JICA JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
BRAZILIAN COOPERATION AGENCY (ABC), MINISTRY OF EXTERNAL RELATION
SEPLAN-PLANNING AND COORDINATION SECRETARIAT OF STATE OF CEARA (CEARÁPORTOS)
SDE-STATE SECRETARIAT OF ECONOMIC DEVELOPMENT (CIPP/GTP)
SEINFRA-INFRASTRUCTURE SECRETARIAT OF STATE OF CEARA

No.

PECEM INDUSTRIAL AND PORT COMPLEX DEVELOPMENT PLAN IN THE FEDERATIVE REPUBLIC OF BRAZIL

FINAL REPORT

VOLUME I

MARCH 2006

INTERNATIONAL DEVELOPMENT SYSTEM Inc. (IDS)
NIPPON KOEI Co., Ltd. (NK)

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FOR

THE STUDY

ON

PECEM INDUSTRIAL AND PORT COMPLEX DEVELOPMENT PLAN

IN

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VOLUME I

MARCH 2006

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PREFACE

In response to a request from the Government of the Federative Republic of Brazil, the Government of Japan decided to conduct a study on Pecem Industrial and Port Complex Development Plan and entrusted to the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Kobune of International Development System Inc. and consists of International Development System Inc. and Nippon Koei Co., LTD. between February, 2005 and March, 2006.

The team held discussions with the officials concerned of the Government of the Federative Republic of Brazil and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

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

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of the Federative Republic of Brazil for their close cooperation extended to the study.

March 2006

KAZUHISA MATSUOKA,
Deputy Vice President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

March 2006

Mr. Kazuhisa MATSUOKA
Deputy Vice President
Japan International Cooperation Agency

Dear Mr. MATSUOKA,

It is my great pleasure to submit herewith the Final Report of "Pecem Industrial and Port Complex Development Plan in the Federative Republic of Brazil".

The Study Team comprised of International Development System Inc. and Nippon Koei Co., Ltd. conducted studies in the Federative Republic of Brazil over the period between February 2005 and March 2006 according to the contract with the Japan International Cooperation Agency (JICA).

The Study Team compiled this report, which proposes the long-term development plan to the target year 2022, the short-term development plan to the target year 2012 and the strategic port management and operation plan for Pecem Port, through close consultations with officials of the Federal Government, Ceara State Government and other authorities concerned.

On behalf of the Study Team, I would like to express my sincere appreciation to the Federal Government, Ceara State Government and other authorities concerned for their cooperation, assistance, and heartfelt hospitality extended to the Study Team.

We are also very grateful to the Japan International Cooperation Agency, the Ministry of Foreign Affairs, the Ministry of Land, Infrastructure and Transport, and Embassy of Japan in the Federative Republic of Brazil for valuable suggestions and assistance during the course of the Study.

Yours faithfully,

Koji KOBUNE,
Team Leader
Pecem Industrial and Port Complex Development Plan
in the Federative Republic of Brazil

Location Map of the Study Port

Pecem Port and its Surroundings

Abbreviation

AAE	Strategic Environment Evaluation
ABC	Brazil Cooperation Agency
ABRATEC	Brazil Association of Public use Container Terminal
AL	Alagoas
AM	Amazonas
ANTAQ	National Agency of Waterway Transport
ANTT	National Terresrial Transport Agency
AP	Amapá
ASEAN	Association of Southeast Asian Nations
ASSFAP	Pecem´s Families Association
Av.	Average
B/C	Benefit/Cost
b/d	barrels/day
B/water	Breakwater
BA	Bahia
BACTSSA	buenos aires container terminal services S.A.
BEC	State Bank of Ceara
BNB	Bank of Northeast of Brazil
BNDES	National Bank of Development
BOI	Board of Investment
BR-xxx	Designation of Brazilian federal highway
C.Y.	Container Yard
C/S	Central/South
c1	Type of Petroleum Chemical Product
c2+	Type of Petroleum Chemical Product
C3	Type of Petroleum Chemical Product
C4	Crude Gasoline
C5+	Type of Petroleum Chemical Product
CAGECE	Water and Sewer System Company of Ceara
Cap	Capita
CCT	Colon Container Terminal
CE	Ceará
CE xxx	Ceara State highway
CEDIN	State Industrial Development Board
CEGAS	Ceara Gas Company
CFN	Companhia Ferroviária do Nordeste
CFS	Container Freight Station
CFSL	Conversion Factor for Skilled Labor
CFUL	Conversion Factor for Unskilled Labor
CGTF	Thermoelectric generated energy Plant of Fortaleza
CHESF	Hydroelectric Company of São Francisco River
CIF	Cargo, Insurance and Freight
CIPP	Pecem Industrial Port Complex
CIS	Commonwealth of Independent States
CMA CGM	Compagnie Maritime d'Affrètement & Compagnie Générale Maritime
CNT	National Transport Confederation
COELCE	Ceara Electric Company
COEMA	State Environment Council

COGERH	Hydrologic Resources General Company
CONAMA	National Environment Council
CRAS	Reference Center for Social Assistance
CSX-WT	CSX World terminals
CTO	Ceara Terminal Operator
CVM	Valores Formuladaturs' Commission
CVRD	Companhia Vale do Rio Doce
CVT	Technological Training Center
DECON	Consumer Rights Department
deg	Degree
DERT	State Highway Department
DHN	Bureau of Hydrolgeology and Navigation
DNER	National Transport Infrastructure Department
DNIT	National Transport Infrastructure Department
DRI	Direct Reduced Iron
DWT	Dead Weight Tonnage
E	East
EAS	Simplified Environmental Study
EDI	Electronic Data Interchange
EIA	Environmental Impact Study
EIRR	Economic Intern Return Rate
EMBRAPA	Brazilian Livestock and Agriculture Company
ENE	East-North-East
EPZ	Environment Protection Zone
ES	Espirito Santo
ESE	East-South-East
EVA	Environmental Viability Study
F/D	Floating Dock
FAO	Food and Agriculture Organization
FDI	Industrial Development Fund
FIEC	Federation of the Industries of Ceara State
Fig.	Figure
FINOR	Fund of Investment of Northeast Region
FIRR	Financial Intern Return Rate
FMR	Fortaleza Metropolitan Region
FOB	Free On Board
FUNCEME	Ceara State Foundation of Meteorology and Hydrologic Resources
GASFOR	Gas Pipeline
GDP	Gross Domestic Production
Gis	Geographic Information System
GL	Ground Level
GM	Metacenter to the Center of Gravity
GRT	Gross Registered Tonnage
GTP	Participative Group of Work
GW	Gigawatt
GWT	Gross Weight Tonnage
H	Height
H/Hi	Wave height at point of interest over incident Wave height ratio
há	Hectare
HHWL	Highest High Water Level

HP	Horsepower
Hs	Wave Height
HWL	High Water Level
Hz	Hertz
IALA	International Association of Lighthouse Authorities
IBAMA	Brazilian Institute of Environment and Renewable Natural Resources
IBGE	Brazilian Institute of Geography and Statistics
ICMS	Brazilian Excise Tax
ICTSI	International Container Terminal Services Inc.
IDACE	Institute of Rural Development of Ceara
IDB	Inter-American Development Bank
IDM	Municipality Development Index
IDS	International Development System
IEE	Initial Environment Evaluation
IMO	International Maritime Organization
INEMET	National Institute of Meteorology
INPH	National Institute of hydrologic Research
IPECE	Institute of Economic Research of Ceara State
IR	Infrared
ISPS	International Ship and Port Facility Security
J2	Jota Dois
JICA	Japan International Cooperation Agency
Kd	Stability Coefficient
Kg	Kilogram
KN	KiloNewton
kV	kilovolt
KWh	Kilowatt/hour
Kxx	Radius of Gyration
Lat	Latitude
LI	License of Installation
LLDPE	Linear Low Density Polyethylene
LLWL	Lowest Low Water Level
LNG	Liquefied Natural Gas
LO	License of Operation
LOA	Length Over All
Long	Longitude
LP	Previous License
LPG	Liquefied Petroleum Gas
LS	Lump sum
LT	Lifting Tonnage
LWL	Low Water Level
m	Meter
m/s	meter/second
m^3	Cubic meter
MA	Maranhão
Max	Maximum
MDF	Medium Density Fiber
MG	Minas Gerais
MHWN	Mean Higher High Water Neap
MHWS	Mean Higher High Water Spring

MISC	Miscellaneous
MIT	Puerto manzanillo International Terminal
MLWN	Mean Lower Low Water Neap
MLWS	Mean Lower Low Water Springs
mm/ye	millimeter/year
MMA	Ministry of Environment
MMBTU	Million British Thermal Units
MOL	Mitsui O.S.K. Lines, Ltd
MS	Mato Grosso do Sul
MSL	Mean Sea Level
MT	Mato Grosso
MTC	Manzanillo International Container terminal
MTI	Ministry of Trade and Industry
MW	Megawatt
N	Newton
N/A	Not available
NAVIS	Navy Automated Video Information System
NE	North-East
NGO	Non-Governmental Organization
NK	Nippon Koei
NNE	North-North-East
NNW	North-North-West
NPV	Net Present Value
Nqgc	Number of Quay side Gantry Crane
Nr	Number
Nrtg	Number of Rubber Tyred Gantry Crane
Ns	Stability Number
NUTEC	Industrial Technology Center
NVOCC	Non-Vessel Operating Common Carrier
NW	North-West
O&M	Operations & Maintenance
OOCL	Orient Overseas Container Line
P&O	Peninsular & Oriental (shipping company)
PA	Pará
PAIF	National Plan for Family Assistance
PB	Parnaíba
PCA	Environmental Control Plan
PDR	Rational deforestation Plan
PE	Pernambuco
PET	Polyethylene Terephthalate
PI	Piauí
PIANC	Permanent International Association of Navigation Congresses
PMF	Forest Management Plan
PP	Polypropylene
PPA	Pluriannual Plan
Pqgs	Productivity of Quay side Gantry crane
PR	Paraná
PRAD	Plan of Recovery of Degraded Areas
PROARES	Social Reforms Support for Children and Adolescent Development Program
PROVIN	Industrial Development Incentive Program

Prtg	Productivity of Rubber-Tyred Gantry crane
PS&D	Production, Supply & Distribution
PU	Polyurethane
PVC	Polyvinyl Chloride
QSGC	Quay Side Gantry Crane
R$	Brazilian Real
RAA	Environmental Consulting Report
RAS	Simplified Environmental Report
RCA	Environmental Control and Monitoring Report
Re	Brazilian Real
Rec	Recession
REFAP	Refinery Alberto Pasqualini
RIMA	Environmental Impact Report
RJ	Rio de Janeiro
RLAM	Refinery Landulpho Alves/Mataripe
RMF	Metropolitan Region of Fortaleza
RMG	Rail-Mounted Gantry crane
RN	Rio Grande do Norte
RO	Roráima
RO/RO	Roll on/Roll off
RPBC	Refinery President Bernades/Cubatão
RS	Rio Grande do Sul
RTG	Rubber-Tyred Gantry crane
S	South
S.B.R.	Styrene Butadiene Rubber
Samp	Sample
SBF	Secretariat of Forest and Biological Diversity
SC	Santa Catarina
SCA	Secretariat of Amazon Coordination
SCF	Standard Conversion Factor
SDE	Secretariat of Economic Development
SE	Sergipe
SE	South-East
SEBRAE	Brazilian Support Service for micro and small companies
SECULT	Secretariat of Culture
SEINFRA	Secretariat of Infrastructure
SEMACE	Secretariat of environment of Ceara
SENAC	National Service of trade training
SEPLAN	Secretariat of Planning and coordination
SESC	Trade Social Service
SINE	National employment System
SOMA	State Secretariat General of Environment
SP	São Paulo
sq.m	Square Meter
SQA	Quality in the Human Settlement
SRH	Secretariat of Water Resources
SSA	Stevedore Service of America
SSE	South-South-East
SSW	South-South-West
SUDENE	Superintendency of Development of Northeast Region

SW	South-West
TECON	Container Company S.A. (Terminal de Contêineres S.A.)
TEP	Temporary jetty
TEU	Twenty-foot equivalent unit
TOR	Terms of reference
Tp	Wave Period
TP&E	Tarcísio Pinheiros & Economistas
TPA	Third Party Administrator
Troll	Natural Period of Rolling of the Waves
TWH	Terawatt/hour
Tz	Mean Wave Period
U	Wind speed
U.S.A.	United States of America
UFC	Federal University of Ceara
ULCV	Ultra Large Container Vessel
US	United States (of America)
US$	US Dollar
USBC	United States Border Control
USC	Ceara Steel Factory
USDA	United States Department of Agriculture
UVA	University of Vale do Acaraú
V	Volt
VAT	Value Added Tax
Vb	Lump Sum
Vel	Velocity
VSL	Vessel
VTMS	Vessel Traffic Management Services
WNW	West-North-West
WSW	West-South-West
YB	Year Book
ZPMC	Shanghai Zhenhua Port Machinery Co., Ltd.

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CHAPTER 3 NATURAL CONDITIONS

CHAPTER 1 INTRODUCTION

1.1 Background

The State of Ceara is one of the under-developed state in the Northeast Region and the per capita GDP is below average of whole Brazil. The state government has been making great efforts in the expansion of irrigated farm lands by constructing reservoirs and canals and in attracting light industries such as footwear, leather textile, steel work by providing industrial estate in various locations in the state. In line with the decentralization policy of the state, these agricultural zones, which are called "Agropolos", and industrial zones are located in remote areas as well as near Fortaleza, he state capital to achieve the goal to reduce the inter-regional and interpersonal inequalities. The infrastructures such as highways, electricity, and water supply system are also upgraded to encourage the investment. With scenic dunes along its coast, the state of Ceara is also well-known as the tourist destination.

To promote further the attraction of industries, a concept of the development of the Pecem Industrial Port Complex (CIPP), which is an integrated industrial zone with anchor industries of steel mill, oil refinery and petrochemicals, was brought to the economic development plan of the state. The construction was started in 1996 in Pecen, which is located about 60 km to the west of Fortaleza City. The land use plan of 33,500 ha of CIPP was prepared and in line with the plan infrastructures, access roads and railways, a deep sea port, water supply system and power stations been ready to accept the anchor industries. Pecem Port, which is a supporting infrastructure for steel mil and oil refinery, was opened in November 2001.

However, establishment of the anchor industries has been delayed and none of the schedule of setting up these anchor industries seemed to start soon. In this circumstance, the study on Pecem Industrial and Port Complex Development Plan has been carried out from February, 2005 to March, 2006 in line with the Scope of Word agreed upon in August 2004 between Federal and State Governments of Brazil and the Japan International Cooperation Agency (JICA).

1.2 Situation

While the establishment of anchor industries in CIPP had been delayed with no definite schedule, Pecem Port started its operation of the Multipurpose Pier (Pier No. 1, water depth of -14m) and the Oil Pier (Pier No. 2, water depth of -15m) in 2001. As soon as the port started its service, container carriers called on the port. After three years of operation, the volume of general cargoes handled at the port has been reaching that handled at Fortaleza Port.

The rapid increase of the cargo volume at Pecem Port does not result only from the shift of cargoes from Mucuipe Port to the Former. Among the principal commodities handled at Pecem Port, there are some commodities that were not seen among those had been handled at Mucuripe before the opening of Pecem Port. There are some other commodities that have shown big leaps in volumes since the opening of Pecem Port. In addition, the origins and destinations of cargoes exported and imported at Pecem port are not limited only within Ceara State. Substantial amount of cargoes are originated from or destined to outside of Ceara State (26% of import cargoes and 36% of export cargoes). Thus, the hinterland has been expanding.

Such a rapid increase of the cargo volumes at Pecem Port seems to result from the facts that Pecem Port is the sole deep sea port within Ceara State and adjacent states and that the container handling charge is the lowest among the ports in Brazil.

Thus, the new port that was constructed with the purpose of the exclusive use by the Steel Mill and Oil Refinery has been recognized by the public as a gateway to the international markets and encouraged investments in the existing and new industries and businesses in the hinterland. In fact, investments in agribusiness, especially fruits growing, have been are under way by foreign and local investors. In addition, the Northeast Railway Company that has been privatized is about to start the implementation of a plan to modernize its facilities and upgrade its service to transport those agricultural products produced in the land locked states to the gateway ports: Itaqui Port, Maranao State, Suape Port. Pernambuco State and Pecem Port, Ceara State.

Now, the construction of the steel mill started in November, 2005. When the steel mill starts operation in 2008, Pier No. 1, which is currently used for the public, will be almost exclusively used by the steel mill company for its importation of iron ore and exportation of its products. Thus, it is very urgent to construct an alternative pier for public use.

1.3 Structure of the report

The report consists of four volumes: Volume I contains the summary, Conclusion and Recommendations, Volume II covers the background data and review of the socioeconomic situation, natural conditions, the discussion of the strategy of the CIPP development, the port traffic demand forecast, the long-term development plan and the social and environmental considerations, Volume III covers the short-term development plan and the feasibility study, while Volume IV is the compilation of the appendices that are background and supporting data of the main text.

1.4 Implementation of the Study

For the implementation of the study, the counterpart of the study team was formulated in such a manner that the Secretariat of Planning and Coordination (SEPLAN) was the principal counterpart that coordinates the other secretariats concerned to this study such as Secretariat of Economic Development (SDE), Secretariat of Infrastructure (SEINFRA), Secretariat of Agriculture (SEAGRI), Secretariat of Local and Regional Development (SDLR), State Superintendence of Environment (SEMACE), CEARAPORTOS and other agencies concerned.

CHAPTER 2 REVIEW AND ANALYSIS OF EXISTING SOCIO-ECONOMIC DATA AND INFORMATION

2.1 Socioeconomic Conditions of Brazil

2.1.1 The Republic, the Federal Government

(1) The general Aspects of the Country

Situated in the central-eastern portion of South America, Brazil covers an area of 8,514,000 km^2, that is equivalent to 21% of the Americas and 48% of the South American continent. It is the fifth largest country in the world.

According to the results of the 2000 Demographic Census, the population of Brazil was 168,800,000. It is projected that the population will have reached 208 million in 2020. Over the past 30 years, the population growth rate in Brazil has dropped from 3% in the 1960's to 1.63% in the 1990's. The population density is low, i.e., 19.8 people per square kilometers, compared with the world average, i.e., 40 people per sq. km. However, 81% of the population lives in urbanized areas.

Brazil comprises of the Federal District, 26 States (see Figure 2.1.1), and 5,561 Municipalities (2001). States are grouped info five large regions: the North, Northeast, Southeast, South and Central West Regions. The North Region, which consists of seven states, is the largest in terms of land area that accounts for 45% of the national territory, while its population accounts 7.6%). The Northeast Region, which covers 18.2% of national territory, comprises of nine states, namely, State of Maranhao, Piaui, Ceara, Rio Grande do Norte, Paraiba, Pernambuco, Alagoas, Sergipe and Bahia.

Figure 2.1.1 Regions and States of Brazil

Its population accounts for 28%, which is the second largest population next to Southeast Region. The Southeast Region, covering 11% of national territory, consists of 4 states. It has the largest population that accounts for 43%. South Region, consists of three states, has the smallest land area, which covers 7% of the national territory. The population of the state accounts for 15%. The Central West Region is the second largest Region and has 19% of national territory, while the population is the smallest, as it accounts for 7% (see Table 2.1.1).

Table 2.1.1 Land area and population of the Regions

Region	Land area		Population	
	(sq. km)	Relative (%)	Year 2000	Relative (%)
Brazil	8.514.876	100,0%	169.799	100,0%
North	3.853.327	45,3%	12.900	7,6%
Northeast	1.554.257	18,3%	47.741	28,1%
Southeast	924.511	10,9%	72.412	42,6%
Southeast	576.409	6,8%	25.107	14,8%
Central West	1.606.371	18,9%	11.636	6,9%

Source: IBGE Statistics

(2) Economy

The economic history of Brazil is briefly summarized in the web site of the Ministry of Foreign Affairs of Brazil. The information presented here was taken from the web site.

The economy of Brazil had steadily grown in 1960's and 1980's. The GDP growth rate of Brazil was among the highest in the world until 1974, the average growth rate was 7.4%. During 1970's, Brazil, like many other countries in Latin America, absorbed excessive liquidity from U.S., European and Japanese banks. Huge capital inflows were directed to infrastructure investments. The state enterprises were formed in the areas that were not attractive for private investment. Due to the huge capital inflows, Brazil achieved a growth rate of 8% between 1970 and 1980 despite the impact of the 1970's world oil crisis. Per capita income rose fourfold during the decade to US$ 2,200 in 1980.

In the early 1980's, however, a sudden substantial increase in interest rates in the world economy occurred coinciding with the lower commodity prices due to Latin America's debt crisis. Brazil was forced into strict economic adjustment, which brought about negative growth rates. The unexpected suspension of capital flows reduced Brazil's capacity to invest. The burden of the debt of Brazil affected public finances and the inflation was accelerated.

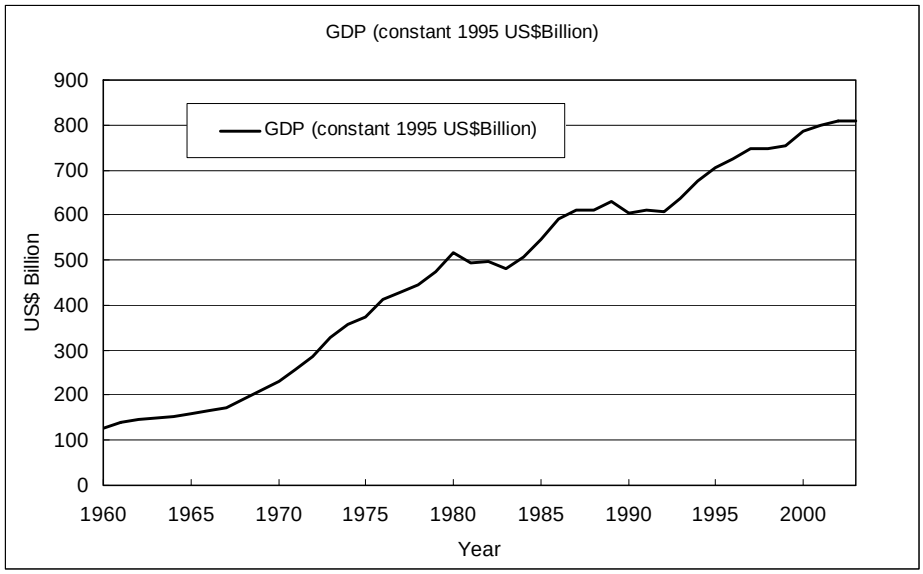
In 1987, the government suspended its interest payment on foreign commercial debt. With this crisis, the Brazilian government had to give up the "Import Substitution" policy and to open the country's economy to the world: "Import Substitution" is a policy that prohibits local industries to purchase certain manufacturing products abroad.

In early 1990's, the government's efforts were focused on economic stabilization, opening up the country's economy to the international trade and investment, and normalizing the relations with the international financial community. While the latter

two were quickly, the inflation was accelerated until a hyper-inflation, i.e. annual inflation rate was 800%, occurred in 1993.

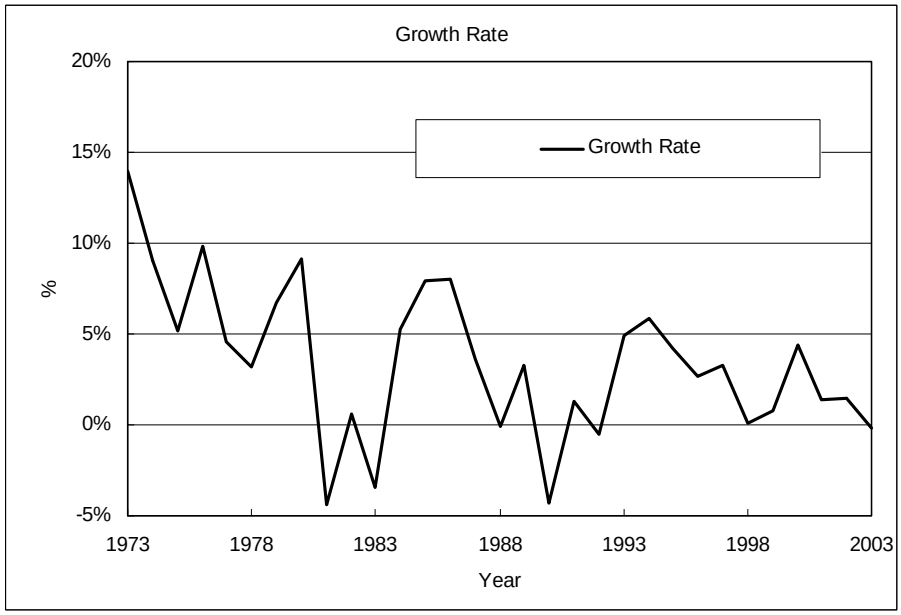
The turning point in the stabilization process came with the launching of the "Real Plan" in June, 1994. With the new currency, the price increases rate had been lowered to a normal level of 2 percent in 1998. The foreign investment had also been increased. In the period from 1995 to 1997, the GDP growth was 4% on the average and, in 1997, the GDP reached US$800 million.

Figures 2.1.2 and 2.1.3 show the GDP and the GDP growth rate, respectively. The growth rate tends seems to slow down in 2002 and 2003.



Source: World Bank: Drawn by the Study Team on the basis of World Development Indicator, the World Bank

Figure 2.1.2 GDP of Brazil (1995 constant price)



Source; Drawn by Study Team on the basis of World Development Indicator, the World Bank

Figure 2.1.3 GDP Growth rate of Brazil

Characteristic socioeconomic indicators are shown in Table 2.1.2.

Table 2.1.2 Socioeconomic Indicators

Index	Year	Amount
Labor force	1999	79.3 million
Employed population	2000	64.7 million
Unemployment Rate	2001	6.2 %
Life Expectancy	2000	68.6 years
Infant mortality rate	2001	32.7 per 1,000
GDP at current price	2001	R$ 1,185 million
		US$ 798.3 billion
GDP per capita	2001	R$ 6,761
		US$ 4,555 (1995 Price)
GDP Growth 2000/2001		1.50 %
Price Index	2001	7.67 %
Energy Consumption peer Capita	2000	1,793 KWh

(3) Government Plans - PLAN PRURIANUAL –PPA 2004-2007 (Multi-annual Plan)

a) The Strategy of Long-period Development

The most fundamental policy of the Federal Government is Social Participation. The Federal Government's policy between 2004 through 2007, which is described in the PLAN Pluriannual-PPA 2004-2007" has been elaborated with "the broad participation of Brazilian society as well as of several government spheres. Forums of Social Participation were accomplished in 26 States and in Federal District, with the presence of 4,738 people, representing 2,170 entities of the civil society. The Counsel of Economical and Social Development met several times to discuss and make suggestions to PPA."

The Federal Government put a special attention on the regional and social disparity。 The PPA identified "the fundamental problems to be faced are social and spatial concentration of income and wealth, poverty and social exclusion, disrespect to the fundamental rights of citizenship, environmental degradation, low job creation and barriers for the transformation of productivity earnings in increase of income to the great majority of hard-working families." The highest priority was given to Social and citizenship programs in order to generate the conditions of eradication of the poverty, of illiteracy, of precocious work, of infant mortality, of racial, gender and minority discrimination to guarantee the universal access to the services of health, education, culture, housing and transport. In addition, it mentions that the appropriate attack to social exclusion and bad income distribution requires also sustained growth, with wealth generation in scale enough to increase the volume of investments and the salary mass of the Country.

The government assumes that Brazil possesses all of the necessary elements for the growth of GDP in a scale higher than 4% per year, with a wide workforce that is disposed to face the challenges of new technologies, abundant natural resources and qualified professionals in all knowledge areas, one of the largest potential markets of the world, undertaking businessmen that are capable to compete in any market, and a wide productive base, diversified and competitive in several sectors. It, for the

sustained growth to become a reality, reiterates the importance of the Social Participation emphasizing the importance of articulating these forces, which have been dispersed for years, and guiding them to a development project.

The strategy inaugurated in PPA 2004-2007 are:

a) long term social inclusion and income distribution with vigorous growth of the product and employment;

b) environmentally sustainable growth;

c) reduction of the regional disparities;

d) expansion of the market of mass consumption, investments, and elevation of productivity; reduction of the vulnerability through the expansion of the competitive activities that make possible the sustained growth and

e) strengthening of the citizenship and democracy.

The key factors to maintain a stable macroeconomic regime are identified to be based on three foundations:

a) solid foreign accounts, in other words, a balance in current account that doesn't impose excessive restrictions to the monetary policy nor turn the Country vulnerable to changes in the flows of international capital;

b) fiscal consistence characterized by a sustainable path for the public debt and

c) low and stable inflation.

The investments of this PPA are orientated by actions of great reach in different areas of infrastructure. In the section of transports, the key targets identifies are the reduction of the logistic cost, the exploration of the potential of multimodal use in substitution to the mostly road mode, the opening of systems of integration with the economical boarders of the Brazilian territory and with the neighbouring countries, and the improvement of the urban mobility. In energy, the investments should guarantee the supply, enjoying the competitive advantages of the hydroelectric generation in the national mould of electrical energy and to reach and preserve the self-sufficiency in petroleum. In the segment of telecommunications it is necessary to move forward in the universal services and to motivate the research, development and production of equipments and software. The investments in infrastructure of hydraulic resources, in sanitation and housing equally open an extensive calendar of projects for the future.

A new element that present government has brought in the economic development policy is to promote the domestic market as well as international markets. “In the long term, it is aimed, with PPA 2004-2007, to inaugurate a process of growth through the expansion of the market of mass consumption and based in the progressive incorporation of the hard-working families to the consuming market of the modern companies. The model is viable, since it is enrolled in the logic of operation of the Brazilian economy: the more the purchasing power of the hard-working families increases, the higher the demand for goods and services produced by the modern productive structure of the economy becomes (processed foods, clothing and shoes, hygiene and cleaning goods, medicines, electronic equipments, appliances,

construction materials, furniture, services of supermarkets, of transport, of electric power, of telecommunications and of entertainment)."

The PPA implicates the government believes that Brazil is one of the few countries in the world having the conditions to grow with this strategy because of the size of its potential consuming market.

b) Growth Scenario

The great macroeconomic challenge of PPA 2004-2007 is to reconcile the need of expansion of the investment and of the exports with the commitment of expansion of the consumption. For that, it is crucial to adopt a sequence of actions that, gradually, eliminate the main obstacles to the continuous growth of the economy.

It was estimated in the PPA that the GDP growth in 2003 was between 1% and 1.5%. It set the goals of the new Government over the coming years to be a growth of 3.5% in 2004; 4.0% in 2005; 4.5% in 2006; and 5.0% in 2007. The strategy to reach these goals is to increase the investment of the economy, to maintain the growth of the exports of goods and services above the growth of GDP and to promote the gradual recovery of the growth of the consumption of the families.

Table 2.1.3 shows the government's estimate of the GDP growth as a whole and of the three sectors.

Table 2.1.3 Goals of real GDP growth Rate, for 2004-2007, in the production (Rate % a year)

	2004	2005	2006	2007
GDP	3.5	4.0	4.5	5.0
Farming	3.7	4.0	4.4	4.9
Industry	4.1	4.6	5.0	5.6
Services	3.2	3.6	4.2	4.6

Source: PPA-2004-2007, Ministry of Planning

The PPA presents the following growth scenario for each sector:

For 2004-2007, it is expected that the accumulated growth of the industrial product is of approximately 21%. This growth is based on the perspective increase in the rate of investment in the industries, especially, in the mineral extractive industry strongly.

Among the main industrial sector specified in the system of national bills of IBGE, the goals of accumulated growth for 2004-2007 are 25% for the building site; 22% for the mineral extractive industry; 20% for the transformation industry; and 17% for the section producing of industrial services of public use.

The agricultural sector should also register substantial growth in the next four years. In accumulated terms, the agricultural product should increase 18% in 2004-2007 approximately, with prominence for the increase of the agricultural production destined to export.

The service sector should register an accumulated growth of 17% in 2004-2007 approximately. In spite of such a slightly inferior rate in the accumulated growth expected of 18% of GDP for the period, it is worth to emphasize that this is due to the

smallest growth projected for the services of Public Administration that are due to the goals of reduction of the public debt in relation to GDP and of increase of the Government's investment for the period.

