152,202,219	872,226	1,345,729	1,055,634	1,982,127	1,780,141	159,238,076
Surface Flow Change Rate	99.0%	95.2%	112.5%	78.1%	100.1%	100.7%	98.9%
Case-II: Average Flow (m^3/day): 2020 at River Mouth	152,877,439	885,585	1,262,332	1,157,043	1,938,052	1,769,527	159,889,978
Surface Flow Change Rate	99.4%	96.7%	105.6%	85.6%	97.9%	100.1%	99.3%
Domestic Wastewater Rate to Surface Flow: 1997	0.02%	1.40%	11.15%	1.64%	1.92%	0.84%	0.16%
Domestic Wastewater Rate to Surface Flow: 2020 Case-I	0.04%	2.74%	16.61%	3.71%	3.25%	1.32%	0.27%
Industrial Water Rate to Surface Flow: 1997	0.01%	2.63%	7.67%	0.24%	0.97%	0.06%	0.09%
Industrial Water Rate to Surface Flow: 2020 Case-I	0.03%	6.51%	30.60%	5.76%	4.76%	0.12%	0.42%

After implementations of the two big projects, Xingo Dam Pipeline Project and Vaza Barris Dam Project, the flows of Sao Francisco River and Vaza Barris River will be decreased. In Sao Francisco River that have abundant flow throughout the year, the decrease will be 0.1% in the Case-I and have no serious impact on the flow regime. In Vaza Barris River, the decrease will be 22% throughout the year. Because the flow changes between the rainy season and the dry season considerably, Vaza Barris Dam project will have some impact on the flow regime.

In Sergipe River, wastewater discharge will increase considerably in 2020. Because, compared with other basins, the wastewater rate will be high level, measures against the water contamination should be given priority in this basin.

4.1.2 Water Pipeline Projects

(1) Potential Environmental Impacts

General water pipeline projects have no serious negative impacts potentially. But depending on the location of pipeline, negative impacts will occur. Major environmental impacts will occur at construction stage.

Land acquisition and relocation of residents in urban areas may be needed. But in the case of pipeline located along existing roads, these problems hardly occur. In the case of pipeline located in archaeological and historical sites, construction works affect directly these properties. Construction works may cause changes in the physical environment. Especially land clearing and excavation may damage the wildlife, the soil, the water and the air. However, significant negative impacts on the wildlife will not occur because most of the study area is flat or rolling topographically, moreover the vegetation is poor and monotonous biologically. Heavy equipment operation may generate harmful dust and noise that would affect trees, crops, animals as well as residents near the construction site. During construction works, temporary traffic jams may occur in urban areas.

Reconsideration of water right may be needed. In case of intake from Federal River such as Sao Francisco River, the reconsideration will be more complicated.

(2) Mitigation and Monitoring

The design of pipeline alignment should consider minimizing the changes to physical environment as well as the construction cost. In forest areas, land clearing and tree-cutting should be well planned and implemented within the restricted area. To minimize soil erosion during construction, land clearing and excavation works should be mainly implemented during the dry season.

The contractors should maintain heavy equipment in good condition and use appropriate methods and equipment to prevent noise, dust, water pollution, soil contamination, vibration and traffic jam.

The water right should be considered strictly at the feasibility study stage.

4.1.3 Vaza Barris Dam Project

(1) Potential Environmental Impacts

Vaza Barris dam project has potentially serious negative impacts on many environmental items. Major environmental impacts will occur at operation stage as well as construction stage.

Large land acquisition and relocation of residents may be needed for the dam site and the reservoir. Vegetation, cultural properties, houses, cemeteries, farm roads and farmland located in the reservoir area will be submerged. However, because there are no villages in the inundated area, people requiring relocation would be expected to be a small number. Because most of the inundated area is extensive pasture land, the agricultural resources loss will not be large. There are no major infrastructure facilities or cultural properties in the area also.

Construction works such as land clearing, excavation, blast and hauling operations will change the physical environment drastically and damage the landscape, the wildlife, the soil, the water and the air. Although the small areas of riverside forests provide wildlife habitats, most of the dam site and reservoir area is relatively void of wildlife. Therefore serious negative impacts on terrestrial wildlife will not occur. Heavy equipment operation may generate harmful dust and noise. However, the impacts are limited because of no residences in the dam site.

After the dam is closed, the hydrological situation will change drastically. The sediment load of the downstream will be greatly reduced. Moreover migration of fish will be obstructed. Changes of water quality and hydrological situation may damage the ecosystem, the water use and the fisheries in downstream area. There is mangrove forest zone in the estuary, where shrimp fishery is flourishing. The registered fisher persons were 1,401 people as of 1998, the total including unregistered reaches approximately 6,000 people in a season. State environmental protection area is located in the estuary. It is said that decreases in down flow, sediment load and nutrient due to dam construction influence ecosystem of mangrove zone.

The reservoir will lead to an increase in the potential of water borne disease and provide breeding areas for mosquitoes. Therefore water or mosquito borne disease such as schistosomiasis or dengue fever would increase.

An increase of workers to the area will put additional pressure on the social services and the medical facilities. On the other hand, dam construction works will bring additional income to the local residents in terms of the employment of workers, the local economy will be revitalized subsequently.

(2) Mitigation and Monitoring

To obtain the agreement of affected population, the information disclosure should be conducted at an early stage. The resettlement program should consider quality of life, economic and social support and cultural background. The compensation for land acquisition must be sufficient.

Land clearing and tree-cutting should be well planned and implemented within the restricted area. To minimize soil erosion, cut slope, land clearing and soil stripping works should be mainly implemented during the dry season. To prevent noise, dust, water pollution, soil contamination and vibration, the contractors should maintain heavy equipment in good condition and use appropriate construction methods and equipment.

Buffer areas around the reservoir should be created, where reforestation programs should be implemented to replace lost vegetation cover such as riverside forests. The choice of plants species must be considered adaptable to the environment. It is available to use local plants on the reservoir area.

Environmental monitoring should be conducted to recognize the transition of environmental aspects such as air, water, soil, noise, vibration, fauna and vegetation in both periods during construction and operation. Especially, the long-term transitions of ecosystem and topography in the estuary should be monitored according to the prior plan before the construction begins.

Disease vectors tend to breed in stagnant drains and field edges. The design of spillway, channel and drainage should be considered measures against vectors. An educational program on these diseases should be conducted for local people and construction worker.

An environmental specialist should be enlisted in the site supervisor consultants to help prevent soil erosion, noise, dust, water pollution and inadequate tree cutting, and to monitor the mitigation measures and the environmental aspects.

More detailed information is given in the Feasibility Study Report.

4.1.4 Well Development Projects

(1) Potential Environmental Impacts

Generally well development projects have no potentially serious negative impacts. But depending on the location of projects, negative impacts will occur. Major environmental impacts will occur at construction stage.

Digging works may generate harmful turbid water, vibration and noise that would affect crops, animals as well as residents near the construction site.

