on the basis of present land use. The government give a permission or approval to an applicant of founding a new building based on this legal recognition of the zoning plan.

The zoning plan illustrated in Fig. V.5.1 presents a zoning system in the urban area. It proposes to classify the urban area into the following zoning categories. Besides, changes of settlement at present are depicted in the following individual category:

(1) Residential zone: this zone is classified into four levels such as special residential zone, residential zone 1, 2, and 3. Residential zone 3 is prepared for new settlers as a developing new residential area. Recently, new residential lots are settled along the Itajai Mirim river and the short-cut canal of the Itajai Mirim river toward the upstream. Furthermore, new settlement of low level housing units is sprawling in low land area along the Itajai river, where it is not prepared for living circumstance and categorized as industrial zone in the zoning plan.

(2) Industrial zone: this zone spreads out along the Itajai river in the two municipalities and along the national highway of BR-101 in Itajai. Most of existing industrial establishments are located in this zone. Industrial zones along the BR-101 are already sold in lots to several industrial establishments so that development of these lots might be a question of time.

(3) Commercial and service zone: the central zone for commercial and service activities is set in the center of Itajai city. The daily service zones are located along the main roads in both the municipalities. The commercial and service zone is classified into two levels in accordance with accumulation degree of establishment, i.e., highly developed central zone and standard commercial zone.

(4) Others: other zones are classified into two categories, such as (a) preserved zone for fluvial low land, coastal ribbon area and forest, and (b) developing zone for urban expansion. The latter zone is reserved for future development by expansion of urbanization, and is left as a grass land at present.

5.4.2 Change of land use in the future

Population and regional economy in the flood protection area is expected to increase at comparatively high speed, although its pace is much lower than before, as explained in Section 5.3. These growth rates are reviewed as follows:

Item	Average annual growth rate (%)		
	1970-1980	1980-2000	2000-2020
Population	3.7	2.5	1.3
GRDP	13.4	5.2	4.0
GRDP per capita	9.9	3.3	2.7

The population in the flood protection area in the year 2020 becomes about 2.1 times of the population in 1980 and GRDP, 6.1 times. To support this growth, the area, Itajai city in particular, would have to be settled intentionally by the year 2020. Since Itajai city has some reserved area for urban expansion as seen in Subsection 2.4.2, urban area will be expected to expand along the reserved area so long as the municipal guideline works well for the urbanization.

Taking these circumstances into consideration, the changes of land utilization in the flood protection area will compel the both municipal governments to take a drastic development policy. This active leadership for urbanization would create the sound urban environment in the future. Expecting this leadership, the expansion of urban area is assumed to proceed as follows and to result in Fig. V.5.1:

(1) Potentiality of population density in the center area is higher than its surrounding areas, but it will spread all over the outskirts as the urban population grows. Then, the expansion of residential area is laid to proceed in conformity to the following assumptions.

   (a) In the 3 km-zone, a gross population density which is the number of inhabitants per gross area increases up to 100 persons/ha, if the density is lower than 100. However, once the number of inhabitants exceeds 100 per ha, those people should transfer to the residential area within the 5 km-zone.
   (b) Even in the 5 km-zone, the same procedure would be applied to urban expansion. People who can not be absorbed in the 5 km-zone would transfer to the residential area over the 5 km-zone in the flood protection area.

(2) A preserved area will not be invaded even in the year 2020 in conformity to the policy.

(3) Industrial areas such as industrial zone and commercial zone keep the same condition as shown in Fig. V.5.1, where the whole increasing establishments will be absorbed in these areas.

By the year 2020, the population in the flood protection area increases from 115,800 in 1989 to 183,500 in 2020. The increment of the population is 67,700, which is distributed as follows: 60,300 in the urban area of Itajai; 6,700 in the urban area and 700 in the rural area of Navegantes. Supposing that the population density in both municipalities keeps the same level, residential area would increase from 17.5 ha in 1989 to 27.9 ha in Itajai, from 4.7 ha to 7.0 ha in the urban area of Navegantes. Thus, the not-utilized land at present such as grassland, bush and reserved area might be transferred to living purposes. In the same manner, industrial establishments will increase in the flood protection area as the regional economy grows in the future. These establishments will be absorbed in the respective zones, as laid in the above (3) assumption.

6. PROJECTION OF PROBABLE FLOOD DAMAGE

6.1 Procedure and Preconditions of Estimation

The structure and types of damageable properties is the same as those mentioned in Section 4.3, even in the future conditions. However, economic values of damageable properties might be different from the present ones. Also, distribution of damageable assets in the flood protection area is different from the present one. Thus, these changes are assumed to proceed in accordance with the following process, taking the foregoing settings in the previous chapter into consideration.

(1) The projected population in Table V.5.1 is applied to estimate the number of damageable residences. Then, the number of residences is estimated as a quotient of projected population divided by family size which is assumed at 4.0, as figured out in Section 5.3.1.

(2) The average damageable value of both residence and its household effects is assumed to increase in proportion as GRDP per capita grows. The growth of GRDP per capita is estimated as shown in Table V.5.2.

(3) The total values of both depreciable assets and inventory stock in the respective industrial sectors (industry and service) basically increase in proportion to the growth of GRDP in the two municipalities of Itajai and Navegantes, which is also shown in Table V.5.2.

6.2 Change of Damageable Properties

6.2.1 Distribution of damageable properties

The present distribution of directly damageable properties in the flood protection area was enumerated in Table V.4.3. Among these properties, the distribution of residences in the future is projected in Table V.6.1. The projection was based on the aforesaid methodology in the previous section.

According to the Table, the following salient features are seen in a transition of residence distribution by elevation: (1) the general trend of centralization into the most densely inhabited areas is observed, which are located around 3.0 m above sea level; (2) accordingly, the people over-flowed from the central areas tend to dwell in the existing developing areas along the Itajai river, which are located in lower level; and (3) in the areas above 5.0 m, the growth rate of dwellers seems to be comparatively small because of physical limitation.

The growth rate of inhabitants by zone from the urban center is quite clear, as seen in the Table. Within 3 km zone, the rate is the lowest among three zones although the number of residences is the largest. Since the central zone has already reached the matured level regarding living space, it has little living room for new inhabitants. On the other hand, the growth rate in the zone over 5 km is quite high in contrast to other zones. Then, the surrounding areas of the city will be urbanized rapidly as mentioned in Section 5.4.

6.2.2 Economic value of damageable properties

The total value of residences is estimated as a product of the number of units and the unit value of a residence comprising building and household effects. The distribution of residences in the flood protection area is estimated in the previous section and unit values of each year are estimated based on the assumptions mentioned in Section 6.1. Table V.6.2 shows the total values of residences by zone in economic terms in the years 1989, 2000 and 2020. In the same manner, the total economic values of other damageable properties such as industrial and service establishments are estimated in the Table. They are summarized as follows:

(Unit: Million New Cruzados)

Item	1989	2000	2020
Residence	1,344	2,530	3,255
Industry	126	221	484
Service	118	208	455
Total	1,588	2,959	4,194

6.3 Probable Flood Damage

It is predicted that flood damage potential will increase due to development of economic activity, increase of population and expansion of urbanization in the project area. Project benefit is considered to also increase with development of the project area. Probable flood damage, therefore, is examined taking into account the change of damageable properties.

Probable flood damages are simulated for economic development level up to 2020. Tables V.6.3 and V.6.4 show the probable flood damage and flood damage for the period from 1989 to 2020, respectively. The following table summarizes the flood damage to be mitigated by implementation of the provisional (10-year flood), mid-term (25-year flood) and long-term (50-year) flood control plans.

(Unit : NCz$ million)

Year	Flood Pattern	Flood Damage to be Mitigated		
		10-year	25-year	50-year
1989	1978	28.9	34.7	37.7
	1980	25.8	30.9	33.4
	1983	24.8	30.4	34.3
	1984	32.1	38.5	42.0
2000	1978	41.0	49.3	53.6
	1980	36.7	43.8	47.4
	1983	35.3	43.3	48.8
	1984	45.7	54.8	59.8
2010	1978	56.9	68.3	74.2
	1980	51.0	60.9	65.9
	1983	49.2	60.2	67.7
	1984	63.5	76.1	82.8
2020	1978	79.3	95.2	103.3
	1980	71.1	85.0	91.7
	1983	68.6	83.8	94.1
	1984	88.7	106.1	115.3

LIST OF REFERENCES AND DATA COLLECTED

No.	Title	Issued on	Issued by
V001	Numeros de Santa Catarina 1987	1988	SEPLAN/SC Municipality
V002	Numeros de Santa Catarina 1986	Jan.1987	GAPLAN
V003	Relatorio dos Prejuizos Causados a Sciedade Catarinense por Fenomenos Clinticos	Oct.1983	GAPLAN
V004	Analise Conjuntural de Santa Catarina No.7, Janeiro-Junho 1988	1988	SEPLAN/SC
V005	Mensagem a Assembleia Legislativa Campos (Governo of SC State)	Apr.1989	Pedro Ivo
V006	Informacoes Basicas, Ano de Referencia: 1987, Itajai; Navegantes; Ilhota; Penha; and Picarras	Oct.1987	GAPLAN
V007	Anuario Estatistico do Brasil, 1987-88	Oct.1988	IBGE
V008	Censo Demografico Dados Distritais-1980 Volume 1 - Tomo 3 - Numero 21, Santa Catarina	July 1982	IBGE
V009	Censo Demografico Dados Gerais-1980 Volume 1 - Tomo 4 - Numero 21, Santa Catarina	Nov.1982	IBGE
V010	Censo Demografico Mao-de-Obra-1980 Volume 1 - Tomo 5 - Numero 21, Santa Catarina	Feb.1983	IBGE
V011	Censo Demografico Familias e Domicilios 1980, Volume 1 - Tomo 6 - Numero 21 Santa Catarina	June 1982	IBGE
V012	Censo Demografico, Santa Catarina-1970 Serie Regional, Volume I - Tomo XX	Mar.1973	IBGE
V013	Censo Demografico de 1960, Santa Catarina Serie Regional, Volume I - Tomo XV - Parte 1	1968	IBGE
V014	Censo Agropecuario, Santa Catarina - 1980 Volume 2 - Tomo 3 - Numero 21 - Parte 1	Oct.1983	IBGE
V015	Censo Agropecuario, Santa Catarina - 1980 Volume 2 - Tomo 3 - Numero 21 - Parte 2	Oct.1983	IBGE
V016	Producao Agricola Municipal - 1980 Volume 7 - Tomo 6, Parana - Santa Catarina - Rio Grande do Sul, Culturas Temporarias e Permanentes	1980	IBGE
V017	Censo Agropecuario, Santa Catarina - 1975 Serie Regional, Volume 1 - Tomo 19	Aug.1979	IBGE
V018	Censo Agropecuario, Santa Catarina - 1970 Serie Regional, Volume III - Tomo XX	Jan.1975	IBGE
V019	Censo Industrial Dasos Gerais - 1980, Santa Catarina - 1980, Volume 3 - Tomo 2 - Parte 1 - Numero 21	July 1984	IBGE

No.	Title	Issued on	Issued by
V02	Censo Comercial Dados Gerais - 1980 Sanata Catarina, Volume 4 - Numero 21	Apr.1984	IBGE
V021	Censo dos Servicos Dados Gerais - 1980 Santa Catarina, Volume 5 - Numero 21	Apr.1984	IBGE
V022	Censo Industrial, Santa Catarina - 1975 Serie Regional, Volume 2 - Tomo 19	Aug.1979	IBGE
V023	Censo Comercial, Santa Catarina - 1975 Serie Regional, Volume 3 - Tomo 19	Nov.1980	IBGE
V024	Censo dos Servicos, Santa Catarina - 1975 Serie Regional, Volume 4 - Tomo 19	Aug.1981	IBGE
V025	Censo Industrial, Santa Catarina - 1970 Serie Regional, Volume V - Tomo XX	1975	IBGE
V026	Censo Comercial, Santa Catarina - 1970 Serie Regional, Volume VI - Tomo XX	1975	IBGE
V027	Censo dos Servicos, Santa Catarina - 1970 Serie Regional, Volume VII - Tomo XX	1975	IBGE
V028	Commissao Municipal de Defensa Civil da Defensa Civil da Prefeitura de Itajai, Enchente Agosto 1984		COMDEC
V029	Flood Damage Records in the years 1983 and 1984 in Municipality of Navegantes		Navegantes Municipality
V030	General Information of Penha Municipality		Penha Municipality
V031	General Information of Picarras Municipality		Picarras Municipality
V032	A Construcao, regiao Sul, No.247 Junho de 1989	July 1989	PINI Editora
V033	Inventory of Industrial and Commercial Establishments in Itajai Municipality as of 1989	1989	Associacao Comercial e Industrial de Itajai
V034	Anuario Estatistico 1987		SUDEPE
V035	Anuario Estatistico 1980		SUDEPE
V036	Anuario Estatistico 1975	March 1987	SUDEPE
V037	Anuario Estatistico 1970	April 1971	SUDEPE
V038	Analise Socio-Economica da Populacao Sedimentada na Zona Urbana Periferica de Blumenau: Areas Sul, Oeste e Norte	March 1988	FURB
V039	Conjuntura Economica, Volume 42, No 9	Sep.1988	FGV
V040	Conjuntura Economica, Volume 43, No 7	July 1989	FGV

No.	Title	Issued on	Issued by
V041	Atlas de Santa Catarina	1986	GAPLAN
V042	Pesquisa Nacional por Amostra de Domicilios Volume 11, Tomo 5, Minas Gerais - Espirito Santo - Rio de Janeiro - Sao Paulo - Parana Santa Catarina - Rio Grande do Sul	Nov.1988	IBGE
V043	Records of Flood Marks along Itajai River and Itajai-mirim River	1984	DNOS
V044	Indice de Precos ao Consumidor Custo de Vida Relatorio/88	Jan.1989	ITAG
V045	Indice de Precos as Consumidor Custo de Vida Florianopolis	Feb.-Aug.1090	ITAG
V046	Cenarios para a Economia Brasileira ate o Ano 2000 e a Previsao de Demanda, de Energia Eletrica, Documento Preliminar	July 1987	BNDES
V047	Santa Catarina Acao da Reconstrucao Relatorio 1983	Dec.1983	State Government
V048	Santa Catarina Acao da Reconstrucao Relatorio 1984	1984	State Government
V049	Relatorio do Banco Central do Brasil 1988	1989	Banco Central do Brasil
V050	Price Prospects for Major Primary Commodities 1989-2000	1989	The World Bank
V051	World Development Report 1989	July 1989	The World Bank
V052	Development and International Economic Co-operation, Long-term Trends in Economic Development Report of the Secretary-General	May 1982	UN General Assembly
V053	International Financial Statistics	June 1989	IMF
V054	Analise Conjuntural de Santa Catarina No.8, Julho-Dezembro 1988	Sept.1988	SEPLAN/SC
V055	I PND: I Plano Nacional de Desenvolvimento da Nova República, 1986 - 1989 (Projeto)	Nov. 1985	SEPLAN

Tables

Table V.2.1 GENERAL CONDITION OF STUDY AREA

Item	Itajai	Navegantes	Penha	Picarras	Total
1. Administrative Area (sq.km)	304	97	46	154	601
- Urban Area	45	27	28	14	114
- Rural Area	259	70	18	140	487
2. Population in 1980 *1	86,460	13,530	9,960	5,594	115,544
- Urban Population	78,779	8,381	7,454	3,173	97,787
- Rural Population	7,681	5,149	2,506	2,421	17,757
3. Population in 1989 *2	110,814	17,115	12,614	6,441	146,984
- Urban Population	105,007	11,170	9,547	4,606	130,330
- Rural Population	5,807	5,945	3,067	1,835	16,654
4. Population Growth Rate (%) *3	2.8	2.6	2.7	1.6	2.7
- Urban Population	3.2	3.2	2.8	4.2	3.2
- Rural Population	-3.1	1.6	2.3	-3.0	-0.7
5. Population Density in 1989 (Persons/sq.km)	365	176	274	42	245
- Urban Area	2,333	414	336	329	1,139
- Rural Area	22	85	174	13	34
6. Number of Establishments *4	1,902	341	172	235	2,650
- Agriculture	368	133	87	145	733
- Industry	199	33	5	7	244
- Commerce	708	107	55	48	918
- Services	627	68	25	35	755

Remark : *1 Latest census
*2 Estimated by the state government (Ref.V001)
*3 Average growth rate per annum between 1980 and 1989.
*4 Data in the year 1986
Source : Ref. V001

Table V.2.2 OUTLINE OF FLOOD PROTECTION AREA : 1989

Item	Itajai			Navegantes			Total		
	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total
1. Municipalities of Itajai and Navegantes									
Area (sq.km)	45	259	304	27	70	97	72	329	401
Population *1	105,007	5,807	110,814	11,170	5,945	17,115	116,177	11,752	127,929
Density (Persons/sq.km)	2,333	22	365	414	85	176	1,614	36	319
2. Flood Protection Area									
Area (sq.km)	38.8	0.0	38.8	6.4	9.6	15.9	45.2	9.6	54.7
-Share to the Administrative Area (%)	86.2	0.0	12.8	23.6	13.7	16.4	62.7	2.9	13.6
Population	100,960	0	100,960	10,560	4,280	14,840	111,520	4,280	115,800
-Share to the Administrative Area (%)	96.1	0.0	91.1	94.5	72.0	86.7	96.0	36.4	90.5
Density (Persons/sq.km)	2,603	-	2,603	1,658	447	931	2,470	447	2,116

Remark : *1 Estimated by the state (Ref. V001)
Source : Ref. V001 and V008

Table V.2.3 POPULATION GROWTH IN MUNICIPALITIES OF ITAJAI AND NAVEGANTES

Item	Population			Percentage Distribution(%)			Average Annual Growth Rate(%)	
	1960	1970	1980	1960	1970	1980	'60-'70	'70-'80
1. Total Population	54,996	73,189	99,990	100.0	100.0	100.0	2.9	3.2
Itajai	-	63,139	86,460	-	86.3	86.5	-	3.2
Navegantes	-	10,050	13,530	-	13.7	13.5	-	3.0
2. Male	27,394	35,980	49,512	100.0	100.0	100.0	2.8	3.2
Itajai	-	30,928	42,619	-	86.0	86.1	-	3.3
Navegantes	-	5,052	6,893	-	14.0	13.9	-	3.2
3. Female	27,602	37,209	50,478	100.0	100.0	100.0	3.0	3.1
Itajai	-	32,211	43,841	-	86.6	86.9	-	3.1
Navegantes	-	4,998	6,637	-	13.4	13.1	-	2.9
4. Urban Population	38,529	59,609	87,160	100.0	100.0	100.0	4.5	3.9
Itajai	-	54,073	78,779	-	90.7	90.4	-	3.8
Navegantes	-	5,536	8,381	-	9.3	9.6	-	4.2
5. Rural Population	16,467	13,580	12,830	100.0	100.0	100.0	-1.9	-0.6
Itajai	-	9,066	7,681	-	66.8	59.9	-	-1.6
Navegantes	-	4,514	5,149	-	33.2	40.1	-	1.3
6. Number of Families	10,650	14,451	23,469	100.0	100.0	100.0	3.1	5.0
Itajai	-	12,587	20,390	-	87.1	86.9	-	4.9
Navegantes	-	1,864	3,079	-	12.9	13.1	-	5.1
7. Average Family Size	5.2	5.1	4.3	-	-	-	-0.2	-1.7
Itajai	-	5.0	4.2	-	-	-	-	-1.7
Navegantes	-	5.4	4.4	-	-	-	-	-2.0
8. Number of Residences	10,635	13,844	22,384	100.0	100.0	100.0	2.7	4.9
Itajai	-	12,103	19,426	-	87.4	86.8	-	4.8
Navegantes	-	1,741	2,958	-	12.6	13.2	-	5.4
9. Number of Residence per Family	1.00	0.96	0.95	-	-	-	-0.4	-0.0
Itajai	-	0.96	0.95	-	-	-	-	-0.1
Navegantes	-	0.93	0.96	-	-	-	-	0.3
10. Possibly Active Economically (10 years old and over)	36,073	51,365	76,588	65.6	70.2	76.6	-	4.1
11. Santa Catarina								
Population (1000)	2,118.1	2,901.7	3,627.9	-	-	-	3.2	2.3
Total Area(sq.km)	95,985	95,985	95,985	-	-	-	-	-
12. Share of Two Municipalities to Santa Catarina (%)								
Population	2.60	2.52	2.76	-	-	-	-	-
Land Area	0.42	0.42	0.42	-	-	-	-	-

Remark : In 1960 Navegantes was included in Itajai Municipality.
Source : Ref. V008, V012 and V013

Table V.2.4 NUMBER OF EARNING WORKERS BY INDUSTRIAL GROUP IN MUNICIPALITIES OF ITAJAI AND NAVEGANTES

Industrial Group	Number of Workers			Percentage Distribution(%)			Average Annual Growth Rate(%)	
	1960	1970	1980	1960	1970	1980	'60-'70	'70-'80
Agriculture	4,753	2,786	2,881	32.1	15.0	8.1	-5.2	0.3
Industry	2,100	4,895	11,445	14.2	26.3	32.0	8.8	8.9
-Manufacturing	-	-	7,806	-	-	21.8	-	-
-Construction	-	-	3,144	-	-	8.8	-	-
-Others	-	-	495	-	-	1.4	-	-
Services	7,967	10,937	19,819	53.8	58.7	55.4	3.2	6.1
-Commerce	-	2,653	5,475	-	14.2	15.3	-	7.5
-Hotel & Catering	-	3,250	7,316	-	17.5	20.5	-	8.5
-Transportation & Communication	-	1,729	1,919	-	9.3	5.4	-	1.0
-Other Services	-	3,305	5,109	-	17.8	14.3	-	4.5
Not specified	-	-	1,630	-	-	4.6	-	-
Total	14,820	18,618	35,775	100.0	100.0	100.0	2.3	6.7

Source : V010, V012 and V013

Table V.2.5 INCOME DISTRIBUTION BY INCOME LEVEL IN MUNICIPALITIES OF ITAJAI AND NAVEGANTES : 1980

Income Level *1	Two Municipalities				Santa Catarina	
	Itajai	Navegantes	Total	Percentage Distribution	Total	Percentage Distribution
Less than 1/4	576	59	635	0.8	33,645	1.2
1/4 to 1/2	1,767	284	2,051	2.7	106,593	3.9
1/2 to 1	7,458	936	8,394	11.0	261,423	9.6
1 to 1.5	8,204	1,249	9,453	12.3	316,132	11.6
1.5 to 2	4,591	523	5,114	6.7	175,962	6.5
2 to 3	5,689	818	6,507	8.5	206,576	7.6
3 to 5	4,200	641	4,841	6.3	149,909	5.5
5 to 10	2,575	254	2,829	3.7	83,845	3.1
10 to 20	996	58	1,054	1.4	33,642	1.2
More than 20	368	13	381	0.5	14,381	0.5
No Income	29,746	5,370	35,116	45.9	1,329,252	48.9
No Answer	185	28	213	0.3	8,200	0.3
Total	66,355	10,233	76,588	100.0	2,719,560	100.0
Average Income	1.58	1.10	1.52	-	1.39	-

