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Japan International Cooperation Agency (JICA)
Ministry of Environment and Water Management, Romania

Final Report

The Study on Protection and Rehabilitation of the Southern Romanian Black Sea Shore in Romania

VOLUME 1

Basic Study and Coastal Protection Plan

August 2007

ECOH CORPORATION

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
MINISTRY OF ENVIRONMENT AND WATER MANAGEMENT, ROMANIA

FINAL REPORT

THE STUDY ON
PROTECTION AND REHABILITATION OF
THE SOUTHERN ROMANIAN BLACK SEA SHORE IN ROMANIA

VOLUME 1
BASIC STUDY AND COASTAL PROTECTION PLAN

AUGUST 2007

ECOH CORPORATION

Exchange rates applied in this Study are:

EURO 1.00 = 3.6 RON (as of October 2005)

FOREWORD

In response to a request made by the Government of Romania, the Government of Japan decided to conduct the Study on Protection and Rehabilitation on the Southern Romanian Black Sea Shore and entrusted the project to the Japan International Cooperation Agency (JICA).

JICA sent to Romania a study team headed by Dr. Yoshimi GODA of ECOH CORPORATION between May 2005 and March 2007.

The team held discussions with the officials concerned of the Government of Romania and conducted field studies in the targeted area in the Study. The team prepared present report upon the final modification.

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 Romania for their close cooperation extended to the team.

August, 2007

Ariyuki MATSUMOTO
Vice-President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

Mr. Ariyuki MATSUMOTO
Vice President
Japan International Cooperation Agency

Dear Mr. Matsumoto,

It is my great pleasure to submit herewith the Final Report of “the Study on Protection and Rehabilitation of the Southern Romanian Black Sea Shore in Romania”.

The study team composed of ECOH CORPORATION conducted surveys in Romania over the period between May 2005 and March 2007 according to the contract with the Japan International Cooperation Agency (JICA).

The study team compiled this report, which proposes an overall coastal protection plan aimed for 2020, and feasibility study on the coastal protection and rehabilitation plan of Mamaia Sud and Eforie Nord, including an operation and management plan, a monitoring plan and an institutional framework, through consultation with officials of the Government of Romania and other authorities concerned.

On behalf of the study team, I would like to express my sincere appreciation to the Government of Romania and other authorities for their diligent cooperation and assistance and for the heartfelt hospitality, which they extended to the study team during our stay in Romania.

I am also very grateful to the Japan International Cooperation Agency, the Ministry of Foreign Affairs of Japan, the Ministry of Land, Infrastructure and Transport of Japan and the Embassy of Japan in Romania for giving us valuable suggestions and assistance during the course of the study

Yours faithfully,

August, 2007

Yoshimi GODA
Team Leader,
The Study on Protection and
Rehabilitation of the Southern Romanian
Black Sea Shore in Romania

PREFACE

In response to the request of the Government of Romania, the Government of Japan has decided to conduct the Study on Protection and Rehabilitation of the Southern Romanian Black Sea Shore (hereinafter referred to as “the Study”), in accordance with the relevant laws and regulations in force in Japan.

Accordingly, Japan International Cooperation Agency (hereinafter referred to as “JICA”), the official agency responsible for implementation of the technical cooperation program of the Government of Japan, has undertaken the Study in cooperation with the authorities concerned of Romania based on the Scope of the Study agreed upon by the both governments on July 30, 2004, which is attached to the present report in Annex J in Volume 3. JICA awarded ECOH CORPORATION the contract for the execution of the Study in March 2005, and the latter has formed a team of seven experts (hereinafter referred to as “the Team”) and dispatched the Team to Romania for six occasions, intermittently since May 2005. The composition of the Team and the information on the Study mission are given in Annex J.

This final report describes the accomplishment of the basic study in the Phase I, the formulation of coastal protection plan in the Phase II, and the feasibility study on the coastal protection and rehabilitation project at Mamaia Sud and Eforie Nord in the Phase II of the Study, which have been executed by the Team during the period of March 2005 to September 2006. The report is comprised of three volumes. Volume 1 presents the main results of the basic study and the coastal protection plan for the whole study area. Volume 2 describes the outcome of the feasibility study on the Mamaia and Eforie Project, while Volume 3 is compilation of Annexes that contain detailed information and data.

Volumes 1 and 2 are provided with their own Executive Summaries for quick references to the contents of the main bodies of the report.

ACKNOWLEDGMENT

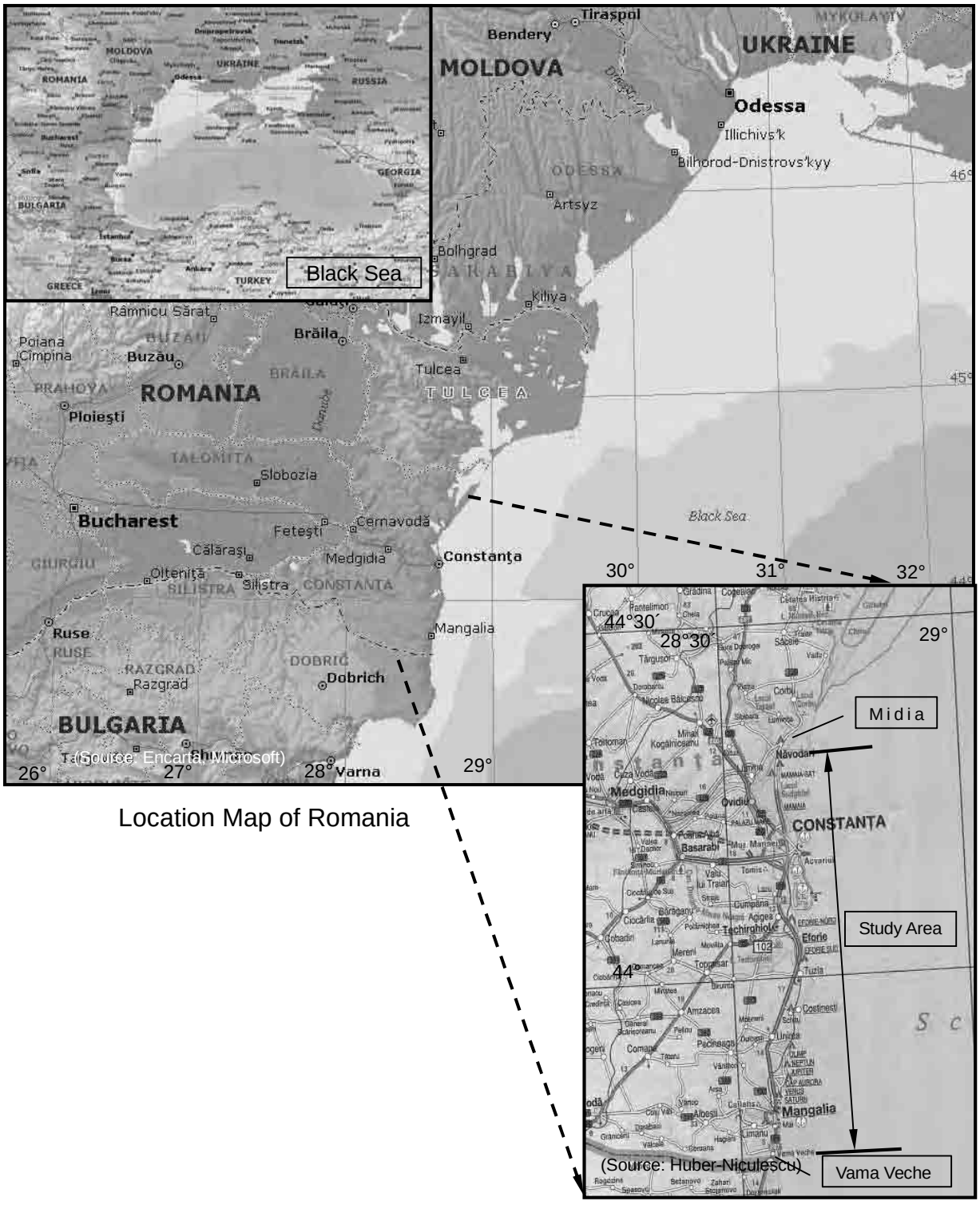
The Study has been made possible through the cooperation and collaboration of many people in Romania. The Team first expresses its sincere thanks to all the Romanian counterparts, the names of which are listed in Annex J.3. They have earnestly assisted the activities of the Team and brought the Study to its completion.

Secondly, the Team acknowledges the excellent works under subcontracts executed by the staff of the National Institute of Marine Geology and Geo-ecology (GeoEcoMar), the National Institute for Marine Research and Development "Grigore Antipa," IPTANA S.A., and INSERT S.R.L., even though the Team refrains itself from listing the names of individual persons involved.

Thirdly, the Team was given invaluable information and data through interviews with the National Agency for Mineral Resources, the River Administration of the Lower Danube Galati, the Administration of Navigable Canal S.H., the National Company Maritime Ports Administration S.A., the Danube Delta Biosphere Reserve Authority, the Delegation of the European Commission in Romania, the Office of the International Bank for Reconstruction and Development, and others.

Last but not least, the Team would like to express its appreciation to Professor Virgil Breaban and his staff at "Ovidius" University of Constanța, who offered the first guidance on coastal problems in Romania in August 2004, assisted the field survey on the willingness-to-pay (WTP), and arranged the use of the university's auditorium for the JICA Symposium in June 2006 and March 2007 in Constanța.

Yoshimi GODA, Prof.
Team Leader of the Study Team


Black Sea
Tiraspol
Bendery
MOLDOVA
UKRAINE
Odessa
Illichivs'k
Bilhorod-Dnistrovs'kyy
Artsyz
Bolhgrad
Kiliya
Izmayil
Rămnicu Sărat
Brăila
Poiana Cîmpina
Buzău
Tulcea
ROMANIA
Ploieşti
Slobozia
Bucharest
Fetești
Cernavodă
Călărași
Medgidia
Constanţa
Oltenița
Silistra
Black Sea
30°
31°
32°
44°30´
28°30
29°
Ruse
Mangalia
Dobrich
Razgrad
BULGARIA
(Source: Encarta Microsoft)
26°
27°
28°
Varna
29°
Location Map of Romania
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Năvodari
CONSTANTA
Study Area
Eforie
Mangalia
Vama Veche
(Source: Huber-Niculescu)
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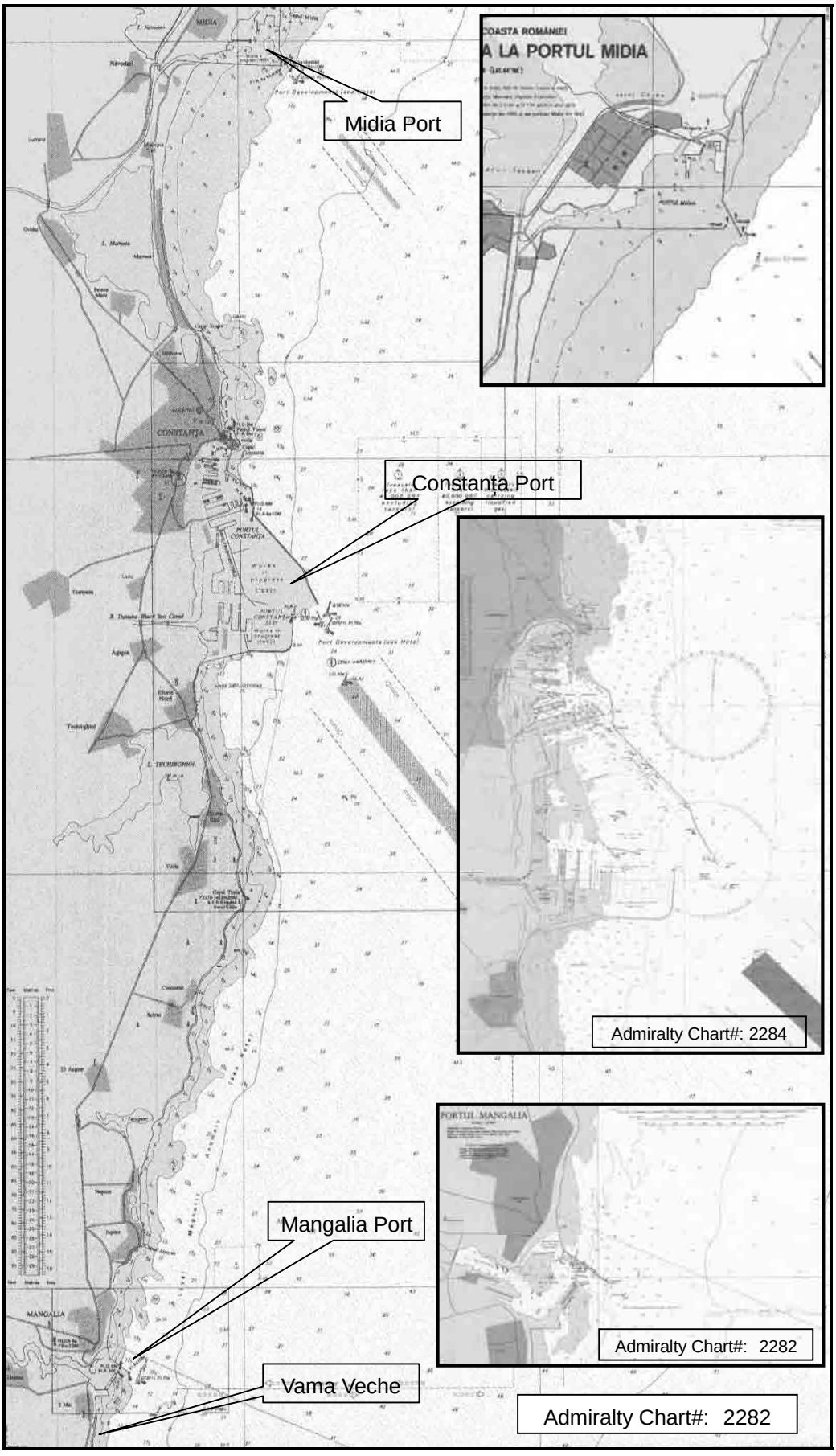
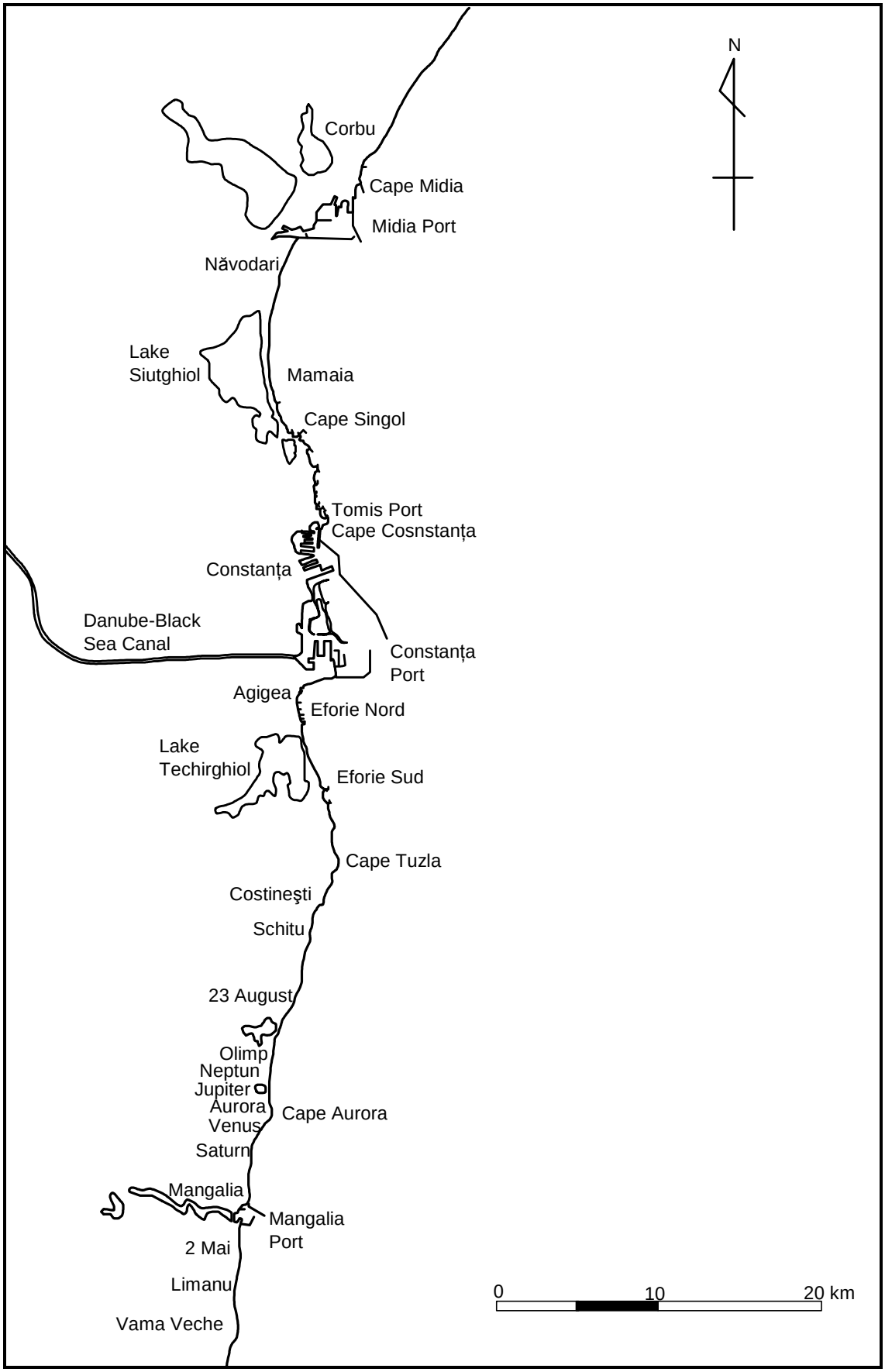


Study Shore Area between Midia and Vema Veche



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ABBREVIATIONS

A	AFDJG:	River Administration of the Lower Danube, Galati
	AIS:	Agreement of Subsidiary Loan
	ANAR:	National Administration of Romanian Waters “Apele Romane”
	AR:	Artificial Reefs
C	C/B:	Cost-Benefit
	CAS:	Country Assistance Strategy
	CBA:	Cost Benefit Analysis
	CBC:	Cross Border Cooperation
	CEB:	Council of Europe Development Bank
	CET:	Heating Power-Station
	CF:	Cohesion Fund
	CFCU:	Central Financial and Control Unit
	CIF:	Cost, Insurance and Freight
	CIGCCE:	Committee for Guarantees and Credits for External Trade
	CNP :	National Commission of Forecast
	COA :	Romanian Court of Accounts
	CPS:	Country Partnership Strategy
	CQ:	Consultant's Qualification
	CRF:	Capital Recovery Factor
	CVM:	Contingency Valuation Method
	CVM:	Contingent Valuation Method
D	DADL:	“Apele Romane”, Water Directorate Dobrogea - Litoral
	DC:	Direct Contracting
	DFI:	Direct Foreign Investment
	DFID:	Department for International Development
	DL:	Datum Level
	DR:	Development Regions
	DSCR:	Debt-service Coverage Ratio
E	EBRD:	European Bank for Reconstruction and Development
	EC:	European Council
	ECMWF:	European Centre for Medium Range Forecasting
	EEC:	European Economic Community
	EFN:	Eforie Nord
	EGO:	Emergency Governmental Ordinance
	EIA:	Environment Impact Assessment
	EIB:	European Investment Bank
	EIRR:	Economic Internal Rate of Return
	EMP:	Environmental Management Plan
	ENPV:	Economic Net Present Value
	EPA:	Environmental Protection Agency
	EPAC:	Environment Protection Agency, Constanța
	EPI:	Environmental Protection Inspectorates
	ERDF:	European Regional Development Fund
	ESF:	European Social Fund
	ESOP:	Environmental Sectoral Operational Program
	EU:	European Union
F	FB:	Final Beneficiary
	FIRR:	Financial Internal Rate of Return
	FOB:	Free on Board
	FX:	Foreign Exchange
G	GD:	Government Decision
	GDP:	Gross Domestic Product

GDRP: Gross Domestic Regional Product
GEF: Global Environment Facility
GeoEcoMar: National Institute of Geology and Geo-ecology
GOR: Government of Romania

H
HC: Hydrocarbons
HRMEP: Hazard Risk Mitigation and Emergency Preparedness Project
HWL: High Water Level

I
IBRD: International Bank for Reconstruction and Development
ICB: International Competitive Bidding
ICCE: International Conference on Coastal Engineering
ICZM : Integrated Coastal Zone Management
IDA: International Development Association
IFC: International Financing Corporation
IFI: International Financing Institutions
IMF: International Monetary Fund
IPCC : Intergovernmental Panel on Climate Change
IPPC: Integrated Pollution Prevention and Control
IRR: Internal Rate of Return
ISPA: Instrument for Structural Policies for Pre-Accession

J
JBIC: Japan Bank for International Cooperation
JICA : Japan International Cooperation Agency

L
L/A: Loan Agreement
LAPEP: Local Action Plan for Environmental Protection
LCP: Large Combustion Plants
LCS: Term of Low Crested Structure
LCS: Least Cost Selection
LEP: Local Environmental Policy
LEPA: Local Environment Protection Agency
LRMC: Long-run Marginal Cost
LWL: Mean Monthly Lowest Water Level

M
M/E: Monitoring and Evaluation
MAFRD: Ministry of Agriculture, Forests and Rural Development
MAI: Ministry of Administration and Interior
MDS: Multivariate Statistics Methods - Multidimensional Scaling
MIG: minimum income guarantee
MIR: Minimum Ratio of Residual Correlation Coefficient
MIU: Management and Implementation Unit
MOC: Marginal Opportunity Cost
MoEWM: Ministry of Environment and Water Management
MoHF: Ministry of Health and Family
MoPA: Ministry of Public Administration
MoPF: Ministry of Public Finance
MoTCT: Ministry of Transport, Construction and Tourism
MTEF: Medium-tern Expenditure Framework
MWL: Mean Water Level

N
NAMR: National Agency for Mineral Resources
NAPEP: National Action Plan for Environmental Protection
NATO: North Atlantic Treaty Organization
NB: Net Benefit
NBR: National Bank of Romania
NCB: National Competitive Bidding
NCCZ: National Committee of the Coastal Zone
NDP: Romanian National Development Plan
NEAP: Romanian National Environment Action Plan
NEG: National Environmental Guard

	NEP:	Romanian National Environmental Policy
	NEPA	National Environmental Protection Agency
	NGO:	Non-governmental Organization
	NIMRD:	National Institute for Marine Research and Development "Grigore Antipa."
	NPV:	Net Present Value
	NSEP:	National Strategy for Environmental Protection
	NSRF:	Develop Basic Infrastructure to European Standards
O	OM:	Operation and Maintenance
P	PAH:	Polycyclical Aromatic Hydrocarbons
	PAL:	Programmatic Adjustment Loan
	PCC:	Project Coordination Committee
	PCO:	Primary Credit Orderers
	PFM:	Public Financial Management
	PIU :	Project Implementation Unit
	PMU:	Project Management Unit
	POP:	PAH and Organochlorine Pesticides
	POT:	Peaks-over-Threshold
	PSC:	Project Steering Committee
	PYG:	Pay-as-you-go
Q	QC:	Consultant Qualification
	QCBS:	Quality and Cost-based Selection
R	Raja:	Water Company
	REPA:	Regional Environment Protection Agency
	RkD:	Rank of Species
	RMA:	Romanian Meteorological Administration
S	SA:	Special Account
	SAPARD:	Special Action Program for Agricultural and Rural Development
	SC:	Steering Committee
	SCF:	Standard Conversion Factors
	SDR:	Social Discount Rate
	SEA:	Strategic Environmental Assessment
	SME:	Small and Medium Scale Enterprises
	SOP:	Sectoral Operational Program
	SRMOC:	Short-run Marginal (Opportunity) Cost
T	TA:	Technical Assistance
	TAC :	Total Admissible Captures
	TC:	Total Cost
	TOR:	Terms of Reference
	TPH:	Total Petroleum Hydrocarbons
	TR:	Total Revenue
	TRC:	Technical Review Committee
U	UGO:	Urgent Government Ordinance
	UNCED:	United Nations Conference on Environment and Development
	USAID:	United States Agency for International Development
V	VAT:	Value Added Tax
	VOC:	Volatile Organic Compound
W	WB:	World Bank
	WD:	Significance Index
	WFD:	EU Water Framework Directive
	WFD:	Water Framework Directive
	WTP:	Willingness to Pay

EXECUTIVE SUMMARY OF VOLUME 1

Volume 1:
Basic Study and Coastal Protection Plan

Executive Summary of Volume 1

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Volume 1:
Basic Study and Coastal Protection Plan

A. Background of Project for Coastal Protection Planning

Romania has a territorial coastline extending over 240 km along the northwestern side of the Black Sea. In the past several decades, however, the Romanian Black Sea shore has been suffering from serious beach erosion problems. The northern unit of the Romanian coastal area, which is designated as the Danube Delta Biosphere Reservation, is most affected, but its southern unit is also in danger where the economical activity is strong, including the tourism industry which attracts some 800 thousands check-in tourists every year.

The coastal erosion not only threatens the tourism industry in summer season through the loss of beach area but also endangers the safety of housing and public welfare. New projects for the protection and rehabilitation of the southern Romanian Black Sea shore are urgently needed. Upon the request of the Government of Romania, the Government of Japan decided to make a technical cooperation for the Study on Protection and Rehabilitation of the Romanian Black Sea Shore (hereinafter referred to as "the Study") through the Japan International Cooperation Agency (hereinafter referred to as "JICA"). Although several cliff failures in the study area have caused damage to local communities, it was excluded from the Scope of Work after the discussion.

The Study was undertaken since March 2005 by a team of experts entrusted by JICA and was concluded in August 2007 by submission of the Final Report. The Final Report, which comprises three volumes, summarizes the outcome of the Study. The Volume 1 mainly discusses the results of the basic study and the formulation of the coastal protection plan for the Southern Romanian Black Sea shore. Volume 2 presents the output of the feasibility study on the priority projects, and Volume 3 lists twelve annexes which contain various data and information related to the Study.

B. Objectives of Coastal Protection Planning

The project for the protection and rehabilitation of the southern Romanian Black Sea shore aims at stopping the coastal erosion and increasing the asset value of coastal zone with creation of new beach areas. The Study by JICA has the objectives of formulating a coastal protection plan aimed at the year 2020 and making a preliminary design on priority projects so that the Government of Romania will be able to implement the coastal protection project with appropriate funding.

The coastal protection plan is to provide a long-term strategy for protection and rehabilitation of the southern Romanian Black Sea shore. Analysis is made of the physical conditions in the Study area that extends from Cape Midia to Vama Veche (hereinafter referred to as "the Study area"), inclusive of the state of beach erosion and it mechanism, for rational planning of coastal protection measures. Based on the following four criteria; 1)urgency of coastal protection, 2)beach utilization, 3)economical feasibility of project implementation, 4)needs for promotion of regional development, a time schedule of project implementation in various sectors is proposed. Selection is made for the areas that are provided with the earliest project implementation, i.e. priority projects.

C. Physical Conditions of the Study Area

C.1 Geological and Geomorphological Features (Section 3.1)

The Study area is divided into the northern sub-unit and the southern sub-unit with the boundary at Cape Constanța. The beaches in the northern sub-unit are mainly composed of terrigeneous fine sand supplied by the Danube, having been transported over 200 km by wave-induced longshore currents. Shell fragments are the secondary source of beach sand. A 13-km long barrier beach of Navodari and Mamaia is present between Cape Midia and Cape Singol. Further south between Cape Singol and Cape Constanța the coast is made of narrow beaches and low cliffs, some of which are in dangerous state of collapse induced by water saturation in the soil by heavy rain etc.

The southern sub-unit between Cape Constanța and Vama Veche is essentially a cliff coast with several barrier beaches in front of seaside lakes, which were land-locked by alongshore transport of sediment in the past. Beach sand is made of shell fragments supplemented by fragments of limestone at the base of cliffs. No trace of terrigeneous sand from the Danube is found in the southern sub-unit.

C.2 Wind and Wave Conditions (Sections 3.2 and 3.4)

Winds mainly blow from the northern sector in winter and from the southern sector in summer, but they are not consistent in the direction. The mean wind speed in Constanța is about 5 m/s, while the 90% and 99% non-exceedance speed are about 10 and 15 m/s, respectively.

Waves follow the wind direction, but large waves mainly come from the northeastern sector with the secondary sector of the southeast. Waves are highest in December and January, while they are lowest in June and July. The mean height of the significant waves during winter is 1.2 m, while it is 0.8 m in summer. The energy averaged waves, which are used for sediment transport computation, is 1.65 m in height and 6.2 s in period from the azimuth N64ºE, and 1.11 m in height and 6.2 s in period from the azimuth N115ºE. The 90% and 99% non-exceedance significant wave height are 1.8 m and 3.6 m, respectively.

The waves with the return period of 100 years are estimated as 7.8 m in height and 11.0 s in period. The values refer to those of the significant waves, the height of which is defined as the average of the highest one-third waves. The single highest wave in 100 years may go up to 14 m.

C.3 Tide and Water Level (Section 3.3)

The astronomical tide is very small. The spring tidal range (twice the sum of the amplitudes of principal lunar and solar semidiurnal components) is 4.0 cm in Constanța and 5.1 cm in Mangalia. However, the mean water level fluctuates widely: the highest and lowest water levels (daily mean) ever recorded in Constanța are 0.90 m and –0.30 m, respectively. The mean monthly highest water level (HWL) is 0.38 m, while the mean monthly lowest water level (LWL) is 0.13 m. The causes of large fluctuation of mean water level are unknown.

The annual mean water level in Constanța has steadily rising since the start of the water level observation in 1933 with the mean rate of 2.2 mm/year, which is much larger than those at the stations along the oceans. This rate of the mean water level rise is equivalent to the shoreline retreat rate of –0.18 m/year at Mamaia and –0.08 m/year at Costineşti.

C.4 Beach Erosion and Its Mechanism (Chapter 4)

The rate of the shoreline position change has been analyzed from the shoreline survey data by the National Institute for Marine Research and Development "Grigore Antipa" and various topographic maps in the past. Examples of the shoreline change rate (average of respective area) are listed below; a negative value indicates erosion.

Mamaia North	–0.4 m/year
Mamaia South	–2.0 m/year
Tomis	–0.2 m/year
Eforie Middle	–0.7 m/year
Eforie Sud	–0.6 m/year
Tuzla	–0.7 m/year
Costineşti	±0.0 m/year
Olimp – Venus	–0.5 m/year
Saturn – Mangalia	–0.8 m/year
2 Mai	–0.6 m/year
Vama Veche	–0.7 m/year

The severest erosion is taking place in the southern part of Mamaia, where the shoreline will retreat more than 40 m in the coming twenty years if no countermeasures are undertaken.

The mechanism of beach erosion differs in the northern and southern sub-units of the southern Romanian Black Sea shore. The major cause of beach erosion in the northern sub-unit is the impoundment of terrigenous sand by the north breakwater of Midia Port, which was extended to the depth of –10 m since 1977. Sand transported southwestward by wave-induced longshore currents was stopped at the breakwater and could not move further toward Navodari and Mamaia. Decrease of the sediment discharge of the Danube contributed to deficiency of sediment supply to the northern sub-unit. Along the long beach of Mamaia, the alongshore sediment transport by waves is estimated as 160,000 m^3/year northward and 140,000 m^3/year southward, which results in the net northward transport rate of about 20,000 m^3/year. This net transport of sediment without new supply is the reason of intensive beach erosion at the south of Mamaia. Sediment transported northward is eventually carried away by the cross-shore currents offshore and lost from the shore area.

The coastal erosion in the southern sub-unit is not as severe as that in Mamaia, except for the area of Balta Mangalia and the soft cliff area of Limanu. Most of the cliff coasts are receding with the rate of about 0.6 m/year for many years, which seem to be the natural process of this sub-unit. With recess of cliff lines, adjacent beaches have to retreat, which is beach erosion. Imbalance between the northward and southward sediment transport also causes local beach erosion, and there is a cross-shore loss of sediment.

C.5 Shoreline Changes and Their Prediction

Topographic survey data of the shoreline positions available since 1976 were analyzed and employed for the calibration of the numerical model based on the one-line theory. With the proper selection of the northerly and southerly representative waves, sediment transport coefficients, and other relevant factors, the numerical model succeeded in reproducing the advances and retreats of the shoreline in the area of Năvodari to Tomis and that of Eforie.

The validated numerical model was used for the prediction of the future changes of shoreline position in 20 years without any protective measures. It was also utilized to evaluate the effectiveness of the proposed shore protection and rehabilitation plan. The model assisted the formulation of priority project with the prediction of a minimum amount of refilling of sand on the nourished beach, though there remains a possibility of unexpected needs for maintenance supply of beach fill owing to occurrence of exceptional storm waves.