The main impacts during the operation stage are related to over pumping-up. Over pumping-up may cause ground subsidence in thick viscous soil layer area and saltwater intrusion in coastal zone or arid areas where increase the salinity level in deep ground water. Private wells may be affected by over pumping-up near the site. However, the quantity of development water identified in this study is suitable, significant impacts will not occur consequently.

The desalination may drain wastewater with high salinity level. The wastewater may affect the river water, the soil and the wildlife.

The fresh water rate of groundwater by municipality is showed in Figure-4.1. Potential of the salinization due to well developments is generally high in the low rate area.

(2) Mitigation and Monitoring

The contractors should maintain heavy equipment in good condition and use appropriate construction methods and equipment to prevent noise, water pollution and vibration.

To prevent water contamination due to wastewater from desalinators, the suitable specifications of desalinator should be selected. The proper disposal measures of the wastewater should be considered.

Water quality monitoring should be conducted to check the saltwater intrusion.

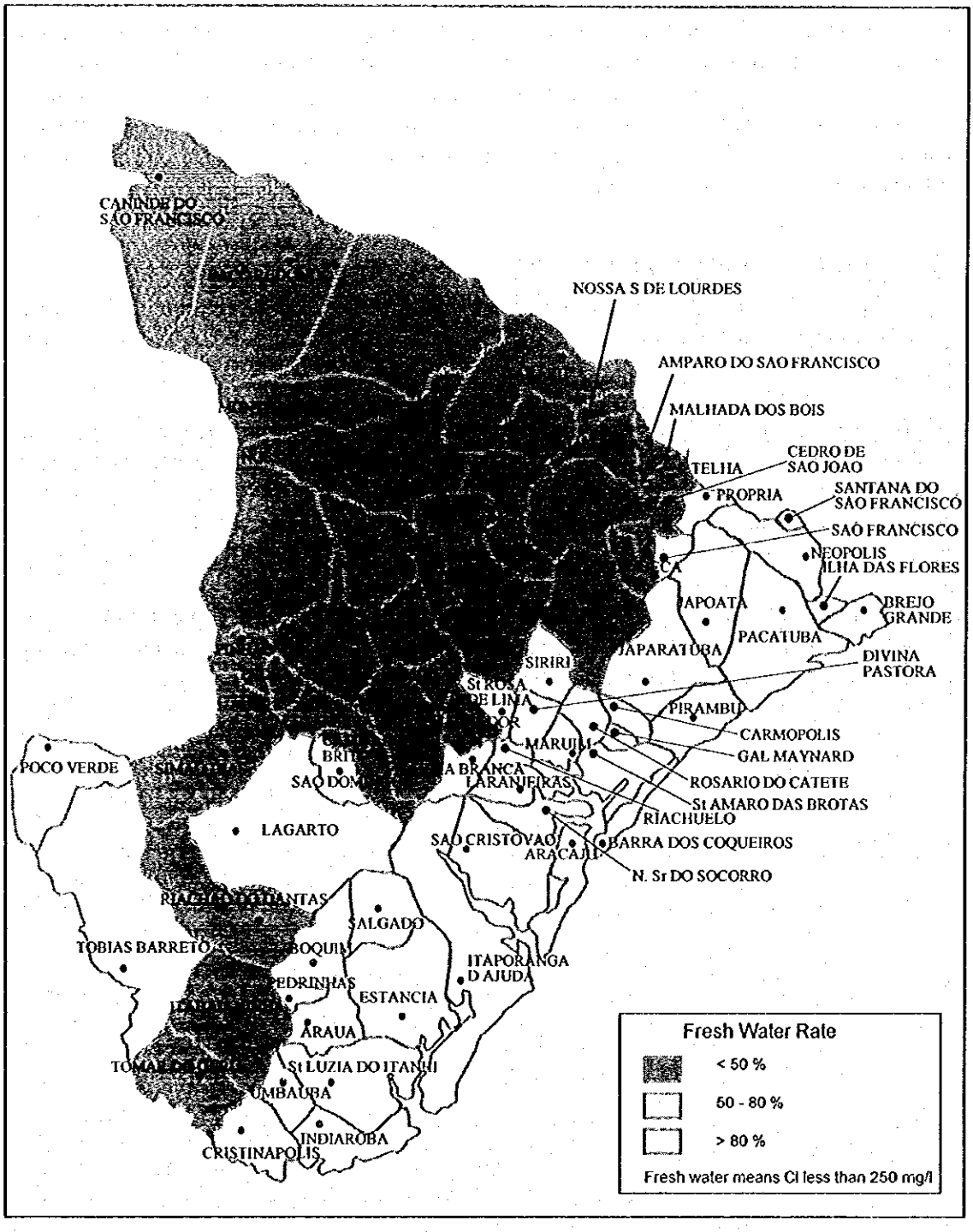

Figure-4.1 Fresh Water Rate of Groundwater by Municipality

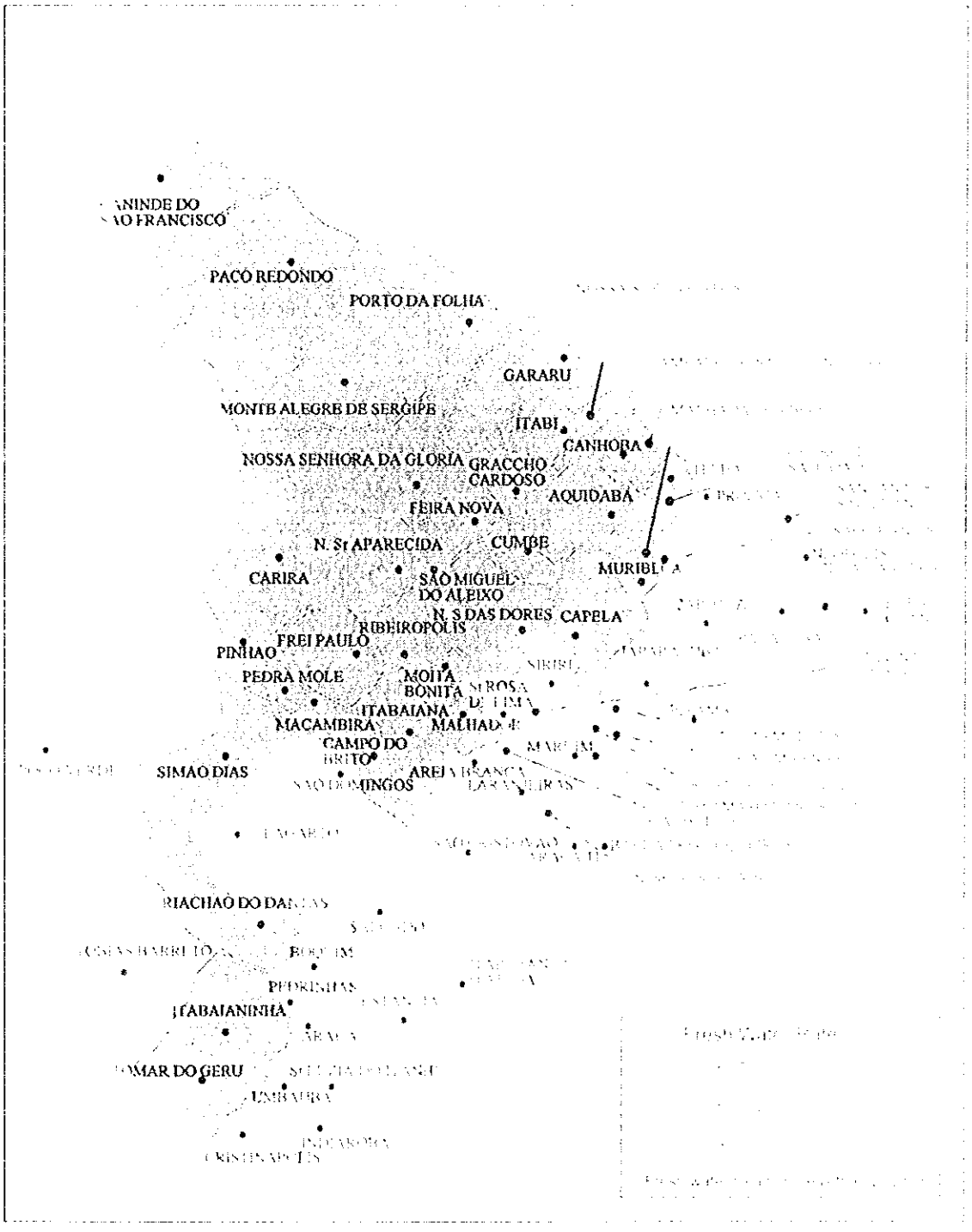

Figure-4.1 Fresh Water Rate of Groundwater by Municipality

4.2 Initial Impact Assessment

The Initial Impact Assessments present in this section are limited in scope. Some of the results are not enough to make an accurate estimate of the impacts. Environmental considerations should be made as soon as a project is conceptualized. During a feasibility study stage, a preliminary Environmental Impacts Assessment should be prepared including a survey of project acceptability by concerned people and agencies. Careful studies on the ecology, the water quality, flow regimes, design standards, alignments and construction methods should be conducted at this stage. All efforts should be made to avoid adverse environmental impacts.

4.2.1 Integrated Water Supply System

The Integrated Water Supply System consists of Project expansion of pipeline system (7 Projects), Aracaju well development project, Xingo dam pipeline project and Vaza Barris dam project.

These projects are relatively large-scale development plans. However, these impacts on natural environment, except for Vaza Barris dam project, will be limited because projects sites are far away from the protected areas and sizable undisturbed forests, moreover these projects are pipeline projects or well development project that have no serious environmental impacts potentially.

The results of Initial Impact Assessment on these projects are show in Table-4.2~4.6. The check items are based on " JICA Environmental Guideline on Rivers and Sediment Control". Only check items concerned with the projects are selected.

Table-4.2 Result of Initial Impact Assessment on Pipeline Expansion

Project Title: Project expansion of pipeline system (7 Projects)	
Project Components	
Total developed water (m^3/day)	: 235,498
Material of pipe	: Steel
Location	: Whole area of Sergipe State
Environment of Projects Site	
Local People/Economy	: No ethnic group / Stack raising, Agriculture