Remark : *1 Numbers of classification indicate multiples for minimum income.
(cf. minimum income in 1980 was Cr$4,149.60)
Source : V010

Table V.2.6 CONDITION OF HOUSING UNIT IN MUNICIPALITIES OF ITAJAI AND NAVEGANTES : 1980

Item	Two Municipalities				Santa Catarina	
	Itajai	Navegantes	Total	Percentage Distribution	Total	Percentage Distribution
1. Urban						
Durable Unit	17,651	1,877	19,528	98.9	469,330	99.2
Rustic Unit	33	18	51	0.3	814	0.2
Barrack	142	4	146	0.7	2,283	0.5
No Answer	15	0	15	0	699	0
Total	17,841	1,899	19,740	100.0	473,126	100.0
2. Rural						
Durable Unit	1,565	1,047	2,612	98.8	280,724	98.6
Rustic Unit	0	0	0	0.0	1,344	0.5
Barrack	20	9	29	1.1	2,009	0.7
No Answer	0	3	3	0	528	0
Total	1,585	1,059	2,644	100.0	284,605	100.0
3. Total						
Durable Unit	19,216	2,924	22,140	98.9	750,054	99.0
Rustic Unit	33	18	51	0.2	2,158	0.3
Barrack	162	13	175	0.8	4,292	0.6
No Answer	15	3	18	0	1,227	0
Total	19,426	2,958	22,384	100.0	757,731	100.0

Source : V011

Table V.2.7 POPULARIZATION OF HOUSEHOLD EFFECTS AND INSTALLATION IN MUNICIPALITIES OF ITAJAI AND NAVEGANTES : 1980

Item	Two Municipalities				Santa Catarina	
	Itajai	Navegantes	Total	Pervasion (%)	Total	Pervasion (%)
1. Number of Households *1	19,264	2,945	22,209	-	753,439	-
2. Water Supply						
- Piped System	15,372	429	15,801	71.1	311,332	41.3
- Well/Spring	3,104	1,520	4,624	20.8	416,891	55.3
- Other	774	988	1,762	7.9	24,549	3.3
- No Answer	14	8	22	0.1	667	0.1
3. Sewerage						
- Sewerage System	0	0	0	0.0	27,982	3.7
- Septic Tank	17,078	2,359	19,437	87.5	611,689	81.2
- Other	1,555	535	2,090	9.4	93,005	12.3
- No answer	631	51	682	3.1	20,763	2.8
4. Electrification	18,607	2,777	21,384	96.3	594,913	79.0
5. Telephone	2,384	89	2,473	11.1	62,160	8.3
6. Electric Appliances						
- Television	16,276	2,276	18,552	83.5	484,785	64.3
- Refrigerator	15,843	2,268	18,111	81.5	479,685	63.7
7. Car	5,900	578	6,478	29.2	224,354	29.8

Remark : *1 Number of answerer to the questionnaire
Source : V011

Table V.2.8 VALUE OF PRODUCTION IN PRIMARY SECTOR IN MUNICIPALITIES OF ITAJAI AND NAVEGANTES

Sub-sector	Production Value (Thousand Crseiros at Market Prices)			Average Real Growth Rate Per Annum*1 (%)		Percentage Distribution in 1980 (%)
	1970	1975	1980	'70-'75	'75-'80	
Crops	2,220	12,547	81,623	10.9	-2.6	6.3
Livestock	1,183	7,913	119,641	14.7	15.3	9.3
Fishery	13,076	63,143	1,077,448	7.5	18.1	83.5
Forestry	254	738	4,770	-2.9	-2.7	0.4
Rural Industry	41	683	6,343	37.7	4.6	0.5
Total	16,774	85,024	1,289,825	8.5	15.4	100.0
Total in the state of Santa Catarina	1,299,617	7,063,896	96,568,551	10.1	13.0	1.34 *2

Remark : *1 Production values are converted to constant value by implicit deflator.
*2 Percentage share of two municipalities to Santa Catarina
Source : V019, V022, V025, V028, V035, V036 and V037

Table V.2.9 CROP PRODUCTION IN MUNICIPALITIES OF ITAJAI AND NAVEGANTES

Item	Harvested Area (ha)	Unit Yield (ton/ha)	Production Volume (ton)	Unit Price	Production Value	Percentage Distribution of Value(%)
1. Production in 1980				(Cr$/ton)	(Cr$1000)	
Paddy	964	3.46	3,340	9,711	32,435	39.7
Maize	206	1.64	338	8,311	2,809	3.4
Cassava	203	17.31	3,513	3,194	11,221	13.7
Beans	103	0.73	75	48,920	3,669	4.5
Onion	0	-	1	5,000	5	0.0
Sugar Cane	494	56.95	28,135	655	18,439	22.6
Tobacco	13	1.85	24	48,500	1,164	1.4
Others	-	-	-	-	11,881	14.6
Total	1,983	-	35,426	-	81,623	100.0
Total in Santa Catarina		-	-	-	44,749,764	0.18 *1
2. Production in 1987				(Cz$/ton)	(Cz$1000)	
Paddy	1,930	4.66	8,985	2,672	24,009	18.6
Maize	265	3.00	795	2,293	1,823	1.4
Cassava	74	15.00	1,110	1,415	1,571	1.2
Beans	254	0.82	208	8,361	1,739	1.3
Onion	0	-	0	-	0	0.0
Sugar Cane	2,480	70.00	173,600	450	78,120	60.4
Tobacco	44	1.41	62	15,667	971	0.8
Others	-	-	-	-	21,166	16.4
Total	5,047	-	184,760	-	129,398	100.0
Total in Santa Catarina		-	-	-	26,283,819	0.49 *1

Remark : *1 Percentage share of two municipality to Santa Catarina
Source : V014 to V018

Table V.2.10 LIVESTOCK PRODUCTION IN MUNICIPALITIES OF ITAJAI AND NAVEGANTES : 1980

Item	Unit	Production Volume	Average Unit Price (Cr$/Unit)	Production Value (Cr$1000)	Percentage Distribution (%)
Cattle	head	1,636	15,759	25,782	21.5
Pig	head	2,735	4,738	12,958	10.8
Hourse	head	24	9,333	224	0.2
Chicken	head	528,825	115	61,016	51.0
Milk	kl	1,407	10,569	14,871	12.4
Egg	1000 dz	223	20,682	4,612	3.9
Bee Products	kg	612	144	88	0.1
Others	-	-	-	90	0.1
Total	-	-	-	119,641	100.0
Total in Santa Catarina		-	-	39,619,412	0.30 *1

Remark : *1 Percentage share of two municipalities to Santa Catarina
Source : V015

Table V.2.11 FISHERY PRODUCTION IN MUNICIPALITIES OF ITAJAI AND NAVEGANTES

Item	Production (ton)	Average Unit Price	Production Value	Percentage Distribution of Value(%)
1. Production in 1980		(Cr$/ton)	(Cr$1000)	
Fish	79,742	9,616	766,790	71.2
Crustacean	1,276	156,050	199,120	18.5
Mollusk	4,218	26,441	111,530	10.4
Total	85,236	12,641	1,077,440	100.0
Total in St.Catarina	118,105	-	2,142,886	50.3 *1
2. Production in 1987		(Cz$/ton)	(Cz$1000)	
Fish	52,721	14,357	756,940	79.3
Crustacean	1,886	98,160	185,130	19.4
Mollusk	554	22,004	12,190	1.3
Total	55,161	17,300	954,260	100.0
Total in St.Catarina	67,896	-	1,262,285	75.6 *1

Remark : *1 Percentage share of two municipalities to Santa Catarina
Source : V028

Table V.2.12 FORESTRY PRODUCTION IN MUNICIPALITIES OF ITAJAI AND NAVEGANTES : 1980

Item	Unit	Production Volume	Average Unit Value (Cr$/Unit)	Value of Production (Cr$1000)	Percentage Distribution of Value(%)
1. Natural Production					
Firewood	1000 cu.m.	21	157	3,287	68.9
Timber	1000 cu.m.	0	-	1,211	25.4
Cabbage palm	ton	-	-	-	-
2. Forested Production					
Firewood	1000 cu.m.	-	-	-	-
Timber	1000 cu.m.	-	-	-	-
Timber for Paper	1000 cu.m.	-	-	-	-
Seedings	1000 cu.m.	-	-	272	5.7
Total	-	-	-	4,770	100.0
Total in Santa Catarina	-	-	-	6,744,508	0.07 *1

Remark : *1 Percentage share of two municipalities to Santa Catarina
Source : V015

Table V.2.13 RURAL INDUSTRY PRODUCTION IN MUNICIPALITIES OF ITAJAI AND NAVEGANTES : 1980

Item	Value (Cr$1000)	Percentage Distribution(%)
Sugar	-	-
Spirit Sugarcane	-	-
Syrup	207	3.3
Custard	83	1.3
Butter	10	0.2
Cheese	1,613	25.4
Cassava-related	2,775	43.7
Grape-related	-	-
Rice	-	-
Tabacco	-	-
Coffee	-	-
Corn-meal	-	-
Lard	344	5.4
Meat	1,245	19.6
Sausage	58	0.9
Bacon	8	0.1
Total	6,343	100.0
Total in Santa Catarina	3,311,981	0.19 *1

Remark : *1 Percentage share of two municipalities of Santa Catarina
Source : V015

Table V.2.14 INVENTORY OF INDUSTRIAL, COMMERCIAL AND SERVICE ESTABLISHMENTS IN MUNICIPALITIES OF ITAJAI AND NAVEGANTES : 1989

Industrial Type	Itajai	Navegantes	Total
1. Manufacturing Sector			
- Non-metal Products	43	-	43 *2
- Metallurgy	25	-	25 *2
- Machinery	17	-	17 *2
- Electric & Communication Products	9	-	9 *2
- Vehicle	16	-	16 *2
- Timber	27	-	27 *2
- Furniture	20	-	20 *2
- Paper	5	-	5 *2
- Rubber	3	-	3 *2
- Leather	-	-	-
- Chemistry	1	-	1 *2
- Medicine	-	-	-
- Soap, Perfume	3	-	3 *2
- Plastic Products	9	-	9 *2
- Textile	2	-	2 *2
- Clothing	12	-	12 *2
- Food Products	40	-	40 *2
- Beverage	-	-	-
- Tobacco	-	-	-
- Printing	9	-	9 *2
- Other Products	4	-	4 *2
Total	245	56	301
2. Commercial & Services' Sector			
- Commerce	708 *1	107 *1	815
- Services	627 *1	68 *1	695
Total	1,335	175	1,510

Remark : *1 Data in 1986
*2 Excluding the number of industrial establishments in Navegantes
Source : Information from Municipality of Itajai and SEPLAN/SC

Table V.2.15 NUMBER OF MANUFACTURING ESTABLESHMENTS IN MUNICIPALITIES OF ITAJAI AND NAVEGANTES

Industrial Type	Number of Establishment			Average Annual Growth Rate(%)		Percentage Distribution in 1980(%)
	1970	1975	1980	'70-'75	'75-'80	
Mining	7	6	3	-3.0	-12.9	1.1
Non-metal Products	31	60	54	14.1	-2.1	19.2
Metallurgy	5	15	26	24.6	11.6	9.3
Machinery	6	11	14	12.9	4.9	5.0
Electric & Communication Products	8	6	6	-5.6	0.0	2.1
Vehicle	12	18	23	8.4	5.0	8.2
Timber	24	39	32	10.2	-3.9	11.4
Furniture	22	21	26	-0.9	4.4	9.3
Paper	2	2	5	0.0	20.1	1.8
Rubber	2	2	1	0.0	-12.9	0.4
Leather	-	-	-	-	-	-
Chemistry	-	1	2	-	14.9	0.7
Medicine	-	-	-	-	-	-
Soap, Perfume	3	3	2	0.0	-7.8	0.7
Plastic Products	1	4	6	32.0	8.4	2.1
Textile	4	2	3	-12.9	8.4	1.1
Clothing	2	2	9	0.0	35.1	3.2
Food Products	53	51	51	-0.8	0.0	18.1
Beverage	-	-	-	-	-	-
Tobacco	-	-	-	-	-	-
Printing	6	9	12	8.4	5.9	4.3
Other Products	4	6	6	8.4	0.0	2.1
Total	192	258	281	6.1	1.7	100.0
Total in Santa Catarina	8,895	9,758	11,371	1.9	3.1	2.5

Source : V019, V022 and V025

Table V.2.16 NUMBER OF WORKERS BY MANUFACTURING ESTABLEHMENTS IN MUNICIPALITIES OF ITAJAI AND NAVEGANTES

Industrial Type	Number of Workers *1 *2			Average Annual Growth Rate(%)		Percentage Distribution in 1980(%)
	1970	1975	1980	'70-'75	'75-'80	
Mining	19	14 *3	*	-	-	-
Non-metal Products	456 *3	777	648	11.2	-3.6	11.8
Metallurgy	25	180	239	48.4	5.8	4.4
Machinery	52	263	281	38.3	1.3	5.1
Electric & Communication Products	21	63	253	24.6	32.1	4.6
Vehicle	114 *3	337 *3	605	24.2	12.4	11.0
Timber	279	523	529	13.4	0.2	9.7
Furniture	145 *3	184 *3	267 *3	4.9	7.7	4.9
Paper	*	*	336	-	-	6.1
Rubber	*	*	*	-	-	-
Leather	-	-	-	-	-	-
Chemistry	-	*	*	-	-	-
Medicine	-	-	-	-	-	-
Soap, Perfume	18	17	*	-1.1	-	-
Plastic Products	*	123	149	-	3.9	2.7
Textile	65	*	*	-	-	-
Clothing	*	*	178	-	-	3.2
Food Products	855	1,323	1,517	9.1	2.8	27.7
Beverage	-	-	-	-	-	-
Tobacco	-	-	-	-	-	-
Printing	44	45	75	0.5	10.8	1.4
Other Products	58	24	111	-16.2	35.8	2.0
Total	2,374	4,343	5,480	12.8	4.8	100.0
Total in Santa Catarina	120,045	189,426	276,813	9.6	7.9	2.0 *4

Remark : *1 "*" means that data are omitted in order to avoid identification of informant.
*2 "-" means that data do not exist according to declaration of informant.
*3 Number of workers in Navegantes are included because of the same reason as "*1".
*4 Percentage share of two municipalities to Santa Catarina

Source : V019, V022 and V025

Table V.2.17 PRODUCTION OF MANUFACTURING ESTABLISHMENTS IN MUNICIPALITIES OF ITAJAI AND NAVEGANTES

Industrial Type	Production Value *1 *2 (Thousand Cruseiros at Market Prices)			Average Real Growth Rate Per Annum (%)		Percentage Distribution in 1980 (%)
	1970	1975	1980	'70-'75	'75-'80	
Mining	43	594 *3	*	-	-	-
Non-metal Products	15,382 *3	105,075	1,502,154	15.2	14.0	20.5
Metallurgy	289	9,012	172,294	56.1	20.8	2.4
Machinery	1,313	27,521	320,599	44.2	9.4	4.4
Electric & Communication Products	373	5,989	459,879	36.7	59.6	6.3
Vehicle	1,904 *3	35,435 *3	439,038	40.8	10.8	6.0
Timber	6,171	66,854	304,744	26.3	-9.3	4.2
Furniture	1,698 *3	25,946 *3	199,981 *3	35.3	0.7	2.7
Paper	*	*	669,081	-	-	9.1
Rubber	*	*	*	-	-	-
Leather	-	-	-	-	-	-
Chemistry	-	*	*	-	-	-
Medicine	-	-	-	-	-	-
Soap, Perfume	411	1,386	*	0.0	-	-
Plastic Products	*	14,656	220,346	-	15.2	3.0
Textile	1,089	*	*	-	-	-
Clothing	*	*	95,305	-	-	1.3
Food Products	41,206	414,230	2,669,933	24.5	-2.8	36.5
Beverage	-	-	-	-	-	-
Tobacco	-	-	-	-	-	-
Printing	356	2,153	21,326	12.4	5.9	0.3
Other Products	339	913	89,672	-4.4	67.6	1.2
Total	73,504	745,257	7,321,045	24.7	5.8	100.0
Total in Santa Catarina	2,947,305	24,163,147	381,526,265	19.5	16.3	1.9 *5

Remark : *1 "*" means that data are omitted in order to avoid identification of informant.
*2 "-" means that data do not exist according to declaration of informant.
*3 Production value in Navegantes is not included because of same reason as "*1".
*4 Production values are converted to constant values by implicit deflator.
*5 Percentage share of two municipalities to Santa Catarina

Source : V019, V022 and V025

Table V.2.18 MANAGEMENT INDICES OF MANUFACTURING ESTABLISHMENTS IN MUNICIPALITIES OF ITAJAI AND NAVEGANTES : 1980

Industrial Type	Prduction Value(PV) per Establishment (Mil. Cr$/Est.)	Number of Workers per Establishment	Productivity of Labor (Mil. Cr$/Worker)	Value Added (VA) (Mil. Cr$)	Coefficient of Value Added (VA/PV : %)	Production of Value Added per Labor (Mil. Cr$/Worker)	Production of Value Added per Establishment (Mil. C$/Est)
Mining	-	-	-	-	-	-	-
Non-metal Products	27.8	12.0	2.32	491	32.7	0.76	9.09
Metallurgy	6.6	9.2	0.72	91	52.7	0.38	3.49
Machinery	22.9	20.1	1.14	211	65.9	0.75	15.10
Electric & Communication Products	76.6	42.2	1.82	225	49.0	0.89	37.57
Vehicle	19.1	26.3	0.73	205	46.7	0.34	8.91
Timber	9.5	16.5	0.58	158	51.8	0.30	4.93
Furniture	7.7	10.3	0.75	107	53.7	0.40	4.13
Paper	133.8	67.2	1.99	242	36.2	0.72	48.40
Rubber	-	-	-	-	-	-	-
Leather	-	-	-	-	-	-	-
Chemistry	-	-	-	-	-	-	-
Medicine	-	-	-	-	-	-	-
Soap, Perfume	-	-	-	-	-	-	-
Plastic Products	36.7	24.8	1.48	109	49.3	0.73	18.09
Textile	-	-	-	-	-	-	-
Clothing	10.6	19.8	0.54	59	61.7	0.33	6.53
Food Products	52.4	29.7	1.76	999	37.4	0.66	19.59
Beverage	-	-	-	-	-	-	-
Tobacco	-	-	-	-	-	-	-
Printing	1.8	6.3	0.28	14	65.2	0.19	1.16
Other Products	14.9	18.5	0.81	80	89.6	0.72	13.40
Average	26.1	19.5	1.34	2,999	41.0	0.55	10.67
Average in the state of Santa Catarina	33.6	24.3	1.38	168,628	44.2	0.61	14.83

Source : V019, V022 and V025

Table V.2.19 AVERAGE ASSETS HOLDINGS OF MANUFACTURING ESTABLISHMENTS BY TYPE OF INDUSTRY IN SANTA CATARINA AT THE END OF 1980

(Unit : 1000 Cruseiros/Establishment)

Insutrial Type	Fixed Assets						Inventory Stock *1		
	Tangible Assets					Intangible Assets	Raw Material & Semi Products	Manufactured Products	Goods for Resale
	Site & Building	Machine & Equipment	Installation	Furniture	Vehicle				
Mining	3,201	8,473	1,418	106	1,209	4,856	738	2,264	-
Non-metal Products	1,800	1,832	349	58	395	87	591	598	15
Metallurgy	2,289	4,048	250	144	232	6,170	2,004	1,195	51
Machinery	2,459	5,311	320	194	304	498	4,840	1,245	131
Electric & Communication Products	1,746	4,458	229	306	137	202	4,622	2,370	114
Vehicle	1,527	1,851	371	109	202	282	1,534	1,446	92
Timber	1,524	1,306	250	62	775	321	621	729	52
Furniture	1,254	1,116	125	71	220	57	1,015	266	49
Paper	12,173	17,460	1,919	328	1,281	2,750	5,695	1,660	112
Rubber	1,269	2,298	213	164	485	181	605	82	227
Leather	3,916	4,589	345	180	402	9	3,352	1,404	193
Chemistry	18,548	27,128	8,752	367	1,151	102	6,591	10,696	6
Medicine	4,378	3,726	986	615	115	258	5,348	1,254	-
Soap, Perfume	648	900	258	51	376	6	948	1,260	86
Plastic Products	4,036	17,744	652	312	300	99	6,089	6,338	32
Textile	7,964	24,248	1,875	885	171	237	9,563	3,647	24
Clothing	1,985	2,183	298	199	201	114	3,492	1,731	34
Food Products	2,850	2,610	773	163	495	130	2,331	2,132	107
Beverage	3,634	3,426	563	207	436	4,204	1,081	1,148	178
Tobacco	21,386	20,358	3,029	1,435	1,565	745	4,831	32,329	8,683
Printing	678	2,308	136	184	111	51	581	55	112
Other Manufacturing	1,329	2,429	212	120	165	288	2,406	1,374	27
Total	2,429	3,409	513	143	488	355	1,850	1,342	83

Remark : *1 Average inventory stock of two values at the ends of both 1979 and 1980.