The so-called 3-D model was not employed in the present study because of no availability of detailed bathymetric data in the past, which is the prerequisite for validation of any 3-D model. The numerical model employed in the present study does not predict any change in sea cliff. It is mentioned that the model has been applied by assuming extension of beaches in the position of sea cliff.

D. Outline of Coastal Protection Plan

D.1 Sectors and Sub-sectors of the Study Area

The Study area from Midia to Vama Veche, which is the southern unit of the Romanian Black Sea shore, is divided into seven sectors and twenty sub-sectors as shown in Fig. I.1 for convenience of executing the Study. Seven sectors are regarded as independent coastal littoral cells, which are as the boundaries defined by littoral processes and zones of sediment convergence and divergence. Thus, measures taken within a specific sediment cell may affect the shore process of the same cell, but they will not impact on adjacent cells. The Constanţa Sector has two independent cells divided at Cape Singol, and the Mangalia Sector also has two independent cells divided at Cape Aurora. Thus, there are nine independent coastal littoral cells within the Study area.

D.2 Strategy of Coastal Protection and Rehabilitation (Section 5.5)

The shoreline of the Study area has been provided with various protective facilities such as seawalls, groins, and detached breakwaters. There were occasional beach fill (nourishment) operations such as that carried out in Mamaia in 1989. However, the majority of existing protective facilities have been deteriorated and not functioning properly. Most of groins are too short and were laid out in close proximity, creating narrow water areas and short beaches. Poor state of water circulation and exchange in these narrow water areas has contributed to the water pollution problems along the beach, even though the main culprit is eutrophication owing to insufficient treatment of waste water from hotels and residential areas.

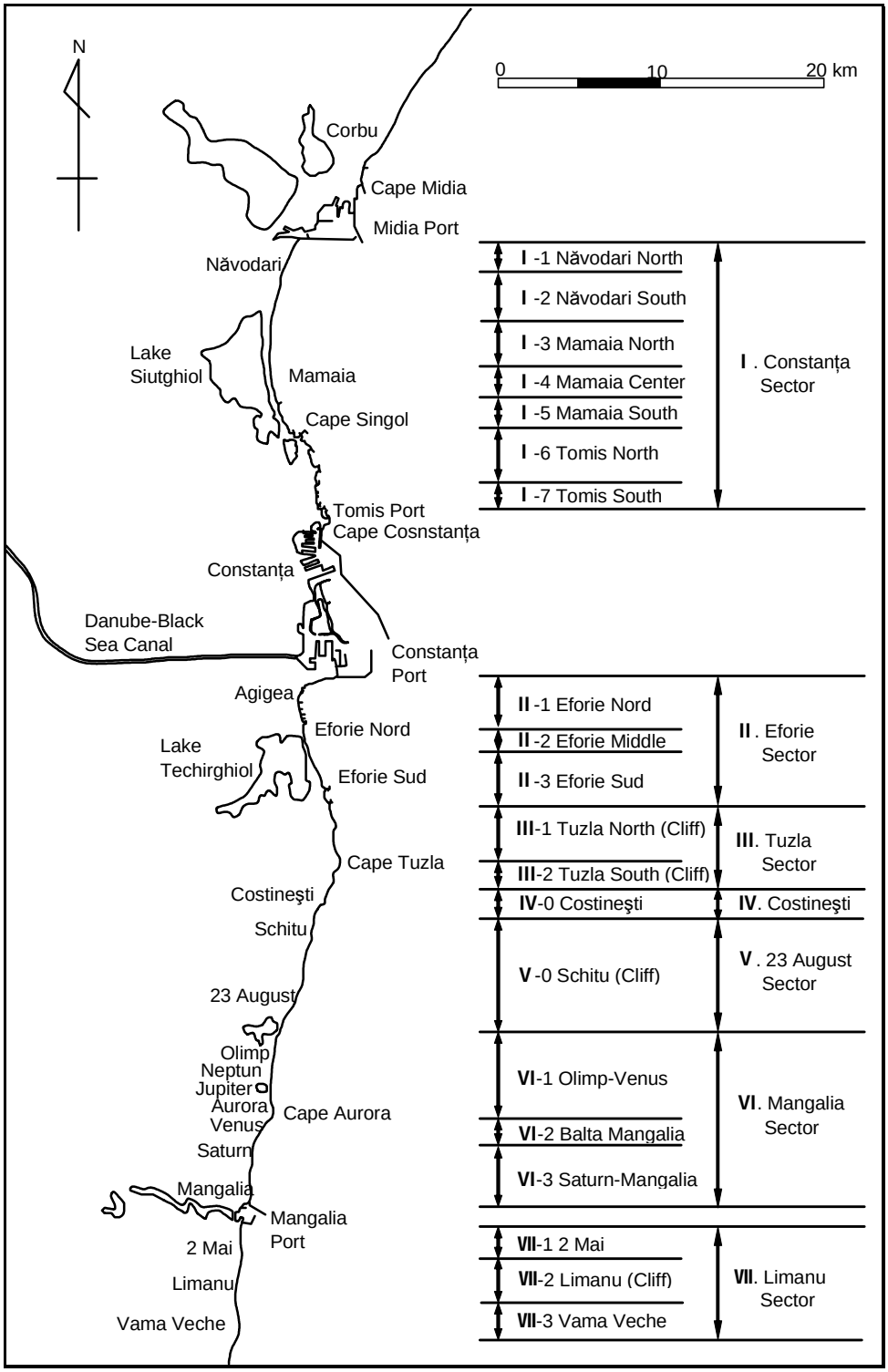

Fig. I.1: Map of sector and sub-sector division of the study area

The strategy to remedy the problems of beach erosion and water pollution is as follows:

1) Make large-scale beach fills (nourishment) to solve beach erosion and to create new beach areas;
2) Protect newly nourished beaches with long jetties and offshore submerged breakwaters;

3) Jetties are extended to the depth of 4 to 5 m so that a major part of longshore sediment transport could be confined within the cell between two jetties;
4) Jetties are laid out with wide spacing of several hundred meters so that long beaches are formed and good water circulation would be maintained;
5) Submerged breakwaters are build to restrict the offshore movement of sediment so that the maintenance supply of beach fill sand would be minimized, while maintaining the aesthetic view of the ocean;
6) Deteriorated, detached breakwaters in Mamaia, which have lost their wave damping function owing to settlement of their crown, are rehabilitated with backing of rubble mounds, the tops of which are armored with stabilopods; and
7) Majority of existing groins and submerged breakwater are demolished and removed for safety of beach visitors and aesthetic reasons. The demolished materials are recycled as the core material of new jetties and submerged breakwaters.

D.3 Scope of Coastal Protection Plan (Sections 5.7 to 5.9)

The Study area is composed of nine coastal littoral cells, which individually respond to waves, currents and other natural environments without being affected by neighboring coastal littoral cells. Because of their independent nature, each cell needs to be diagnosed for the state of beach stability and provided with appropriate countermeasures against beach erosion. The coastal protection plan is an assortment of countermeasures for individual cells. Alternative plans are to be prepared and examined for individual coastal littoral cells.

The areas to be provided with beach fill and various shore protection facilities have been selected on the basis of the urgency of coastal protection, the state of coastal utilization, the necessity of environmental preservation, and other considerations. The following areas are to be implemented with projects in due course:

1) Mamaia South: beach fill and rehabilitation of two detached breakwaters;
2) Mamaia Center: rehabilitation of four detached breakwaters;
3) Tomis North, Center and South: beach fill, long jetties and submerged breakwaters;
4) Eforie Nord: beach fill, long jetties and submerged breakwaters;
5) Eforie Middle: beach fill, long jetties and submerged breakwaters;
6) Eforie Sud: beach fill, long jetties and submerged breakwaters;
7) Olimp – Venus: beach fill, long jetties and submerged breakwaters; and
8) Saturn – Mangalia: beach fill, long jetties and submerged breakwaters.

Figures I.2 to I.4 show the layout of proposed shore protection facilities to be installed in the forthcoming projects of coastal protection and rehabilitation in the Mamaia and Tomis Sector, Eforie Sector, and Mangalia Sector, respectively. Zones of yellow color are beach fill areas, and jetties and submerged breakwaters are shown in pink color.

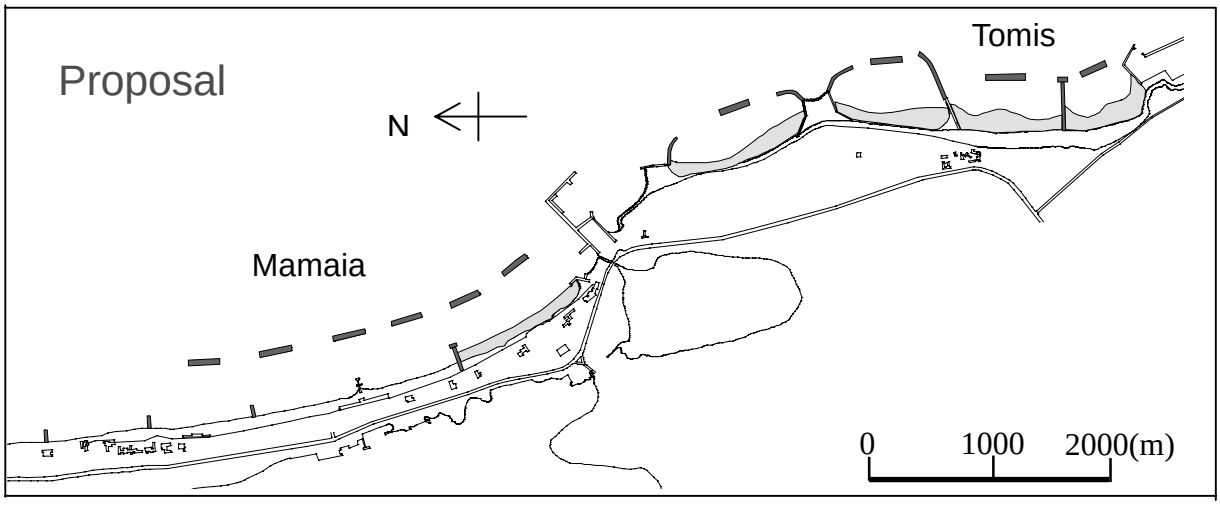

Fig. I.2: Proposed shore protection facilities at Mamaia and Tomis sub-sectors

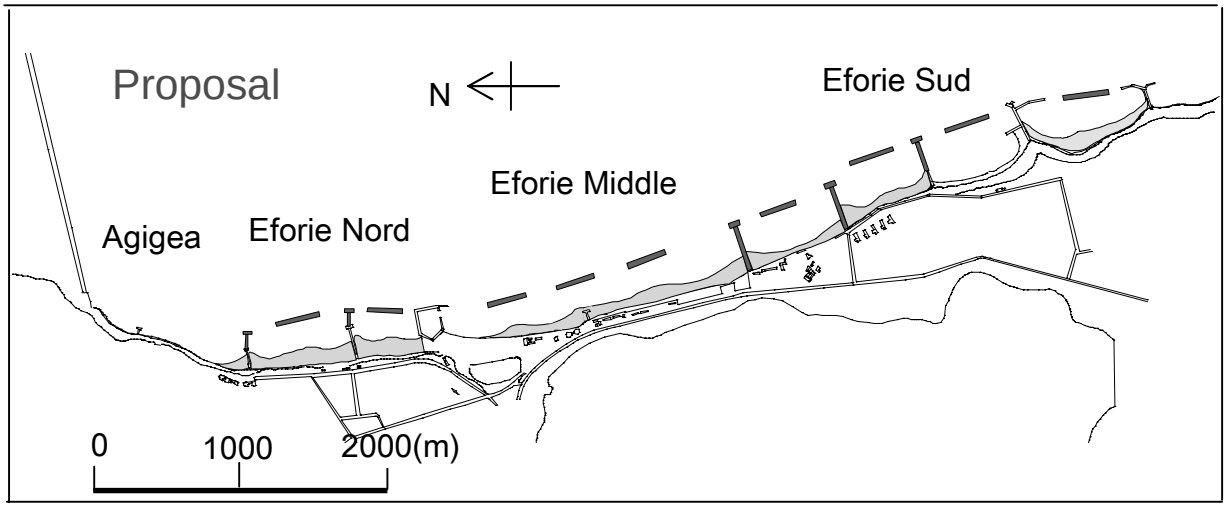

Fig. I.3: Proposed shore protection facilities at Eforie Sector

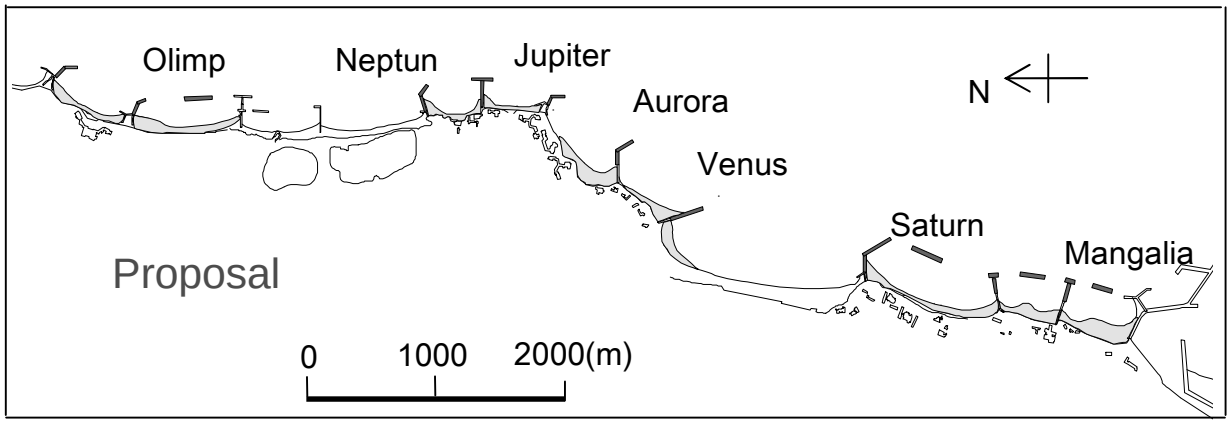

Fig. I.4: Proposed shore protection facilities at Mangalia Sector

The cliff coasts of Tuzla and 23 August are left without protective measures, because land use behind the cliff seems not productive enough to assure sufficient benefit to balance the project cost. The area from 2 Mai to Vama Veche has a marine natural reserve of 5000 ha between the isobaths of 2 and 20 m, which preserves the richest benthic association in the western part of the Black Sea. Because the wide beaches there can tolerate the present rate of erosion for a certain duration of time to come, no shore protection project is proposed in this area. The beach of Costineşti has been stable without suffering from any erosional problem, and no project is needed there.

The total quantity of various shore protection and rehabilitation facilities and their estimated cost of construction works are listed below.

Breakwater rehabilitation:	1,500 m in total	15,000 thousand Euro
Jetties and groins:	6,020 m in total	69,000 thousand Euro
Submerged breakwaters:	4,360 m in total	69,000 thousand Euro
Beach fill:	3,150,000 m^3 in total	80,000 thousand Euro
Rehabilitation of existing facilities:		6,000 thousand Euro
Net construction cost:		252,000 thousand Euro
Total cost of coastal protection plan:		316,000 thousand Euro

The volume of 3.2 million cubic meters of beach fill sand is for the period of 20 years or longer. The annually required volume of sand is 200 thousand cubic meters at most. The volume and cost of beach fill is based on the condition that the river sand of the Danube can be dredged and utilized for the coastal protection plan. If the sea sand to be mined from the seabed off east of Midia Port is used, the required volume will be increased twice or more, because the sea sand is of fine grain size and the beach fill profile become much milder than the case using coarse river sand.

Availability and quality of beach fill sand have been investigated during the Study. It has been identified that the river sand at the location between km 300 and 340 can be utilized for beach fill purpose. However, sand mining from the Danube is a contentious matter from the political and environmental viewpoint. The use of river sand should be subject to further discussion at the stage of environmental impact assessment.

The total cost of 316 million Euro for the overall coastal protection plan is the net construction cost added with the expenses for feasibility studies, engineering services including detailed designs, operational and maintenance cost. However, the use of river sand should be subject to further discussion at the stage of environmental impact assessment.

It should be mentioned that the above cost estimate is prepared on the basis of the bathymetric and topographic information available at the end of 2005. For each project to be undertaken from now on, detailed bathymetric and topographic surveys are to be carried out. Design of shore protection facilities will be made with the new information and the cost estimate will be revised accordingly.

D.4 Source of Beach Fill Sand

Possible sources of beach fill sand examined are as follows: 1) relic barrier beaches in the offshore area, 2) sand layers in the offshore area, 3) sand bars in front of the Sulina Channel, 4) impounded sand deposit at the east of Midia Port, 5) sand shoals on the bed of branch channels of the Danube, and 6) sand deposit in the inland. The sources 1), 2), and 6) were found unsuitable for the present coastal protection plan because of scarcity of available sand volume and/or possible environmental impacts.

Samples of the sea sand in 3) and 4) and the river sand 6) were tested for grain size distribution, heavy mineral content, and organic pollutants. Both the sea sand and the river sand were found to contain no harmful materials. The sea sand is characterized with small grain size (median diameter of around 0.1 mm) and contained a fraction of silt and clay depending on the location. The grain size of the river sand is 0.2 to 0.3 mm. Because the beach fill sand should have a large grain size to be capable of staying for longer time against wave actions, the sea sand is not a favorable choice.

The river sand has been mined as construction materials for many years under the permit of the National Administration of Mineral Resources. The recent volume of mined sand in the km 271 to km 373 is about 100 to 150 thousand cubic meters per year, which is less than 20 percent of the authorized volume. With availability of further sand mining from the Danube within the authorized volume, the river sand can be used for beach fill works.

The present Study is being conducted with the assumption that the river sand of the Danube could be used as the beach fill material. However, sand mining from the Danube is a contentious matter from the political and environmental viewpoint. From the technical viewpoint, it would be necessary to examine riverbed geomorphology change, however, in this respect, it has been agreed that the Romanian authorities could provide a guidance, making use of the EIA study for another project on the navigation improvement of the Danube with regard to the possible impact on riverbed geomorphology by the priority projects at Mamaia and Eforie. Thus, the scientific assessment of potential morphological changes by sand mining is not implemented in this Study.

D.5 Implementation Schedule (Section 5.8)

Originally the coastal protection plan for the southern Romanian Black Sea shore was aimed to be completed by the year 2020. However, in consideration of the required volume of construction materials and the estimated total cost, it is proposed to extend the target year to a later date by dividing the plan into two stages: the first stage for the initial 14 years and the second stage after the 15th year. The first stage is further divided into three phases. The areas to be included in each phase and the project cost are as listed in Table I-1.

Since this project is subject to the environmental impact assessment (EIA), careful response by the proponent is required. Because of the uncertainty on the time of the first project implementation, the schedule is given not in the calendar year but the consecutive year after the start of the coastal protection plan.

Table I-1: Implementation schedule and estimated project cost

Stage	Phase	Year	Area	Project cost (million Euros)
First	First	1st – 4th	Mamaia, Eforie Nord	44
	Second	5th – 9th	Mamaia Center (part), Tomis North, Eforie Middle	65
	Third	10th – 14th	Mamaia Center (part), Tomis Center, Eforie Sud (part)	68
	overall	1st – 14th	Mamaia to Eforie Sud (part)	177
Second	overall	After 15th year	Tomis South, Eforie Sud (part), Olimp – Venus, Saturn – Mangalia	139

During the first stage, a certain amount of rehabilitation works for the areas from Olimp to Mangalia should be planned and the rest of those works should be planned during second stage.

D.6 Priority Projects (Chapter 6)

The projects earmarked in the first phase of the first stage are the priority projects that will be implemented in the areas of Mamaia South and a part of Eforie Nord. Selection of these sites was made at the second steering committee of the Study on November 4, 2005. The selection was acknowledged by the stakeholders at the meetings at Constanța and Bucharest on November 24 and 25, 2005, respectively. Likewise the priority project site selection was recognized by the stakeholders at the Constanța meeting on June 5, 2006.

In Mamaia South, two southernmost breakwaters are rehabilitated with backing of rubble mounds and stabilopods armoring and a beach fill is executed with 180,000 m^3 of river sand. A sand-retaining groin of 200 m long and three submerged groins of 100 m long each are constructed. In case of sea sand for beach fill, the sand volume is increased to 460,000 m^3 and an underwater dike of 1,200 m long to retain the filled sand must be constructed.

In Eforie Nord, the area with the alongshore distance of 1,200 m at the north side of the marina “Yacht Club Europa” is to be protected with two long jetties, two submerged breakwaters and a beach fill with 330,000m^3 of river sand. In case of sea sand for beach fill, the sand volume is increased to 740,000 m^3 and an underwater dike of 1,200 m long must be constructed.

The feasibility study of the priority projects at Mamaia South and Eforie Nord has been carried out in May to July, 2006 and presented in Volume 2 of the Final Report. It should be mentioned that the above figures of the volumes of beach fill sand and the lengths of structures are somewhat different from those designed in the feasibility study, because the former figures have been derived on the basis of insufficient information of bathymetric and topographic survey result in the end of 2005.

D.7 Environmental and Social Considerations (Chapter 7)

First, a survey is made on the policy, legal aspects and administrative framework of environmental protection in Romania. Tables of the elements and assessment standards have been prepared for various environmental factors. Then, the environmental conditions in the coastal sectors are described with some details on the ecosystem.

The initial environmental examination of the coastal protection plan for the Southern Romanian Black Sea shore begins with an overview of the shore protection projects considered in the Coastal Protection Plan for the Southern Romanian Black Sea shore. Thirty items stipulated in the JICA guidelines have been examined by the Study team as well as the stakeholders in Romania

The stakeholder meeting has been held five times in Constanța and twice in Bucharest from June 2005 to June 2006. During the initial three meetings, the outline of the Study and the on-going planning of coastal protection and rehabilitation were presented to the participating stakeholders.

Based on the scoping of the influential items, a study of initial environmental examination of the coastal protection plan was commissioned to the National Institute of Marine Geology and Geo-ecology. The twelve screened items were examined for their nature and degrees of impacts such as those direct or indirect, temporal (during construction) or permanent, local or regional, mitigable fully or partially, and monitoring capable fully or partially. The degrees of impact were assessed for eight coastal units within the study area on the twelve screened items.

The fourth and fifth stakeholder meetings in November 2005 acknowledged the selection of the priority project sites at Mamaia South and Eforie Nord. Some discussions were made on the possible impacts of the implementation of priority projects on environment and society. The sixth stakeholder meeting in March 2006 was concerned with the overall coastal protection plan, which was finalized and presented by the Study team. The priority project sites of Mamaia South and Eforie Nord was finally confirmed by the stakeholders attending the seventh meeting in June 2006.

Romania has introduced the Strategic Environment Assessment (SEA) procedure in 2004 and begun its execution 2006. The Coastal Protection Plan has been selected as the first case of the SEA procedure. The Ministry of Environment and Water Management made a contract with an authorized environmental consultant firm for assisting SEA in October 2006. The consultant firm utilized the initial environmental examination report and the Interim Report of the Study for preparation of the SEA report, which was submitted to the Ministry in February 2007. The SEA report pointed out that a part of coastal protection facilities planned at the Eforie Sector may have significant environmental impacts. To avoid the environmental impacts, the original coastal protection plan at the Eforie Sector has been partially modified. The facilities proposed in Fig. 1.9 are those after modification.

The public debate regarding the SEA on the Coastal Protection Plan is scheduled to be held at Constanța on March 29, 2007 for discussion on the Master Plan. Meantime, the number of participants was 49 (including 19 numbers related to the Study). In response to the result of public debate, environmental approval on Coastal Protection Plan as the Master Plan was issued by The Ministry of Environment and Water Management with the final decision numbered 13/05 07 09 and the SEA procedure was completed in July of 2007.

D.8 Administration and Monitoring of Coastal Protection Plan (Sections 8.1 and 8.2)

The coastal protection plan has to be administered for a long period of time, say more than 20 years, because of the limited financial resources available in Romania and the long coastline

to be protected. To ensure the realization of the coastal protection plan, there should be established a special coastal administrative unit within the Ministry of Environment and Water Management (MoEWM) in charge of coastal protection and rehabilitation. At the same time, the corresponding sections should be established in the National Administration Romanian Waters (ANAL) and the Water Directorate Dobrogea Litoral (DADL).

The coastal administrative unit together with the corresponding sections will be charged with the responsibility of effective and efficient execution of the coastal protection plan consecutively year after year. They will also be responsible for preparing and executing the plans for monitoring geophysical, environmental, and structuring aspects of the coastal areas. Undertaking of timely operations for maintenance beach fill is also necessary, because mitigation against beach erosion always requires maintenance works. Details of the monitoring plan is given in Chapter 6 of Volume 2.

D.9 Management Assessment and Institutional Aspects (Sections 8.3 and 8.4)

An overview of project implementation framework is provided with two projects financed by EU and World Bank for reference. Then the fund management and auditing systems are discussed with examples of several international financing institutions. Availability of project financing to the coastal protection plan is explained by listing possible international funds. Budgetary process in Romania is described together with the procedure of external borrowing. Affordability analysis will be provided in Volume 2 in relation with the feasibility study for the projects at Mamaia South and Eforie Nord.

E. Recommendations and Further Issues

E.1 Recommendations

The following five recommendations related to the Study are made:

1) Establishment of special coastal administrative unit with the minimum number of four permanent staff;
2) Collaboration with the Local Environmental Protection Agency and authorities in charge of sewerage system for improvement of water quality in the nearshore water area;
3) Formulation of coastal protection plan for the northern unit of the Romanian Black Sea shore;
4) Development of expertise in coastal engineering in Romania; and
5) Investigation of the mechanism of long-period fluctuations of water level and their effect on water circulation along the Black Sea shore.

Explanation of these recommendations is given in **9.2**.

E.2 Further Issues

Key to the successful and efficient implementation of a project is the planning/managerial and operational capacities of the administrative and operational bodies, namely, MoEWM, ANAR Headquarters and/or DADL. MoEWM has the responsibility to promote the Plan over a long time span. It should first establish a special coastal administrative unit to strengthen its capacity as recommended in **E.1.** The most urgent task for the priority project is the

establishment of the project implementation unit (PIU) with clearly defined authority and power in procurements and fund management.

To make financial analysis in compliance with the financial and economic guidelines for project analysis of external financing resources, it is definitely in need to examine fiscal capacity of MoEWM to appropriate capital and recurrent budgets to DADL through ANAR or directly to ANAR Headquarters for the foreseeable period of project horizon, say, up to 2040. Budgeting to the project implementing body (or bodies) is the task of the Romanian side, because it is a policy matter beyond the reach of the Study team.

Although the present JICA Study formulated the coastal protection plan for the southern unit of the Romanian Black Sea shore, the northern unit where beach erosion is much severe should also be provided with an appropriate protection plan. Initiation of an overall study will be the task of MoEWM.

Last, but not least, the forthcoming feasibility study with a focus on the institutional, financial and economic aspects of the prospective projects on the Romanian Southern Black Sea shore will need to expeditiously be undertaken, while considering the indicative timing and schedule of the application for the external funds.

CHAPTER 1:

INTRODUCTION

Chapter 1 Introduction

1.1 Background of the Study

Romania as a country located at the southeastern part of Europe has a territorial coastline along the northwestern side of the Black Sea, together with Bulgaria, Turkey, Georgia, Russia, and Ukraine around the Black Sea in the counterclockwise direction. The coastline has the length of approximately 240 km from Sulina at the Danube Delta to Vama Veche in the south. It occupies about 6% of the whole coastline around the Black Sea.

The Danube has been carrying a vast quantity of sediment over many years to the Black Sea and developed a large delta in the area from Chilia in Ukraine to Sfântu Gheorghe in Romania. The Danube Delta in Romania has been designated as the Biosphere Reservation. The sediment supply from the Danube has decreased greatly in the past several decades, however. The chronic sand deficit occurred along the Romanian Black Sea shore and caused intensive beach erosion, especially along the northern unit. The speed of beach erosion exceeds 5 m per year at several areas and it becomes 19 m per year at the outer shore of Sakhalin Island.

The Romanian Black Sea shore is divided into two units of the north and the south with the boundary at Cape Midia. While the northern unit is reserved for the nature protection, the southern unit has been developed for ports, housing, industry, and tourism. Especially, the ocean bathing and sunbathing at beaches are most popular not only among Romanians but also for Europeans. Every year, more than 800 thousand tourists come to the southern unit, including 60 thousand foreigners. However, the number of tourists recorded 1.5 million in 1989 among which the foreigners were counted as 267 thousands.

The problem of beach erosion is also acute along the southern Romanian Black Sea shore. The beach of Mamaia located in the northern part of the City of Constanța, which has attracted people since the early twentieth century, was eroded by more than 80 m. In the late 1980s, the Government of Romania undertook the urgent countermeasures against beach erosion by constructing six offshore shore-parallel breakwaters and by filling beach with a half million cubic meters of sand taken from a lake behind the beach. Although the beach recovered temporarily by the countermeasures, the breakwaters began to settle down gradually and the beach erosion is still continuing. Many beaches south of Constanța are also suffering from the problem of beach erosion.

Alarmed by the loss of beaches in the southern unit of the Romanian Black Sea shore, the Government of Romania requested the Government of Japan for the technical cooperation on the Study on Protection and Rehabilitation of the Southern Romanian Black Sea Shore (hereinafter referred to as “the Study”) and the latter decided to conduct the Study. Accordingly, the Japan International Cooperation Agency (hereinafter referred to as “JICA”), the official agency responsible for the implementation of the technical cooperation programs of the Government of Japan, undertook the Study and agreed upon the Scope of Works with the representatives of the Government of Romania for the Study on July 24, 2004.

1.2 Necessity of the Coastal Protection Project in Romania

As will be discussed in the present report, beaches along the southern unit of the Romanian Black Sea shore are losing the areas covered by sand, which is the major resource for tourism

industry. In the southern part of Mamaia beach, the shoreline is retreating at the rate exceeding 2 m per year, and the beach erosion will be accelerated if no countermeasures are implemented A computer simulation predicts the loss of more than 70 m of the beach in twenty years, which means collapse of many hotels near the shore.

The number of tourists visiting the beaches along the Southern Romanian Black Sea was about 760,000 in 2004, among which 84,000 were foreigners. They stayed in hotels and other accommodation for six days on average. A trend analysis of the number of tourists indicates that foreign visitors may reach the level of 200,000 in five years. Tourism is the important economical activities of Constanța County. When it is represented by the hotel and restaurant sector in the gross domestic regional product (GDRP) analysis, it is estimated to amount to US$112 million or 6.8% of GDRP of Constanța County in 2002.

Without implementation of the appropriate protection and rehabilitation works for beach preservation, the beach areas are going to be lost and the local economy will suffer greatly from the loss of tourism industry. On the other hand, a properly designed beach project can expand the beach area and maintain it economically, thus increasing the asset value of the coastal zone. The expanded beach will attract the tourists more than predicted by a trend analysis. The project implementation will also create employment of construction workers during construction and people working for increased tourists in the hotel and restaurant sector. A “do-nothing” policy is not applicable one for the Southern Romanian Black Sea shore.

Furthermore, many of seawalls and revetments protecting the feet of cliffs along the coast are already deteriorating and facing the danger of destruction by wave attacking. There are many housing built on top of these cliffs, and disasters by cliff collapses are eminent if no rehabilitation works are undertaken. The northeastern shore of Constanța City and the cliff coast of Eforie Nord are typical examples. The major feature of cliff collapse is a circular slip of the upper slope of the cliff, which is caused by geotechnical instability induced by heavy rain and other. Cliff consolidation works will require a reshaping of cliff slope into a gradient milder than the present steep one and provision of efficient drainage system. Widening of beach at the feet of cliffs will provide an ample space for cliff consolidation works and relieve the local residents from the threat of cliff collapse.

Therefore, the formulation of a well prepared coastal protection plan and the implementation of coastal protection and rehabilitation projects are urgently needed in Romania.

1.3 Objectives of the Study

The objectives of the Study agreed upon in the Scope of Works are as follows:

i) To formulate a coastal protection plan for the Southern Romanian Black Sea Shore;
ii) To conduct a preliminary design on priority project(s); and
iii) To transfer skills and technology of coastal protection and management to the counterpart personnel of Ministry of Environment and Water Management (hereinafter referred to as “MoEWM”) and other authorities concerned in the course of the Study.

To achieve the above objectives, the additional objectives are set forth as in the following:

iv) To clarify the technical and management problems for the protection and rehabilitation of the Southern Romanian Black Sea Shore; and

v) To quantify the benefit of the shore protection measures in consideration of environmental conservation, tourism, and economic activities of the coastal area for its sustainable management.