Land Use/Terrain	: Pasture, Farmland, Wasteland, Built-up area / Flat, Rolling
Fauna and Flora/Protected Areas	: Shrub area, Cerrado, Caatinga, / No protected areas
Environmental issues	: High salt concentration of groundwater and surface water

Check Item	During Construction		Operation		Remarks
	Assessment	Mitigating Measures	Assessment	Mitigating Measures	
Social Environment					
Resettlement	C	Relocation scheme	D		
Economic Activity	C	Compensation	D		To acquired land
Traffic and public facilities	B	Warning signs	D		To vehicles passing construction site
Split of communities	D		D		
Cultural property	C	Property survey	D		
Water rights, Right of common	B	Reconsideration of water right	D		
Public health condition	D		D		
Waste	B	Proper disposal plan	D		
Hazard	D		D		
Natural Environment					
Topography and geology	D		D		
Soil erosion	B	Proper design and construction plan	D		
Groundwater	D		D		
Hydrological situation	D		D		
Coastal zone	D		D		
Flora and fauna	B	Ecological survey Proper construction plan	D		Traverse natural vegetation zone partly
Landscape	B	Proper construction plan	B	Harmonious design	
Public Nuisance					
Air pollution	B	Water spray	D		
Water pollution	B	Pollution control	D		
Soil contamination	D		D		
Noise and vibration	B	Machinery control	D		
Ground subsidence	D		D		
General Assessment: Major environmental impacts will occur at only construction stage. Reconsideration of water right may be needed in advance. Serious impacts will not occur in the end.					

Assessment: A: High Negative Impact, B: Low Negative Impact, C: Unknown Impact, D: No Impact

Table-4.3 Result of Initial Impact Assessment on Well Development

Project Title: Aracaju well development project	
Project Components	
Developed water (m^3/day)	: 23,292
Depth of wells	: 100 m (Coastal plain area)
Number of wells	: 9 wells
Location	: Aracaju, Laranjeiras, N. S. do Socorro
Environment of Projects Site	
Local People/Economy	: No ethnic group / Stack raising, Agriculture, Mining, Industry
Land Use/Terrain	: Pasture, Farmland, Built-up area, Forest / Flat
Fauna and Flora/Protected Areas	: Shrub area / No protected areas
Environmental issues	: River water pollution, Population concentration, Solid waste disposal

Check Item	During Construction		Operation		Remarks
	Assessment	Mitigating Measures	Assessment	Mitigating Measures	
Social Environment					
Resettlement	D		D		
Economic Activity	C	Compensation	D		To acquired land
Traffic and public facilities	B	Warning signs	D		To vehicles passing construction site
Split of communities	D		D		
Cultural property	D		D		
Water rights, Right of common	B	Reconsideration of water right	D		
Public health condition	D		D		
Waste	B	Proper disposal plan	D		
Hazard	D		D		
Natural Environment					
Topography and geology	D		D		
Soil erosion	D		D		
Groundwater	B	Monitoring program	B	Monitoring program	
Hydrological situation	D		D		
Coastal zone	D		D		
Flora and fauna	C	Ecological survey	D		
Landscape	D		D		
Public Nuisance					
Air pollution	D		D		
Water pollution	B	Pollution control	C	Monitoring program	To check saltwater intrusion
Soil contamination	D		D		
Noise and vibration	B	Machinery control	D		
Ground subsidence	D		C	Monitoring program	
General Assessment: Serious impacts will not occur. But the monitoring program of saltwater intrusion will be needed during operation.					