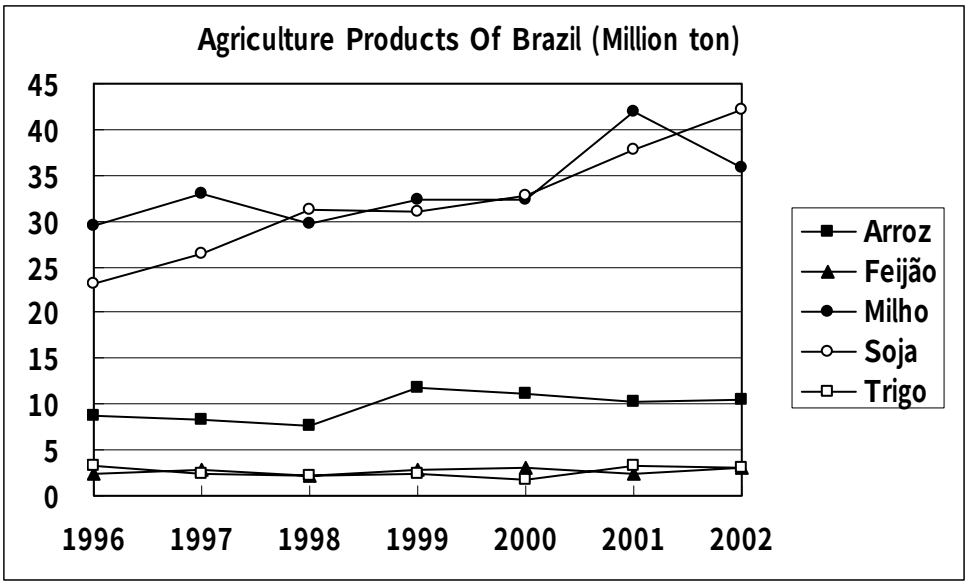
c) Programs

On the basis of development strategy distributed in five dimensions, i.e., social, economical, regional, environmental and democratic, the PPA-2004-2007 sets three mega-objectives that include 30 challenges, through 374 programs, which consist of approximately 4,300 actions.

2.1.2 Production and trade

(1) Agricultural Production

The productions of cereals in the whole Brazil are shown in Figure 2.1.4. Milho(Corn) and Soja (Soy beans) are the two principal products. The volumes of these two crops are about 40 million tons. It is seen that soy bean production is increasing continuously.



Source: Prepared by JICA Study Team on the basis of the statistics of Ministry of Agriculture Web Site

Figure 2.1.4 Major Cereal Production of Brazil

The productions of other agricultural Products are shown in Table 2.1.4 Sugar cane, Cassava, Tomato, Potato, Cotton, Coffee are the principal products. The volumes of these products are more than one million tons. , and the volume of the production is steadily increasing. Productions of fruits are also increasing in the recent years: orange, Banana, apple, etc. It should be noted that the units of volumes of the three kinds of fruits were changed after 2001 in the statistics of the Ministry of Agriculture, thus, only the recent years are shown in the table.

Those states in the Southeast and South Regions are the major areas of the agricultural production. Northeast Region is also producing various kinds of products.

Table 2.1.4 Agricultural Products in Brazil

1,000 ton

Year	Sugar	Cassava	Tomate	Potato	Cotton	Cofee
1990	262.674	24.322	2.261	2.234	1.783	2.930
1991	260.888	24.538	2.344	2.267	2.041	3.041
1992	271.475	21.919	2.141	2.432	1.863	2.589
1993	244.531	21.856	2.348	2.368	1.127	2.558
1994	292.102	24.464	2.689	2.488	1.351	2.615
1995	303.699	25.423	2.715	2.692	1.442	1.860
1996	317.106	17.743	2.649	2.413	952	2.738
1997	331.613	19.896	2.718	2.670	821	2.457
1998	345.255	19.503	2.784	2.784	1.172	3.379
1999	333.848	20.864	3.305	2.905	1.477	3.264
2000	326.121	23.041	3.005	2.607	2.007	3.807
2001	344.293	22.580	3.103	2.849	2.644	3.639
2002	364.391	23.066	3.653	3.126	2.166	2.650
2003	389.929	22.236	3.641	3.070	2.196	1.970
States of Major Production	São Paulo 226.277 Paraná 30.970 Alagoas 24.766 Minas Gerais 20.872 Pernambuco 18.522	Pará 4.506 Bahia 3.999 Paraná 2.271 Rio Grande do Sul 1.315 Maranhão 1.242	Goiás 1.017 São Paulo 768 Minas Gerais 693 Bahia 168 Pernambuco 154	Minas Gerais 1020 São Paulo 864 Paraná 615 Rio Grande do Sul 313	Mato Grosso 1104 Goiás 305 Bahia 258 São Paulo 167 Mato Grosso do Su 159	Minas Gerais 890 Espírito Santo 484 São Paulo 170 Paraná 121 Bahia 91

1,000 ton

Year	Onion	Coco	Caju	Peanut	Cacau	Papya
1990	869	734	107,7	138,3	356,2	148,0
1991	888	851	186,0	140,5	321,0	129,7
1992	896	891	108,0	172,2	328,5	102,1
1993	929	837	77,1	151,5	340,9	43,2
1994	1.020	919	149,8	160,2	330,6	54,0
1995	941	967	185,2	170,1	296,7	33,1
1996	907	957	167,2	154,3	256,8	41,3
1997	881	967	125,4	141,3	278,0	97,4
1998	838	1.027	54,1	193,2	280,8	16,7
1999	989	1.207	145,4	179,4	205,0	33,4
2000	1.156	1.301	138,6	187,9	196,8	116,0
2001	1.050	1.421	124,1	201,8	185,7	100,0
2002	1.222	1.928	164,5	195,3	174,8	71,7
2003	1.187	1.889	178,4	177,1	170,7	86,9
States of Major Production	Santa Catarina 410 São Paulo 267 Rio Grande do Sul 123 Bahia 139 Pernambuco 91	Bahia 697 Pará 225 Ceará 218 Espírito Santo 136 Pernambuco 182	Ceará 107,8 Rio Grande do Nor 30,7 Piauí 26,7 Bahia 5,6 Maranhão 4,7	São Paulo 148,3 Minas Gerais 4,2 Paraná 7,5 Rio Grande do Sul 6,9 Bahia 7,6	Bahia 110,8 Pará 31,9 Rondônia 17,9 Espírito Santo 8,5	Bahia 82,5 Ceará 1,6 Minas Gerais 1,4 São Paulo 1,1 Pernambuco 0,2

1,000 ton

Year	Laranja	Banana	Apple
2001	16.983	6.177	716
2002	18.531	6.423	857
2003	16.936	6.518	842
States of Major Production	São Paulo 13.347 Bahia 772 Minas Gerais 667 Sergipe 691 Paraná 350	São Paulo 1183 Bahia 765 Pará 698 Santa Catarina 618 Minas Gerais 548	Santa Catarina 475 Rio Grande do Sul 329 Paraná 35 São Paulo 2

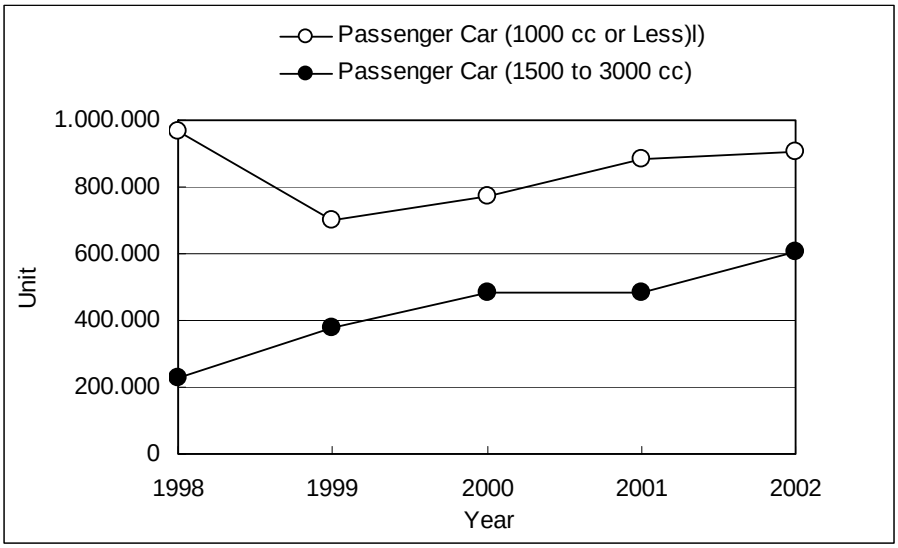
Source: Ministry of Agriculture

In particular, Cashew is mainly produced in the northeast states including Ceara, which is ranked at the top. It should be noted that Bahia State is ranked in the top five states in variety of products.

(2) Industrial Production

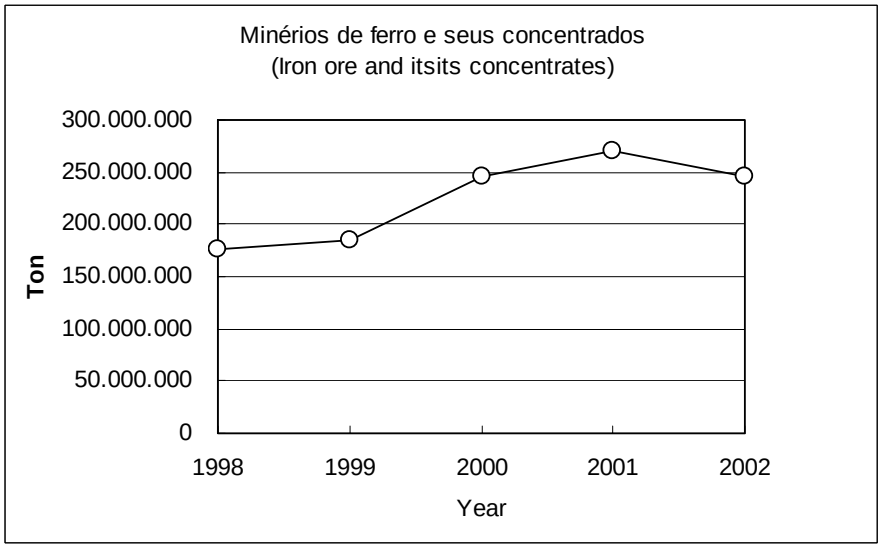
The principal industrial products of Brazil are automobile and parts, iron ore and its concentrates, Crude oil and Petroleum products, Sugar, ethyl-alcohol, beer, cell-phone and parts, Cement, fertilizer.

The annual variation of production of automobile, iron ore, and Gasoline and Diesel are shown in Figure 2.1.5 through 2.1.7, respectively.



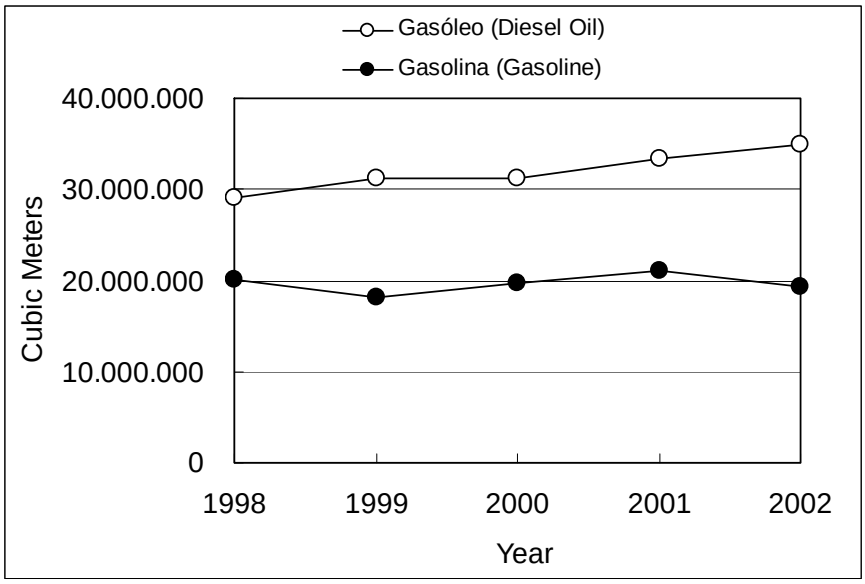
Source: Drawn by the JICA Study Team from the statistics of Ministry of Trade and Industry Web Site

Figure 2.1.5 Production of Automobile



Source: Drawn by the JICA Study Team from the statistics of Ministry of Trade and Industry Web Site

Figure 2.1.6 Production of Iron ore and its Concentrates



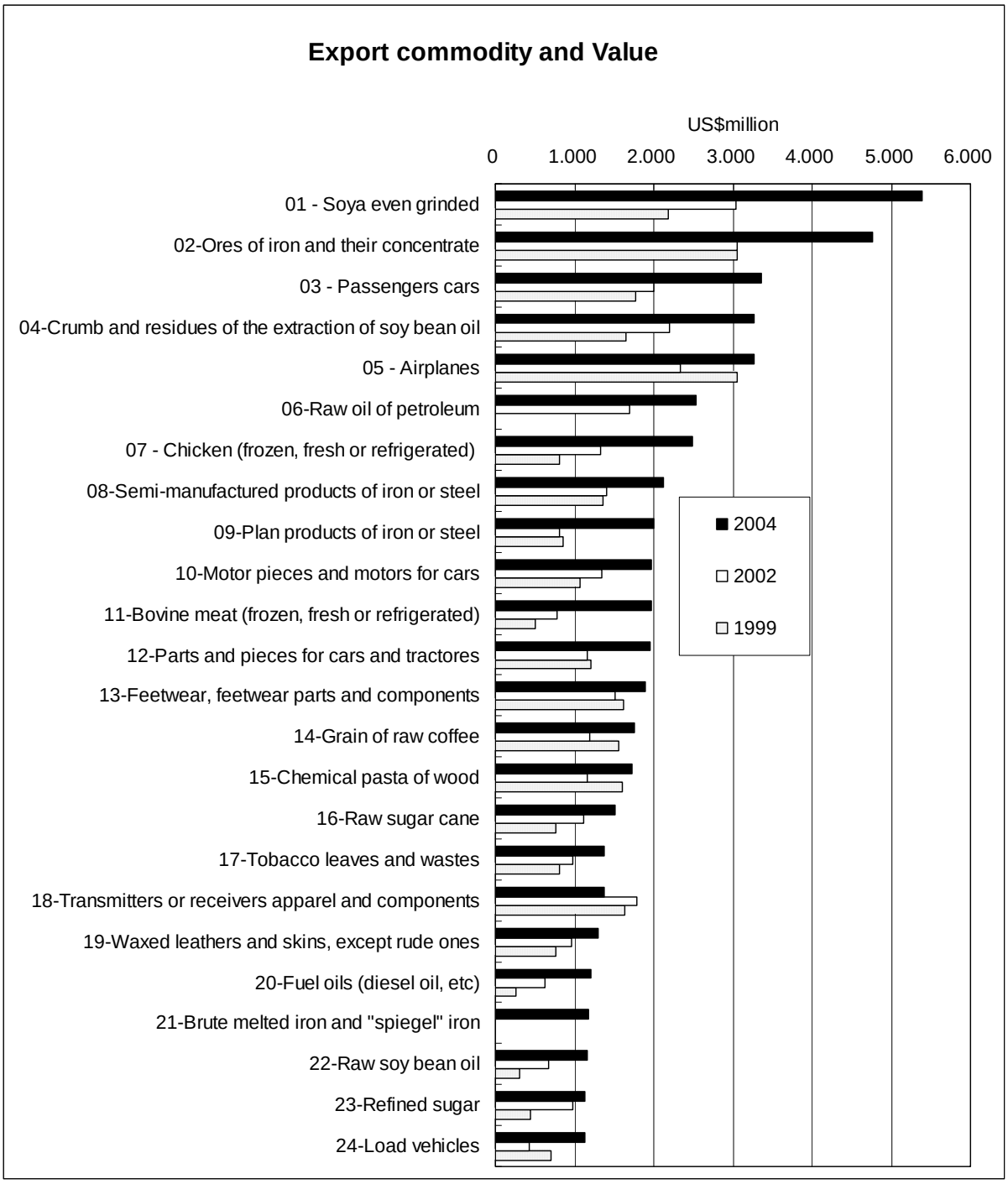
Source: Drawn by the JICA Study Team from the statistics of Ministry of Trade and Industry Web Site

Figure 2.1.7 Production of Gasoline and Diesel oil

(3) Export and Import

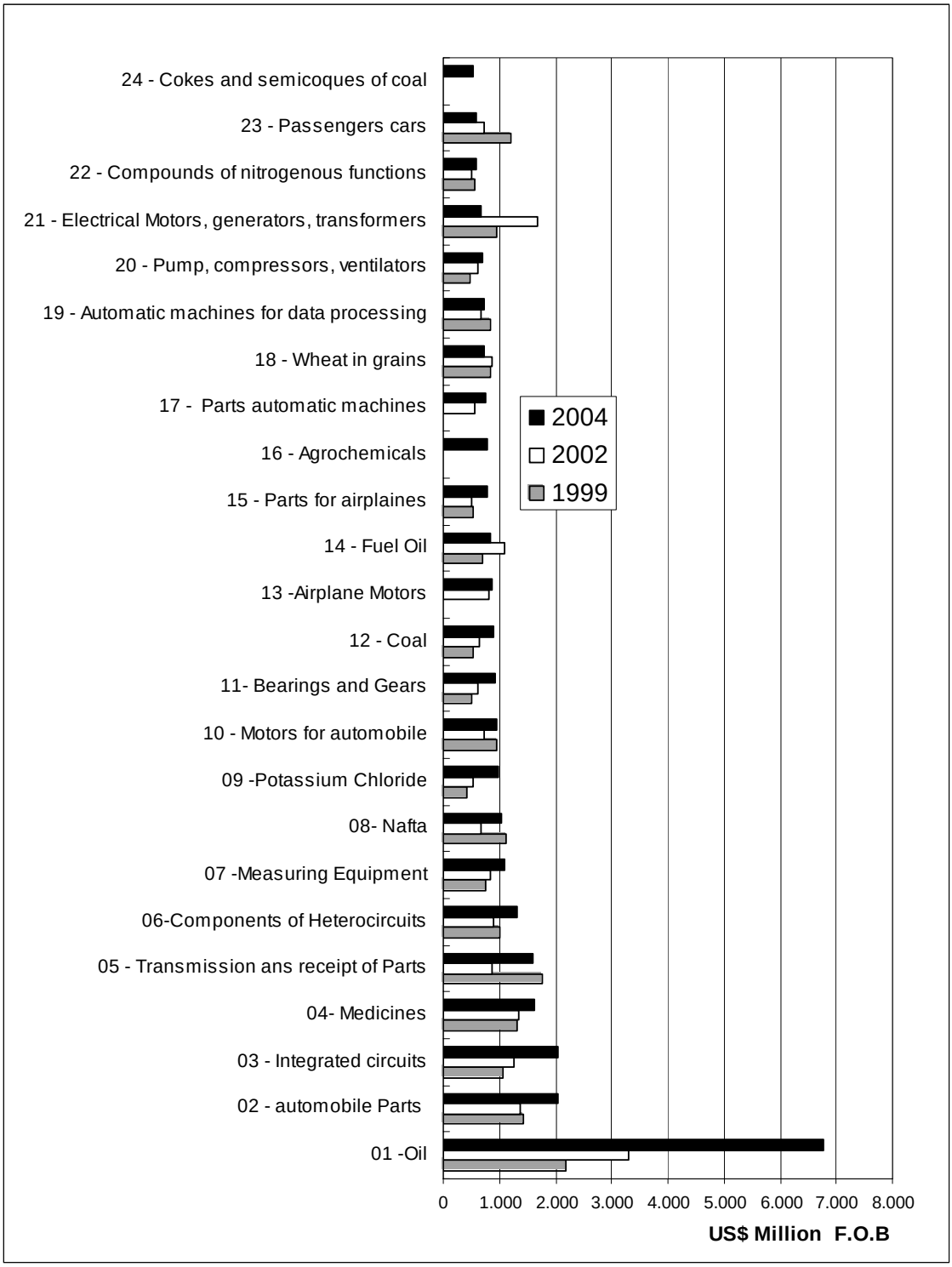
Figure 2. 1 .8 shows the top 24 export products in terms of value in US$ F.O.B. Iron ores and its concentrates have been the top commodity until export volume of Soybean exceeded the former in 2003. It is also observed that except apparel and components, all the commodities have increased the export values over the past five years.

Figure 2.1.9 shows the values of import commodities in 1999, 2002 and 2004. It is observed that, many of these commodities are oil and petroleum products, vehicle parts, electronic instruments, and many of them are increasing. It should be noted that the import of agro-chemical entered in the top 24 commodities, which coincides with the increase in agricultural production. .



Source: Drawn by JICA Study Team on the basis of the statistics of MTI

Figure 2.1.8 Major export commodities of Brazil



Source: Drawn by JICA Study Team on the basis of the statistics of MTI

Figure 2.1.9 Import Commodities and Values in Brazil

2.1.3 Infrastructure in Brazil (Existing and Planned)

(1) Energy – Electricity / Oil & Gas

Brazil's domestic power supply amounted to 261 million tons of petroleum equivalent in 2000.Of this approximately 57% consist of clean renewable energy, of which 39% is hydro-electricity and 18% biomass.

At the time of oil crisis in 1979, Brazil was dependent of foreign supplies for 85% of its oil needs. In 2000, its dependence accounted for 30%, and in the near future, Brazil is expected to cover its oil needs with domestic production.

In 2000, the government program to stimulate the share of natural gas in the energy market, and especially its use as fuel in thermoelectric power stations. It also provided incentives for the use of non-conventional and decentralized energy sources such as solar and wind power, forestry and agricultural waste, vegetable oils, and small-scale hydroelectric plants. Co-generation of electrical and thermal energy was also pursued.

In December 2000, installed electric-power generation capacity reached 72.4GW, not including the 6.3GW from the Paraguayan portion of the production of Itaipu, which is almost totally consumed by the Brazilian market. As a consequence of increased generating capacity and growth of the consumer market, the 324TWH of domestically-generated electric power for public use (93% of which is from hydroelectric plants), plus the 42.4TWH imported from Paraguay and Argentina, and the 24.6TWH of power generated by self-producers, a total of 331 TWH was available for consumption, a 5.2% increase over 1999.

Although 95% of Brazilian homes are connected to an electricity supply, the transmission network does not cover a significant portion of Brazil's territory. The greatest electricity supply problems occur in the North region, where remote communities are served by inefficient isolated diesel-powered thermoelectric systems. This signifies the opportunities for private investors in small and medium scale generating facilities.

Privatization of power sector is proceeding from 1995, and R$33 billion was so far brought to the government. Brazilian oil and gas industry, after decades as a Federal monopoly exercised by Petrobras, entered a new phase when Constitutional Amendment 9, approved in 1995, abolished the state's exclusive monopoly on basic activities in the oil industry and Law 9.478/97 ordained the opening up of all of the phases of the production process to direct participation by the private sector.

(2) Water Resources

Brazil is endowed with plenty of water resources, except for Nordeste region, where most part belong to tropical and semi-arid climate zones with 6-8 dry months. Nevertheless, with ambitious water management program of Castanhao dam and Integrated Canal system, plus the project of inter-connection with Sao Francisco river system for water exchange in case of draught, Ceara is not any more a state short of water resources. With $22m^3$/sec water supply, Ceara can supply industrial and most of irrigation water from the system after 2006.

2.2 Socioeconomic Conditions of the State of Ceará

2.2.1 Ceara State Government

Ceara State is located in the north-eastern region of Brazil and its area is 146.8 thousand sq.km. Except for the area near the border- lines surrounding the state, the soil is very hard and repels water, making approximately 90% of the land unfit for agriculture. Its population is 8,114,000 (2005), with 29% or 2,383,000 people concentrating in the state capital of Fortaleza. Its GDP in 2002 was R$ 24,204 million, ranking third among Nordeste states, but its per-capita GDP ranked sixth at 3,158 Re/person. About 10% of the population enjoys about 52% of the state income while about 50% enjoys only about 12.5%

Thus, the major difficulties faced currently by Ceara State are: a) the large gap between the wealthy and the poor, b) its poverty due to difficulties in carrying out agricultural activities, and c) excessive concentration of population and wealth in Fortaleza, the state capital.

The budget for 2004 of the Ceara State Government is about $R7,048 million, and its executive staff accounts for about 131 thousand (including the police and the fire fighters). Figure 2.2.1 shows the government organization.

Organization chart and number of employees by secretariat of Ceara State Government will be explained in the Interim Report.

2.2.2 Socio-economic indicators

(1) Purpose of the Study

In this report, socio-economic frameworks such as population and gross domestic product (GDP) are applied to the cargo volume for import in 2012 and 2022, which are the target years of the Short Term Plan and the Master Plan in this project.

(2) Present Conditions

The population of Brazil reached approximately 169,800,000 in 2000 according to the 2000 Census. The annual growth rate of population is 2.05 % from 1980 to 1991 and 2.74 % from 1991 to 2000 respectively.

In Ceara State and Northeast Region, the population in 2000 is approximately 7,431,000 and 47,742,000 respectively. The growth rate from 1980 to 1991 and from 1991 to 2000 is 1.70 % and 1.73 % for the state and 1.8 % and 1.1 % for the region.
Table 2.2.1 shows the populations of Brazil, Northeast Region and Ceara State in 1980, 1991 and 2000, which are the census years.

Figure 2.2.1 Government Organization Chart

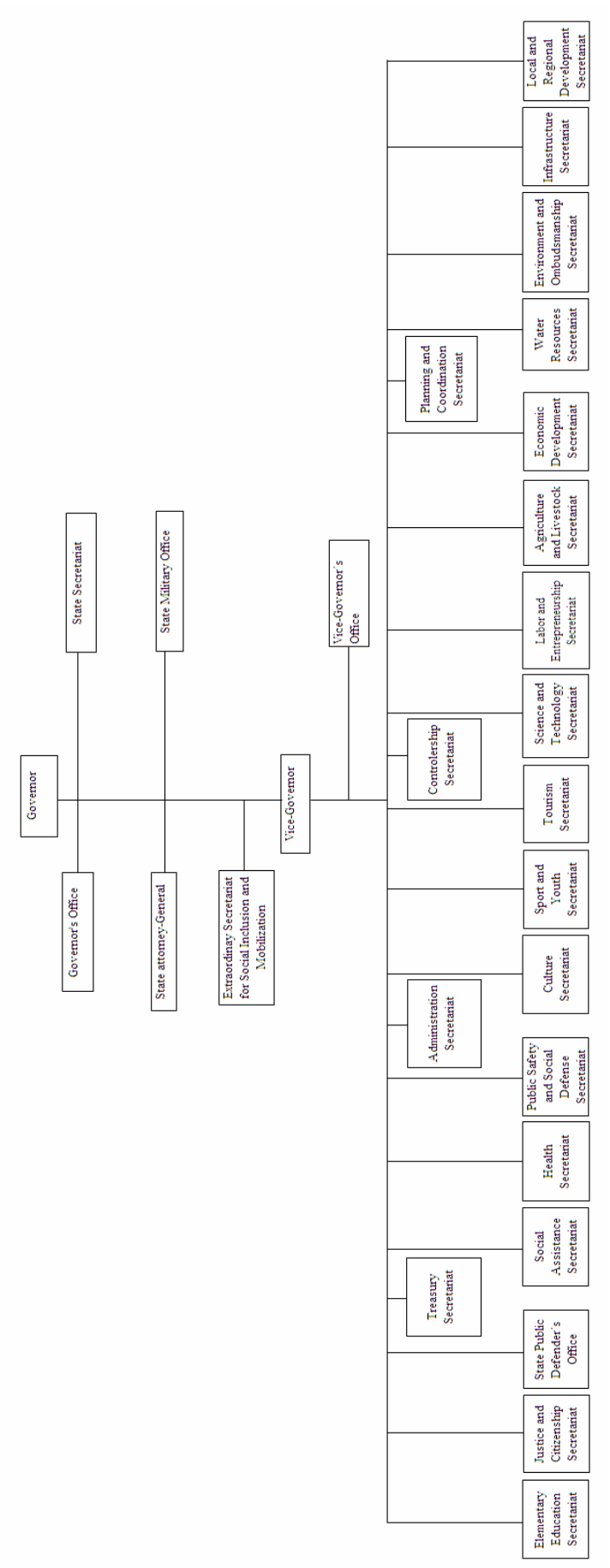


Table 2.2.1 Population in Northeast Region in 1980, 1991 and 2000

	1980	1991	2000
Maramhao	3,996	4,930	5,651
Piaui	2,139	2,582	2,843
Ceara	5,288	6,367	7,431
Rio grand do norte	1,899	2,416	2,777
Paraiba	2,770	3,201	3,444
Pemambuco	6,142	7,128	7,918
Alagoas	1,983	2,514	2,823
Sergipe	1,140	1,492	1,784
Bahia	9,455	11,868	13,070
Total in Nordeste	34,814	42,498	47,742
Total Brazil	119,011	146,825	169,799

Source: IBGE

GDP in Brazil exceeded 1,769,201.8 million Reais at the 2004 constant price. GDP and Per capita GDP growth rates in Brazil from 2003 to 2004 are approximately 5.2 % per and 3.7% per annum respectively. Table 2.2.2 shows Brazil's GDP and per-capita GDP from 1994 to 2003.

Table 2.2.2 GDP and Per Capita GDP in Brazil from 1994 to 2004

Year	GDP Current Price	GDP at 2004 Constant Price	Per-capita GDP Current Price	Per-capita GDP at 2004 Constant Price
Unit	Million Re	Million Re	Re	Re
1994	349,205	1,392,139	2,232	8,899
1995	646,192	1,450,940	4,067	9,133
1996	778,887	1,489,515	4,828	9,233
1997	870,743	1,538,242	5,317	9,392
1998	914,188	1,540,272	5,499	9,265
1999	973,846	1,552,370	5,771	9,199
2000	1,101,255	1,620,064	6,430	9,459
2001	1,198,736	1,641,328	6,896	9,443
2002	1,346,028	1,672,954	7,631	9,484
2003	1,556,182	1,682,071	8,694	9,398
2004	1,769,202	1,769,202	9,743	9,743

Source: IBGE

According to the statistics of IPECE (Ceara Research Institute), GDP in Ceara State reached 27,791 million Reais. The average growth rate of GDP from 1999 to 2004 is approximately 1.1 % per annum. Per capita GDP in Ceara State in 2004 is approximately 3,516 Reals per person.
Table 2.2.3 shows GDP from 1996 to 2004 in Ceara.

As Northeast Region, GDP and per capita GDP in 2002 are approximately 181,933 million Reals and 3,721 Reais per person. The annual growth rates of GDP and per-capita GDP from 1997 to 2002 in Northeast Region are 2.0 % and 0.8% respectively. Table 2.2.4 shows GDP with its added value and per-capita GDP from 1997 to 2002 in Northeast Region.

Table 2.2.3 GDP in Ceara State from 1996 to 2004

Year	Unit	GDP at Current Market Price	GDP at 2004 Constant Market Price
1996	R$ Milhão	15,641	**23,359**
1997	R$ Milhão	17,589	**24,204**
1998	R$ Milhão	18,836	**24,721**
1999	R$ Milhão	19,511	**25,138**
2000	R$ Milhão	20,800	**26,146**
2001	R$ Milhão	21,581	**25,858**
2002	R$ Milhão	24,204	**26,566**
2003	R$ Milhão	25,620	**26,619**
2004	R$ Milhão	27,791	**27,791**

Source: IPECE

Table 2.2.4 GDP and Per Capita GDP in Northeast Region at 2002 Constant Market Price from 1997 to 2002

(R$ million)

	1997	1998	1999	2000	2001	2002
Agricultural	17,232	14,937	14,930	16,657	16,312	19,081
mineral Industry	2,389	1,900	3,163	3,856	5,483	5,598
Heavy and processing industry	27,040	27,771	31,723	34,139	35,398	37,483
Electricity, gas and water	4,664	4,874	5,042	4,849	6,476	7,343
Civil Construction	21,852	22,741	20,691	20,131	18,397	16,769
trade	14,467	13,642	14,065	15,034	15,215	14,247
Business Servics	41,769	42,883	42,183	40,608	40,414	40,500
Public administrations	31,031	32,616	33,298	37,001	36,171	36,858
Others	4,014	4,053	4,047	4,077	4,085	4,053
Total (GDP)	164,459	165,417	169,142	176,304	177,950	181,933
Per-Capita GDP (Unit:Re)	3,581	3,556	3,589	3,693	3,683	3,721

Source: IPECE

(3) Future Population

Censuses are conducted usually once every 10 years in Brazil, the recent censuses having been conducted in 1980, 1991 and 2000.

The Instituto Brasileiro de Geografia (IBGE) estimated the future population of Brazil up to 2050, but they have not revised the estimates based on the census results.

Population is generally estimated based on the birth and the death rates. Since it is necessary to estimate the population for the target years in a short period of time for this report, we made simple revisions to the data for Ceara State and nine states in the northeastern area (Nordeste) of Brazil in order to make IBGE estimates since 1980 to concur with the census results by using the ratio between IBGE estimates and the census results.

The estimate method used was as follows;

- The ratio between IBGE estimate and the census result was used as the adjustment coefficient, which was obtained for the years the census was conducted. (Assuming that the census result for 1991 for Ceara State was

6,367,000 and that for IBGE was 6,454,000, the adjustment coefficient for 1991 is 6,367/6,454 = 0.98.)