By accomplishing these objectives, the Study aims at providing the Government of Romania with most effective and fundamental documentation for implementation of the coastal protection project with appropriate funding.

1.4 Execution of the Study and Composition of the Report

JICA awarded ECOH COROPORATION (hereinafter referred to as "ECOH") the contract for execution of the Study in March 2005. ECOH dispatched a team of seven experts headed by Prof. Yoshimi Goda for the on-site studies five times in May to June, August, and October to December in 2005, and February to March and May to July in 2006 to Romania. Several subcontracts were given to Roman consultants for collection of various data and execution of topographic and bathymetric surveys for the feasibility study of the priority projects.

The present Pre-Draft Final Report describes the results of the Study in three volumes. Volume 1 describes the results of the basic study for collection and review of existing data and the formulation of coastal protection plan aimed at the year 2020. Volume 2 is concerned with the feasibility study of the priority projects to be implemented at Mamaia South and Eforie Nord. Volume 3 is a compilation of Annexes, but it includes only those revised after submission of the Interim Report in February 2006. Readers are requested to refer to the Interim Report for the contents of other Annexes.

Volume 1 is composed of eight chapters. Chapter 1 is an introduction, being followed by Chapter 2, which presents the social and economic background of Romania for the Study with a short introduction of her political situation. The physical conditions such as geomorophological features, winds, and waves of the study area are discussed in Chapter 3. The state of beach erosion of the study area is analyzed in Chapter 4 and the magnitude of beach erosion in the future without further protection works is predicted. The coastal protection plan for the Study area is presented in Chapter 5 together with the total cost estimate and the implementation schedule. Chapter 6 describes the selection process of two priority projects at Mamaia South and Eforie Nord with presentation of the project outlines. Aspects of the possible environmental and social impacts of the coastal protection and rehabilitation projects of the southern Romanian Black Sea shore are examined in Chapter 7 together with the present environmental conditions in Romania. Chapter 8 presents the methodology of operation, maintenance, and management of rehabilitated beaches. The last chapter 9 discusses further issues and policy recommendations.

Volume 2 is composed of eight chapters. Chapter 1 describes the selection of two project sites of Mamaia Sud and Eforie Nord, and overviews the following chapters. Chapter 2 outlines the project itself and the surrounding social, economical, physical, and geomorphological conditions, the material of which are taken from Volume 1. This chapter also discusses the possible sources of beach fill sand. Chapter 3 presents the project component "A" at Mamaia

Sud with the implementation schedule and cost estimate. Two cases using the river sand from the Danube and the sea sand around Midia Port are dealt with. Chapter 4 presents the project component “B” at Eforie Nord in a manner similar as Chapter 3. Estimate of the total cost at Mamaia Sud and Eforie Nord is given at the end of Chapter 4. The next chapter 5 scrutinizes potential environmental impacts by the project implementation and proposes the mitigation measures. Chapter 7 is the project evaluation, which analyzes the financial affordability and the economical internal rate of return for the two components at Mamaia Sud and Eforie Nord as well as the total project as one package. Chapter 8 is the institutional analysis. Legal and institutional framework for coastal protection is discussed, overall management scheme is analyzed, and the operational framework for project implementation is proposed. The last chapter 9 of Volume 2 is the conclusion and recommendations concerning the feasibility study of the priority projects.

Volume 2 is also accompanied with several appendices related with the feasibility study.

Details of various aspects of the Study are presented in Annexes A to N in Volume 3 for references in further examination by the readers.

CHAPTER 2:

SOCIAL AND ECONOMIC BACKGROUND

Chapter 2 Social and Environmental Background

2.1 Political Evolution in Romania

2.1.1 Political History

For centuries the principalities of Wallachia and Moldavia were under the sovereignty of the Turkish Ottoman Empire. They secured their autonomy in 1856, united in 1859 and a few years later adopted the new name of Romania. The country gained full independence in 1878, and subsequently the Kingdom was proclaimed three years later.

The disparities in the Romanian society could be tracked quite far in history. Romania's modernization was influenced by France in the Old Kingdom, and by the former Austrian empire in the regions of Transylvania, Banat and Bukovina. A second aspect is the Byzantine-Orthodox legacy, which is hardly compatible with the western Catholic, let alone the northern Protestant traditions. Last but not least, the traditions and the everyday way of living, shaped for centuries by the Turkish influence and which often came in contradiction with those under the Viennese influence, could never be totally overcome in Romania even after more than a century as an independent state.

Romania joined the Allied Powers in the World War I and acquired the territories occupied by the vast majority of Romanian population of Transylvania and Banat following the conflict. In 1940 the country allied with the Axis powers and ceded territory to Hungary and the USSR after the signing of the German-Soviet pact. It participated in the 1941 German invasion of the USSR but switched sides three years later as Soviet forces closed in. After the World War II, the communist party gained the political power. Starting this point, Romania entered under soviet influence, and the post-war Soviet occupation led to the formation of a communist "people's republic" in 1947 and the abdication of the king. In 1955, Romania joined Warsaw Pact. For the fifty years after World War II, Romania faced a dark period that culminated with the dictatorial Ceausescu's period. The communist era finished with the Romanian Revolution in December 1989, which led to important changes in the economic, political and social aspects. Step by step the political and economic reforms have led to substantial changes in the entire society. Major events after the Romanian Revolution are listed in Table 2.1.1.

2.1.2 Political Situation Currently in Place

According to the Constitution, the Romanian State is a Republic, a sovereign, independent, unitary and indivisible National State. The new version of this Act has been ratified in a referendum in 2003 to bring Romanian law into line with those of the EU member countries as part of the process for EU accession. It was also considered as a referendum on EU accession since new provisions for "sharing sovereignty" within the EU were introduced.

Romania is considered a transition economy, as it tries to embark on the capitalist path putting in place a market economy since December 1989 when the communist regime was removed from power. The process is still ongoing and has several particularities that differentiate it from the rest of the Central and Eastern European countries that are on the same path. At present, after fifteen years from the Revolution that took place on December 1989, Romania became a member of NATO and the country is now on the track to become one of the member states of the European Union starting January 2007.

Table 2.1.1: Major events after Romanian Revolution

December 1989	The Fall of Communism
December 1991	Adoption of a new constitution
1993	Signing of the "European Agreement Establishing an Association between the European Communities and their Member States, on the one part, and Romania, on the other part".
1999	Start of the negotiation process with EU
March 2004	The Protocol for Admission into NATO was concluded
December 2004	Negotiations ending for Romania's accession into the European Union
April 25, 2005	The EU accession treaty was signed. The treaty contains a safeguard clause, which allows delaying entry for a year, in case EU-standards are not met. The government faces two main challenges for the time left till EU-entry: eradication of the currently widespread corruption and reform of the judicial system

Currently Romania operates a bicameral parliamentary system with the Senate (137 seats) and Chamber of Deputies (The Lower House, 331 seats). Both chambers are elected from 41 multi-member constituencies comprising 40 counties and the Municipality of Bucharest.

The top line of the political agenda for the government is to become a member of the European Union that is scheduled on 1 January 2007. While Romania together with Bulgaria signed the Accession Treaty in April 2005, the European Union (EU) Competition Commissioner recently stressed the need for the Romanian Government to enforce anti-trust rules, with the abolition of subsidies for the steel industry in particular. EU Competition Commission further warned that the accession of Romania to EU could lead a delay to 2008 in lieu of 2007 unless Romanian Government complies with the safeguard clauses that include fair competition in the Romanian market[1]. With this, and in pursuance of the government's strong commitment to achieve macroeconomic targets as set out in the Pre-Accession Economic Program by EU Commission, President Mr. Traian Basescu reshuffled the cabinet to replace the ministers for, among others, European Integration and Public Finance, to enhance his political power and leadership in the feeble four-party coalition government[2].

While these progresses are coming in place, Romania is lagging behind in several important fields such as justice, fight against corruption and others that could bring about a delay in EU entry to 2008. The decision on accession point will be taken in 2005 based on the report elaborated by the European Commission, and made public in the beginning of October 2005.

2.1.3 EU Integration – Top of the Policy Agenda

In December 1999, the European Council Union commenced an accession negotiation with Romania with the reform agenda that Romania has to comply with. The accession criteria imposed to the country, known as the Copenhagen Criteria, were the same for all of the countries that want to join the European Union (EU). The policy triggers (policy

[1] Source: *Business Review*, Vol.11, No.18, 16-22 May 2005, p.9

[2] Coalition government comprises the National Liberal party (NLP), Democratic Party (DP), Conservative Party (CP, formerly the Romanian Humanist Party), and the Hungarian Democratic Union in Romania (HDUR). (Source: Economic intelligence Unit, *Economist. com*, Country Brief: Romania, September 2005)

conditionality) that candidate member state must fulfil the followings[3]:

- To be a stable democracy, respecting human rights, the rule of law, and the protection of minorities;
- To have a functioning market economy and to be able to cope with the competitive pressures from the EU; and
- To adopt the common rules, standards, and policies which constitute the EU laws.

In addition, another criterion as agreed upon in the 1995 Madrid European Council meeting was for Romania to have the administrative capacity to assume the responsibilities of a Member State of the EU[4]. Immediately following the meeting on 12 December 2003, the European Council (EC) announced its decision to conclude negotiations with Romania in 2004 and to welcome Romania as a member state of EU in January 2007, provided that the country satisfactorily fulfils the accession triggers. Subsequently in April 2004, EC reoriented the accession strategy with Romania in order to prioritize the full establishment of the rule of law. In response, Romanian government produced a "To Do List" which indicated a series of priority measures that the government intends to implement by July 2004 in order to demonstrate its commitment to the reform process. Based on the decision at the European Parliament on 13 April, the Accession Treaty was signed in Luxembourg on 25 April 2005. The signature marks the completion of the fifth enlargement of the EU, and Romania became an "Acceding State" that is allowed to participate in virtually all of the committees and bodies of the EU as an active observer.

Against the historical background of the Accession, the country is now in the advent of convergence with EU, while endeavouring further to improve economic performance, enhance institutional capacity and governance framework for better-functioning market mechanism, and provide quality and equitable access to social services regardless of location of living and income level of the nationals. *The Government Program 2005-2008* elucidates the political agenda of the Basescu administration for accelerating EU accession, highlighting the three major policy issues of (i) the private-sector led economic growth, (ii) governance in terms of transparent and accountable fiscal (public expenditure) management, and (iii) the public sector reform to enhance institutional capacity and governance in the light of anti-corruption.

To address these issues, the first line of the policy agenda is set forth at infrastructure modernization as well as strengthening international competitiveness of the agriculture sector and enhancing human capacity. As regards the second issue of governance in the framework for public financial management (PFM) to meet the fiscal need for the allotment of counterpart funds that match inflowing external funds on a transparent and accountable basis, the government for socio-economic development, the government has been on the track to improve allocative and technical efficiencies in respective of budgeting and spending. The World Bank and the EU, among others, have supported the government commitment in this light while providing loan/grant assistances inclusive of the Programmatic Adjustment Loan (PAL) and EU PHARE programs. The third issue will be addressed by a set of public administration reform programs that aims at unifying the institutional capacity at the central and local administration, accelerating fiscal and administrative decentralization associated with delegation of power from the central to local

[3] http://www.europa.eu.int/comm/enlargement/enlargement.htm
[4] http://www.mie.ro/mie.htm

governments, and providing better qualified and equitable access of people to public services.

A bird's eye view of economic performance in Romanian and other EU-8 countries in the region is given below (Fig. 2.1.1)[5]. As shown, the country is still running a bit behind the neighbouring states, with income level (GDP per capita) and anti-inflationary macro management in particular.

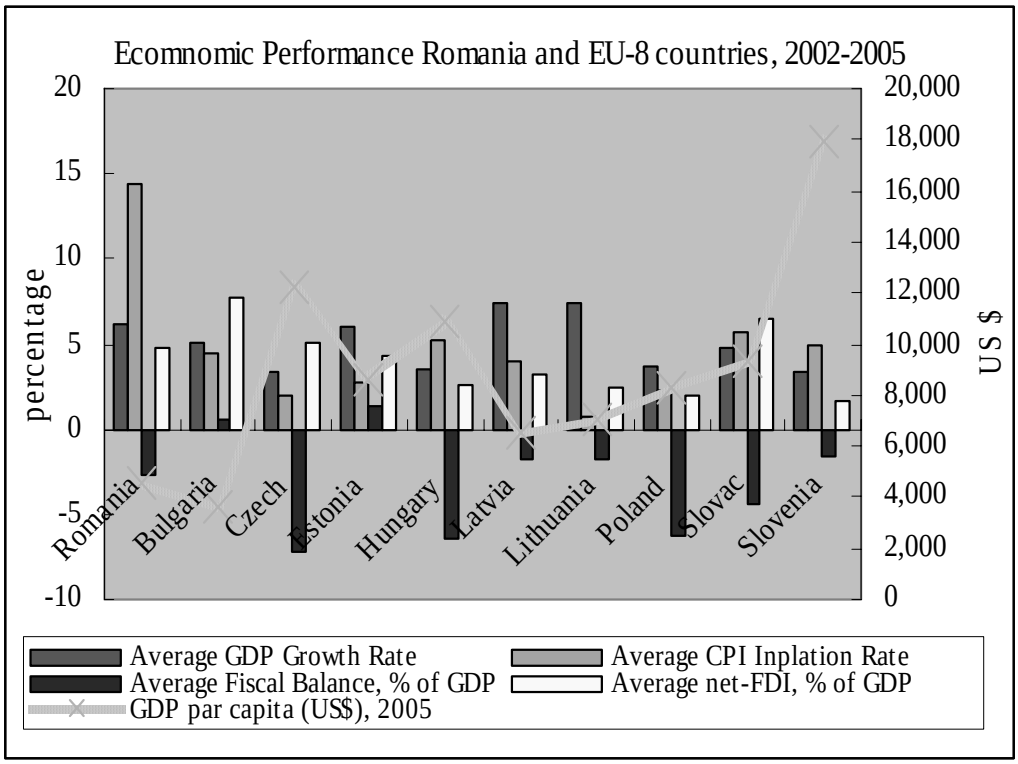

Fig. 2.1.1 Economic Performance of Romania and other EU-8 countries in the region, 2002-2005

2.2 Economic Background

2.2.1 Introductory Remarks

Romania, with Gross Domestic Products (GDP) per capita standing at US$3,240 in 2004, is placed at a lower-middle income country[6]. Economic difficulties were encountered by the Romanian government when the three-year-long economic downturn resulted in a devastating performance as indicated by the average GDP growth rate of minus15 percent per annum (1980-2000), whereas the average inflation rate during 1990 to 2000 being posted at 100.5 percent per annum. In order for Romania to bounce back from this disastrous condition, the government embarked on the new economic reform plans that include fundamental change in macro-management of the economy while focusing on fiscal and monetary policies for growth and anti-inflation in particular. The following section

[5] Source: WB, *Country Partnership StrategyFY06-FY09*, May 2006, p.3

[6] GDP in 2004 amounted US$ 70.2 billion, with the percentage shares by industrial sector of 13.1 percent (the primary sector), 33.7 percent (the secondary), and 53.2 percent (the tertiary sector). It would be noted that GDP per capita at Purchasing Power Parity (PPP) was US$ 7,230 in 2004, implying that the price level in general in Romania is less than a half of that in the "rest of the world". (Source: Economic Intelligence Unit, 2005).

gives a bird-eye-view of the economic policy and outcome that took place in the past, now and would come in place hereafter.

Dating back to the communist period prior to 1989, the basic thrust of the economic policy adopted by then-government was import substitution and full employment by opening installing industrial plants in every town regardless of factor endowments and financial viability. In many cases technologies and production methods used in these plants were obsolete and the management was inappropriate, thereby often leading to misallocation of scarce resources and economic losses.

Another historical path that worsened the economy in Romania was the fact that the late president Mr. Nicolae Ceausescu wanted to repay external debts of the country that was beyond the country's debt-serviceability, and consequently hampered the government's fiscal capacity to maneuver the difficulties encountered by economic bureaucrats due largely to a loss in foreign reserves and accumulated fiscal deficits[7]. The Romanian reform that came in place even in the wake of the revolutionary change in the political power and the country's transition to the market economy was characterized as a gradual process or "stop-and-go" process that turn out to be somewhat late in emergence of policy outputs and outcome. In many cases, the expected results from economic policy and measures did not come in place in time. Meanwhile, the economic reforms that came in place in the early 1990s included devaluation of ROL, demolition of subsidies on most of the consumer goods, and conversion of some state-owned entities to private ownership.

The breaking point in this "stop-and-go" process was the commencement of the accession negotiations with the European Union (EU) in 1999-2000. Under the policy constraints (triggers) imposed by EU, Romania embarked on the reform process in order to fulfill the accession conditions. With this, associated with well-driven micromanagement of the economy and strong demand in EU export market, Romanian has since mid-2000 been on the right track of sustainable growth with GDP increased by 5.5% in real terms in average per annum. This high growth rate was accompanied by a downturn of inflation and lower unemployment rate during the first half of the decade of the 2000s. An IMF standby agreement signed in 2001 also helped providing the government a firm fiscal basis that gave maneuverability to proceed with deficit reduction, privatization in the energy and transportation sectors in particular, and curbing of inflation. With a successful achievement of macro-management of the economy inclusive of reduced budget deficit and curbed inflation rate in 2003, Romania completed a stand-by agreement with IMF in October 2003 for the first time, after five times failures in the 1990s[8]. Followed by discussions held between IMF and the Government, the second Stand-by Credit Agreement was approved in July 2004 in a bid to consolidate those economic gains emanating from the previous Agreement for sound macroeconomic framework that would enable the country a smooth EU accession.

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[7] Debt serviceability is measured by Debt-service ratio, as defined as follows, where *t* denotes any year during the project period.

$$DSR_t = \frac{(AnnualDebtService)}{Revenue}$$

[8] In May 1994, IMF issued the Romanian Government a US$700 million loan that helped curbing inflation rate in the following year. Nonetheless, IMF did not release loan proceeds twice in 1996 and 1999 to Romania due to poor performance in policy commitments of economic reform inclusive of privatization of state enterprises.

Nonetheless, the IMF mission to Romania released, in the end of last year, the break of discussions on the Agreement, while denouncing the government for unsatisfactory performance in economic reform in an "unusually profound" term and tone[9]. The Mission expressed "the arrangement with Romania is now off track", while stressing structural vulnerability of the country's macroeconomic framework for sustainable growth and productivity. IMF also stressed the importance of embarking on the tight fiscal policy to curb inflationary pressure, while endeavoring to profoundly increase government revenue. The Fund was also concerned about the government decision to widening macro-disequilibrium with 0.9 percent of 2006 budget deficit to GDP as well as 5±one percent inflation target being unmet. Split of views between the parties, IMF and the Romanian Government, on performance in micromanagement of the economy with the fiscal policy in particular eventually resulted in the cancellation of the second Stand-by Agreement (SBA) in summer of 2006[10]. This would undermine the country's credibility in international aid/commercial financing and accession process to EU.

In the meantime, IMF has since 1990 extended a vigorous support by sending more than 40 technical assistance missions to the country through its grant-facility of Expert Fund. IMF TAs focused on, among others, macro-management of the economy in the frameworks for public financial management, with specific issues related with fiscal reforms, modernization of the central bank and the banking system, fostering market-oriented legal structure, improving statistical system, based on which a comprehensive policy reform in tax administration commenced in 2003. The Government and IMF reportedly indicated continued linkages and dialogues on further collaboration, as necessary, even without the SBA framework.

In the meantime, there is still a large part of the population under the poverty threshold (around 29% in 2002) against the economic performance, and the disparities between the "Haves" and the "Have-nots" have increasingly been widened.

The accession negotiations with EU has by now completed, and subsequently the Accession Treaty was sign on 25th of April 2005, while EU accepted Romania's fulfillment of the Copenhagen criteria. With this, Romania is now expected to gain the membership of EU by 2007, subject to further conditionalities that the country is to satisfy. Provided that Romania has failed to fulfill the policy triggers as stipulated in the Treaty, the country's entry would be postponed to the following year of 2008. The hot issues that are taken into consideration include justice, fair competition in trade, and corruption. The reform process is now going on with an important change in fiscal policy specifically in view. The issue is the government's economic policy and strategy that are still somewhat in a short eye-sighted, while missing clear direction as to what change would be in need and by when.

Meanwhile, the government stepped ahead towards the implementation of her currency policy to denominate Romanian Lei in July 2005, while converting ROL 10,000 to being equivalent to RON 1.0. The policy objective in so doing include: (i) increasing public confidence in the national currency, (ii) supporting anchoring inflation expectation, (iii)

[9] Source: *NINE O'CLOCK* (daily newspaper in English), 1 November 2005
[10] Reference: The World Bank, *Country Partnership Strategy for the Period FY2006-FY09*, May 2006, p.5

simplifying records and transactions, (iv) improving structure of banknotes, and (v) paving the path for Euro adoption that is presumably envisaged in 2012-2014[11].

2.2.2 Macro-Management of the Economy

As given in the foregoing, Romania embarked on the new economic reform in 2000 in the wake of the devastating economy over the period of 1997-1999. The economy was uplifted and the growth rates bounced back to the point where EU had initially imposed. As seen in Figure 2.2.1, Romania posted a high economic growth in real terms, and this trend is forecasted by EU to go on.

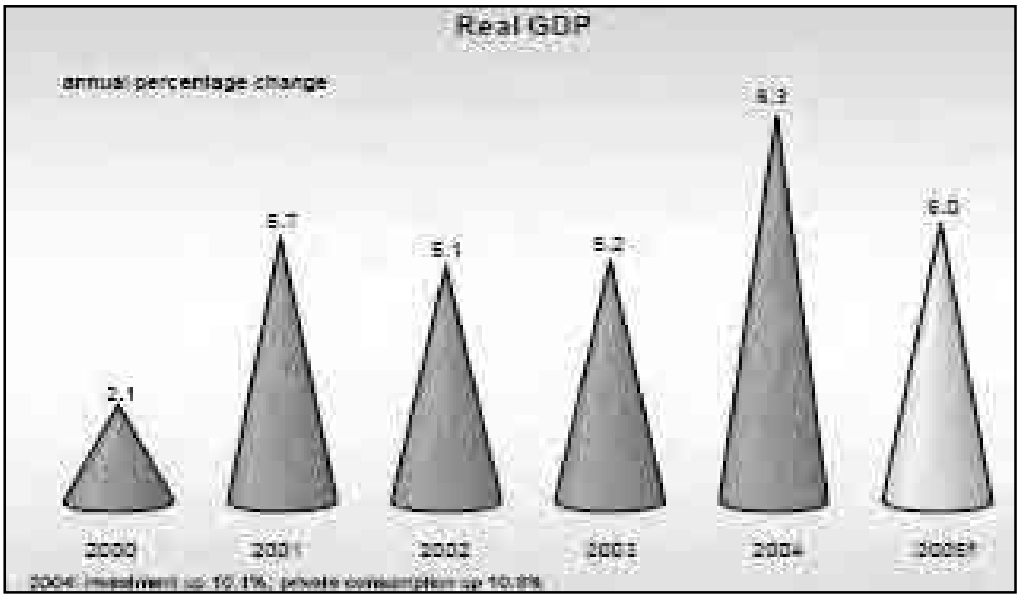


Fig. 2.2.1: Real GDP growth 2000-2005 (**source: http://www.bnro.ro/)**

With regard to the trade policy, Romania and the European Commission (EC) signed in 1993 and entered into force in 1995 the Economic Agreement that immensely requested Romania to lower its trade barrier to open the economy on the rest of the world, with the EU 25 countries in particular. In this light, the country's economy is now liberalized with the summated percentage of export and import in GDP was more then 80 percent in 2004 (Fig. 2.2.2). In 2004, merchandise exports and imports totalled respective of US$ 25.6 billion and US$ 32.7 billion, for which the European Union countries as the major trading partner while accounting for 74 percent of the aggregate Romanian exports and imports. The major trade partners of Romania both in import and export are Italy, Germany, and France with the percentage share of imports and exports as listed in Table 2.2.1.

Table 2.2.1: Major trading partners

Exports (percentage share of the total)		Imports (percentage share of the total)	
Italy	21.2	Italy	17.2
Germany	15.0	Germany	14.9
France	8.5	France	7.1
UK	6.7	Russia	6.8

[11] National Bank of Romania, *Romania, macroeconomic Development*, May 2005, p.35

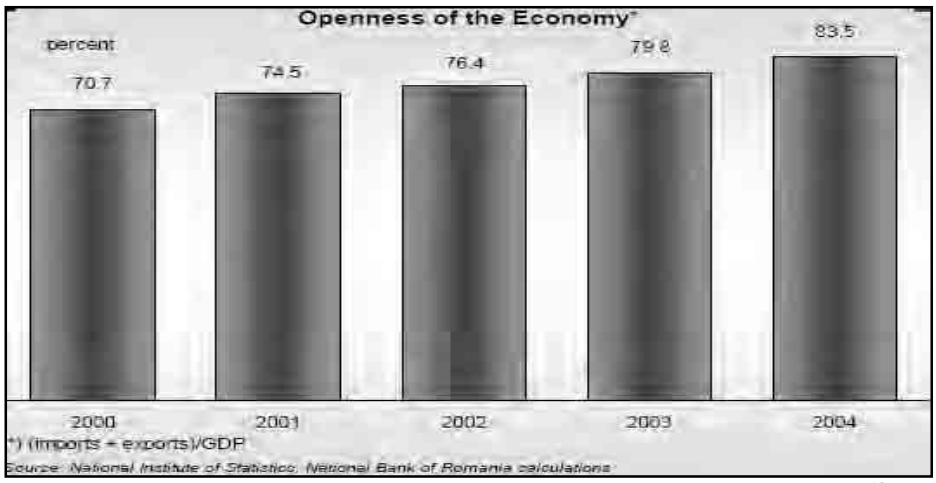


Fig. 2.2.2: Trade liberalization and openness of the Romanian Economy[12]

Inflation in general has been substantially under the control with the downsizing of the indicator figures of 54.8 percent in 1999 to as low as 9.3 percent in 2004 (Fig. 2.2.3). The country's favorable performance in price control was almost as par the yearly target as set out by EU, and in this light EU foresees the economy keeping on a right track to the years that lie ahead. Nonetheless, the target benchmarks of inflation have slightly changed upwards to 7.5 percent and 5.0 percent in respective of 2005 and 2006 in lieu of 7.0 percent and 4.0 percent in the same year, following the recent evolution in the economy. Macro-economic targets as set out in the *Pre-Accession Economic Program for 2004* by EC are summarized in Table 2.2.3 in the following.

In the *Country Partnership Strategy* which was recently approved and by the Board, the World Bank observed the country's better and weaker performances in macro-management of the economy in 2005. On the favorable side, the 2005year-end inflation was 8.6 percent exceeding the benchmarked target of 7.5 percent but downsized form 9.3 percent in 2004. Fiscal deficit is estimated at around 0.8 percent of GDP that went below the target figure of one percent. Government revenue to the budget increased in real terms by 8-9 percent on account of strong VAT collection and wider tax-base. In order to curb inflationary pressure, the central bank tightened its fist to raise interest rate in February to 8.5 percent from the preceding 7.5 percent rate. In the meantime, Real GDP growth downsized to 4.1 percent from 8.3 percent in the previous year due partly to lower agricultural outputs by flood damages and industrial production possibly by the appreciation of the LON against the Euro. Another macro-disequilibrium indicator of current account deficit was worsened at 9.2 percent of GDP, far exceeding the target rate of 7.5 percent. Even though revenue increased by around 3-4 percent of GDP, capital expenditure remained lower with the percentage share of around 2-7 points of GDP.

[12] Source: Cristian Popa (National Bank of Romania), *Policy & Regulations and Investment in Romania*, British-Romanian Chamber of Commerce Business Breakfast, Bucharest, 5 April 2005

Table 2.2.2: Macroeconomic targets set by pre-accession economic program for 2004

Benchmark Indicators (Percentages unless otherwise indicated)	2003	2004	2005	2006	2007
1. Real GDP Growth	5.2	8.3	6.0	6.1	6.3
2. GDP (EURO billion) at current price	50,681	57,767	69,633	79,269	90,448
3. GDP Deflator	19.5	13.6	9.5	7.3	5.7
4. CPI Increase	15.3	11.9	8.1	6.0	4.4
5. Unemployment Rate Decrease	-0.1	-0.6	-0.1	-0.1	-0.1
6. Labour Productivity Growth	5.3	8.9	6.1	6.2	6.4
7. Share of Investment (% of GDP)	22.2	23.3	24.4	25.5	26.8

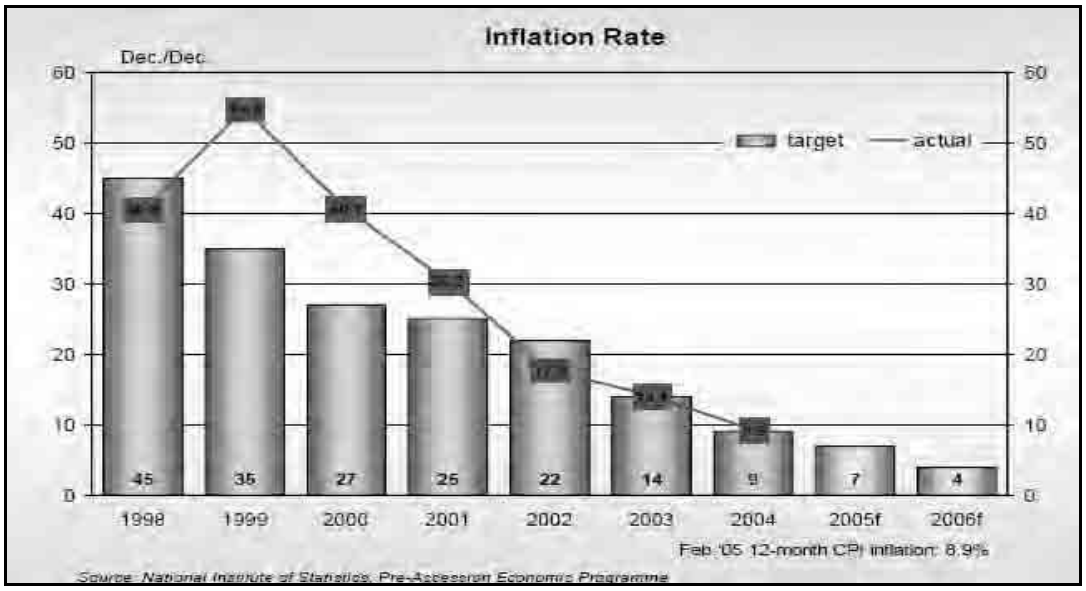


Fig. 2.2.3: Inflation rates as agreed upon in PEP[13]

2.2.3 Monetary and Fiscal Policy under the New Regime

The new government that came in power in the end of 2004 has since then faced formidable policy changes to manage fiscal tightening, inflation targeting, capital account liberalization, denomination of the Romanian Leu, and flat income and profit taxes within the framework for fiscal policy realignment. The year 2005 started with an important change in fiscal policy followed by the reengineering the monetary policy strategy in August 2005. The followings will provide an outline view of the changes that have taken place in the fiscal and monetary policies.

(1) Monetary policy

One of the focal points in benchmark targeting in macro-management of the economy is a curbing of inflation while looking at both the factors of supply- and demand-sides. The inflation targeting policy through monetary policy was extremely debated among economists because of the risks it implies for the economy in the face of capital market

[13] Source: Cristian Popa (National Bank of Romania), *Op. Cit.*, 5 April 2005

liberalization in the spring of 2005 that might bring about a possible inflow of vast speculative external funds into Romania. This measure, which was a part of the policy commitments to EU, substantially limits the instruments of currency quotation control for the National Bank of Romania (NBR) as a monetary authority. There would be a need for the government and NBR as well to redress balancing between NBRs currency control for disinflation and the financial market liberalization in the broad framework for governance. In this connection, both administrative and monetary authorities are profoundly requested to undertake their responsibility with discipline, accountability, transparency, and predictability.

Currently the general price-hike in the country was 9.9 percent by the end of the second quarter of 2004 as against the annual benchmark target of 7.5 percent. This relatively higher inflationary pressure on the economy is accrued to both the supply-and demand-sides. On the supply side, the factor that inversely affected most was the increases in the proportion of subsidized prices, excise duties, and the world oil price as seen in Fig. 2.2.4 below.