Assessment: A: High Negative Impact, B: Low Negative Impact, C: Unknown Impact, D: No Impact

Table-4.4 Result of Initial Impact Assessment on Pipeline Project

Project Title: Xingo Dam Pipeline Project	
Project Components	
Developed water (m^3/day)	: 43,999
Length of pipeline	: Approximately 140 km
Material of pipe	: Steel
Location	: Caninde Do Sao Francisco, Poco Redondo, Porto De Folha, Monte Alegre De Sergipe, Nossa Senhora Da Gloria, N. S. Aparecida, Ribeiropolis, Frei Paulo, Itabaiana (Most construction works will be along existing road and pipeline)
Environment of Projects Site	
Local People/Economy	: No ethnic group / Stack raising, Agriculture
Land Use/Terrain	: Pasture, Farmland, Wasteland, Built-up area / Gently rolling
Fauna and Flora/Protected Areas	: Shrub area, Caatinga / No protected areas
Environmental issues	: High salt concentration of groundwater and surface water

Check Item	During Construction		Operation		Remarks
	Assessment	Mitigating Measures	Assessment	Mitigating Measures	
Social Environment					
Resettlement	C	Relocation scheme	D		
Economic Activity	C	Compensation	D		To acquired land
Traffic and public facilities	B	Warning signs	D		To vehicles passing construction site
Split of communities	D		D		
Cultural property	C	Property survey	D		
Water rights, Right of common	A	Reconsideration of water right	A	Reconsideration of water right	To use Sao Francisco River water
Public health condition	D		D		
Waste	B	Proper disposal plan	D		
Hazard	D		D		
Natural Environment					
Topography and geology	D		D		
Soil erosion	B	Proper design and construction plan	D		
Groundwater	D		D		
Hydrological situation	D		D		
Coastal zone	D		D		
Flora and fauna	B	Ecological survey Proper construction plan	D		Traverse natural vegetation zone partly
Landscape	B	Proper construction plan	B	Harmonious design	
Public Nuisance					
Air pollution	B	Water spray	D		
Water pollution	B	Pollution control	D		
Soil contamination	D		D		
Noise and vibration	B	Machinery control	D		
Ground subsidence	D		D		
General Assessment: Major environmental impacts will occur at only construction stage. Reconsideration of water right may be needed in advance. Serious impacts will not occur in the end.					

Assessment: A: High Negative Impact, B: Low Negative Impact, C: Unknown Impact, D: No Impact

Table-4.5 Result of Initial Impact Assessment on Dam Project

Project Title: Vaza Barris Dam Project	
Project Components	
Developed water (m^3/day)	: 222,134
Dam Height	: 50 m
Dam Crest Width	: Approximately 280 m
Reservoir Area	: 9.5 km^2
Reservoir Volume	: 94,000,000 m^3
Location	: Lagarto, Campo Do Brito
Environment of Projects Site	
Local People/Economy	: No ethnic group / Stack raising, Agriculture
Land Use/Terrain	: Pasture, Farmland, Wasteland / Rolling, Mountainous
Fauna and Flora/Protected Areas	: Shrub area, Cerrado / Vaza-Barris River Estuary Protection areas (Approximately. 40km downstream)
Environmental issues	: River water pollution, High salt concentration

Check Item	During Construction		Operation		Remarks
	Assessment	Mitigating Measures	Assessment	Mitigating Measures	
Social Environment					
Resettlement	C	Relocation scheme	D		
Economic Activity	B	Compensation	C	Compensation	To acquired land and fishery in estuary
Traffic and public facilities	D		B	New road planning	Submergence of existing local roads
Split of communities	D		D		
Cultural property	D		D		
Water rights, Right of common	B	Reconsideration of water right	B	Reconsideration of water right	
Public health condition	C		B	Sanitary program	Dengue fever, schistosomiasis area
Waste	B	Proper disposal plan	D		
Hazard	B	Proper design and construction plan	B	Maintenance program	
Natural Environment					
Topography and geology	B	Proper design and construction plan	D		
Soil erosion	B	Proper design and construction plan	D		
Groundwater	D		C	Monitoring program	
Hydrological situation	A	Hydrological survey Proper construction plan	A	Hydrological monitoring Proper drainage plan	Mangrove forest in downstream area
Coastal zone	D		C	Monitoring program	
Flora and fauna	B	Ecological survey Protection plan	B	Monitoring program Proper drainage plan	Protected area in downstream area
Landscape	A	Harmonious design	A	Harmonious design Maintenance program	
Public Nuisance					
Air pollution	B	Water spray	D		
Water pollution	A	Pollution control	C	Monitoring program	
Soil contamination	D		D		
Noise and vibration	B	Machinery control	D		
Ground subsidence	D		D		

General Assessment:

Serious impacts on several environmental items will occur. Especially, the impact of hydrological situation should be studied in detail. More detailed information is given in the Feasibility Study Report.

Assessment: A: High Negative Impact, B: Low Negative Impact, C: Unknown Impact, D: No Impact

4.2.2 Independent Water Supply System

The Independent Water Supply System consists of 3 Sao Francisco River direct intake projects, 23 deep well development projects, 18 river development projects and Jabiberi dam raising project. Municipalities of each project proposed in "Independent Water Supply System" are shown in Figure-4.2.

Because these projects are not large scale, the impacts on social and natural environment will be limited. However, if the projects are located in environmental critical area such as forest, mangrove zone, archeological or cultural site, and urban area, proper environmental considerations should be made as soon as a project is conceptualized.

Small areas of riverside forests provide wildlife habitats. In case of projects with clearing the forests, environmental considerations on the wildlife should be needed.

In case of surface water development projects located in Sao Francisco River basin, because schistosomiasis has broken out in Sao Francisco River basin more than other basins, the channel and drainage should be considered measures against the vectors. An educational program on these diseases should be conducted for local people and construction worker.

In case of well development projects located in groundwater with high salinity level, the salinization may accelerate. Moreover wastewater with high salinity level will be drain from desalination works and may affect the river water, the soil and wildlife.

Among municipalities of deep well development sites proposed in "Independent Water Supply System", Malhador, St, Rosa de Lima, Divina Pastora and Riachuelo are in zone where fresh water rate of existing wells is low. In these municipalities, To prevent salinization, water quality monitoring should be conducted.

4.2.3 Small Rural Water Supply Project

"Small Rural Water Supply Project" is development of single well systems (Public taps) in the whole area of Sergipe.

In case of well development projects located in northern part of Sergipe State, the salinization may accelerate. Moreover wastewater with high salinity level will be drain from desalination works and may affect the river water, the soil and wildlife. To prevent salinization, water quality monitoring should be conducted.

The maintenance plan including collection of the cost should be considered by local people to all projects in advance.