- It is assumed that the adjustment coefficient varies as the linear function between two census years (eg. Between 1991 and 2000), and the coefficients for each year during the period are estimated.
- Populations estimated for years between 1981 and 1999 excluding the census years are obtained by multiplying IBGE estimates by adjustment coefficient. The census results for census years are used as the actual population.
- As for population estimates after 2000, the census result for 2000 is calculated by the population growth rate obtained from IBGE estimate.

We used the data obtained by revising IBGE estimates for the states for the years between 2004 and 2020. The estimates from 2020 to 2022 were obtained in time series using the population growth rate, which was obtained from IBGE estimates for years between 2010 and 2020.

Table 2.2.5 shows the population estimates in the project target years for Northeast Region consisting of nine states.

Table 2.2.5 Estimated Population of Northeast Region in 2010,2012 and 2022

(Unit: thousand people)

	2010	2012	2022
Maramhao	6,447	6,597	7,261
Piaui	3,132	3,186	3,428
Ceara	8,604	8,823	9,805
Rio grand do norte	3,175	3,250	3,584
Paraiba	3,713	3,763	3,988
Pemambuco	8,792	8,956	9,688
Alagoas	3,164	3,227	3,513
Sergipe	2,107	2,167	2,436
Bahia	14,395	14,643	15,753
Total in Nordeste	53,528	54,613	59,455

Source: JICA Study Team

(4) Gross Domestic Products in the Target Years

1）Introduction

It is quite hard to make any forecast of the gross domestic products (GDP) in Nordeste Region, Brazil. As for Ceara State, no estimates made by the Federal Government of Brazil are available except for those made by the Instituto de Pesquisa e Estrategia Economica do Ceara (IPECE) for the years up to 2009.

Destinations for most of the import cargoes arriving at Pecem Port are assumed to be in Northeast Region, most of which are assumedly in Ceara State.

In cargo estimations, GDP is used mainly to estimate the import cargo volumes (particularly sundries). In this study, GDP of Ceara State as well as those of the nine states in Northeast Region are estimated.

2) Method of Estimation

GDP is estimated in many cases by using aggregate consumption, aggregate investments and total import/export earnings. It requires, however, an enormous amount of information and time to estimate their future figures. As the purpose of GDP estimation in this study is to use GDP as an indicator for estimating the cargo volumes in Pecem Port in the project target years, not to obtain GDP per se, it is necessary to estimate the approximate GDP for the target years in a short period of time.

In this study, GDP is approximated by basically multiplying the value added generated by a worker (per capita activity for value added) with the number of workers for each economic activity sector comprising GDP.
As for Ceara State, we need to take into consideration effects of a large scale project on GDP which is scheduled for implementation in the State by 2022, the project target year.

3) Estimation procedure

Estimation is implemented for each of the nine states in the Northeast Region by using the following procedure.

a) Productivity of value added per worker for each economic activity sector comprising GDP is sought for the period from 1991 (1996 for Ceara State) to 2004. The ratio of the number of workers for each sector to the total population of the state is assumed to remain unchanged.

By assuming that the ratio of workers to the total population remains constant, the total number of workers for the project target years is obtained, and then the number of workers in each sector in the target years is estimated.

In this estimate, 11 sectors of agriculture, mineral industry, transformation industry, electricity, gas and water, civil construction, trade, hotels and restaurants, transport, storage and communication, public administration, health and education and others are subjected to analyses. The sector “others” is distributed to other sectors at the time of estimation so that 10 sectors are analyzed.

b) The per capita productivity for value added in the project target years are estimated for each sector based mainly on the past trends.

c) The per capita productivity estimated in b) is multiplied by the number of workers of each sector in the target years estimated in a) in order to obtain the added values comprising GDP for target years. The values thus obtained are used as “basic values” for estimating GDP for the target years.

d) The values added for each sector estimated in c) are totaled and used as the proposed GDP in target years. GDP for target years in each state is estimated by comprehensively considering the past trend of GDP, the recent trend in the industry, the resource status, and the improvement plans for infrastructures including railway.

As for Ceara State, contributions to be made to GDP by the large scale industrial project to be implemented (including iron manufacturing and construction of oil

refinery) by 2022, the target year for the master plan, are estimated and reflected in GDP estimate.

In Brazil, there are formal workers who are registered with the administration and informal workers who are not. Currently, the ratio of formal workers to informal workers is 1:1. Statistics for informal workers is not adequate for estimating the added values comprising GDP because its job classification is crude compared to that of formal workers. In estimating GDP, this study presumes that the ratio of formal workers and the informal workers will not change much in the future. In practice, however, the worker registration is carried out in accordance with the official policy of the Brazilian Government, and the ratio of formal workers is expected to grow annually. Accordingly, the present study will estimate GDP for three cases, viz. the high case, the base case and the low case. For the high and the base cases, the values used will not be lower than the minimum past per capita productivity for value added.

4) Types of Forecast

GDP will be forecast for the base case, the high case and the low case.

Base Case: The average trend in the past will be focused. As for the sector currently with a decreasing tendency, the added value will not be lower than the minimum values in the past.

As for Ceara State, it is assumed that the big scale construction project for completion by 2022 will be implemented.

High Case: The highest growth rate excepting those rates, which appear abnormally high compared to the growth rates before and after that rate, is chosen from the existing per capita productivity for added value for each sector and used to estimate the per capita productivity for added value in the target years of this project.

As for Ceara State, it is assumed that the big scale construction project for completion by 2022 will be implemented.

Low Case: The lowest growth rate excepting those rates, which appear abnormally low compared to the growth rates before and after that rate, is chosen from the existing per capita productivity for added value for each sector and used to estimate the per capita productivity for added value in the target years of this project. Provided, however, per capita productivity for added value will be estimated at the mean growth rate of zero, if the per capita productivity for added value becomes minus.
The large scale construction project in Ceara State will not be implemented.

5) Results of Forecast

Tables 2.2.6, 2.2.7 and 2.2.8 show the high, the base and the low cases forecasted for Ceara State using the procedure shown in 3) above.

Tables 2.2.9, 2.2.10 and 2.2.11 show the high, the base and the low cases forecasted for Northeast Region.

Table 2.2.6 Estimated GDP in Ceara State at 2002 Constant Market Price in 2009, 2010, 2012, 2018, 2020 and 2022 for High Case

(Unit: million Re)

	2004	2009	2010	2012	2018	2020	2022
Agricultural	**1,405**	**2,213**	**2,412**	**2,832**	**4,327**	**4,922**	**5,518**
Industry	**9,565**	**15,678**	**16,815**	**19,450**	**32,901**	**39,988**	**48,731**
mineral Industry	315	754	825	976	1,513	1,774	1,989
transformation Industry	5,134	7,532	7,942	8,819	12,781	14,200	15,572
Electricity, gas and water	1,090	2,748	3,260	4,580	12,602	17,661	24,513
Civil Construction	3,027	4,644	4,787	5,076	6,006	6,353	6,656
Services	**13,246**	**21,053**	**22,766**	**26,422**	**36,830**	**41,058**	**45,298**
trade	2,131	2,863	3,046	3,440	4,917	5,540	6,182
Hotel and restrant	605	1,344	1,386	1,469	1,739	1,839	1,927
Transport and storage	387	1,762	1,901	2,207	3,428	3,971	4,556
Communication	702						
Intermediation finance	1,501	2,159	2,309	2,632	3,874	4,407	4,965
Real estate activities	1,889	4,128	4,673	5,839	10,051	11,739	13,459
Public administrations	4,964	7,793	8,418	9,739	11,524	12,190	12,771
Private medical and educational facilities	630	1,003	1,034	1,096	1,297	1,372	1,437
Others	436	-	-	-	-	-	-
GDP in Ceara	**24,216**	**38,944**	**41,992**	**48,703**	**74,058**	**85,968**	**99,547**
Per Capita GDP (Unit: Re)	**3,064**	**4,587**	**4,881**	**5,661**	**7,850**	**8,932**	**10,155**

(Source: JICA Study Team)

Table 2.2.7 Estimated GDP in Ceara State at 2002 Constant Market Price in 2009, 2010, 2012, 2018, 2020 and 2022 for Base Case

(Unit: million Re)

	2004	2009	2010	2012	2018	2020	2022
Agricultural	**1,405**	**1,732**	**1,859**	**2,126**	**3,065**	**3,436**	**3,803**
Industry	**9,565**	**13,397**	**13,873**	**14,844**	**18,789**	**20,136**	**21,257**
mineral Industry	315	529	545	578	684	772	806
transformation Industry	5,134	6,864	7,138	7,704	10,340	11,150	11,845
Electricity, gas and water	1,090	1,360	1,402	1,487	1,759	1,861	1,949
Civil Construction	3,027	4,644	4,787	5,076	6,006	6,353	6,656
Services	**13,246**	**15,666**	**16,277**	**17,525**	**21,690**	**23,279**	**24,741**
trade	2,131	2,636	2,718	2,881	3,409	3,606	3,778
Hotel and restrant	605	974	1,004	1,065	1,260	1,333	1,396
Transport and storage	387	1,404	1,571	1,926	3,204	3,715	4,234
Communication	702						
Intermediation finance	1,501	1,870	1,931	2,055	2,458	2,610	2,745
Real estate activities	1,889	2,105	2,170	2,300	2,722	2,879	3,017
Public administrations	4,964	5,936	6,119	6,487	7,677	8,120	8,508
Private medical and educational facilities	630	742	765	811	959	1,015	1,063
Others	436	-	-	-	-	-	-
GDP in Ceara	**24,216**	**30,795**	**32,009**	**34,495**	**43,544**	**46,851**	**49,801**
Per Capita GDP (Unit: Re)	**3,064**	**3,627**	**3,720**	**4,009**	**4,615**	**4,868**	**5,080**

(Source: JICA Study Team)

Table 2.2.8 Estimated GDP in Ceara State at 2002 Constant Market Price in 2009, 2010, 2012, 2018, 2020 and 2022 for Low Case

(Unit: million Re)

	2004	2009	2010	2012	2018	2020	2022
Agricultural	**1,405**	**1,340**	**1,332**	**1,305**	**1,166**	**1,100**	**1,012**
Industry	**9,565**	**10,010**	**10,320**	**10,941**	**12,947**	**13,743**	**14,397**
mineral Industry	315	339	350	371	439	512	535
transformation Industry	5,134	5,003	5,157	5,468	6,470	6,844	7,171
Electricity, gas and water	1,090	862	889	942	1,115	1,180	1,236
Civil Construction	3,027	3,806	3,924	4,160	4,923	5,207	5,456
Services	**13,246**	**12,988**	**13,073**	**13,189**	**13,224**	**13,149**	**12,896**
trade	2,131	2,189	2,214	2,258	2,356	2,380	2,377
Hotel and restrant	605	703	725	768	909	962	1,008
Transport and storage	387	1,404	1,448	1,535	1,816	1,921	2,013
Communication	702						
Intermediation finance	1,501	1,246	1,284	1,362	1,611	1,705	1,786
Real estate activities	1,889	2,105	2,170	2,300	2,722	2,879	3,017
Public administrations	4,964	4,599	4,467	4,154	2,850	2,287	1,633
Private medical and educational facilities	630	742	765	811	959	1,015	1,063
Others	436	-	-	-	-	-	-
GDP in Ceara	**24,216**	**24,339**	**24,724**	**25,435**	**27,337**	**27,992**	**28,305**
Per Capita GDP (Unit: Re)	**3,064**	**2,867**	**2,874**	**2,956**	**2,897**	**2,908**	**2,887**

(Source: JICA Study Team)

Table 2.2.9 Estimated GDP in Northeast at 2002 Constant Market Price in 2009, 2010, 2012, 2018, 2020 and 2022 for High Case

(Unit: million Re)

	2002	2009	2010	2012	2020	2022
Agropecuária	19,081	21,594	22,218	23,504	29,200	30,783
Extrativa Mineral	5,598	10,868	11,956	14,513	33,248	41,528
Industria de Transformação	37,483	45,325	47,513	52,177	75,282	82,364
Serviços Industriais de Utilidade Públic	7,343	9,732	10,289	11,471	17,266	19,033
Construção Civil	16,769	18,803	19,009	19,412	20,915	21,263
Comércio	14,247	16,082	16,267	16,630	17,995	18,314
Serviços	40,500	43,987	44,744	46,275	52,683	54,373
Administração Pública	36,858	37,925	38,846	40,792	50,445	53,478
Outros	4,053	-	-	-	-	-
GDP	181,933	243,259	252,834	273,477	383,002	420,682
Per Capita GDP (Real/person)	3,721	4,592	4,723	5,008	6,540	7,076

(Source: JICA Study Team)

Table 2.2.10 Estimated GDP in Northeast at 2002 Constant Market Price in 2009, 2010, 2012, 2018, 2020 and 2022 for Base Case

(Unit: million Re)

	2002	2009	2010	2012	2020	2022
Agricultural	19,081	19,828	20,279	21,185	24,856	25,780
mineral Industry	5,598	8,670	9,128	10,062	12,680	13,348
Heavy and processing industry	37,483	43,636	45,213	48,417	61,886	65,400
Electricity, gas and water	7,343	8,067	8,349	8,913	11,159	11,707
Civil Construction	16,769	12,759	12,652	12,417	12,658	12,688
trade	14,247	12,777	12,925	13,213	14,299	14,553
Business Servics	40,500	37,630	38,119	39,081	42,753	43,624
Public administrations	36,858	32,315	32,604	33,152	34,931	35,270
Others	4,053	-	-	-	-	-
GDP	181,933	206,479	211,276	220,934	262,073	272,172
Per Capita GDP (Real/person)	3,721	3,898	3,947	4,045	4,475	4,578

(Source: JICA Study Team)

Table 2.2.11 Estimated GDP in Northeast at 2002 Constant Market Price in 2009, 2010, 2012, 2018, 2020 and 2022 for Low Case

(Unit: million Re)

	2002	2009	2010	2012	2020	2022
Agriculture	19,081	15,151	15,436	15,314	14,570	14,321
Mineral	5,598	5,549	5,671	5,914	6,895	7,139
Transformation Industry	37,483	42,092	43,524	46,420	58,371	61,433
Electricity, Gas and Water	7,343	6,663	6,763	6,960	7,720	7,901
Civil Constraction	16,769	12,285	12,118	11,756	11,389	11,243
Trade	14,247	12,777	12,925	13,213	14,299	14,553
Service	39,773	36,724	37,195	38,125	41,671	42,512
Public Administration	36,858	32,068	32,345	32,868	34,546	34,859
Others	3,932	-	-	-	-	-
GDP	181,933	187,648	190,700	196,007	217,453	222,267
Per Capita GDP (Real/person)	3,721	3,543	3,563	3,589	3,713	3,738

(Source: JICA Study Team)

According to Tables 2.2.7 through 2.2.11, the growth rates of estimated GDP in Ceara State and Northeast from 2002 to 2012, from 20012 to 2022 for Base case are as follows:

- Growth rate of GDP in Ceara State for Base Case

  From 2002 to 2012 : 5.7%
  From 2012 to 2022 : 3.7%

- Growth rate of GDP in Northeast for Base Case

  From 2002 to 2012 : 1.5%

  From 2012 to 2022 : 2.1%

Figure 2.2.2 shows estimated GDP at 2002 constant market price in Ceara State for High Case, Base Case and Low Case.

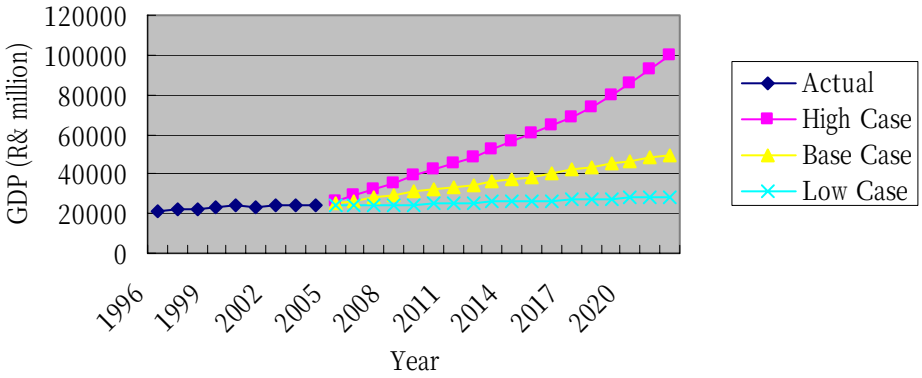


Figure 2.2.2 GDP Estimate of Ceara (2002 constant price)

2.3 Regional and Social Development Plan and Policy of Ceara State Government

2.3.1 General Directive

In 2003, the State Government firstly drafted “CEARA CITIZENSHIP-Growth with Social Inclusion”, under the policy of the Federal Government. The State Government Plan “PLAN PRURIANUAL-PPA 2004-2007, State of Ceara” was finalized after the open discussion held at municipal level at 20 locations in the state.

In the PPA 2004-2007, the state government estimate the economic growth up to 2007.

Table 2.3.1 presents GDP growth rate of Ceará, for the three idealized sceneries (A, B and C). It is worth to remind that, in the beginning of 2003, they were accomplished by IPECE growth projections for the state economy, to base the State Government Plan.

Table 2.3.1 Ceará Macroeconomic Sceneries Projected for the Period from 2004 to 2007 GDP growth rate in %

Years	Scenery A	Scenery B	Scenery C
2004	2,39	3,65	4,70
2005	2,37	3,62	4,66
2006	2,35	3,59	4,62
2007	2,34	3,56	4,58
Annual Geometric Rate	2,36	3,61	4,64

Source: SEPLAN-CPLOR. Regional Econometric of Input-Product Model

To elaborate PPA, the annual geometric average of growth of GDP of Ceará of the scenery "B", (3,61%) was chosen considering the trend of the local, national and international economical sceneries.

On the basis of the analyses of the existing socioeconomic situation, the “Ceara CITIZENSHIP”, the draft of the State over the period from 2004 through 2007, placed the following themes as the foundation of the plan:

Participation - understanding the involvement of the society in the elaboration of plans and programs and in the mediation of the social control;.

Cooperation and partnership - base of the government's of the state action for the work inter-institutional, regional integration and induction to the development;

Transparency- contribution factor for the trust of those governed and for the effectiveness of the government action; .

Rationality - imposition of limits to the use of the public resources,

Integration with decentralization - the integration involves the environmental, economical, social, political dimensions and of infrastructure, overcoming the sectoral perspective and creating synergies. The decentralization implicates to approximate the decisions and the government actions of the generating facts, guaranteeing larger resolubility to the public services.

Justice and social inclusion - the first involves unalterable beginnings of justice that induce moderation criteria and of justness; the second is based on a strategy of adoption of redistributive politics supported by the education.

Sustainability - seeking for the obtaining of permanent results in the development process, involving the environmental, economical, politics and social dimensions.

Cearensidade (Cearense-ship) - it treats of the feeling of belonging to the community of Ceará, understanding the preservation of the historical and cultural lines and of the values that give identity to the people from Ceará.

On the basis of these foundations, the state government posted four axis to pursuit:

Axis-1 CEARA ENTERPRISING

This axis indicates the policy for economic development and aims to enlarge the opportunities of labor and income and focusing the competitiveness and territory.

Axis -2 CEARA BETTER LIFE

This axis indicates the policy for social development and aims to advance in the improvement of quality of life of the people.

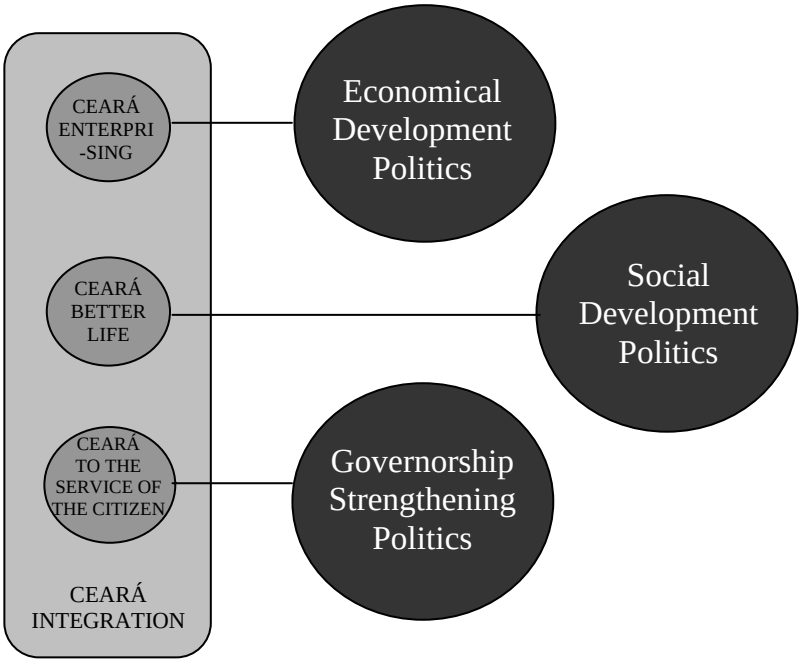
Axis -3 CEARA INTEGRATION.

This is the policy to integrate the local and regional development. It is also intended to integrate the municipalities within the State to reduce the local disparities.

Axis - 4 CEARA STATE TO THE SERVICE OF THE CITIZEN

This axis indicates the policy for strengthen the Administrative capacity of the State and Municipal governments

Axis - 1, 2 and **4** are the driving axis, while **Axis-3** provide the policy in integrating and coordinating the other three axis (see Figure 2.3. 1).



Source: Ceara in numbers 2004, SEPLAN, Ceara State

Figure 2.3.1 Structure of the four Axes

For each axis, specific objectives among these four Axes, the Axis -1 includes the following strategic objectives, which are closely interrelated with the development of Pecem Port. The strategies presented to drive this axis are identified as follows:

Strategic Objective 1 -to Stimulate export Industries.

Strategic Objective 2 - Ceará as preferential destiny for the tourism.

Strategic Objective 3 - to Promote the Development of the Rural Areas

Strategic Objective 4 - to promote Industry and public consumption commerce

Strategic Objective 5 - to Stimulate the Capacity of Innovation of the Companies

Strategic Objective 6 - to Strengthen the Infrastructure

Strategic Objective 7 - to Lead the Development of the Mineral extraction Activity into Competitive Bases

Specific actions to achieve these objectives are also indicated in the PPA.

2.3.2 Major Programs

Strategic Objective 1 is the key element to the plan and it also is the base of the development of PICC and Pecem port. Thus, the proposed actions under the strategic objectives are as follows:

“The first strategic objective will be to stimulate the industrial exporter, reorienting the politics to attract medium and large scale companies to focus on exportation, with priority to industrial units that can complement the links of the existent productive chain.

The products that the State exports in these sectors have overcome some of the difficulties in finding external markets. Besides, the expansion in exports also lead to the increase of income.

Since the important factor is to generate income and job, the external trade is the essential element as the strategy for the development of Ceará. With the politics of attraction of industrial investments, Ceará should attain the image of industrialized State that has the major industrial poles such as the second textile pole and the third footwear pole of the country and the first pole of metal production/ mechanic of the North and Northeast. With the activities of the exporters that were established between 1999 and 2001, they created thousands of new productive occupations. In addition, they brought direct and indirect benefits to commercial activities, of services and of the science and of the technology. These positive impacts also reached in some pole-municipalities in the countryside of the State. the industrial activities linked to the exports.

The first sub objective is to elevate the competitiveness industries to promote the reduction of costs of products is the investment in technology for the export industries, in order to increase their competitiveness in international market. To achieve this goal, the Government will try to carry out the following;

Lines of Action:

- improvement of the productivity and the quality of the productions units
- modernization of the already existing productive chains
- support to initiatives to increase value-added of industrial products, with the aim to continuously increase growth rates and diversify the range of exportable products from Ceara.
- -creation of an information network system, allowing the entrepreneurs from the exportation sectors to extend their knowledge over international markets for Products from Ceara.
- identification of other market and opportunities for new products
- promotion of products from Ceara throughout the country and the world
- -identification of economically emerging areas in Ceara, industrial sectors able to become competitive as well as export potentialities.
- -incentive to the use of modern inputs, making possible a wide network of information on raw materials, materials and inputs, detaching their characteristics, advantages and alternative or main suppliers;
- -incentive to the accomplishment of investments in the modernization of equipments, once they are the main source of absorption of new technologies and modernization for the industries of Ceara
- Following this policy, the priority of support will keep on being given to the textile, leather and shoes, food, furniture, metal-mechanic and agrobusiness industries. The latter will be based on strengthened agro-poles> Such a strategy will be adopted according to the potentiality of

employment and income generation each type of industry can bring to the State.

- The second objective will be to promote industrial decentralization, the main focus being the creation and consolidation of industrial poles in country cities.

The Lines of Action to achieve this objective will be:

- continuity of the consolidation process of the Industrial and Port Complex of Pecém-CIPP. Political efforts should be made in the promotion of the attraction of investments such as oil refinery; steel industry; eolian energy production park (Wind power generation); LNG re-gasification plants; implantation of the companies of technological base and reorientation and implementation of the Program of Attraction of Industries of Medium and Large Scale;

- investment in the Industrial and Port Complex of Pecém, for the conclusion of the necessary infrastructure should be developed to make it viable, including: works of the port and port back-up area; accesses, facilities and equipments needed for the inter-modal transport; Electric power net through Line of Transmission between President Dutra and Fortaleza; duplication of the gas pipeline along the route Guamaré-Fortaleza-Pecém; water supply network and sewage;

- diversification of the energy sources, with emphasis on the energy eolian, and implantation of the international cargo warehouse that is a part of the logistics platform of the international airport of Fortaleza, creating larger competitiveness of the products in the world markets.

- enlargement and improvement of the infrastructure, associated to the industrial poles, and promotion of the interface of these with other sections, with views to turn them attractive and competitive;

- incentive to the formation of Associations and Business and Municipal Consortia, so that they will turn to be active partners in the decentralization process, in order to make countryside of Ceara most attractive for the accomplishment of new investments;

- implementation of search for institutional mechanisms: the incentive and the promotion of the inter-sector cooperation and the formation of industrial networks; the connection with the municipal districts for the decentralization of the industry; the implementation of assistance of industrial technique and training in the main areas of the State and the establishment of partnerships for the strengthening and the diversification of the current industrial productive structure.

Those Lines of Action will be implemented by the following programs:

- Program of Attraction of the Industry of Medium and Large Size – This program seeks to attract new industrial enterprises of medium and large size, by offering industrial infrastructure, dissemination of opportunities of investments and of an appropriate politics of fiscal incentives. The program will have a reorientation so that the motivated companies assume a social

commitment with the municipal districts seeking to contribute for the improvement of the life conditions, mainly of their more lacking communities. Like this, the basic guidelines for the concession of the benefits of Fund of Development Industrial-FDI to the companies will be considered: the cost-effectiveness in the decision on the concession; the increase of the efficiency of the industrial system saw complementation of the missing links of the productive chain and warranty of maintenance of the process of decentralization of the industrial activities in the State.

- Industrial and Port Complex program of Pecém-CIPP - it aims at the realization of enterprises that has great impacts for the economical development of the State of Ceará, with actions gone back to the steelworks implantation, refinery, thermoelectric power plant, among other investments.

2.4 Transport Activity, Development Plan and the Policy

2.4.1 Federal Level

As focused in the Federal government's policy, upgrading of the national transport system is one of the key elements for the economic growth. Integration of the various mode of transport and the promotion of inter-modal transport are the objectives to be achieved. The Ministry of Transport, besides providing general guidelines, rules and standards for the operation and coordination of the transport system of the nation, is taking various actions to promote the integration of the transport system in each region and among the various modes of transport. The Ministry has been reorganizing its institutional structure to strengthen its planning, regulatory and supervisory functions over the transport services including those provided by private sector on a concession basis.

As the legal instrument for the Ministry to integrate national transport system, Law 10,233 of 5th June , 2001 was enacted to establish the National Council for the integration of transport policies, the national terrestrial Transport and Water Transport Infrastructure. The law also defines the structure and responsibilities of various agencies in the transport sector.

Figure 2.4.1 shows the existing national transport system of Brazil. The system consists of road, rail, maritime and inland water transport systems, highways, railways, seaports and river ports.

As seen in the figure, the road and railway systems are concentrated the populated regions, especially Southeast and South Regions. The railways are operated by different operators by regions on concession basis, and need connection between them. Since the railways were privatized, several development plans have been proposed.

In some metropolitan areas, challenges were made to provide urban rail transport service: Recife, Salvador and Fortaleza, for instance.

There are Federal Highways an State Highways. The National Transport Infrastructure Department (DNER) is responsible for planning, construction and maintenance of federal highway infrastructure, while State Highway Department (DERT) is responsible for the state highways and other roads at municipal level. The National Terrestrial Transport Agency (ANTT) has the conceding power for international and interstate passenger and freight services.

There has been a challenge to implement Highway Concession Program with an aim to introduce a management of highways by private sector on concession basis. As of 2003, five federal highways are operating under private management: a part of Highway BR-116 is managed by a private sector.

There have been attempts to develop multi-modal transport corridors in each region with the purpose of providing the growing farming states, most of them being loan locked, with the access to the world markets.

The following are the plan elaborated for the Northeast Region in the 2000-2003 Multi-Year Plan (PPA) together with the plans for other regions. The development of Pecem Port as well as Suape Port is an important element for the realization of the plan. The 2004-2007 PPA inherits the development concepts.

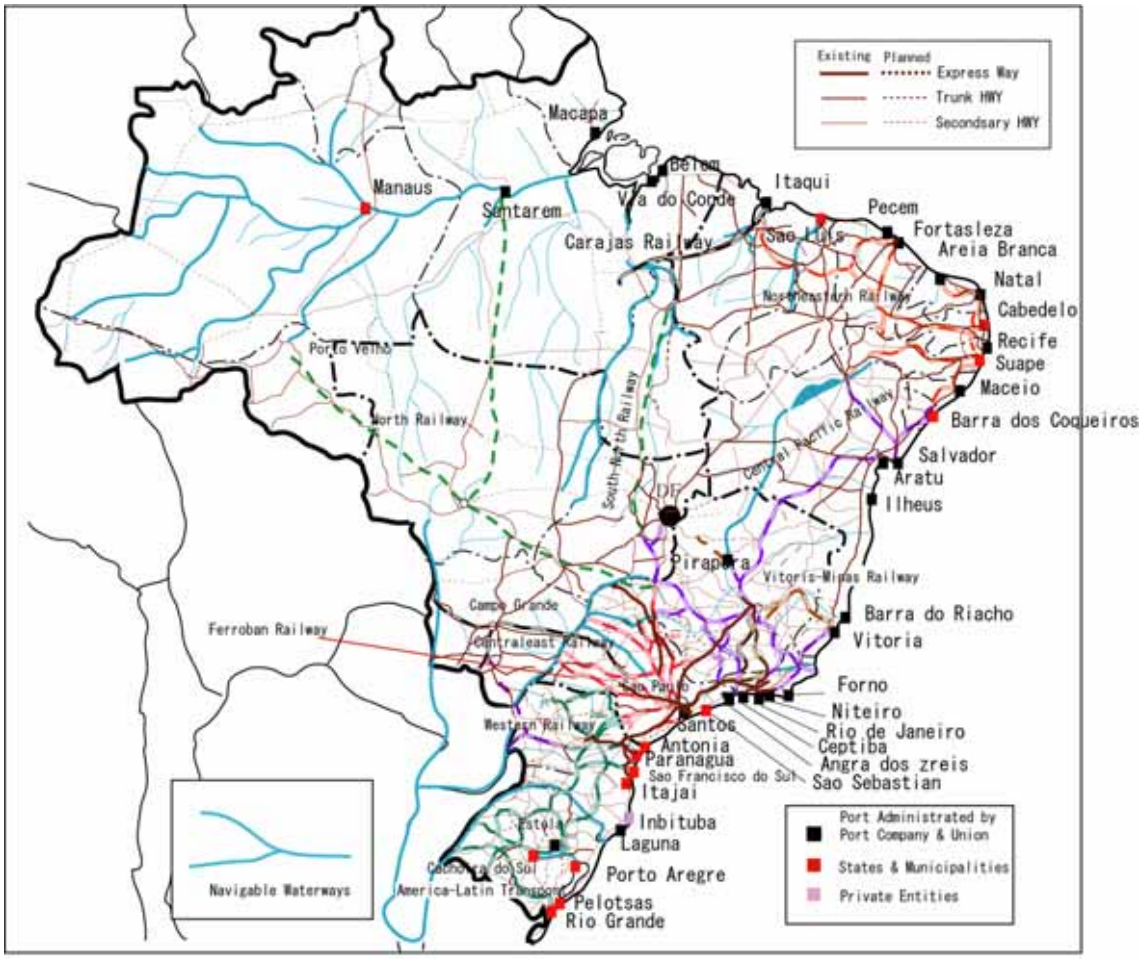


Figure 2.4.1 Existing National Transport System

Northeast Corridor

The aim of the Northeast Corridor is to establish the multimodal transport system of the State of Piaui, Ceara, Rio Grande do Norte, Paraiba, Pernambuco, Alagoas, Sergipe and Northeast of Bahia. The plan includes projects to streamline the freight costs, improve the competitiveness of the distribution of the products of these states in the domestic and international markets.