Source : V019

Table V.2.20 NUMBER OF COMMERCIAL AND SERVICE ESTABLESHMENTS IN MUNICIPALITIES OF ITAJAI AND NAVEGANTES

Industrial Type	Number of Establishment			Average Annual Growth Rate(%)		Percentage Distribution
	1970	1975	1980	'70-'75	'75-'80	in 1980(%)
Commerce	714	706	832	-0.2	3.3	49.7
Retail Store	649	629	747	-0.6	3.5	44.6
Wholesale	65	77	85	3.4	2.0	5.1
Services	436	606	842	6.8	6.8	50.3
Hotel and Catering	159	250	288	9.5	2.9	17.2
Maintenance and Fixing	95	217	294	18.0	6.3	17.6
Personal Care	79	57	94	-6.3	10.5	5.6
Broadcasting	5	7	5	7.0	-6.5	0.3
Other Services	98	75	161	-5.2	16.5	9.6
Total	1,150	1,312	1,674	2.7	5.0	100.0
Total in Santa Catarina	30,603	28,934	46,660	-1.1	10.0	3.59 *1
- Commerce	19,602	19,431	23,637	-0.2	4.0	3.52 *1
- Services	11,001	9,503	23,023	-2.9	19.4	3.66 *1

Remark : *1 Percentage share of two municipalities to Santa Catarina
Source : V019, V022 and V025

Table V.2.21 NUMBER OF WORKERS BY COMMERCIAL AND SERVICE ESTABLEHMENTS IN MUNICIPALITIES OF ITAJAI AND NAVEGANTES

Industrial Type	Number of Workers			Average Annual Growth Rate(%)		Percentage Distribution
	1970	1975	1980	'70-'75	'75-'80	in 1980(%)
Commerce	2,709 *1	3,761 *1	4,846	6.8	5.2	61.7
Retail Store	1,776	2,553	3,408 *1	7.5	5.9	43.4
Wholesale	933 *1	1,208 *1	1,152 *1	5.3	-0.9	14.7
Services	784	1,722	3,011	17.0	11.8	38.3
Hotel and Catering	394	651	781	10.6	3.7	9.9
Maintenance and Fixing	186	509	737	22.3	7.7	9.4
Personal Care	124	87	149	-6.8	11.4	1.9
Broadcasting	39	53	35	6.3	-8.0	0.4
Other Services	41	422	1,172 *1	59.4	22.7	14.9
Total	3,493	5,483	7,857	9.4	7.5	100.0
Total in Santa Catarina	77,925	94,546	183,297	3.9	14.2	4.29 *2
- Commerce	53,585	72,263	100,236	6.2	6.8	4.83 *2
- Service	24,340	22,283	83,061	-1.8	30.1	3.63 *2

Remark : *1 Production value in Navegantes is not included because data are not officially announced to avoid identification of informant in the Census of IBGE.
*2 Percentage share of two municipalities to Santa Catarina
Source : V019, V022 and V025

Table V.2.22 PRODUCTION OF COMMERCIAL AND SERVICE ESTABLISHMENTS IN MUNICIPALITIES OF ITAJAI AND NAVEGANTES

Industrial Type	Production Value (Thousand Cruseiros at Market Prices)			Average Real Growth Rate Per Annum(%)*3		Percentage Distribution in 1980 (%)
	1970	1975	1980	'70-'75	'75-'80	
Commerce	292,074	1,946,980	26,489,139	14.6	12.9	95.4
Retail Store	80,644 *1	569,369 *1	7,034,204 *1	16.0	10.7	25.3
Wholesale	211,430 *1	1,360,803 *1	19,112,523 *1	13.8	13.6	68.9
Services	8,951	70,681	1,263,127	18.6	19.2	4.6
Hotel and Catering	4,891	26,977	243,076	10.4	3.9	0.9
Maintenance and Fixing	1,477	16,879	222,876	27.7	12.2	0.8
Personal Care	725	2,142	42,447	-2.6	21.7	0.2
Broadcasting	438	1,795	15,757	4.0	3.4	0.1
Other Services	1,420	22,888	725,150 *1	36.8	33.7	2.6
Total	301,025	2,017,661	27,752,266	14.8	13.1	100.0
Total in Santa Catarina	3,220,120	21,923,197	254,762,241	15.1	9.4	10.89 *2
- Commerce	2,999,202	20,314,200	224,916,773	15.0	8.3	11.78 *2
- Services	220,918	1,608,997	29,845,468	16.7	20.1	4.23 *2

Remark : *1 Production value in Navegantes is not included because data are not officially announced to avoid identification of informant in the Census of IBGE.
*2 Percentage share of two municipalities to Santa Catarina
*3 Production values are converted to constant values by implicit deflator.

Source : V019, V022 and V025

Table V.2.23 MANAGEMENT INDICES OF COMMERCIAL AND SERVICE ESTABLISHMENTS IN MUNICIPALITIES OF ITAJAI AND NAVEGANTES : 1980

Industrial Type	Sales Amount (SA) per Establishment (Mil. Cr$/Est.)	Number of Workers per Establishment	Productivity of Labor (Mil. Cr$/Worker)	Value Added (VA) (Mil. Cr$)	Coefficient of Value Added (VA/SA : %)	Production of Value Added per Labor (Mil. Cr$/Worker)	Production of Value Added per Establishment (Mil. Cr$/Est.)
Commerce	34.0	5.9	5.73	2,732	10.4	0.60	3.55
Retail Store	10.3	5.0	2.06	735	10.4	0.22	1.07
Wholesale	227.5	13.7	16.59	1,765	9.2	1.53	21.01
Services	1.5	3.4	0.43	993	79.5	0.35	1.18
Hotel and Catering	0.8	2.7	0.31	128	52.5	0.16	0.44
Maintenance and Repairing	0.8	2.5	0.30	159	71.1	0.22	0.54
Personal Care	0.5	1.6	0.28	33	77.3	0.22	0.35
Broadcasting	3.2	7.0	0.45	15	97.2	0.44	3.06
Other Services	4.5	7.3	0.62	658	90.8	0.56	4.09
Average	17.0	4.6	3.69	3,725	13.6	0.50	2.31
Average in Santa Catarina	5.5	3.9	1.39	29,976	11.8	0.16	0.64
- Commerce	9.5	4.2	2.24	22,458	10.0	0.22	0.95
- Services	1.3	3.6	0.36	7,518	25.2	0.09	0.33

Source : V020 and V021

Table V.2.24 AVERAGE ASSETS HOLDINGS OF COMMERCIAL AND SERVICE ESTABLESHMENTS BY TYPE OF INDUSTRY IN SANTA CATARINA AT THE END OF 1980

(Unit : 1000 Cruzeiros/Establishment)

Industrial Type	Fixed Assets					Inventory Stock *1
	Tangible Assets				Intangible Assets	
	Site and Building	Equipment	Office Furniture	Vehicle		
Commerce	446	178	75	152	108	1,156
Retail Store	391	150	69	97	28	875
Wholesale	1,375	660	180	1,096	169	5,946
Services	380	211	66	41	161	72
Hotel and Catering	456	169	81	7	9	57
Maintenance and Repairing	166	149	20	17	3	104
Personal Care	87	98	31	7	0	26
Broadcasting	1,044	1,108	162	41	8	102
Other Services	2,202	728	290	359	1,514	125
Total	413	194	71	98	97	703

Remark : *1 Average inventory stock of two values at the ends of both 1979 and 1980.
Source : V020 and V021

Table V.2.25 GROSS REGIONAL DOMESTIC PRODUCT BY INDUSTRIAL ORIGIN IN SANTA CATARINA AT CURRENT PEICES

Item	GRDP of Santa Catarina						Percentage Distribution (%)					
	1975	1980	1985	1986	1987	1988	1975	1980	1985	1986	1987	1988
1. GRDP at Current Prices	(Million Cruseiros)			(Million Cruzados)								
Agriculture	6,793	64,028	8,588,082	21,197	81,028	640,058	21.6	16.0	16.0	14.9	16.8	17.1
Industry	10,745	151,485	20,321,550	55,460	196,472	1,473,518	34.1	37.9	37.9	39.0	40.8	39.4
- Mining	286	4,463	-	-	-	-	0.9	1.1	-	-	-	-
- Manufacturing	9,125	131,321	-	-	-	-	29.0	32.8	-	-	-	-
- Construction	1,046	13,405	-	-	-	-	3.3	3.4	-	-	-	-
- Public Utility	288	2,296	-	-	-	-	0.9	0.6	-	-	-	-
Services	13,970	184,592	24,765,882	65,512	204,522	1,627,267	44.3	46.1	46.1	46.1	42.4	43.5
- Commerce	3,171	41,636	-	-	-	-	10.1	10.4	-	-	-	-
- Transportation & Communication	2,049	33,090	-	-	-	-	6.5	8.3	-	-	-	-
- Finance	2,475	38,901	-	-	-	-	7.9	9.7	-	-	-	-
- Government	1,525	15,294	-	-	-	-	4.8	3.8	-	-	-	-
- Real Estate	1,776	12,068	-	-	-	-	5.6	3.0	-	-	-	-
- Others	2,974	43,603	-	-	-	-	9.4	10.9	-	-	-	-
Total	31,508	400,105	53,675,514	142,170	482,021	3,740,843	100.0	100.0	100.0	100.0	100.0	100.0
2. GRDP per Capita	(Cruseiros)			(Cruzardos)			(Average) Annual Growth Rate (%)					
- Current Price	9,711	110,285	13,184,702	34,126	113,525	873,004	-	-	-	-	-	-
- US$ Equivalent	1,670	2,555	2,767	2,957	3,028	2,968	9.9	8.9	1.6	6.8	2.4	-2.0
3. GRDP at 1982 Constant Prices												
- Total (Mil.Cz$)	972,243	1,662,634	2,020,725	2,209,335	2,306,148	2,281,011	12.3	11.3	4.0	9.3	4.4	-1.1
- Per Capita (Cz$)	299,649	458,287	496,365	530,330	543,139	532,322	9.9	8.9	1.6	6.8	2.4	-2.0
4. Population in SC (1000) *2	3,244.6	3,627.9	4,071.0	4,166.0	4,246.0	4,285.0	2.3	2.3	2.3	2.2	1.9	0.9

Remark : *1 Denominated one cruzado to 1000 cruseiros since February 1986.
*2 Quoted from Ref.V001, but populations in 1975 and 1986 are estimated by the team.
Source : V001, V005 and V054

Table V.2.26 ESTIMATED GROSS REGIONAL DOMESTIC PRODUCT BY ECONOMIC SECTOR IN MUNICIPALITIES OF ITAJAI AND NAVEGANTES AT CURRENT PRICES

Item	Gross Regional Domestic Product			Percentage Distribution (%)			Average Real Growth Rate Per Annum (%) *2	
	1970 (Mil. Cr$)	1980 (Mil. Cr$)	1987 (Mil. Cz$)	1970	1980	1987	'70-'80	'80-'87
1. GRDP in Santa Catarina *1								
Agriculture	1,176	64,028	81,028	22.5	16.0	16.8	8.3	5.5
Industry	1,536	151,485	196,472	29.4	37.9	40.8	13.6	5.9
Services	2,519	184,592	204,522	48.2	46.1	42.4	12.0	3.5
Total	5,231	400,105	482,021	100.0	100.0	100.0	11.8	4.8
Per Capita GRDP	Cr$1,803	Cr$110,286	Cz$113,525	-	-	-	9.4	2.5
Population (1000)	2,901.7	3,627.9	4,246.0	-	-	-	2.3	2.3
2. Estimated GRDP in Municipalities of Itajai and Navegantes *3								
Agriculture	15.2	855.2	1,612.3	10.8	7.0	10.6	8.6	11.7
Industry	38.3	2,906.8	3,770.1	27.2	23.6	24.8	10.7	5.9
Services	87.2	8,534.2	9,794.3	62.0	69.4	64.5	15.3	4.1
Total	140.7	12,296.2	15,176.7	100.0	100.0	100.0	13.4	5.1
Per Capita GRDP	Cr$1,922	Cr$122,974	Cz$124,765	-	-	-	9.9	2.2
Population (1000)	73.2	100.0	121.6	-	-	-	3.2	2.8
3. Share of Two Municipalities to Santa Catarina								
Percentage Share (%)								
GRDP	2.7	3.1	3.1	-	-	-	-	-
GRDP per Capita	106.6	111.5	109.9	-	-	-	-	-

Remark : *1 Estimation by SEPLAN/SC
*2 Real Values are calculated by implicit deflator.
*3 GVA of each sector in two Municipalities is estimated on the basis of both municipal production value and coefficient of value added (refer to Table 2.23).
*4 Growth of the sector is assumed to be the same as that of the state.
Source : V001 and V054

Table V.2.27 PUBLIC INVESTMENT FOR FLOOD CONTROL IN SANTA CATARINA

(Unit : 1000 New Cruzados)

Item	1984	1985	1986	1987	1988
1. Gross Domestic Product*1	393,745	1,413,792	3,708,196	11,884,734	92,993,145
2. Actual Disbursement of the Federal Government	33,817	130,426	548,109	1,615,100	15,511,064 *1
3. Actual Disbursement of the Ministry of Agriculture	953	3,437	17,217	45,759	230,254
4. Actual Disbursement of the 14th Regional Office of DNOS	19	57	110	195	6,157
5. - Flood Control Schemes in the 14th Regional Office of DNOS	16	52	85	121	5,168
6. Actual Disbursement of the Federal Government for Santa Catarina	131	598	1,704	7,194	47,435
7. Percentage Share (%)					
- (2)/(1)	8.59	9.23	14.78	13.59	16.68
- (3)/(2)	2.82	2.64	3.14	2.83	1.48
- (4)/(3)	1.94	1.65	0.64	0.43	2.67
- (5)/(4)	87.37	91.58	77.35	61.75	83.94
- (4)/(2)	0.05	0.04	0.02	0.01	0.04
- (6)/(2)	0.39	0.46	0.31	0.45	0.31

Remark : *1 Quoted from Ref.V049.
Source : V007, V049 and DNOS

Table V.2.28 CHANGE OF PRICE INDEX AND FOREIGN EXCHANGE RATE

Year /Month	Consumer Price Index *1		GDP Implicit Deflator		Foreign Exchange Rate*1 (NCz$/US$)	
	Brazil	Santa Catarina *2	Brazil	Santa Catarina	Official Rate	Tourist Rate
1980	100	100	100	100	0.000065	-
1981	194	200	208	213	0.000127	-
1982	388	414	428	416	0.000251	-
1983	1,077	1,169	1,032	1,058	0.000979	-
1984	3,331	3,571	3,253	3,389	0.003168	-
1985	11,293	12,707	10,777	11,037	0.010440	-
1986	17,978	19,773	26,279	26,731	0.014917	-
1987	88,930	98,699	81,294	85,757	0.071892	-
1988	1,012,444	975,485	637,716	681,454	0.761490	-
1989						
January	1,385,847	1,413,714	-	-	0.995500	1.550000
February	1,552,050	1,560,599	-	-	1.000000	1.580000
March	1,616,528	1,611,630	-	-	1.000000	1.840000
April	1,699,482	1,766,025	-	-	1.032000	-
May	1,916,230	2,035,167	-	-	1.148000	2.930000
June	2,427,807	2,619,667	-	-	1.512000	3.170000
July	3,515,476	3,577,631	-	-	2.156000	3.680000
August	4,689,083	4,951,115	-	-	2.788000	4.500000
September	6,386,421	6,685,491	-	-	3.778000	7.155100

Remark : *1 At the end of year (or month) ; Base : December 1980 = 100
*2 Prices in Florianopolis
Source : V007, V039, V040, V044 and V045

Table V.2.29 ESTIMATION OF STANDARD CONVERSION FACTOR

Item	1983	1984	1985	1986	1987	Average
1. Import (CIF Price)						
- Cz$10^6	9,025	26,521	84,815	207,785	597,939	185,217
- US$10^6	16,801	15,210	14,332	15,557	16,581	15,696
2. Export (FOB Price)						
- Cz$10^6	11,653	49,423	148,572	319,271	947,659	295,315
- US$10^6	21,899	27,005	25,639	22,349	26,225	24,623
3. Import Tax (Cz$10^6)	490	1,423	5,199	16,712	44,449	13,655
4. Export Tax (Cz$10^6)	213	528	2,949	1,534	3,663	1,777
5. Export Subsidies (Cz$10^6)	-	-	-	-	-	-
6. Total of Foreign Trade (Cz$10^6) *1	20,678	75,944	233,387	527,056	1,545,598	480,532
7. (1)+(2)+(3)-(4)+(5) (Cz$10^6)	20,955	76,839	235,637	542,234	1,586,384	492,410
8. Conversion Rate ((6)/(7))	0.99	0.99	0.99	0.97	0.97	0.98
9. SCF *1					==>	0.90

Remark : "-" means data are not available.
*1 Taking the internal transfer portions (taxes and excise duty) into account.
Source : V007

Table V.2.30 INVENTORY OF SOCIAL INFRASTRUCTURE IN MUNICIPALITIES OF ITAJAI AND NAVEGANTES : 1989

Item	Itajai	Navegantes	Total
1. Educational Facility	121	25	146
- Nursery School/Kindergarten	45 *2	11 *2	56
- First Grade School	63 *2	13 *2	76
- Second Grade School	13 *2	1 *2	14
- University/Colledge	0	0	0
2. Medical Facility	14	3	17
- Hospital	2 *3	0 *3	2
- Clinic	4 *3	1 *3	5
- Other facilities	8 *3	2 *3	10
3. Religious Facility	51	-	51 *4
- Church	51 *1	-	51 *4
4. Public Facility	35	1	36 *4
- City Hall	1 *1	1	2
- Assembly Hall	34 *1	-	34 *4

Remark : *1 Data in 1989
*2 Data in 1987
*3 Data in 1986
*4 Excluding the number of respective facilities in Navegantes
Source : V001 and information by Municipality of Itajai

Table V.2.31 PRESENT LAND USE IN STUDY AREA

(Unit : sq.km.)

No	Item	Itajai	Nave-gantes	Penha	Picarras	Total	Percentage Distribution (%)
I.	Total Area	304	97	46	154	601	100.0
II.	Land Use						
1	Built-up Area	33	12	9	8	62	10.3
2	Agriculture	36	23	5	20	84	14.0
	- Paddy	18	5	1	5	29	4.8
	- Sugar Cane	12	15	2	11	40	6.7
	- Other Crops	6	3	2	4	15	2.5
3	Grassland & Pasture	93	30	16	54	193	32.1
4	Forest & Bush	142	32	16	72	262	43.6

Table V.2.32 PRESENT LAND USE IN FLOOD PROTECTION AREA

(Unit : sq.km; %)

No	Item	Municipalities of Itajai and Navegantes		Flood Protection Area				
		Total of Municipal Areas (a)	% Distribution (b)	in Itajai (c)	in Navegantes (d)	Total (c)+(d) (e)	% Distribution (f)	% Share to (a) (e)/(a) (g)
I.	Total Area	401.0	100.0	38.8	15.9	54.7	100.0	13.6
II.	Land Use							
1	Built-up Area	45.0	11.2	22.2	5.2	27.5	50.2	61.0
	- Residential	-	-	17.6	4.8	22.4	40.9	-
	- Others	-	-	4.7	0.4	5.1	9.3	-
2	Agriculture	59.0	14.7	0.0	1.3	1.3	2.3	2.1
	- Paddy	23.0	5.7	0.0	1.3	1.3	2.3	5.4
	- Sugar Cane	27.0	6.7	0.0	0.0	0.0	0.0	0.0
	- Other Crops	9.0	2.2	0.0	0.0	0.0	0.0	0.0
3	Grassland & Pasture	123.0	30.7	13.2	7.4	20.6	37.6	16.7
4	Forest & Bush	174.0	43.4	*3	*3	*3	-	-
5	River & Marsh	*2	-	3.4	2.1	5.5	10.0	-
III.	Population	127,929	-	100,960	14,840	115,800	-	90.5
IV.	Density (Persons/sq.km.)							
	- Gross	319	-	2,603	931	2,116	-	663.3
	- Net *1	-	-	5,746	3,092	5,177	-	-
V.	Number of Establishments							
	- Agriculture	501	-	0	7	7	-	1.4
	- Industry	301 *4	-	190	18	208	-	69.1
	- Commerce and Service	1,510 *4	-	1,221	108	1329	-	88.0

Remark : *1 "Net" means population per residential area.
*2 Area for water surface is included in other categories.
*3 Included in grassland and pasture land
*4 Refer to Table V.2.14

Table V.3.1 ACTUAL FLOOD DAMAGE RECORDS IN MUNICIPALITIES OF ITAJAI AND NEVEGANTES

No. Item	Unit	1983		1984	
		Itajai	Navegantes	Itajai	Navegantes
1. Inundated Area	ha	-	-	-	11.9
2. Victims	Person	-	-	60,000	2,030
3. Affected Houses					
3.1 Destroyed	Nos	-	-	90	1
3.2 Damaged	Nos	-	-	2,500	0
3.3 Inundated	Nos	-	-	20,000	323
4. Damage to Private Sector					
4.1 Agriculture	Mil. Cr$	-	-	610.4	21.2
4.2 Industry	Mil. Cr$	-	-	2,174.1	80.8
4.3 Commerce & Services	Mil. Cr$	-	-	2,951.1	27.1 *1
5. Damage to Public Sector					
5.1 Public Facility					
School	Mil. Cr$	-	8.4	-	12.6
Municipal Bldg	Mil. Cr$	72.9	-	147.5	6.5
Electricity	Mil. Cr$	-	10.4	-	-
Others	Mil. Cr$	-	6.3	12.6	25.0
5.2 Road System					
Road	Mil. Cr$	1,084.3	186.0	10,869.5	206.3
Bridge	Mil. Cr$	5.8	48.4	467.5	18.0
Drainage	Mil. Cr$	192.7	65.0	290.7	11.1
Road Equipment	Mil. Cr$	22.7	99.7	119.7	16.2
5.3 Port	Mil. Cr$	68,200.0 *3	-	-	-
6. Relief Activity for Victims	Mil. Cr$	0.5	-	-	-
7. Total of 4 to 6	Mil. Cr$	69,578.9	424.1	17,643.0	424.7

Remark : *1 Damage on commercial sector is included in industrial sector.
*2 Most of figures indicate repairing costs for damaged facilities.
*3 Converted by the reconstruction cost by the national government.
Source : V028 & V029

Table V.3.2 FLOOD DAMAGE TO AGRICULTURAL SECTOR IN MUNICIPALITIES OF ITAJAI AND NAVEGANTES : 1984

No.	Item	Itajai		Navegantes		Total
		Volume	Amount (Mil.Cr$)	Volume	Amount (Mil.Cr$)	
1.	Crop					
1.1	Paddy	150 tons	37.5	34 sac.	0.5	38.0
1.2	Beans	14 tons	9.4	3 sac.	0.6	9.9
1.3	Cassava	-	-	49 tons	4.5	4.5
1.4	Sugarcane	900 tons	162.0	-	-	162.0
1.5	Others	-	282.4	-	3.1	285.5
	Sub-total	-	491.3	-	8.6	499.9
2.	Livestock					
2.1	Cattle	-	40.8	10.0	2.1	42.9
2.2	Pig	-	6.6	3.0	0.4	7.0
2.3	Chicken	-	17.4	102.0	0.4	17.7
2.4	Others	-	12.0	-	3.6	15.6
	Sub-total	-	76.8	-	6.4	83.2
3.	Other Facilities and Equipment	-	42.4	-	6.1	48.5
	Total	-	610.4	-	21.2	631.6

Source : V028 & V029

Table V.3.3 FLOOD DAMAGE TO INDUSTRIAL AND COMMERCIAL SECTORS IN ITAJAI MUNICIPALITY DUE TO 1984 FLOOD

Type of Industry	Number of Facilities			Number of Employees	Annual Sales Amount	Direct Damage (Million Cruzeiros)						Loss of Operation
	Damaged (Nos)	Suspended (Nos)	Total (Nos)	(Person)	(Mil.Cr$)	Instal-lation	Equip-ment	Furni-ture	Stock	Others	Total	(day)
1. Industrial Sector												
Non-metal Products	8	8	16	86	665	6.1	10.4	0.3	22.5	6.4	45.6	48
Metallurgy	3	2	5	68	913	4.0	3.5	1.3	3.6	0.0	12.4	50
Machinery	3	2	5	51	110	0.5	25.0	2.0	69.1	13.0	109.6	20
Electric & Communication Products	1	1	2	478	10,336	38.1	5.6	5.1	24.0	0.0	72.8	60
Vehicle	3	2	5	115	527	6.5	15.0	6.0	19.0	15.0	61.5	40
Timber	8	6	14	151	2,372	8.5	24.7	5.3	89.1	10.0	137.6	33
Furniture	4	2	6	128	2,143	4.3	10.4	0.0	44.9	41.0	100.5	30
Paper	2	0	2	268	10,280	2.0	0.0	0.0	0.0	0.0	2.0	15
Plastic Products	3	3	6	195	5,908	22.5	30.5	9.5	141.0	1.0	204.5	40
Textile	1	1	2	143	1,834	0.0	3.0	0.0	55.0	0.0	58.0	30
Clothing	5	5	10	30	132	3.0	3.2	1.9	13.5	11.0	32.6	36
Food Products	19	15	34	1,258	41,470	227.9	173.3	42.3	449.0	298.4	1,190.8	30
Other Products	2	1	3	188	5,038	10.0	15.5	5.0	55.5	60.1	146.1	30
Total	62	48	110	3,159	81,728	333.3	320.1	78.7	986.2	455.8	2,174.1	33
2. Commercial Sector												
Total	47	43	90	2,218	37,463	309.8	0.0	297.1	1,471.7	872.4	2,951.1	30