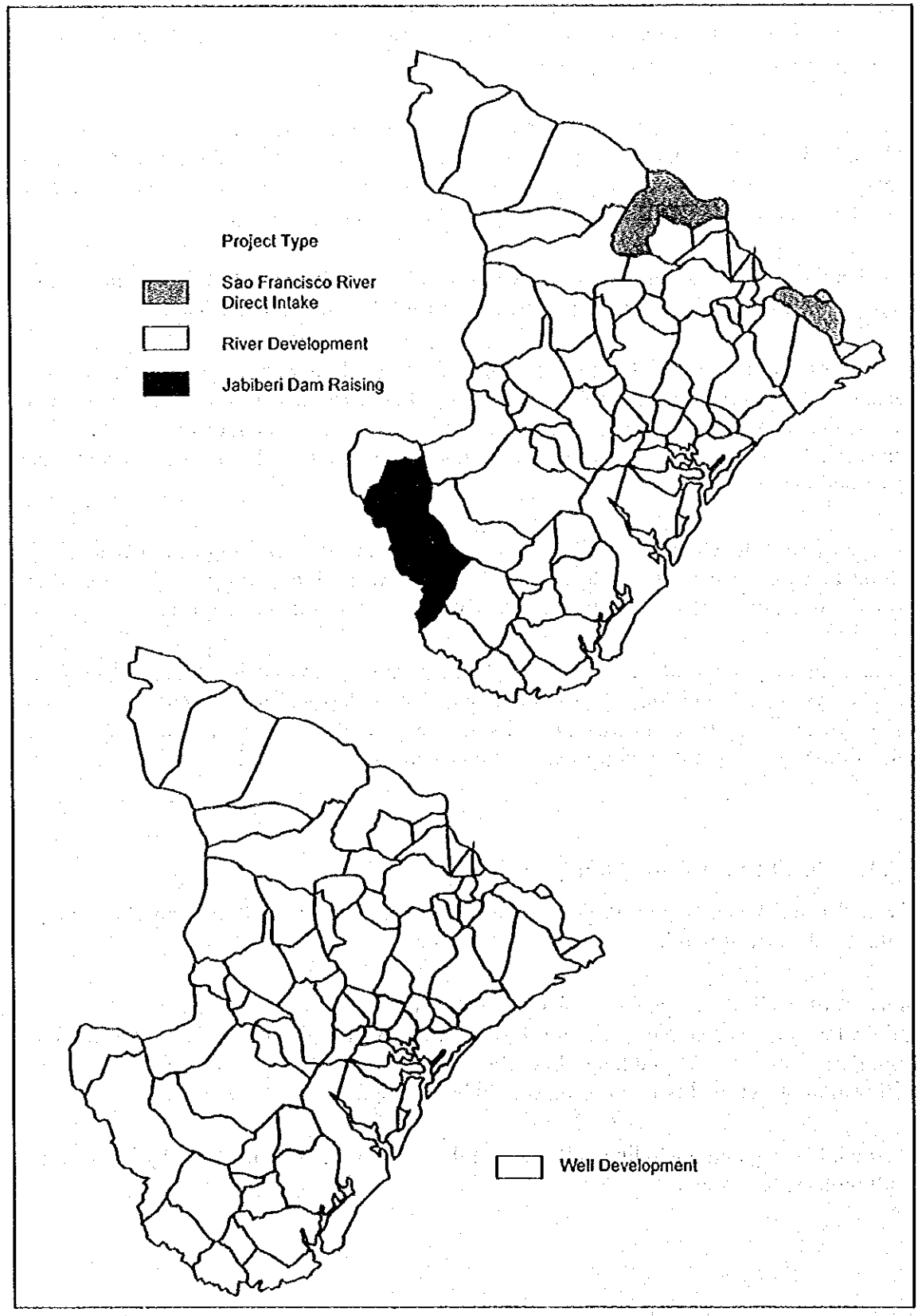

Figure-4.2 Location of Independent Water Supply System

4.2.4 Irrigation Water Supply Projects

8 Irrigation Water Supply Project are proposed in this Master Plan Study. There are as follows:

Table-4.6 Irrigation Water Supply Projects

Project Name	Developed water (m^3/day)	River Basin	Natural Vegetation
Quixabera	262,873	Sao Francisco	Caatinga (Intense Arid)
Jacare-Curituba	272,394	Sao Francisco	Caatinga (Intense Arid)
Sao Francisco	933,333	Sao Francisco	Caatinga (Intense Arid)
Ladeirinhas	58,147	Sao Francisco	Cerrado
Jacarecica II	97,900	Sergipe	Cerrado
Vaza Barris	260,000	Vaza Barris	Cerrado
Rntre Rios	16,095	Piaui	Cerrado
Estancinha	5,559	Piaui	Cerrado

Because "Quixabeira", "Jacare-Curituba" and "Sao Francisco" will use Sao Francisco River water, reconsideration of the water right should be needed in advance.

Because schistosomiasis has broken out in Sao Francisco River basin more than other basins, the channel and drainage should be considered measures against the vectors. An educational program on these diseases should be conducted for local people and construction worker.

The maintenance plan including collection of the cost should be considered by local people to all projects in advance.

JAPAN INTERNATIONAL COOPERATION AGENCY

STATE SECRETARIAT OF PLANNING, SCIENCE AND TECHNOLOGY
THE STATE OF SERGIPE, THE FEDERATIVE REPUBLIC OF BRAZIL

THE STUDY
ON
WATER RESOURCES DEVELOPMENT
IN THE STATE OF SERGIPE
IN
THE FEDERATIVE REPUBLIC OF BRAZIL

FINAL REPORT
SUPPORTING
(VOLUME I)
MASTER PLAN STUDY

[L] ECONOMIC, FINANCIAL AND SOCIAL EVALUATION

MARCH 2000

THE STUDY ON WATER RESOURCES DEVELOPMENT
IN THE STATE OF SERGIPE
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SUPPORTING REPORT (L)
ECONOMIC, FINANCIAL AND SOCIAL EVALUATION

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CHAPTER 1 ECONOMIC EVALUATION

Economic evaluation means the analysis of a project from the point of view of development planning or the country as a whole to judge whether an investment will generate worthwhile public benefit. In economic evaluation, financial cash inflow and outflow should be adjusted according to the principle of cost-benefit analysis. Because financial cash inflows and outflows are not always real costs and benefits from the point of view of a country. In adjustment process of cash flows to cost-benefit, so-called shadow pricing method is usually used in practice. After adjustments of cash flow, Economic Internal Rate of Return (EIRR), Net Present Value (NPV) and Benefit-Cost Ratio (B/C) are calculated. From those figures, it becomes evident whether this project is meaningful or not from the point of view of a country. Economic evaluation is presented in this Chapter.

1.1 Assumptions

In estimating the economic cost and benefit, the following conditions and assumptions are applied. Assumptions in detail are given in Appendix-1.

1.1.1 Price Level

For economic evaluation, the basic price level for cost and benefit estimates were set at prices of August 1998. Foreign exchange rate was set at R$ 1.18 to US$ 1.00 based on the official exchange rate at the time.

1.1.2 Opportunity Cost of Capital

Opportunity cost of capital represents the permissible economic rate of return for development projects. In Brazil, 10% or 12% of opportunity cost of capital is generally applied as a discount rate to assess the economic viability of projects. In this study, 10% of opportunity cost of capital is applied from the viewpoint of social purpose and needs for water resources development.

1.1.3 Economic Value

In economic analysis, all goods and services applied in the project cost and benefits are estimated on the basis of real economic value. In terms of non-tradable goods and services in local market, the following points have to be considered in the case of converting their financial values to economic values: (a) internal transfer payment and (b) shadow wage of unskilled labor in particular taking unemployment and underemployment conditions into account. On the other hand, the tradable goods and services are estimated based on the international market prices so as to reflect real economic prices. In this report, however, economic values are estimated to be at 85% (the same as applied in the Master Plan Study on the Utilization of Water Resources in Parana State in 1995 by JICA) of total financial values including both local and foreign portions.