The region has great potential for tourism and need a better transport infrastructure, including airports for tourists.

The Public investment in the Port of Suape and Pecem has already born fruit in terms of new jobs and development in their respective areas of influence. The port of Suape, close to Recife is an important link in the multimodal corridor that combines the São Francisco Waterways and the Trans-Northeastern Railway. The Trans-Northeastern Railway is taking steps to expand the transport capacity to meet the increasing traffic demands from the countryside to the ports in Northeast Region.

The railway system and the highway system in the Northeast Region are shown in Figure 2.4.2 and 2.4.3, respectively.

Source: Ministry of Transport Web Site

Figure 2.4.2 National Railway system

Source: Ministry of Transport Web Site

Figure2.4.3 Existing highway system in Northeast Region

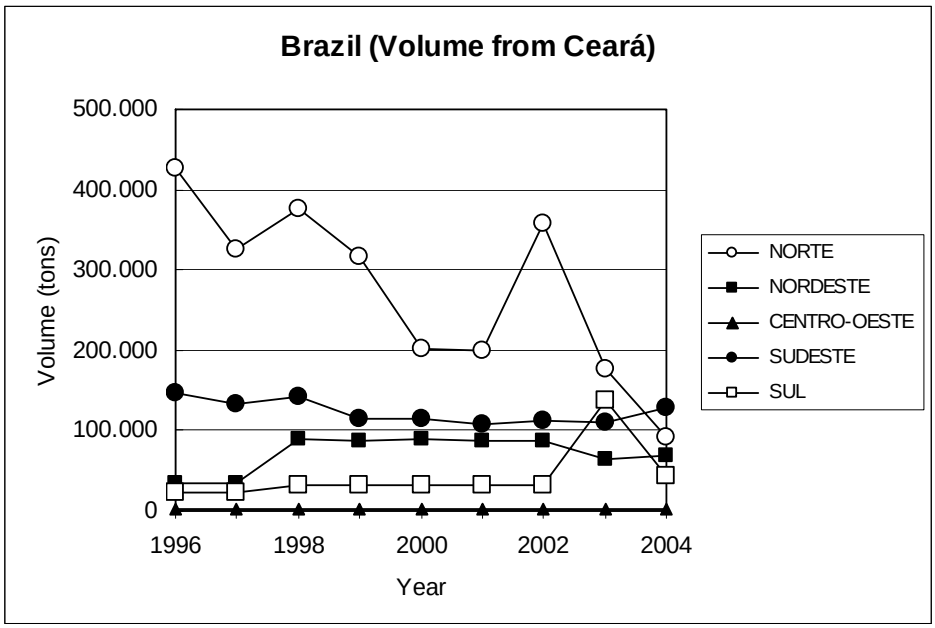
2.4.2 Regional and State Level

Statistical data of land transportation are available from the Web site of the Foundation Institute of Economic Research. On their web site, the annual traffic between the regions can be obtained. Figures 2.4.4 and 2.4.5 are drawn on the basis of the data published in their Web Site to exhibit the traffic volumes by origins and destinations.

The cargos transported from Ceara to North Region used to have the largest share. However, the volume has been decreasing. Cargoes carried to Southeast, Northeast and South Regions have been almost the same volume over the past seven years.

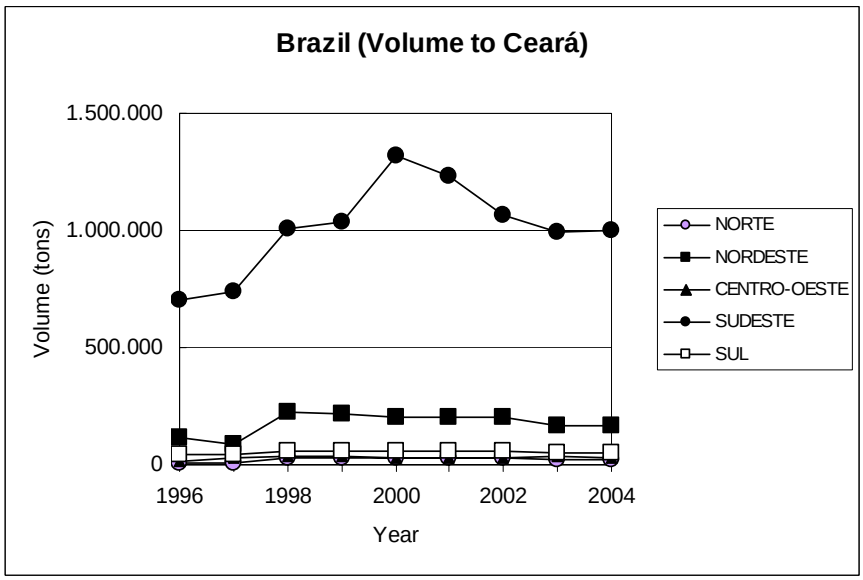
The total outflow volume in 2004 was 334,500 tons: 92,700 tons to North, 69,000 tons to Northeast, 127,600 tons to Southeast, 43,000 tons to South and 570 tons to Central-West Regions.

Regarding the cargo inflow to Ceara, the volume brought from Southeast Region has been the largest. The cargo volume from Northeast Regions is the second largest. The cargo volumes from other Regions are small. In 2004, the total volume of 1.27 million tons was brought to Ceara. Of this amount, 1.0 million tons were from Southeast Regions, and 170,000 tons were brought from other states in the Northeast Region. The rest of 100,000 tons of cargoes were brought from the other three Regions.



Source: Drawn by JICA Study Team on the basis of data from Foundation Institute of Economic Research, Web Site

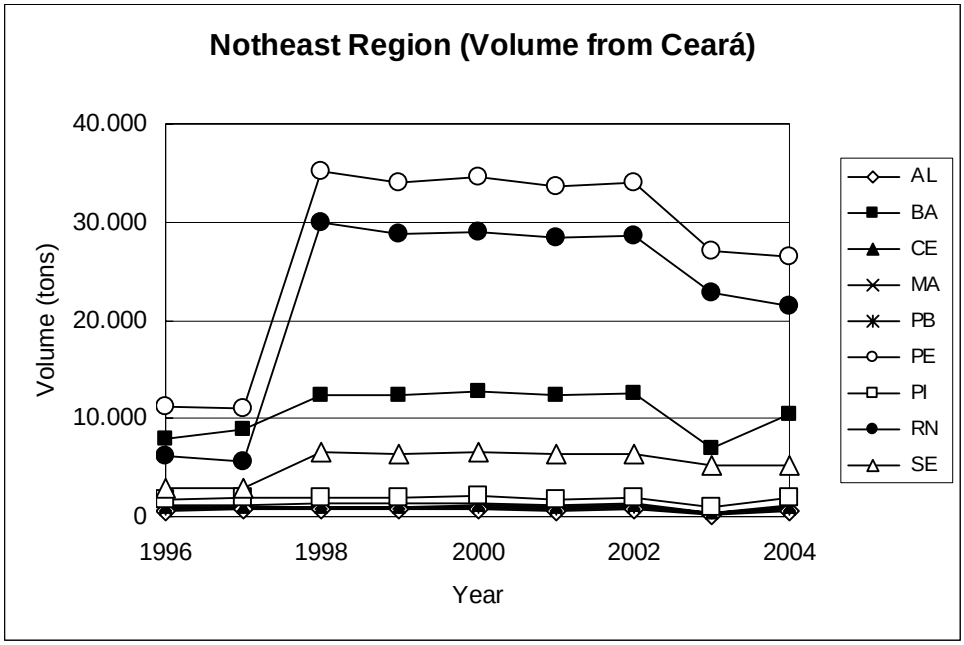
Figure 2.4.4 Cargo Volume outflow from Ceara via Road



Source: Drawn by JICA Study Team from Foundation Institute of Economic Research, Web Site

Figure 2.4.5 Cargo Volume inflow to Ceara via Road

The Cargo outflow from Ceara to other states within the Northeast Region is shown in Figure2.4.6. Pernambuco and Rio Grande do Norte States are the major destinations. Five to ten thousand tons of cargoes are transported to Bahia and Sergipe.

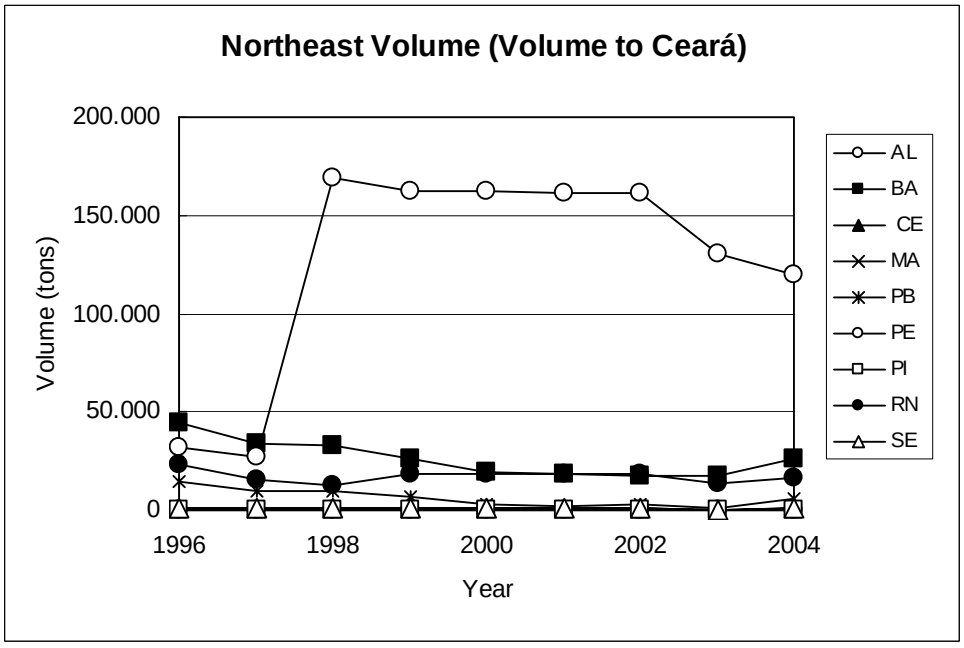


Source: Drawn by JICA Study Team from Foundation Institute of Economic Research, Web Site

Figure 2.4.6 Outflow cargo volume from Ceara to other states in Northeast Region

In 2004, a total of 70,000 tons of cargoes were transported to other state in Northeast Region. Of the total, 26,400 tons to Pernambuco, 21,400 tons to Rio Grande do Norte, 10,400 ton to Bahia and 5,200 ton to Sergipe.

Figure 2.4.7 shows inflow of land transport cargo brought to Ceara from other states within the Northeast Region. Pernambuco is the major origin of the cargoes. of the total inflow cargo of 170,000 tons, 120,000 tons were brought from Pernambuco State.



Source: Drawn by JICA Study Team from Foundation Institute of Economic Research, Web Site

Figure 2.4.7 Inflow cargo volume to Ceara within Northeast Region

Summing up the facts described above, it is seen that Southeast Region is the principal origin and destination of the land-based cargoes, and about one million tons of cargoes are brought from Southeast Region to Ceara overland, while about 100,000 tons of cargoes are transported to Southeast Region.. The cargo movement to and from other states are small.

The largest cargo movement within the Northeast Region is seen between Ceara and Pernambuco. more than 100,000 tons of cargoes are brought from Pernambuco to Ceara, while 20,000 to 25,000 tons of cargoes are transported to Pernambuco and Bahia State.

2.4.3 Marine Transport

(1) Present Marin Transport in the World

The shipping industry has entered the era of mass transportation and high operational efficiency by the introduction of large scale container carriers, dry bulk carriers, crude oil tankers and quicker transportation.

Assuming that the current trend of vessel size enlargement will continue in the future, the projection of future vessel size, loading ratio, the design size are shown in Table 2.4.1.

Table 2.4.1 Future Average Vessel size and Loading Ratio (DWT)

Commodity	Loading %	Short Term (2012)	Long Term (2022)
Foreign Trade Container Vessel			
Container Carrier	80 %	35,000 (3,500TEU)	48,000 (4,000TEU)
Foreign Trade Bulk Cargo Carrier			
Rice	70 %	20,000	20,000
Cement	70 %	10,000	10,000
Fertilizer in bulk	70 %	10,000	10,000
Soya Bean / Wheat in Bulk	70 %	35,000	45,000
Heavy Machinery / Equipment	20 %	7,000	7,000
Construction Material	70 %	8,000	12,000
PetroleumProduct(Chemical)	60 %	35,000	45,000
General Break Bulk Cargo	70 %	10,000	15,000
Domestic (Mercosur) Trade Container Carrier			
Container Carrier (DCNDB)	80~90%	2,000 TEU	2,300 TEU
Domestic Trade Conventional Cargo Carrier			
Bulk Cargo Carrier	80%	15,000	20,000
Conventional Break Bulk Carrier	70%	8,000	12,000

Source: Ocean Consultant Report 2003

1). Container Vessel Size (Capacity)

One of the most important trends affecting the ocean-going container carriers industry has been the progressive increase in the size of vessels This trend is expected to continue in the future.

To accommodate very large vessels ever increasing their sizes ports need massive expenditure on their infrastructures, dredging and equipment. Berth depth requirement for vessels on the scale of the Hapag Lloyed vessel and OOCL vessel with capacity of 8,200 TEUs series is now approaching 15 m in water depth. Near future around

10,000 TEUs capacity vessel is said to be inaugurated, and the latest quay side gantry cranes were designed to enable to reach across 22 or 23 cell width containers.

In order to maximize economies of scale, shipping lines tend to concentrate their services at fewer major container hub ports to reduce the staying times at the ports as much as possible and that consequently leads to the rapid growth of transhipment traffic to link hub ports with webs of regional and local container ports.

Subsequently, the continued growth in container traffic and the cooperation of operators in the in mega-consortia (alliance) have facilitated development of some ports as secondary hubs, capable of attracting second or subsequent strings of somewhat smaller mainline vessels. These facilitate a variation of port calls and to meet the needs of different geographical concentrations of customers.

The container handling industry at ports is therefore assuming a tiered structure, where a concentration on fewer hub ports for the largest vessels is accompanied by the emergence of secondary or alternative hub ports, and feeder ports serving mainline hauls indirectly as growing intra-regional flows.

Modern container vessels place increasing pressure on front-rank ports by virtue of their size:

- Some major ports repeatedly find themselves being criticized for draft limitation
- Terminals are required to provide at least three and usually fourth generation post-PANAMAX type quay side gantry cranes per vessel, in order to turn them as rapidly as vessels half their size.
- Container yards need to be capable of accepting consignments of containers which are twice as large, but in the same time period. The maximum consignment for a front-rank port has doubled from some 1,500-3,000 boxes over the post of late years.

The reduction of port calls depends on the continued development of hub and spoke networks, based on one or two direct calls per major port range and ever-increasing use of transhipment container. The layer will continue to boost port demand at hub ports at twice the rate of increase in trade, by doubling the number of moves per container.

2). Inter-Modal Service

Given the degree of demand expansion that is forecast, the ability of terminal to expedite landside movements will become increasingly critical. In many markets, investment in inter-modal rail service is vital to offset threatening road congestion, which may otherwise act as a brake on demand growth.

(2) World Fleet

1). World Container Carrier

Container fleet play an important role in the field of maritime transport. The container fleet has been getting larger and larger to pursue the economy of scale. It is expected that this trend will continue in the future too.

According to the maritime business plan including future building plan of container vessels, many "Over Panamax Type Vessels" have been ordered. At present larger container vessels of which capacity are 8,000~+10,000 TEU Type are employed on the main service routes between Europe and Asia / US West coast to Asia. Summary of the world wide container fleets in service and on order are shown in Table 2.4.2

Table 2.4.2 Comparison of Vessel Capacity Between Smaller and lager Vessel

Year	Large Size (4,000TEU or Lager)		Medium and Small Size (Less than 4,000)		Total	
	Number of Vessel	Capacity (%)	Numbr of Vessel	Capacity (TEU)	Numbr of Vessel	Capacity (TEU)
1990	5	21,700 (1.3%)	1.284	1,616,800	1,289	1,638,500
1995	15	65,900 (2.6%)	1.717	2,426,700	1,732	2,492,600
2000	105	568,000 (12.9%)	2.498	3,821,800	2,603	4,389,800
2001	138	761,200 (15.8%)	2.602	4,051,100	2,740	4,812,800
2002	201	1,129,100 (20.9%)	2.694	4,274,800	2,895	5,403,900
2003	246	1,400,800 (23.5%)	2.792	4,567,500	3,038	5,968,300
*2004	312	1,764,000 (27.2%)	2.900	4,730,000	3,212	6,494,000
*2005	399	2,250,000 (31.6%)	3.000	4,870,000	3,399	7,120,000
*2006	503	2,854,000 (36.2%)	3.090	5,020,000	3,593	7,874,000
*2007	611	3,600,000 (41.3%)	3.185	5,120,000	3,796	8,720,000

Note: *: Estimated figure
Source: Clarkson Research Studies "The container Ship Register 2003

In line with the trend of larger container vessels, many over 6,000TEU type vessels have been ordered. With an additional 1,682,009TEUs of capacity provided by some 219 vessels still awaiting delivery over the year 2005, the over capacity of the container liner business looks to increase more services (see Table 2.4.8).

As larger container vessels go into services on trunk routes such as Far East–Europe service route and Far East–Trans-Pacific service route, the container vessels retiring from trunk routes are transferred to North/South routes and more regional routes. Feeder vessels will also become larger in the future. Future trend of container vessels by route is shown in Table 2.4.3. It is expected that the largest container vessel coming to Brazilian ports will be those vessels having the capacity of from 3,500 to 4,000 TEUs.

Table 2.4.3 World Container Carrier in Service and on Order by Vessel Type and Size (October 2004)

Capacity and		Under 1,000	1,000 –	2,000 –	3,000 –	4,000 –	5,000 –	6,000 –	7,000 +	Total
Full Cellular Type										
Present Slots		565.578	1.311.505	1.316.462	950.715	1.057.158	978.898	721.856	126.030	7.028.202
Present Vessels		1,021	928	530	276	241	178	111	16	3.301
Slots on Order		106.719	194.814	374.974	184.707	634.837	493.248	461.456	1.220.553	3.362.901
Vessel on Order		132	136	142	55	148	92	71	148	924
RO/RO Type										
Present Slots		281.386	94.932	13.706	-	-	-	-	-	390.024
Present Vessels		817	72	6						
Slots on Order		1.800	-	-	-	-	-	-	-	1.800
Vessel on Order		2	-	-	-	-	-	-	-	2
Non Cellular Type										
Present Slots		1.025.682	459.893	54.682	-	-	-	-	-	1.540.257
Present Vessels		3.216	334	24	-	-	-	-	-	3.574
Slots on Order		5.726	9.322	8.184	-	-	-	-	-	232.332
Vessel on Order		13	5	4	-	-	-	-	-	22
Total Container Vessels										
Present Slots		1.872.646	1.866.330	1.384.850	950.715	1.057.158	978.898	721.856	126.030	8.958.483
Present Vessels		5.054	1.334	560	276	241	178	111	16	7.770
Slots on Order		114.245	204.136	383.158	184.707	634.837	493.248	461.456	1.220.553	3.696.340
Vessel on Order		147	141	146	55	148	92	71	148	948
Total	Capacity	1.986.891	2.070.466	1.768.008	1.135.422	1.691.995	1.472.146	1.183.312	1.346.583	12.654.823
	Number of Vessel	5.201	1.475	706	331	389	270	182	164	8.718

Source: Containerisation International Yearbook 2005
Note: Standard Maximum Draft of Container Carrier by GWT and Capacity

The relationship between capacity and draft of container vessels is shown in Table 2.4.4. It is customarily required that water depth of a port should be the draft plus 10% allowance.

Table 2.4.4 Standard Vessels by GRT and Capacity of Maximum Draft

Typical GWT	Capacity (TEUs)	Maximum Draft	Typical GRT	Capacity (TEUs)	Maximum Draft
9,780 GWT	820 TEUs	8m-75cm	48,305 GWT	3,720 TEUs	12m-20cm
17,156 GWT	1,250 TEUs	9m-53xm	51,047 GWT	5,200 TEUs	13m-03cm
35,234 GWT	2,020 TEUs	11m-50cm	81,530 GWT	6,600 TEUs	14m-00cm
41,442 GWT	2,977 TEUs	11m-51cm	101,000GWT	9,200 TEUs	14m-85cm

Source: JICA Study Team

2) World Dry Bulk Carrier

Currently, the number of dry bulk carriers is 5,944 in total equivalent to approximately 3.3 million tons, and by 2007, 795 vessels equivalent to 5.3 million tons are planned to be built. Regarding capacity, it tends to be fixed around 60,000 GRT, which is typical to a handy type vessel.

Table 2.4.5 World Bulk Carrier Capacity and Ordered New Vessels

Tonnage	Fleet at Present (End of 2004)			New Ordered Vessels (Until'2007)		
Range (GRT)	No. of Vessel	Tonnage (tons)	Ratio	No. of Vessel	Tonnage (tons)	Ratio
10,000~30,00	1.934	42.100.000	32,50%	33	712.000	4,20%
30,000~55,00	2.137	89.800.000	36,00%	353	11.352.000	44,40%
55,000~80,00	1.197	84.000.000	20,20%	234	16.042.000	29,40%
80,000~100,0	64	5.600.000	1,10%	72	5.912.000	9,10%
100,000~150,	165	22.800.000	2,80%	2	200.000	0,25
Over 150,000	446	78.500.000	7,40%	101	19.037.000	12,70%
Total	5.944	322.800.000	100,00%	795	53.255.000	100,00%

Source: JICA Study Team

Table 2.4.6 Details of New Ordered Vessels (2005 ~ 2007)

Tonnage Range (GRT)	2005		2006		After 2007	
	No of VSL	Tonnage (ton)	No of VSL	Tonnage (ton)	No of VSL	Tonnage (ton)
10,000~30,000	26	567,000	5	110,000	2	35,000
30,000~55,000	118	5,267,000	185	3,812,000	50	2,273,000
55,000~80,000	103	7,114,000	72	4,885,000	59	4,043,000
80,000~100,000	18	1,473,000	28	2,312,000	26	2,127,000
100,000~150,000	-	-	1	100,000	1	100,000
Over 150,000	45	8,037,000	31	5,541,000	25	5,461,000
Total	310	22,458,000	322	16,760,000	163	14,039,000

Source: Drewry Shipping Report and JICA Study Team
Standard Maximum Draft of Bulk Carriers by GRT

The relationship between capacity and draft of bulk carrier are shown below Table 2.4.7. It is customarily required that depth of a port should be the draft plus 10% allowances.

Table 2.4.7 Comparison of GWT and Maximum Draft of Bulk Carriers

Typical Tonnage	Max Draft	Typical Tonnage	Max Draft
15,000 GWT	9m-50cm	44,000 GRT	12m-50cm
17,000 GWT	10m-01cm	75,000 GRT	15m-10cm
23,000 GWT	11m-80cm	90,000 GRT	16m-52cm
36,000 GWT	13m-30cm	100,800 GRT	19m-82cm

Source: JICA Study Team

3) World Liquid Bulk Carriers.

Comparison of the world crude oil transportation volume between main supply countries and consumption countries in 2003 and 2010 by region is shown in Table 2.4.8.and 2.4.9.

Table 2.4.8 Actual Transport Volume in 2003

(Unit mbpd = million barrels per day)

	CONSUMPTION REGION							
	Region	N.America	Europe	China	Japan	Other Asia	MISC	Total
SUPPLY REGION	C/S.America	4.2	0.4	0.0	0.0	0.2	5.3	10.2
	Europe	1.5	4.4	0.0	0.0	0.1	0.4	6.5
	CIS	0.3	4.9	0.2	0.0	0.2	4.8	10.5
	Mid East	2.7	3.1	1.0	4.2	6.7	4.9	22.7
	W.Africa	1.5	0.7	0.3	0.1	0.7	0.7	4.0
	Other Count	10.7	2.8	3.9	0.9	2.3	3.3	24.0
	Total	20.8	16.4	5.6	5.3	10.3	19.5	77.8

Source: British Petroleum Annual Report

Table 2.4.9 The Amount of Prospect in Transport volume in 2010

(Unit mbpd = million barrels per day)

	CONSUMPTION by REGION							
	Region	N.Amarica	Europe	China	Japan	Other Asia	MISC	Total
SUPPLY REGION	C/S America	5.0	0.4	0.1	0.0	0.2	5.8	11.5
	Europe	0.9	4.5	0.0	0.0	0.0	0.1	5.5
	CIS	1.1	6.2	0.5	1.0	0.3	3.6	12.6
	Mid East	2.7	3.1	3.1	4.1	9.1	6.5	28.5
	W. Africa	2.2	0.7	1.0	0.1	0.7	0.9	5.8
	Other Count	10.9	2.2	3.5	0.7	2.0	3.1	22.5
	Total	22.8	17.2	8.2	6.0	12.2	20.1	86.4
Compare in 2003		+2.0	+0.8	+2.6	+0.8	+1.9	+0.6	+8.6

Source: British Petroleum Annual Report

Currently there are only a small number of oil refineries in Latin America. Development sites for new refineries should take into consideration the need to reduce domestic transportation costs, as energy consumption is expected to grow in the near future.

- Standard Maximum Draft of Crude Oil Carrier by GWT and Capacity
- The relationship between capacity and draft of liquid carrier are shown in Table 2.4.10. It is customarily required that depth of a port should be the draft plus 10% allowances.

Table 2.4.10 Comparison of GWT and Maximum Draft of Liquid Bulk Carrier

Type of Vessel	GWT	Max Draft	Type of Vessel	GWT	Max Draft
Coastal Tanker	3,858	6m-95cm	Product Tanker	67,524	15m-37cm
Small Handy	22,602	11m-27cm	AFRA max Type	109,296	16m-50cm
Handy Type	28,480	11m-65cm	Standard VLCC	149,537	19m-60cm
Medium Product	55,048	13m-83cm	Standard ULCC	238,517	28m-20cm

Source: JICA Study Team

2.5 Port Activity

2.5.1 Federal Level

(1) National Port System

According to the classification in the port statistics published by the Ministry of Transport, the commercial ports in Brazil are categorized in two groups: public ports and private ports. Public Ports are administrated and managed by Port Companies under the administration of the Ministry of Transport, while private ports include those ports managed by states, municipalities and private firms. In some cases, certain properties of the public port are operated by private firms under concession contract.

By definition in the Law 8360 ports are categorized into either “Organized port” or “Terminal ports”. Almost all the public ports and many private ports fall on the category of “Organized port”, while some ports that handle only the companies’ own cargo and those of the third party fall on “Terminal port”. The Ports of Pecem falls on “Terminal Port”: since the essential role of the port is basically intended to handle the

cargoes related to the activities of the industries within CIPP, such as steel mil and oil refinery.

Forty-four ports are listed as the public ports in the port statistics of the Ministry of Transport: 6 in North Region including river ports along The Amazon River, 12 in the Northeast Region, 16 in Southeast Region, 10 in South Region and two in the Central-west Region. Fifty-seven private ports and terminals are listed in the Ministry's statistics: 13 ports in the north Region, 8 in the Northeast Region, 20 in the Southeast Region, 13 in South Region and 3 in the Central-west Region. The locations of these ports are shown in Figure 2.1.5.1. All the states along the coast have commercial ports

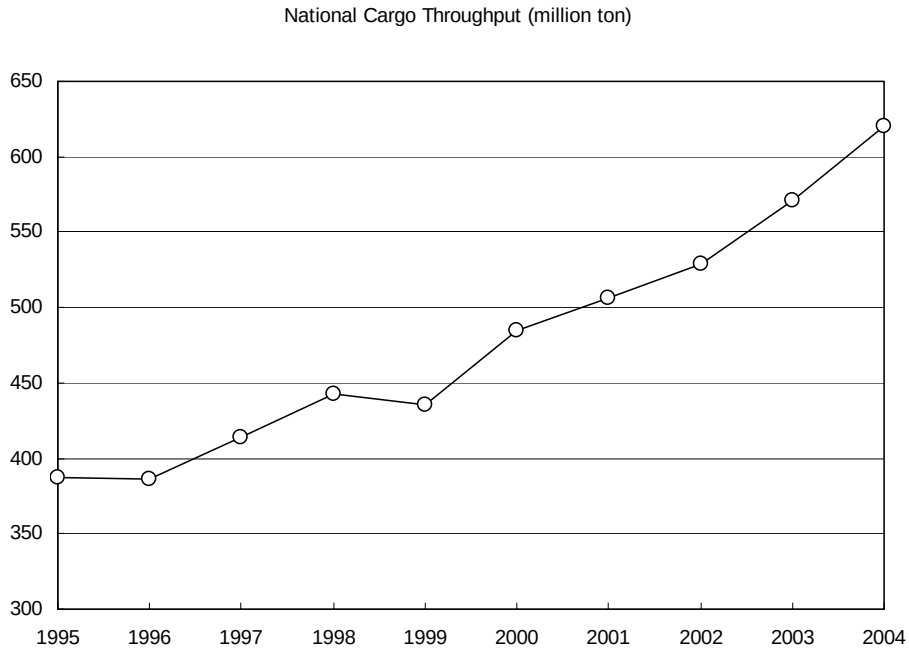
(2) Activities of the Ports

The activities as well as the physical features of the port facilities are compiled and published by the Ministry of Transport of the federal government. The information is available through the web site of the ministry.

Currently, internet information covers the port statistics up to 2002. The detailed figures are shown in the Attachment A.

a. Cargo throughput of the Brazilian Port

The annual total cargo throughput of all the Brazilian port has been steadily growing (see **Figure 2.5.1**), though slight declines were observed in 1996 and 1999. The average growth rate over the period from 1996 to 2002 is 4.5%.



Source: Drawn by the JICA Study Team on the basis of Statistics of Ministry of Transport Web site

Figure 2.5.1 Total cargo throughput of Brazilian port system

The regional total cargo throughputs are shown in Table 2.5.1. It is observed that the cargo throughputs are growing at a high rate in the North Region, while the growth rate in the Northeast Region is the lowest.

Of the national total cargo throughput of 529 million tons, 177 million tons were handled at the public ports, while 333 million tons were handled at the private ports.