Source : V028

Table V.3.4 DAMAGE RECORD OF ROAD SYSTEM IN MUNICIPALITIES OF ITAJAI AND NAVEGANTES

(Unit : Million Cruseiros)

Item	1983				1984			
	Itajai	Nave-gantes	Total	% Distri-bution	Itajai	Nave-gantes	Total	% Distri-bution
1. Main Street	155.3	83.7	239.1	14.0	6,541.7	66.4	6,608.1	55.1
2. Street	934.8	102.3	1,037.0	60.6	4,327.7	139.9	4,467.7	37.2
- Urban	934.8	-	934.8	-	4,327.7	-	4,327.7	-
- Rural	-	-	-	-	-	-	-	-
3. Bridge	5.8	48.4	54.2	3.2	467.5	18.0	485.5	4.0
- Urban	5.8	-	5.8	-	276.0	-	276.0	-
- Rural	-	-	-	-	191.5	-	191.5	-
4. Dramage System	192.7	65.0	257.7	15.1	290.7	11.1	301.8	2.5
- Urban	-	-	-	-	167.0	-	167.0	-
- Rural	-	-	-	-	123.7	-	123.7	-
5. Machines & Automobiles	22.7	99.7	122.4	7.2	119.7	16.2	135.9	1.1
Total	1,311.3	399.1	1,710.4	100.0	11,747.3	251.6	11,998.9	100.0

Source : V028 and V029

Table V.4.1 INUNDATION AREA DUE TO PROBABLE FLOOD

(1) 1978 Flood Pattern

Water Depth	Return Period (Year)					
(m)	2	5	10	25	50	100
0.0-0.5	8.3	5.7	6.5	7.9	6.9	4.9
0.5-1.0	5.1	8.3	4.9	5.7	8.1	6.9
1.0-1.5	6.1	9.3	13.3	14.6	11.7	13.4
2.0-3.0	0.1	1.1	3.5	6.2	11.1	13.4
More than 3.0	0.0	0.1	0.1	0.2	3.0	6.3
Total	19.6	24.4	28.3	34.5	40.9	45.0

(2) 1980 Flood Pattern

Water Depth	Return Period (Year)					
(m)	2	5	10	25	50	100
0.0-0.5	8.0	5.6	6.0	8.3	6.9	5.6
0.5-1.0	5.0	8.6	7.8	4.3	8.3	7.1
1.0-1.5	5.3	8.4	10.3	14.6	12.9	11.9
2.0-3.0	0.1	0.8	2.4	5.3	8.2	13.4
More than 3.0	0.0	0.0	0.1	0.1	2.0	5.4
Total	18.4	23.4	26.5	32.6	38.4	43.4

(3) 1983 Flood Pattern

Water Depth	Return Period (Year)					
(m)	2	5	10	25	50	100
0.0-0.5	6.9	6.5	5.6	7.9	5.4	2.4
0.5-1.0	4.9	7.4	7.8	5.5	7.1	4.8
1.0-1.5	5.3	8.1	10.1	14.3	12.3	12.4
2.0-3.0	0.1	0.7	2.3	6.4	11.1	10.6
More than 3.0	0.0	0.0	0.1	1.1	9.6	18.5
Total	17.1	22.7	25.8	35.3	45.6	48.8

(4) 1984 Flood Pattern

Water Depth	Return Period (Year)					
(m)	2	5	10	25	50	100
0.0-0.5	8.6	5.9	7.9	8.6	6.1	4.4
0.5-1.0	5.0	7.9	4.1	5.8	7.4	6.8
1.0-1.5	6.8	9.8	13.9	14.4	11.6	14.0
2.0-3.0	0.2	2.0	4.4	6.7	12.9	13.4
More than 3.0	0.0	0.1	0.1	0.6	4.5	7.4
Total	20.6	25.6	30.4	36.1	42.6	45.9

Table V.4.2 POPULATION AND DAMAGEABLE PROPERTY IN FLOOD PROTECTION AREA : 1989

Item	Itajai	Navegantes	Total
1. Population	100,960	14,840	115,800
- Urban	100,960	10,560	111,520
- Rural	-	4,280	4,280
2. Building (Nos)			
- Housing Unit	25,240	4,360	29,600
Urban	25,240	3,290 *1	28,530
Rural	-	1,070	1,070
- Industrial Facility	190	18	208
- Commercial & Service Facility	1,221	108	1,329
3. Agricultural Land (ha)	1,286	844	2,130
- Paddy Field	-	125	125
- Grassland & Bush	1,286	719	2,005

Remark : *1 Including resort houses along the coast.

Table V.4.3 NUMBER OF BUILDINGS BY ELEVATION AND BY ZONE IN FLOOD PROTECTION AREA : 1989

Item	Number of Buildings (Nos)			Percentage Distribution (%)		
	House	Industry	Service	House	Industry	Service
1. Distribution by Elevation above Sea Level						
Less than 1.0m	962	4	0	3.3	1.9	0.0
1.0m - 2.0m	3,498	36	209	11.8	17.3	15.7
2.0m - 3.0m	7,339	51	490	24.8	24.5	36.9
3.0m - 4.0m	13,547	92	401	45.8	44.2	30.2
4.0m - 5.0m	3,158	24	227	10.7	11.5	17.1
Over 5.0m	1,096	1	2	3.7	0.5	0.2
Total	29,600	208	1,329	100.0	100.0	100.0
2. Distribution by Zone						
Within 3km Zone	17,801	148	1,213	60.1	71.2	91.3
3km - 5km Zone	10,708	31	84	36.2	14.9	6.3
Over 5km Zone	1,091	29	32	3.7	13.9	2.4
Total	29,600	208	1,329	100.0	100.0	100.0

Table V.4.4 AVERAGE UNIT VALUE OF NEW RESIDENCE AND HOUSEHOLD EFFECTS

Item	Unit	Size	Unit Cost (NCz$/Unit)	Financial Unit Price(NCz$)	Economic Unit Price(NCz$)*4
Residence	Sq.m.	80	960 *1	76,800	69,100
Household Effects	Point	36 *2	670 *3	24,120	21,700
Total	-	-	-	100,920	90,800

Remark : *1 Average unit value for housing loan by Caixa Economico Federal at the end of September 1989 is 20VRF-32VRF (equivalent to NCz$738-1,181:mean NCz$960) per square meter.

*2 Average point is assumed at 36, referring to the following research results of FURB.

Point Level*5	Zone West *6	Zone North*6
Less than 9	1.42 %	5.30 %
10 - 19	11.55 %	20.70 %
20 - 39	47.54 %	40.00 %
40 - 59	33.49 %	19.80 %
More than 60	6.01 %	14.20 %
Average	37 points	35 points

*3 Average value of one point is assumed to be NCz$500, referring to the following results of the market research in the city. Then, it is converted to NCz$670 by the price inflation (35% per month) in September.

Item	Point*5	Market Price	Price per Point
TV-Black & White	2	900	450
TV-Color	3	2,000	667
Radio	1	500	500
Stereo Set	2	2,000 - 4,200	1,000 - 2,100
Video Player	3	4,000 - 5,800	1,333 - 1,933
Refrigerator	1	1,000 - 6,000	1,000 - 6,000
Home Freezer	4	1,800 - 3,000	450 - 750
Electric Stove	2	800	400
Air Conditioner	3	1,400 - 3,600	467 - 1,200
Washing Machine	3	900 - 3,200	300 - 1,067
Dish Washer	3	1,400 - 3,300	467 - 1,100
Drier	2	700 - 2,600	350 - 1,300
Knitting Machine	3	1,600 - 1,900	533 - 633
Microcomputor	3	2,300 - 3,000	767 - 1,000
Organ / Piano	4	1,500 - 4,500	375 - 1,125
Polisher	2	300	150
Vacuum Cleaner	2	400	200
Electric Fan	2	300	150
Electric Shaver	1	500	500
Juicer	1	80 - 150	80
Hair Drier	1	100 - 240	100
Electric Iron	1	100 - 300	100
Telephone	3	20,000 *7	6,667
Gardener	2	30 *8	15
Domestic	4	220 *9	55
Temp. Worker	2	20 *8	10

*4 Converted by the SCF (0.90)

*5 Points for furniture and electric appliances are set by the researcher of FURB.

*6 In the parts of Blumenau city

*7 Initial cost for installation

*8 Daily wages

*9 Monthly wages

Source : V032 and V038

Table V.4.5 ESTIMATION FOR ASSETS HOLDINGS OF INDUSTRIAL ESTABLISHMENT

Item	Average Value in 1980 *1 (Cr$1000)	Estimated Value in 1989 *2 (NCz$1000)
1. Fixed Tangible Assets		
- Site *3	486	32.5
- Building *3	1,943	130.2
- Equipment & Machine	3,409	228.4
- Installation	513	34.4
- Furniture & Utensil	143	9.6
- Vehicle	488	32.7
Total	6,982	467.8
2. Inventory Stock		
- Raw Material & Semi-Products	1,850	124.0
- Manufactured Products	1,342	89.9
- Goods for Resale	83	5.6
Total	3,275	219.4
3. Expected Net Profit through Inventory Stock *4	261	17.5
4. Damageable Properties		
- Depreciable Assets *5	6,496	435.2
- Inventory Stock *6	3,536	236.9
Total	10,032	672.2
5. Economic Value of Damageable Properies *7		
- Depreciable Assets	-	392.0
- Inventory Stock	-	213.0
Total	-	605.0

Remark : *1 Refer to Table V.2.19
*2 Converted into the price in September 1989 by the price index (67,000 : refer to Table V.2.28) from the value of the census data in 1980
*3 Site is assumed to be one-fifth of the total value and building, four-fifth.
*4 Production value / Turnover ratio of inventories * Net profit ratio
Production value = Cr$26.1 x 10^6 (refer to Table V.2.18)
Turnover ratio of inventories = 10 times (Cr$33.6 x 10^6 / Cr$3,275 x 10^3 : refer to Table V.2.18 & 19)
Net benefit ratio = 10% (assumed to be a quarter of value added rate)
*5 Total value of the fixed tangible assets excluding the value of the site.
*6 Including the expected net profit
*7 Converted by The SCF (0.90)

Table V.4.6 ESTIMATION FOR ASSETS HOLDINGS OF COMMERCIAL AND SERVICE ESTABLISHMENT

Item	Average Value in 1980 *1 (Cr$1000)	Estimated Value in 1989 *2 (NCz$1000)
1. Fixed Tangible Assets		
- Site *3	83	5.5
- Building *3	330	22.1
- Equipment	194	13.0
- Furniture & Utensil	71	4.8
- Vehicle	98	6.6
Total	776	52.0
2. Inventory Stock	703	47.1
3. Expected Net Profit through Inventory Stock *4	72	4.8
4. Damageable Properties		
- Depreciable Assets *5	693	46.5
- Inventory Stock *6	775	51.9
Total	1,469	98.4
5. Economic Value of Damageable Properties *7		
- Depreciable Assets	-	42.0
- Inventory Stock	-	47.0
Total	-	89.0

Remark : *1 Refer to Table V.2.24.
*2 Converted into the price in September 1989 by the price index (67,000 : refer to Table V.2.28) from the value of the census data in 1980
*3 Site is assumed to be one-fifth of the total value and building, four-fifths.
*4 Sales Amount / Turnover ratio of inventories * Net profit ratio
Sales amount = Cr$17.0 x 10^6 (refer to Table V.2.23)
Turnover ratio of inventories = 8 times (Cr$5.5 x 10^6 / Cr$703 x 10^3 : refer to Table V.2.23 & 24)
Net benefit ratio = 3.4% (assumed to be a quarter of value added rate)
*5 Total value of the fixed tangible assets excluding the value of the site.
*6 Including the expected net profit
*7 Converted by the SCF (0.90)

Table V.4.7 FLOOD DAMAGE RATE

Item	Below Floor Level	More than Floor Level				
		Less than 0.5m	0.5-0.99m	1.0-1.99m	2.0-2.99m	More than 3.0m
1. Residence*1						
- Building (Housing Unit)	0.030	0.053	0.072	0.109	0.152	0.220
- Household Effects	-	0.086	0.191	0.331	0.499	0.690
2. Industrial and Service Establishment						
- Depreciable Assets	-	0.180	0.314	0.419	0.539	0.632
- Inventory Stock	-	0.127	0.276	0.379	0.479	0.562

Remark : *1 In areas with slope of less than 1/1,000
Source : Summary of Economic Research on Flood Control, Ministry of Construction, Japan.

Table V.4.8 PROBABLE FLOOD DAMAGE UNDER PRESENT CONDITION (1/4)

(A) 1978 Flood Pattern

(1) Number of Inundated Buildings

(Unit : Nos.)

Kinds of Buildings and Inundation Depth	Return Period					
	2	5	10	25	50	100
1) Residencial Building						
- Below floor level (0.2 m)	1249	1193	1618	2558	2292	990
- 0.0 < Water Depth < 0.5 m	1738	2400	2453	5426	6941	4386
- 0.5 < Water Depth < 1.0 m	684	1414	2004	1602	4477	6227
- 1.0 < Water Depth < 2.0 m	972	1338	1229	2770	3493	5816
- 2.0 < Water Depth < 3.0 m	0	134	909	1113	1417	2776
- Water Depth > 3.0 m	0	0	0	0	571	1107
2) Commercial Building						
- 0.0 < Water Depth < 0.5 m	120	173	238	197	394	225
- 0.5 < Water Depth < 1.0 m	2	25	27	116	154	292
- 1.0 < Water Depth < 2.0 m	3	5	17	36	88	172
- 2.0 < Water Depth < 3.0 m	0	0	1	3	13	33
- Water Depth > 3.0 m	0	0	0	0	1	3
3) Industrial Building						
- 0.0 < Water Depth < 0.5 m	23	29	38	33	53	25
- 0.5 < Water Depth < 1.0 m	11	17	10	25	39	51
- 1.0 < Water Depth < 2.0 m	6	14	23	29	25	47
- 2.0 < Water Depth < 3.0 m	1	3	6	7	19	28
- Water Depth > 3.0 m	0	0	0	1	6	8

(2) Probable Flood Damage

(Unit : NCz$ million)

Kinds of Buildings and Inundation Depth	Return Period					
	2	5	10	25	50	100
Redidence						
- Building	9.8	14.9	20.6	32.8	51.2	69.4
- Household effects	6.5	10.7	15.8	24.4	40.2	61.2
Commercial						
- Depreciable Assets	1.0	1.7	2.5	3.7	6.9	9.4
- Inventry stock	0.8	1.4	2.1	3.4	6.2	9.0
Industrial						
- Depreciable Assets	4.2	7.1	9.0	11.9	18.1	23.7
- Equipment and inventry stock	1.9	3.2	4.1	5.5	8.4	11.3
Sub-total	24.2	39.1	53.9	81.7	131.1	184.0
Infra-structure	7.3	11.7	16.2	24.5	39.3	55.2
Indirect damage	3.1	5.1	7.0	10.6	17.0	23.9
Grand total	34.6	55.8	77.1	116.9	187.4	263.1

Table V.4.8 PROBABLE FLOOD DAMAGE UNDER PRESENT CONDITION (2/4)

(B) 1980 Flood Pattern

(1) Number of Inundated Buildings

(Unit : Nos.)

Kinds of Buildings and Inundation Depth	Return Period					
	2	5	10	25	50	100
1) Residencial Building						
- Below floor level (0.2 m)	1255	978	1486	2696	2770	922
- 0.0 < Water Depth < 0.5 m	1499	2734	2180	3913	7260	6105
- 0.5 < Water Depth < 1.0 m	520	930	1959	1785	2209	6526
- 1.0 < Water Depth < 2.0 m	953	1300	1282	2105	3433	3942
- 2.0 < Water Depth < 3.0 m	0	50	557	995	1238	2015
- Water Depth > 3.0 m	0	0	0	0	137	992
2) Commercial Building						
- 0.0 < Water Depth < 0.5 m	100	153	211	205	323	307
- 0.5 < Water Depth < 1.0 m	2	13	27	98	144	264
- 1.0 < Water Depth < 2.0 m	3	5	11	25	58	115
- 2.0 < Water Depth < 3.0 m	0	0	0	3	6	25
- Water Depth > 3.0 m	0	0	0	0	0	3
3) Industrial Building						
- 0.0 < Water Depth < 0.5 m	23	21	29	34	45	41
- 0.5 < Water Depth < 1.0 m	12	18	19	19	33	43
- 1.0 < Water Depth < 2.0 m	6	9	15	28	29	37
- 2.0 < Water Depth < 3.0 m	0	3	5	6	11	27
- Water Depth > 3.0 m	0	0	0	1	4	7

(2) Probable Flood Damage

(Unit : NCz$ million)

Kinds of Buildings and Inundation Depth	Return Period					
	2	5	10	25	50	100
Redidence						
- Building	8.9	13.5	18.2	27.6	42.1	61.3
- Household effects	5.9	9.4	13.7	20.3	31.4	51.7
Commercial						
- Depreciable Assets	0.8	1.4	2.1	3.4	5.5	8.5
- Inventry stock	0.7	1.2	1.8	3.0	5.0	7.9
Industrial						
- Depreciable Assets	4.1	5.8	7.9	10.9	15.3	21.7
- Equipment and inventry stock	1.8	2.7	3.6	5.0	7.1	10.2
Sub-total	22.2	34.0	47.4	70.1	106.4	161.4
Infra-structure	6.7	10.2	14.2	21.0	31.9	48.4
Indirect damage	2.9	4.4	6.2	9.1	13.8	21.0
Grand total	31.8	48.6	67.7	100.2	152.2	230.8

Table V.4.8 PROBABLE FLOOD DAMAGE UNDER PRESENT CONDITION (3/4)

(C) 1983 Flood Pattern

(1)Number of Inundated Buildings

(Unit : Nos.)

Kinds of Buildings and Inundation Depth	Return Period					
	2	5	10	25	50	100
1) Residencial Building						
- Below floor level (0.2 m)	1179	1014	1534	2415	1314	501
- 0.0 < Water Depth < 0.5 m	1500	2537	2370	5345	4681	1664
- 0.5 < Water Depth < 1.0 m	525	874	1784	1864	5704	2983
- 1.0 < Water Depth < 2.0 m	947	1254	1034	2760	6070	10950
- 2.0 < Water Depth < 3.0 m	0	50	557	1178	2420	4145
- Water Depth > 3.0 m	0	0	0	7	1145	2649
2) Commercial Building						
- 0.0 < Water Depth < 0.5 m	98	154	214	282	174	96
- 0.5 < Water Depth < 1.0 m	2	12	22	113	376	257
- 1.0 < Water Depth < 2.0 m	3	5	11	40	162	345
- 2.0 < Water Depth < 3.0 m	0	0	0	3	34	115
- Water Depth > 3.0 m	0	0	0	0	4	26
3) Industrial Building						
- 0.0 < Water Depth < 0.5 m	22	21	28	36	28	8
- 0.5 < Water Depth < 1.0 m	9	17	19	24	52	28
- 1.0 < Water Depth < 2.0 m	6	9	15	27	43	72
- 2.0 < Water Depth < 3.0 m	0	3	5	10	22	31
- Water Depth > 3.0 m	0	0	0	2	17	32

(2) Probable Flood Damage

(Unit : NCz$ million)

Kinds of Buildings and Inundation Depth	Return Period					
	2	5	10	25	50	100
Redidence						
- Building	8.8	12.9	17.2	33.6	68.4	94.1
- Household effects	5.9	9.0	12.6	25.2	59.7	89.3
Commercial						
- Depreciable Assets	0.8	1.4	2.1	4.4	10.0	13.5
- Inventry stock	0.7	1.2	1.8	3.9	9.7	13.3
Industrial						
- Depreciable Assets	3.6	5.7	7.8	12.5	24.3	30.3
- Equipment and inventry stock	1.6	2.6	3.6	5.8	11.6	14.7
Sub-total	21.5	32.7	45.1	85.4	183.6	255.3
Infra-structure	6.4	9.8	13.5	25.6	55.1	76.6
Indirect damage	2.8	4.2	5.9	11.1	23.9	33.2
Grand total	30.7	46.7	64.5	122.2	262.5	365.0

Table V.4.8 PROBABLE FLOOD DAMAGE UNDER PRESENT CONDITION (4/4)

(D) 1984 Flood Pattern

(1)Number of Inundated Buildings

(Unit : Nos.)