1.1.4 Economic Life

Various components with different specifics are used to construct water supply facilities. The economic life of each component is hard to define correctly because it varies depending on the conditions such as maintenance, weather and so forth. In this analysis,

the economic life of the structure such as dam is estimated at 80 years. Weir and well are estimated at 50 years and other structures are assumed to be 40 years. Mechanical facilities and equipment such as steel pipeline are considered as 15 years. However, cast-iron pipeline used in the some part of the projects is considered as 50 years. The components, if its economic life is less than economic evaluation period, would be replaced periodically during the period.

The economic evaluation period is set at 50 years in this analysis.

1.1.5 Economic Cost

The financial construction costs of projects are described in Section II. The costs are converted to economic cost by applying economic value as mentioned above.

1.1.6 Economic Benefit

(1) Domestic Water

The Team conducted the water use survey, which showed that willingness to pay of rural inhabitants was 3 % of the household income. The household income was R$ 270 and the family size was 5.2. Accordingly, economic benefit of rural area is assumed as R$ 1.6 /capita. The urban area is also assumed to be 3 % of the household income in this analysis. The family size was 4.2. As a result, R$ 4.6 /capita is applied to the economic benefit of urban area.

The economic benefit of commercial and public sector is estimated at actual water charge, respectively R$ 0.5/capita and R$ 0.8/capita, calculated from the actual consumption data of DESO in 1997.

(2) Industrial Water

There is no statistical information regarding industries in the state such as input-output table of intermediate product of manufacturing sector to assess the economic benefit. So the averaged actual charge based on the data of DESO in 1997 is assumed also to be the economic benefit in this analysis, which is R$ 2.6 /m^3.

(3) Agricultural Water

The annual benefit of agriculture development schemes is estimated at net cash flow basis under with- and without-project conditions.

In the with-project area, fruits culture and vegetables are the main crops as described in section E. The product of fruit culture is assumed to be mainly grapes, banana and acerola. 10 to 20 % of the production of grapes are considered as export purpose. For the vegetable culture, cash crops such as carrot and lettuce are assumed in this analysis. In the without-project area, traditional crops such as cassava are considered as the assumption.

FOB price based on FAO data is estimated for tradable products. Farm gate price based on 'Orcamento para Implantacao' of COHIDRO in November 1997 is applied to non-tradable products. Unit yield and production cost are estimated from the data of EMDAGRO and COHIDRO as of August 1998 and 'Cost for Production of Grapes', Petrolina, PE.

1.2 Results of Evaluation

54 projects are analyzed in this section: 46 projects of Domestic and Industrial Water Supply System (10 projects of Integrated System, 35 projects of Independent System, Small Rural Area System in each municipality) and 8 projects of Irrigation Water Supply System.

Table-1.1 shows the summarized results of the analysis of each project. The results of analysis of each project in detail are given in Appendix-2.

The EIRR of total (54) projects resulted in 13.1 %, exceeding opportunity cost of 10 %. 37 projects or 70 % of 54 projects exceeded opportunity cost of 10 %. As a whole, the projects are judged to be in economic efficiency and worth promoting.

1.2.1 Analysis of Projects

(1) Domestic and Industrial Water Supply Projects

Domestic and Industrial Water Supply Projects contain 10 projects of Integrated System, 35 projects of Independent System and Small Rural System.

It is quite costly to provide water to Small Rural Area that showed negative EIRR. Integrated System resulted in 10.8 %, slightly above the opportunity cost. However, Independent System resulted in good economic efficiency of 27.7 % mainly due to the lower investment cost. Consequently, the EIRR of total water supply projects resulted in 11.8 % that means economic feasible level.

(2) Irrigation Water Supply Projects

The EIRR of all projects resulted in 17.2 %. Six projects out of total (8 projects) exceeded 14 %.

Projects with lower investment cost per hectare and higher profit such as Quixabeira, Jacare-Curituba and Sao Francisco resulted in more than 20 % of EIRR. As to the Vaza Barris, Ladeirinhas and Jacarecica-II, investment cost per hectare is extremely high due to the dam construction. However, the Vaza Barris resulted in 15.0 % of EIRR that means sufficient for economic efficiency.

Table-1.1 Results of Economic Analysis of Projects

	Project	EIRR*1 (%)	NPV *2 (R$ million)	B/C
Domestic and Industrial Water Supply Projects		**11.8**	**91.1**	**1.13**
	Urban and Large Rural Area (Integrated System)	**10.8**	**32.9**	**1.06**
1	Project Expansion of São Francisco Pipeline System	11.7	34.3	1.15
2	Aracaju Well Development Project	13.6	10.0	1.28
3	Project Expansion of Agreste Pipeline System	8.2	-4.8	0.86
4	Project Expansion of Piauitinga Pipeline System	25.6	19.0	1.59
5	Xingo Dam Pipeline Project	7.1	-17.7	0.76
6	Vaza Barris Dam Project	12.1	13.1	1.19
7	Project Expansion of Itabaianinha Pipeline System	4.7	-6.7	0.67
8	Project Expansion of Propria Pipeline System	17.8	1.3	1.26
9	Project Expansion of Alto Sertao Pipeline System	---	-4.8	0.56
10	Project Expansion of Sertaneja Pipeline System	---	-10.6	0.36
	Urban and Large Rural Area (Independent System)	**27.7**	**87.7**	**1.82**
1	Gararu: SFR Direct Intake	---	-0.7	0.39
2	Muribeca: Deep Well Development	15.0	0.1	1.28
3	Nossa Senhora das Dores: Pinol R. Development	17.1	0.7	1.27
4	Malhador: Vermelha R. Development, Deep Well Development	---	-0.9	0.50
5	Tobias Barreto: Jabiberi Dam Raising Project	8.5	-0.6	0.94
6	Brejo Grande: Deep Well Development	66.5	0.7	2.68
7	Ilha das Flores: Deep Well Development	20.8	0.2	1.54
8	Neopolis: SFR Direct Intake	37.1	13.9	2.94
9	Santana do Sao Francisco: SFR Direct Intake (Exp.)	29.8	1.8	1.82
10	*Capela: Siriri R. Development, Adeira R. Development*	20.8	3.1	1.59
11	Divina Pastora: Deep Well Development	19.6	0.1	1.68
12	Santa Rosa de Lima: Deep Well Development	16.0	0.1	1.36
13	*Siriri: Deep Well Development*	32.6	0.1	1.51
14	Japaratuba: Deep Well Development	27.5	1.5	2.21
15	Japoata: Deep Well Development	14.1	0.0	1.18
16	Pacatuba: Santo Antonio R. Development	75.0	11.1	6.14
17	Pirambu: Deep Well Development	21.1	0.7	1.72
18	Sao Francisco: Deep Well Development	14.4	0.0	1.24
19	*Carmopolis: Deep Well Development*	82.0	0.6	3.68
20	General Maynard: Deep Well Development	14.4	0.0	1.24
21	Maruim: Deep Well Development	37.8	3.5	3.97
22	Riachueiro: Jacarecica R. Development, Deep Well Development	39.7	8.9	3.81
23	Rosario do Catete: Siriri R. Development, Deep Well Development	53.2	23.2	5.26
24	Santo Amaro das Brotas: Deep Well Development	43.4	0.5	2.43
25	Barra dos Coqueiros: Deep Well Development	9.1	-0.1	0.96
26	*Sao Cristovao: Deep Well Development*	70.3	3.1	2.99
27	Araua: Camboata R. Development, Deep Well Development	6.4	-0.2	0.86
28	Boquim: Garangal R. Development	10.1	0.0	1.00
29	Cristinapolis: Itamirim R. Development	---	-1.2	0.52
30	Pedrinhas: Araua R. Development, Deep Well Development	21.9	1.2	1.50
31	Salgado: Grilo R. Development, Deep Well Development	5.9	-0.4	0.86
32	*Estancia: Piauitinga R. Development, Piaui R. Development and Deep Well Development*	33.3	20.1	2.78
33	Indiaroba: Paripe R. Development	---	-0.8	0.47
34	Itaporanga d'Ajuda: Fundo R. Development, Tejupeba Development	6.1	-2.5	0.92
35	Santa Luzia do Itanhy: Ariquitiba R. Development	---	-0.4	0.79
	Small Rural Area (Municipal Water Supply Only)			
1	Single Well System (Public Tap)	---	-29.5	0.18
	Irrigation Water Supply Projects	**17.2**	**116.1**	**1.48**
1	Quixabeira	26.9	9.4	1.93
2	Jacare-Curituba	22.5	27.7	1.68
3	Sao Francisco	22.3	83.1	1.68
4	Ladeirinhas	10.2	0.1	1.02
5	Jacarecica II	3.1	-16.3	0.55
6	Vaza Barris	15.0	11.8	1.46
7	Entre Rios	14.4	0.1	1.22
8	Estancinha	14.4	0.0	1.22
	Total of Projects (54)	**13.1**	**207.2**	**1.23**