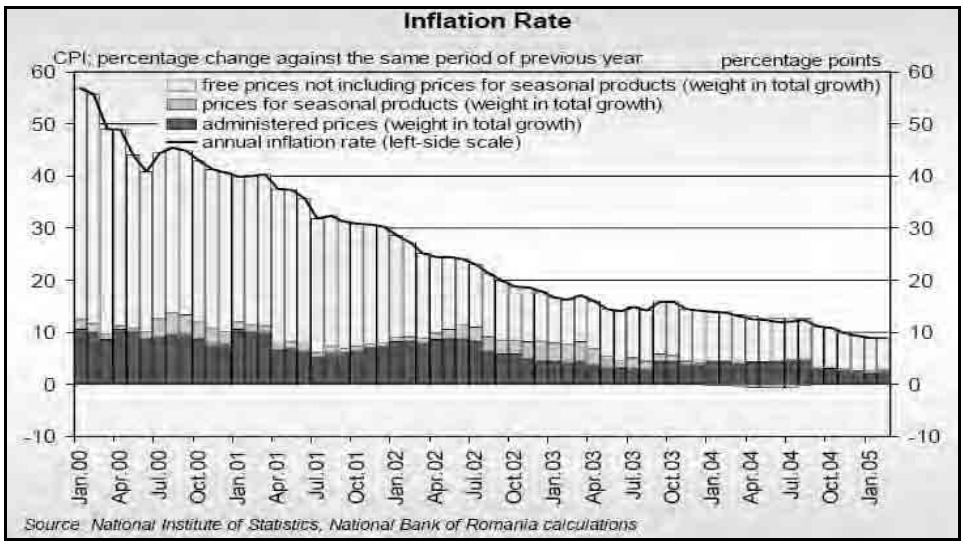


Fig. 2.2.4: Main determinants of the inflation rate[14]

On the demand side, excess aggregate demand driven by the acceleration of domestic consumption in GDP was a major game player in this economic booming. While excess demand diminished at the beginning of 2005 in comparison with 2004, it still is robust pushing the prices of consumer goods and services in particular. As is in common, growth in consumption in Romania has contributed more to GDP growth than that in capital formation (investment) due to a larger portion of consumption in GDP (see Fig. 2.2.5).

Of the aggregate demand, the driving force of inflationary uprising in prices includes private consumption (C), investment (I), and government consumption (G). Behind consumption lies the expansion in income basis due to (i) looser wage policy commenced in the latter half of 2004, (ii) higher disposable incomes by reduction in income tax and profit tax, and (iii) Wage hike in the public sector. There could also be observed that the quick inflow of non-government credits, large part of which are foreign exchange-denominated. (Fig. 2.2.6) Foreign exchange denominated external commercial debts imposes a double-folded vulnerability to the country in the light of inflationary pressure by excess

[14] Source: Cristian Popa (National Bank of Romania), *Op. Cit.*, 5 April 2005

supply of money and debt sustainability in the short-run.

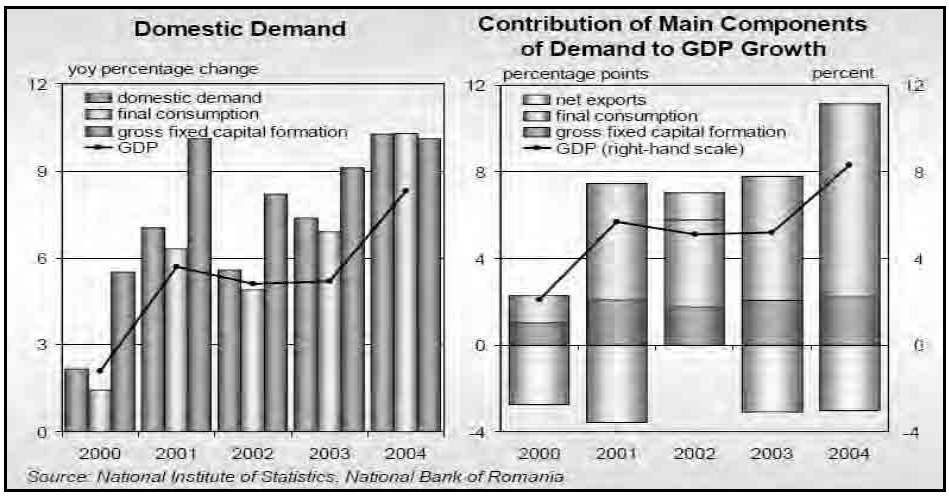


Fig. 2.2.5: Domestic demand and gross capital formation[15]

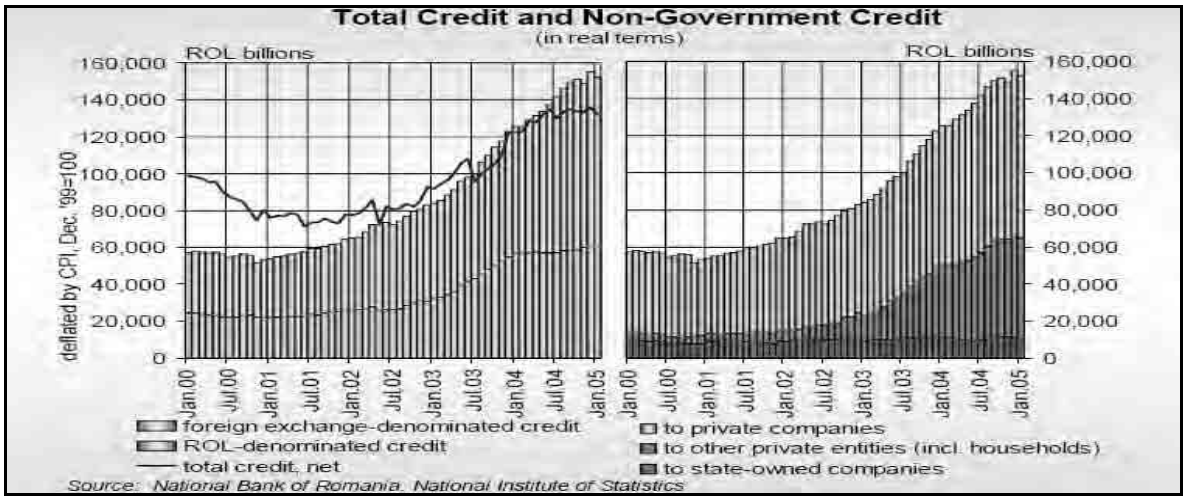


Fig. 2.2.6: Evolution of total and non-government credits[16]

Government spending as part of elements that led inflationary pressure has been growing with deficits in current account. Figure 2.2.7 depicts the deteriorating fiscal discipline resulting in the current account deficit of 6 percent of GDP in 2003 to 7.5 percent in 2004. It is envisaged to increase even further this year and in the years ahead.

Current account deficit has been worsening with 3.7 percent of GDP in 2000 to 5.9 percent in 2003. Terms of Trade has also been worsening due largely to exportable goods comprising low-value-added textiles and footwear that accounting for some 30 percent (Fig. 2.2.8). While the share of textiles and footwear has been downsized, the proportional increase in higher-value-added industrial products (machinery, equipment and transportation means) is obvious, thereby leading to a structural trade deficits. Another salient feature that is in place in Romania is the real and nominal appreciation of the RON against Euro and USD. This inversely affects the export sector with less receivables and stimulated imports. While NBR intervenes in the financial market trying to hold the foreign exchange quotation as it used be,

[15] Source: Cristian Popa (National Bank of Romania), *Op. Cit.*, 5 April 2005
[16] Source: Cristian Popa (National Bank of Romania), *Op. Cit.*, 5 April 2005

appreciation trend is envisaged to continue resulting consequently in the continued current account deficit at least in the short run

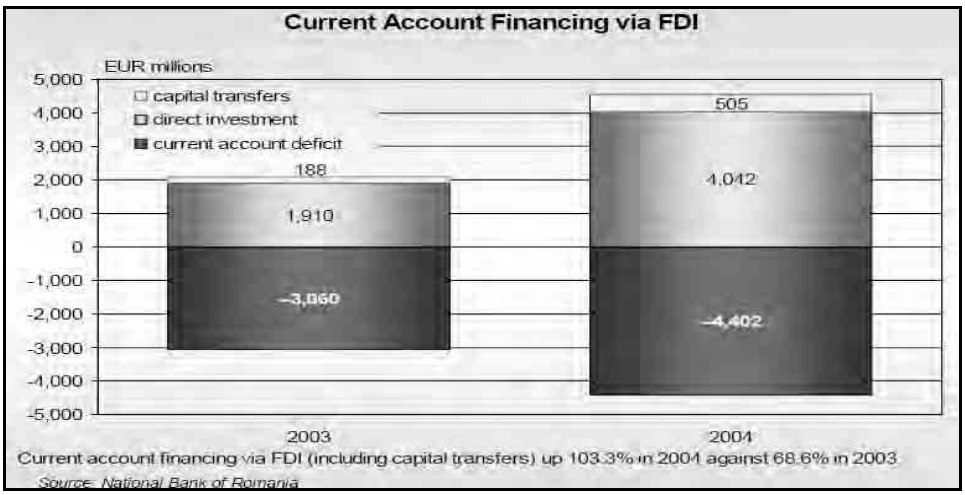


Fig. 2.2.7: Major financing sources of the current account

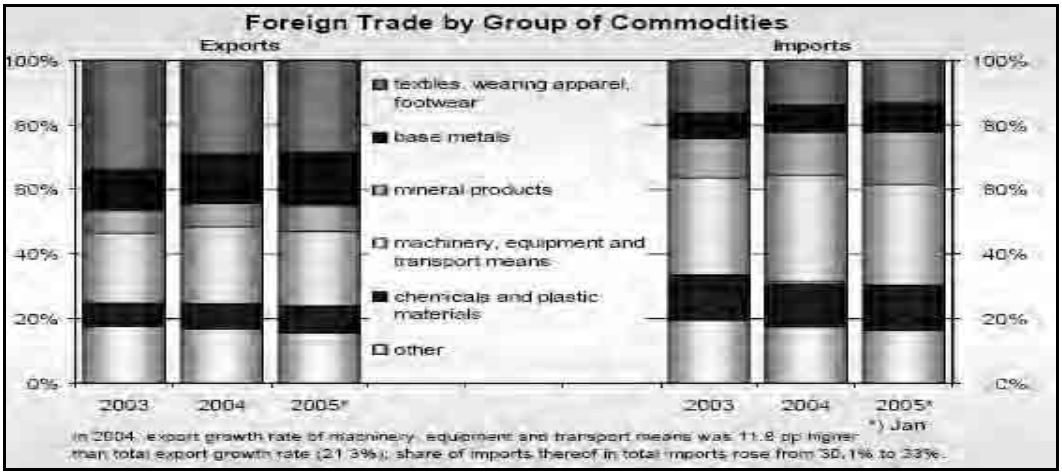


Fig. 2.2.8: Foreign trades by commodity

(2) Fiscal policy

The major change in fiscal policy took place on the 1st January 2005 while introducing flat income tax of 16 percent of gross earning for both personal income and corporate profits regardless of income cohorts. Corporate tax was previously 25 percent, and the lowered tax rate would stimulate investment in the private sector thus leading to higher employment and associated diminishment of income disparities in the society. Personal income tax previously ranged between 18 to 40 percent of gross earning, thereby leading to an economic drive of further household consumption. While the government revenue would be inversely affected by less tax collection in the short run, the government is resisting pressure from IMF to raise value added tax (VAT) to 25 percent arising from 19 percent currently in place.

In the meantime, fiscal deficit is still under the range of control, with 4.0 percent, 3.2 percent, 2.5 percent, 2.3 percent, and 1.5 percent of GDP in 2000 through 2004, in the descending order (Fig. 2.9). While fiscal deficit is estimated at 0.8 percent of GDP in 2005, the consolidated budget for 2006 is targeted to bounce back to 0.9 percent of GDP. .

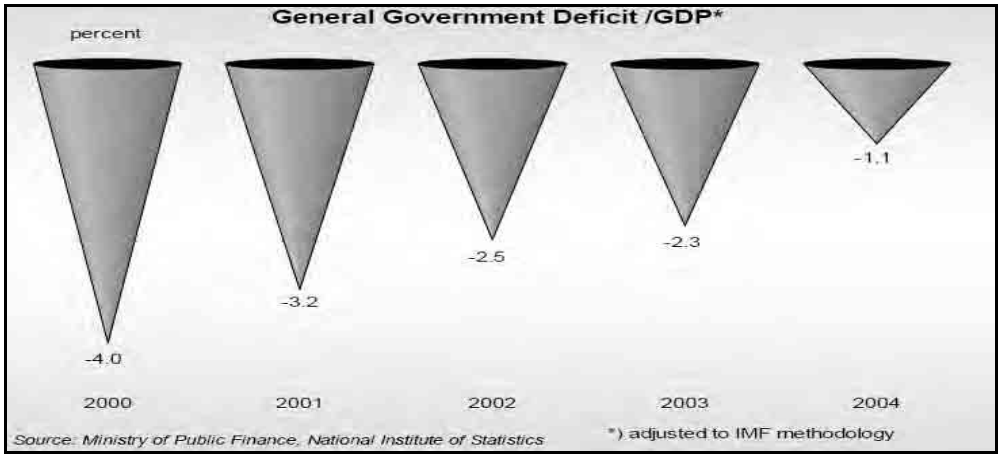


Fig. 2.2.9: Fiscal deficit as percent of GDP, 2000-2004

2.2.4 Income Distribution in Romania

The average monthly gross and net earnings per household in Romania stood at respective of ROL 9.7 million (US$298.2 as par 2004 foreign exchange quotation of ROL32,637/US$) and ROL 6.9 million (US$210.6) in December 2004, respectively[17]. In the meantime, Constanța Chamber of Commerce estimated the monthly average of wage and salary to workers stood at ROL 9.45 million (Gross) in the county, *vis-à-vis*, ROL 9.2 million for all of the Romanian in March 2005[18]. Income distribution in the economy is highly skewed with the Gini coefficient of 0.32 in 2002[19]. Consumption shares of the poorest 10 percent and 20 percent are respective of 3.2 percent and 8.0 percent, whereas those of the richest 10 percent and 20 percent standing at 25.0 percent and 39.4 percent, respectively. In terms of household income, the lowest 10 percent and the highest 10 percent account for 27.6 percent and 2.4 percent, respectively[20]. The skewness in income distribution in Romania has been about the same over the period of economic re-launching in mid-2000 to date, while the average household income has risen to a certain extent. The right-hand side shift of average income and its shape of distribution by frequency among the nationals is depicted and given as shown in Fig. 2.2.10.

In the meantime, the registered unemployed and unemployment rate were 558,000 and 6.2 percent in 2004, downsizing from respective of 659,000 and 7.4 percent in the preceding year. Of this, women account for 42.0 percent in 2004.

[17] Source: Romania National Institute of Statistics, Press Release, No.3 of January 2005

[18] Source: The Constanța Chamber of Commerce and Industry, Shipping and Agriculture, *Constanta Short Economic Profile of the Region*, 2005, p.2.

[19] In comparison, Romania is behind Russia, Bulgaria, and Poland, with 0.52 (2001), 0.37 (2000), and 0.35 (2002), in that order.
(source: http://www.centrueurope.org/overview/gini_coefficient_central_eastern_europe.htm)

[20] Nationmaster.com, Romania Profile, http://www.nationmaster.com./country/ro/economy

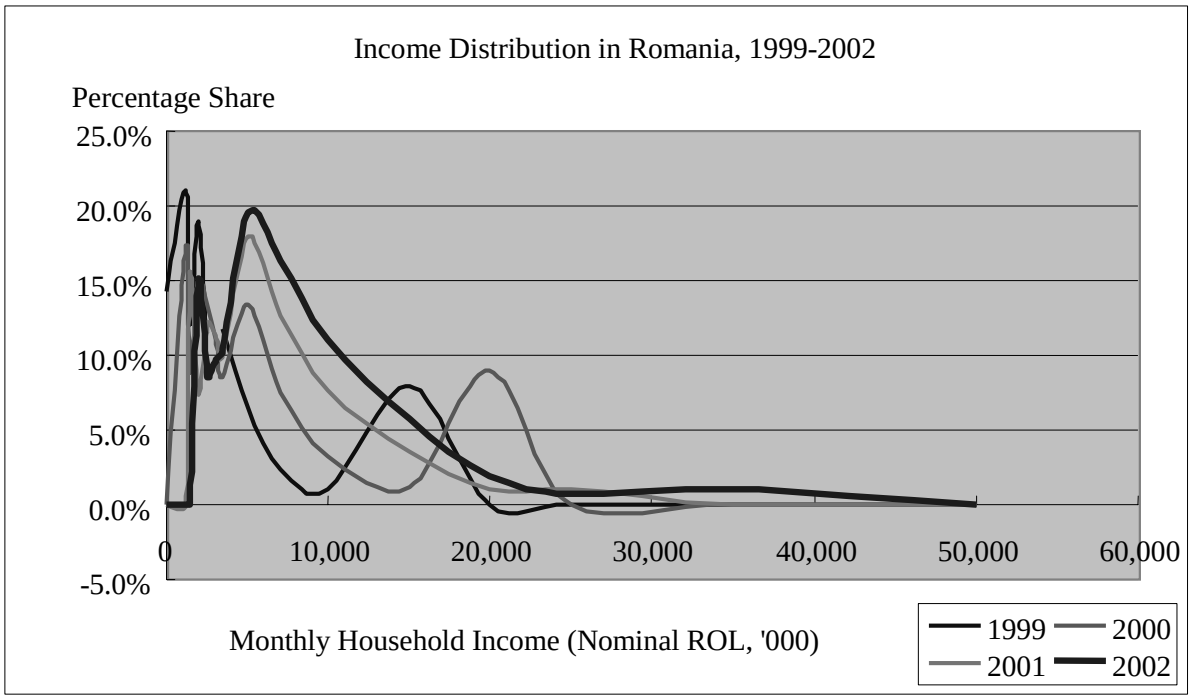


Fig. 2.2.10: Income distribution in Romania during 1999-2002

2.2.5 Regional Economy

(1) Developing regions

Romania, in accordance with the European NUTS 2 classification, is divided into 8 development regions under the administrative power of the Regional Development Agency. Development Regions (DRs) that comprise several counties therein are different from territorial-administrative entities, as such DRs do not have legal personality. The major objective of DRs is to formulate and assist in the implementation of regional development strategy with a view to promoting economic diversification, stimulating domestic and direct foreign investments in the private sector, curbing of unemployment, and enhancing social and economic welfare of people in the region. DRs currently in place include the followings:

- Regional Development Agency 1 : Northeast Region
- Regional Development Agency 2 : Southeast Region
- Regional Development Agency 3 : South Region
- Regional Development Agency 4 : Southwest Region
- Regional Development Agency 5 : West Region
- Regional Development Agency 6 : Northwest Region
- Regional Development Agency 7 : Central Region
- Regional Development Agency 8 : Bucharest

Specific Terms of Reference (Job description) for DRs as stipulated in the law are elucidated in the Box 1.1 in the following.

Box 1.1 The main attributions of a Regional Development Agency in accordance with the Law no. 151/July 15, 1998 on regional development in Romania

Article 8 - The Regional Development Agency shall have the following main attributions to:

a) elaborate and propose to the Regional Development Council for approval the regional development strategy, the regional development programs, and the funds' management plans;
b) put in operation the regional development programs and the fund management plans conformably to the decisions adopted by the Regional Development Council, with observance of the legislation in force, and to answer for their achievement before it;
c) identify the socially and economically disfavored zones in the development region, together with the local or county councils, as the case may be, and forward the necessary documentations, previously approved by the Regional Development Council, to the National Regional Development Agency and to the National Regional Development Council;
d) provide technical assistance, together with the local or county councils, as the case may be, to natural or juristic persons with state or private capital, investing in the disfavored zones;
e) submit to the National Regional Development Agency proposals for financing from the National Regional Development Fund, of the approved development projects;
f) act for the attraction of financing sources to the Regional Development Fund;
g) manage the Regional Development Fund for the purpose of achieving the objectives provided in regional development programs; and
h) be responsible toward the Regional Development Council and toward the bodies enabled by law for the correct management of the allocated funds.

Regional development policy is an ensemble of measures formulated by the local and central public administration authorities to ensure a dynamic and sustainable economic growth through the efficient and effective use of local and regional resources. The major areas of policy commitments include: development of enterprises and the labor market, attracting domestic and foreign investments, development of the Small and Medium-Size Enterprises, improving social and economic infrastructure and the quality of natural environment, curbing of regional disparities between the urban and rural areas, and enhancing the social sectors inclusive of health and education.[21]

Average monthly income is estimated by the National Commission of Forecast (CNP) at US$360.7 equivalent as par early June 2006 foreign exchange quotation in Bucharest Region, followed by the South West, West, South East, South, North West, Central, and North East Regions with each of the amounts at US$295.7, US$283.6, US$278.9, US$275.7, US$269.9, and US$263.8, in that order. Constanta is one of the six counties in the South east Region. It is also forecasted that the monthly income will increase by 10 percent per annum in the following years of 2007 and 2008. Meanwhile, unemployment rate will decline to 5.9 and 5.6 percent in respective of 2006 and 2008 from 30.5 percent in 2000. That in Bucharest in 2008 will be 2.2 percent downsizing from 2.7 percent in 2006[22]. Economic discrepancy by Region is depicted and given in the following figure (Fig.2.2.11).

[21] Source: Ministry of European Integration
http://www.mie.ro/english/mie.htm?PHPSESSID=9c7600b82b3ab2e3feafdff92bdd9c76
[22] Source: *Breninentul Zlei* (Romanian daily paper), 12 June, 2006

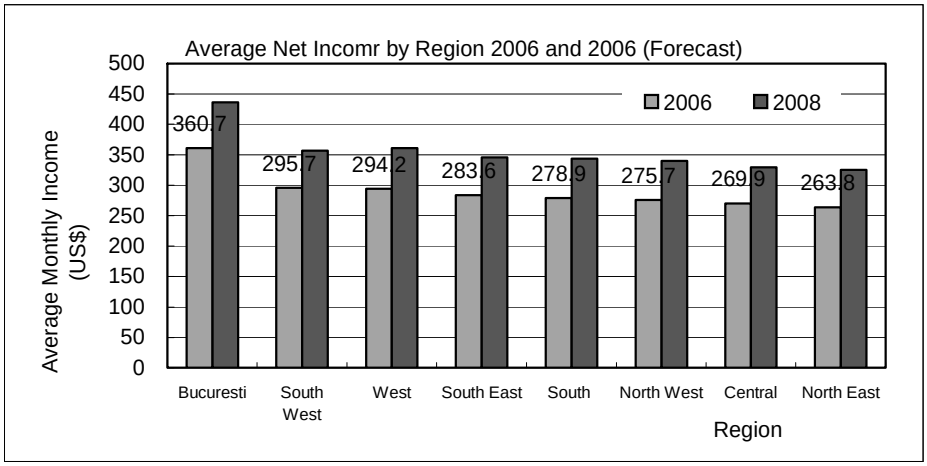


Figure 2.2.11: Average monthly income by Region, 2006 and 2008

(2) Tourism and Constanța County

Constanța County constitutes a part of the Southeast Development Region, together with the counties of Braila, Buzau, Galati, Tulcea and Vrancea. Table 2.2.3 and Figure 1.2.12 gives a brief look at the economic size of the South East Region, followed by a set of demographic and social indicators in Table 2.2.4.

Commonwealth in Constanța County emanates from Constanța harbor that was founded in 1909 and now covering 3,926 ha and maritime transport, followed by agriculture, and food processing, with all of which accounting for around 80 percent of gross regional products (GRP)[23].

Table 2.2.3: Major economic indicators of the Southeast Region[24]

South-East Region	1995	1998	1999	2000	2001
GPR- total (US$ thousand)	4,556.2	5,5161.9	4,315.4	4,281.1	4,530.2
GPR per capita (US$)	1,542.0	1,874.4	1,469.5	1,468.4	1,545.0

Table 2.2.4: Main indicators for Constanța County[25]

	2002	2003
Population	715,151	-
Population Density per km^2	101.1	-
Unemployment Rate (percent)	8.7	6.9
Average nominal wage (US$/employee/month)	123.05	159.55
Tourism: Accommodation capacity	119466	119785
Tourism: Check-in (thousands)	4,582.9	4,471.6

[23] http://www.ccina.ro/en/ct_prez_4.php
[24] Source: http://www.braila.insse.ro/main.php and own calculations
[25] Source: http://www.constanta.insse.ro/main.php

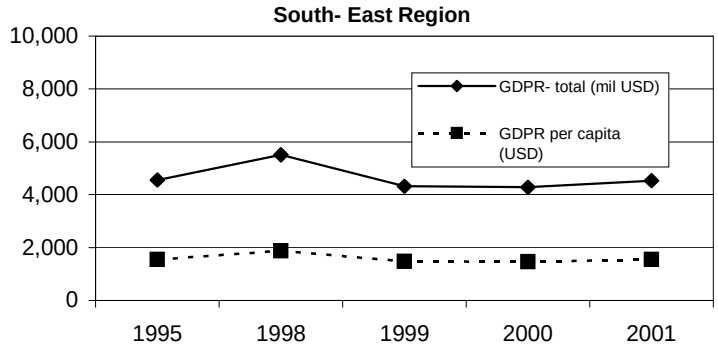


Fig. 2.2.12: Gross regional products (GRP) and GRP per capita

The tourism sector have faced difficulties in the past 10 years with the followings:

(1) 20 percent decline in the number of foreign tourists from 6.5 million in 1990 down to 5.2 million in 2000;
(2) 14 percent decrease in beds in hotel and other accommodation facilities from 328,000 to 283,000 over the same period immediately above;
(3) Drop of bed occupancy rate of 57.8 percent in 1990 to 34.5 percent in 2000; and
(4) Reduction of the days of stay in accommodation by 61 percent and 53 percent for the Romanians and expatriates, respectively.

Constanța County as a whole provides over 41 percent of national accommodation capacity. Along the 82 km-Romanian Black Sea Coast, there are thirteen resorts among which Mamaia is located near downtown Constanța, while offering the largest accommodation capacity on the whole seaside. The number of tourists visiting Constanța County had been downsized with around 1.81 million in 1989 to 0.74 million in 2001, prior to the bounce back of 788,763 and 845,000 in respective of 2003 and 2004. Of this, expatriate visitors to Constanța grew 7.2 percent in 2004, while inviting foreigners from Germany (19,490) followed by Italy (7,417), Sweden (7,207), Russian Federation (6,715), France (5,744), Denmark (5,740), and the USA (2,856)[26]. A time series look at the number of the Romanians and foreign tourists to Constanța from 1989 to 2001 are summarized and given in Table 2.2.5. One of the reasons behind the increase of tourists to Constanța may be the lowering of value added tax (VAT) that took place at the beginning of 2004, from 19 percent in the past to 9 percent.

Table 2.2.5 Tourists in Constanța County

1989	locals	1.542.700
	Expatriates	267.600 [17.4%]
1999	locals	720.648
	Expatriates	48.275 [6.7%]
2000	locals	713.972
	Expatriates	43.817 [6.1%]
2001	locals	687.479
	Expatriates	58.025 [7.8%]

[26] Source: The Constanța Chamber of Commerce and Industry, Shipping and Agriculture, *Constanta Short Economic Profile of the Region*, 2005, p.7, http://www.ccina.ro/en/ct_prez_7.php

Of the aggregate population of 713,783 in 2002, three municipalities inclusive of Constanța, Medgidia, and Mangalia account for 55.5 percent with 309,668, 44,850, and 41,153, in that order. The largest chunk of labor force in the County emanates from the transportation sector with almost a third of 29 percent of the aggregate, followed by the trade, the manufacturing, the construction sectors, each of this accounting for 25 percent, 22 percent and 11 percent, in that order (Fig. 2.2.13).

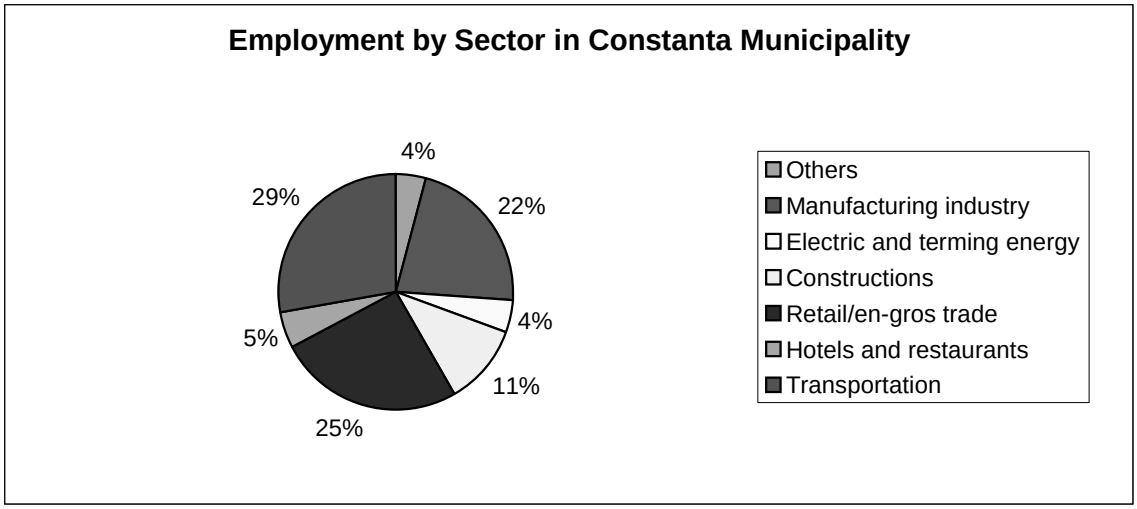


Fig. 2.2.13: Labor force by sector in Constanța County, 2002

(3) Public expenditure of Constanța County

Of the aggregate, the largest part of county expenditure is allotted to regional development and housing construction, with 35 percent of the budget 2005, followed by education (24 percent), administration (11 percent), social security (11 percent), and others (Fig. 2.2.14). Public expenses for the health and agriculture sectors are much less paid attention while being incorporated in the expenditure category of “others” that only accounts for 4 percent of the aggregate. Budget use realized by the end of March 2005 is almost in compliance with the budget appropriation, as depicted in Fig. 2.2.15 below.

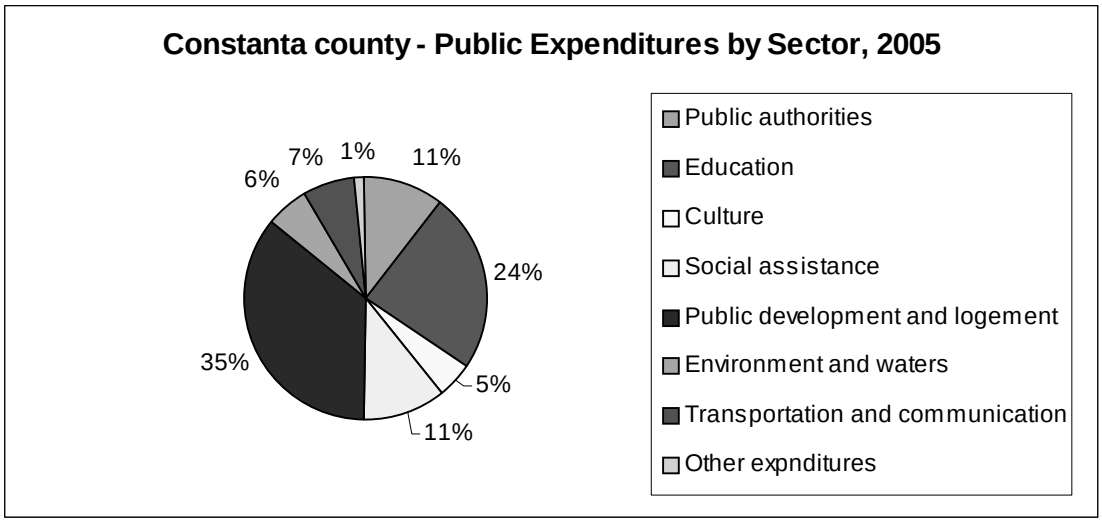


Fig. 2.2.14: Budget appropriation for the year 2005

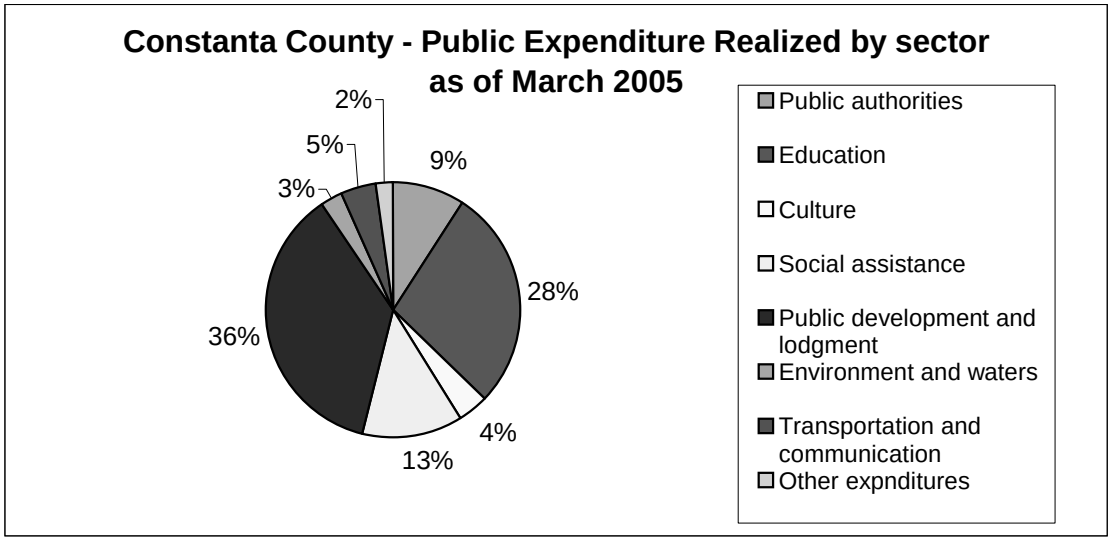


Fig. 2.2.15: Public expenditure realized as of March 2005

2.3 Social Background

2.3.1 Population and Society[27]

Romania, with 238,391 km^2 of land and 21,680,976 of a population (2004), is the second largest country in Central and Eastern Europe, and is placed the fifth in the 25 current members of the European Union (EU). The most populated city in the country is Bucharest with 1.9 million, followed by Constanța (312,000), Timisoara (309,000), Lasi (304,000) Galati (303,000), Craiova (300,000), Cluj-Napoca (297,000), Brasov (286,000), and others. Inclusive of the cities immediately above, seventeen Romanian cities have more than 100,000 populations. Besides, another 12 million of Romanians inhabits live out of the border, of which a majority in the Republic of Moldova with around 2.8 million, followed

[27] All of the numerical information and figures in this section are from The National Institute of Statistics, *Statistical Yearbook 2003.*

by Ukraine, Hungary, Serbia, Greece, and Albania. The Romanian communities in the United States of America and Canada comprise somewhere around 2 million. Nowadays, a number of Romanians could also be found in Australia, South Africa, Spain, Italy and South America, a large portion of this are illegal workers. It would be noteworthy that the total population of Romania has been on a downward path with the average annual population decrease of –0.7 percent over the period of 2000-2004[28]. The low fertility rate of 1.3 (2004) and negative migration on net basis has brought about this population downsizing.