Kinds of Buildings and Inundation Depth	Return Period					
	2	5	10	25	50	100
1) Residencial Building						
- Below floor level (0.2 m)	901	1384	2854	2489	1143	1092
- 0.0 < Water Depth < 0.5 m	2228	2297	2699	6211	6617	3110
- 0.5 < Water Depth < 1.0 m	826	1710	2105	1766	5909	6322
- 1.0 < Water Depth < 2.0 m	1081	1237	1483	3038	4036	6894
- 2.0 < Water Depth < 3.0 m	0	349	911	1173	1469	3093
- Water Depth > 3.0 m	0	0	0	7	911	1125
2) Commercial Building						
- 0.0 < Water Depth < 0.5 m	123	213	254	289	374	151
- 0.5 < Water Depth < 1.0 m	8	23	28	118	200	379
- 1.0 < Water Depth < 2.0 m	3	7	16	38	121	177
- 2.0 < Water Depth < 3.0 m	0	0	3	5	16	38
- Water Depth > 3.0 m	0	0	0	0	3	5
3) Industrial Building						
- 0.0 < Water Depth < 0.5 m	26	28	40	40	44	24
- 0.5 < Water Depth < 1.0 m	9	20	8	28	41	49
- 1.0 < Water Depth < 2.0 m	8	13	27	28	32	52
- 2.0 < Water Depth < 3.0 m	1	4	6	9	27	31
- Water Depth > 3.0 m	0	0	0	1	6	8

(2) Probable Flood Damage

(Unit : NCz$ million)

Kinds of Buildings and Inundation Depth	Return Period					
	2	5	10	25	50	100
Redidence						
- Building	11.1	16.4	23.5	36.0	57.8	73.3
- Household effects	7.7	12.0	17.1	26.8	47.7	65.9
Commercial						
- Depreciable Assets	1.1	2.0	2.6	4.5	8.0	10.2
- Inventry stock	0.9	1.7	2.2	4.0	7.4	10.0
Industrial						
- Depreciable Assets	4.5	7.4	9.5	13.0	20.6	24.8
- Equipment and inventry stock	2.0	3.4	4.3	6.0	9.7	11.8
Sub-total	27.2	42.9	59.4	90.4	151.2	196.1
Infra-structure	8.2	12.9	17.8	27.1	45.4	58.8
Indirect damage	3.5	5.6	7.7	11.7	19.7	25.5
Grand total	39.0	61.4	84.9	129.2	216.3	280.4

Table V.5.1 POPULATION PROJECTED IN FLOOD PROTECTION AREA

Item	1980	1989	2000	2010	2020
I. Projected Population					
1. Brazil	119,002,706	147,404,375	179,486,530	207,453,526	233,816,990
2. Santa Catarina	3,627,933	4,368,196	5,184,300	5,829,444	6,383,204
3. Two Municipalities of Itajai and Navegantes	99,990	127,929	155,076	177,635	196,998
4. Flood Protection Area					
a. Total Population	87,334	115,800	142,421	164,530	183,474
- Itajai	75,707	100,960	124,536	144,319	161,245
- Navegantes	11,627	14,840	17,885	20,211	22,228
b. Urban Population	83,627	111,520	137,709	159,631	178,484
- Itajai	75,707	100,960	124,536	144,319	161,245
- Navegantes	7,920	10,560	13,173	15,312	17,239
c. Rural Population	3,707	4,280	4,712	4,899	4,990
- Itajai	-	-	-	-	-
- Navegantes	3,707	4,280	4,712	4,899	4,990
II. Average Annual Growth Rate (%)					
1. Brazil	2.3	2.4	1.8	1.5	1.2
2. Santa Catarina	2.3	2.1	1.6	1.2	0.9
3. Two Municipalities of Itajai and Navegantes	2.3	2.8	1.8	1.4	1.0
4. Flood Protection Area					
a. Total Population	3.7	3.2	1.9	1.5	1.1
- Itajai	3.8	3.3	1.9	1.5	1.1
- Navegantes	3.2	2.7	1.7	1.2	1.0
b. Urban Population	3.8	3.2	1.9	1.5	1.1
- Itajai	3.8	3.3	1.9	1.5	1.1
- Navegantes	4.1	3.2	2.0	1.5	1.2
c. Rural Population	1.3	1.6	0.9	0.4	0.2
- Itajai	-	-	-	-	-
- Navegantes	1.3	1.6	0.9	0.4	0.2
III. Percentage Share (%)					
- Santa Catarina to Brazil	3.0	3.0	2.9	2.8	2.7
- Two Municipalities to Santa Catarina	2.8	2.9	3.0	3.0	3.1
- Flood Protection Area to Two Municipalities	87.3	90.5	91.8	92.6	93.1

Remark : Growth rates in the column 1980 show average annual rates between 1970 and 1980.
Source : V007

Table V.5.2 PROJECTED GROSS REGIONAL DOMESTIC PRODUCT IN MUNICIPALITIES OF ITAJAI AND NAVEGANTES AT 1987 CONSTANT PRICES

Item	1980	1987	2000	2010	2020
I. Projected GDP and GROP					
1. Brazil					
- GDP (NCz$ Million)	10,080.4 *1	11,884.7 *1	23,853.5 *2	35,309.0	52,266.0
- GDP per Capita (NCz$)	83.1 *1	84.0 *1	132.9	170.2	223.5
2. Santa Catarina					
- GROP (NCz$ Million)	347.5 *3	482.0 *3	954.1	1,412.4	2,090.6
- GROP per Capita (NCz$)	95.8 *3	113.5 *3	184.0	242.3	327.5
3. Municipalities of Itajai and Navegantes					
- GROP (NCz$ Million)	10.7 *3	15.2 *3	29.6	43.8	64.8
- GROP per Capita (NCz$)	106.8 *3	124.8 *3	206.2	264.2	350.7
II. Average Annual Growth Rate (%)					
1. Brazil					
- GDP	8.6	2.4	5.5	4.0	4.0
- GDP per Capita	5.9	0.2	3.6	2.5	2.8
2. Santa Catarina					
- GROP	11.8	4.8	5.4	4.0	4.0
- GROP per Capita	9.4	2.5	3.8	2.8	3.1
3. Municipalities of Itajai and Navegantes					
- GROP	13.4	5.1	5.3	4.0	4.0
- GROP per Capita	9.9	2.2	3.9	2.5	2.9

Remark : *1 Refer to Ref. V049
*2 Estimated on the basis of GDP in 1988 (NCz$92,993 million at 1988 prices)
*3 Refer to Table V.2.26
Growth rates in the column 1980 show average annual rates between 1970 and 1980.
Source : V001 and V049

Table V.6.1 DISTRIBUTION OF RESIDENCE BY ELEVATION AND BY ZONE IN FLOOD PROTECTION AREA IN THE FUTURE

Item	1989	2000	2020	Average Annual Growth Rate (%)	
				1989/2000	2000/2020
1. Population	115,800	142,421	183,474	1.9	1.3
2. Distribution by Elevation above Sea Level (Unit) *1					
- Less than 1.0m	962	1,228	1,689	2.2	1.6
- 1.0m - 2.0m	3,498	4,342	5,718	2.0	1.4
- 2.0m - 3.0m	7,339	9,117	11,986	2.0	1.4
- 3.0m - 4.0m	13,547	16,543	21,033	1.8	1.2
- 4.0m - 5.0m	3,158	3,848	4,780	1.8	1.1
- Over 5.0m	1,096	1,327	1,634	1.8	1.0
Total	29,600	36,405	46,840	1.9	1.3
3. Distribution by Zone (Unit) *1					
- Within 3km Zone	17,801	21,395	24,964	1.7	0.8
- Between 3km & 5km Zone	10,708	13,236	16,476	1.9	1.1
- Over 5km Zone	1,091	1,774	5,400	4.5	5.7
Total	29,600	36,405	46,840	1.9	1.3
4. Residence Density (Unit/sq.km.) *2					
- Within 3km Zone	8.8	10.5	12.3	1.7	0.8
- Between 3km & 5km Zone	5.5	6.8	8.4	1.9	1.1
- Over 5km Zone	0.7	1.2	3.6	4.5	5.7
Total	5.4	6.7	8.6	1.9	1.3

Remark : Respective zones have the following gross areas.
- Within 3km zone : 2,033 ha
- Between 3km & 5km Zone : 1,951 ha
- Over 5km Zone : 1,487 ha
- Total : 5,471 ha

*1 Including summer resort houses along the Navegantes coast
*2 The number of residences per gross area

Table V.6.2 TOTAL ECONOMIC VALUE OF DIRECTLY DAMAGEABLE ASSETS IN FLOOD PROTECTION AREA AT 1989 CONSTANT PRICES

(Unit : Million New Cruzados)

Item	1989			2000			2020		
1. Residence	Resi-dence	Household Effects	Total	Resi-dence	Household Effects	Total	Resi-dence	Household Effects	Total
- 3km Zone	615	193	808	1,131	355	1,487	1,320	415	1,735
- 3km-5km Zone	370	116	486	700	220	920	871	274	1,145
- Over 5km Zone	38	12	50	94	29	123	286	90	375
-Total	1,023	321	1,344	1,925	605	2,530	2,477	778	3,255
2. Industrial Establishment	Depreci-able Assets	Inven-tory Stock	Total	Depreci-able Assets	Inven-tory Stock	Total	Depreci-able Assets	Inven-tory Stock	Total
- 3km Zone	58	32	90	102	55	157	223	121	344
- 3km-5km Zone	12	7	19	21	12	33	47	25	72
- Over 5km Zone	11	6	18	20	11	31	44	24	67
-Total	82	44	126	143	78	221	313	170	484
3. Service Establishment	Depreci-able Assets	Inven-tory Stock	Total	Depreci-able Assets	Inven-tory Stock	Total	Depreci-able Assets	Inven-tory Stock	Total
- 3km Zone	51	57	108	89	100	190	196	219	415
- 3km-5km Zone	4	4	7	6	7	13	14	15	29
- Over 5km Zone	1	2	3	2	3	5	5	6	11
-Total	56	62	118	98	110	208	215	240	455
4. Economic Growth Rate (% per annum) *1									
- GRDP		5.2			5.3			4.0	
- GRDP per Capita		2.6			3.9			2.7	

Remark : *1 Refer to Table V.5.2.

Table V.6.3 PROBABLE FLOOD DAMAGE UP TO 2020 (1/4)

(1) 1978 flood pattern

(Unit:NCz$ million)

Year	Return Period (Year)					
	2	5	10	25	50	100
1989	34.6	55.8	77.1	116.9	187.4	263.1
1990	35.5	57.4	79.3	120.3	192.9	271.2
1991	36.5	59.0	81.6	123.8	198.7	279.6
1992	37.6	60.7	84.0	127.4	204.7	288.3
1993	38.6	62.4	86.4	131.2	210.9	297.3
1994	39.8	64.2	89.0	135.1	217.3	306.7
1995	40.9	66.0	91.7	139.2	223.9	316.4
1996	42.9	69.0	95.7	145.2	233.3	329.8
1997	44.9	72.4	100.5	152.1	243.7	344.4
1998	46.2	74.6	103.5	156.7	251.2	355.3
1999	47.6	76.8	106.7	161.5	258.9	366.6
2000	49.1	79.2	110.1	166.6	267.1	378.4
2001	51.0	82.1	114.1	172.5	276.1	391.1
2002	52.2	84.0	116.8	176.5	282.6	400.4
2003	54.2	87.5	121.7	183.6	292.9	414.8
2004	55.5	89.5	124.6	187.9	299.8	424.6
2005	57.6	92.8	129.0	194.3	309.5	438.4
2006	59.8	96.5	134.2	201.8	320.6	453.6
2007	61.2	98.8	137.4	206.5	328.1	464.4
2008	63.4	102.3	142.2	213.4	338.6	479.2
2009	64.9	104.7	145.6	218.4	346.5	490.4
2010	68.1	110.0	152.8	228.7	361.3	510.9
2011	69.7	112.6	156.4	234.0	369.8	523.2
2012	72.3	116.9	162.6	242.9	382.8	541.3
2013	74.9	121.0	168.1	250.8	394.9	558.4
2014	76.7	123.9	172.2	256.8	404.4	572.0
2015	80.4	130.0	180.6	268.8	421.8	596.0
2016	82.3	133.2	185.1	275.3	432.1	610.7
2017	85.3	138.3	192.2	285.7	447.3	632.0
2018	88.3	143.1	198.8	295.1	461.5	652.1
2019	90.5	146.6	203.7	302.3	473.0	668.5
2020	94.8	153.7	213.5	316.2	493.0	696.2

Table V.6.3 PROBABLE FLOOD DAMAGE UP TO 2020 (2/4)

(2) 1980 flood pattern

(Unit:NCz$ million)

Year	Return Period (Year)					
	2	5	10	25	50	100
1989	31.8	48.6	67.7	100.2	152.2	230.8
1990	32.7	49.9	69.6	103.1	156.6	237.7
1991	33.6	51.3	71.6	106.0	161.1	244.9
1992	34.5	52.8	73.7	109.1	165.9	252.4
1993	35.5	54.3	75.8	112.3	170.8	260.2
1994	36.5	55.9	78.1	115.6	175.9	268.2
1995	37.6	57.5	80.4	119.1	181.2	276.6
1996	39.4	60.1	84.0	124.2	188.8	288.2
1997	41.2	63.1	88.1	130.4	197.4	301.3
1998	42.4	65.0	90.8	134.3	203.4	310.7
1999	43.7	67.0	93.6	138.4	209.6	320.4
2000	45.1	69.1	96.5	142.7	216.1	330.7
2001	46.9	71.7	100.1	147.7	223.5	341.8
2002	48.0	73.3	102.5	151.2	228.7	349.9
2003	49.8	76.4	106.7	157.5	237.3	362.8
2004	51.0	78.2	109.3	161.2	242.9	371.3
2005	52.9	81.1	113.2	166.7	250.9	383.4
2006	54.9	84.4	117.7	173.4	260.2	397.2
2007	56.2	86.4	120.6	177.4	266.2	406.5
2008	58.3	89.5	124.8	183.4	274.8	419.5
2009	59.7	91.6	127.8	187.7	281.1	429.3
2010	62.6	96.3	134.1	196.8	293.7	447.8
2011	64.1	98.5	137.3	201.4	300.5	458.4
2012	66.4	102.4	142.6	209.3	311.4	474.7
2013	68.8	106.0	147.5	216.3	321.4	489.8
2014	70.5	108.5	151.1	221.4	329.0	501.7
2015	73.9	114.0	158.5	232.1	343.7	523.3
2016	75.6	116.8	162.3	237.7	352.0	536.1
2017	78.4	121.3	168.6	247.0	364.8	555.2
2018	81.2	125.5	174.3	255.1	376.5	572.9
2019	83.1	128.6	178.7	261.4	385.8	587.2
2020	87.0	134.8	187.1	273.8	402.7	612.3

Table V.6.3 PROBABLE FLOOD DAMAGE UP TO 2020 (3/4)

(3) 1983 flood pattern

(Unit:NCz$ million)

Year	Return Period (Year)					
	2	5	10	25	50	100
1989	30.7	46.7	64.5	122.2	262.5	365.0
1990	31.6	48.0	66.3	125.7	270.5	376.4
1991	32.5	49.4	68.2	129.4	278.8	388.4
1992	33.4	50.8	70.2	133.1	287.4	400.8
1993	34.3	52.2	72.2	137.1	296.4	413.7
1994	35.4	53.7	74.3	141.2	305.7	427.1
1995	36.4	55.3	76.5	145.4	315.3	440.8
1996	38.2	57.8	79.9	151.6	328.6	459.6
1997	39.9	60.7	83.9	158.9	343.3	480.1
1998	41.1	62.5	86.4	163.7	354.1	495.6
1999	42.3	64.4	89.0	168.8	365.4	511.7
2000	43.7	66.4	91.8	174.1	377.2	528.6
2001	45.4	68.9	95.2	180.1	389.8	546.4
2002	46.5	70.6	97.4	184.4	399.1	559.6
2003	48.2	73.5	101.5	191.8	413.6	579.5
2004	49.4	75.2	103.9	196.3	423.5	593.5
2005	51.3	78.0	107.6	202.9	437.2	612.7
2006	53.2	81.2	112.0	210.9	452.7	634.0
2007	54.4	83.1	114.6	215.8	463.4	649.2
2008	56.5	86.1	118.7	223.0	478.2	669.9
2009	57.9	88.1	121.5	228.1	489.4	685.8
2010	60.7	92.6	127.6	238.9	510.2	714.2
2011	62.1	94.8	130.6	244.5	522.4	731.6
2012	64.3	98.5	135.7	253.8	540.8	756.9
2013	66.7	102.0	140.4	262.1	558.0	780.9
2014	68.3	104.4	143.8	268.4	571.6	800.3
2015	71.6	109.6	150.9	281.0	596.0	833.6
2016	73.3	112.3	154.6	287.8	610.7	854.5
2017	75.9	116.6	160.6	298.7	632.4	884.2
2018	78.6	120.7	166.1	308.5	652.5	912.5
2019	80.6	123.7	170.2	316.1	668.9	935.7
2020	84.3	129.7	178.4	330.6	697.1	974.4

Table V.6.3 PROBABLE FLOOD DAMAGE UP TO 2020 (4/4)

(4) 1984 flood pattern

(Unit:NCz$ million)

Year	Return Period (Year)					
	2	5	10	25	50	100
1989	39.0	61.4	84.9	129.2	216.3	280.4
1990	40.1	63.1	87.3	133.0	222.7	289.1
1991	41.2	64.9	89.8	136.9	229.5	298.1
1992	42.4	66.8	92.4	140.9	236.4	307.5
1993	43.6	68.7	95.1	145.0	243.7	317.2
1994	44.9	70.7	97.8	149.4	251.2	327.3
1995	46.2	72.8	100.7	153.9	259.0	337.7
1996	48.3	76.0	105.2	160.4	269.9	352.0
1997	50.7	79.8	110.5	167.9	281.9	367.4
1998	52.2	82.2	113.8	173.0	290.7	379.1
1999	53.8	84.7	117.3	178.3	299.9	391.3
2000	55.4	87.3	120.9	183.8	309.5	404.1
2001	57.6	90.5	125.3	190.2	319.9	417.6
2002	59.0	92.7	128.3	194.6	327.5	427.6
2003	61.3	96.6	133.7	202.2	339.4	442.7
2004	62.8	98.8	136.8	206.9	347.4	453.2
2005	65.1	102.4	141.6	213.9	358.7	467.9
2006	67.7	106.5	147.5	222.0	371.5	484.1
2007	69.3	109.1	150.9	227.2	380.2	495.6
2008	71.8	112.9	156.1	234.7	392.4	511.3
2009	73.5	115.5	159.8	240.1	401.6	523.3
2010	77.2	121.4	167.8	251.1	418.7	545.0
2011	79.0	124.3	171.7	257.0	428.6	558.1
2012	82.0	129.2	178.5	266.5	443.7	577.3
2013	84.9	133.6	184.5	275.2	457.7	595.6
2014	86.9	136.9	189.0	281.7	468.8	610.2
2015	91.2	143.7	198.3	294.6	488.9	635.6
2016	93.4	147.2	203.1	301.7	500.8	651.3
2017	96.8	152.9	211.1	312.9	518.5	673.8
2018	100.3	158.2	218.2	323.1	535.0	695.3
2019	102.7	162.1	223.5	331.0	548.3	712.8
2020	107.6	170.0	234.3	345.9	571.5	742.2

Table V.6.4 ANNUAL FLOOD DAMAGE UP TO 2020 (1/4)

(1) 1978 flood pattern

(Unit:NCz$ million)

Year	Accumlated Value Return Period (Year)						Annual Flood Damage
	2	5	10	25	50	100	
1989	8.6	22.2	28.9	34.7	37.7	40.0	40.0
1990	8.9	22.8	29.7	35.7	38.8	41.1	41.1
1991	9.1	23.5	30.5	36.7	39.9	42.3	42.3
1992	9.4	24.1	31.4	37.7	41.0	43.5	43.5
1993	9.7	24.8	32.3	38.8	42.2	44.7	44.7
1994	9.9	25.5	33.2	39.9	43.4	46.1	46.1
1995	10.2	26.3	34.2	41.1	44.7	47.4	47.4
1996	10.7	27.5	35.7	43.0	46.7	49.6	49.6
1997	11.2	28.8	37.5	45.0	49.0	51.9	51.9
1998	11.6	29.7	38.6	46.4	50.5	53.5	53.5
1999	11.9	30.6	39.7	47.8	52.0	55.1	55.1
2000	12.3	31.5	41.0	49.3	53.6	56.8	56.8
2001	12.7	32.7	42.5	51.1	55.6	58.9	58.9
2002	13.0	33.5	43.5	52.3	56.9	60.3	60.3
2003	13.6	34.8	45.3	54.4	59.2	62.7	62.7
2004	13.9	35.6	46.3	55.7	60.6	64.2	64.2
2005	14.4	37.0	48.0	57.7	62.8	66.5	66.5
2006	14.9	38.4	49.9	60.0	65.2	69.1	69.1
2007	15.3	39.3	51.1	61.4	66.8	70.7	70.7
2008	15.9	40.7	52.9	63.6	69.1	73.2	73.2
2009	16.2	41.7	54.2	65.1	70.7	74.9	74.9
2010	17.0	43.8	56.9	68.3	74.2	78.6	78.6
2011	17.4	44.8	58.2	69.9	76.0	80.4	80.4
2012	18.1	46.5	60.4	72.6	78.9	83.5	83.5
2013	18.7	48.1	62.6	75.1	81.6	86.4	86.4
2014	19.2	49.3	64.1	76.9	83.5	88.4	88.4
2015	20.1	51.7	67.2	80.7	87.6	92.7	92.7
2016	20.6	52.9	68.8	82.6	89.7	94.9	94.9
2017	21.3	54.9	71.4	85.7	93.1	98.5	98.5
2018	22.1	56.8	73.9	88.7	96.3	101.9	101.9
2019	22.6	58.2	75.7	90.9	98.6	104.4	104.4
2020	23.7	61.0	79.3	95.2	103.3	109.2	109.2

Table V.6.4 ANNUAL FLOOD DAMAGE UP TO 2020 (2/4)

(2) 1980 flood pattern

(Unit:NCz$ million)

Year	Accumlated Value Return Period (Year)						Annual Flood Damage
	2	5	10	25	50	100	
1989	7.9	20.0	25.8	30.9	33.4	35.3	35.3
1990	8.2	20.6	26.5	31.7	34.3	36.3	36.3
1991	8.4	21.1	27.3	32.6	35.3	37.3	37.3
1992	8.6	21.7	28.1	33.5	36.3	38.4	38.4
1993	8.9	22.4	28.9	34.5	37.3	39.5	39.5
1994	9.1	23.0	29.7	35.5	38.4	40.6	40.6
1995	9.4	23.7	30.6	36.5	39.6	41.8	41.8
1996	9.8	24.8	32.0	38.2	41.4	43.7	43.7
1997	10.3	26.0	33.5	40.1	43.4	45.8	45.8
1998	10.6	26.7	34.5	41.3	44.6	47.2	47.2
1999	10.9	27.5	35.6	42.5	46.0	48.7	48.7
2000	11.3	28.4	36.7	43.8	47.4	50.2	50.2
2001	11.7	29.5	38.1	45.5	49.2	52.1	52.1
2002	12.0	30.2	39.0	46.6	50.4	53.3	53.3
2003	12.5	31.4	40.5	48.5	52.4	55.4	55.4
2004	12.7	32.1	41.5	49.6	53.6	56.7	56.7
2005	13.2	33.3	43.0	51.4	55.6	58.8	58.8
2006	13.7	34.6	44.7	53.5	57.8	61.1	61.1
2007	14.0	35.4	45.8	54.7	59.2	62.5	62.5
2008	14.6	36.7	47.5	56.7	61.3	64.8	64.8
2009	14.9	37.6	48.6	58.0	62.7	66.3	66.3
2010	15.7	39.5	51.0	60.9	65.9	69.6	69.6
2011	16.0	40.4	52.2	62.4	67.4	71.2	71.2
2012	16.6	41.9	54.2	64.7	69.9	73.9	73.9
2013	17.2	43.4	56.1	67.0	72.4	76.4	76.4
2014	17.6	44.5	57.4	68.6	74.1	78.3	78.3
2015	18.5	46.6	60.3	72.0	77.7	82.1	82.1
2016	18.9	47.8	61.7	73.7	79.6	84.1	84.1
2017	19.6	49.5	64.0	76.5	82.6	87.2	87.2
2018	20.3	51.3	66.3	79.2	85.5	90.2	90.2
2019	20.8	52.5	67.9	81.1	87.6	92.4	92.4
2020	21.8	55.0	71.1	85.0	91.7	96.8	96.8

Table V.6.4 ANNUAL FLOOD DAMAGE UP TO 2020 (3/4)

(3) 1983 flood pattern

(Unit:NCz$ million)