Note: *1 "---" indicates EIRR with less than zero percent.
*2 Discounted at 10%

1.2.2 Analysis of Multi-purpose Projects

The economic efficiencies of two multi-purposes Projects respectively exceed opportunity cost of 10 % as shown in Table-1.2.

Table-1.2 Result of Economic Analysis of Multi-purpose Projects

Project	EIRR (%)	NPV (R$ million)	B/C
Xingo Dam Pipeline	15.2	65.4	1.33
Vaza Barris Dam	12.9	24.9	1.26

1.2.3 Analysis by River Basin

The results of economic evaluation of the six river basins are shown in the Table-1.3. Five river basins with the exception of Real river basin indicate more than 10 % of EIRR. Japaratuba river basin showed the highest result among all due to the low project cost of Independent System that is mostly planned in the area.

Table-1.3 Result of Economic Analysis of Sector by River Basin

River Basin		EIRR*1 (%)	NPV (R$ million)	B/C
San Francisco	Total	18.0	123.0	1.45
	Domestic and Industrial Water	10.2	2.6	1.02
	Irrigation Water	22.3	120.4	1.67
Japaratuba	Total	26.0	24.0	2.10
	Domestic and Industrial Water	26.0	24.0	2.10
	Irrigation Water 1)			
Sergipe	Total	10.8	27.5	1.07
	Domestic and Industrial Water	11.4	43.8	1.12
	Irrigation Water	3.1	-16.3	0.55
Vaza Barris	Total	11.6	7.8	1.09
	Domestic and Industrial Water	8.5	-4.0	0.93
	Irrigation Water	15.0	11.8	1.46
Piaui	Total	14.8	34.6	1.46
	Domestic and Industrial Water	14.8	34.5	1.30
	Irrigation Water	14.4	0.1	1.22
Real	Total	2.0	-9.7	0.66
	Domestic and Industrial Water	2.0	-9.7	0.66
	Irrigation Water 1)			
Total	Total	13.1	207.2	1.23
	Domestic and Industrial Water	11.8	91.2	1.13
	Irrigation Water	17.2	116.0	1.48

Note: 1) No planning of projects

CHAPTER 2 FINANCIAL EVALUATION

Financial evaluation has two different analysis; 1) to judge whether an investment will generate worthwhile profit from point of view of private and public firms and/or individual owner like farmer and 2) to assess the financial affordability and sustainability of the state for implementation of the projects. Financial evaluation of the latter is discussed in this Chapter.

2.1 State Budget

The water supply system is managed by the public entities, mostly by DESO and COHIDRO. The state government basically provides the entities with funds for capital investment of water resources development. In order to consider the possibility of capital investment for the development, the changes of the state budget from 1994 to 1998 are presented in the Table-2.1.

The investment of water resources development in the table was mostly provided to DESO and COHIDRO according to data of the budget of the government. The averaged share of water resources development investment to the total expenditures and to the tax revenues in the state budget was respectively 2.4% and 3.1%.

Table-2.1 State Budget and Investment for Water Resources Development

Unit: R$ million

	1994	1995	1996	1997	1998
Revenues	429.3	733.9	934.1	1,575.9	893.6
Tax Revenues *	305.8	617.8	710.2	814.2	782.7
Expenditures	453.3	770.4	938.0	1,253.0	893.6
Capital Investment	141.3	70.0	218.8	409.2	206.3
(% of Expenditures)	(31.1)	(9.1)	(23.3)	(32.7)	(23.1)
Water Supply Investment	15.8	18.9	17.7	41.7	7.6
(% of Expenditures)	(3.5)	(2.5)	(1.9)	(3.3)	(0.9)
(% of Tax Revenues)	(5.1)	(3.0)	(2.5)	(5.1)	(1.0)

Source: Balanco Geral, Governo de Sergipe, 1994,1995,1996 and 1997
Orcamento-Programa, Governo de Sergipe, 1998 (Original Budget)
Note: * Tax revenues include transfers from Federal Government

2.2 Investment by Public Entity

The investment for water resources development by DESO for three years from 1995 to 1997 is assumed in Table-2.2. It shows that the company has spent more funds than provided from the state budget. It means that DESO raised 40 % of the funds required to the investment for the water resources development during the period from public financial institutions. The company has raised them mostly from the state banks generally with the conditions of long-term maturity and low interest rate.

Table-2.2 Investment for Water Resources Development by DESO

Unit: R$ million

	1995	1996	1997	Total
Investment by DESO	14.1	19.0	39.0	72.1
(Funds from State Budget)	(7.0)	(10.4)	(27.1)	(44.5)

Source: Financial Statement of DESO and COHIDRO in 1995, 1996 and 1997
Balanco Geral, Governo de Sergipe, 1995,1996 and 1997

2.3 Domestic and Industrial Water Supply Projects

2.3.1 Projected Investment Amount

In the Master Plan, total initial investment for all 54 projects (46 Domestic and Industrial Water Supply Systems and 8 Irrigation Water Supply Systems) amounts to R$ 1,370 million (equivalent to US$1,160 million at the exchange rate of August 1998) as described in Section H.