Table 2.3.1: Romania by ethnicity

	Total population 21,680,976 of which:		Percentage Share
1	Romanians	19,399,597	89.5%
2	Hungarians	1,431,807	6.6%
3	Roma	535,140	2.5%
4	Ukrainians	61,098	0.3%
5	Germans	59,764	0.3%
6	Lippovan-Russians	35,791	0.2%
7	Turks	32,098	0.2%
8	Tartars	23,935	0.1%
9	Serbians	22,561	0.1%
10	Slovakians	17,226	0.1%
11	Bulgarians	8,025	0.03%
12	Croatians	6,807	0.03%
13	Greeks	6,472	0.03%
14	Jews	5,785	0.02%
15	Czechs	3.941	0,01%
16	Poles	3.559	0,01%
17	Italians	3.288	0,01%
18	Chinese	2.243	0.003%
19	Armenians	1.780	0,008%
20	Other ethnic groups	18.116	0,01%
21	Non-stated ethnic origin	5,935	0,02%

Table 2.3.1 provides an overview of Romanian population by ethnicity. While Roma is officially accounting for 2.5 percent of the aggregate, it is allegedly totaled around one fifteenth to twentieth of the total population. Likewise, a bird's eye view of Romanian as numerically measured by a set of social indicators is given in Table 2.3.2.

[28] Source: EIU, Op. cit., September 2005

Table 2.3.2: Social indicators in Romania

Population:	21,680,976 (July 2004 estimation)
Age structure:	*0-14 years:* 16.2% (male 1,861,801; female 1,770,746)
	15-64 years: 69.4% (male 7,712,612; female 7,791,900)
	65 years and over: 14.4% (male 1,330,994; female 1,887,498) (2004 est.)
Median age:	*total:* 36.1 years
	male: 34.7 years
	female: 37.5 years (2004 est.)
Population growth rate:	-0.11% (2004 est.)
Birth rate:	10.69 births/1,000
Death rate:	11.69 deaths/1,000
Net migration rate:	-0.13 migrant(s)/1,000
Infant mortality rate:	*total:* 27.24 deaths/1,000 live births
	female: 23.86 deaths/1,000 live births (2004 est.)
	male: 30.41 deaths/1,000 live births
Life expectancy at birth:	*total population:* 71.12 years
	male: 67.63 years
	female: 74.82 years (2004 est.)
Total fertility rate:	1.35 children born/woman (2004 est.)
Ethnic groups:	Romanian 89.5%, Hungarian 6.6%, Roma 2.5%, Ukrainian 0.3%, German 0.3%, Russian 0.2%, Turkish 0.2%, other 0.4% (2002)
Religions:	Eastern Orthodox (including all sub-denominations) 87%, Protestant 6.8%, Catholic 5.6%, other (mostly Muslim) 0.4%, unaffiliated 0.2% (2002)

Gender-wise population pyramids by age group is presenting a sensible situation due to the decrease of birth rate in the last 10 years caused of socio-cultural and economical reasons (see Fig. 2.3.1).

The structure of the population by sex reveals a slight imbalance between the genders, with 51.2 percent and 48.8 percent for female and male, respectively (2002). Unlike urban region where more pronounced difference in gender-wise population (51.9% female and 48.1% male), a relatively balanced birth of population by gender is seen in rural area where female and male are respective of 50.3 percent and 49.3 percent. (Fig. 2.3.2)

The two paths of the live-birth rate and mortality rate came coincided in 1991-1992 and have since then been placed where mortality rate exceed live-birth rate. This naturally led the country to a downsizing of population (Fig. 2.3.3). This is the result of the socio-cultural and economic conditions which does not affect the younger and fertility generation in their favor.

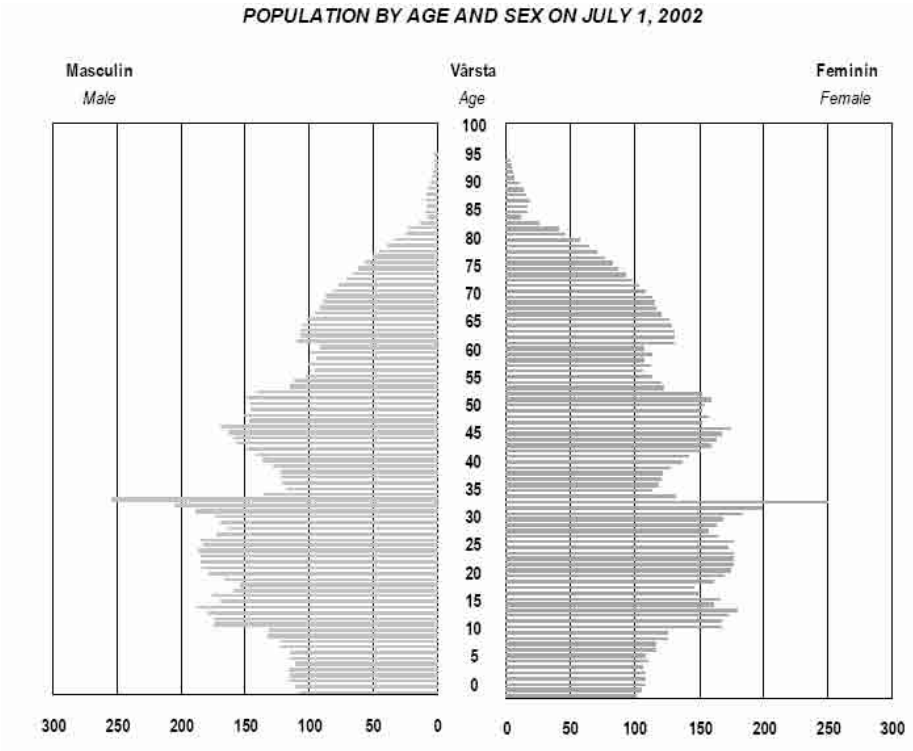


Fig. 2.3.1: Population by Age and Sex on July 1, 2002

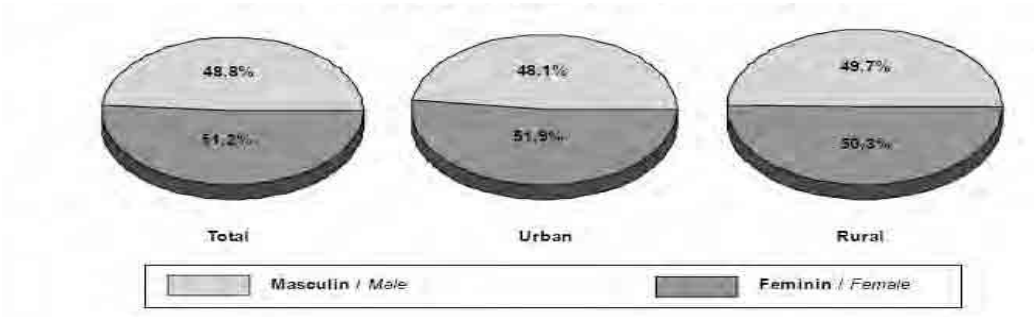


Fig. 2.3.2: Structure of population by sex on July 1, 2002

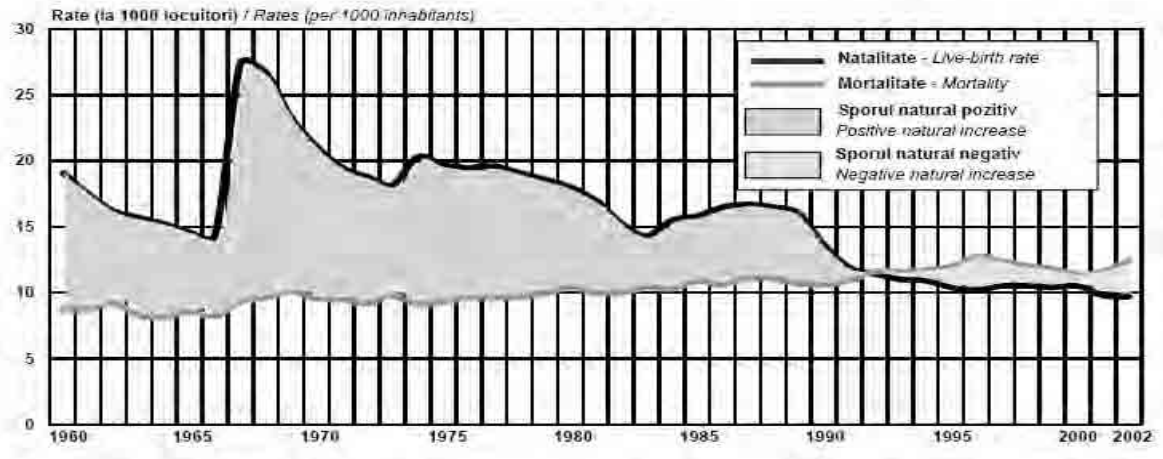


Fig. 2.3.3: Live-birth rate, mortality and natural increase during 1960 – 2002

The average life expectancy by gender has been stable with somewhat a little improvement in the last eight years, as depicted in Fig. 2.3.4. Difference between the female and male in life expectancy years at birth has also been 7 years since the later half of the 1990s to date.

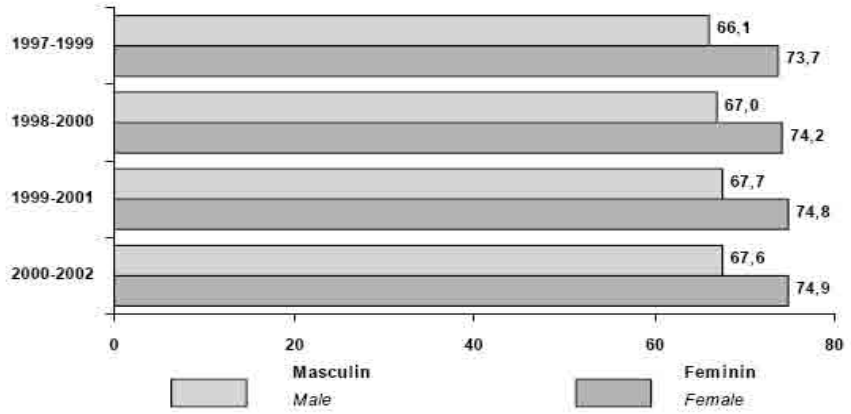


Fig. 2.3.4: Average life expectancy by sex (years)

2.3.2 Education Sector – System and Policy Issues[29]

(1) Access to Education

The Constitution of Romania complacently stipulates the right to education for all of the children and youths irrespective of social or ethnic origin, gender or religious beliefs in the framework of free-of-charge public education. In this light, the Law on Education also lays down the policy objectives of free, comprehensive and harmonious development of the human individuality, as well as the creation of independent and productive personality. The compulsory education system in the country consists of nine years starting from six years of age to fifteen years old (primary education with grades I-IV and lower secondary education (gymnasium) with grades V-IX). While primary education is only day education only, evening or extra mural courses organized for persons having exceeded the age corresponding to the grade by over two years are offered at secondary education, besides the normal day-care education. Since 1998, a Capacity Examination takes place in the end of the lower secondary education, and sequentially Capacity Certificate, with the score of the Exam being referred to at the time of access to the higher education.

The year 2002 enrollment rates at the primary level (category of 7-10 years) and the secondary level (category of 11-14 years) stood at 96.5 percent and 94.1 percent, respectively. The rates for women's enrollment were also high with respective of 96.2 percent and 94.3 percent in the same year, which was almost as par the national level (Table 2.3.3). This implies an equal opportunity of education in place to both of the genders, and of an open door of social opportunity on women in general.

[29] All of the numerical information and figures are, unless otherwise specified, stemmed from The Romanian *National Institute of Statistics- Yearbook 2003.*

Table 2.3.3: Enrolment rate for school aged population

procente / *percentage*

	1997/ 1998	1998/ 1999	1999/ 2000	2000/ 2001	2001/ 2002	2002/ 2003	
Total	65,1	66,3	67,3	68,9	70,6	72,9	*Total*
3 - 6 ani	67,0	68,5	69,5	66,1	72,3	76,5	*3 - 6 years*
7 - 10 ani	94,4	95,8	95,5	94,2	97,2	96,5	*7 - 10 years*
11 - 14 ani	98,0	98,1	96,9	95,5	93,2	94,1	*11 - 14 years*
15 - 18 ani	61,6	63,0	65,9	74,6	73,9	73,7	*15 - 18 years*
19 - 23 ani şi peste	24,3	26,7	28,9	32,9	36,4	40,7	*19 - 23 years and over*
Masculin	65,0	65,4	66,3	67,7	69,2	71,2	*Male*
3 - 6 ani	66,3	67,6	68,3	65,1	71,1	75,5	*3 - 6 years*
7 - 10 ani	94,6	95,9	95,7	94,5	97,4	96,6	*7 - 10 years*
11 - 14 ani	99,3	98,2	96,9	95,6	93,3	94,0	*11 - 14 years*
15 - 18 ani	62,0	61,4	64,0	72,5	71,6	71,4	*15 - 18 years*
19 - 23 ani şi peste	23,6	25,2	27,2	30,4	33,3	37,1	*19 - 23 years and over*
Feminin	65,1	67,2	68,3	70,2	72,1	74,6	*Female*
3 - 6 ani	67,8	69,6	70,7	67,1	73,5	77,6	*3 - 6 years*
7 - 10 ani	94,2	95,6	95,2	93,9	97,0	96,2	*7 - 10 years*
11 - 14 ani	96,6	98,0	97,0	95,4	93,2	94,3	*11 - 14 years*
15 - 18 ani	61,2	64,6	67,8	76,6	76,3	76,1	*15 - 18 years*
19 - 23 ani şi peste	25,1	28,3	30,7	35,5	39,6	44,5	*19 - 23 years and over*

(2) Policy Issues

By definition in Romania, literacy is defined for the ones who can read and write over the age of 15 years and more. In aggregate 98.4 percent of the Romanian fulfills this criterion, of which male and female account for 99.1 percent and 97.7 percent, respectively (2003). Even for this high literacy rate in the country, the issue now is early stoppage of educating amongst the youth. As seen in Figs 2.3.5 and 2.3.6, disparities in population between the ones at school and out of schools are growing bigger after the age of 15 years, while the primary education and the secondary school almost coinciding with the total number of population of that age group. Those who quit further schooling after 9-years compulsory education account for 47.9 in aggregate. While the 14.4-percentage-rate of graduates from the tertiary education underscores the average rate of the European Union member states average, this situation has recently been improved by the increase of private universities in the country.

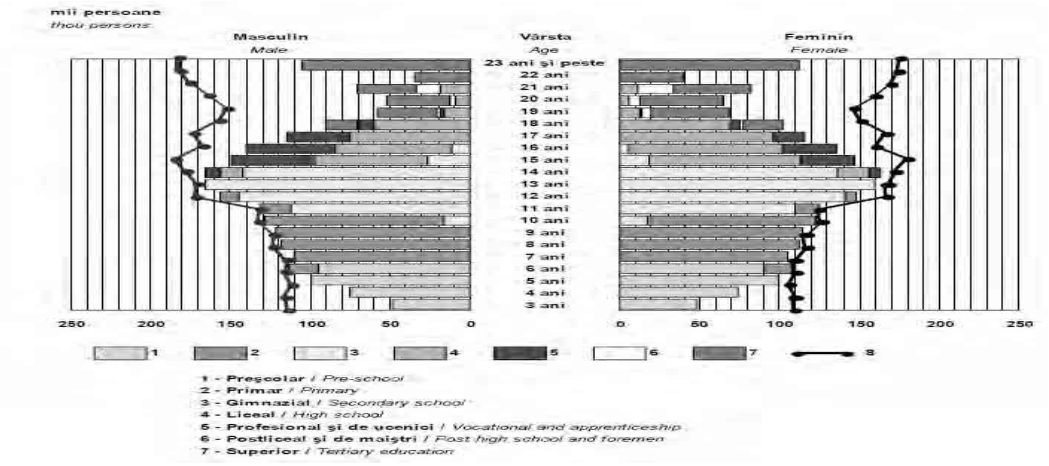


Fig. 2.3.5: School aged population by age, gender, and education level in 2002/03 academic year

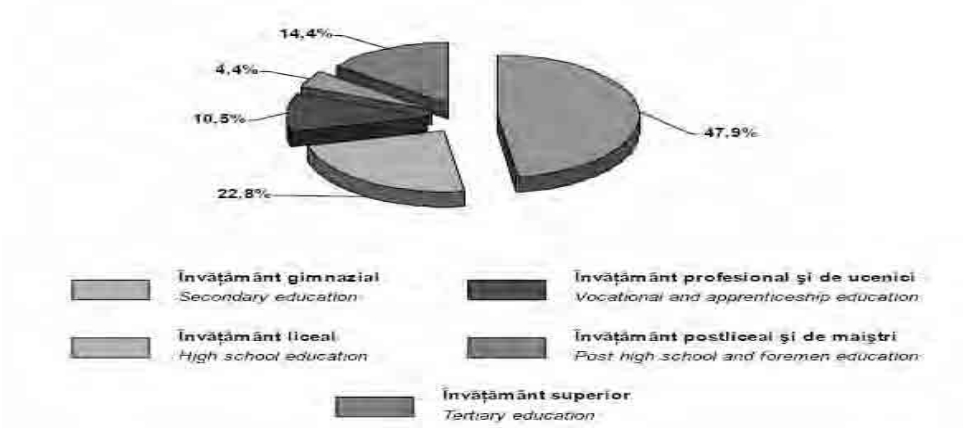


Fig. 2.3.6: Graduates of all Levels of education in 2001/2002 school (academic) year

2.3.3 Poverty Reduction – Current Status and Policy Issues

(1) Current status

In this subsection, consumption-based poverty is being assessed in Romania, in lieu of income-based poverty measures, within the analytical framework of the following definition[30].

> Extreme poverty line: ROL 1,060,658 equivalent of food, purchases of non-food and services and durables per adult per month (around US$31.5 as par December 2002 price level and December 2002 foreign exchange quotation). Individuals are classified as *severely (extremely) poor* provided that their consumption per adult equivalent is lower than this severe poverty line;
>
> Total poverty line: ROL 1,535,570 (RON 153.6 equivalent) per month of food, purchases of non-food and services and durables per adult (US$ 45.6 as par December 2002 price level and average exchange rate in December 2002). Individuals are classified as *total poor* provided that their consumption of food, purchases of non-food and services and durables per adult equivalent is lower than this severe poverty line;
>
> Poverty headcount: Percentage share of population under the poverty line:

As given in Table 2.3.4, Romanian poor has substantially been in the society, while the poverty headcount accounting for round 30 percent in the wake of 1997-1999 devastating economy. With regard to community poverty, poverty share in the rural area was 58 percent, whereas that in urban area being 82 percent[31].

Table 2.3.4: Poverty rates (headcount, percent)[32]

	1995	1996	1997	1998	1999	2000	2001	2002
Total poverty	25.4	20.1	30.3	30.8	33.2	35.9	30.6	28.9
Extreme poverty	9.4	6.3	11.2	11.3	12.5	13.8	11.4	10.9

[30] Reference: The World Bank, *Romania Poverty Assessment*, volume II, Background Papers, 2003
[31] Source: *Ibid*., pp.12-14
[32] Source: The World Bank, *Romania - Restructuring for EU Integration ,The Policy Agenda*, June 2004

The population share of the "poor" under the poverty line ("total poverty") downsized to 18.8 percent in 2004 from 35.9 percent in 2000, due thanks to the bounce back of the economy that has since 2000 been in place. Nonetheless, disparity in poverty between urban and rural areas remains significant, with 11.6 and 27.3 percents of poverty population in that order, in 2004.

Social equity issue as reflected by the consumption-based Gini coefficient (0.29 in 2002) reveals that Romania, in terms of inequality, is placed at the 4th amongst the countries in the Central and Eastern Europe Region, with Bulgaria, Hungary, and Slovenia running ahead with those of 0.27, 0.28, and 0.28, in that order. The country is followed by Croatia (0.32), Armenia (0.32), Tajikistan (0.32), Latvia (0.34), Poland (0.34), Macedonia (0.34), Georgia (0.37), Moldova (0.41), Kyrgyz (0.42), and Russia (0.47). Relatively equitable income distribution of Romania in the Region would be attributable to (i) equally distributed primary income sources, that is, wages and salaries, in a relative and comparative term, (ii) lesser unevenly distribution of self-employment earnings in the farming and non-agricultural low-productivity sectors in Romania, and (iii) government policy of income redistribution. This issue will be discussed in the following subsection.

(2) Policy Issue on Social Safety Net for the Poor

Classification of the country's public expenditure on social protection for unemployed is broadly classified by the National Institute of Statistics as given in the following:

(1) Unemployment benefit and vocational integration allowance: Grants at the request of eligible persons for 270 calendar days at maximum, in according to Law no. 1/1991, republished in 1994 and amended by the Government Priority Ordinance no. 47/1997;
(2) Unemployment indemnity: Partial compensation of income granted to the unemployed after losing their jobs or to the graduates of educational institutions and to the military who ended their military service and who could not get employed (Law no. 76/2002 on unemployment insurance system and employment stimulation coming into force since March 1, 2002); and
(3) Support allowance: Grants to persons who got unemployment benefit or vocational integration allowance, but could not find job. This allowance is granted for 18 months at maximum (Law no. 1/1991 republished in 1994 and amended by the G.P.O. no. 47/1997); Romanian social safety-net system would be stated as to what the socialistic system in the days past having been dragged, with higher unemployment indemnity in comparison with minimum wage. During the heavy economic recession over the period of 1997-1999, public allowance exceeded the minimum wage rate, thus likely led to encouragement to people to stay out of the labor market as unemployed. (Table 2.3.5 and fig. 2.3.7 below)

Table 2.3.5: Unemployment indemnities – percentage against the minimum wage rate[33]

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Unemployment benefit	63.6	64.8	71.3	102.7	97.4	112.9	135.8	103.8	118.9	96.6	72.5	77.5
Allowance for vocational integration	-	-	-	70.7	65.0	65.0	65.0	57.5	66.4	54.2	40.6	42.1
Support allowance	-	43.8	41.1	41.2	60.0	60.0	53.2	47.1	53.3	40.0	25.8	26.9

[33] Source: National Institute of Statistics, Yearbook 2003, http://www.insse.ro/anuar_2003/asr2003.htm

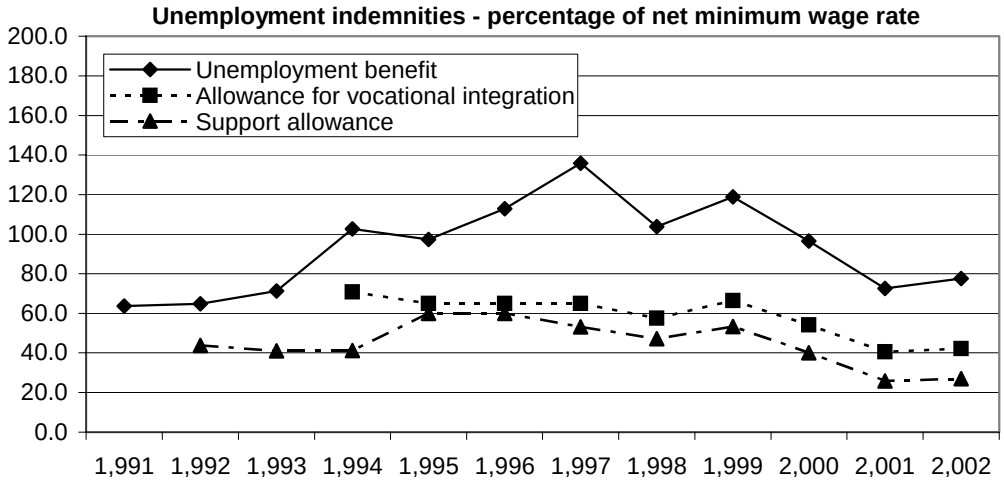


Fig. 2.3.7: Unemployment benefits as percentage of minimum wage

2.3.4 Social Insurance System – Social Safety Net

The contributions to social insurance are paid both by employer and employee and it covers both the pension and social insurance of the nationals. Pension system now applied in Romania is that of a Pay-as-you-go (PYG) system. Likely in Japan, one of the major policy issues in social safety-net is the increase in number of pensioners receiving pension fund. This is due in large to the ageing of population and the lenient condition to retire, and consequently a financial burden of pension system to employed people currently in place constantly is on the rise whereas the amount of pension being lowered. The number of pensioners excluding farmers increased by 81.5 percent over the period of 1990 to 2002, with 2.57 million in the former and 4.67 million in the latter year. Likely for farmers, those who receive pension were counted at 1.67 million in 2002 arising from 1.0 million in 1990 (67.7percent hike over 13 years). Monthly average of pension for non-farmers has been contracted in the face of pensioners' increase in number, with US$74.3 down to US$51.2 over the same period of 1990-2002. So is the case for farmers whose monthly average pension downsizing from US$22.6 (1990) to US$10.4 (2002) in nominal term (Fig. 2.3.8)[34].

Meanwhile, the labor market interventions were mainly focused on the uprising trend of unemployment (almost 12% in 1995) and unemployment social benefits introduced in the beginning of December 1990. The state pension fund (social insurance budget) finances both the contributory benefits (for the aged, disabled, and veterans pensions) and non-contributory benefits (for sick and maternity leaves).

[34] Source: National Institute of Statistics, *Ibid.*,, http://www.insse.ro/anuar_2003/asr2003.htm

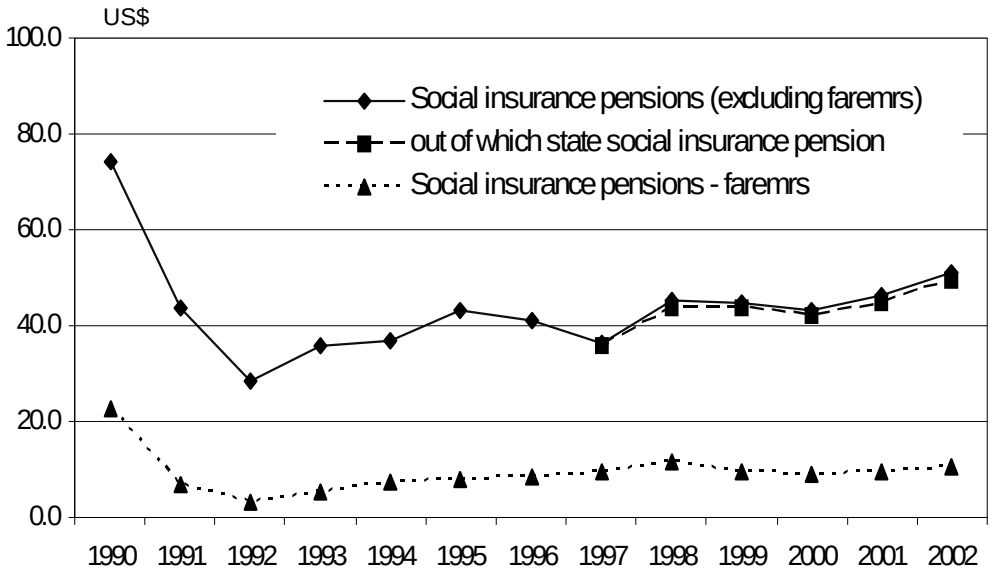


Fig. 2.3.8: Average monthly pension (US$ per person)

2.3.5 Health Sector

In 1997, Romania embarked on the health sector reform in a way to shift from the model of centralized government financing and delivery of services to a more decentralized and pluralistic approach. In this light, the government in 1997 introduced a compulsory health insurance fund, paid for through an earmarked wage tax and contracting services from public and private providers. With this, 19 percent of the gross payment of wage earners and pensioners is being deducted from their wage/pension bills for pension and social insurance fund.

Policy issues as pointed out by the World Bank[35], and now the Romanian health system confronts are, among others,

- shortcomings in the efficiency, equity and transparency of sector financing,
- inefficient use of physical capacity and human resources in health care delivery,
- weaknesses in governance of the system and the legislative framework;
- critical infrastructure deficiencies resulting from inadequate maintenance and investment; and
- client dissatisfaction with and distrust on health services delivered.

It would be noteworthy in connection with the last point enlisted immediately above, the interview survey as currently carried out by the JICA study team reveals that no one out of around 100 interviewee expressed they or one of their family underwent any medical care at the public hospitals and/or clinics due to injuries/diseases in the past one year. This might be a symptom and an expression of people's perception of dissatisfaction with and distrust on the medical care system currently in place. Now the external assistance inclusive of the World Bank aspires to provide more accessible health care services, increased quality and improved sector outcome for those requiring maternal and infant mortality, general mortality in rural areas, and overall quality care.

[35] The World Bank, Project Information Document, *Health Sector Reform APL II*, 2005,

The following figures show the health sector performance as reflected by the indicators.

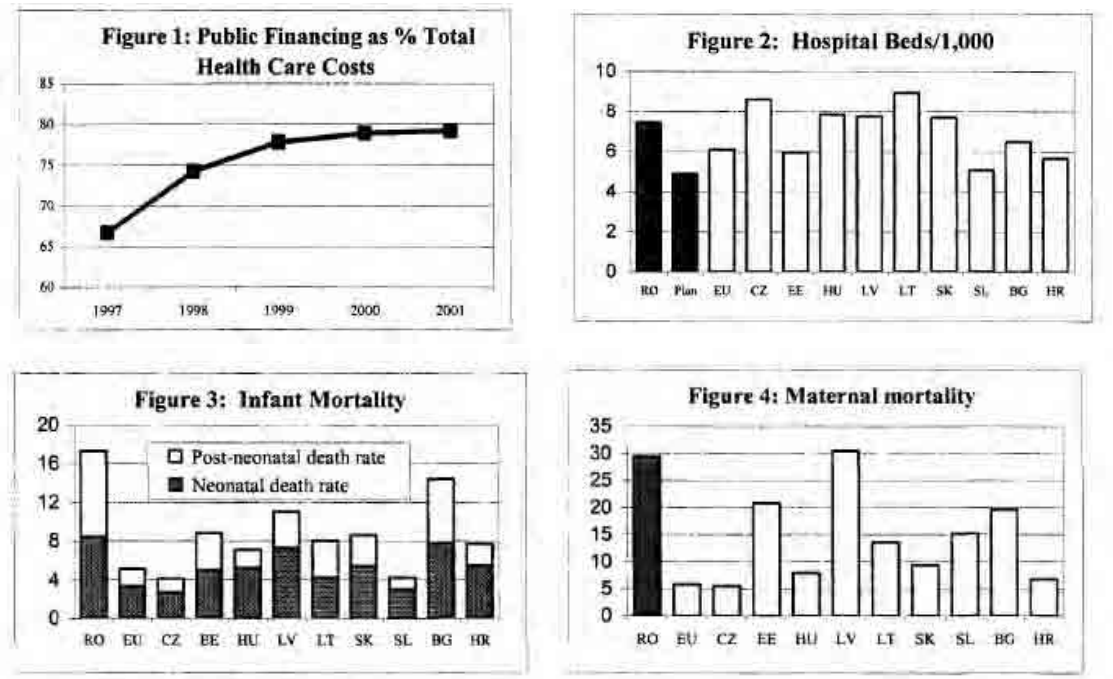


Fig. 2.3.9: Health sector indicators (Source: World Bank, November 2004)

2.3.6 Further Issues – Basic Human Rights

Part of the policy conditionalities for Romania to join the European society, the country had to adopt the values of the industrialized economies in the region inclusive of human rights. With this in view, Romania ratified the revised European Social Charter adopted in Strasbourg, Germany on the 3rd of May 1996 in 1999 through the Law no. 74. As such the country committed itself to comply with the majority of the basic rights of people as stipulated in the Charter as follows.