Year	Accumlated Value Return Period (Year)						Annual Flood Damage
	2	5	10	25	50	100	
1989	7.7	19.3	24.8	30.4	34.3	37.4	37.4
1990	7.9	19.8	25.5	31.3	35.3	38.5	38.5
1991	8.1	20.4	26.3	32.2	36.3	39.6	39.6
1992	8.3	21.0	27.0	33.1	37.3	40.8	40.8
1993	8.6	21.6	27.8	34.1	38.4	42.0	42.0
1994	8.8	22.2	28.6	35.1	39.5	43.2	43.2
1995	9.1	22.9	29.4	36.1	40.7	44.5	44.5
1996	9.5	23.9	30.8	37.8	42.6	46.5	46.5
1997	10.0	25.1	32.3	39.6	44.6	48.7	48.7
1998	10.3	25.8	33.3	40.8	45.9	50.2	50.2
1999	10.6	26.6	34.3	42.0	47.3	51.7	51.7
2000	10.9	27.4	35.3	43.3	48.8	53.3	53.3
2001	11.4	28.5	36.7	45.0	50.7	55.4	55.4
2002	11.6	29.2	37.6	46.0	51.9	56.7	56.7
2003	12.1	30.3	39.1	47.9	53.9	58.9	58.9
2004	12.3	31.0	40.0	49.0	55.2	60.3	60.3
2005	12.8	32.2	41.5	50.8	57.2	62.5	62.5
2006	13.3	33.5	43.1	52.8	59.4	64.9	64.9
2007	13.6	34.2	44.1	54.0	60.8	66.4	66.4
2008	14.1	35.5	45.8	56.0	63.0	68.8	68.8
2009	14.5	36.4	46.8	57.3	64.5	70.4	70.4
2010	15.2	38.2	49.2	60.2	67.7	73.8	73.8
2011	15.5	39.1	50.3	61.6	69.3	75.5	75.5
2012	16.1	40.5	52.2	63.9	71.9	78.3	78.3
2013	16.7	42.0	54.1	66.2	74.4	81.1	81.1
2014	17.1	43.0	55.4	67.8	76.2	83.0	83.0
2015	17.9	45.1	58.1	71.1	79.8	87.0	87.0
2016	18.3	46.2	59.5	72.8	81.8	89.1	89.1
2017	19.0	47.9	61.7	75.5	84.8	92.4	92.4
2018	19.7	49.6	63.9	78.1	87.8	95.6	95.6
2019	20.1	50.8	65.5	80.1	89.9	97.9	97.9
2020	21.1	53.2	68.6	83.8	94.1	102.5	102.5

Table V.6.4 ANNUAL FLOOD DAMAGE UP TO 2020 (4/4)

(4) 1984 flood pattern

(Unit:NCz$ million)

Year	Accumlated Value						Annual Flood Damage
	Return Period (Year)						
	2	5	10	25	50	100	
1989	9.7	24.8	32.1	38.5	42.0	44.5	44.5
1990	10.0	25.5	33.0	39.6	43.2	45.7	45.7
1991	10.3	26.2	33.9	40.7	44.4	47.0	47.0
1992	10.6	27.0	34.9	41.9	45.7	48.4	48.4
1993	10.9	27.7	35.9	43.1	47.0	49.8	49.8
1994	11.2	28.5	37.0	44.4	48.4	51.3	51.3
1995	11.5	29.4	38.1	45.7	49.8	52.8	52.8
1996	12.1	30.7	39.8	47.8	52.1	55.2	55.2
1997	12.7	32.2	41.7	50.1	54.6	57.8	57.8
1998	13.0	33.2	43.0	51.6	56.2	59.6	59.6
1999	13.4	34.2	44.3	53.2	58.0	61.4	61.4
2000	13.9	35.3	45.7	54.8	59.8	63.3	63.3
2001	14.4	36.6	47.4	56.9	62.0	65.7	65.7
2002	14.7	37.5	48.5	58.2	63.4	67.2	67.2
2003	15.3	39.0	50.5	60.6	66.0	69.9	69.9
2004	15.7	39.9	51.7	62.0	67.6	71.6	71.6
2005	16.3	41.4	53.6	64.3	70.0	74.1	74.1
2006	16.9	43.1	55.8	66.8	72.8	77.0	77.0
2007	17.3	44.1	57.1	68.4	74.5	78.9	78.9
2008	18.0	45.7	59.1	70.8	77.1	81.6	81.6
2009	18.4	46.7	60.5	72.5	78.9	83.5	83.5
2010	19.3	49.1	63.5	76.1	82.8	87.6	87.6
2011	19.8	50.2	65.0	77.9	84.8	89.7	89.7
2012	20.5	52.2	67.5	80.9	88.0	93.1	93.1
2013	21.2	54.0	69.9	83.7	91.0	96.3	96.3
2014	21.7	55.3	71.6	85.7	93.2	98.6	98.6
2015	22.8	58.0	75.1	89.9	97.7	103.4	103.4
2016	23.3	59.4	76.9	92.1	100.1	105.9	105.9
2017	24.2	61.7	79.9	95.6	103.9	109.9	109.9
2018	25.1	63.8	82.6	98.9	107.5	113.6	113.6
2019	25.7	65.4	84.7	101.3	110.1	116.4	116.4
2020	26.9	68.5	88.7	106.1	115.3	121.9	121.9