The initial investment costs for 46 projects of Domestic and Industrial Water Supply System amount to R$ 950 million. The construction period is planned for 20 years, from the year of 2000 to 2019. However, R$ 660 million or 70 % of initial investment costs concentrate in the first decade according to the implementation schedule.

The investment amount of the water resources development in the state budget was 3.1 % of the tax revenues on average during five years from 1994 to 1998 as shown in Table-2.1. Tax revenues would increase generally with economic growth that would take place (assumed at 5 % per annum of economic growth rate in the master plan). Thus, the future investment amount for water resources development during 20 years from 2000 to 2019 was estimated at R$ 900 million. For the first decade, the amount would be R$ 390 million.

2.3.2 Source of Fund for Initial Investment

The state budget is considered as the principal source of funds for the initial investment of the projects, which would be R$ 390 million in the first decade and RS$ 510 million in the second decade. In case that the economic growth as set in the plan is attained, the required investment will possibly be arranged by the state. Public entities are assumed also to share the financial burden: 10 % of the initial investment.

As a result, an amount of R$ 210 million (equivalent to US$ 180 at the exchange rate of August 1998) should be raised in the first decade. However, initial investment could be covered entirely by the state budget in the second decade, moreover the excess amount of R$ 250 million could be used for debt payment such as repayment and interest of the loan.

Table-2.3 Estimated Source of Fund for Domestic/Industrial Water Supply Projects

Unit: R$ million

	1st decade	2nd decade	Total	Remarks
Expenditures	660	500	1,160	
Initial investment	660	290	950	Proposed in master plan
Repayment	-	210	210	Repayment of soft loan
Source of Fund	660	540	1,200	
State Budget	390	510	900	3.1 % (max) of tax revenue
Public Entities	60	30	90	Self-finance (10% of initial investment)
Soft Loan	210	-	210	Amount to be raised
Balance	0	40	40	Surplus

The current debt amount of the state government as of September 1998 was R$ 740 million, which are almost with long-term (12 to 30 years of maturity) and low interest rate from the federal government. Judging from the current debt service coverage ratio that was 7.7 % in 1998 fiscal budget as described in section A, the state government financial situation is expected to keep still healthy condition if the additional funds of R$ 210 million would be soft loan with long-term maturity and low interest rate.

2.3.3 Financial Burden of the Government

As described in the Operation and Maintenance Plan in the section J, recovery of financing cost for initial investment (R$ 70 million) of domestic water supply projects in the small rural area cannot be expected. So all the related investment cost should be covered by the state budget.

As to other domestic and industrial water supply projects, it would be almost impossible to raise the tariff to cover the financial cost for initial investment (R$ 870 million) because customers suffers from comparatively high tariff mainly caused by inefficient management of the public entity. However, some portion of the related cost could be covered by the entity in the second decade after expansion of the service and enhancing the management efficiency. So the financial burden of the state government could be eased in the second decade.

2.4 Irrigation Water Supply Projects

In the Master Plan, total initial investment costs for 8 projects amount to R$ 430 million as described in section H. The construction period is planned for 20 years, from the year of 2000 to 2019. However, R$ 280 million or 70 % of initial investment costs concentrate in the first decade according to the implementation schedule.

The funds for initial investment for irrigation water supply projects should be covered by the State Government, considering the size of investment costs and financial conditions of agricultural producers.

CHAPTER 3 SOCIAL EVALUATION

Social evaluation is to assess the projects from the viewpoint of the social benefits such as positive effects on regional economy and society and to mitigate the negative impacts to the social environment.

The proposed 54 projects in the master plan will induce several positive and negative effects to the project area as well as to the state. The projects will increase a supply of safe and sufficient domestic, industrial and agriculture water to users. At the same time, the projects will induce other social benefits and social environmental impacts to the affected area.

3.1 Social Benefits

(1) Increase of Employment Opportunity and Activation of Regional Economy

Construction works for projects such as dam and pipelines for domestic and industrial water supply and irrigation water supply would offer a new labor opportunity to the people unemployed and underemployed of the region in construction sector itself and the related sectors.

In general, the workers spend their earnings for living such as food, clothes and miscellaneous goods there. Their consumption behavior will stimulate the business activities of the related manufacturers and retail shops of the region. Thus, this increased consumption by new workers will induce a multiplied economic effect to the region, which activate the regional economy as a whole.

(2) Improvement of Safe Water Coverage and Public Hygiene

After the completion of the projects in 2020, all incremental urban population and 85% of rural population could enjoy their living conditions with safe and sufficient potable water.

Residential water supply rate in 1998 was 100% in urban but only 37% in rural. According to the water use survey conducted by the Study Team on August 1998, almost all (93%) of rural inhabitants without residential water supply systems desired an implementation of the projects for private tap system in the area. The most remarkable reason that was seen in the survey was a hygienic improvement in Agreste Sergipano meso-region, while stable supply in the rest of meso-regions. Also according to the survey, those inhabitants spend around 2 hours for carrying water to satisfy their demand for living.

The expansion of potable water supply could decrease water-borne diseases and mortality rate in the region. And it is clear that the inhabitants not supplied with potable water at moment in the dwellings can reduce significantly the time spent for carrying water. These times saved could be used for another effective activities.

(3) Alleviation of Centralization in the State Capital and Mitigation of Economic Disparity

According to the survey, the industries supplied by public entities pointed out instability of water supply and the industries with private industrial water supply system pointed out water quality as the most serious matter. They are not satisfied completely with current water supply system. Considering this, the industrial water supply rate currently assumed at only 5% of the demand will be lifted to 30% by the target year of 2020 in the master plan.

Irrigated agriculture projects could produce many benefits as follows: 1) higher yields per unit area of land, 2) extension of cultivating season and possible multi-cropping, and 3) safe cropping particularly during droughts and so on.

Thus, the projects will alleviate the impact of water scarcity in the project area in the state that will attract the manufacturing companies to set up its plant in the region and also give agricultural farmers an incentive to cultivate more intensively. That will stimulate regional economic activities and bring the people more sufficient living conditions there. As a result, it could lead the mitigation of economic disparity compared with the nation level and the alleviation of economic and demographic centralization to metropolitan area like Aracaju.

3.2 Social Environment Impacts

On the other hand, the proposed projects could induce several social problems among societies and residents in the affected area during construction and operation period. The negative social impacts derived from the problems must be mitigated for implementation of the projects. So the social environmental problems that might break out and the mitigating measures should be carefully studied.

The careful planning of these measures will be effective to mitigate the social negative impacts, but should be disclosed and explained publicly, and discussed with the society and the residents. All of theses entire implementations could minimize effectively the social environment impacts.

Initial environment examination (IEE) on each project of the master plan was conducted in Section K. The mitigating measures for these negative social impacts are presented as results of IEE in the same section.

More specifically, environmental impact assessment (EIA) will be conducted in the feasibility study.