- to work
- to equitable work conditions;
- to work security and hygiene;
- of equitable remuneration;
- to form unions;
- to collective negotiation process;
- of children and young to protection;
- of women workers to maternity;
- to professional orientation;
- to professional formation;
- to health protection;
- to social protection;
- to social and medical assistance;
- to benefit from social services;
- of handicapped persons to autonomy, social integration and participation to the life of the community;
- of the family to social, economic and juridical protection;
- of the children and adolescents to social, economic and juridical protection;

- of exercitation of an lucrative activity on the territory of the other countries signing this Charter;
- of migrant workers and of their family to protection and assistance
- to equal chances and treatment regarding employment and profession, regardless of sex discrimination;
- of information and consultation;
- to take part in the determination and improvement of the work conditions and environment;
- of elder persons to social protection;
- of protection in case of dismissal;
- of employees to protect their own claims in case of employer insolvability
- to dignity in work;
- of employees with familial responsibilities to equal chances and treatment;
- of workers' representatives to protection in the firm and facilities granted;
- to information and consultation regarding the collective dismissal procedures;
- of protection against poverty and social exclusion;
- to accommodation.

2.4 Utilization and Administration of Coastal Area

2.4.1 Inhabitants and Visitors of Shore Area

The aspects of population and society in Romania have been described in **2.3.1**, while those of Constanța will be presented in **7.3.4**. In this sub-section, discussion is given on people living nearby the shore, because they are most affected by coastal erosion and demanding early implementation of coastal protection measures.

The Study area from Midia to Vama Veche is composed of the following four geographic areas:

1) Resort beach areas
2) Port areas
3) Urban cliff areas
4) Country cliff areas

Geographically, the Study area is composed of beach coast and cliff coast. The most part of beach coast is utilized as the resort beaches. The resort beach areas are located on barrier beaches, the definition and formation of which are described in **3.1** as well as Annex **D.1**. They include Năvodari, Mamaia, Eforie, Costineşti, Olimp, Vama Veche, etc. During three months from mid-June to mid-September, the areas are flooded with beach visitors. Annex **A.2** provides pictures of crowded beaches in the summer. A large number of hotels, lodges, and guest houses have been built to accommodate them and the number is increasing year after year. Restaurants, bars, and shops are open during the summer season and make good business. However, most of these accommodations are closed during off-season, and owners and employers leave the resort beach areas, which look like deserted towns during off-season. In this sense, there are few permanent inhabitants in the resort beach areas.

The port areas include Midia, Tomis, Constanța, and Mangalia. A marina "Yacht Club Europa" in Eforie Nord may be included in the port areas, even though it occupies only a

space of a few hundred meters along the shore. Among the port areas, Constanța is the busiest with the annual cargo handling of around 20 million tons per year. All the port areas are well protected by long stretches of breakwaters, and thus they do not require further coastal protection. Therefore, the port areas are excluded in the Study.

The cliff coast is characterized with cliffs of several to thirty meters in height along the shore and narrow beaches at their feet. Cliffs are made of loess and mud with limestone outcrops at some of the base of cliffs, as illustrated in Fig. 3.1.2 in **3.1.4**. The cliff coast in the urban areas such as Constanța, Eforie Nord, Eforie Sud, and Mangalia are densely inhabited with many housing including high-rise apartments built near the cliff edges. Historically, the cliffs in the Study areas have been subject to occasional collapse and the municipalities have been struggling for cliff consolidation. There are left several photographs taken in the beginning of the twenties century that a mass of cliff soil fell down to the sea in Constanța with loss of buildings and disappearance of cliff-side streets. The cause of cliff collapse is twofold: one is the weakness of upper slopes of cliffs against rain and water penetration, and the other is wave abrasion at the base of cliffs. The problem of cliff protection is discussed in **5.5.5**.

The number of people living near the urban cliff coast is difficult to count, because there is no official delimitation of the coastal zone. If one dares to assume a zone of 100 m wide from the shoreline, the number of permanent inhabitants may be a few thousands at most.

The cliff coast in the country side is not much inhabited. The inland side of the cliff is mostly agriculture fields, but it is not well cultivated near the cliff edge. The inhabitants near the edge of cliff coast are not many because of danger of gradual cliff collapse. In the north and south of Cape Tuzla, there have occurred several occasions of large-scale land sliding at the upper parts of cliffs, which extends over a few kilometers at each place as described in **3.6.4**. The land slides created broad, mild slopes with the width of some 60 m from the shoreline. A number of fishermen's huts and bungalows have been built there. Fishermen also live around the boundaries between beaches and cliffs or on the lower parts of cliffs. They are making stationary fishing with passive gears, using rowboats which are pulled onto high positions of beaches while not in use. Judging from the fact that the number of net traps installed in the nearshore water is about twenty in the Study area, the fishermen inhabiting along the shore area may be a few hundred persons at most.

The great majority of the visitors to the shore areas are for sunbathing and ocean bathing during the summer. Some local people enjoy fishing with rod and lines at beaches, but their number is small. The number of the tourists visiting Constanța County was 845 thousands in 2004 as described in **2.2.5 (2)**; the recent records of annual visitors is listed in Table 2.2.5. Further details by the locality are given in Fig. I.3.2 in Annex **I.3.2**. The number of visitors from other countries counts about 61 thousands in 2004, but it was about 270 thousands among the total of 1.8 million in 1989 before the Romanian Revolution. With the accession of Romania to EU and the development of expressway network in the Central and Eastern Europe, the number of foreign visitors will surely increase in the near future. A forecast of the increase of tourists is very difficult, however, because of many uncertain factors.

In summing up, it can be said that the human beings to be considered in the Study are nearly one million summer visitors, a few thousands citizens, a few hundred fishermen, and many owners of hotels and restaurants who are living outside the shore area.

2.4.2 Natural Threats to Shore Area

In many countries, people living nearby the sea are plagued by various threats of the nature. Beach erosion is a daily threat, while tsunamis are sudden calamities befallen upon people as witnessed in the occasion of the Indian Ocean Tsunami of December 2004. Storm waves may rush up the shore and destroy dwellings near the shore. Storm surges may cause inundation over large urban areas, causing huge loss of lives and properties as occurred in New Orleans, USA by Hurricane Katrina in August 2005. Red tides and blue tides often induced by eutrophication of the seawater may kill crustacean, shellfish and fish, causing damage to fishermen.

Along the Romanian Black Sea shore, tsunamis are not generated fortunately and severe storm surges have not been observed yet. Direct wave actions take place only in the area around Casino of Constanța, where no beach remains and a vertical seawall is erected directly from the sea bottom. Eutrophication was a problem in the 1980s and 1990s owing to pollutants emitted from the upstream countries along the Danube, but the situation is improving gradually.

Thus, the coastal erosion has been the impending threat to the Romanian Black Sea shore. For this reason, the Study focuses on the identification of the coastal erosion problem and the development of protection and rehabilitation measures.

2.4.3 Administration of Coastal Zone in Romania

Before the Romanian Revolution in 1989, coastal protection and development works were carried out as a part of public construction works. Construction of short groins in Eforie Nord and Eforie Sud began around 1956, and an extensive resort development in Neptune to Aurora took place after 1969. In 1988 to 1990, the emergency rehabilitation works of beach restoration was undertaken at the southern part of Mamaia by building six detached breakwaters and a beach fill operation using sediment from the bottom of Lake Siutghiol. Existing shore protection facilities with their construction years are listed in Table 5.3.1 in **5.3**.

Since 1990, however, the public authority responsible for coastal protection was not clearly designated and most of shore protection facilities were left without any monitoring and maintenance. Change was made in 2002 by setting of the legal framework of the integrated coastal zone management with issuing of the Emergence Ordinance no.202/2002, the outline of which is introduced in Annex **C.1**. Its Article 62 stipulates that Ministry of Environment and Water Management (MoEWM) has the responsibility and duty for promotion of the national strategy for integrated coastal zone management and its action plan among others. The policy implementation arm of MoEWM is the National Administration of Romanian Waters (ANAR) and its branch offices. With respect to coastal management, the Water Directorate Dobrogea – Litoral (DADL) is the only branch office to deal with coastal areas.

Ports and navigation channels somewhat related to coastal areas are managed by the Ministry of Transport, Construction and Tourism (MoTCT). In corroboration with MoTCT are the National Company Maritime Ports Administration, the River Administration of the Lower Danube Galati, and the Administration of Navigable Canals S.H.

The Emergence Ordinance no.202/2002 also stipulates the establishment of the National Committee of the Coastal Zone in its Article 68. The committee is comprised of 37 members from 24 authorities and institutions with the permanent technical secretariat designated at the National Institute of Marine and Development "Grigore Antipa." Three meetings of the National Committee of the Coastal Zone were held in 2005 as briefly described in Annex **C.2**. However, the central issue of the delimitation of the coastal zone has not been discussed yet. Setting-up of working groups for this and other purposes was approved at the third meeting, but no progress has been made as of March 2006.

Uncompleted delimitation of the coastal zone is causing some conflict between MoEWM / DADL and the municipalities in the Study area with regard to jurisdiction of the coastal area such as which side should be responsible for the cliff protection. In addition, there are several administrative tasks to be solved for management of the coastal area. First, there are no established units in MoEWM, ANAR, or DADL, to which the responsibility and duty of the management and monitoring of the coastal area should clearly be stipulated. This problem will be discussed in **8.1** with a certain recommendation. Second, the budgetary basis for coastal protection and rehabilitation has not been established yet. Although there are some recent efforts in acquiring specific budget allocation for coastal protection as described in **8.4.3**, they seems to be made in an ad hoc manner and not to represent a stationary one. The Study makes affordability analysis of the Romanian Government with respect to coastal protection and rehabilitation projects, as reported in **8.4.3**.

CHAPTER 3:

GEOPHYSICAL CONDITIONS

Chapter 3 Geophysical Conditions

3.1 Geological and Geomorphological Features

3.1.1 Geological Characteristics

The Romanian Black Sea shore extends from Sulina at the territorial border with Ukraine to Vama Veche at the border with Bulgaria with the coastal length of about 240 km. It is usually divided into the northern and southern units with the boundary set at Cape Midia. The southern unit is called as the Southern Romanian Black Sea shore, which is the area to be examined in the present study (hereinafter referred to as "the study area").

The southern unit is further divided into the northern and southern sub-units in the present study. The northern sub-unit is defined here to cover the area from Cape Midia to Cape Constanța, which is a coast of sandy beach. The southern sub-unit extends from Cape Constanța to Vama Veche, which is a combination of barrier beaches and sea cliff coasts with narrow beaches. Although the study area includes the port areas of Midia, Tomis, Constanța, and Mangalia, the coasts within these areas are excluded from the present study.

Geographically speaking, the starting point of the north breakwater of Midia Port is called Cape Clisargic, and Cape Midia is located at the latitude 44º15´N with Cape Ivan in between as shown in Fig. 3.1.1. However, the Study deals with the coast south of the southern breakwater of Midia Port, because the beaches between Cape Clisargic and Cape Midia are accretionary one and no problem of beach erosion exists.

The study area is situated at the eastern shore of South Dobrogea Platform, which is an old geological formation since the Palaeozoic (some 540 to 250 million years ago). The Platform has been uplifted and subsided several times; the process yielded limestone layers on top of the Platform while it was submerged and shallow marine environment prevailed. Since around 2 million years ago, South Dobrogea became an emerged tableland and continental sediment (clay, loess, etc.) blown by winds continued to be deposited during the cold climate of glaciations in the Quarternary (since 1.8 million years ago to the present).

South Dobrogea is a slowly undulating tableland with the elevation varying from a few meters to some 40 m. The surface is covered by several layers of loess and clay in the total thickness of about 20 to 30 m. Below them, there appears the limestone layer formed during the Sarmatian age (about 13 to 6.5 million years ago). At the cliff shore, one can easily observe the outcrop of multiple layers of loess, clay, and limestone (see Fig. 3.1.2).

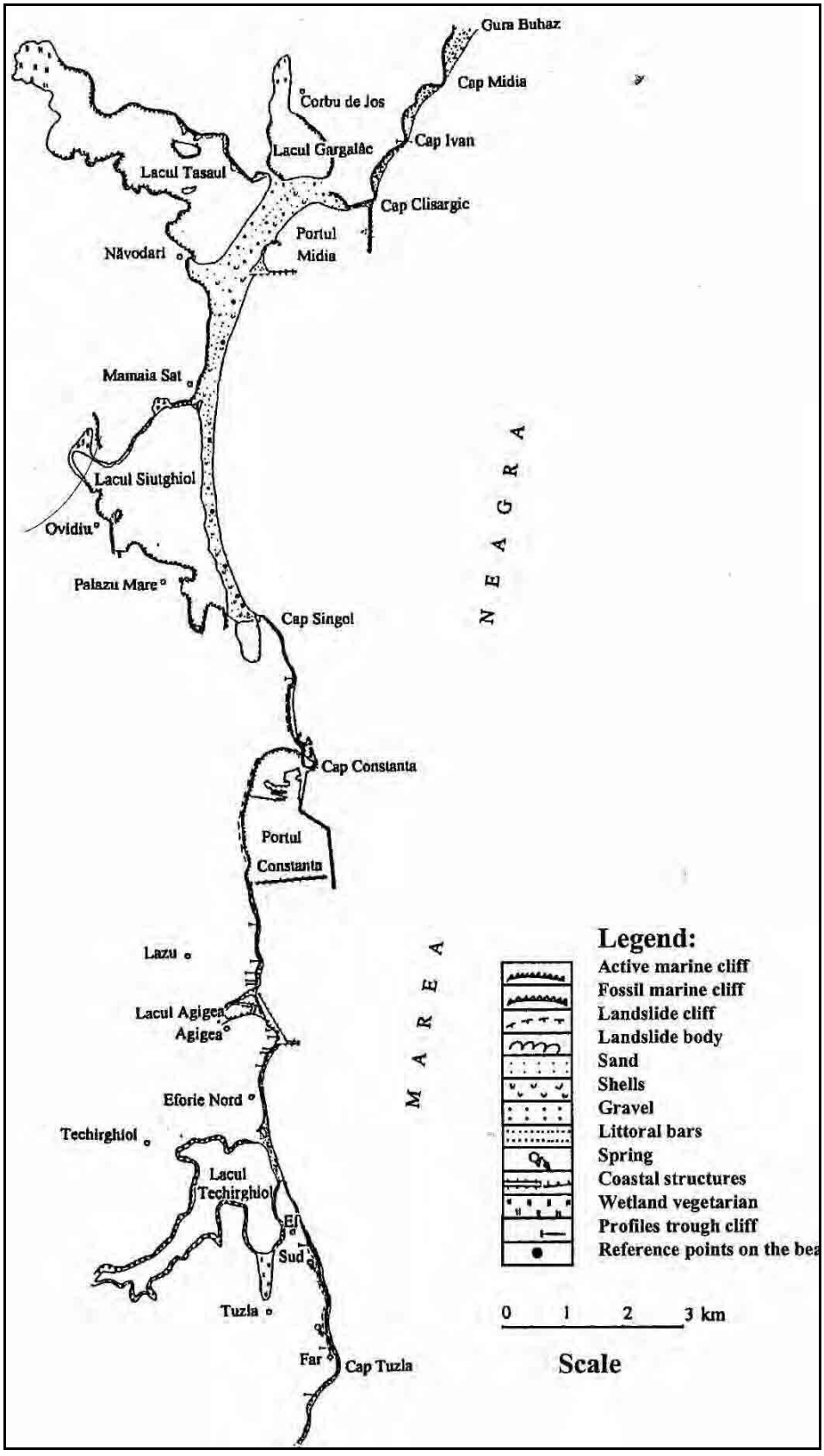


Fig. 3.1.1: Geomorphological map of Southern Romanian Black Sea Coast (Cape Midia – Cape Tuzla) around 1970 (source: GeoEcoMar 2005)

3.1.2 Chronological Changes of the Level of Black Sea

The worldwide rise and fall of the mean sea level have been taken place many times in the past. In about 18,000 to 20,000 years ago at the peak of the Würm glaciation, the sea level was around –120 m below the present sea level. Global warming and melting of glaciers caused the sea level to rise with the average rate of 1 cm per year for about 15,000 years, and it reached to the level of 3 to 5 m above the present sea level around 4,000 to 5,000 years ago. The gradual rise of the sea level was not a monotonous one but repetitions of rise and stop process. In the Black Sea area, the ingression of the sea into the land that took place around 4,000 to 5,000 years ago is known as the Neolithic transgression. Compared with the mean sea level of the oceans, the mean level of the Black Sea has been subject to wide fluctuations due to climatic changes, probably owing to its land-locked environment. In a short period of 500 to 1,500 years after the Neolithic transgression, the Black Sea level fell down to –5 to –8 m below the present sea level around 3,500 years ago; this is called the Phanagorian regression. The low level of the Black Sea continued for 1,000 years or so. When Hellenic people established coastal ports along the Black Sea in the first millennium BC, they could make use of natural reefs emerged at the low water level as shelters for harbors.

The mean level of the Black Sea rose again around the 6th century AD to the level of +1 to +3 m, which is called the Nymphaean or Istrian transgression. The Black Sea level fell to –1 to –2 m round the 11th century, and then gradually recovered to the present level.

These rise and fall of the mean level of the Black Sea, which are called transgression and regression respectively, have exercised large influence on coastal topography. At the depth of –14 to –42 m on the continental shelf of the western Black Sea, evidences of wave-cut terraces and relic barrier beaches have been recognized, which must have been formed when the sea level lingered at some elevation during its rising process. Along the coastal land, “Old Black Sea” terraces are found at the elevation of +3 to +5m, which were formed during the Neolithic transgression. Thus, the coastal morphology of the Black Sea shore should be studied with due consideration of the mean sea level variations.

3.1.3 Formation of Sandy Beaches along the Northern Sub-unit of Study Area

The northern unit of the Romanian Black Sea shore as well as the northern sub-unit of the southern unit are occupied by beaches with terrigeneous gray sand of fine to very fine grain size, a large amount of which have been supplied by the Danube over many years. With the supply of sediment from the Danube, sand spits extended southwestward year after year and formed littoral barriers at the entrances of the lakes of Razim, Sinoie, and Siutghiol, which were originally embayments but later became land-locked lakes.

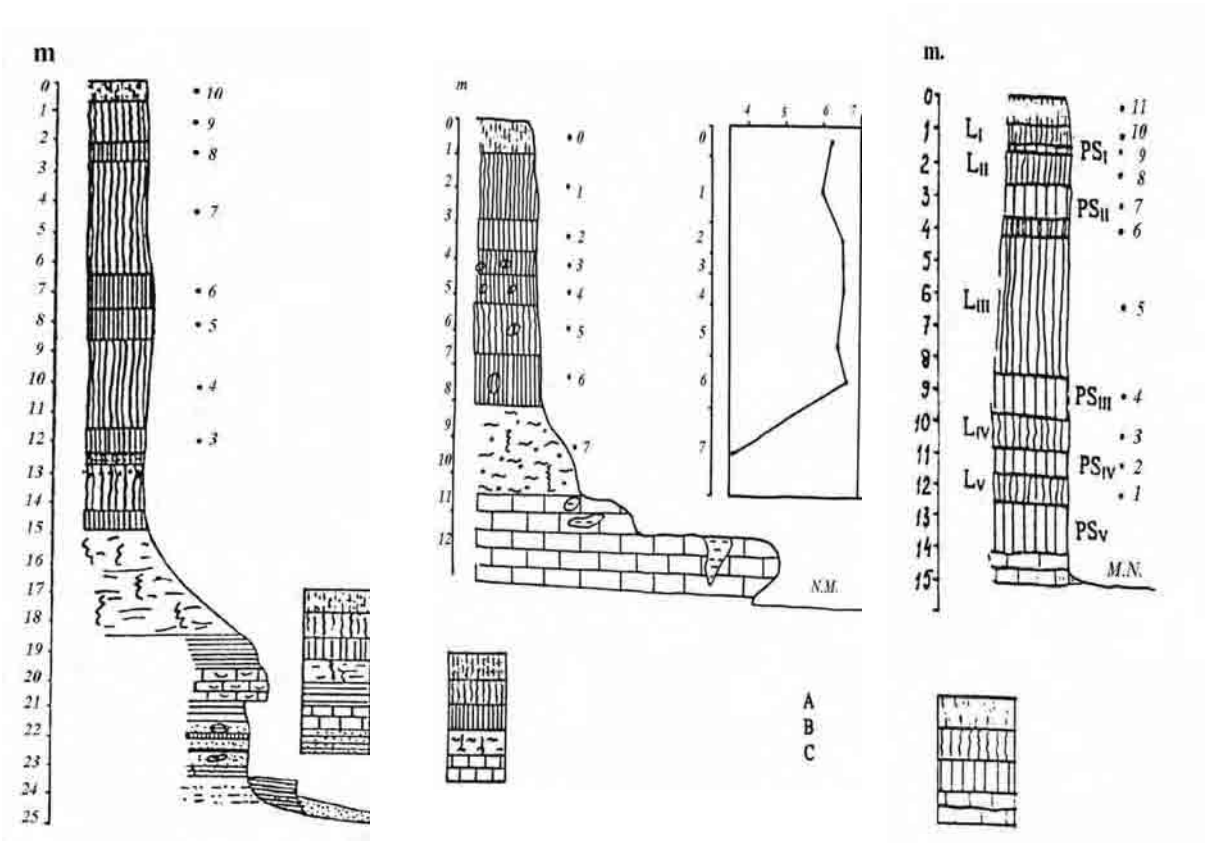
The dates of the closures of these lakes are difficult to assess. Nevertheless, Lake Sinoie seems to have been land-locked in the 3rd to 4th century BC, judging from the history of the Hellenistic colony of Historia. Sand spit of Mamaia seems to have reached to Cape Singol and closed off Lake Siutghiol around the first century AD, judging from the history of the port town of Ovidiu, which was located at the western bank of Siutghiol Lake.

The supply of sediment from the Danube decreased drastically in recent years, as the result of the construction of many dams in the main channel and tributaries of the Danube. Compared with the middle of the 19th century, the present rate of sediment discharge before the entrance

of the Danube Delta became less than one half according the estimate by Bondar and Panin[1]; i.e. 73 million m^3 to 36 million m^3 per year. Decrease of sediment supply has been causing serious beach erosion problems in the northern unit and the northern sub-unit of the southern unit of the Romanian Black Sea shore.

3.1.4 Formation of Sandy Beaches along the Southern Sub-unit of Study Area

The coast from Cape Singol to Vama Veche is essentially of cliff coast with narrow sandy beaches at the base of the cliff. Often the outcrop of limestone is found at the base of the cliff. At places where the top of the tableland of South Dobrogea descends almost to the sea level with provision of lakes or marshes near the sea, natural barrier beaches have been developed. They include beaches of Eforie Nord to Eforie Sud, Costinești, Olimp, and Saturn. In addition, beaches of 2 Mai and Vama Veche exist in front of low-elevation land.



(a) Northeast Constanța (b) Cape Agigea (c) Cape Tuzla

Fig. 3.1.2: Examples of lithology of cliffs in the southern sub-unit of Black Sea shore (source: GeoEcoMar 2005)

[Legend of lithology in the case of Cape Agigea refers to soil, loess, paleosoils, clay with gypsum, and limestone from the surface. In the case of Northeast Constața, greenish clay appears above limestone and the lowest layer is quartizitic sand. The lithology of Cape Tuzla does not have clay with gypsum. The diagram in the right of the panel for Cape Agigea is the mean diameter in the ϕ-scale: $\phi = 6$ corresponds to $d = 0.015$ mm.]

[1] Bondar, C. and Panin, N: The Danube delta hydrologic database and modeling, *GEO-ECO-MARINA*, 5-6/2000-2001, pp. 5-52 (see Table 4). The total amount of sediment into the Delta entrance is estimated as about 30 million cubic meters per yea at present, of which about 4% is sand.

Examples of the cross section of the cliff are shown in Fig. 3.1.2 with classification of lithology. As indicated in this figure, the most part of cliff is composed of loess and clay and the limestone is exposed only at the base of cliff. The mean diameter of loess and clay is 0.01 to 0.03 mm, but it contains small quantities of coarse fraction of limestone fragments, quarts and feldspars, mica, and heavy minerals, each varying 0.05% to 2%, depending on the location.

The lakes and marshes near the sea in the southern sub-unit of the study area were originally the embayments but later closed off from the sea by development of barrier beaches in front of them. Because of the low altitude of the area, the layer of limestone goes down deep beneath the seabed and has not presented any resistance to the ingression of the sea.

Beach sand of the southern sub-unit of the study area is of brownish color with fine to medium grain size. Its mineral content analysis has shown the presence of more than 90% of CaO and less than 10% of SiO_2 as will be discussed in **4.3** and **E.3**. Therefore, sand is mostly made of calcium carbonate with only a small quantity of silicides (quartz). The fact excludes the contribution of the sediment from the Danube to the beach sand of the southern sub-unit of the study area.

3.1.5 Origin of Beach Sand

The beach sand of the northern sub-unit of the study area from Năvodari to Cape Constanța has been supplied by the Danube, having been transported by longshore currents over the distance of nearly 160 km from the river mouths. Around the central to southern parts of Mamaia Beach, there is a certain amount of sediment containing calcium carbonate, which should represent fragments of bivalve shells. The contribution of shell fragments has increased in the recent decades. Table 3.1.1 summarizes the primary and secondary sources of beach sand of the study area.

The source of beach sand of the southern sub-unit has not been verified yet. However, the sediment sample analysis to be discussed in **4.3** indicates that majority of the minerals contained in sediment is calcium carbonate as mentioned above. The result suggests bivalve shell fragments being the primary source of beach sand. Microscopic inspection of sand provides images of very angular grains. At the same time, rock fragments (clasts) of limestone can be the secondary source of beach sand. It is difficult however to distinguish shell fragments and limestone clasts, because they are both made of calcium carbonate.

Table 3.1.1: Origin of beach sand

Source	Năvodari to Cape Constanța	Eforie to Vama Veche
Primary	terrigenous sand from the Danube	shell fragments
Secondary	shell fragments	rock fragments of limestone

The sea cliff in the southern sub-unit of the study area has been retreated with the average rate of about 0.6 m per year in the period from 1924 to 2002 (see **4.1**). If this rate had continued in the past 1,000 years, the shoreline must have retreated by 600 m. Although the elevation of the limestone layer at the base of cliff varies from place to place and the volume of abraded limestone was of a limited amount, the portion of abraded limestone must have produced a certain quantity of calcium carbonate sand to the beaches of the southern sub-unit of the study area. The limestone fragments contained in the soft layer of loess and clay must have also contributed to calcium carbonate sand of the beach, although the amount seems to be in the

order of 1% or less.

3.2 Meteorological, Geotechnical, and Seismological Conditions

Statistical data of temperature and precipitation have been derived from "Romanian Statistic Yearbook". The data on wind direction and speed have been purchased from the National Agency of Meteorology. Use was also made of the hindcast data by ECMWF for the period of 1991 to 2000.

3.2.1 Air Temperature

The statistics of air temperature are listed in Table 3.2.1 for the period of 1901 to 1990 and for the years of 2002 and 2003.

Weather condition in Constanța area shows four typical seasons and is influenced by the presence of the Black Sea. The annual air temperature variation is smaller than those in other inland areas in Romania. The mean temperature through the year is 11.3 degrees. The mean temperatures in the summer season (June to August) and in the winter season (December to February) are around 21 degrees and 1 degree, respectively. A feature of the air temperature is a wide range of the highest and lowest temperature, which varies from year to year. For example, the highest temperature in January during the period from 1901 to 1990 was 18.8 degrees, while the lowest temperature in May was 1.8 degrees.

Table 3.2.1: Monthly air temperature at Constanța

(Celsius degrees)

Year \ Month		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave
1901 - 2000	mean	0.1	1.2	4.5	9.6	15.2	19.7	22.2	22.0	18.2	13.2	7.6	2.8	11.4
	max.	18.8	24.5	30.8	31.9	36.9	36.9	38.5	36.8	34.8	31.0	26.5	21.0	
	min.	-24.7	-25.0	-12.8	-4.5	1.8	6.4	7.6	8.0	1.0	-12.4	-11.7	-21.6	
2002	mean	0.3	7.4	8.1	9.8	17.2	21.6	25.8	23.2	18.9	13.7	10.2	-0.8	13.0
	max.	17.2	21.7	25.4	20.1	27.2	30.6	33.2	32.4	30.7	24.0	21.8	14.3	
	min.	-12.4	-1.8	1.2	-0.5	8.8	10.0	17.4	17.0	9.0	4.0	1.0	-13.6	
2003	mean	1.0	-2.8	2.8	7.7	17.9	22.4	23.1	24.2	17.6	12.3	8.7	3.2	11.5
	max.	13.0	8.9	13.6	19.8	29.0	32.5	31.2	31.6	27.6	25.5	21.8	12.9	
	min.	-10.7	-12.9	-5.8	-0.2	7.7	13.6	16.0	13.8	9.4	-0.9	0.7	-7.0	
2004	mean	-0.7	2.4	7.2	11.4	15.4	20.7	22.3	22.2	18.7	15.1	8.9	5.2	12.4
	max.	12.4	19.0	25.0	26.8	25.4	28.8	28.8	31.6	29.1	23.0	23.0	19.7	
	min.	-12.4	-9.7	-5.4	0.2	7.1	13.6	14.6	14.0	7.8	7.2	-6.9	-4.5	

Source: Romanian Statistical Yearbooks (2003 to 2005)

3.2.2 Precipitation

The annual amount of precipitation averages out at 380 mm, which is relatively lower than other areas in Romania. The monthly difference is small, ranging from 27.1 mm to 38.4 mm as listed in Table 3.2.2. In recent years, however, the precipitation has recorded volatile variations year after year. The precipitation in August, for example, was 0.2 mm in 2003. But it was 259 mm in 2004, which caused a cliff erosion at Eforie Nord as reported in several newspapers. A heavy rain in the late September of 2005 witnessed flood damage in Costineşti with beach scouring as described in **3.6.5**. Large variations in the amount of precipitation are characteristic of meteorological phenomena, but recent event of heavy rains seems to exceed the norms.

Table 3.2.2: Monthly precipitation at Constanța

(units: mm)

Year＼Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Total**
1901-2000	28.8	26.3	24.9	28.7	36.6	42.2	33.7	29.8	29.7	33.7	39.6	34.3	368.1
2002	15.1	4.7	82.1	16.6	19.3	21.2	20.4	50.6	57.1	65.3	34.0	45.2	431.6
2003	53.0	14.9	16.9	25.4	5.2	9.1	32.9	0.2	80.1	63.7	25.5	23.3	350.2
2004	51.3	20.2	25.9	2.3	100.2	59.0	38.3	259.2	27.4	13.5	5.9	71.4	674.6

Source: Romanian Statistical Yearbooks (2003 to 2005)

3.2.3 Wind Direction and Wind Speed

The hindcast wind data by the European Center for Medium Range Weather Forecasting (ECMWF) has been analyzed for the direction-wise frequency distribution of wind speeds. The hindcast was made every 6 hours for the period of 1991 to 2000 at the location 44.0ºN and 29.0ºE, which is about 25 km southeast by east of the entrance of Constanța Port. Table 3.2.3 lists the direction-wise frequencies of wind speeds throughout the year with total occurrences and rate of frequency. Seasonal wind statistical data are listed in Annex **D.2.1**.