Figures

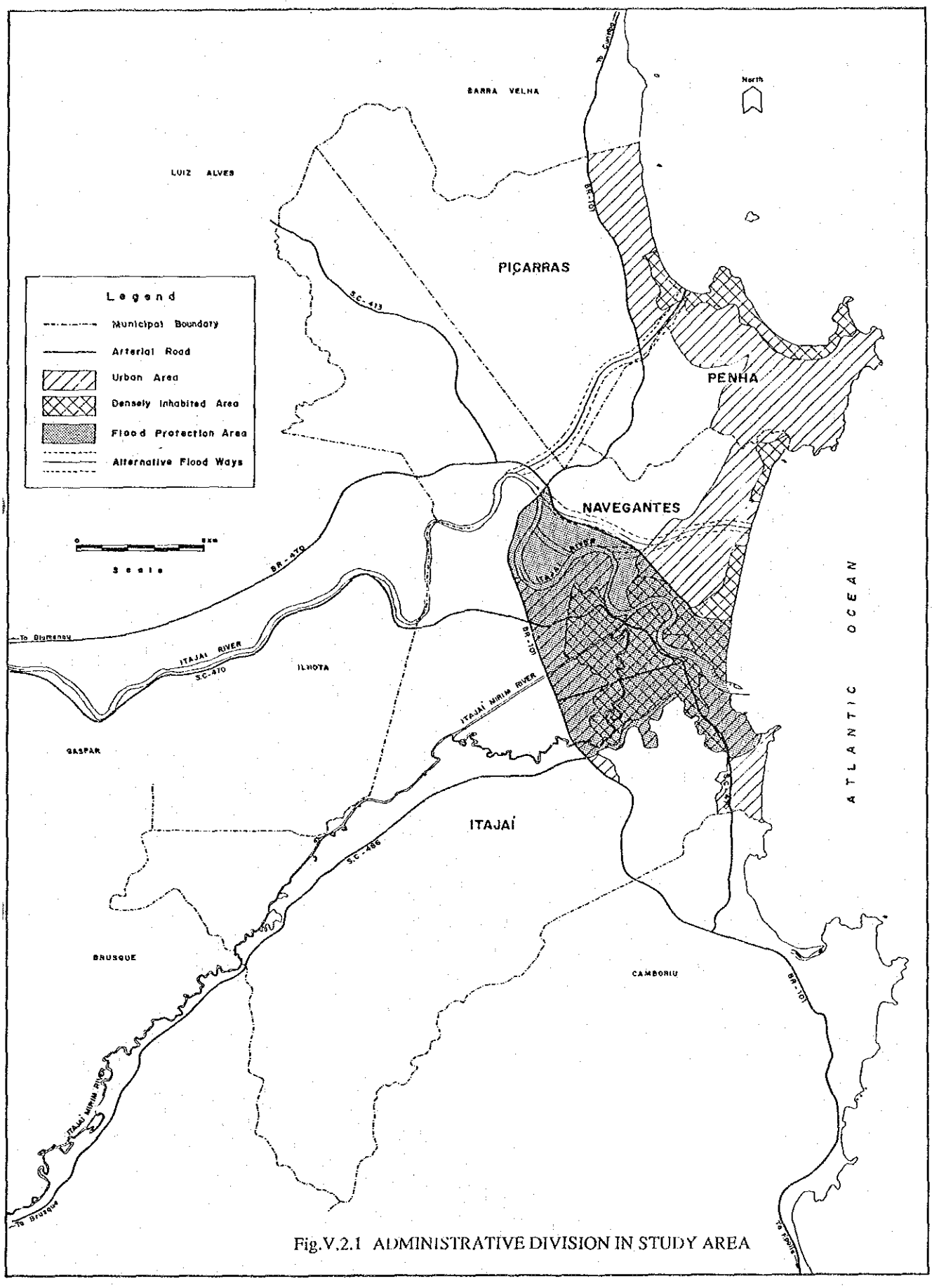

Fig.V.2.1 ADMINISTRATIVE DIVISION IN STUDY AREA

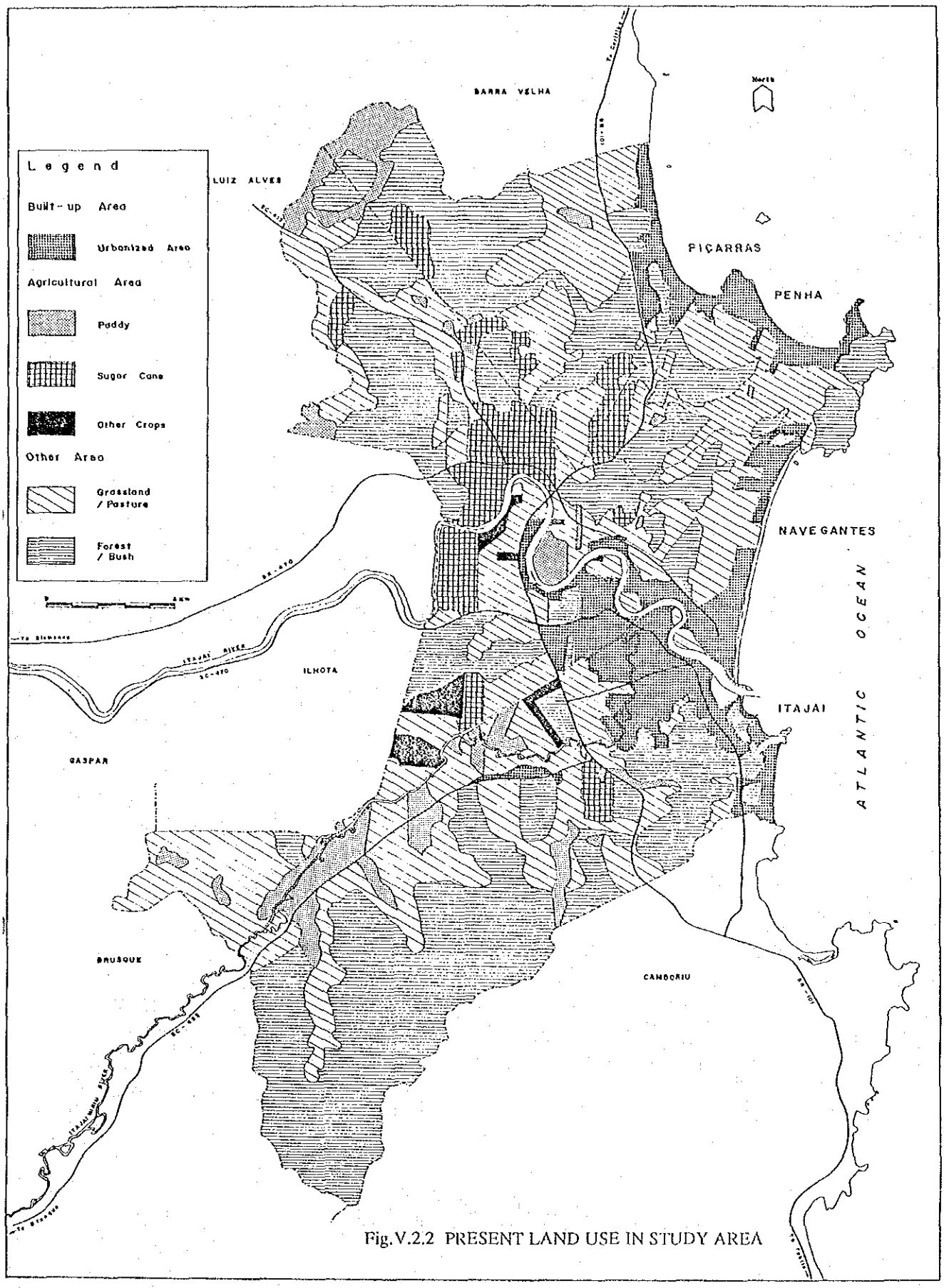

Fig.V.2.2 PRESENT LAND USE IN STUDY AREA

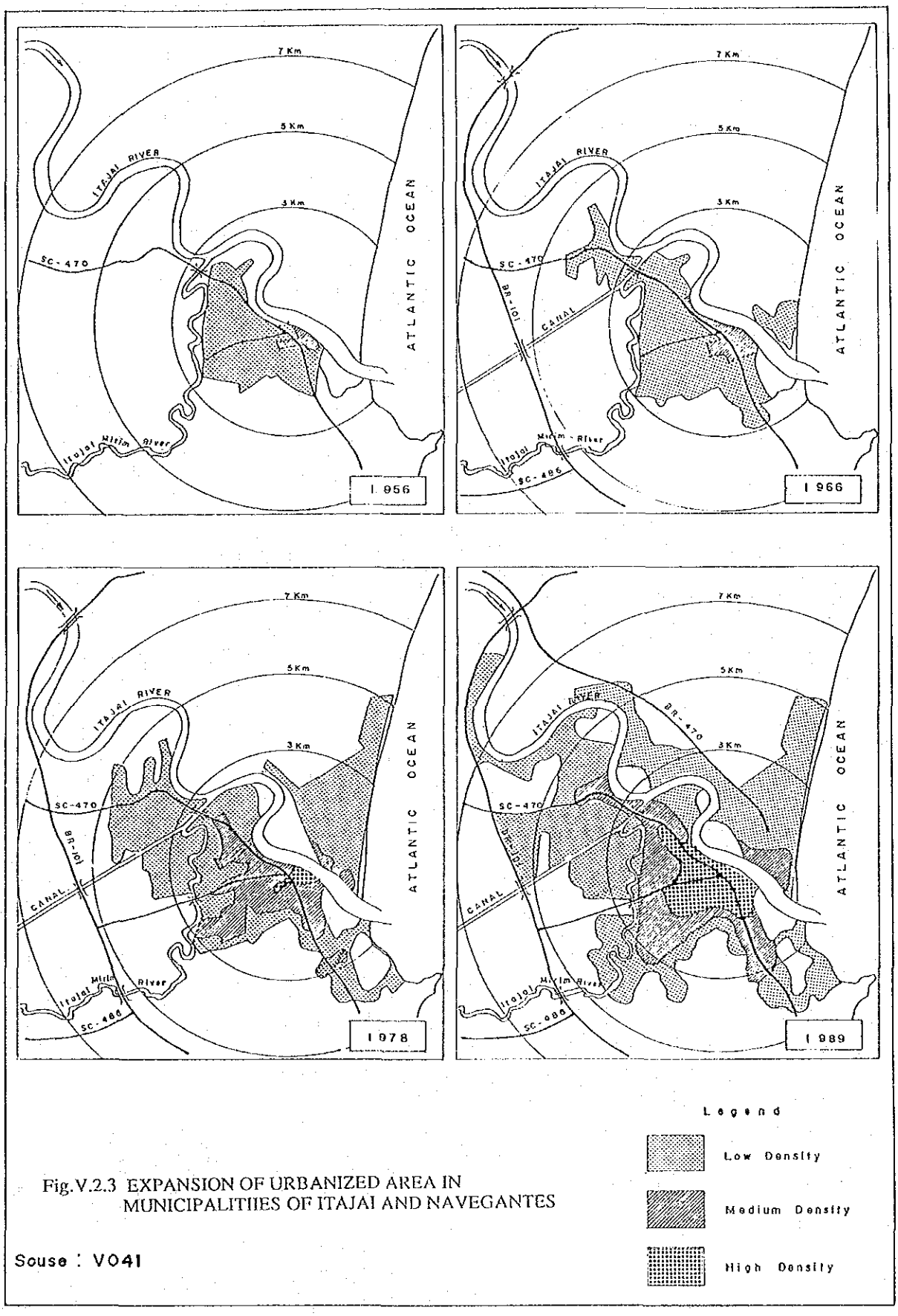

Fig.V.2.3 EXPANSION OF URBANIZED AREA IN MUNICIPALITIES OF ITAJAI AND NAVEGANTES

Souse : V041

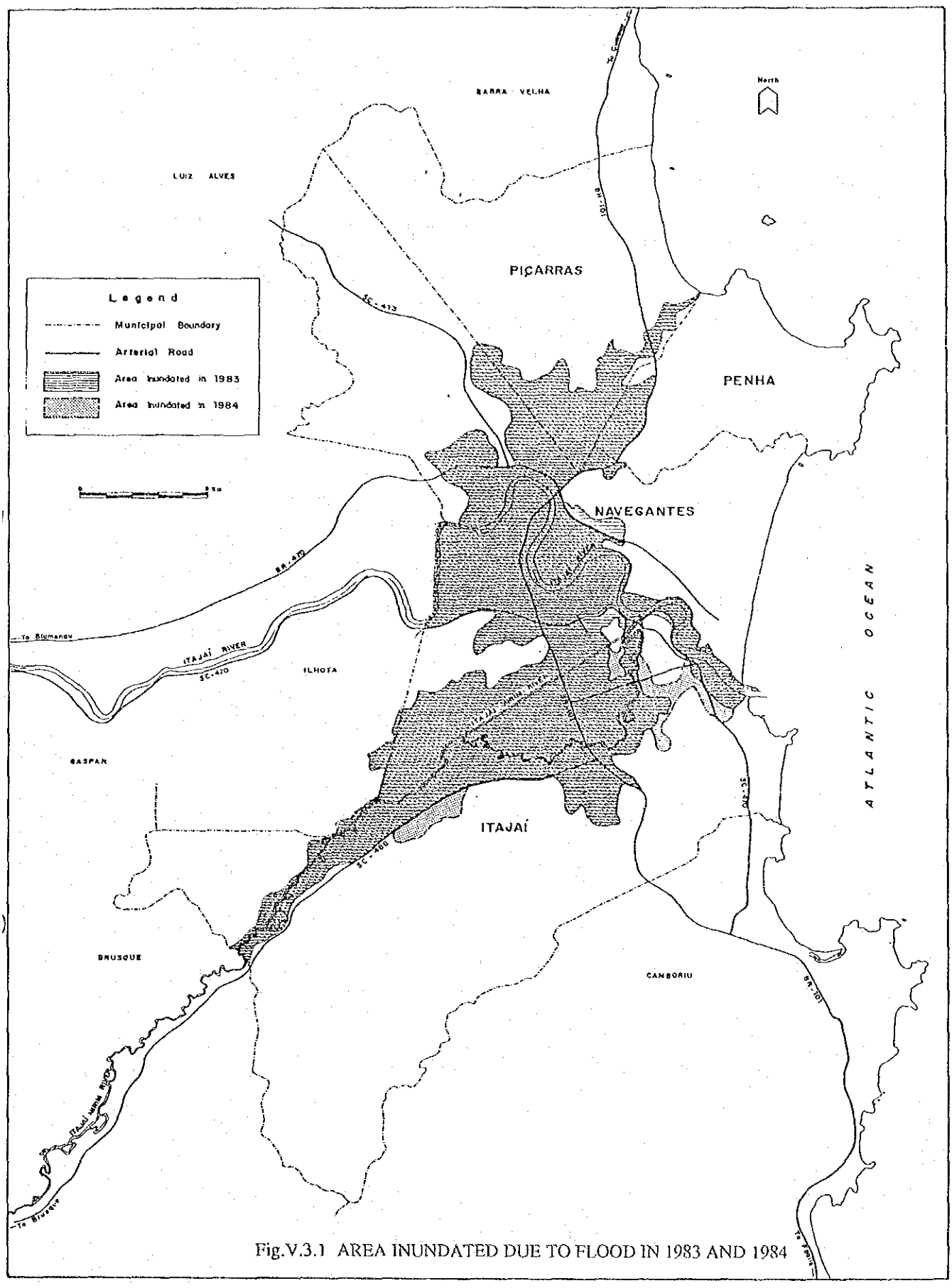

Fig.V.3.1 AREA INUNDATED DUE TO FLOOD IN 1983 AND 1984

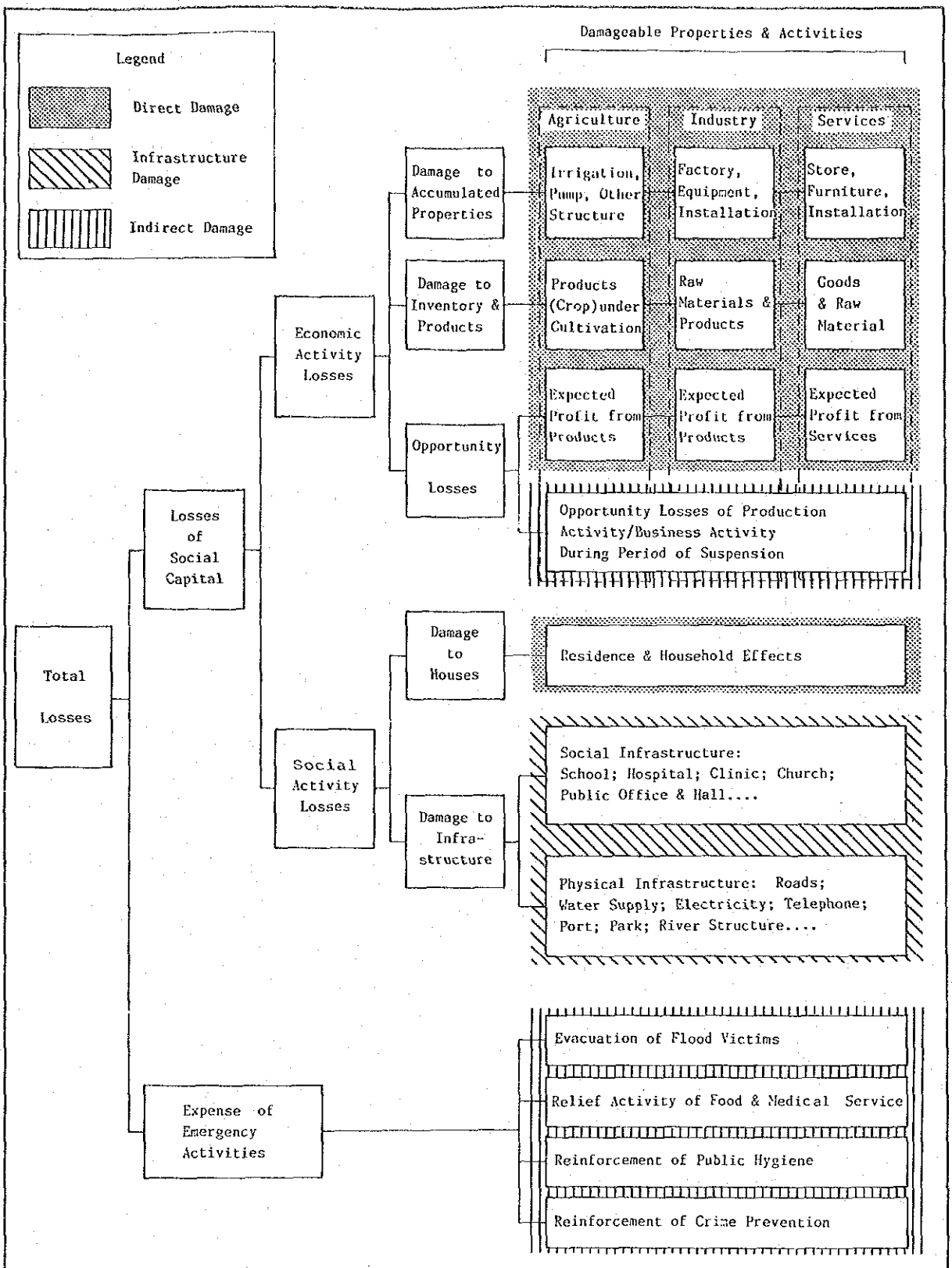

Fig.V.4.1 STRUCTURE OF FLOOD DAMAGE

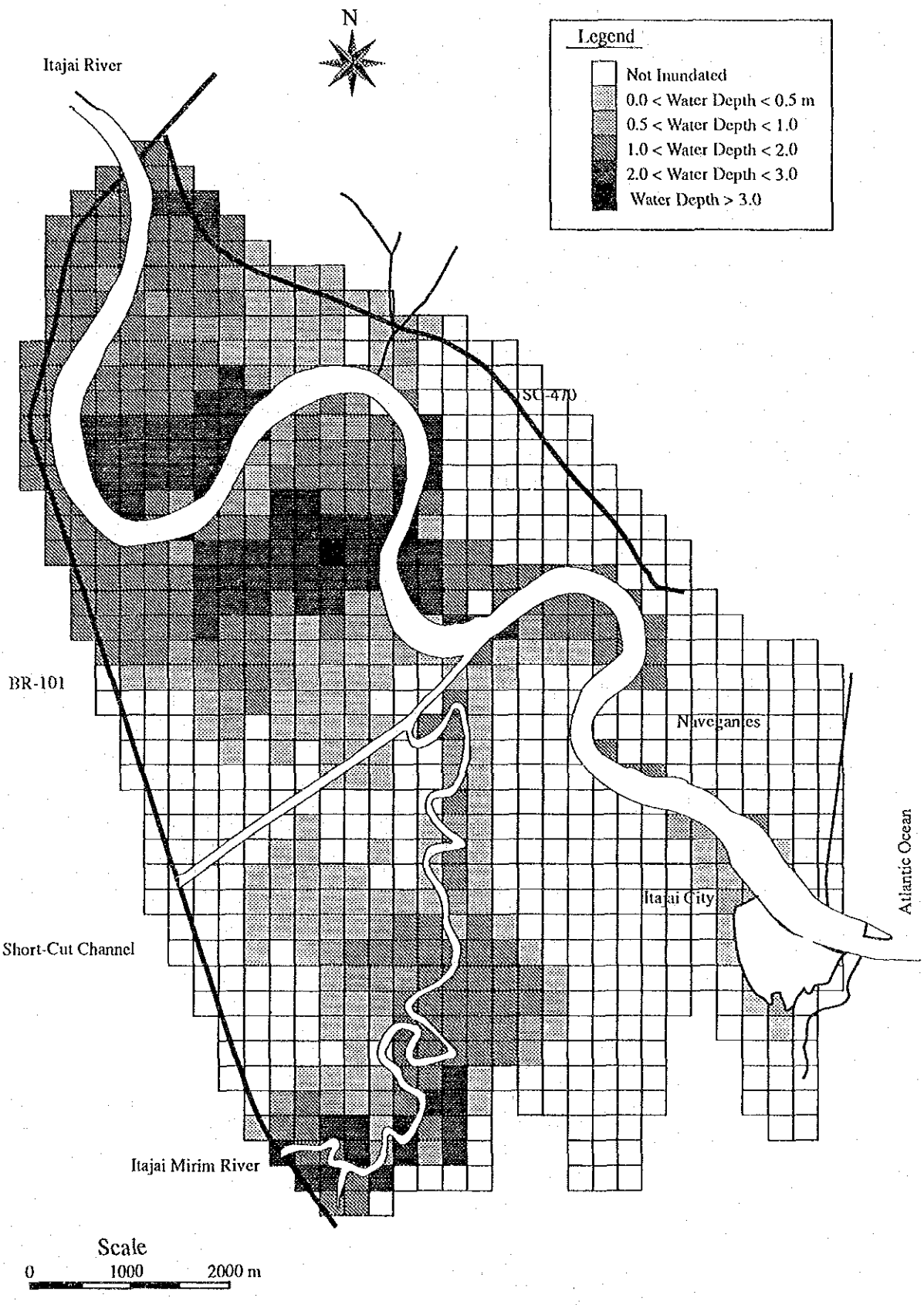

Fig. V.4.2 INUNDATION MAP DUE TO 10-YEAR PROBABLE FLOOD

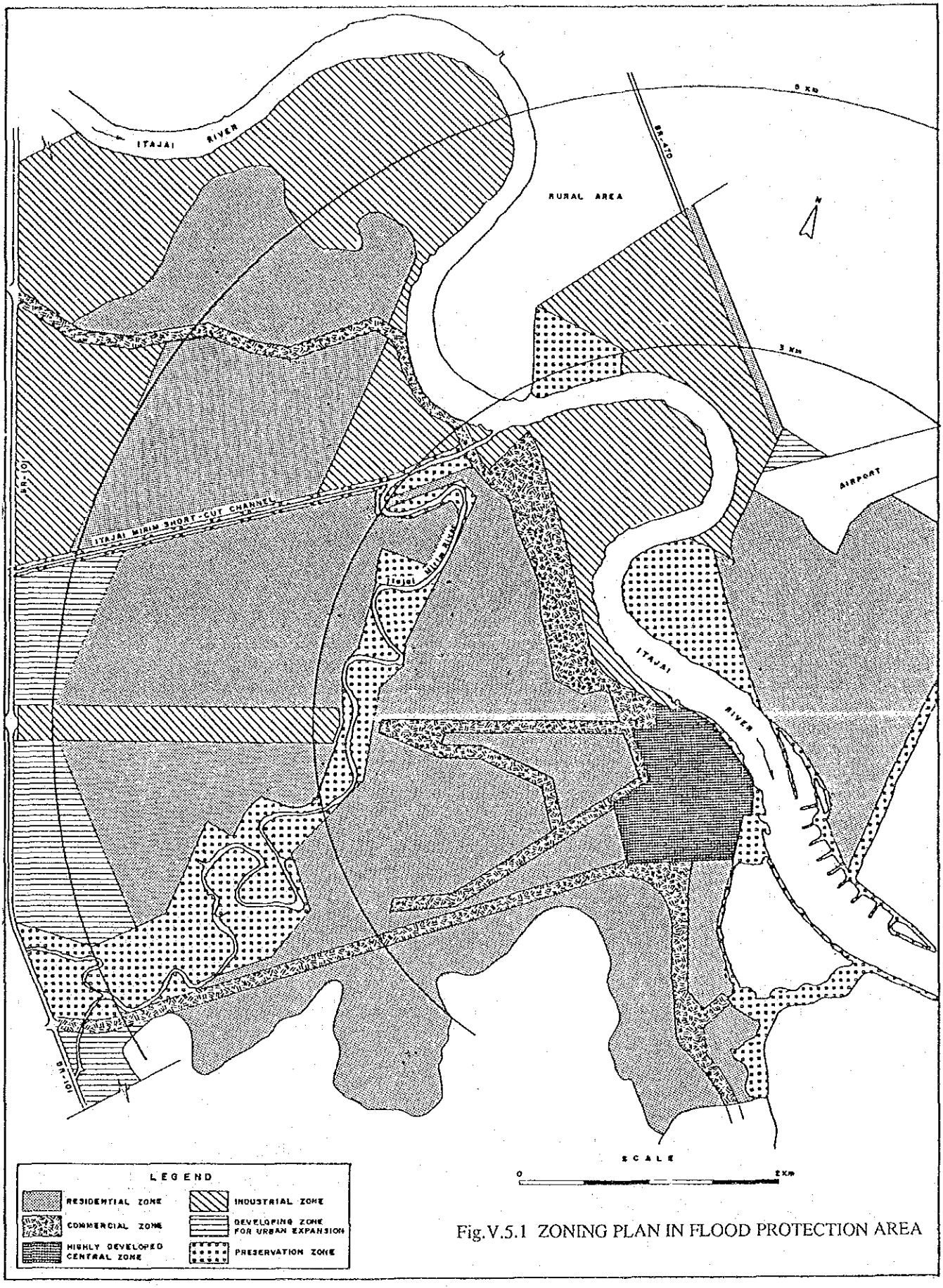

Fig.V.5.1 ZONING PLAN IN FLOOD PROTECTION AREA

ANNEX VI.

FLOOD CONTROL PLAN

ANNEX VI. FLOOD CONTROL PLAN

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VI. FLOOD CONTROL PLAN

1. INTRODUCTION

A comprehensive flood control plan for the whole Itajai river basin covering a catchment area of 15,220 km^2 was worked out through the master planning carried out between April 1986 and January 1987. In the master plan, the stage-wise river improvement plan consisting of provisional plan, mid-term plan and long-term plan was established for the respective stretches so as to cope with the necessity of earlier realization of the flood control plan in compliance with urgent social need. As a result of the plan formulation study made in the course of the master planning, the first priority is given to river improvement in the Blumenau-Gaspar stretch, and the second priority to the flood control project in the lower Itajai river basin which comprises constructing about 11 km of floodway and river improvement for the Itajai main stream, Itajai Mirim river at and its short-cut channel in order to protect the Itajai and Navegantes cities from flooding. Out of these two priority projects, a feasibility study on the river improvement project in the Blumenau-Gaspar stretch was completed in January 1988. Hence, it is noted that the Flood Control Project in the lower Itajai River Basin has to be formulated so as to be consistent with the flood control plan in the upstream Blumenau-Gaspar stretch.

The project area covers most of the downstream stretch of the Itajai river, some 23 km of the river course between its river mouth and around 4.6 km upstream from the existing bridge of the national road BR-101. The Itajai river flows down through the alluvial flat plains, with repeated semicircular meanders. The Itajai Mirim river joins the Itajai river at about 7.8 km upstream from the river mouth.

In the geological aspect, the project area is generally composed of clayey soil and fine sand with a depth of 25 to 30 m from the ground surface, below which is distributed a zone of rock. There is a hilly area in the left side of the Itajai main stream at around 1 km downstream of the existing bridge of BR-101, which consists of gneiss and migmatite. Massive rock material can be obtained from here to be used for the outer shell of the floodway outlet facility. Besides, quarry site consisting of granite has been developed by a local contractor in the hilly area surrounding Camboriu city, mainly for production of concrete aggregate material. Furthermore, there are many places along the Itajai main stream, at which sand material is being collected using pumping facilities for use in construction.

Most of the Itajai river basin in the project area belongs administratevily to the Itajai and Navegantes cities. Itajai city area spreads along an 8.5 km long stretch of the right bank of the

Itajai main stream and Navegantes city is on the left bank. There are port facilities near the river mouth. Itajai port plays an important role as a base for marine transportation and fishing port in Santa Catarina State.

Along a 12.5 km long stretch of the Itajai main stream from the river mouth, both banks are intensively utilized up to their edges for a number of wharfs of fish and cement factories, shipbuilding yards, oil storage tanks, etc., except for the low land area in the meandering portion which is generally utilized as pasture. Thus, the industrial activity in the project area is being performed, utilizing the lower reach of the Itajai main stream as a part of the marine transportation route.

The municipal land area of the Itajai and Navegantes cities totals around 400 km^2 of which 11% is developed for residential and industrial uses. The remaining flood prone area is used mainly for agriculture. Accordingly, most of the flood prone area would be worth protecting from flooding.

Up to now, the riverside areas along the Itajai river and its tributaries have suffered from inundation due to medium and large scale floods. In particular, the recent large scale floods in 1983 and 1984 caused tremendous damage for the inhabitants and the various kinds of property in Itajai and Navegantes cities. In 1983 the area along the Itajai main stream was inundated. Whereas in 1984 it occurred along the Itajai Mirim river. The total area inundated within the study area in the 1983 and 1984 floods was 31 km^2 and 34 km^2, respectively.

To cope with such flooding in the project area, it was contemplated in the master plan that a floodway be constructed connecting the main stream at about 1.3 km upstream of the BR-101 bridge and the Picarras coast to discharge excess water which the Itajai main stream could not handle. The feasibility study was initiated in October 1988 in order to formulate the optimum flood control plan in the lowest stretch of the Itajai river. In this study, two floodway routes leading to the Navegantes coast were conceived as the promising alternatives in the early stage of the feasibility study. These three floodway routes are depicted in Fig. VI.1.1. They are named Floodway-I, Floodway-II and Floodway-III in order from upstream to downstream in terms of their inlet site on the left bank of the Itajai main stream. Further explanation on each floodway route is given in Section 2.6.

This ANNEX VI describes the results of the study on the flood control in the lower Itajai river basin, comprising:

- Overview of the present condition of the lower stretch of the Itajai river and its tributaries as well as the proposed floodway routes,
- River improvement plan in the lower stretch of the Itajai river, Itajai Mirim river and its short-cut channel,
- Optimum study on the proposed floodway to select the most suitable floodway route and to determine the optimal scale of the floodway plan.
- Structural design of floodway, river structure and related structures for flood control plan, and
- Establishment of urban drainage plan in the Itajai and Navegantes city areas.

2. PRESENT CONDITION IN LOWER ITAJAI RIVER BASIN AND PROPOSED ALTERNATIVE FLOODWAY ROUTES

2.1 River Features

2.1.1 Itajai river

Fig. VI.2.1 shows the river bed profile of the whole stretch of the Itajai river along the longest river course. As seen in the Figure, the river bed slope, as a whole, forms an irregular shape. It is largely classified into three stretches, namely, upstream, middle and lower stretches. The upstream stretch has a gentle river slope upstream of Lontras city. The middle stretch has remarkably steep river slopes between Lontras city and Subida, and rather steep river slope between Subida and Blumenau city. The lower stretch has a remarkably gentle river slope between the Blumenau city and the river mouth.

Thus, the river bed slope of the Itajai river in the project area, over a length of about 23 km from the river mouth, is so gentle as being about 1:12,000. The river width ranges approximately from 170 m to 400 m and river bank elevation varies from 0 m to 4 m as shown in Fig. VI.2.2. The river depth is around 10 m on an average. The average riverbed elevation varies from -5 m to -12 m. The lower Itajai river stretch forms its river course of repeated semicircular meanders of 400 to 800 m in radius, and a 700 m long jetty was constructed at the river mouth to maintain the river course and functioning of the port.

The river cross sections at major points are shown in Fig. VI.2.3. Present bankful flow capacity in the project stretch of the river is calculated by non-uniform flow method using the river cross sections at an interval of 300 m, as shown in Fig. VI.2.2. It clarifies that the bankful capacity is in a range of less than 1,000 m^3/sec to 3,500 m^3/sec as explained in ANNEX II, HYDROLOGICAL STUDY. It is noticeable that the river flow capacity in low elevation areas around the meandering portion is as small as less than 1,000 m^3/sec.

2.1.2 Itajai Mirim river

The Itajai Mirim river, a tributary of the Itajai river, has a catchment area of about 1,700 km^2 up to its confluence with the main stream. The Itajai Mirim river, which originates in the mountainous zone in the southern part of the basin, flows to northeastwards passing through Botuvera town and Brusque city. This remarkably meandered river stretch between Brusque and Itajai cities was straightened by means of a short cut 26 years ago. The Itajai Mirim river divides into two stretches at the southwestern part of Itajai city, one is the largely meandered original river channel and the other is the straight channel short cutting the meandered river channel. Immediately after the junction of these two channels, the Itajai Mirim

debouches into the Itajai river at the northern part of Itajai city at about 8 km upstream of the river mouth.

The project area covers approximately a 11 km long stretch of the Itajai Mirim river downstream of the national road BR-101 to the confluence with the Itajai river. In the project stretch of the Itajai Mirim river, it flows down meandering irregularly through pasture and agricultural land in the southern part of the Project area and finally joins the Itajai river after passing through the residential area of Itajai city. As shown in Fig. VI.2.4, its river width is about 40 to 80 m and river bank elevation is in a range of 0.0 m to 4.5 m. Average riverbed elevation varies from -2.2 m to -7.5 m and river bed slope is about 1:10,000.

The present bankful flow capacity of the Itajai Mirim river is dependent on the water level at the confluence with the Itajai main stream. The bankful flow capacity estimated by means of uniform flow calculation method is shown in Fig VI.2.5. It shows that the flow capacity is in a range of 100 to 200 m^3/sec.

2.1.3 Itajai Mirim short-cut channel

There is a straight short-cut channel connecting the meandered Itajai Mirim stretch between 0.9 km and 19.5 km upstream of the confluence with the Itajai river, and it has a channel length of 3.2 km and a width ranging from about 50 to 80 m in the study area. As shown in Fig.VI.2.4, the river bank elevation is in a range of 2.9 m to 5.4 m and the average riverbed elevation varies from -1.7 m to -3.9 m. The riverbed slope is about 1:2,560.

The river banks along the Itajai Mirim short-cut channel are slightly elevated in comparison with the surrounding area. Although the flow capacity of the Itajai Mirim short-cut channel is dependent on water level of the Itajai main stream, as is the case in the Itajai Mirim river, the short-cut channel has a sufficient capacity such as 400 to 700 m^3/sec because of its steep river bed slope and large flow area in comparison with the Itajai Mirim river.

2.2 Existing River Structure and Related Structure

2.2.1 Itajai river

Groins for maintaining the river course were provided at eight places in the Itajai river mouth, which jut out from the left bank jetty into the river channel. The length of the groins is about 150 m and its interval is about 130 m. Except for these structures, there are no river structures in the project stretch of the Itajai river.

There is a sea port in the mouth of the Itajai river, which is equipped with berth facilities for 20 to 30 thousand ton class ships. This port is utilized by domestic and foreign ships for agricultural products and timber and as a fishing port. There are also a lot of small to large scale shipyards along both banks of the project stretch, which are utilized for loading raw materials from various kinds of factories and facilities such as fish processing factories, cement factory, oil storage tanks, and shipbuilding yards. Thus, the project stretch of the Itajai river constitutes an important part of the marine transportation route for industrial activities in the project area.

Furthermore, there are two ferry sites on the Itajai main stream to connect the municipalities of Itajai and Navegantes on the right and left banks, respectively. One is located at about 2.4 km upstream of the river mouth, and the other at about 7.6 km upstream as shown in Fig. VI.2.5. These ferry facilities are utilized by the inhabitants as an important transportation facility to cross the river.

Two lanes water pipes cross the Itajai river at around 6 km and 6.8 km upstream of the river mouth in order to supply domestic water from Itajai to Navegantes as shown in Fig. VI.2.5. These pipes are laid out along river bed and their diameters are 250 and 200 mm.

As regards irrigation use of water in the project stretch, the river water is taken to irrigate about 130 ha of paddy fields extending on the left bank, approximately 1 to 5 km downstream of the existing BR-101 bridge. Five farming families are cultivating these paddy fields and harvesting them once a year. The irrigation water is conveyed to the paddy fields using privately owned pumping facilities installed on the bank. An inventory of the paddy field cultivation along the project stretch of the Itajai river is shown in Table VI.2.1.

In the project area along the Itajai river, there is a concrete bridge for BR-101 national road at 20 km upstream of the river mouth. The main features of this bridge are shown in Table VI.2.1 and summarized as follows;

Bridge Length (m)	Width (m)	Lowest Elevation of Girder (El.m)	Type of Bridge
472	8.0	4.0	Concrete Arch

2.2.2 Itajai Mirim river

There are no river structures such as revetments and groins along the course of this river. The intake facilities for municipal water supply are provided at around 1 km downstream of the BR-101 bridge crossing the Canhanduba river, a tributary of the Itajai Mirim river. A distribution tank is provided on the right bank of the river to convey the municipal water to the Itajai city area through water pipe by gravity flow.

There is also a pier for shipping oil on the left bank at about 50 m upstream of the confluence with the Itajai river. Besides this, there are six bridges along the Itajai Mirim river. The main features of these bridges are shown in Table VI.2.1 and summarized as follows;

No.	Distance from Confluence (km)	Bridge Length (m)	Width (m)	Lowest Elevation of Girder (El.m)	Type of Bridge
(1)	0.22	91.5	13.15	3.1	Concrete
(2)	1.06	45.90	7.85	1.82	Concrete
(3)	3.07	52.00	11.10	2.3	Concrete
(4)	4.55	31.00	13.40	1.8	Concrete
(5)	9.61	48.50	6.00	3.5	Concrete
(6)	11.04	70.00	10.04	4.35	Concrete (BR 101)

2.2.3 Itajai Mirim short-cut channel

Two bridges are provided between the confluence with the Itajai Mirim river and BR-101 national road. Their main features are shown in Table VI.2.1 and and summarized as follows;

Distance from Confluence (km)	Bridge Length (m)	Width (m)	Lowest Elevation of Girder (El.m)	Type of Bridge
0.69	77.90	12.05	4.10	Composite
3.17	147.23	9.70	4.30	Concrete (BR-101)

2.3 Existing Jetty and Construction Plan of Spur Dike

2.3.1 Existing jetty at the Itajai river mouth

The construction of the existing jetty was started in 1928 and completed in 1952. Its main features are as follows:

- Length : 700 m for both left and right banks
- Crest width : 10 m
- Crest elevation : 6 m
- Shape of embankment : Trapezoid
- Side slope : 1:3

The embankment body is composed of rock materials of granite, migmatite and gneiss of about 4 tons, which are distributed in the Navegantes and Camboriu hilly areas. During 37 years since the construction of the jetty, they have been exposed to the strong wave action of the Atlantic Ocean, and such damages as slope failure and slipping of surface rock are found at several portions.

To cope with the damages, PORTOBRAS is establishing a rehabilitation plan for the existing jetty. In this plan, slope protection works are proposed to rehabilitate the embankment by dumping stones of 1 to 4 tons and tetrapod of about 8 tons doubly.

2.3.2 Construction plan of dikes for protection of Itajai harbor

PORTOBRAS also sets up a plan to construct a spur dike to protect the existing quays from flooding and it is scheduled to implement this plan in the near future. The type of spur dike proposed is trapezoid with a crest width of about 6 m and its slope is planned to be constructed by the stone pitching method as shown in Fig. VI.2.6.

2.4 Dredging Work for Itajai Port

Itajai port at the mouth of the Itajai river is operated and maintained by PORTOBRAS. This agency has periodically carried out dredging works of the sediment deposited in the port because Itajai city and the port play an important role as a base of the economic activity in the southern region.

According to the data and information collected, the dredging works were carried out at four portions: 1) Itajai river in front of the existing quays: 2) access channel including the

river course along the jetty: 3) offshore of the jetty and 4) Itajai river in front of the oil base as shown in Fig. VI.2.7.

The quantity dredged in the 8 years from 1978 to 1985 was 4,990,000 m^3 corresponding to 623,750 m^3/year as follows:

Dredging Area	Year				Total
	1978	1980	1982	1983-1985	
Quays of Itajai Port	358	198	241	-	-
Access channel	396	233	237	-	-
Offshore of jetty	531	43	107	-	-
Oil base site	112	0	0	-	-
Total	1,397	474	585	2,534	4,990

The dredging works above were done by pump dredgers having the following capacities:

- Dredging capacity : 800 m^3/hour for sandy soil
  : 400 m^3/hour for clayey soil
- Hauling capacity : 830 m^3/time
- Draft : 3.5 m
- Maximum dredging depth : 10 m

The spoil area of dredged materials is situated offshore of the Navegantes coast, to which it takes about one hour in a round trip.