Table 2.5.1 Cargo throughput by Region

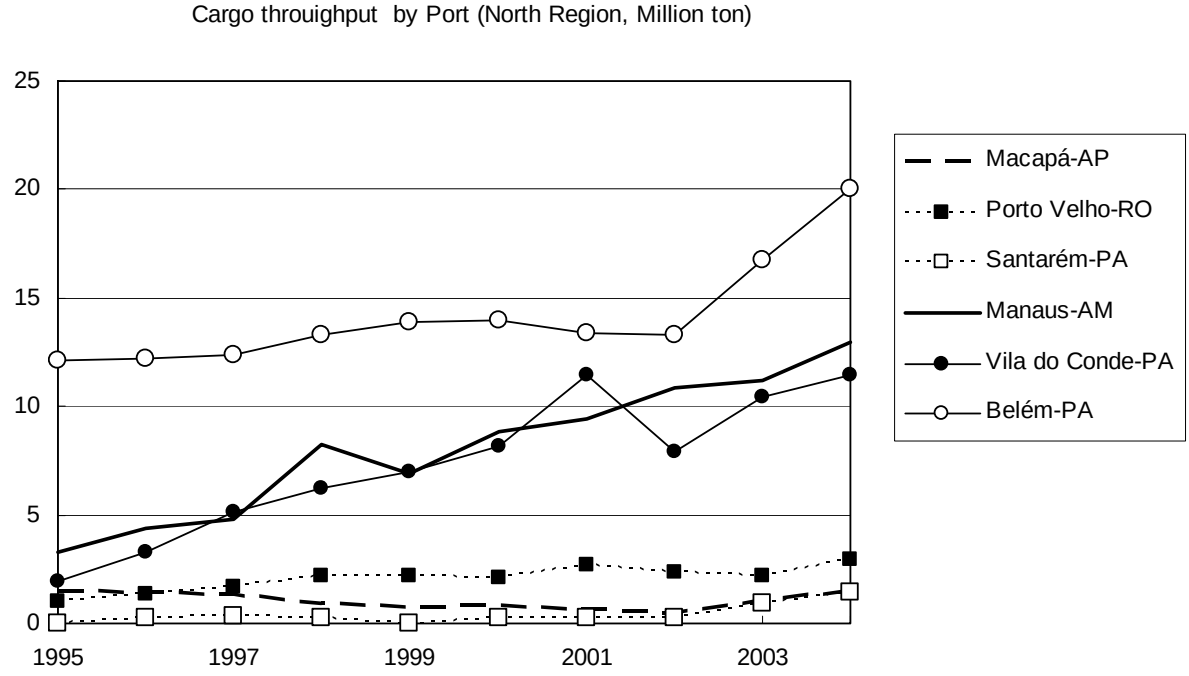
Milliom ton

Region	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Growth Rate 1995-2004
North	20,1	22,9	25,7	31,2	30,9	34,1	37,9	35,2	42,6	50,4	10,7%
Northeast	92,1	91,1	94,8	99,6	93,9	107,0	114,0	115,4	119,2	134,5	4,3%
Southeast	225,8	222,0	240,2	253,2	253,0	276,6	277,1	299,7	318,2	345,2	4,8%
South	48,4	48,9	51,6	56,9	55,8	65,0	75,7	76,5	88,0	88,0	6,9%
Central-west	1,3	1,4	2,0	2,2	2,1	1,9	1,6	2,2	2,7	2,7	9,0%
TOTAL	387,7	386,4	414,2	443,0	435,7	484,7	506,2	529,0	570,8	620,7	5,4%

Source: Prepared by JICA Study Team on the Basis of the statistics of Ministry of Transport

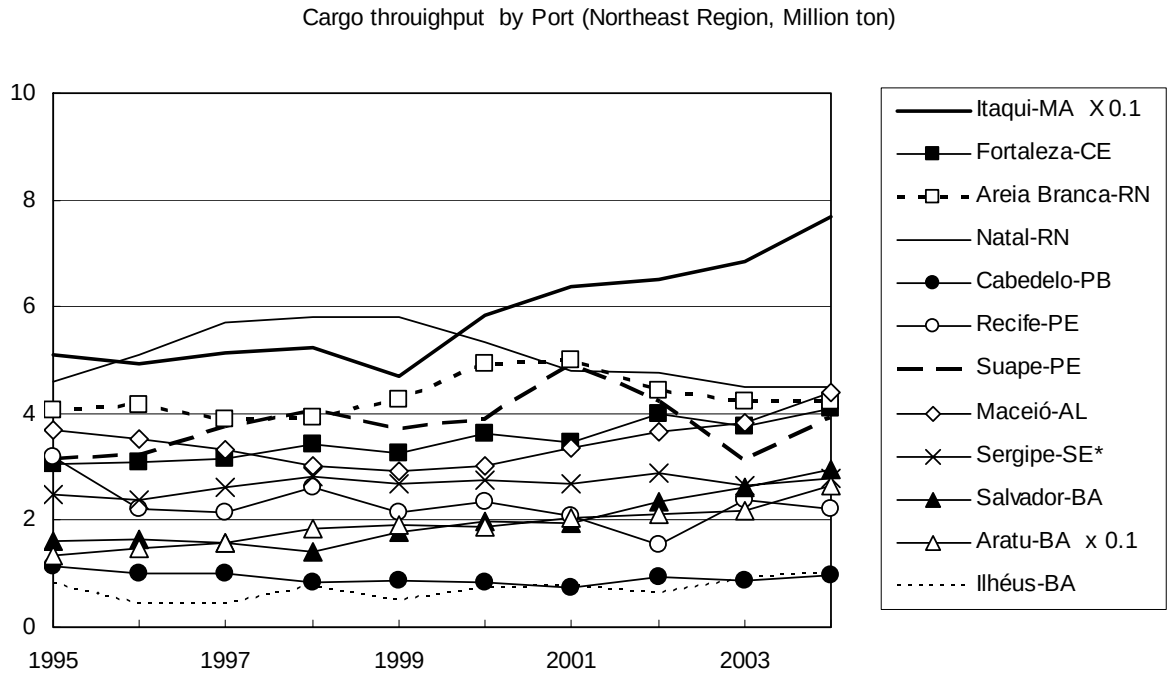
2.5.2 Regional Level

The cargoeshroughput of the commercial ports are shown in Figure 2.5.2 through 2.5.6.



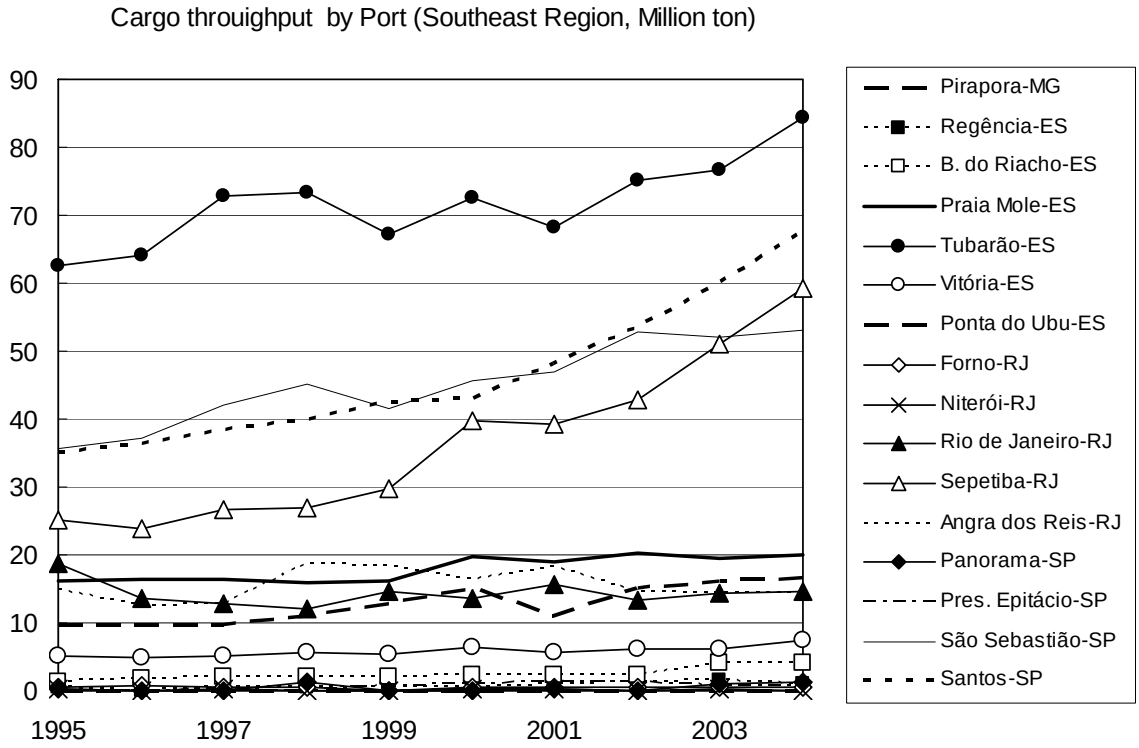
Source: Prepared by JICA Study Team on the Basis of the statistics of Ministry of Transport

Figure 2.5.2 Cargo throughput at the ports in North Region



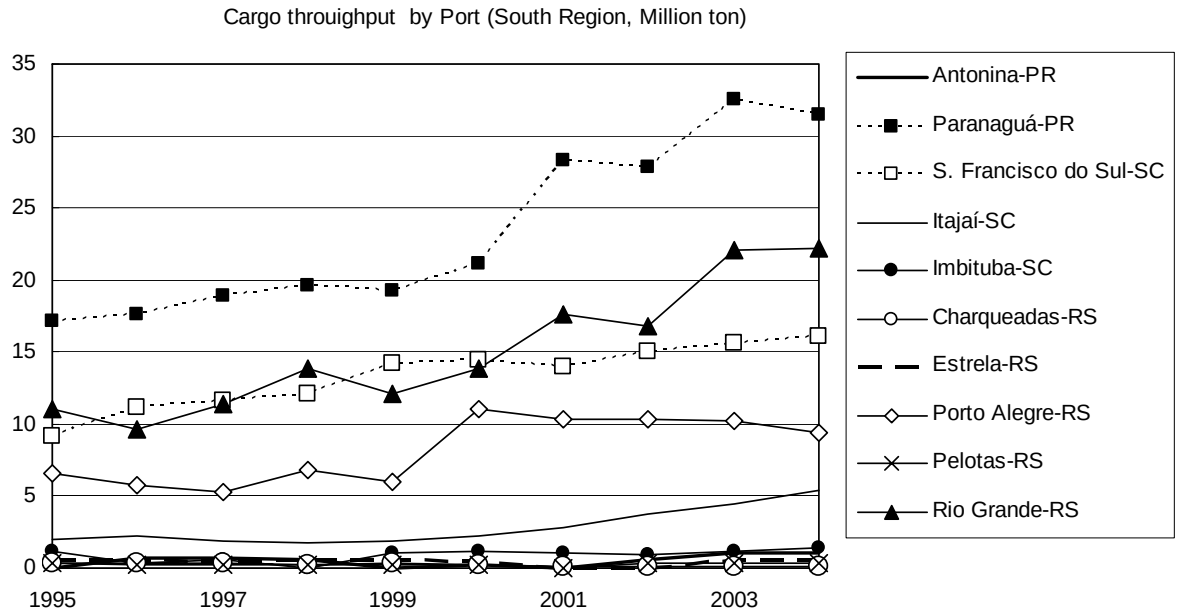
Source: Prepared by JICA Study Team on the Basis of the statistics of Ministry of Transport

Figure 2.5.3 Cargo throughput at the ports in Northeast Region



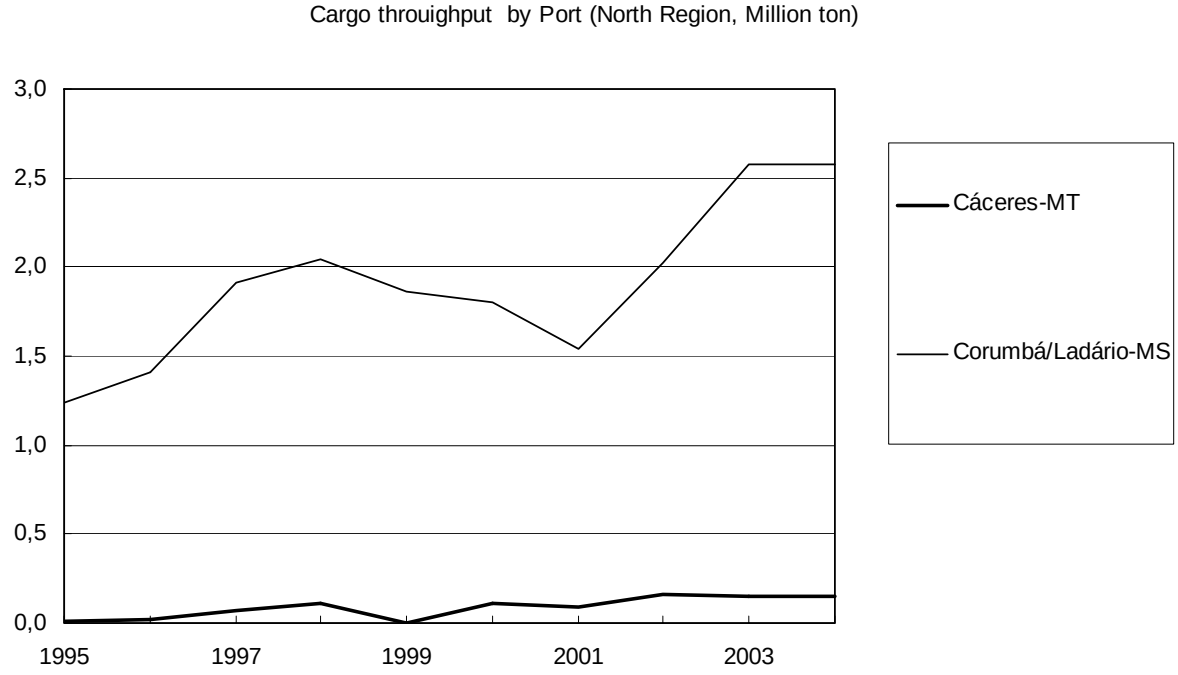
Source: Prepared by JICA Study Team on the Basis of the statistics of Ministry of Transport

Figure 2.5.4 Cargo throughput at the ports in Southeast Region



Source: Prepared by JICA Study Team on the Basis of the statistics of Ministry of Transport

Figure 2.5.5 Cargo throughput at the ports in South Region



Source: Prepared by JICA Study Team on the Basis of the statistics of Ministry of Transport

Figure 2.5.6 Cargo throughput at the ports in Central-West Region

2.5.3 State Level

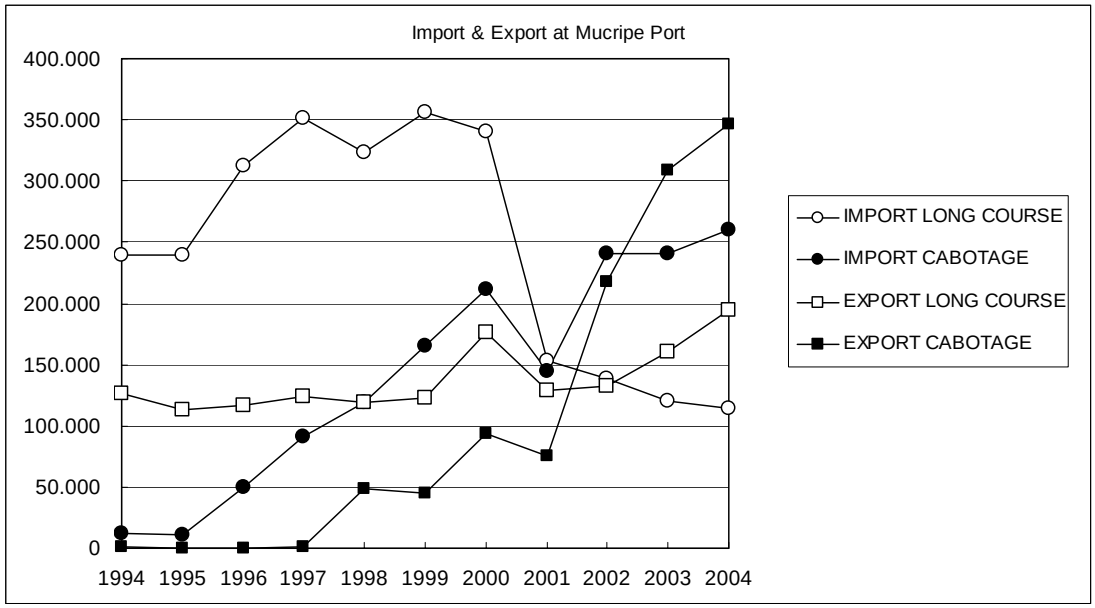
Presently, two commercial ports are operational in Ceara State: Mucuripe and Pecem Port. Though Pecem Port is essentially intended to handle cargoes generated within CIPP, it handles variety of commodities generated in whole Ceara State and other adjacent states.

(1) Mucuripe Port

Mucuripe Port has been the sole commercial port in Ceara State until Pecem Port started its operation in November 2001.

a. General cargoes (including container cargoes)

The import and export general cargo volumes handled at Mucuripe Port are shown in Figure 2.5.7. The volume of general cargoes had been increasing until 2000. The increase of cargo volume is remarkable in cabotage (domestic cargo). There was a big drop in both international and domestic cargoes in the year 2001. It is remarkable that the import cargoes (international trade) keep decreasing, while domestic and export cargoes have been increasing.

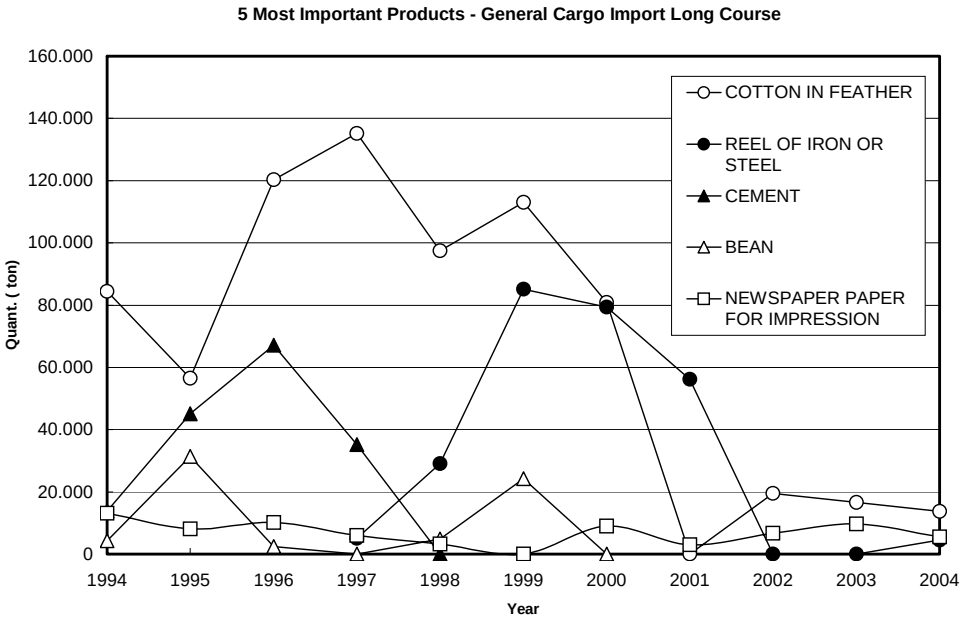


Source: Edited by JICA Study team from the statistics of Mucuripe Port

Figure 2.5.7 Mucuripe Port General Cargoes

Imports

The annual volumes of the major import commodities are shown in Figure 2.5.8. Major import commodities at Mucuripe Port have been cotton feather, reels of steel, cement and paper. The import volume of cotton used to be more than 130,000 tons. However, the volume decrease to about 10,000 ton in 2004.

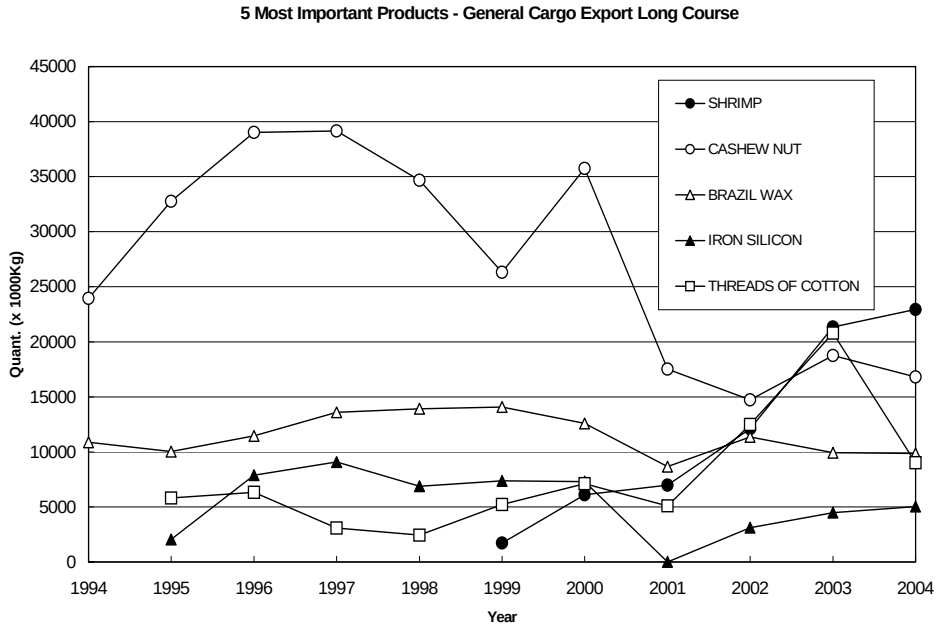


Source: Edited by JICA Study Team from the statistics of Mucuripe Port

Figure 2.5.8 Major import commodities

Export commodity

Major export commodities are cashew nuts, carnauba wax, shrimp, cotton thread and silicon iron. The export volume of cashew nut used to be 40,000 ton, but it dropped to 17,000 tons, i.e., about a half of the peak period. While export volume of Brazil wax maintains the same level of 10,000 tons, the export of shrimp has been increasing over the last few years (see Figure 2.5.9).

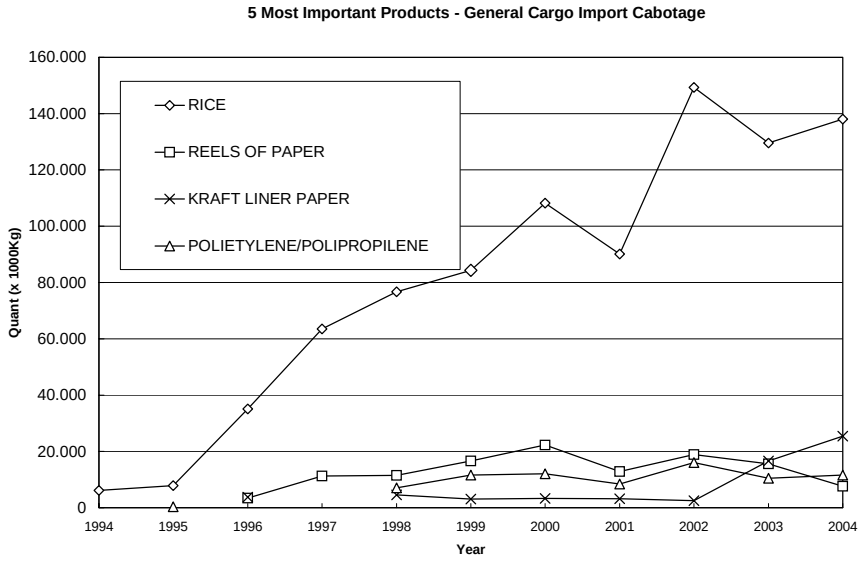


Source: Edited by JICA Study Team from the statistics of Mucuripe Port

Figure 2.5.9 Major export commodities

Unloaded commodity (Domestic cargoes)

Major unloaded commodities in domestic trade are rice. While the volumes of unloading of other commodities are about 20,000 tons or less, the volume of rice has been increasing rapidly (see Figure 2.5 .10).

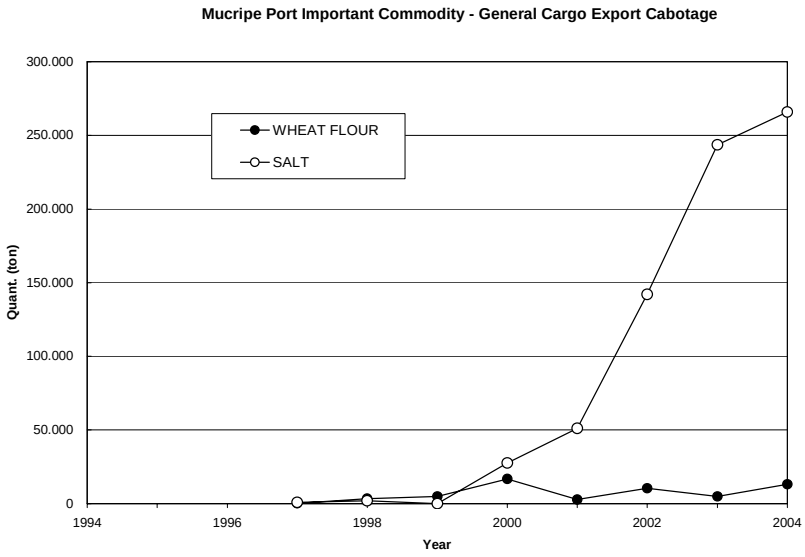


Source: Edited by JICA Study Team from the statistics of Mucuripe Port

Figure 2.5.10 Major unloaded commodity (Domestic trade)

Loaded commodity

The Major commodities for loading are Salt and wheat. The volume of loading is increasing the wheat remains almost the same level (see Figure 2.5.11).

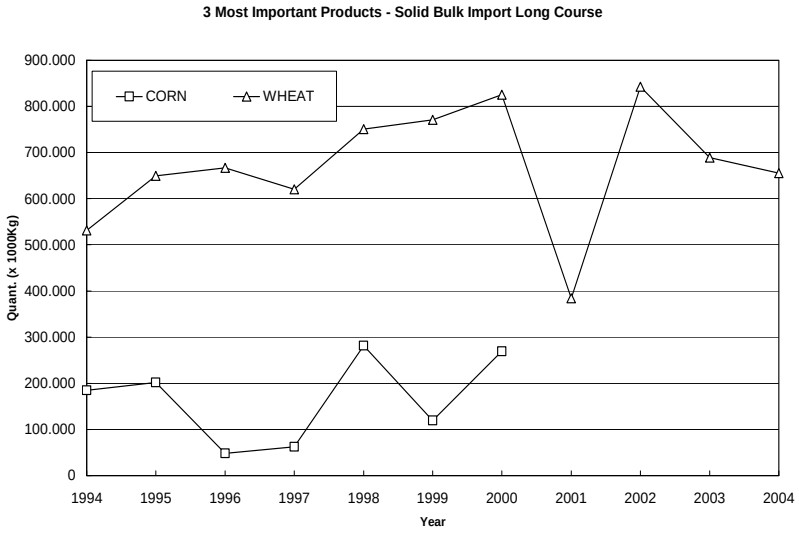


Source: Edited by JICA Study Team from the statistics of Mucuripe Port

Figure 2.5.11 Major loaded commodity (Domestic trade)

b. Dry bulk

The major import commodity as dry bulk cargoes are Wheat and corn. The import of corn ended in 2000, while the import of wheat is at the level of 600,000 tons. Wheat is the most dominant commodity at Mucuripe Port.

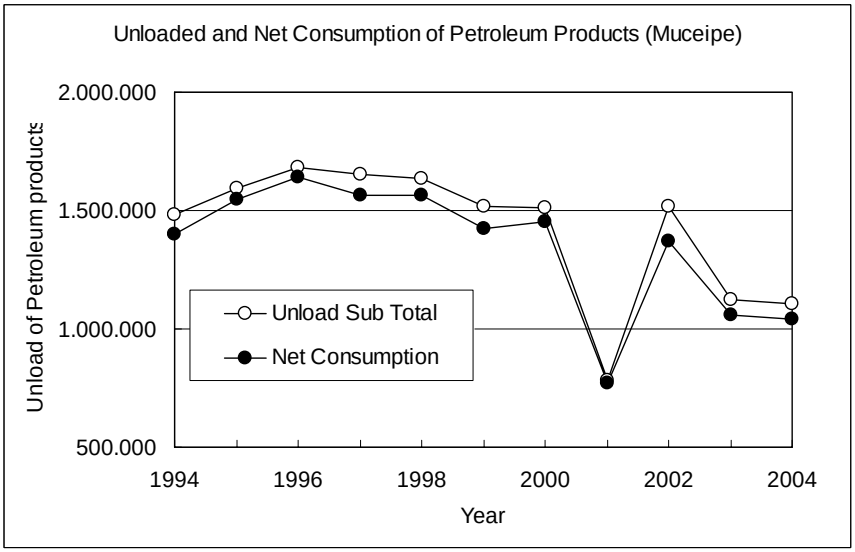


Source: Edited by JICA Study Team from the statistics of Mucuripe Port

Figure 2.5.12 Major import dry bulk

c. Import and export of Liquid bulk (petroleum products, including loading for domestic trade)

The volume of petroleum product unloaded (including both international and domestic) and the net consumption (Unloaded volume – re-exported and loaded volume) are shown in Figure 2.5.13. It is seen that the unloaded volume of petroleum products at Mucuripe port is about one million tons in recent years, which is about two thirds (2/3) of the volumes at peak years.



Source: Edited by JICA Study Team from the statistics of Mucuripe Port

Figure 2.5.13 Unloaded volume and net consumption of Petroleum products

As seen in the figures presented above, at Mucuripe port the volumes of general cargoes are decreasing or slow growth since 2002, while the domestic general cargoes are increasing. Thus, it might be interesting to compare the volumes of major commodities of international trade handled at Mucuripe and Pecem Port.

(2) Cargo-sharing between Mucuripe and Pecem Ports

Figure 2.5.14 shows the cargo volume sharing of some major commodities between Mucuripe and Pecem Ports.

a. Import commodities

Cotton feather:

At Mucuripe port, the import volume of cotton tends to decrease. However, Pecem port is now importing larger volume of cotton than Mucuripe. Thus, it seems that Pecem Port is overtaking the import of cotton.

Rolls of steel

The import of rolls of steel at Mucuripe Port has been overtaken by Pecem Port since 2002.

Rice

Though Pecem Port imports a little amount of rice, Rice import is dominant at Mucuripe Port

b. Export

Footwear, and shrimp

Both Mucuripe and Pecem Ports are handling almost the same volume. In addition, the total export volume of the two commodities seems accelerated by the opening of Pecem port.

Cotton thread

Export at Mucuripe Port is dominant. Pecem Port handles much smaller amount.

c. Domestic trade

Salt

Export of salt is very small. Mucuripe port handles practically almost all the salt export.

(3) New Commodities That Were Not Seen Among The Major Commodities At Mucuripe Port

Among the major commodities handled at Pecem Port since 2002, there are several commodities that had net seen or classified as minor commodities at Mucuripe Port until 2001.

Figure 2.5.15 is drawn to show the cargo sharing of other commodities that are not shown in Figure 2.5.14 by the two ports over the past years.

a. Export commodities

Banana and melon

Banana and melon used to be exported occasionally at Mucuripe Port. Since Pecem Port was operational, substantial amount of Banana has been exported at Pecem Port every year.

Mangoes, Footwear, Cotton thread

Mucuripe Port has been exporting increasing volumes of these commodities every year. Since the opening of Pecem Port, these commodities tend to move to Pecem Port. Mango was quickly shifted, footwear flowed. Shift of cotton thread is rather gradual.

Granite and steel bar

Granite used to be occasionally exported at Mucuripe Port. Since the opening of Pecem Port, the export volume jumped up suddenly. In 2004, both ports almost equally shared the export of granite. Steel bar had not been seen in the major export commodity of Mucuripe Port. The export of steel bar suddenly started in 2003 at a notable volume. In 2004, it appeared in the major export commodity of Mucuripe Port for the first time.

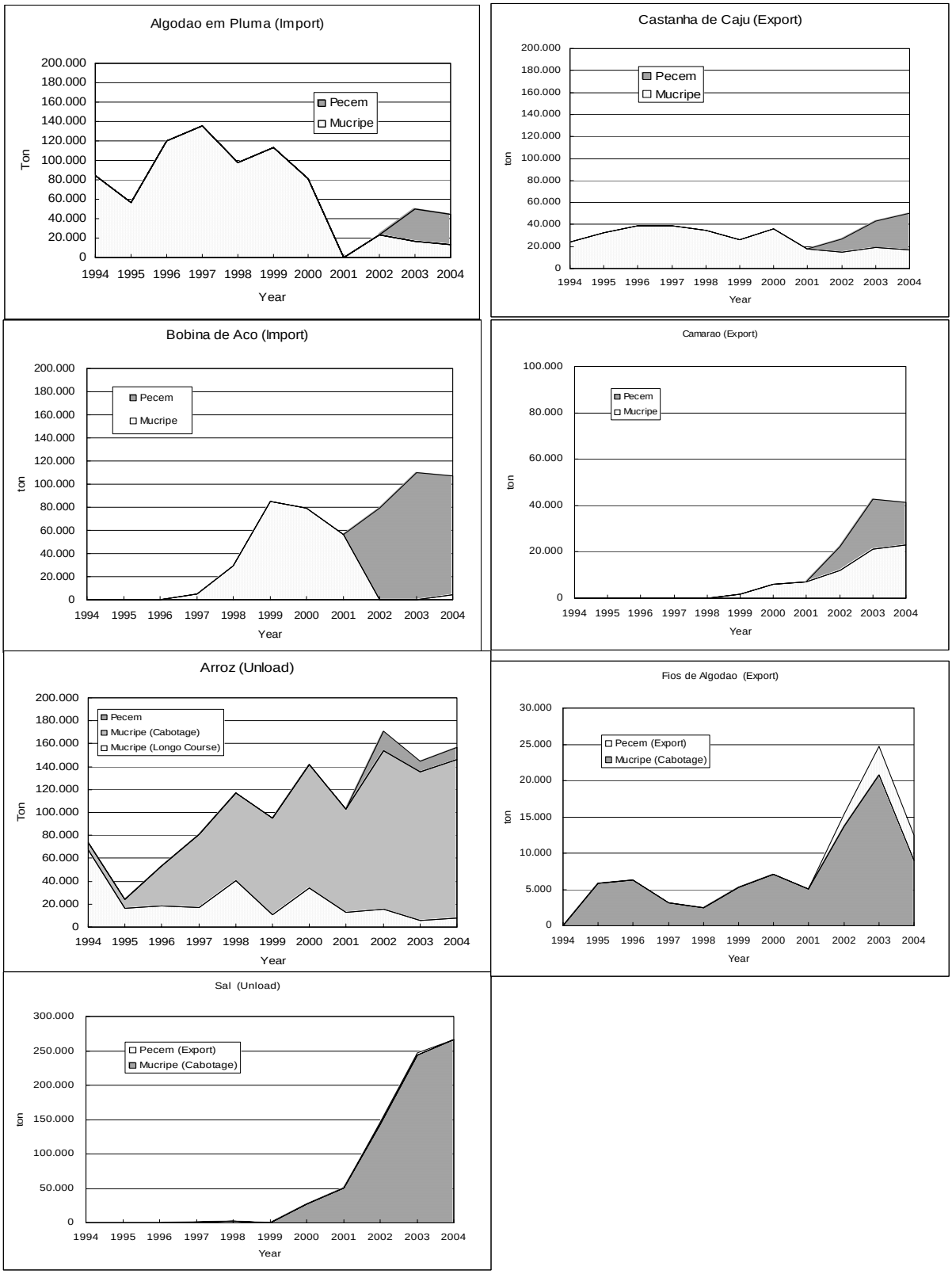
b. Import

Chemical products

The import of chemical products started in 1997 at Mucuripe Port and the import volume has been steadily increasing. Now, the two port equally share the commodity.