Table 3.2.3: Direction-wise frequency distribution of wind speeds off Constanța on the Black Sea

Direction / Speed(m/s)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	Total
0.0-2.0	126	143	140	143	122	113	144	134	106	140	139	147	141	150	135	144	2167
(%)	0.9	1.0	1.0	1.0	0.8	0.8	1.0	0.9	0.7	1.0	0.9	1.0	1.0	1.0	0.9	1.0	14.8
2.0-4.0	235	230	225	197	195	189	149	177	222	257	247	217	170	171	174	228	3283
(%)	1.6	1.6	1.5	1.3	1.3	1.3	1.0	1.2	1.5	1.8	1.7	1.5	1.2	1.2	1.2	1.6	22.4
4.0-6.0	264	253	217	203	183	157	178	245	307	328	307	284	142	121	131	280	3600
(%)	1.8	1.7	1.5	1.4	1.2	1.1	1.2	1.7	2.1	2.2	2.1	1.9	1.0	0.8	0.9	1.9	24.5
6.0-8.0	201	235	161	140	134	104	113	198	278	299	260	135	87	55	74	97	2571
(%)	1.4	1.6	1.1	1.0	0.9	0.7	0.8	1.3	1.9	2.0	1.8	0.9	0.6	0.4	0.5	0.7	17.5
8.0-10.0	116	135	104	77	64	61	62	155	245	240	149	65	33	17	26	34	1583
(%)	0.8	0.9	0.7	0.5	0.4	0.4	0.4	1.1	1.7	1.6	1.0	0.4	0.2	0.1	0.2	0.2	10.8
10.0-12.0	30	55	38	25	34	13	26	76	183	145	114	34	16	7	5	6	807
(%)	0.2	0.4	0.3	0.2	0.2	0.1	0.2	0.5	1.2	1.0	0.8	0.2	0.1	0.0	0.0	0.0	5.5
12.0-14.0	14	25	17	11	20	5	11	42	81	78	74	17	5	2	3	2	407
(%)	0.1	0.2	0.1	0.1	0.1	0.0	0.1	0.3	0.6	0.5	0.5	0.1	0.0	0.0	0.0	0.0	2.8
14.0-16.0	4	6	2	5	5	3	1	11	33	44	40	12	2	0	0	0	168
(%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.3	0.3	0.1	0.0	0.0	0.0	0.0	1.1
16.0-18.0	0	4	0	1	2	1	2	4	10	16	22	4	1	0	0	0	67
(%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.5
18.0-20.0	0	0	0	0	0	0	1	0	1	3	7	4	2	0	0	0	18
(%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Total	990	1086	904	802	759	646	687	1042	1466	1550	1359	919	599	523	548	791	14671
(%)	6.7	7.4	6.2	5.5	5.2	4.4	4.7	7.1	10.0	10.6	9.3	6.3	4.1	3.6	3.7	5.4	100.0

Source: ECMWF 1991-2002

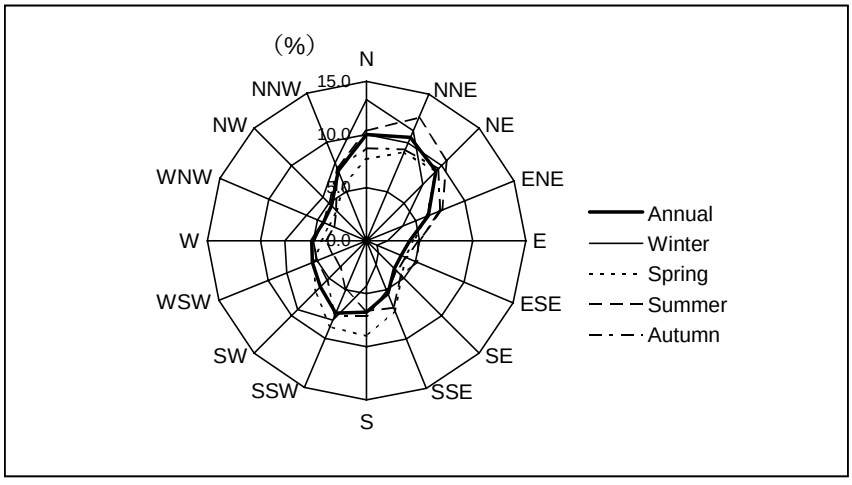


Fig. 3.2.1: Directional distribution of wind frequency (in percentage) in Black Sea off Constanța

The mean wind speed based on the class-wise median speeds and frequencies is calculated as 5.5 m/s. Northerly winds from NNW to NE are predominant in the Constanța area, occupying 37 percent of the total occurrences. Strong winds exceeding 10 m/sec also appear frequently in the northerly direction. Figure 3.2.1 shows the wind rose based on the ECMWF hindcast data.

Wind data based on ground observation was obtained from Romanian Meteorological Administration (RMA). It is presented in Table 3.2.4 for the yearly data at the Constanța Meteorological Station. The data represents the 3 hourly observations for ten years (1995 – 2004) in the form of percentage. The original data is tabulated in percentage with the numbers of observations per month. The numbers of observations in Table 3.2.4 were estimated by the Study team by converting the percentage into the frequency; a slight increase in the number of observations has taken place through a conversion process of .percentage to frequency in integers. The downtime appears to be 3.07%.

Table 3.2.4: Direction-wise frequency distribution of wind speeds observed at Constanța Metrological Station

Direction Speed(m/s)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	Total
0.0-0.5 Calm (%)																	3850 13.6
0.5-2.0	230	194	36	175	263	250	31	99	117	47	17	91	99	83	22	164	1918
(%)	0.8	0.7	0.1	0.6	0.9	0.9	0.1	0.3	0.4	0.2	0.1	0.3	0.3	0.3	0.1	0.6	6.8
2.0-4.0	1111	704	132	750	1189	1066	148	638	658	238	103	567	487	398	114	879	9182
(%)	3.9	2.5	0.5	2.6	4.2	3.8	0.5	2.2	2.3	0.8	0.4	2.0	1.7	1.4	0.4	3.1	32.4
4.0-6.0	888	394	64	393	734	743	119	575	714	275	108	575	340	205	74	696	6897
(%)	3.1	1.4	0.2	1.4	2.6	2.6	0.4	2.0	2.5	1.0	0.4	2.0	1.2	0.7	0.3	2.5	24.3
6.0-8.0	353	166	19	125	296	264	42	242	512	219	80	384	165	72	24	234	3197
(%)	1.2	0.6	0.1	0.4	1.0	0.9	0.1	0.9	1.8	0.8	0.3	1.4	0.6	0.3	0.1	0.8	11.3
8.0-10.0	91	46	6	30	84	79	13	92	305	123	45	205	63	28	4	50	1264
(%)	0.3	0.2	0.0	0.1	0.3	0.3	0.0	0.3	1.1	0.4	0.2	0.7	0.2	0.1	0.0	0.2	4.5
10.0-12.0	47	21	2	19	71	74	11	70	375	224	67	276	78	37	4	22	1398
(%)	0.2	0.1	0.0	0.1	0.3	0.3	0.0	0.2	1.3	0.8	0.2	1.0	0.3	0.1	0.0	0.1	4.9
12.0-14.0	3	4	0	3	15	13	2	9	106	92	26	98	24	13	0	2	410
(%)	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.4	0.3	0.1	0.3	0.1	0.0	0.0	0.0	1.4
14.0-16.0	1	0	0	1	4	3	0	3	46	29	10	39	13	4	0	2	155
(%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.5
16.0-18.0	0	0	0	0	1	1	0	3	16	8	4	19	4	0	0	0	56
(%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.2
18.0-20.0	0	0	0	0	0	0	0	0	5	1	1	6	2	1	0	0	16
(%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
>=20.0	2	3	0	0	1	1	0	1	10	1	0	0	0	0	0	0	19
(%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Total	2726	1532	259	1496	2658	2494	366	1732	2864	1257	461	2260	1275	841	242	2049	28362
(%)	9.6	5.4	0.9	5.3	9.4	8.8	1.3	6.1	10.1	4.4	1.6	8.0	4.5	3.0	0.9	7.2	100.0

Source: National Meteorological Administration 1995-2004

Table 3.2.5: Annual and monthly mean wind speed and occurrence rate of calm conditions at Constanța Metrological Station

	Annual	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean speed (m/s)	3.8	4.5	4.2	4.4	3.5	3.4	3.3	3.1	3.0	3.7	4.0	4.2	4.3
Calm (%)	13.7	8.3	10.3	9.9	11.7	14.6	15.8	16.5	19.5	15.7	14.6	14.0	10.3

Source: National Meteorological Administration 1985-2004

Seasonal variation of wind conditions is listed in Table 3.2.5 as the annual and monthly wind speed and the occurrence rate of calm conditions (defined as the wind speed less than 0.5 m/s). January is the month of strongest winds with the mean speed o 4.5 m/s, while August is the month of weakest winds with the mean speed of 3.0 m/s. Tables of seasonal frequency distribution of wind speeds are listed in Annex **D.2.2.** The annual mean wind speed is 3.8 m/s

as reported by RMA, but the calculation based on the class-wise median speeds and frequencies yields the mean speed of 4.3 m/s; a small difference of 13% is due to a gross error by the calculation method based o the class statistics.

Figure 3.2.2 shows the non-exceedance curves of the wind speed by ECMWF and RMA. The wind speed by ECMWF is slightly greater than the data by RMA. As stated before, the mean wind speed is 5.5 and 4.3m/s by ECMWF and RMA, respectively. The 90% non-exceedance speed is 10.0 and 8.7 m/s, and the 99% non-exceedance speed is 15.3 and 13.7 m/s, respectively. The difference in the wind speed of the both data reflects the fact that winds over the sea are stronger than those over the land.

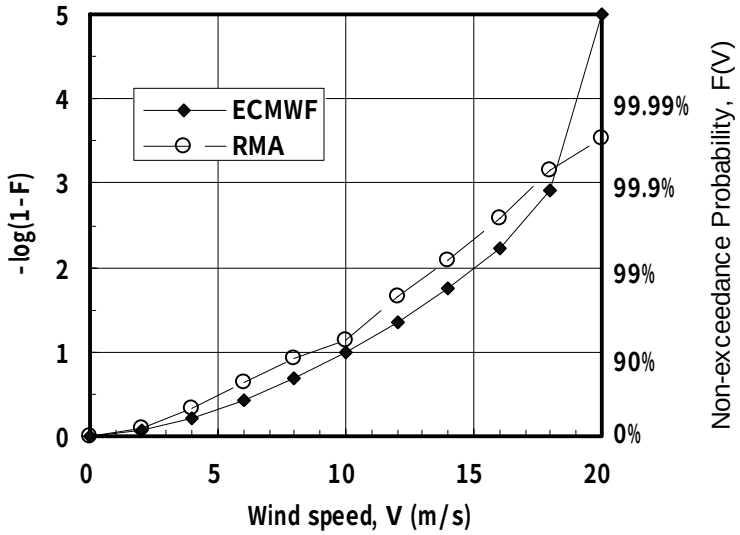


Fig. 3.2.2: Non-exceedance curves of wind speed at Constanța by ECMWF (on the sea) and RMA (on the land)

The wind direction reported by RMA indicates only a few frequencies in NE, SE, SW, and NW. It seems that the original wind data of RMA has been compiled in the 30 degree divisions and converted subjectively into the 16-points bearing system. It also records 19 cases of winds in excess of 20 m/s, which include outliers with the wind speed of 32, 40, 42, and 50 m/s. These outlying winds are not accompanied by other observations in excess of 20 m/s and seem to have occurred singularly.

Table 3.2.6: Monthly lowest barometric pressure at Conatanța (1961–2004)

	Months											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
hPa	978.9	978.8	985.4	985.6	994.4	993.1	994.9	994.9	987.5	992.9	989.8	979.4
Day	12	14	2	5	6	6	8	17	23	22	29	17
Year	1968	1962	1988	1964	1981	1994	1998	1961	1964	1974	1983	1962

3.2.4 Barometric Pressures

A search was made for the lowest barometric pressures, because a lowering of the barometric pressure by 1 hPa yields a rise of the mean water level by 1 cm. Table 3.2.6 lists the monthly lowest pressure observed at Constanța during the past 44 years from 1961 to 2004. The lowest

pressure ever observed is 978.4 hPa, which corresponds to a rise of the mean water level by about 35 cm in reference to the mean barometric pressure of 1013 hPa.

3.2.5 Geotechnical Conditions

As described in **1.3**, the main objective of the Study is to formulate the coastal protection plan for the Southern Romanian Black Sea Shore. Facilities to be installed for coastal protection are groins, jetties and detached breakwaters (emerged or submerged ones). Unless the seabed is very soft such as in case of muddy bed, the seabed has the sufficient bearing capacity to support the weight of such facilities.

The areas between the backshore of beaches and the inshore zone of several meters deep are covered by layers of sand of fine to medium grain sizes. In the Mamaia area, the layer of fine sand (median diameter of 0.1 mm) has the thickness of more than 10 m, as evidenced by the borehole tests made during the discharge pipeline study for the Constanța North Wastewater Treatment Station in 2003.

In the area south of Agigea, the sand layer on the seabed becomes thin and disappears at some places, as experienced by the Study team during sediment sampling from the seabed (see **4.3.2**). Another borehole tests at Eforie Sud for the wastewater treatment station there have indicated that the sand layer is absent in the water deeper than 3 m and the limestone layer is exposed.

The geotechnical conditions for the present study on coastal protection are thus quite different from those for port development projects at Constanța and other ports, where thick deposits of soft clay layers are found over broad areas of the inner basins.

3.2.6 Seismological Conditions

A part of the territory of Romania is located amid the seismic active zone of the world. It is the area of the mountain range of Carpați (Transilvania Alps) where the seismic coefficient[2] for structural design is assigned the value of 0.32. As the location of interest moves away from the Carpați, the seismic activity is lessened. The seismic coefficient applicable for Bucharest, for example, is 0.20. The Romanian Black Sea Coast belongs to the mildest seismic activity zone and the seismic coefficient for this area is assigned the value of 0.12.

It would be unnecessary to consider the seismic forces for design of shore protection facilities of groins, jetties, and breakwaters, because of the large capacity of these structures in resisting to the seismic forces. Beach fill is not affected by earthquakes because they will be consolidated by wave actions after having been placed upon the existing beach area.

3.3 Water Level and Astronomical Tide

(1) Data source

The water level in Constanța Port has been measured since 1933 with a sea level recorder of float operating type. In the period between 1933 and 1955, the measurement was carried out

[2] The seismic coefficient K_s is multiplied to the acceleration of gravity g to yield the horizontal acceleration to be taken into account for evaluation of horizontal inertia force.

by the Maritime Harbours Directorate and by Maritime Routes Compartment. From 1956 until 1973, it was done by Hydrographic Directorate of the Navy. In 1973, the sea level recorder was transferred to Romanian Marine Research Institute, which became the National Institute for Marine Research and Development (NIMRD) "Grigore Antipa." NIMRD has been conducting the water level measurement and provided the Study team with the following data:

1) Monthly and annual mean water level (1933 – 2004)
2) Daily mean water level (February 1972 – December 2004)
3) Hourly water level (January 1993 – December 2004)

NIMRD also provided the Study team with the hourly water level in Mangalia Port (January 1991 – August 2004). A part of the above data have been analyzed and presented in this report.

The report submitted by NIMRD lists the following information on the water level:

Highest water level (daily mean) ever recorded:	0.902 m (19 February 1979)
Mean monthly highest water level (HWL) ˜ HWOST:	0.357 m (December 2002)
Mean sea level for recent 5 years period:	0.233 m (2000 – 2004)
Mean sea level for Constanța Port:	0.163 m (1933 – 2004)
Mean monthly lowest water level (LWL) ˜ LWOST:	0.028 m (November 2001)
Lowest water level ever recorded:	–0.304 m (18 January 1992)

Although the mean monthly highest (lowest) level is listed with the month and year, it is not clear how the date is related with the specified water level.

(2) Mean water level

There is a clear tendency of the rise of mean water level. Figure 3.3.1 shows the variation of the annual mean water level in Constanța Port for the period from 1933 to 2004; the data of 1935 and 1944 were missing and they were supplemented by interpolation. The dashed line is the linear regression line fitted to the data. It is observed that the mean water level rose by about 15.4 cm over seventy years. The rate of mean sea level rise is about 2.2 mm per year, which is large compared with various records at the ocean side. The land-locked characteristics of the Black Sea might have accelerated the rise of the means sea level.

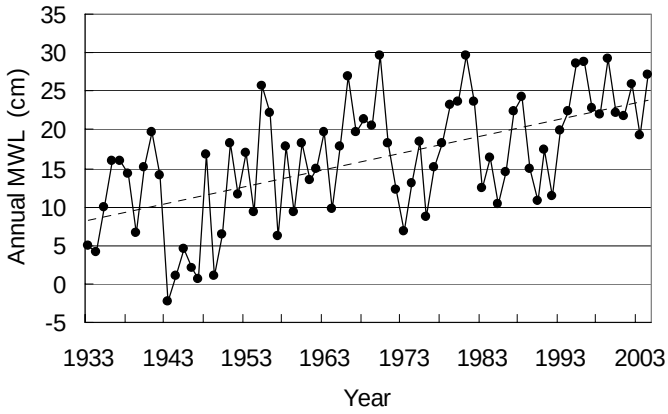


Fig. 3.3.1: Trend of annual mean water level in Constanța Port

The gradual rise of mean sea level must have contributed to the shoreline retreat in the Study area. Estimate has been done for the annual rate of the shoreline retreat with Bruun's formula, and the result is listed in Table 4.6.1 in **4.6**. The shoreline in Mamaia Beach is calculated to have receded with the rate of 0.18 m per year, for example. Because the rise of mean water level directly affects the beach erosion process, it should be monitored carefully.

(3) Astronomical tide

The water level in the Ports of Constanța and Mangalia is characterized by large and irregular fluctuations over several days to several weeks. Compared with these fluctuations, the amplitudes of astronomical tides are small and not easy to analyze accurately. The water level records in the both ports contained a number of downtimes over several hours to more than one month. The records of 2000 and 2001 of the both ports were selected for the harmonic analysis of astronomical tides, because they had a fewer occasions of downtimes; the portions of downtimes up to a few days were supplemented by a linear interpolation between the good records just before and after the downtimes. The records were separated into two time series of low and high frequency components by applying a smoothing filter with a bandwidth of 24 hours. Samples of the two time series are presented in Annex **D.3**.

The time series of high frequency components were analyzed with a standard computer program for tidal harmonic analysis. Table 3.3.1 lists the amplitudes and phases of the major tidal components in the Ports of Constanța and Mangalia.

Table 3.3.1: Amplitude and phase of major tidal components in the Ports of Constanța and Mangalia

Tidal components	Constanța Port		Mangalia Port	
	Amplitude (m)	Phase (deg)	Amplitude (m)	Phase (deg)
Principal lunar semidiurnal component, M_2	0.0151 0.0125	209.2 198.5	0.0163 0.0195	232.8 224.8
Principal solar semidiurnal component, S_2	0.0068 0.0061	209.7 196.9	0.0064 0.0089	228.5 219.3
Luni-solar diurnal component, K_1	0.0080 0.0060	294.9 295.2	0.0100 0.0121	315.6 311.3
Principal lunar diurnal component, O_1	0.0053 0.0040	317.1 312.7	0.0067 0.0052	332.9 330.3
Principal solar diurnal component, S_1	0.0044 0.0050	231.2 233.0	0.0086 0.0120	282.4 281.4
Spring tidal range, $2(M_2 + S_2)$	0.0438 0.0377	–	0.0454 0.0566	–

Note: The upper figure in each cell is the result of the year 2000 and the lower figure is of 2001.

Probably because of small contribution of astronomical tides to the water level fluctuation, the results of the harmonic analysis of the two years have differences of about 20%. The most influential tidal component of M_2 has the amplitude less than 2 cm in the both ports and the mean amplitude of spring tide is less than 3 cm. The spring tidal range, which is twice the sum of the amplitudes of M_2 and S_2, is 4.0 cm at Constanța and 5.1 cm at Mangalia. The neap spring range, which is twice the difference of the amplitudes of M_2 and S_2, is 1.5 cm at Constanța and 2.1 cm at Mangalia. One interesting feature is a relatively large presence of the principal solar diurnal component, S_1, which is not included in the major four tidal components in general.

(4) Monthly mean water level

Because of the small contribution of astronomical tides to the total water level fluctuation, the daily averaged water level has been used in Constanța Port. The ever-recorded highest and lowest water levels presented in **(2)** are the daily averaged water level. When the highest water level of 0.902 m was recorded, the water level was higher than 0.50 m for seven consecutive days. When the lowest water level of –0.304 m, the water level was lower than 0.0 m for five consecutive days.

It was customarily in Japan to calculate the mean monthly highest (lowest) water level as the indicators of representative high (low) water level. The highest (lowest) water level in each month within five days after the new or full moon is listed and their annual mean is calculated. The condition of five days is to make sure that the spring tide is observed. Unusual water levels due to storm surges or tsunamis are excluded. The mean monthly highest (lowest) water level is approximately equivalent to the high (low) water ordinary spring tide.

The monthly highest and lowest water levels were picked up from the table of daily averaged water level for the period of 12 years from 1993 to 2004. The data of respective years were compiled for each month and the average highest and lowest water levels were calculated. Figure 3.3.2 shows the seasonal variation of monthly highest and lowest water levels. During the period of 1993 to 2004, the mean water level was 0.225 m. The result of Fig. 3.3.2 indicates that the seasonal variation of the monthly mean water level is about 0.12 m (highest in May and lowest in September) but the difference between the highest and lowest water levels is large during winter and small during summer.

The data also yields the following annual mean of water level:

Mean monthly highest water level (HWL) ˜ HWOST: 0.377 m
Mean monthly lowest water level (LWL) ˜ HWOST: 0.134 m

Although these water levels differ from those reported by NIMRD, they may be used for the reference in marine construction works.

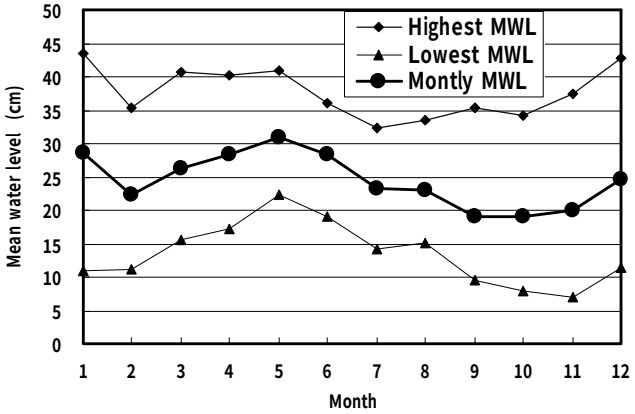
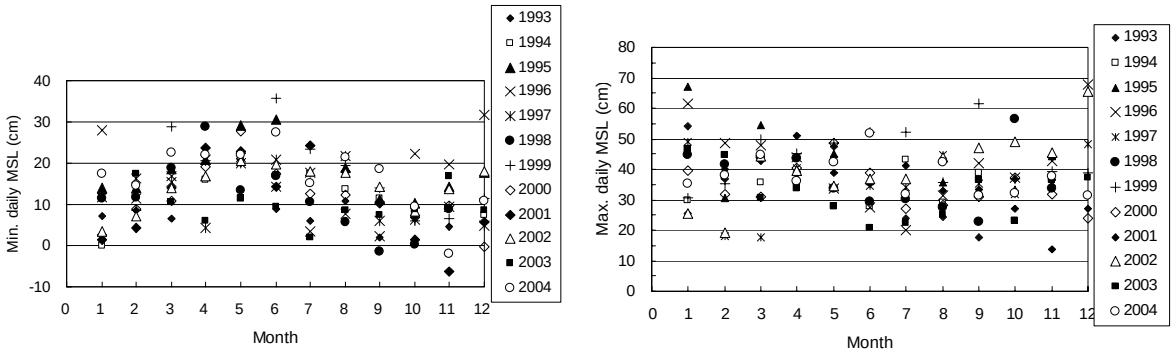


Fig. 3.3.2: Seasonal variation of monthly highest, lowest, and mean water level.

The yearly variations of the monthly highest and lowest water levels, which are the averages of 24 hour data of one day, are shown in Figs. 3.3.3. Quite large variations from year to year is observed



(a) Monthly highest water level (daily averaged) (b) Monthly lowest water level (daily averaged)

Fig. 3.3.3: Yearly variations of the monthly highest and lowest water levels in Constanța

(5) Analysis of irregular fluctuations of water level

Examples of water level records in the Ports of Constanța and Mangalia are shown in Figs. D.3.1 and D.3.2 in Annex **D.3**. After filtering out of astronomical tidal variations, the water level exhibit irregular fluctuations, which may be called the long-period oscillation of water level. The filtered-out records of the long-period oscillation in the both ports in 2000 and 2001 were analyzed by the zero-up crossing methods that have been employed for the analysis of ocean wave data. The conventional definitions of the mean, significant, one-tenth highest, and maximum wave heights and periods were applied and their values were quantified. Table 3.3.2 lists the result of the long-period oscillation analysis.

Table 3.3.2: Height and period of long-period oscillations of water level

Port	$(H_l)_{mean}$ (cm)	$(T_l)_{mean}$ (day)	$(H_l)_{1/3}$ (cm)	$(T_l)_{1/3}$ (day)	$(H_l)_{1/10}$ (cm)	$(T_l)_{1/10}$ (day)	$(H_l)_{max}$ (cm)	$(T_l)_{max}$ (day)
Constanța	11.3	7.4	19.5	13.2	16.1	16.1	28.0	13.3
Mangalia	12.2	7.4	21.1	13.4	29.3	21.3	35.4	21.0

The mean height of the long-period oscillation is about 12 cm with the mean period of about 7 days. The significant height is about 20 cm and the significant period is about 13 days. The amplitude of fluctuation seems to be slightly larger in Mangalia than in Constanța, but the difference may be insignificant in consideration of its irregularity. The largest fluctuation was 35 cm in height, but it may go up 50 cm or more as indicated in Fig. D.3.2.

The long-period oscillation of water level occurs almost simultaneously in the both ports with a time lag of 1 to 2 hours. The mechanism that induces such long-period oscillation of water level in the Black Sea coast is not known. The following is a list of possible causes:

1) Barometric pressure fluctuation;
2) Surface drag forces of strong winds that induce a rise of water level at the down-wind side and a fall of water level at the up-wind side; the water level change by winds depends on the direction and speed of winds
3) Resonant oscillation (seiches) of the whole Black Sea;
4) Others.

Even though the causes of the long-period oscillation of water level have not been revealed yet, the presence of such oscillation should be duly taken into account in the coastal protection planning.

3.4 Wave Climate and Extreme Waves

3.4.1 Wave Climate

(1) Data source

Two sources of wave data are available for the Study. One is the wave hindcast data by the European Centre for Medium Range Forecasting (ECMWF) and the other is the visual observation by means of a buoy and a set of special binoculars ("perspectometru" in Romanian). The former is the result of the Eurowaves project for the Black Sea for the period of November 1991 to June 2002 with the WAM model. The hindcast has been made four times a day at 6 hours interval. The wave height was validated and corrected by using satellite altimeter data from Topex/Poseidon. The correlation coefficients between the WAM and Topex/Poseidon data in the western part of the Black Sea was larger than 0.85. The hindcast data at the location 44.0ºN and 29.0ºE is utilized in the present analysis and the total of about 16,000 hindcast results were analyzed. Although the hindcast point is located in the area of about 45 m deep, the WAM model has been developed for deepwater waves and no effect of the sea bottom is taking into account in the wave hindcast.

The visual observation had been carried out at the depth of about 11 m at the location 44º10´N and 28º40´E from 1966 to 2000. An observer watched the vertical movement of a buoy, took note of the heights, periods, directions, and wavelengths of five representative waves that were subjectively picked up by him, and calculated the mean values for three times a day (usually 0700, 1300 and 1700 hours, but dependent on the daylight hours of the season). At the southeastward direction of the buoy, the east breakwater of Constanța Port obstructs propagation of waves in the directional range from the azimuth 150º by the north and further southward.

The whole wave data from 1966 to 2000 were provided by the National Institute for Marine Research and Development (NIMRD) to the Study team. The accuracy and quality of the measurements largely depended on the skill and eagerness of the observer. In early years of the visual wave observations, the quality was generally good and the frequency of downtime was not large. However, with the lapse of time, the downtime frequency increased with lowering in the reliability of measured data. As described in Annex **D.4.2**, a subjective judgment was made to select the months of the years in which the reliability of the measured data is relatively high. Thus the data analysis was made only for the selected 92 months with the total of about 7000 observations.

(2) Joint distribution of wave height and period

Table 3.4.1 lists the joint distribution of wave height and wave period in the whole year based on ECMWF data. The wave height H_s is estimated from the hindcasted spectral moment m_0 as equal to $4.0m_0^{1/2}$, which usually yields the height about 5% greater than $H_{1/3}$. The wave period T_m is estimated from the spectral moments as equal to m_{-1}/m_0, which is known to yield the period somewhat equivalent to the significant wave height $T_{1/3}$. The joint distribution of wave height and period in the whole year based on NIMRD data is listed in Table 3.4.2.

The two wave data indicate almost the same cumulative distribution of wave heights off Constanța as shown in Fig. 3.4.1. Although the visual measurement data of NIMRD does not represent the significant wave height by definition, the comparison shown in Fig. 3.4.1

indicates that the NIMRD data can be regarded to represent the significant wave height. Comparison of the frequency distribution of wave period by ECMWF and NIMRD data is shown in Fig. 3.4.2. In case of wave period, NIMRD data tend to show shorter periods than ECMWF data. The observers watching wave motions with a set of special binoculars must have a tendency of catching wind waves of short periods rather than swell of long periods. Nevertheless, the overall tendency is the same, thus validating the reliability of ECMWF data.

Table 3.4.1: Joint distribution of wave height and wave period in the whole year (ECMWF data)

Source ECMWF 1991-2002

Hs(m) \ Tm(s)	0 -1	1 -2	2 -3	3 -4	4 -5	5 -6	6 -7	7 -8	8 -9	9 -10	10 -11	11 -12	12 -13	13 -14	14 -15	15 -	total
0 - 50			77 0.5	1673 10.7	1915 12.3	528 3.4	93 0.6	26 0.2	3 0.0	1 0.0							4316 27.7
50 - 100			46 0.3	1302 8.4	2495 16.0	1484 9.5	446 2.9	76 0.5	21 0.1	9 0.1	3 0.0	3 0.0	1 0.0				5886 37.8
100 - 150			1 0.0	41 0.3	1043 6.7	1166 7.5	499 3.2	109 0.7	10 0.1	3 0.0		1 0.0		1 0.0			2874 18.4
150 - 200				2 0.0	79 0.5	654 4.2	447 2.9	93 0.6	12 0.1								1287 8.3
200 - 250					1 0.0	130 0.8	333 2.1	100 0.6	13 0.1	1 0.0	1 0.0						579 3.7
250 - 300						4 0.0	143 0.9	129 0.8	17 0.1	2 0.0							295 1.9
300 - 350							19 0.1	105 0.7	25 0.2	2 0.0							151 1.0
350 - 400								41 0.3	37 0.2	6 0.0							84 0.5
400 - 450							1 0.0	6 0.0	29 0.2	7 0.0	1 0.0						44 0.3
450 - 500								1 0.0	18 0.1	12 0.1	2 0.0						33 0.2
500 - 550									5 0.0	7 0.0	3 0.0						15 0.1
550 - 600									1 0.0	5 0.0	2 0.0	1 0.0					9 0.1
600 - 650										3 0.0	2 0.0	1 0.0					6 0.0
650 - 700										1 0.0							1 0.0
700 - 750																	
-750																	
total			124 0.8	3018 19.4	5533 35.5	3966 25.5	1981 12.7	686 4.4	191 1.2	59 0.4	14 0.1	6 0.0	1 0.0	1 0.0			15560 100.0

Upper figures Number of contents
Lower figures Percentage of occurrence

Table 3.4.2: Joint distribution of wave height and wave period in the whole year (NIMRD data), expressed in percentage of occurrence

Wave Height	Period T (s)										
H (m)	0 - 1	1 - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10	Total
0 - 0.5			5.94	12.19	5.44	3.04	0.60	0.07			27.28
0.5 - 1.0			1.81	16.03	13.94	6.11	2.17	0.21	0.05		40.31
1.0 - 1.5				2.33	7.96	4.91	2.12	0.28			17.61
1.5 - 2.0				0.28	1.79	3.97	1.41	0.25	0.02		7.71
2.0 - 2.5					0.47	1.70	1.29	0.39	0.03		3.88
2.5 - 3.0					0.07	0.35	0.55	0.47	0.03	0.01	1.47
3.0 - 3.5						0.13	0.40	0.26	0.03		0.82
3.5 - 4.0						0.07	0.05	0.28	0.02		0.42
4.0 - 4.5						0.02	0.07	0.14	0.02		0.25
4.5 - 5.0							0.04	0.10	0.01	0.02	0.17
5.0 - 5.5								0.03	0.02		0.05
5.5 - 6.0									0.02		0.02
6.0 - 6.5								0.02			0.02
Total	0	0	7.75	30.82	29.67	20.29	8.71	2.50	0.23	0.03	100.00

Calculation based on the class-wise frequencies in Table 3.4.1 yields the mean wave height being 0.95 m and one-percent exceedance height being about 3.7 m, while the largest wave

hindcasted in the period from November 1991 to June 2002 was 6.77 m in height and 9.9 s in period. Waves are typical wind waves with the steepness mostly ranging from 0.02 to 0.04 with some low swell having the period up to 13 s. The overall mean period is 5.1 s.