2.5 Variation of River Bed of the Itajai Main Stream

The annual sediment yield in the Itajai river basin is estimated to be around 100 m^3/km^2 or 0.1 mm in denudation rate based on the results of the suspended load analysis as described in ANNEX II, HYDROLOGICAL STUDY. The estimated sediment yield rate is considered to be reasonable in comparison with those for other river basins in southern Brazil.

To examine the river bed variation of the Itajai main stream, river cross sections obtained through the topographic survey in the feasibility study stage were compared with those for 1983. The latter river cross sections were applied to the master planning. Fig. VI.2.8 shows the river cross sections of 1983 and 1989 at each of eight different points.

As seen in this Figure, no outstanding change of the river bed elevation took place during the period of 5 years.

2.6 Features and Existing Facilities on the Proposed Alternative Floodway Routes

2.6.1 Floodway-I to the Picarras coast

The Floodway-I was proposed originally in the master planning to discharge flood excessing the flow capacity of the Itajai river. Floodway-I is planned to branch off the Itajai main stream at about 1.3 km upstream of the existing BR-101 bridge and to flow down through the sugarcane fields, which have a low elevation area of 2 to 3 m for a distance of about 6 km, extending on the left bank of the Itajai main stream. The sugarcane areas to be dissected by Floodway-I belong administratively to the municipalities of Navegantes and Penha.

Thereafter, the Floodway-I is aligned through the flat area which is confined by hills of 50 and 100 m in elevation on both sides of the Lagoa do Furado river, a tributary of the Picarras river. Then it passes through a U-shaped valley of this river. In this section, a centerline of the Floodway-I is aligned almost along the Lagoa do Furado river in order to avoid the excessive excavation of the hilly area.

At about 8 km from the inlet site on the left bank of the Itajai river, it crosses a bridge of the BR-101 over the present Lagoa do Furado river. In the downstream reach of this bridge, the floodway route is aligned to pass through the hilly area on the right bank of the Lagoa do Furado and Picarras rivers. After rejoining the Picarras river near its mouth, it finally debouches into the Picarras coast through the proposed jetty. Location map of this route alignment is shown in Fig. VI.1.1.

The total length of Floodway-I along its centerline is estimated to be around 10 km, which is longer than that of Floodway-II and Floodway-III by around 1 km and 4 km, respectively. The main compensation items to be considered for Floodway-I would consist of the following;

- Sugarcane fields and houses in the Navegantes and Penha municipalities
- A bridge of the BR-101 national road and relocation of the road
- Cemetery currently under construction in Picarras
- Substation for electricity supply in Picarras.

2.6.2 Floodway-II to the Navegantes coast

Floodway-II is proposed as one of the alternative routes of the aforesaid Floodway-I as shown in Fig. VI.1.1. The inlet site of the floodway-II is located at about 0.3 km downstream of the existing BR-101 bridge or around 1.6 km downstream of the proposed Floodway-I inlet site. The Floodway-II route is aligned to pass through the flat area of 2.5 m to 4 m in ground elevation, which extends on the left bank of the Itajai main stream. Floodway-II cuts the existing BR-470 state road at two portions, which connects the municipality of Navegantes with the BR-101 national road.

After passing through foot of a hill at around 8 km downstream of its inlet site, it changes its direction to the northeast to avoid passing through the residential area of Navegantes. Then, it changes its direction again, before reaching the Navegantes coast, to make a right angle with the line of the coast, and finally debouches into the Navegantes coast through the proposed jetty.

The total length of Floodway-II excluding the jetty portion is around 9 km, which is less than that of Floodway-I by around 1 km. The main compensation items would be as follows;

- Land and houses in the Navegantes municipality
- BR-470 state road
- Water treatment facility privately owned by a fish processing company in the Navegantes municipality and plain land in the downstream reach.

2.6.3 Floodway-III to the Navegantes coast

Floodway-III is proposed as one of the alternative routes to Floodway-II. The inlet site is located in the vicinity of the churchyard in the middle of the Navegantes municipality (Machados town), at around 7.4 km downstream of the proposed Floodway-II. The total length of Floodway-II is around 10.8 km.

The Floodway-III is aligned to join the route of Floodway-II by providing about 2 km long channel between its inlet and junction point of Floodway-II as shown in Fig. VI.1.1. However, to discharge the design flood up to the inlet portion of the floodway, a short-cut channel will have to be provided by connecting large meandering portion in the upstream of the inlet site.

The main existing facilities on the floodway-III route are as follows:

- Navegantes city area including the church, cemetery, municipal water distribution tower and houses, etc,
- National road BR-470
- Plain land in the downstream reach.

3. FLOOD CONTROL PLAN IN THE LOWER ITAJAI RIVER BASIN

3.1 General

In this Section, the flood control plan in the lower Itajai river basin comprising river improvement plan of the Itajai river, Itajai Mirim river and its short-cut channel and proposed floodway plan was worked out to meet the provisional plan to cope with 10-year probable flood.

3.2 Formulation of Flood Control Plan

3.2.1 Criteria for plan formulation

The flood control plan in the lower Itajai river basin was formulated under the following criteria;

(1) It has been planned to proceed with the flood control plan by such stage-wise development as provisional, mid-term and long-term plans. Among them, this flood control plan is targeted for the provisional plan. The design flood in the Itajai river for the provisional plan is 3,300 m^3/sec. While, the average flow capacity in the lower Itajai river stretch is about 1,500 m^3/sec. It is intended in this flood control plan that as much flood flow as possible is discharged through the Itajai main stream by effectively utilizing its river channel by increasing its flow capacity. To meet this intention, it should be planned to increase the flow capacity by means of dredging the river channel and raising the flood water level by levee construction. However, increase in the flow capacity of the Itajai river channel by means of raising the design flood water level should be limited to the extent that it does not exert any influence on the design water level in the Blumenau-Gaspar stretch, which was formulated in the feasibility study of the river improvement project. The flood flow exceeding the increased flow capacity of the river channel is discharged through the proposed floodway.

(2) The design flood and dimension of the proposed floodway should be determined by optimization study. For this optimization study, a natural diversion method without any gated weir on the proposed floodway and Itajai main stream is adopted for dividing the flood discharge just upstream of their branching point into two channels in consideration of difficulty of gate operation and its cost overburden.

(3) To raise the design flood water level in the Itajai river stretch, a levee or parapet is needed to be provided. The height of the parapet along the street is limited to less than 1 m above surface elevation of road sidewalk, and also the height of levee in the urban area should be limited to less than 1.5 m from the ground elevation of the surrounding from the viewpoint of landscape in the urban area.

(4) The flow capacity in the Itajai Mirim river and its short-cut channel is enhanced by means of dredging and provision of levee or parapet.

3.1.2 Optimization study on the proposed floodway

(1) Alternative cases examined

A 50-year probable flood discharge was adopted for the optimization study on the floodway plan. The 50-year probable flood in the project river stretch upstream of the confluence with the Itajai Mirim river is estimated at 5,100 m^3/sec. The corresponding figure in the Itajai Mirim river just upstream of the confluence with the Itajai river is 930 m^3/sec. Then 50-year probable flood in the Itajai river stretch downstream of the confluence with the Itajai Mirim river comes to 6,030 m^3/sec assuming these flood peaks reach there simultaneously.

For optimization study on the proposed floodway, three alternative routes were contemplated as illustrated in Fig. VI.1.1. They are route to Picarras coast (Floodway-I) and route to Navegantes coast (Floodways-II and III). The Floodway-II branches from the Itajai river at just downstream of BR-101 bridge, while Floodway-III branches at about 4 km downstream of the BR-101 bridge.

To determine the optimal scale of the floodway plan, the following five alternative cases by varying the dividing flow to the floodway and Itajai main stream at their branching point were studied for the respective three alternative routes;

(Unit : m^3/sec)

Alternative Case	Itajai d/s	Itajai Mirim	Itajai u/s	Floodway
1	1,000	930	70	5,030
2	2,000	930	1,070	4,030
3	3,000	930	2,070	3,030
4	4,000	930	3,070	2,030
5	5,000	930	4,070	1,030

Note; (1) Itajai d/s means the stretch between river mouth and Itajai Mirim confluence.
(2) Itajai u/s means the stretch between Itajai Mirim confluence and branch point.

With regard to the above alternative cases, the hydraulic calculations for the Itajai main stream and floodway are made by means of the non-uniform flow method on each alternative floodway route in order to estimate the required width of floodway channel as well as water levels under the condition of the natural flood diversion method. The results of study on each alternative floodway route are derived as summarized in Table VI.3.1.

(2) Examination of influence on the Blumenau - Gaspar stretch formulated in the feasibility study

A feasibility study on the river improvement project in this Blumenau - Gaspar stretch was completed in January 1988. In this feasibility study, the river improvement works were contemplated in line with the comprehensive plan established in the master planning for whole Itajai stretch. According to the flood discharge distribution plan in the master plan, the design flood for the project stretch downstream of confluence with the Itajai Mirim river was set at only 1,000 m^3/sec for a recurrence interval of 50-year under the condition that the flood water level does not rise above the river bank. It is herein contemplated to minimize the cost for the floodway by increasing the flood discharge in the Itajai river by means of provision of parapet or levee along the lower Itajai river stretch under the condition that the rise of flood water level in the lower Itajai river stretch does not exert any influence to the flood control plan in the Blumenau - Gaspar stretch.

In order to examine the influence on the Blumenau-Gaspar stretch in each of the alternative cases, the non-uniform flow calculations were made for a stretch from the branching point of each alternative floodway to the Blumenau - Gaspar stretch. The initial water level for each flood peak discharge at the branch point of the floodway for

respective alternatives was calculated by non-uniform flow calculation. The result of the calculation is given in Table VI.3.2.

The water levels at Gaspar and Ilhota, which are derived from the non-uniform flow calculation for 50-year flood, are shown in Table VI.3.2 and Fig. VI.3.1 together with those at the existing BR-101 bridge close to the upstream end of the project for each of the alternative cases. These reveal that;

(a) For Floodways-I and -II, the water levels at Ilhota and Gaspar is almost the same as the design high water levels formulated in the master plan and feasibility study in case that the design discharge of the Itajai main stream downstream of confluence with the Itajai Mirim river is less than 3,000 m^3/sec. In addition, it is clarified that 3,000 m^3/sec is marginal for performing the river improvement works without relocation of the existing BR-101 national road and BR-470 national road connecting the BR-101 and the Blumenau city under the condition of a freeboard of 0.5 m.

From the above considerations, the design flood for the project stretch for the long-term plan is determined to be in a range of less than 3,000 m^3/sec.

The layout plan and longitudinal profile of the Floodway-I are illustrated in Figs. VI.3.2 and VI.3.3, respectively, while those of the Floodway-II in Fig. VI.3.4 and Fig. VI.3.5, respectively.

(b) In case of the Floodway-III, it is unavoidable to have an influence on the design water level at Ilhota and Gaspar for any alternative cases and to relocate BR-470 national road for the design flood larger than 2,000 m^3/sec even for without freeboard conditions. Furthermore, the water level in the upper project stretch, upstream of the existing BR-101 bridge exceeds the elevation of both banks. Therefore, it is considered to be desirable that the water level upstream of the branching point is lowered by means of the river improvement plan comprising of a short-cut channel in the meandering portion just downstream of the existing BR-101 bridge as well as raising the banks of the river with parapets and levees. The river improvement plan comprising the short-cut channel is discussed in the followings.

The layout plan and longitudinal profile of the Floodway-III without short-cut channel are illustrated in Figs. VI.3.4 and VI.3.6, respectively.

(3) Preliminary cost estimate and selection of the optimum scale

Since the project benefit attributable to the river improvement works definitely applies to every alternative case, the economic comparison among them is made based on the extent of direct total construction cost. Besides, the construction cost for the urban drainage work is not included in the direct cost, since there is no large difference between those for the alternative cases.

On the basis of the topographic maps on a scale of 1:5,000 with contour intervals of 1 m, the preliminary design of the river improvement works comprising the floodway and its outlet facility was made for the respective alternative cases.

The quantity calculation is carried out for the following major work items.

- Excavation/dredging for the river improvement works and provision of floodway
- River bed protection.
- Revetment for slope protection
- Embankment for levee
- Stripping for levee
- Rock fill for jetty proposed as floodway outlet facility
- Deformed concrete block for jetty
- Land area and number of houses to be acquired

Out of the above major items, the excavation volume of the floodway would be the key one, for which a noticeable difference in the direct cost of the alternative cases occurs. Fig. VI.3.7 shows curve of the excavation volume for each proposed floodway.

As seen in the diagram, the excavation volume decreases remarkably with increase in design flood for the Itajai main stream downstream of the confluence with the Itajai Mirim river.

Since the design flood for the Itajai main stream downstream of the confluence with the Itajai Mirim river is determined to be less than 3,000 m^3/sec, the construction costs for the alternative cases of Floodways-I and -II are estimated for the cases that the flood discharge in the Itajai river stretch is 1,000, 2,000 and 3,000 m^3/sec. The result of the estimation is shown in Table VI.3.3 and illustrated in Fig. VI.3.8. This Figure shows that the construction cost decreases as the design flood for the lowest stretch of the Itajai river increases. It is concluded that the floodway scale for the case of

3,000 m^3/sec of flood discharge in the Itajai main stream downstream of the confluence with the Itajai Mirim river is the most economical for Floodways-I and II.

In case of the Floodway-III, a short-cut channel is considered as a supplemental structural measure to lower the water level upstream from the branching point. A layout plan of the short-cut channel was worked out on the condition that the design flood for the lowest Itajai stretch is equal to 3,000 m^3/sec as illustrated in Fig. VI.3.9. The required width of the short-cut channel is estimated to be around 150 m to lower the water level upstream from the branching point. The required work quantities and construction cost for the short-cut channel plan are summarized in Table VI.3.4.

The construction costs for the alternative cases in which the design flood for the lowest Itajai river stretch is equal to 3,000 m^3/sec are summarized below for each alternative floodway route.

Floodway Route	Construction Cost Excluding That for Urban Drainage Work (Million US$)
Floodway-I	129.24
Floodway-II	103.16
Floodway-III	105.46

(4) Selection of the optimal plan

The three proposed alternative floodway routes are compared from the economical, environmental and social aspects. The environmental assessment study on these alternatives is made in Annex VII of this report. The result of the comparison is shown in Table VI.3.5 and summarized as follows;

a) The amount of construction cost for Floodway-I is larger than that for Floodways-II and III due to its longer route and topographic conditions of hilly area along the route. From the environmental aspect, pollution of sea water in the Picarras coast is predicted to be accelerated due to intrusion of the contaminated and muddy water from the Itajai river. The acreage of the diffusion of turbid water due to construction of the floodway is presumed to be almost the same for both the Picarras and Navegantes coasts. While the fishery activity is being carried out at the river mouth of the Itajai in spite of diffusion of turbid water discharged from the Itajai river. Considering this fact, it seems that there are no objection for the fishery activity for both the Picarras and Navegantes coasts even if the floodway is constructed.

b) Although the construction cost of Floodway-III with short-cut channel is almost equal to that for Floodway-II, construction of Floodway-III is predicted to cause great environmental and social change since it is aligned along the town area of Navegantes municipality and a lot of public facilities will have to be relocated. The area of land to be acquired for the long-term plan is about 624 ha in which a lot of facilities such as church, cemetery distribution tank for municipal water supply houses, etc. are involved.

Taking into consideration that the tourist industry taking advantage of the seashore is crucial for Picarras, construction of Floodway-I might have unfavourable social affects on its surrounding municipalities. It is concluded that the Floodway-II is the optimum plan among three alternatives.

3.3 Principle of the Flood Control Plan

3.3.1 Proposed flood discharge distribution for 10-year probable flood

The proposed flood discharge distribution for the provisional plan to cope with 10-year probable flood is established on the following conditions and assumptions:

a) 10-year probable flood for the Itajai stretch just upstream of the inlet site of the Floodway-II is 3,300 m^3/s as analysed in ANNEX II, HYDROLOGICAL STUDY.

b) The design flood for a long term plan to cope with 50-year probable flood in the Itajai main stream downstream of the confluence with the Itajai Mirim river is set at 3,000 m^3/sec. In this case, the design flood in the Itajai stretch between the confluence with the Itajai Mirim river and inlet site of the floodway is set at 2,070 m^3/sec considering the flood flow from the Itajai Mirim river. The design flood for the provisional plan to cope with 10-year probable flood in the main stream downstream of the confluence with the Itajai Mirim river is set at 2,770 m^3/sec under the condition that the design flood in the Itajai stretch between the confluence with Itajai Mirim river and inlet site of the floodway is the same as that for the long term plan.

c) It is assumed that 10-year probable flood peaks from the Itajai and Itajai Mirim rivers join simultaneously.

The flood discharge distribution for 10-year probable flood thus established is shown in Fig. VI.3.10.

3.3.2 River improvement method

The river improvement for the project stretch is contemplated to be carried out by applying the following methods;

a) The river improvement method by means of providing levee and parapet wall is adopted to increase the present flow capacity, since in general it is practically impossible to widen the river channel in consideration of the densely settled houses and various facilities along the stretch, and

b) River dredging is carried out for each stretch in accordance with the planned river bed slope and cross section to reduce the coefficient of roughness.

Typical cross sections of river improvement works in the project stretch are shown in Fig. VI.3.11.

3.4 River Improvement Plan and Structural Plan of the Project Stretch

The river improvement plan worked out for the Itajai river, Itajai Mirim river and its short-cut channel is as follows.

3.4.1 Itajai main stream

Since it is practically impossible to enlarge the width of river channel along the project stretch of the Itajai river due to the densely settled houses, factories and port facilities on both banks, a river improvement plan consisting of river dredging and provision of levee/parapet wall is designed under the following criteria;

a) The river channel is dredged and partially widened to have a regular trapezoid cross section and the planned river gradient is set at 1 to 12,000. The width of the river bed is 180 m corresponding to the average of the present river channel and its side slopes are 1:2. In this design, the special attention should be given to the followings;

The project stretch of the Itajai river remarkably meanders and the river channel at the meandering portion generally forms a triangular section due to the erosion of concave side. It is planned in this river improvement scheme to align the

river channel along the present meandering stretch. In case that the river channel in the meandered portion is reformed by excavation of convex side to fix the design river bed width of 180 m, it is anticipated that the reformed river cross sections gradually change due to the sediment deposit on the convex side of the river channel. To maintain the designed river cross section as it is, annual maintenance dredging will have to be carried out.

b) Concrete parapet wall and levee are provided on the river banks in the low elevation areas to secure a freeboard of 0.5 m above the designed high water level estimated by means of the non-uniform flow calculation for 50-year probable flood as shown in Fig. VI.3.13. The parapet wall is provided along the urban area of Itajai and Navegantes. In the streets adjacent to the river channel, its maximum height is limited to 1 m above the sidewalk in order to conserve the landscape. In principal, the maximum height of the levee is 1.5 m above the surrounding ground elevation in the urban area.

The general plan, longitudinal profile and representative river cross sections of the river improvement plan thus designed are shown in Figs. VI.3.12, VI.3.13 and VI.3.14, respectively.

3.4.2 Itajai Mirim river

The design of river improvement in the Itajai Mirim river was carried out based on the following criteria;

a) The upstream meandering stretch is improved by employing a short-cut channel at three portions to secure the area for construction of the regulating ponds for the urban drainage of Itajai city.

b) River dredging is performed along the whole project stretch to increase the present flow capacity as well as to restore the unfavourable environmental conditions of river water polluted by the accumulation of sewage owing to the low flow velocity of the river water in the downstream stretch.

c) Both banks of the Itajai Mirim river are elevated by construction of levees to protect Itajai city from floods caused by the Canhanduba river and the back water from the Itajai main stream during a flood.

d) The standard cross section for the river dredging is of a trapezoid shape with a 20 m wide river bed and side slopes of 1:2. The planned river bed slope is 1:10,000.

The general plan, longitudinal profile and representative cross sections of the river improvement plan thus designed are shown in Figs. VI.3.15, VI.3.16 and VI.3.17, respectively.

3.4.3 Itajai Mirim short-cut channel

Although the dredging and excavation works for the Itajai Mirim short-cut channel were carried out by DNOS to protect the Itajai city area from flooding, the channel cross sections in the project stretch are still irregular. In addition, there are slightly low elevation areas from place to place on both banks, though earth materials produced from the river dredging and excavation were placed on the banks without any definite principle. Accordingly, the river improvement plan consisting of dredging and construction of levees is designed for the Itajai Mirim short-cut channel based on the following criteria;

a) The dredging work is to be performed in accordance with a standard trapezoid cross section as shown in Fig. VI.3.18, which has a river bed width of 40 m and both side slopes of 1:2. The planned river bed slope along the longitudinal profile is 1:2,560, which almost corresponds to the present one.

b) The designed high water levels for 10-year and 50-year probable floods are estimated by means of the non-uniform flow calculation based on the standard cross section and planned river bed profile. In this estimates, design flood water level in the Itajai river for 10-year and 50-year probable floods at the confluence with the Itajai river is applied as the initial water level.

The general plan, longitudinal profile and representative river cross sections of the river improvement plan thus designed are shown in Figs. VI.3.15, VI.3.16 and VI.3.19, respectively.

3.5 Basic Concept and Structural Plan of the Proposed Floodway

3.5.1 General

Floodway-II was selected as the most favourable plan through the optimization study from among three alternative routes, in combination with enhancement of the present flow capacity of the project stretch of the Itajai river.

Although the floodway is optimized for the long-term plan to cope with 50-year probable flood, its structure was designed for a 10-year probable flood, considering stage-wise construction. However, such structures as the jetty to be constructed at its outlet facility, road

bridge crossing over it and the levees on the both banks were designed for the long-term plan, since stage-wise construction of these is generally uneconomical.

3.5.2 Selection of flood diversion method

Several methods for dividing the flood flow into the floodway and Itajai main stream are conceivable as follows;

a) Diversion method by controlling upstream water level through operation of gates installed on the Itajai main stream and/or floodway.
b) Natural flood division method without any gate on the floodway and the Itajai main stream.

As a result of the examination of the above diversion methods, the natural flood diversion method is adopted due to the following reasons;

a) It is too difficult practically to properly control the gate opening against the flood discharge which varies largely in the wet season. If there was a mistake made in the gate operation during a large scale flood, there is a possibility that an artificial flood would cause damage in Itajai and Navegantes cities.
b) Construction cost of a gated weir including its foundation treatment is considerably costly due to the unfavourable geological condition of the site. For instance, it is roughly estimated in this preliminary study stage that the direct construction cost of gated weir of 135 m in width would be equivalent to that of the river improvement works including that of the floodway construction.

It is, however, noted for the natural flood diversion method that;

a) Due to an application of the natural flood diversion method for the proposed floodway, the river water of the Itajai will be distributed in the ratio of 0.3 for the proposed floodway and 0.7 for the Itajai river under the condition that tide water level is at the mean sea level of 0.067 m, regardless of magnitude of river flow discharge .
b) The river flow in the Itajai river decreases due to the provision of the floodway and its flow velocity will also decrease since the flow area of river channel is almost same as that in case of without floodway due to tidal effect, and
c) Consequently, the sediment transported tends to deposit in the lower Itajai river channel. To avoid the sediment deposit, it may be necessary to provide a