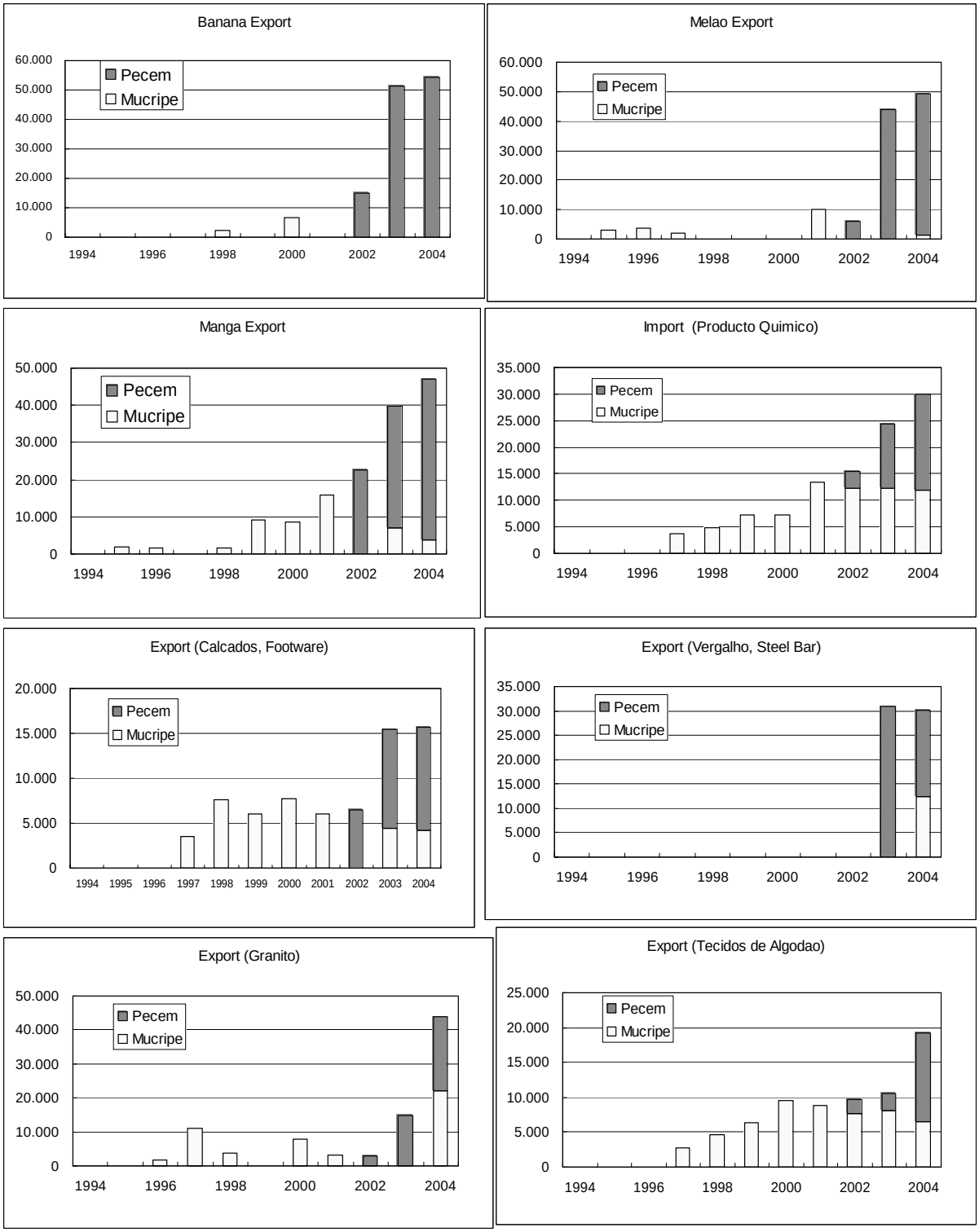
(4) Observations

The statistical data shows the impact of the opening of Pecem Port in the industrial activities in the area. While some commodities have been shifting from Mucuripe Port to Pecem Port, the latter is attracting the export of new commodities. This trend is remarkable in the export of fruit, steel bar and granite. Pecem Port seems to surely stimulate the industrial activities in the region.



Source: Prepared by JICA Study Team from Mucuripe and Pecem Port Statistics

Figure 2.5.14 Cargo-sharing between Mucuripe and Pecem Port



Source: Prepared by JICA Study Team from Mucuripe and Pecem Port Statistics

Figure 2.5.15 Volumes of major commodities at the Ports of Mucuripe and Pecem

2.6 Present Condition of Pecem Port

2.6.1 Existing Port Facilities (See Figure 2.6.1)

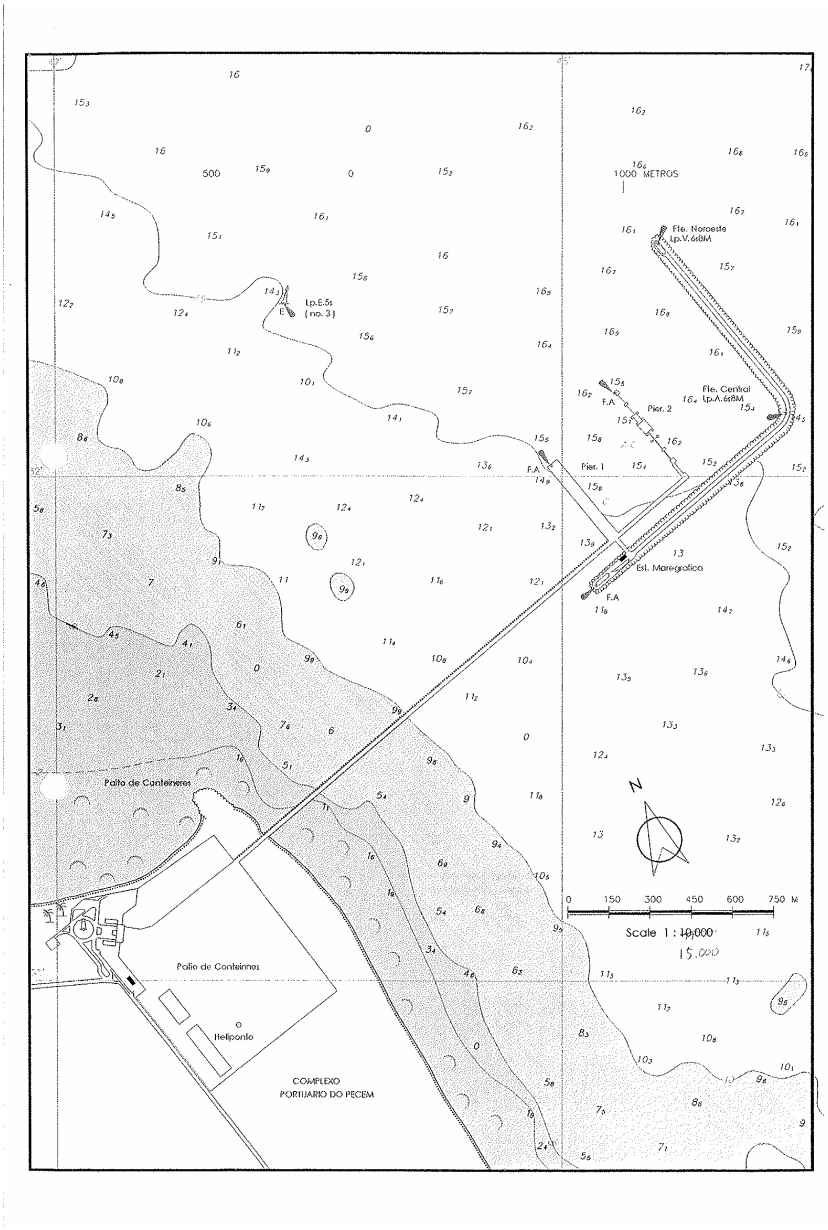


Figure 2.6.1 Facility Layout of Pecem Port

(1) Pier 1 (for handling solid bulk, break-bulk and containers cargoes)

Infrastructures

- Specification
- Length (363 x 2 berths) 726.0m
- Width 45.0m
- Maximum bearing capacity 10 tons/m^2

- Cargo handling capacity (Berth-1) 100 tons
  (Berth-2) 158 tons
- Water Depth 15.0m
- Access channel water depth 15.5m~18.0m
- No1 (Inner) (Southwest): Cargo type: Bulk cargo: Raw materials for CIPP
- Maximum vessel size: Panamax type of up to 65,000 DWT
- No2: (Outer) (Northeast): Cargo type: Break-bulk cargo and containers
  Maximum vessel size: Cape size type of up to 65,000 DWT.

Equipment

No1 (Internal): One (1) unit of rail-mounted gantry type un-loader (lifting capacity 35/45tons) of rope trolley type with a grab bucket (clam shell type), with nominal capacity of 1,250 tons per hour for mineral bulk ore cargo.

No2 (External): One (1) unit of rail-mounted level lifting type crane (lifting capacity 35 tons)

Two (2) units of tyre-mounted mobile harbour cranes (Model HMK300) for handling 20'/40' containers, average cycle times in discharging and loading are about 3.5 minutes and 4.0 minutes, respectively.

Table 2.6.1 Quay Side Equipment

Kind of Crane	Capacity	Unit	Manufacture	Year
Mobile Harbour Crane	100 tons	2 Units	Gottward (HMK-300)	2003
Mineral Ore Un-loader	35/45 tons	1 Unit	ZPMC of China	2000
Level Luffing Crane	35 tons	1 Unit	ZPMC of China	2000

(2) Pier 2 (for handling liquid bulk cargo)

Infrastructures

- Berth length (300m x 2 berths) 414m
- Berthing area With No-4 dolphin 775m^2
  With No-8 dolphin 500m^2
- Maximum water depth 16.50m
- Access Bridge: Width: 40.40m - 10.35m
  Length 1,440m^2
- Beam for supporting pipelines: Width: 6.2m
- Loading arm length: 17.0m
- Fire resistance in compliance with IMO rule 1 Set

Two (2) docking berths, outer (No.4) and inner (No.3): capacity of 25.0 million/year at each berth with berth occupancy rate of 87%

The outer berth permits the operation of vessels of up to 175,000 ton/berth (Afra Max type); the inner berth able to handle vessels in the range 9,000 DWT (domestic size carrier) up to 100,000 DWT(medium size tanker)/berth.

Installations on the operation platform and pipe-line have enough capacity for motionless both incoming and outgoing products, making possible simultaneous operations with both mooring berths;

Equipment

No.3 (Inner); Gasoline / alcohol of one (1) set (12")
Diesel oil / kerosene of one (1) set (12")
Fuel oil of one (1) set (10")
Liquid Petroleum Gas one (1) set (8")
No.4 (Outer) Gasoline / alcohol of one (1) set (12")
Diesel oil / kerosene one (1) set (12")
Fuel oil one (1) set (10")

(3) Open Yard and Warehouse

The open yard mainly used for container stacking and marshalling and partly for storing general cargo has a surface area of 300,000m^2 (600m x 500m) in total. Two (2) million square meters of land is reserved for future expansion.

Two (2) warehouse with 10,000m² (import cargo) and 6,250m² (export) for general cargo, respectively, are prepared to receive and release cargoes stuffed and un-stuffed there.

Equipment

Equipment used at the open yard and warehouses w is shown in Table 2.6.2.

Table 2.6.2 Container Yard and Warehouse Equipment

Kind of Equipment	Unit	Capacity	Manufacture	Year
Reach Stacker	5 Units	70 tons	Ferrari	2001~2005
Top Loader	1 Unit	39 tons	Milan	1987
Top Loader	2 Units	33 tons	Milan/Hyster	19987~1988
Fork Lift Truck	1 Unit	15 tons	Milan	2002
Fork Lift Truck	1 Unit	12 tons	Milan	2002
Small Fork Lift Truck	4 Units	4 tons	Hyster	1991~1997
Small Fork Lift Truck	6 Units	2.5 tons	Hyster	1993~2001
Tractor Head/Chassis	It arranges vessel operation and if necessary by yard operation			

Source: CEARAPORTOS

(4) Gate Facility

- Receiving lane3 Lanes
- Delivery lane 3 Lanes
- Weighting Bridge (capacity 80 tons): 2 units

(5) Security System

The securities monitoring system corresponding are compliance with ISPS code.

2.6.2 Port Operation Service

(1) Outline of the Establishment of Pecem Port

The Pecem Port Complex was established in 1995. In November, 2001 the port began to operate and the port was named Complex Industrial Port of Pecem (CIPP). Figure 6.2.2 shows the organization structure of the CEARAPORTOS.

The number of port proper staff is about 30 persons and other party organization staff about 100 persons (Shipping Agents, stevedore and Terminal operation staff etc,) as on 30th April 2005.

Regarding the development of Pecem Port, the basic principles are stipulated in Law No. 8630 and it became effective as of December 22, 1995 pursuant to Law No. 12,536. It was formally notified by CVM (Valores Formuladatutrs' Commission) of Ceara State.

Regarding the privatisation of the Port, Law No.8630 Art.6 is generally applied.

In order to introduce modernized equipment and facilities and to avoid risk for the customers, Pecem Port is administered by the state government. This is because the state government is pursuing following three aims;

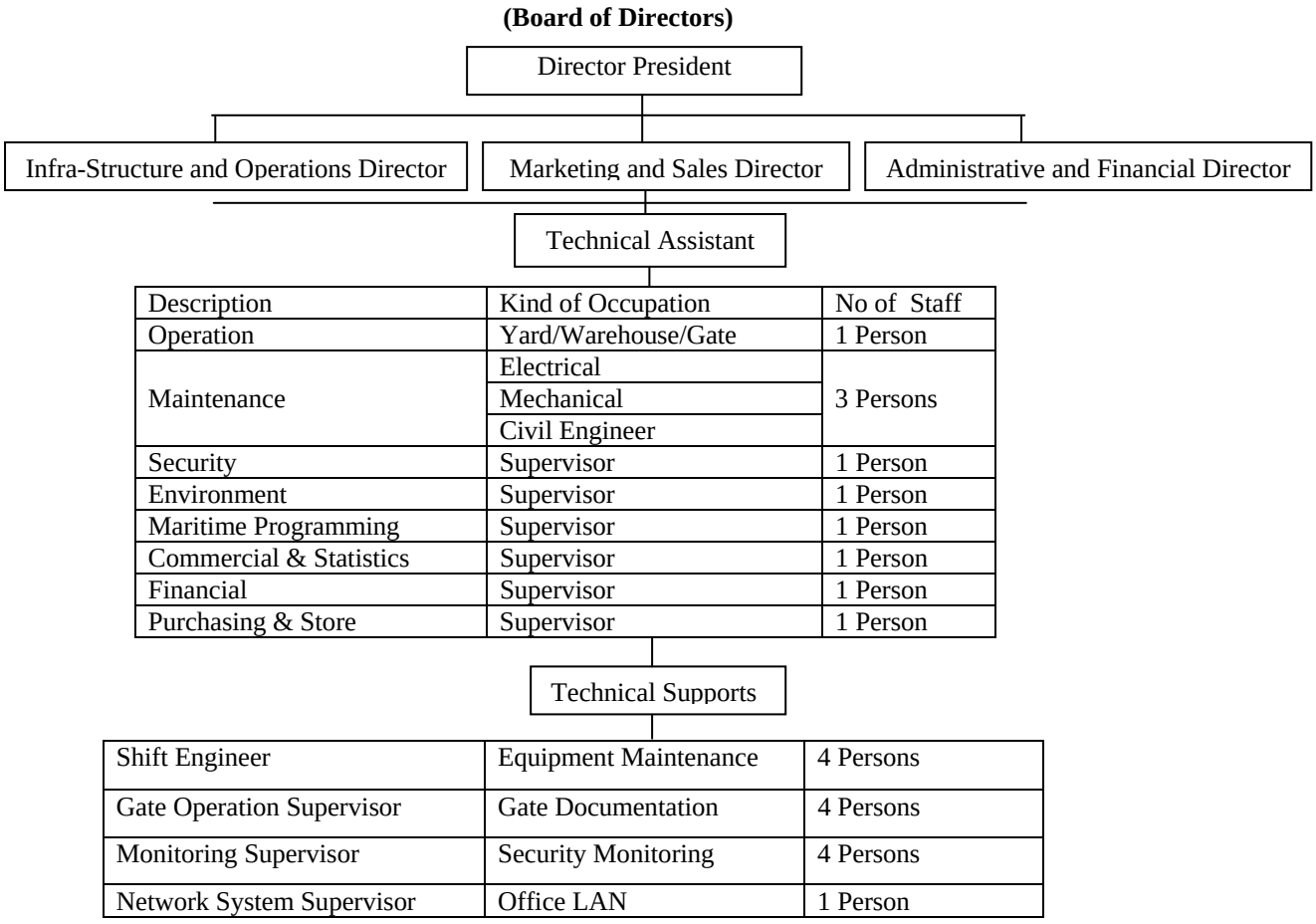
- The exportation of agricultural and marine products
- Supply of energy to adjacent areas
- Attraction of heavy industries as well as light industries

In light of these aims, Pecem Port is positioned as a logistics base for agricultural and industrial products, whose business territories include MERCOSUL, NAFTA and EU.

By the development of Pecem Port, as economic developments of Ceara state and potential area for international market, CEARAPORTOS, with its efficient facilities and organization, will contribute positively and significantly to Brazil as well as worldwide economy.

(2) Organization of Port

Only four years have passed since the opening of Pecem Port, which is the newest in Brazil. However, the actual number of calling vessels in 2004 is only 259 and its berth occupation ratio (actual mooring hours/annual working hour) is less than 20%, both of which are insufficient for the port capacity. The organization of the port complex is shown in the organizational chart (Figure 2.6.2) below, which indicates organizational imperfection. At least, divisions of "public relation and "port promotion" are required.



Description	Kind of Occupation	No of Staff
Operation	Yard/Warehouse/Gate	1 Person
Maintenance	Electrical	3 Persons
	Mechanical	
	Civil Engineer	
Security	Supervisor	1 Person
Environment	Supervisor	1 Person
Maritime Programming	Supervisor	1 Person
Commercial & Statistics	Supervisor	1 Person
Financial	Supervisor	1 Person
Purchasing & Store	Supervisor	1 Person

Shift Engineer	Equipment Maintenance	4 Persons
Gate Operation Supervisor	Gate Documentation	4 Persons
Monitoring Supervisor	Security Monitoring	4 Persons
Network System Supervisor	Office LAN	1 Person

Figure 2.6.2 Organization Chart of Ceara Port

(3) Port Operation Services

1) Pilot Services

This is compulsory for all vessels. There are specific boarding point 3.5 nautical miles off shore and vessels must wait there, flying flag "G" either at anchor or under way, Operation is and 24 hours per day.

Pilot Boat	**"Jeri"**	**Multiple-purpose use (Survey and Inspection)**

2) Tug Boat Services

Tug-boat services are compulsory for all calling vessels in Pecem port. Usually 2 tugs of 1,820 hp and 1,010 hp are stationing at the port, and are available 24 hours per day.

Name of Tug Boat	Length	Width	H/Power	Purpose
"AQLILA"	26-00	8-00	1,010	Assistant for mooring
"ERIDANUS"	24-96	7-80	1,830	Assistant for mooring

(4) Other services

a. Loading and Unloading Container to/from Rail Wagon

If there is a request from shipping company or its agent and shipper or consignee、24-hoursoperation is possible.

b. Fresh Water supply

If necessary, service available.

c. Fuel Oil Supply

:If necessary, service available by

d. Hull and engine Repair

Arranged from Fortaleza

e. Garbage disposal

Not available.

2.7 Present Condition of Pecem Port Industrial Activity, Development Plan and the Policy

2.7.1 Existing situation of Industrial Activities in the State of Ceara

Most of the companies coming to Ceara state claim the reason for locating their plants in Ceara is the incentive of the state government and the relatively low labour cost of qualified human resources. According to the IBGE regional accounts report, the per-capita GDP of Ceara is very low; 5th from the bottom in 27 states, and also within the Northeast region. Although the per capita GDP does not necessarily mean a low pay to the labour, there should be some inter connection with this regard. Ceara government is aware of this fact and trying to put priority in inducing the incoming investment to eventually improve personal wage.

Table 2.7.1 Per Capita GDP by State (R$)

Region/State	1998	1999	2000	2001	2002	2003
NORTE	**3,304**	**3,392**	**3,871**	**4,255**	**4,939**	**5,512**
Rondônia	3,453	3,541	3,888	4,123	4,843	5,743
Acre	2,730	2,865	3,048	3,347	3,833	4,338
Amazonas	5,625	5,646	6,663	7,125	8,374	9,100.
Roraima	2,445	2,540	3,347	3,528	4,162	4,569
Pará	2,608	2,710	3,007	3,383	3,887	4,367
Amapá	3,385	3,542	4,216	4,628	5,233	5,584
Tocantins	1,742	1,861	2,117	2,591	2,931	3,346
NORDESTE	**2,549**	**2,688**	**2,998**	**3,233**	**3,694**	**4,306**
Maranhão	1,308	1,409	1,616	1,782	1,949	2,354
Piauí	1,578	1,672	1,863	1,930	2,113	2,485
Ceará	***2,602***	***2,643***	***2,774***	***2,833***	***3,129***	***3,618***
Rio Grande do Norte	2,524	2,771	3,319	3,463	4,039	4,688
Paraíba	2,136	2,312	2,670	2,946	3,311	3,872
Pernambuco	3,190	3,301	3,655	3,938	4,482	5,132
Alagoas	2,219	2,289	2,471	2,631	3,012	3,505
Sergipe	2,904	3,068	3,283	4,469	5,082	6,155
Bahia	3,015	3,230	3,666	3,934	4,629	5,402
SUDESTE	**7,522**	**7,881**	**8,713**	**9,240**	**10,086**	**11,257**
Minas Gerais	5,112	5,269	5,888	6,215	6,775	7,709
Espírito Santo	5,774	6,105	6,880	7,078	7,631	8,792
Rio de Janeiro	7,134	7,991	9,513	10,092	11,459	12,671
São Paulo	8,990	9,251	9,919	10,547	11,353	12,619
SUL	**6,502**	**6,922**	**7,650**	**8,326**	**9,157**	**10,998**
Paraná	6,066	6,489	6,847	7,457	8,241	9,891
Santa Catarina	6,225	6,708	7,844	8,462	9,272	10,949
Rio Grande do Sul	7,054	7,441	8,302	9,071	9,958	12,071
CENTRO-OESTE	**5,560**	**5,442**	**6,498**	**7,177**	**8,166**	**9,278**
Mato Grosso do Sul	4,963	5,280	5,656	6,448	7,092	8,634
Mato Grosso	4,093	4,713	5,297	5,585	6,773	8,391
Goiás	3,611	3,614	4,276	4,840	5,921	6,825
Distrito Federal	12,747	10,960	14,224	15,517	16,361	16,920.
BRASIL	**5,518**	**5,771**	**6,430**	**6,896**	**7,631**	**8,694**

According to IBGE 2002 sector-wise structure of GDP statistics, Ceara's agriculture produces 6.1% of GDP, lower against total Brazil's 9.6%. Transformation industry's 17.7% is also lower than total Brazil's 25.4%. Public administration's 21.3% contribution is far higher than total Brazil's 15.1%, also construction's share is high in Ceara (14.5%) compared with total Brazil's 7.3%. Other sub-sectors don't show much difference between Ceara and Brazil.

Within the Nordeste, Ceara's agriculture share of 6.1% is lower than all the other states. Ceara's transformation industry's 17.7% in the middle group, lower than Paraiba (19.1%), Alagoas (22.7%), and Bahia (27.9%).

Export-Import balance turned plus in 2003, and the expected increase as Ceara's export drive continues. The top destination country in 2004 was the U.S.A., followed by Argentina, Netherlands, Spain, Italy, Mexico, Canada, France, Hong Kong and Germany. The Group of Latin American countries belong to the next group. Top

origin countries of Ceara's import were Argentina, the U.S.A., Netherlands, Saudi Arabia, China, India Italy, Ukraine, Germany and Paraguay.

Top export items in 2004 in value were cashew nuts, leather, leather footwear, denim, shrimp, lobster, fresh melon, in this order. Top import items were, in the order of value, diesel oil, wheat, cotton, steel coil, polyester resin.

Table 2.7.2 Ceara Export by product

PRODUTOS/SETORES	EXPORTAÇÕES 2004 (US$ FOB)	PART. 04 (%)	EXPORTAÇÕES 2003 (US$ FOB)	PART. 03 (%)	VAR. 04/03 (%)
Calçados	186.520.089	21,70	167.514.704	22,01	11,35
Castanha de Caju (amêndoa)	142.109.570	16,54	109.947.173	14,45	29,25
Têxteis	125.291.209	14,58	125.226.813	16,46	0,05
Couros e peles	110.546.242	12,86	87.647.025	11,52	26,13
Camarão	65.187.775	7,59	80.944.384	10,64	-19,47
Lagosta	40.097.728	4,67	30.756.009	4,04	30,37
Ferro e suas obras	32.922.116	3,83	16.101.479	2,12	104,47
Frutas	24.828.848	2,89	21.561.620	2,83	15,15
Confecções	19.075.772	2,22	13.759.502	1,81	38,64
Cera vegetal	13.781.950	1,60	10.490.835	1,38	31,37
Granito e suas obras	11.673.252	1,36	5.927.295	0,78	96,94
Acessórios de couro, têxteis e outros	10.306.024	1,20	12.808.473	1,68	-19,54
Sucos ou conservas de frutas	10.471.778	1,22	5.620.058	0,74	86,33
Máquinas e equipamentos mecânicos	7.579.764	0,88	2.466.477	0,32	207,31
Outros freios e suas partes	7.679.324	0,89	8.482.810	1,11	-9,47
Demais	51.297.586	5,97	61.672.657	8,10	-16,82
TOTAL EXPORTADO	**859.369.027**	**100**	**760.927.314**	**100**	**12,94**

Source: SDE

Table 2.7.3 Ceara Import (by product)

PRODUTOS	IMPORTAÇÕES 2004 (US$ FOB)	PART. 04 (%)	IMPORTAÇÕES 2003 (US$ FOB)	PART. 03 (%)	VAR. 04/03 (%)
GASÓLEO (ÓLEO DIESEL)	124,345,773	21.68	33,103,839	6.12	275.62
TRIGO (EXC.TRIGO DURO OU P/SEMEADURA),E TRIGO	89,666,184	15.63	99,048,603	18.32	-9.47
OUTROS TIPOS DE ALGODÃO NAO CARDADO NEM PENTE	44,282,876	7.72	42,087,392	7.78	5.22
ALGODÃO SIMPLESMENTE DEBULHADO,NAO CARDADO NE	23,488,797	4.10	23,421,940	4.33	0.29
LAMIN.FERRO/AÇO,A FRIO,L>=600MM,EM ROLOS,0.5MM<	13,206,912	2.30	7,660,463	1.42	72.40
TEREFTALATO DE POLIETILENO EM FORMA PRIMÁRIA	12,386,866	2.16	9,641,557	1.78	28.47
METAMIDOFOS	8,940,743	1.56	3,762,346	0.70	137.64
LAMIN.FERRO/AÇO,L>=600MM,GALVAN.OUTRO PROC.E<4.	8,094,023	1.41	11,083,417	2.05	-26.97
CHAPAS DE LIGAS ALUMÍNIO,0.2<E<=0.3MM,L>=1468	7,875,672	1.37	4,863,759	0.90	61.93
OUTS.FIO-MÁQUINAS DE FERRO/AÇO,N/LIGADO,SEC.C	7,531,352	1.31	2,052,986	0.38	266.85
FIBRAS DE POLIESTERES,NAO CARDADAS,NAO PENTEA	7,521,887	1.31	3,265,768	0.60	130.33
ÓLEOS DE DENDÊ,EM BRUTO	7,381,732	1.29	5,433,022	1.00	35.87
LAMIN.FERRO/AÇO,A FRIO,L>=600MM,EM ROLOS,1MM<E<	7,196,451	1.25	3,618,800	0.67	98.86
FIO TEXTURIZADO DE POLIESTERES	6,852,837	1.19	5,903,222	1.09	16.09
OUTS.COMPOSTOS HETEROCICL.CONT.CICLO TRIAZOL	6,216,435	1.08	---	xxxx	xxxx
OUTROS AGENTES DE APRESTO/ACABAMENTO,ETC.P/IN	5,859,235	1.02	4,203,046	0.78	39.40
Demais produtos	192,742,269	33.60	281,625,772	52.08	-31.56
TOTAL IMPORTADO	**573,590,044**	**100**	**540,775,932**	**100**	**6.07**

Source: SDE

The number of establishments of transformation industry in Ceara was 15,465 in 2003, 3.49% up from 2002. Apparel is the top at 4,213 followed by food processing (2,979), and non-metallic minerals (1,051). Official employment by transformation industry was 176,611 as of the end of 2004, up from end 2003 by 7.38%. Top employer was footwear (46,210), followed by apparel (34,167), food processing (28,921). It is estimated that there is similar magnitude of unofficial employment. Concentration of the transformation industry in establishment numbers and employment is noticeable. Municipality wise, Fortaleza has 50.35% of establishments and 36.82% of employment. Top 10 municipalities (Fortaleza, Maracanau, Sobral, Caucaia, Eusebio, Juazeiro do Norte, Pacajus, Horizonte, Crato, Maranguape) has 69.10% of establishments and 78.75% of employment. Except for Sobral, Juazeiro do Norte and Crato, 7 municipalities of the above-mentioned belong to Fortaleza metropolitan area.

2.7.2 State Government's efforts in the promotion of Industrial activities

There are several incentives available for the new investment in Ceara as explained in Investor's Guide and a pamphlet titled General Information, both by SDE:

(1) Exemption of ICMS (sales tax)

- Exemption of destination state ICMS for domestic equipment
- Deferment of ICMS on imported equipment
- Deferment of ICMS for 1 year on imported raw material
- Exemption of Income Tax
- Exemption of Municipality Tax
- BNDES and BNB loans
- Investment of part of income tax-FINOR System
- Credit line on working capital based on ICMS due –PROVIN and import of finished goods for resale
- Other exemptions such as tax on maritime freight and tax related to import exchange operation, both applicable up to 2010

Total picture of the incentive system is difficult to grasp for a foreigner or a third party. It is recommended to issue a textbook available for public and through website with sufficient numbers of actual examples.

Economic Development Policy of the government of Ceara, issued by SDE highlights following aspects for industrial development.

- Interior-bound trend of the industrial sector
- Promotion of industry competitiveness
- Support to the implantation of micro, small and medium industrial companies
- Consolidation of Pecem Industrial and Port Complex
- Promotion of science and technology as a strategic component for the industrial development

- Promotion of the innovating and venturing industrial view
- Industrial Development Support and Incentive Policy

The Incentives system is defined in the Economic Development Policy as a mechanism to optimize the available resources with selectivity for adjusting the system to economic and sector-based guidelines. Projects to be attracted are to be significant for:

- Generation of direct and indirect jobs
- Development of micro, small and medium companies, and creation of first-job opportunities
- Use of local raw material
- Production of high socioeconomic impact
- Regional development decentralization and interior-bound trend
- Supply chain strengthening and consolidation
- Heavy industry, technology-based industry, biotechnology and information technology industries
- Transfer of technology to Ceara companies

Based on the above mentioned policy, Industrial Development Fund grants incentive in the form of loan, in accordance with the benefit calculated through points system. Transformation industries eligible to the above benefits include

- Structuring industries, including capital goods industry, such as ironworks, alternative power, refineries, machines, equipment and respective parts and components
- Manufacturing industries, especially those strengthening the local productive chains, such as leather-footwear chain, ready-made cloth chain, furniture chain, textile chain, electro-electronics chain, metal-mechanics chain
- High-technology industry or technology-based industry, such as information technology, pharmaco-chemistry, biotechnology, genetic engineering, renewable energy, essential oils, physio-therapeutics
- Recycling industry
- Agro-industry, with respect to its industrial segment

Industries planned for CIPP are; Steel Mill, Refinery, Petrochemicals, Petroleum Tank Yard, Thermal Power Plant, LNG Re-gasification Plant and their downstream and auxiliary industries. In view of the state's industrial promotion policy, those industries which may locate in rural parts of the states are encouraged to do so.