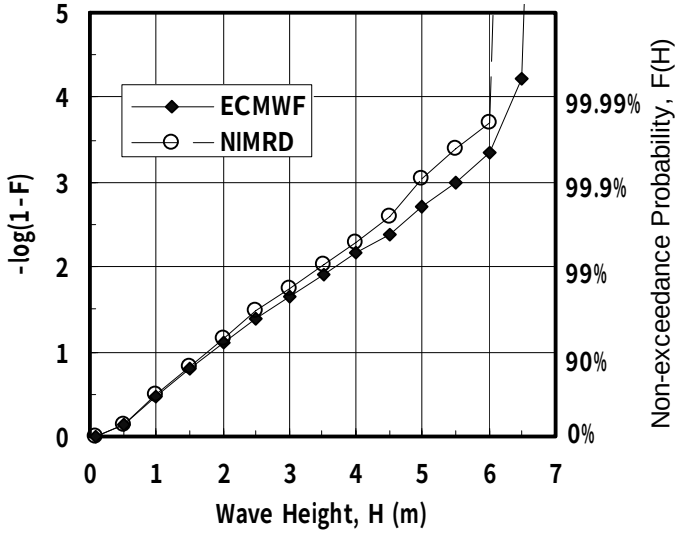


Fig. 3.4.1: Cumulative distributions of significant wave height off Constanța based on ECMWF and NIMRD data

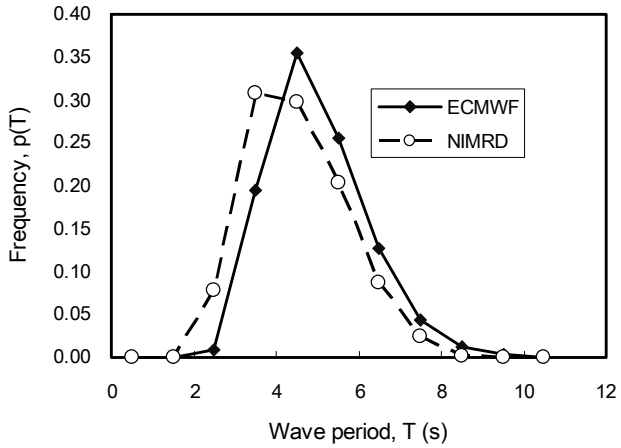


Fig. 3.4.2: Cumulative distribution of wave period off Constanța based on ECMWF and NIMRD data

(3) Characteristic wave heights and periods

Characteristic wave heights and periods in each month, season and year are calculated as listed in Table 3.4.3 for both ECMWF and NIMRD data. They are based on monthly, seasonal, and yearly tabulation of joint frequencies of wave heights and periods. Seasonal joint distributions of wave height, period, and direction are presented in Annex **D.4.1**. The heights and periods of the mean waves are obtained as the overall averages. The heights and periods of 10% and 1% exceedance waves are calculated from the cumulative distributions of wave heights and periods at the upper 10% and 1% ranges. Thus, the 1% exceedance wave period is not directly correlated with the 1% exceedance wave height.

The difference between the wave height data of ECMWF and NIMRD is small and no particular tendency of deviation is observed. In the former data, one month's data contain about 120 hindcast with no downtime and the statistics of monthly data have been compiled from about eleven years' data. In the latter data, one month's data is composed of about 58 observations on average with the downtime of 36% (including reports of calm) and the data of respective months are compiled from the data of six to nine years. Any difference between the two set of data can be attributed to the small sample sizes of the NIMRD data.

As for the wave periods, the NIMRD data are shorter than the ECMWF data owing to inherent limitation of the visual wave observation method.

As seen in Table 3.4.3, waves are high during winter and low during summer. The months of December and January have the roughest waves and the months of June and July have mildest waves. In this table, the winter season is arbitrarily defined as the period from November to March.

Table 3.4.3: Monthly, seasonal and yearly characteristic wave heights and periods

Month	Mean waves		10% exceedance wave		1% exceedance wave	
	ECMWF	NIMRD	ECMWF	NIMRD	ECMWF	NIMRD
January	1.11 m (5.1 s)	1.30 m (5.1 s)	2.0 m (6.8 s)	2.5 m (6.8 s)	4.4 m (9.1 s)	4.9 m (8.1 s)
February	1.06 m (5.1 s)	1.02 m (5.0 s)	2.0 m (6.7 s)	1.7 m (6.6 s)	3.6 m (8.4 s)	3.8 m (7.8 s)
March	1.05 m (5.2 s)	1.05 m (5.1 s)	1.8 m (6.8 s)	2.2 m (6.8 s)	3.7 m (8.2 s)	3.4 m (8.1 s)
April	0.88 m (5.1 s)	0.74 m (4.5 s)	1.6 m (6.6 s)	1.4 m (6.4 s)	2.9 m (8.0 s)	2.5 m (7.6 s)
May	0.71 m (4.8 s)	0.77 m (4.4 s)	1.4 m (6.4 s)	1.5 m (5.8 s)	2.6 m (7.8 s)	2.5 m (7.2 s)
June	0.65 m (4.5 s)	0.65 m (4.2 s)	1.3 m (5.8 s)	1.3 m (5.8 s)	2.2 m (7.3 s)	2.3 m (7.0 s)
July	0.68 m (4.5 s)	0.62 m (4.1 s)	1.4 m (6.1 s)	1.0 m (5.5 s)	2.3 m (7.5 s)	1.9 m (6.9 s)
August	0.73 m (4.8 s)	0.73 m (4.3 s)	1.4 m (6.2 s)	1.4 m (5.6 s)	2.3 m (7.8 s)	2.2 m (6.8 s)
September	0.89 m (4.9 s)	0.90 m (4.6 s)	1.7 m (6.6 s)	1.8 m (6.0 s)	3.1 m (8.0 s)	3.2 m (7.4 s)
October	1.03 m (5.2 s)	1.03 m (4.7 s)	2.0 m (6.9 s)	1.9 m (6.3 s)	3.4 m (8.6 s)	4.0 m (7.7 s)
November	1.18 m (5.3 s)	1.14 m (5.0 s)	2.4 m (7.2 s)	2.3 m (6.8 s)	4.4 m (9.4 s)	4.2 m (8.2 s)
December	1.31 m (5.5 s)	0.97 m (4.9 s)	2.7 m (7.4 s)	1.9 m (6.4 s)	4.9 m (9.5 s)	3.6 m (7.7 s)
Winter (Nov. – Mar.)	1.16 m (5.2 s)	1.10 m (5.0 s)	2.3 m (6.9 s)	2.2 m (6.7 s)	4.4 m (9.0 s)	4.1 m (8.0 s)
Summer (Apr. – Oct.)	0.79 m (4.8 s)	0.78 m (3.8 s)	1.5 m (6.5 s)	1.5 m (5.5 s)	2.8 m (7.9 s)	2.8 m (7.0 s)
Whole year	0.95 m (5.1 s)	0.91 m (4.7 s)	1.8 m (6.6 s)	1.8 m (6.3 s)	3.6 m (8.4 s)	3.5 m (7.8 s)

(4) Wave direction

The joint distribution of wave height and wave direction is listed in Tables 3.4.4 and 3.4.5 for ECMWF and NIMRD data, respectively. Based on these joint distributions, the frequency distribution of the wave direction is shown in Fig. 3.4.3 for the whole waves in the left panel and for waves larger than 1.5 m in the right panel.

Table 3.4.4: Joint distribution of wave height and wave direction in the whole year (ECMWF data)

Source ECMWF 1991-2002

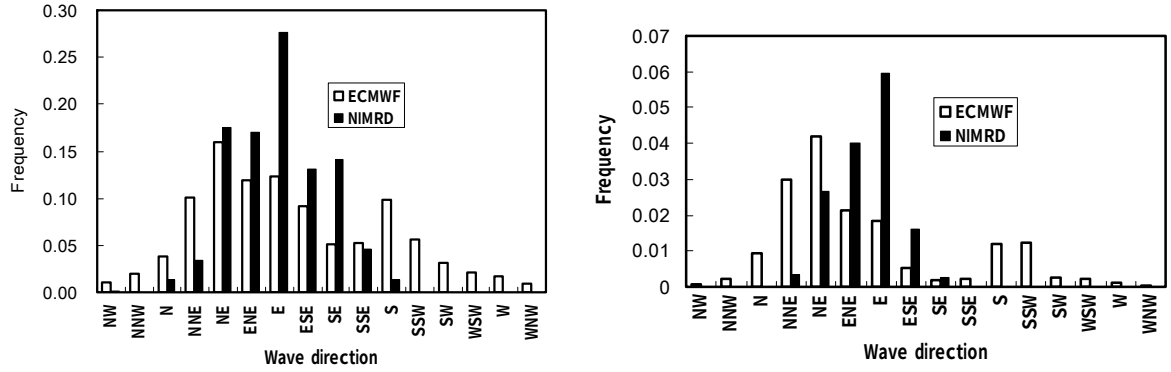
H(m) \ DIR	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	total
0 - 50	293 1.9	399 2.6	181 1.2	132 0.8	85 0.5	52 0.3	36 0.2	46 0.3	74 0.5	101 0.6	317 2.0	633 4.1	506 3.2	620 4.0	540 3.5	301 1.9	4316 27.7
50 - 100	369 2.4	596 3.8	308 2.0	219 1.4	144 0.9	127 0.8	79 0.5	78 0.5	125 0.8	199 1.3	440 2.8	767 4.9	725 4.7	743 4.8	598 3.8	369 2.4	5886 37.8
100 - 150	114 0.7	345 2.2	190 1.2	104 0.7	64 0.4	64 0.4	22 0.1	35 0.2	60 0.4	142 0.9	351 2.3	454 2.9	289 1.9	319 2.0	217 1.4	104 0.7	2874 18.4
150 - 200	20 0.1	118 0.8	121 0.8	35 0.2	15 0.1	14 0.1	3 0.0	11 0.1	26 0.2	99 0.6	246 1.6	254 1.6	121 0.8	118 0.8	64 0.4	22 0.1	1287 8.3
200 - 250	10 0.1	44 0.3	45 0.3	7 0.0	17 0.1	3 0.0	3 0.0		9 0.1	28 0.2	120 0.8	157 1.0	61 0.4	59 0.4	13 0.1	3 0.0	579 3.7
250 - 300	3 0.0	18 0.1	17 0.1	1 0.0	3 0.0		2 0.0		2 0.0	15 0.1	49 0.3	98 0.6	56 0.4	26 0.2	4 0.0	1 0.0	295 1.9
300 - 350		5 0.0	8 0.1		2 0.0	1 0.0			1 0.0	3 0.0	23 0.1	55 0.4	43 0.3	9 0.1	1 0.0		151 1.0
350 - 400			2 0.0							2 0.0	12 0.1	39 0.3	23 0.1	6 0.0			84 0.5
400 - 450		1 0.0	2 0.0								7 0.0	17 0.1	14 0.1	3 0.0			44 0.3
450 - 500											5 0.0	15 0.1	9 0.1	4 0.0			33 0.2
500 - 550											3 0.0	4 0.0	4 0.0	4 0.0			15 0.1
550 - 600											2 0.0	2 0.0	2 0.0	3 0.0			9 0.1
600 - 650												4 0.0	2 0.0				6 0.0
650 - 700											1 0.0						1 0.0
700 - 750																	
-750																	
total	809 5.2	1526 9.8	874 5.6	498 3.2	330 2.1	261 1.7	145 0.9	170 1.1	297 1.9	589 3.8	1576 10.1	2499 16.0	1855 11.9	1914 12.3	1437 9.2	800 5.1	15580 100.0

Upper figures Number of contents
Lower figures Percentage of occurrence

Table 3.4.5: Joint distribution of wave height and wave direction in the whole year (NIMRD data) expressed in percentage of occurrence

Wave Height	Wave Direction																
H (m)	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	Total
0 - 0.5			0.06		0.66	1.07	4.44	3.28	5.38	3.02	6.25	2.33	0.78				27.27
0.5 - 1.0			0.03		0.47	1.42	7.23	5.97	10.69	5.66	6.43	1.92	0.49				40.29
1.0 - 1.5			0.03		0.12	0.53	3.27	3.72	5.64	2.79	1.16	0.27	0.03				17.57
1.5 - 2.0						0.22	1.51	1.90	2.83	1.07	0.16						7.70
2.0 - 2.5						0.09	0.66	1.12	1.45	0.44	0.11						3.88
2.5 - 3.0							0.32	0.40	0.65	0.10							1.47
3.0 - 3.5							0.12	0.28	0.45								0.85
3.5 - 4.0						0.02	0.02	0.19	0.24								0.48
4.0 - 4.5								0.07	0.17								0.24
4.5 - 5.0							0.03	0.04	0.08								0.16
5.0 - 5.5								0.02	0.03								0.05
5.5 - 6.0									0.01								0.01
6.0 - 6.5									0.02								0.02
Total			0.12		1.25	3.35	17.61	16.99	27.66	13.10	14.12	4.52	1.30				100.00

There is a noticeable difference in the predominant wave direction between the data of ECMWF and NIMRD. While the predominant wave direction is from NNE to E according to the former data, it is from NE to ESE in the latter data. The weighted mean direction of the all ECMWF data is the azimuth 36º from the north and that of the NIMRD data is 88º. However, the mean direction of the waves higher than 1.5 m is the azimuth 68º for the ECWMF data and 78º for NIMRD data; the difference becomes small for high waves.



(a) Whole waves (b) Waves greater than $H_{1/3}$ = 1.5 m

Fig. 3.4.3: Frequency distribution of wave direction

The main reason of the difference is the effect of wave refraction on the wave direction in shallow water for the NIMRD data. The depth contours of 10 to 20 m run along the direction of NNE–SSW to NE–SE in the water area north of the wave observation point. Waves with the period of 5 s coming from the direction of the azimuth 40º from the north would be refracted with a change of wave direction by 30º or more. Deflection of wave direction is large for waves of longer periods. Waves with the period of 8 s, for example, would change their principal direction from the azimuth 65º in the offshore to that of 85º at the depth of 11 m. Thus, the predominant direction of the northeasterly waves should be adjusted with due consideration of wave refraction effect for the ECMWF data, by referring to the directional distribution of the NIMRD data.

A lack of waves from the southeastward direction in the NIMRD data is caused by the presence of the east breakwater of Constanța Port as discussed in **3.4.1 (1)**. Therefore, the data by ECMWF should be referred to when dealing with the southeasterly waves.

The wave direction is northeasterly during the winter season, while it is southeasterly during the summer season. Details can be seen in Annexes **D.4.1**, **D.4.3**, and **E.6.1**. However, the northerly and southerly waves appear throughout the year with their ratio varies depending on the season. This feature of wave directions affects the alongshore sediment transport rate as discussed in **4.5.1**.

3.4.2 Extreme Waves

The time series of ECMWF wave data were also analyzed for estimation of extreme waves such as 100-year wave height. The peaks-over-threshold method was employed to define storm wave events with the threshold height of H_s = 3.5 m. There were 46 events of storm waves during 11 years (the mean rate of 4.18). The standard procedure of the extreme statistics[3] has yielded the estimates listed in Table 3.4.6. Details of extreme wave analysis are presented in Annex **D.5**.

The extreme wave heights and periods are those at the wave forecast location 44.0ºN and 29.0ºE. For design of shore protection facilities, wave transformation processes of wave shoaling, refraction, and breaking should duly be taken into consideration. Their offshore

[3] For example, see Chapter 11 of "*Random Seas and Design of Maritime Structures* (2nd Ed.)," by Y. Goda published in 2000 by World Scientific, Singapore.

wave direction also needs to be modified in consideration of wave refraction effect on the continental shelf of the Black Sea, because the ECMWF data is based on the WAM model for deepwater waves.

Table 3.4.6: Estimates of return wave heights and periods

Return period	Wave height (m)	Wave period (s)
5 years	6.08	9.9
10 years	6.52	10.2
50 years	7.45	10.8
100 years	7.83	11.0

3.5 Coastal Currents

The Black Sea is an inland sea of almost no tide, and thus there exist no tidal currents. Major components of currents in the Black Sea are river outflows and wind-driven currents. The effluent of the Danube is most influential, but its strength weakens with the distance from the river mouths. During the winter season, the predominant northerly winds generate the counter-clockwise currents along the northwestern part of the Black Sea, while the clockwise currents appear in the summer season owing to the southerly winds. There is an observation report[4] of the southward currents being about 0.5 m/s on the continental shelf off Midia in 1972, but generally wind-driven currents are weak and irregular.

The speed of wind-driven currents is usually 3% to 5% of the wind speed on the sea; winds of 20 m/s may induce the currents of 0.6 to 1.0 m/s. Wind-driven currents are confined in the surface layer of the sea only. The water in the inshore zone from which beach accretion or erosion takes place is little affected by the wind-driven currents as far as the movement of bottom sediment is concerned.

There is some local belief that the counter-clockwise currents along the northwestern shore of the Black Sea carry the river sediment of the Danube along the Romanian Coast beyond Cape Constanța. It cannot be true, because the currents flow only in the surface layer and have the capacity to carry very fine materials such as clay and silts only in suspension. It may transport chemical materials causing eutrophication of the seawater, but it cannot transport fine to coarse sediment such as sand along the seabed.

Currents responsible for alongshore and cross-shore transport of sand are those induced by waves in the surf zone, which are called the nearshore currents. They are uncorrelated with surface currents induced by the winds. Examination and analysis of wave conditions and nearshore bathymetry are essential for investigation of the nearshore currents. There are no persistent nearshore currents through a year, but they daily change the direction and speed depending on the wave condition.

[4] Aquaproiect S.A.: Studiu pentru Inentificarea Zonelor Critice de Eroziune a Plajelor şi de Instabilitate a Falezelor Litoralului Românesc a al Mării Negre, 1998, Anexa Nr. 5.

3.6 Geomorphological Features of Shore Sectors

The Study area covers the shoreline of about 80 km and exhibits various characteristics of sandy beaches and cliff shores. In this section, they are described in sector by sector as in the following subsections. The sector names are based on the definition listed in Table 5.2.1 of **5.2**.

3.6.1 Sub-Sectors of Năvodari and Mamaia Beaches

This sector is made of a barrier beach with the terrigeneous sediment supplied by the Danube, as explained in **3.1**. With a vast quantity of sediment supply, the barrier beach had grown for thousands of years and finally closed off Lake Siutghiol, probably around the first century AD. Even after that event, the barrier beach continued to grow and the beach became very wide.

Mamaia Beach was developed in the early 20th century as the first summer resort in Romania, and frequented by the upper class people as well as by common people. There was no shortage of beach area for people to enjoy sunbathing and ocean bathing. However, chronic beach erosion began since 1977, when the extension works of the north breakwater of Midia Port from –5 m to –10 m were undertaken. Compared with data of 1963 the shoreline retreated more than 80 m at the southern part of Mamaia Beach (see **4.1.2**).

The cause of beach erosion is twofold. One is the rapid decrease of sediment discharge from the Danube as the result of many dam constructions in the main stream as well as the tributaries. The quantity of coarse sediment discharge at the final outlets of the Danube must have decreased more rapidly than that of fine sediment of silt and clay, because coarse sediment was easily deposited at the bottom of dam lakes. The decrease in the sediment supply from the Danube has been causing serious beach erosion along the northern sub-unit of the Romanian Black Sea shore (see **4.2.2**), but this effect is rather indirect in the case of the southern sub-unit.

The event that affected Mamaia Beach more severely is the construction of the north breakwater of Midia Port, which was prolonged to the depth of 10 m since 1977. The alongshore transport of the decreased amount of sediment was diverted to the offshore by the breakwater and could not reach to the beaches of Năvodari and Mamaia anymore. The National Institute of Geology and Geoecology (GeoEcoMar) estimates a sedimentary deficit of 10 to 12 million cubic meters for the entire area of Mamaia Bay up to the 6–7 depth contours for the period of ten years from 1974 to 1984.

In order to remedy the acute beach erosion problem, six detached breakwaters were constructed in 1988 to 1990 and a beach fill operation was undertaken simultaneously. With these countermeasures, the beach erosion was stopped temporarily. However, the area at the southern end of Mamaia Beach still experiences a fast rate of shoreline retreat more than 2 m per year (see **4.2.3**).

The other parts of Năvodari and Mamaia Beaches are somewhat in a stable condition after the initial stage of beach erosion. It seems that the Midia breakwater and a large jetty of the fishing port at Cape Singol are functioning as the headlands and the coast of a long beach between them is taking an equilibrium plan shape.

In the recent decades, mollusks began to flourish in the inshore and a large number of mollusk

shells are presently observed along the shoreline of this shore sector. The shell fragments have become an important source of beach sediment. The proportion of shell fragments in beach sediment increases toward the southern part of this shore sector, exceeding 50% at certain places. Inclusion of a large quantity of shell fragments changes the grain size of sediment from fine to medium, as indicated by the sediment sample analysis in **4.3**.

3.6.2 Sub-Sectors between Cape Singol and Cape Constanța

This sector is a cliff shore with narrow beaches at its foot. On top of the cliff, the streets and housings of Constanța City are expanded. A number of multi-storied housings are clustered at the edge of the cliff, especially in the northern part of this shore sector. The cliff is susceptible of collapse by sliding when the upper soil is saturated by rainwater or leakage from waste water pipes. The City of Constanța has been working to stabilize the cliff slope by providing good drainage works and changing the slope gradient into a milder one.

The cliff is also scoured by waves at its foot, and as a result the shoreline has been retreated gradually over years. Thanks to the protection works during the past 25 years, the retreat was at most 5 m, according to the report of GeoEcoMar (see Annex **L.8** in CD-ROM). Nevertheless, a possible disaster of cliff collapse due to geotechnical instability at the upper part and/or wave scouring at the foot should be duly taken into consideration in the urban planning.

Beaches in this shore sector are well preserved by a number of jetties and submerged detached breakwaters, though all of the latter are not visible nowadays.

The southernmost part of this sub-sector is occupied by Tomis Tourist Port and then the promenade of the Casino. The shore around the Casino has been subjected by erosive action of waves over years and it has been protected by massive seawalls and a detached breakwater. The cliff around Cape Constanța has retreated quite a lot over years. A comparison of an old chart in 1854 and the recent one indicates a significant shoreline retreat even though its quantification is difficult because of the differences in the chart coordinates.

3.6.3 Sub-Sectors of Eforie Nord to Eforie Sud

As discussed in **3.1.5**, beach sand of the shore sectors from Eforie Nord to the south is composed of bivalve shell fragments, being supplemented by limestone clasts (rock fragments).

The sub-sector “Eforie Nord” can be divided into the northern and southern parts with the boundary at a marina named “Yacht Club Europa.” The northern part is a cliff shore, which has a danger of cliff sliding from top by water saturation. Like the shore sector south of Cape Singol, this shore sector needs further protection against cliff collapse because of a high density of housing near the edge of the cliff. The southern part is a wide beach frequented by many summer visitors.

Important events for the sub-sectors of Eforie Nord to Eforie Sud are the construction of the south harbor of Constanța Port in the 1970s with extension of the south breakwater from 1978 and that of the Yacht Club Europa since 1986. The construction of the south harbor was made in pace with digging of the southern branch of the Danube and Black Sea Canal passing through Lake Agigea, the area of which has shrunk greatly. The new south breakwater of

Constanța Port has reduced the intensity of wave actions on the northern part of the sub-sector of Eforie-Nord through the wave diffraction process.

The marina "Yacht Club Europa" was constructed in a shape of a deformed pentagon with the apex oriented toward the shore. Sand was deposited behind it, and the beach width increased greatly there. Most of the accumulated sand must have come from the southern beach in the sub-sector of Eforie Middle, accelerating beach erosion there. There is also possibility that sand may have come from narrow beaches in the north of the marina, thus accelerating beach erosion between Agigea and the marina in spite of the reduction of wave actions by the south breakwater of Constanța Port.

The sub-sector of Eforie Middle is a barrier beach that closed off Lake Techirghiol from the Black Sea in the time unknown. Around its boundary to the sub-sector of Eforie Sud, a rapid retreat of shoreline exceeding 2 m per year is recorded (see **4.2.4**).

The sub-sector of Eforie Sud is another cliff shore. The cliff is relatively low, but it has experienced a number of the events of land sliding from the cliff top, owing to water saturation in upper soil. The foot of cliff is well protected by beaches and seawalls and the danger of scouring by waves is small.

3.6.4 Sub-Sectors of Tuzla North and Tuzla South

This shore sector is a cliff shore extending over some 8.5 km. The cliff is 15 to 30 m high and has a very narrow beach at its foot. Geologically, the cliff is composed of vegetable soil, loess layers, clay layers, and limestone layers from the top as shown in Fig. 3.1.2. When the water table in the loess layers rises by some reason, the portion of the cliff above the clay layers began to slip down due to geotechnical instability. A large irrigation project initiated in the 1970s caused the rise of the ground water in this area, and land slides extending over a few kilometers took place. Scarps of land slides are easily observed presently, and mild slopes of soil are formed beneath them. Trees, bushes, and a numbers of huts remain on the mild slopes.

In parallel to the land slides from the cliff crest, waves have been abrading the foot of cliff and caused the shoreline retreat. Cliff erosion by waves is attested by falling down of old German pillboxes, which were originally installed around 1940 on top of the cliff as watch stations against the allied forces but are now sitting in water near the shoreline.

Although protection of cliff coast against erosion is technically feasible such as by construction of seawalls along the shore, it would be difficult to justify such a project from the economical point of views because of the low asset level of the area behind the cliff. Exception is the area around Cape Tuzla, where the important lighthouse is located and a countermeasure against cliff erosion should be taken to protect the lighthouse from falling down.

3.6.5 Sub-Sector of Costinești

This shore sector is a 2.0-km long natural beach having a wide backshore. The beach is one of the favorite places of summer visitors, especially of young people. The beach of Costineşti shows slight erosion in the north and a slight accretion in the south, but it has been quite stable as a whole. The erosion in the north is reported as partly the result of illegal mining of sand to be used for the foundations of housing and other purposes.

There was torrential rain on September 22nd and 23rd, 2005 in the southern Dobrogea and the total rainfall exceeded 200 mm at some places. The rain caused severe flooding damage on the locality, which has not been accustomed to such disasters. The rainwater fallen in the plain behind Costineşti poured into a small beachside lake, overflowed and disrupted a low dike along the beach for a roadway, and washed away beach sand into the sea. It is expected however that the beach would recover its original foreshore by the natural process of waves and currents by next summer season.

3.6.6 Sub-Sector of Schitu

This shore sector is a 4.2-km long cliff shore with narrow beaches at it foot. The shoreline has been retreated over years by wave abrasion at the foot of cliff. Just like the sub-sectors of Tuzla North and Tuzla South, grain fields and/or barren grass fields extend on top of the cliff. From the monetary point of views, the shoreline retreat does not yield significant loss, though it represents a loss of the territorial land.

3.6.7 Sub-Sector of Olimp–Venus

This shore sector is mostly man-made beaches, except a stretch of natural barrier beach in front of Lake Tătlăgeac at the north of this sector. The shore sector as a whole has a convex shape protruding to the sea, and there would have been few natural beaches there. However, many jetties and breakwaters were built in the late 1970s and sand was artificially nourished to the shore. The source of beach fill sand is unknown as no record is available, but it could have been the nearby natural beaches of Balta Mangalia and/or Olimp.

Because the artificial beaches are heavily protected by jetties and breakwaters, not much erosion has been reported. The jetties are built at the alongshore interval of one hundred meters or so and thus the beaches are quite small. Closely-built T-shaped jetties have created the problem of water pollution with bad smell, especially because of poor treatment of waste water from groups of hotels built in the area. Owing to the low water quality, the beach areas do not attract people for ocean bathing and sunbathing. Remedy of water pollution is one of the important tasks to be taken for revitalization of this resort area.

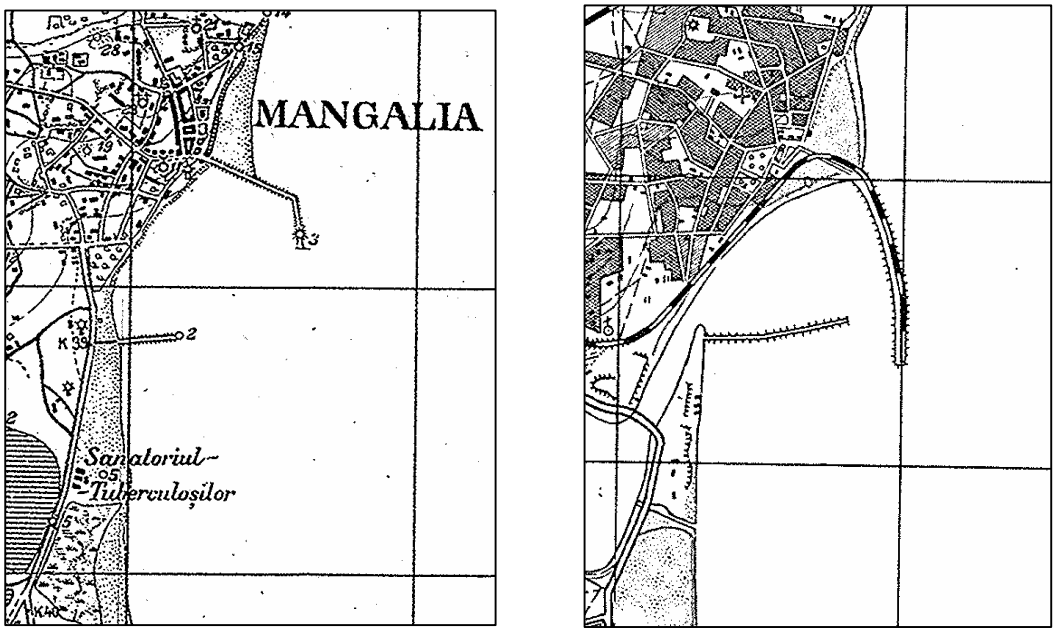
3.6.8 Sub-Sector of Balta Mangalia

The word “Balta” in Romania means a bog or marsh. Balta Mangalia is also called “Hagieni.” In front of this marsh there is a barrier beach of 800 m long. At the shore of this beach, several springs are present and one of them contains a small quantity of sulfur; people are using that water for their healthcare. The beach of this sub-sector is experiencing erosion with the rate of 1.4 m per year.

3.6.9 Sub-Sector of Saturn–Mangalia

This shore sector has five small beaches that are protected by eight jetties and one detached breakwater, but until the early 1980s it had only one beach at the north side of the north breakwater of Mangalia Port. The Port itself was a small harbor with two short breakwaters in front of a beach, and Lake Mangalia was separated from the Black Sea by a short barrier beach. In 1960 the port expansion began by cutting ship channels to the lake, extending the north breakwater, and creating a turning basin by dredging.

In the nautical charts of the late nineteenth century, however, the barrier beach of Lake Mangalia was not completed yet, and there was a small opening to the Black Sea. Thus, the closure of Lake Mangalia from the Black Sea took place in the early twentieth century and then it was reopened artificially in 1960.



(a) Lake Mangalia in 1924 (b) Cut of channel in 1960

Fig. 3.6.1: Historical development of Mangalia Port (source: GeoEcoMar 2005)

There are four small pocket beaches between jetties at Saturn and one relatively wide beach at the north side of Mangalia Port. However, the central part of this sector has no beach and the seawall is exposed to direct wave actions. The beach shoreline at the north side of Mangalia Port is retreating at the rate of 0.7 m/year, indicating inadequacy of the present shore protection facilities (see **4.2.5**).

3.6.10 Sub-Sectors of 2 Mai to Vama Veche

This area covers the length of about 5.9 km, including three sub-sectors of 2 May, Limanu, and Vama Veche. The sub-sector of Limanu is a cliff shore, but the northern part of 2 Mai and the central part of Vama Veche are sandy beaches. The sub-sectors of 2 Mai and Vama Veche also include the portions of cliff shore.

The limestone outcrop at the cliff shoreline in the north of Vama Veche beach was being covered by thick layers of half-decayed seaweed when visited in May.