CHAPTER 3 NATURAL CONDITIONS

3.1 Meteorological and Hydrological Conditions

3.1.1 Meteorological Station

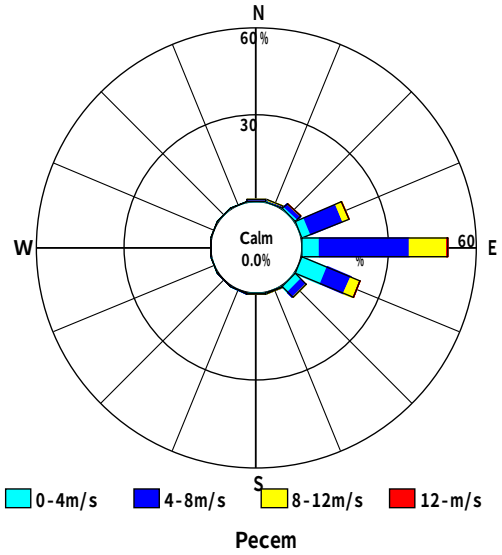
In Ceará State, two organizations are responsible for meteorological data, INEMET (National Institute of Meteorology) and FUNCEME (The Ceará Foundation of Meteorology and Recursos Hídricos). INEMET is under the control of the federal government and has a total of 400 monitoring stations inside the country. There are 13 monitoring stations in Ceará state and the meteorological monitoring in Fortaleza has been carried out since 1961.

FUNCEME is under the control of the Ceará state government and has a total of 35 monitoring stations inside Ceará state. The meteorological observations in Fortaleza have been carried out since 1974. In the Pecém area, an automatic weather station was set up in 2003 in Sao Gonçalo do Amarante located about 20km from Pecém village. However, rainfall observations have been carried out continuously since 1974 in Sao Goncalo do Amarante, and since 1998 in Pecém.

In the Port area, Cearáportos has been carrying out meteorological monitoring since April 2002 using the automatic weather station set on the access bridge. Monitoring of wind (speed and direction), temperature, humidity and air pressure has been conducted at this station. In addition, INPH (Instituto de Pesquisas Hidroviarias) has also been carrying out the meteorological monitoring since 1995.

3.1.2 Wind

Figure 3.1.1 and Table 3.1.1 show the wind rose and the frequency distribution of wind speed and direction in Pecém. The wind direction is almost constantly from ENE to ESE throughout the year with a frequency of 90%. The most frequent wind speed is 4-8 m/s from the East. The characteristics of wind in Pecém are almost the same as those in Fortaleza. Figure 3.1.2 shows the frequency distribution of strong wind exceeding 10 m/s. The strong winds appear from July to November.



Original Data: INPH

Figure 3.1.1 Wind Rose in Pecém

Table 3.1.1 Frequency Distribution of Wind Speed and Direction in Pecém

(Original Data: INPH)

	Average Velocity (m/s)								Total	Av. of Max
Direction	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	(%)	(m/s)
N	0.2%	0.2%	0.1%	0.1%	0.1%	0.0%			0.6%	11.40
NNE	0.2%	0.4%	0.2%	0.1%	0.0%	0.0%			0.8%	10.80
NE	0.2%	1.0%	1.0%	0.4%	0.1%	0.0%	0.0%		2.6%	12.20
ENE	0.5%	2.9%	6.7%	5.1%	1.9%	0.4%	0.0%		17.5%	13.10
E	1.4%	4.7%	12.9%	18.1%	10.2%	2.9%	0.1%		50.3%	13.30
ESE	3.9%	5.4%	4.8%	4.1%	2.7%	0.7%	0.0%		21.7%	13.90
SE	1.0%	2.0%	1.7%	0.6%	0.1%	0.0%			5.3%	11.70
SSE	0.1%	0.2%	0.1%	0.0%	0.0%				0.4%	9.20
S	0.1%	0.1%	0.0%	0.0%	0.0%				0.1%	8.30
SSW	0.1%	0.1%	0.0%						0.1%	5.80
SW	0.0%	0.0%		0.0%					0.0%	6.10
WSW	0.0%	0.0%							0.0%	2.80
W	0.0%	0.0%	0.0%	0.0%					0.0%	6.10
WNW	0.0%	0.0%	0.0%						0.0%	4.70
NW	0.0%	0.1%	0.0%		0.0%				0.1%	9.20
NNW	0.1%	0.1%	0.0%						0.1%	5.80
Total	7.8%	17.0%	27.5%	28.5%	15.0%	4.0%	0.2%		100.0%	13.90

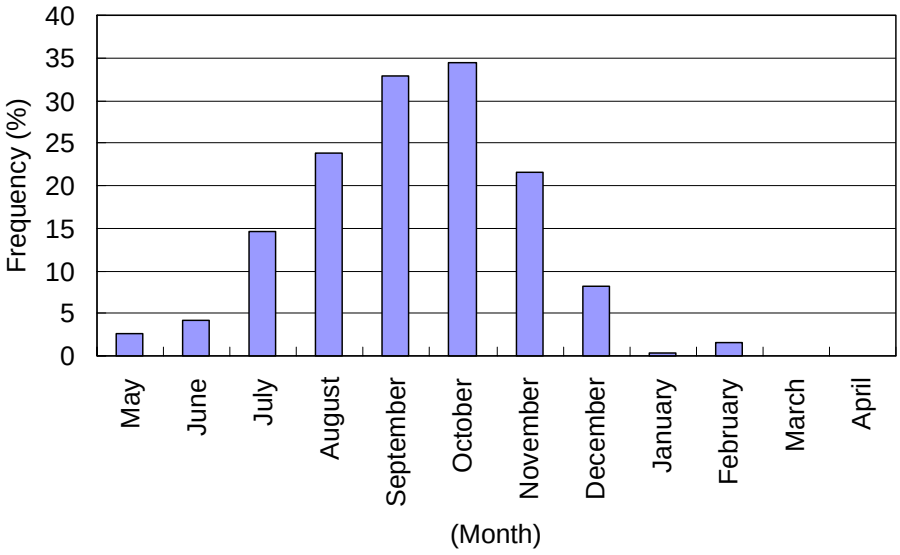


Figure 3.1.2 Frequency Distribution of Strong Wind (U>10m/s) in Pecém

3.1.3 Rainfall

Figure 3.1.3 shows the yearly change of rainfall in Fortaleza from 1974 until 2004. The yearly rainfall changes greatly within a range of about 1,000mm to 2,800mm. This is one of the main characteristics for rainfall in the North-east region of Brazil. The average rainfall in the past 40 years was 1,645mm.

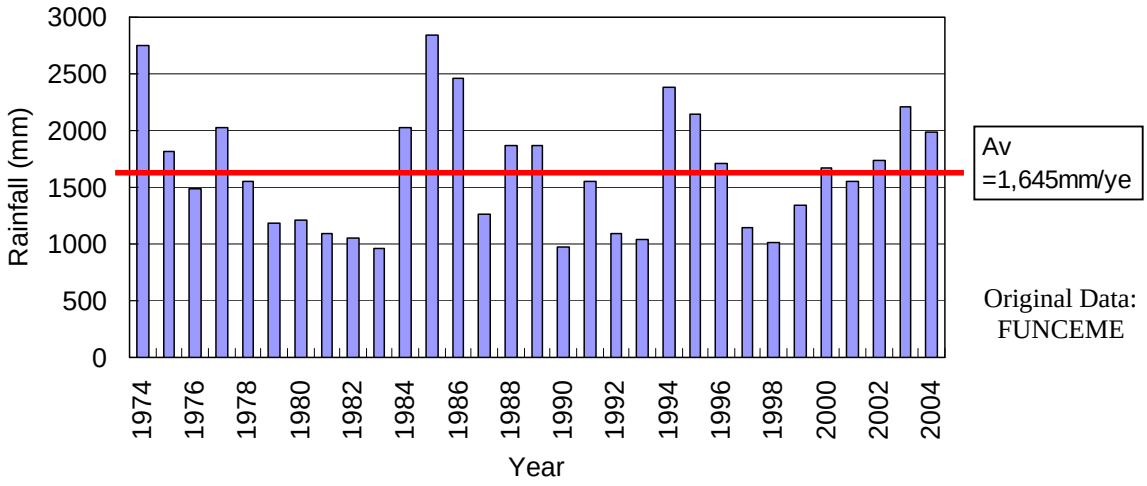


Figure 3.1.3 Yearly Change of Rainfall in Fortaleza (from 1974 to 2004)

Figure 3.1.4 shows the monthly change of rainfall in Fortaleza. Generally, the rainy season is from January to June, especially in March and April, when it gets really rainy. The dry season is from August to December when there is rarely any rainfall.

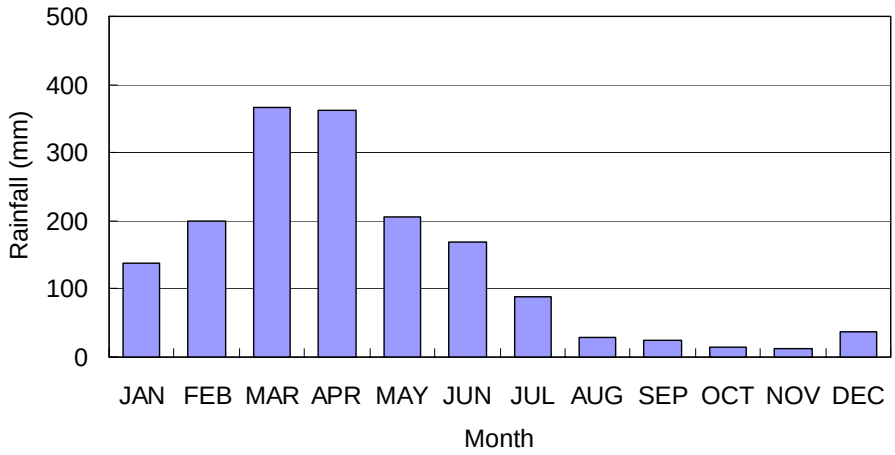
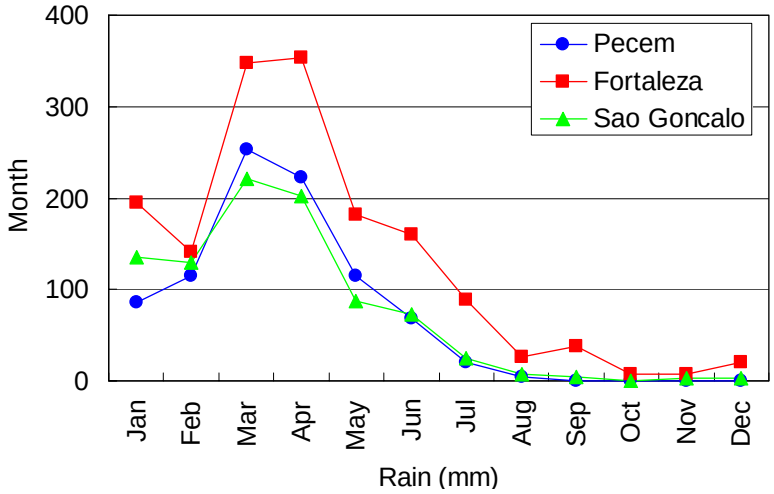


Figure 3.1.4 Monthly Change of Rainfall in Fortaleza (Source: FUNCEME)

The rainfall was compared in three locations, Fortaleza, Pecém and Sao Gonçalo do Amarante. Figure 3.1.5 shows the monthly rainfall for three locations from 1998 to 2004. The pattern in Sao Gonçalo do Amarante, which is 20km from Pecém, is almost the same as that of Pecém. However, the rainfall at the two locations is about 60% of that in Fortaleza.



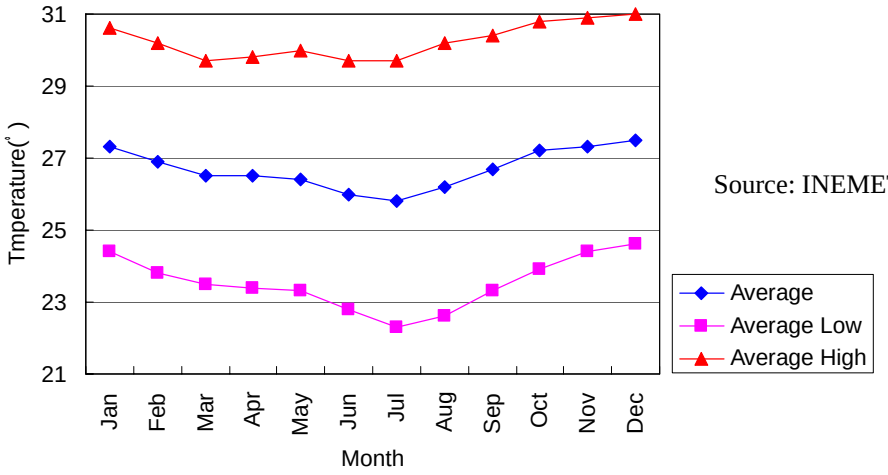
Original Data: FUNCEME

Area	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Pecem	86	115	254	222	115	68	20	4	0	0	0	0	884
Fortaleza	194	141	347	354	182	160	89	26	38	7	7	21	1565
Sao Goncalo	136	129	222	203	87	72	24	8	4	0	3	2	891

Figure 3.1.5 Monthly Change of Rainfall for Three Locations

3.1.4 Air Temperature

The monthly air temperature in Fortaleza is shown in Figure 3.1.6. The air temperature in the coastal area in Ceará state is almost constant throughout the year. The average temperature is 26.7℃, the average high is 30.3℃ and the average low is 23.5℃. From June to August, the air temperature becomes slightly lower than during the other months.



Source: INEMET

Temperature	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Av.
Average	27.3	26.9	26.5	26.5	26.4	26	25.8	26.2	26.7	27.2	27.3	27.5	26.7
Average Low	24.4	23.8	23.5	23.4	23.3	22.8	22.3	22.6	23.3	23.9	24.4	24.6	23.5
Average High	30.6	30.2	29.7	29.8	30	29.7	29.7	30.2	30.4	30.8	30.9	31	30.3

Figure 3.1.6 Monthly Change of Air Temperature at Fortaleza (1961-1990)

3.2 Oceanographic Conditions

3.2.1 Tide

The tide condition in Pecém is presented in the sea chart, which was published in 2002 by the hydrographic office of the Brazilian Navy as follows.

MHWS (Mean High Water Springs)	+2.7 m
MHWN (Mean High Water Neap)	+2.1 m
MLWN (Mean Low Water Neap)	+0.9 m
MLWS (Mean Low Water Springs)	+0.3 m
MSL (Mean Sea Level)	+1.5 m

(From NR DHN reference Level)

INPH has been performing continuous measurements of water level in Pecém and Mucuripe port. Table 3.2.1 shows the observed sea water levels in Pecém from March 1996 to October 2001. The tidal range is of the order of 3m.

Table 3.2.1 Observed sea water levels at Pecém

Maximum	Medium	Minimum
+3.16	+1.45	-0.26

A harmonic analysis was conducted using this observation data. Table 3.2.2 shows the analyzed harmonic constant, which is calculated by using the data of 273 days.

Table 3.2.2 Harmonic Constants at Pecém

Harmonic Constants	H(cm)	Grad.
O1	6.43	181.15
K1	7.11	218.54
M2	90.71	133.76
S2	29.24	154.41
N2	19.19	118.86
K2	7.83	148.31

The tidal currents, which were observed over the time period of 2 weeks using an electromagnetic current meter, are very weak, of the order of 0.1m/s.

3.2.2 Waves

(1) Wave Statistics

INPH has carried out wave observations in both Mucuripe Port and Pecém Port. The wave observations at Mucuripe port were conducted from 1991 to 1995 by means of a buoy type wave meter, a Wave Rider, located approximately 1 km offshore of Mucuripe port with the water depth of 15m as shown in Figure 3.2.1. The measurement of wave direction was carried out by visual observation.

The wave observations at Pecém port have been carried out since 1997 with a directional wave rider located approximately 4 km offshore with the water depth of

18m as shown in Figure 3.2.1. The measurements are conducted every 3 hours with an observation period of 20 minutes. The observed data is automatically transmitted to the landside station using a telemeter system. Ceará Port has also been carrying out wave monitoring with a laser type wave gage together with a laser Doppler type current meter since 2002 at the tip of Pier No.1. The wave data is measured continuously and the calculated wave statistic parameters such as wave height, period, direction etc. are automatically transmitted to the control room in the Ceará Port office every 3 minutes.

(1) Pecém Port **(2) Mucuripe Port**

Figure 3.2.1 Location of Wave observations

Table3.2.3 shows the combined frequency distributions of wave height and direction, and of wave height and period. Those have been recalculated using daily wave statistic data since 1997 to 2000.

Here, the significant wave height (H_s) was calculated using the wave spectrum with the relation $H_s=4\sqrt{m_0}$ and the wave period at the peak of the wave spectrum (T_p). Figure 3.2.2 shows the frequency and cumulated distributions of wave height. The monthly frequency distributions for wave height and direction, and wave height and period are shown in the Appendix A.3.2.

The main characteristics of the waves in Pecém are the following:

- The significant wave height with dominant frequency is 1.25 to 1.50 m and rarely exceeds 2m.
- The cumulated frequency of wave height not exceeding 1.0m is 7.2%, not exceeding 1.5m is 66.3% and not exceeding of 2.0m is 96.8%.
- The dominant wave direction is from the ESE with a frequency of 40.3%. The second peak is from the NE with a frequency of 24.5%.

- The dominant wave period is about 5 to 6 seconds. However, long period waves of more than 10 s appear with a frequency of about 20 %.

Table 3.2.3 Frequency Distributions of Wave Height in Pecém (March 1997 to December 2000)

(1) Wave Height (H_s) and Direction

Hs (m) / Direction	～0.5	0.5-0.75	0.75-1.0	1.0-1.25	1.25-1.5	1.50-1.75	1.75-2.00	2.00-2.25	2.25-2.5	Total
N				0.1%	0.0%	0.0%				0.1%
NNE		0.0%	0.5%	2.9%	3.4%	0.7%	0.0%	0.0%	0.0%	7.5%
NE		0.2%	2.5%	10.1%	9.4%	2.1%	0.1%	0.0%	0.0%	24.5%
ENE		0.1%	1.2%	3.8%	3.1%	0.5%	0.0%	0.0%	0.0%	8.8%
E		0.0%	1.1%	4.6%	7.9%	4.1%	1.0%	0.1%	0.0%	18.8%
ESE		0.0%	0.6%	6.0%	14.9%	13.3%	4.5%	0.8%	0.2%	40.3%
SE					0.0%	0.0%				0.0%
SSE										
S										
SSW										
SW										
WSW										
W										
WNW										
NW										
NNW										
Total		0.3%	5.9%	27.5%	38.8%	20.8%	5.7%	0.9%	0.2%	100%

(2) Wave Height (H_s) and Period (T_p)

Hs (m) / Tp (s)	～0.5	0.5-0.75	0.75-1.0	1.0-1.25	1.25-1.5	1.50-1.75	1.75-2.00	2.00-2.25	2.25-2.5	Total
～3										
3-4			0.0%	0.1%	0.0%	0.0%				0.1%
4-5			0.5%	2.5%	1.9%	0.4%	0.0%	0.0%		5.4%
5-6		0.0%	0.6%	6.2%	12.7%	7.0%	1.1%	0.0%		27.6%
6-7			0.3%	1.9%	7.5%	8.0%	3.0%	0.4%	0.0%	21.1%
7-8			1.1%	3.4%	2.8%	2.3%	1.3%	0.5%	0.2%	11.6%
8-9		0.1%	0.9%	2.6%	1.2%	0.1%	0.0%			4.9%
9-10		0.0%	1.0%	3.4%	2.6%	0.6%	0.0%			7.5%
10-11		0.0%	0.1%	0.9%	1.0%	0.2%	0.0%			2.2%
11-12		0.1%	0.4%	1.8%	1.3%	0.3%	0.0%			3.9%
12-13		0.1%	0.2%	1.1%	1.3%	0.3%	0.0%			3.0%
13-14		0.0%	0.3%	1.2%	1.7%	0.4%	0.0%			3.7%
14-15		0.0%	0.2%	1.2%	2.1%	0.6%	0.1%			4.2%
15～			0.1%	1.3%	2.6%	0.7%	0.1%			4.7%
Total		0.3%	5.9%	27.5%	38.8%	20.8%	5.7%	0.9%	0.2%	100%

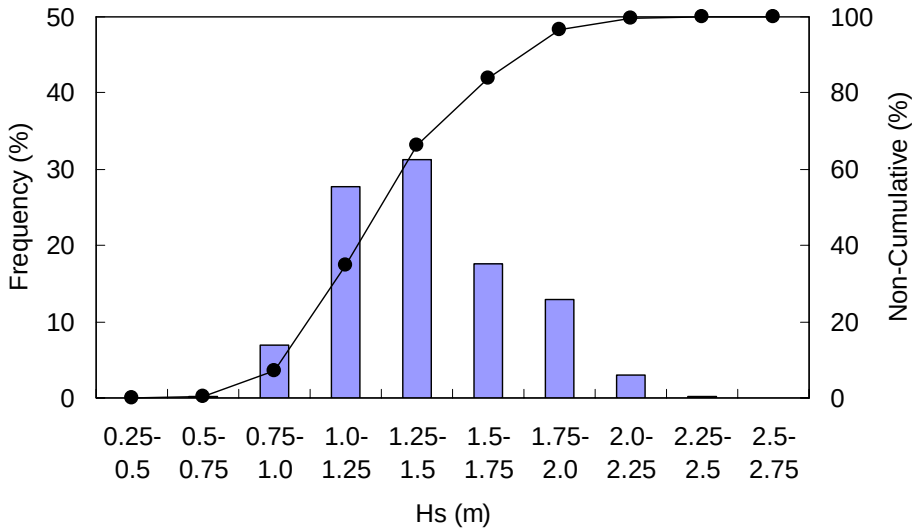


Figure 3.2.2 Frequency and Cumulative Distributions of Wave Height

Figure 3.2.3 shows the monthly change of average values for significant wave height (H_s), wave period (T_p) and wave direction together with the frequency distribution of strong wind with wind speed exceeding 10m/s, in order to make the characteristics of waves at Pecém clear.

- During the period from December to April, that is the rainy season, the wave height becomes smaller and the wave period longer. The dominant wave direction in this season is mostly NE. The long period waves appearing during this season are called “swell waves”.
- During the period from May to November, that is the dry season, the wave direction changes from NE to ESE. The wave height becomes higher than that of the rainy season. It is seen that the average value of significant wave height exceeds 1.5m from August to October. The wave period for this season, at about 6 seconds, is generally shorter than that for the rainy season. The waves appearing in this season are called “sea waves”.
- These differences in wave characteristic between those two seasons are mainly caused by the seasonal change of wind characteristics. During the rainy season especially from January to May, there is a lower frequency of strong winds. On the other hand, a remarkably high frequency of strong winds appears from June to November. Strong winds act on the waves making the wave period become shorter and the wave height higher.

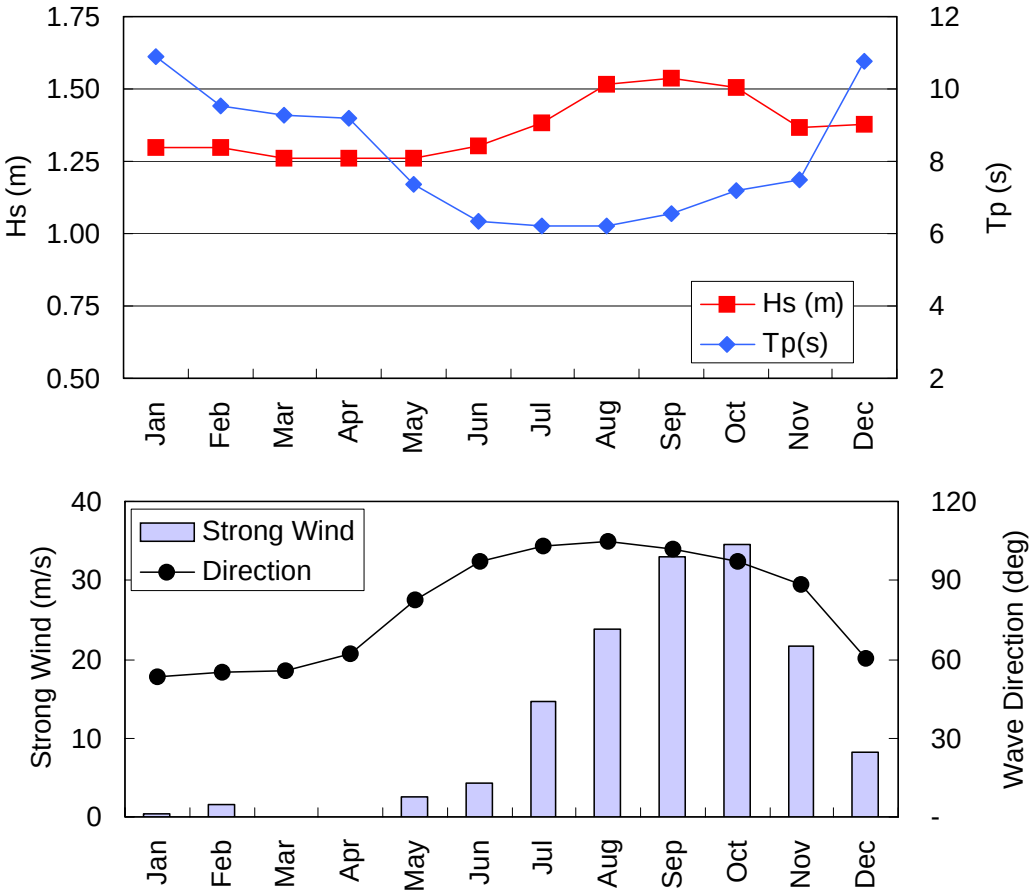


Figure 3.2.3 Monthly Change of H_s, T_p, direction and Frequency of Strong Wind (U>10m/s)

Following, the wave characteristics are compared for two locations, Mucuripe and Pecém Port.

Figure 3.2.4 shows the frequency distributions of significant wave height for each direction. The distribution of wave direction at Mucuripe Port is almost constant with 80% from the ESE. On the other hand, the wave direction at Pecém Port is distributed from ENE to SE. The reason for the difference between the two sets of reported results is mainly the difference in measuring methods. The measurement of wave direction at Pecém port has been conducted using a directional wave meter. In contrast, the visual observation method was applied at Mucuripe port. This latter method makes it difficult to distinguish the long period waves such as swell waves.

Figure 3.2.5 shows the comparison of frequency distributions of wave height and period at Mucuripe Port and Pecém Port. Here, the mean wave period (T_z) was used for the comparison, because the wave period at Mucuripe port was recorded only for this value. The frequency of wave height at Pecém port is distributed in a much higher range than that at Mucuripe port.

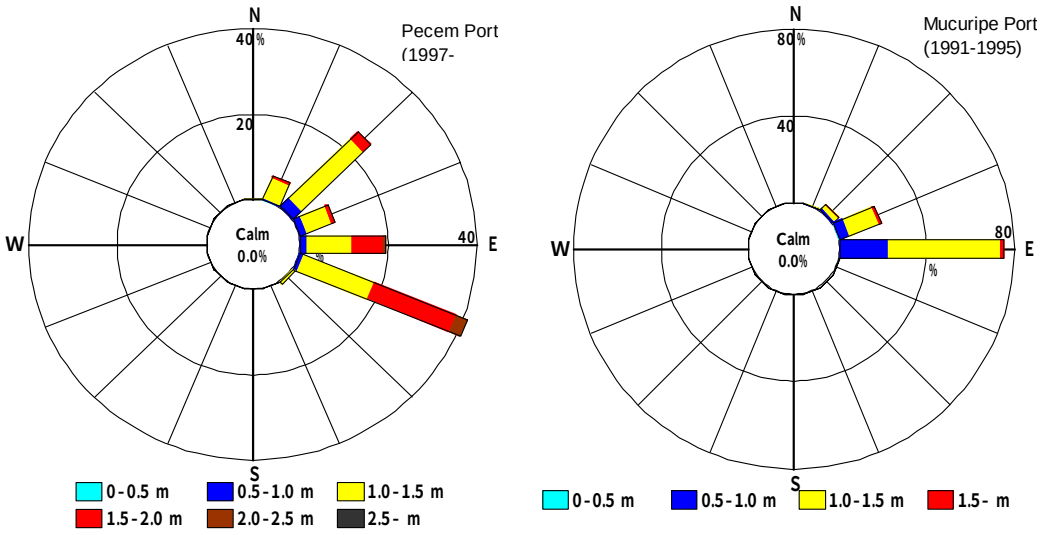


Figure 3.2.4 Frequency Distributions of Wave Height (H_s) for each direction

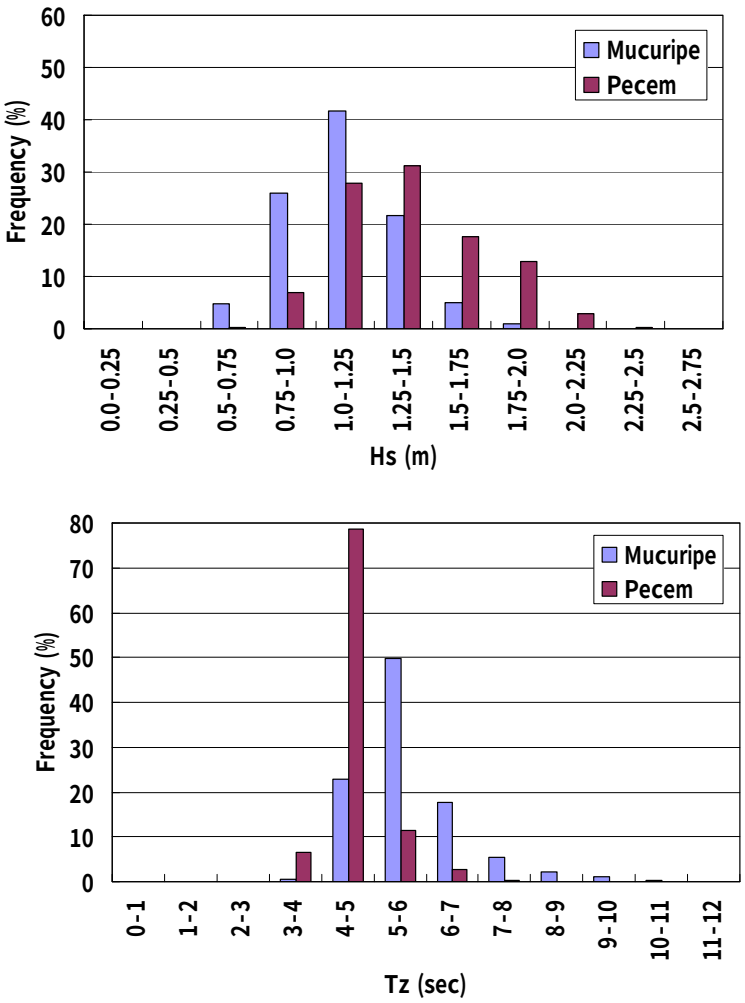


Figure 3.2.5 Comparison of Frequency Distributions of Wave Height and Period at Pecém and Mucuripe Port

Tables 3.2.4 and 3.2.5 show the extreme values of maximum wave height (H_{max}) and significant wave height (H_s) at Mucuripe Port and Pecém Port during each observation period. The greatest maximum wave height was 4.1m at Mucuripe port and 4.7m at Pecém port, and the greatest significant wave height was 2.1m at Mucuripe Port and 2.5m at Pecém Port.

Table 3.2.4 Extreme Values of H_{max} at Pecém and Mucuripe port

H_{max}	Pecem						Mucuripe				
	Date	Time	H_{max} (m)	H_s (m)	$T_{1/3}$ (s)	Direction	Date	Time	H_{max} (m)	H_s (m)	$T_{1/3}$ (s)
1	2-Sep-99	4:20	4.7	2.2	7.7	107(ESE)	2-Dec-02	11:00	4.1	1.8	5.5
2	8-Oct-99	3:20	4.7	2.1	6.7	110(ESE)	20-Oct-94	5:00	4.1	1.9	5.7
3	7-Dec-99	23:15	4.5	2.1	6.3	110(ESE)	10-Dec-93	2:00	3.8	1.9	4.2

Table 3.2.5 Extreme Values of H_s at Pecém and Mucuripe port

$H_{1/3}$	Pecem						Mucuripe				
	Date	Time	H_s (m)	$T_{1/3}$ (s)	H_{max} (m)	Direction	Date	Time	H_s (m)	$T_{1/3}$ (s)	H_{max} (m)
1	23-Jun-98	3:00	2.5	7.7	3.8	105(ESE)	23-Dec-93	23:00	2.1	5.0	3.8
2	1-Oct-00	2:20	2.4	7.1	3.2	108(ESE)	20-Sep-94	5:00	2.1	5.9	3.6
3	25-Sep-98	6:00	2.4	7.7	3.6	107(ESE)	13-Sep-93	23:00	2.0	4.9	3.8

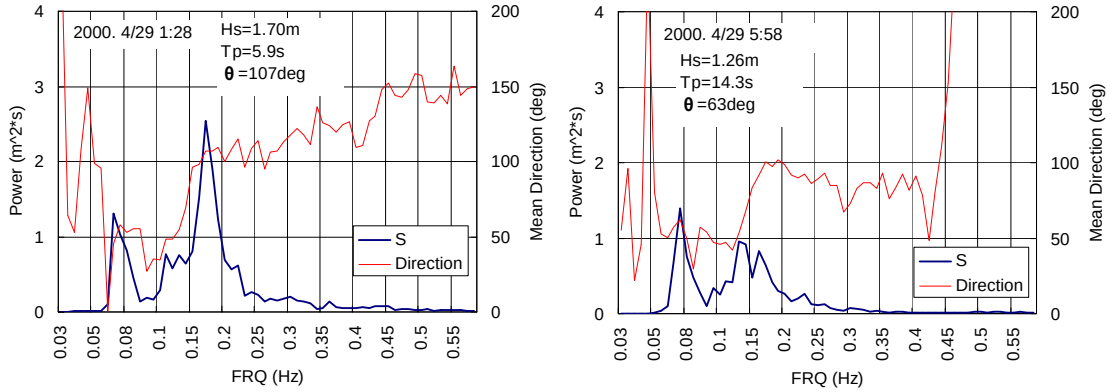
(2) Wave Spectrums

There are two kinds of wave characteristics in Pecém Port: the short crested waves called “sea waves”, due to almost constant E-direction winds, and the long crested waves called “swell waves”, which are transmitted over a long distance from the northern hemisphere. If only statistical parameters such as H_s and T_p were used to characterize the waves, a lot of information of the spectrum would be lost, especially for the swell waves. This has caused the misunderstanding of wave characteristics for the hydraulic study of wave calmness, ship motion, etc. Therefore, it is necessary to know all the characteristics of the wave spectrum.

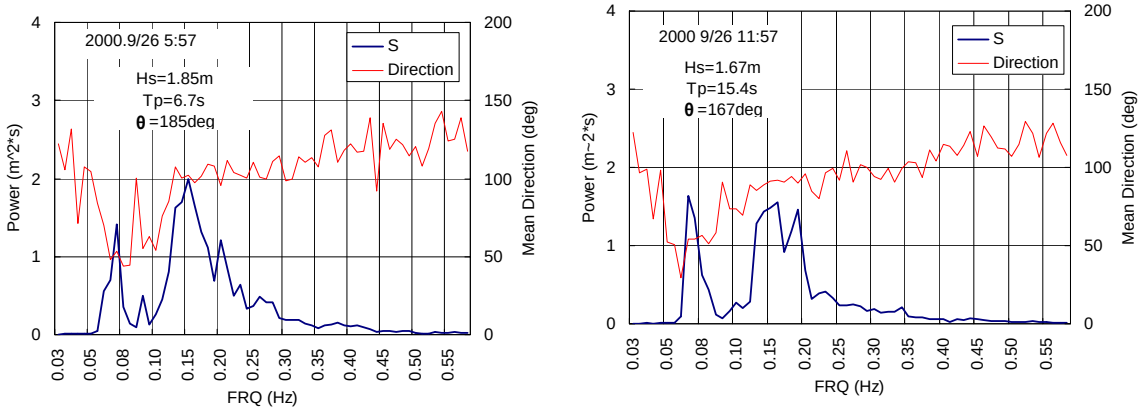
Figure 3.2.6 shows an example of the wave spectrum obtained at Pecém. The upper figure shows the spectrum in April. In this season, it is said that swell waves are predominant. The wave spectrum has two obvious peaks at 0.07 Hz and 0.14 Hz. The peak of 0.07 Hz corresponding to a wave period of 14 s is for the swell wave component, and the second peak of 0.14 Hz corresponding to a wave period of 7 s is for that of sea waves. The mean direction for the first peak is about 50° (NE), and for the second peak, about 100° (E to SSE). Though T_p and θ as the representative values of wave statistics are different for both left and right side figures due to the difference in peak values of spectrum, there exist both swell and sea wave components.

The lower figure shows the spectrum in September. In this season, it is said that sea waves are predominant. However, components of the swell waves are still remaining

in this season and this component is from the direction of about 50° (NE), the same as that in April. From this, it is understood that the components of swell waves exist despite the dry season. Since the components of sea waves in this season become much bigger than in the rainy season, the characteristics of the components of the swell waves are hidden from the representative values such as wave period (T_p) and mean direction. For the medium and large size vessels, the components of swell (long period) waves greatly influence the ship motion.



(1) During Rainy Season (April)



(2) During Dry Season (September)

Figure 3.2.6 Wave Spectrums Obtained at Pecém

3.2.3 Currents

The current observations at Pecém port were carried out by UFC (Federal University of Ceará State) in 1999. In this measurement, three kinds of methods were employed, current meters, current graphs and floaters. Figure 3.2.7 shows the location for each set of measurements. The measurements were carried out for two seasons during May and November in 1999 during the different tide conditions of spring and neap tide and of HWL and LWL. The measurements using current meters were conducted at 12 points in water depth of approximately 18m with every 2m interval in a vertical direction.

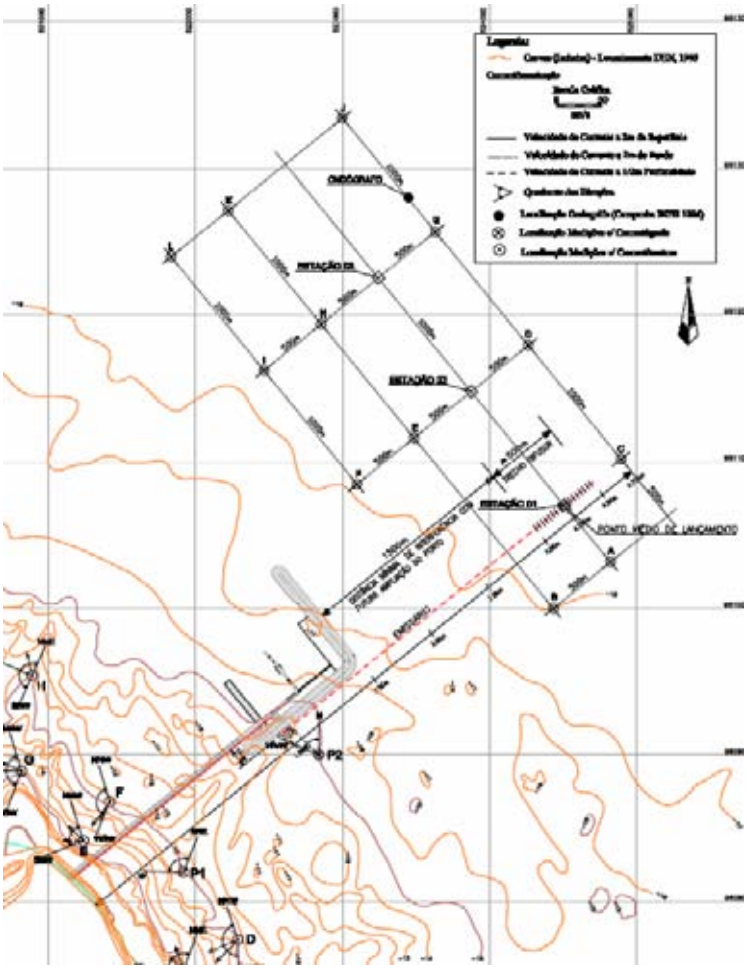
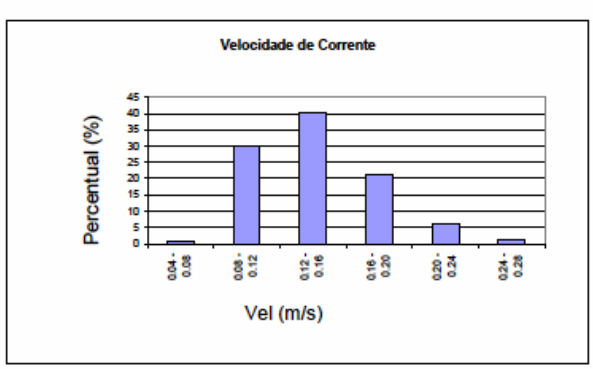


Figure 3.2.7 Location of Current Measurements (UFC, 1999)

Figure 3.2.8 shows an example of observation results produced by the current meter. Although the current speed and direction change slightly, the current speed and direction are distributed around 0.1 to 0.2 m/s and 285°～315°(W～NW) regardless of the differences in each tide condition. As the current speed and direction are not affected by the change in tide conditions, it is thought that this current is the ocean current that exists in this region.

In the shallow water region, a wave-induced current, which is called the “nearshore current”, is formed. Although field observations for nearshore current have not executed yet, a mathematical analysis was conducted by DHI and INPH in 1997. Figure 3.2.9 shows the computed result for the nearshore current under the condition

of Hs=1.75m, Tp=7s and θ=82.5°(E). The strong nearshore current flows mostly within the surf zone. The strength of nearshore current becomes greater in proportion to the wave height. When the waves are incident from the NE to E direction, westward nearshore currents are formed in the surf zone. In Pecém, the waves with high wave height are mostly incident from this direction. This means the westward currents are formed during the high wave conditions. It is important to know the characteristics of the nearshore current for the study of littoral drift and of influence of the surrounding coast.



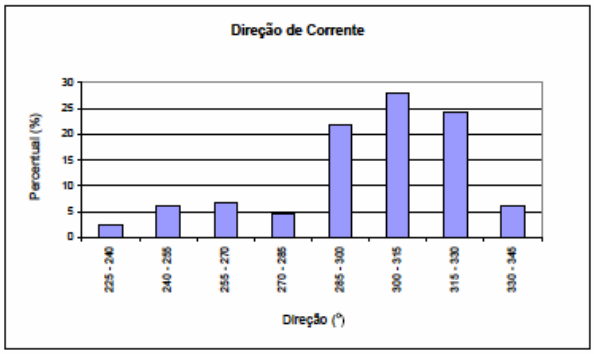


Figure 3.2.8 Example of Current Measurements (UFC, 1999)

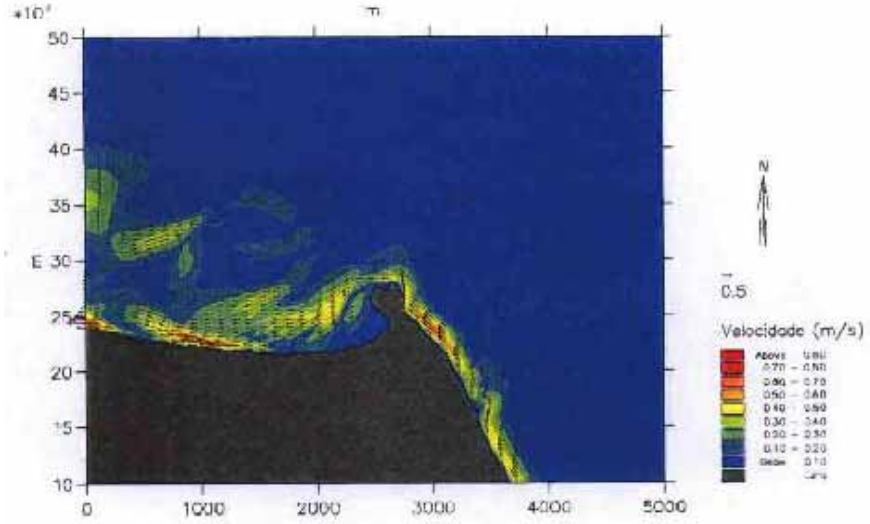


Figure 3.2.9 Example of the Numerical Analysis of the Nearshore Current (DHI & INPH, 1997)

3.3 Geological and Geographical Conditions

3.3.1 Land Side

(1) Geological Map in CIPP Area

Figure 3.3.1 shows the geological map that was made using remote sensing and GIS techniques in the Strategic Environment Evaluation (AAE) study for the area influenced by the CIPP development.

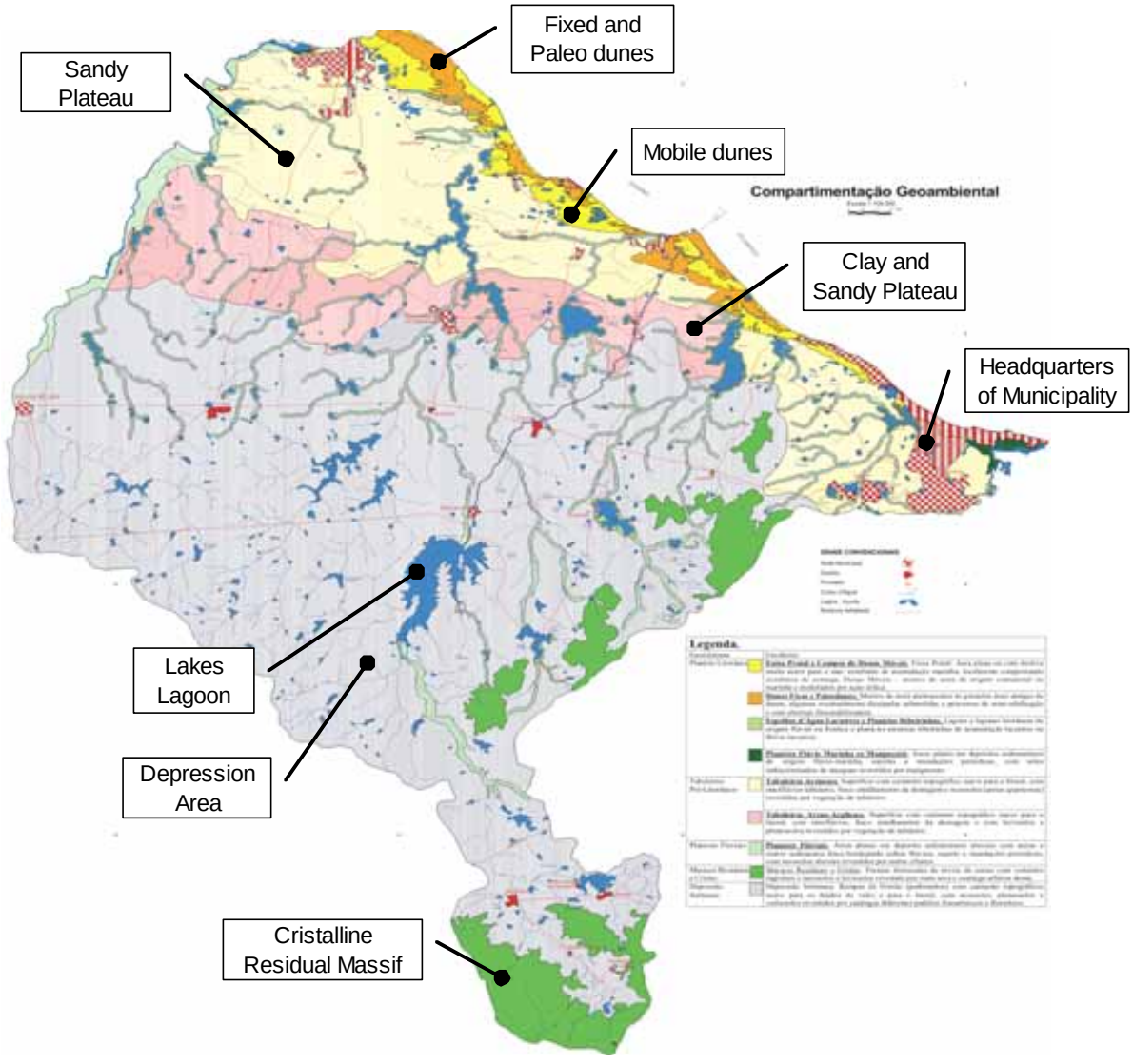


Figure 3.3.1 Geological Map (Source: SEPLAN)

Around Pecém, most coastal regions are coastal dunes. The area behind the coastal region is clay and sandy plateaus.

(2) Coastal Dunes

Along the entire coastline in Ceará state, the coastal dunes spread several kilometres inland from the coast. There are two kinds of coastal dune area; free mobile and fixed and paleo-dunes as shown in Photo 3.3.1.

Along the entire coastline in Ceará state, the coastal dunes spread several kilometres inland from the coast. There are three kinds of coastal dune; mobile dunes, semi-fixed dunes and fixed and paleo dunes as shown in Photo 3.3.1.

Photo 3.3.1 Coastal Dune near the Pecém Port

The fixed and paleo dunes are covered by vegetation. The coastal dunes are formed by wind-blown marine sand due to constant directional wind. Photo 3.3.2 is an aerial photograph of the Pecém coast. The direction of expansion is consistent with that of prevailing wind direction, east. The height of coastal dunes exceeds 30m in some locations. The width of coastal dunes is related to the orientation of the coast line. When the angle between the coast line and the prevailing wind direction is great, the coastal dunes are driven further inland. On the other hand, when the coast line is more or less parallel to the prevailing wind direction such as in the area of Pecém village, the sand are blown along the coast line and the coastal dune is less developed. The coastal dunes act as a source of or sink for sediment, depending on the orientation of the coastline.

Photo 3.3.2 Coastal Dunes in Pecém Area (Source: SEINFRA)

The dune sand has a higher degree of sorting characteristics compared with that taken from the beach. A geometrical parameter σ_g ($=D_{84}/D_{16}$, which is called the geometrical spreading parameter) is commonly used to indicate the sorting degree. In the previous study report on sediment by DHI and INPH in 1997, it was reported that the value of σ_g for the dune is 1.27, whereas the value of σ_g for beach sand is of the order of 1.5.

As the orientation of the coastline on the east side of the tip of Pecém is SE-NE, the wind-blown sand migrates inland from the coastline. This means the coastal dunes act as a sink for the sediment. On the other hand, the orientation of the coastline on the west side of the tip of Pecém is E-W. This means the coastal dunes can provide some portion of sand to the beach.

On the east side of the tip of Pecém, the dunes extend about 3 km inland from the coast. Photo 3.3.3 shows a comparison of the coastal dunes for both 1968 and 1996. It was shown by comparison of two aerial photographs that the dunes migrate with a speed of about 3 to 10m per year (average speed of migration is 6.6m/year). This is almost the same value as presented in previous reports (DHI and INPH, 1997).

Some vegetation areas are spreading in the coastal dunes. The vegetation has a stabilizing effect on the dunes. To stabilize the dunes artificially around the port area and access road, a transplantation project has been conducted by SEINFRA upwind of the port area since 1998. Top soil of about 10 to 15 cm and vegetation from the future development area of a steel mill in CIPP area was transplanted to an area upwind of the port. The total area is 150 ha and the amount of transplanted soil is about 1,500,000 m^3.

Photo 3.3.3 Comparison of Dune in 1968 and 1996 (Source: SEINFRA)

3.3.2 Sea Side

(1) Geological and Geographical Conditions Obtained by Bathymetric and Seismic Surveys

Bathymetric surveys of the port area have been conducted by SEINFRA and Ceará Port several times beginning before the construction of the port and continuing up to present. A bathymetric survey for making marine charts was carried out in 2001 by the hydrological office of the Brazilian Navy around Pecém Port. Figure 3.3.2 shows the contour map obtained from the bathymetric survey (DHI & INPH, 1997).

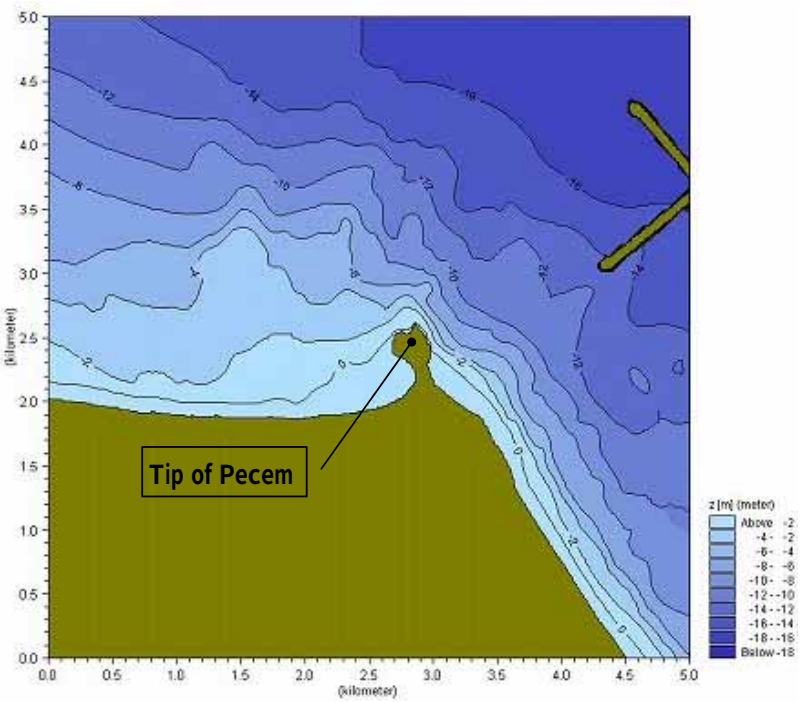


Figure 3.3.2 Contour Map (Source: DHI & INPH, 1997)

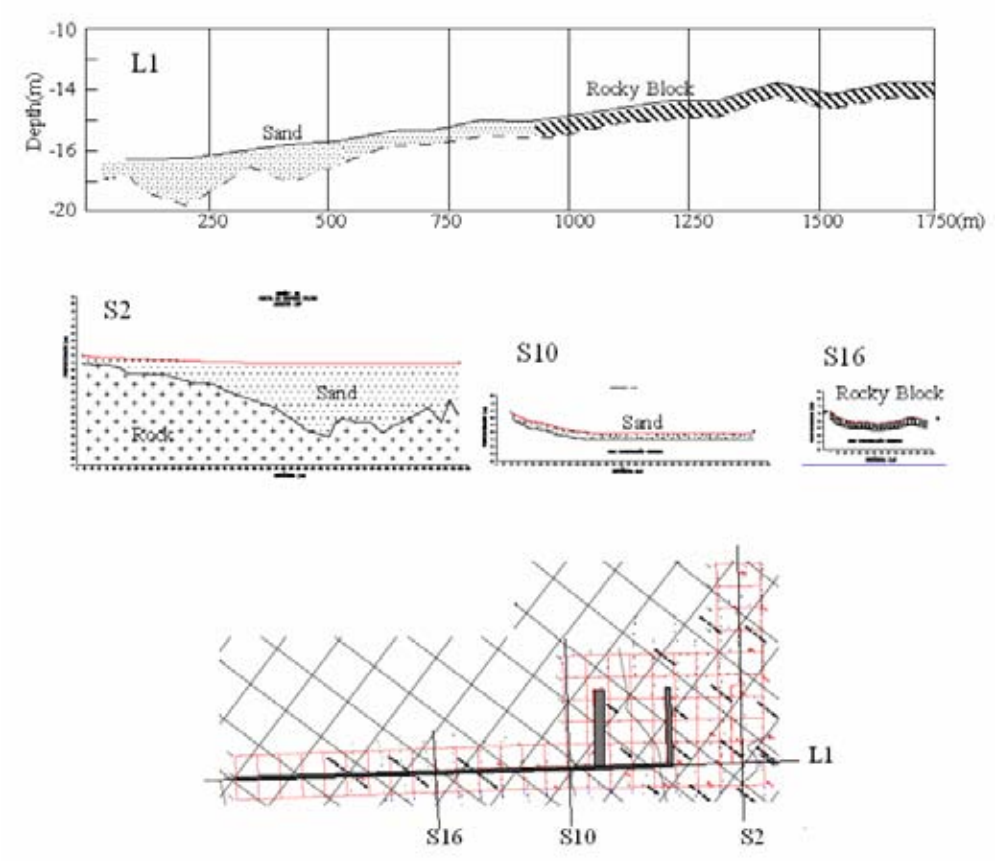


Figure 3.3.3 Seismic Survey Result (Source: SEINFRA 1995)

A seismic geophysical survey was conducted in 1995 covering the location of exiting mooring pier and access bridge. Figure 3.3.3 shows the result of the seismic survey. The characteristics concerning geological and geographical conditions are summarized as follows.

- The bottom topography is very gentile and uniform. The slope up to the water depth of 10m is about 1/100 on the east side of the Tip of Pecém and 1/200 to 1/250 on the west side. The seabed slope in water from 10 to 15m deep is about 1:200 and the slope in water deeper than 15m is about 1/600 to 1/700.
- The bottom topography is dominated by the occurrence of rock in the near shore zone. In addition to the Tip of Pecém, large areas are covered by rock. At the east side of Pecém the orientation of the coast line extends in a NW to SE direction. The depth contours are more or less parallel around the 5m depth. At the west side of Pecém the orientation of the coast line extends in an E to W direction. The depth contour is quite irregular indicating the existence of rock. The contour lines around the water depth of 10 to 12m are irregular. From the bottom sampling survey which was carried out by the JICA Study Team, it was confirmed that the bottom surface was covered almost only by rock to both sides of the port.
- The results of seismic survey show that the volcanic rocks which form the bottom foundation are covered by a sediment composed of sand and silt. The thickness of the sediment layer varies irregularly from 0 to 16m in both the onshore-offshore and alongshore directions. This is caused mainly by the fluctuation of the boundary level of the layer underlying the rock.
- The sand layer is thin at water depths less than 10m. Around water depths of 10 to16m, the volcanic rock is dominant. At water depths deeper than 16m, the bottom surface is covered by the sand layer.

(2) Characteristics of Bottom Sediments

1) Bottom Sampling in Previous Study

Bottom sampling and sieve analysis was conducted before the construction of the port (INPH, 1997). Bottom samples were taken for 8 points at onsore and 13 points on the seabed as shown in Figure 3.3.4.

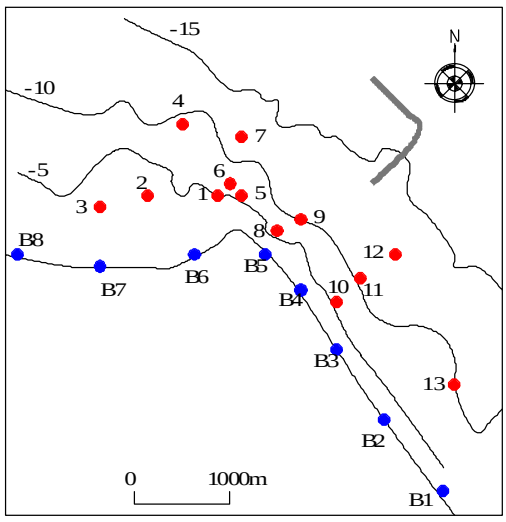


Figure 3.3.4 Location of Bottom Sampling (Source: INPH, 1997)

Table 3.3.1 Result of Sieve Analysis (Source: INPH, 1997)

Samp. No.	D50 (mm)	Shell (%)	Samp. No.	D50 (mm)	Shell (%)
B1	0.17	<5	1	0.24	40
B2	0.19	<5	2	0.24	75
B3	0.30	<5	3	0.31	28
B4	0.24	<5	4	0.29	51
B5	0.22	<5	5	0.34	55
B6			6	0.33	86
B7	0.20	<5	7	0.83	50
B8	0.24	<5	8	1.09	16
			9	1.18	9
			10	5.03	20
			11		100
			12	0.21	10
			13	0.20	63

The results of the sieve analysis are shown in Table 3.3.1. The characteristics of sediment are as follows.

- The beach material usually consists of medium to fine sand, with the medium diameter of the grain typically of 0.25 mm in the seabed and of 0.20mm in the beach area.
- Fragments of shells were abundant in many samples, in particularly in those collected at water depths greater than approximately 5m, which contained more than 50 percent of fragments of shells and, in some cases, vegetal material.

2) Bottom Sampling by the JICA Study Team

A new bottom sampling survey was conducted by the JICA Study Team to determine the change in the characteristics of sediment after completion of the port for the environmental aspects and to use the condition as input for the prediction of critical water depth for sediment for the engineering aspects. To determine the characteristics of the bottom materials, physical and chemical analyses were carried out.

The bottom samples were taken at 17 points for each onshore-offshore line west and east of the port, and 6 points in the basin as shown in Figure 3.3.5 by using a sand sampler (Photo 3.3.4).

Figure 3.3.5 Sampling Line and Area

Photo 3.3.4 Sand Sampler

(1) Sand

(2) Silt

Photo 3.3.5 Bottom Samples Obtained by the JICA Study Team

Photo 3.3.5 shows an example of bottom samples obtained. The results of sieve analyses for each area are shown in Tables 3.3.2 to 3.3.4. The characteristics of physical conditions, which were obtained by the sieve analysis, are summarized as follows.

- The components of the bottom material are mainly divided into for four categories, sand, silt, gravel and fragments of shells.
- In the shallow water areas with a depth of less than about 5m, the bottom surface is mostly covered by sand. From a depth of about 7 to 11m, the rock is exposed on the surface and it was difficult to take samples for both sampling lines. In the deep water area with a depth of more than about 12m, the bottom surface is covered by different components, that is, sand, silt and fragments of shells.
- The median diameter of bottom material (D50) varies from 0.1mm to 0.5mm for the both west and east lines, and the average of the median diameter is about 0.26mm for the west line and 0.33mm for the east line.
- The contents of bottom samples taken inside the basin (Sample Nos. B1 to B4) are almost totally silt, which precipitated due to the forming of a shadow area for waves after construction of the breakwater. In the bottom samples B5 and B6, which were collected onshore of Pier No.1, the sand content increases.

Table 3.3.2 Results of Sieve Analysis for Samples Taken at West Line

No.	Depth (m)	D50 (mm)	Contents				
			Gravel	Course Sand	Medium Sand	Fine Sand	Silt+Clay
W-1	-16.6	-	0%	2%	74%	21%	3%
W-2	-15.5	0.44	5%	22%	37%	22%	14%
W-3	-14.8	0.39	1%	0%	40%	54%	5%
W-4	-14.0		0%	0%	1%	35%	64%
W-5	-11.7		0%	0%	3%	16%	81%
W-6	-10.8	0.15	0%	0%	6%	74%	20%
W-7	-9.8		0%	1%	3%	19%	77%
W-8	-7.8	0.21	0%	0%	6%	88%	6%
W-9	-6.5	0.25	0%	0%	4%	87%	9%
W-10	-6.5	0.25	0%	0%	9%	87%	4%
W-11	-5.9	0.16	16%	7%	8%	41%	28%
W-12	-4.8	0.23	0%	0%	6%	91%	3%
W-13	-4.1	0.27	0%	0%	6%	90%	4%
W-14	-1	0.27	0%	0%	28%	71%	1%
W-15	0	0.21	0%	0%	2%	94%	4%
W-16	1	0.25	0%	0%	1%	94%	5%
W-17	-	0.26	0%	0%	7%	91%	2%
Average		0.26					

Table 3.3.3 Results of Sieve Analysis for Samples Taken at East Line

No.	Depth (m)	D50 (mm)	Contents				
			Gravel	Course Sand	Medium Sand	Fine Sand	Silt+Clay
E-1	-19.4	0.44	0%	2%	50%	44%	4%
E-2	-16.3	0.32	1%	6%	30%	36%	27%
E-3	-15.2	0.41	3%	5%	39%	50%	3%
E-4	-14.0	0.52	6%	5%	58%	30%	1%
E-5	-13.2	-	6%	16%	53%	21%	4%
E-6	-11.8	-	20%	20%	43%	14%	3%
E-7	-10.7	0.36	0%	0%	44%	46%	10%
E-8	-9.7	-	0%	0%	76%	20%	4%
E-9	-7.4	-	0%	1%	73%	19%	7%
E-10	-6.3	0.13	0%	0%	1%	84%	15%
E-11	-4.9	0.14	0%	1%	4%	74%	21%
E-12	-3.9	0.13	0%	0%	1%	89%	10%
E-13	-1.0	0.24	0%	0%	23%	74%	3%
E-14	0	-	0%	0%	81%	15%	4%
E-15	1.0	0.43	0%	0%	51%	48%	1%
E-16	-	0.49	0%	0%	71%	26%	3%
Average		0.33					

Table 3.3.4 Results of Sieve Analysis for Samples Taken at Port Basin

No.	Depth (m)	D50 (mm)	Contents				
			Gravel	Course Sand	Medium Sand	Fine Sand	Silt+Clay
B-1 (pier 2-3)	-17.2		0%	0%	6%	8%	86%
B-2 (Pier 2-3)	-17.0		0%	0%	0%	3%	97%
B-3 (Pier 1-2)	-16.7		0%	0%	1%	6%	93%
B-4 (Pier 1-2)	-16.4	0.24	1%	3%	26%	29%	41%
B-5 (Pier 1)	-15.1	0.21	3%	2%	10%	52%	33%
B-6 (Pier 1)	-14.3	0.30	2%	1%	16%	59%	22%
Average		0.25					