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No. 5

JAPAN INTERNATIONAL COOPERATION AGENCY

THE ECONOMIC SOCIALIST REPUBLIC OF MACEDONIA
MINISTRY OF DEVELOPMENT

THE STUDY
ON
INTEGRATED WATER RESOURCES DEVELOPMENT AND MANAGEMENT MASTER PLAN
IN
THE FORMER YUGOSLAV REPUBLIC OF MACEDONIA

FINAL REPORT

VOLUME II
MAIN REPORT

MAY 1999

NIPPON KOEI CO., LTD.
KRI INTERNATIONAL CORPORATION

JAPAN INTERNATIONAL COOPERATION AGENCY

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COMPOSITION OF FINAL REPORT

EXCHANGE RATES

The exchange rates used in this Study are:
US Dollar (US$)1.00 = Macedonian Denar (MKD) 52.00
Deutsche Mark (DM) 1.00 = Macedonian Denar (MKD) 30.98
as of Jan.1999

PREFACE

In response to the request from the Government of the Former Yugoslav Republic of Macedonia, the Government of Japan decided to conduct the Study on the Integrated Water Resources Development and Management Master Plan in the former Yugoslav Republic of Macedonia and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Kazuharu Hashimoto of Nippon Koei Co., Ltd., and composed of staff members of Nippon Koei Co., Ltd. and KRI International Corporation to Macedonia, four times between December 1997 and May 1999. In addition, JICA set up an advisory committee headed by Mr. Yoshiyuki Kawakami, Senior officer, Reservoir Area Development Measures Section, Development Division, River Bureau, Ministry of Construction between December 1997 and March 1999, which examined the study from specialist and technical points of view.

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

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

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

May, 1999

Kimio Fujita
President
Japan International
Cooperation Agency

May 1999

Mr. Kimio Fujita
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Sir,

Letter of Transmittal

We are pleased to submit to you the Final Report on Integrated Water Resources Development and Management Master Plan in the Former Yugoslav Republic of Macedonia (FYROM). This Report presents the results of all the works performed in both Macedonia and Japan during a total period of 18 months from December 1997 to May 1999.

The Master Plan, formulated on the purpose of giving the comprehensive scope of effective and sustainable development in FYROM setting the target year 2025 consists of the two components. The water resources development plan proposes the development strategy and projects as well as rehabilitation projects. The water resources management plan proposes reinforcement and establishment of an efficient and effective management system for not only the development projects but also commissioned projects to bring out the best of the projects effects.

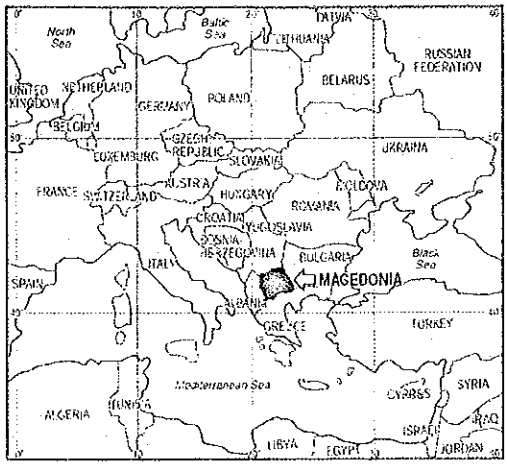
We are confident that the Master Plan will contribute to the integrated approach with environmental aspects required for dealing with water-related problems now being faced and for the optimum utilization of the limited water resources in Macedonia. Hence, we recommend to promote the Master Plan as early as possible.

We wish to take this opportunity to express sincere gratitude to your Agency and the Advisory Committee for the Study. We also wish to express our deep gratitude to the Government of Macedonia, the Embassy of Japan in Vienna, the JICA Austria Office for close cooperation and assistance extended to our Team during field investigations and studies in Macedonia.

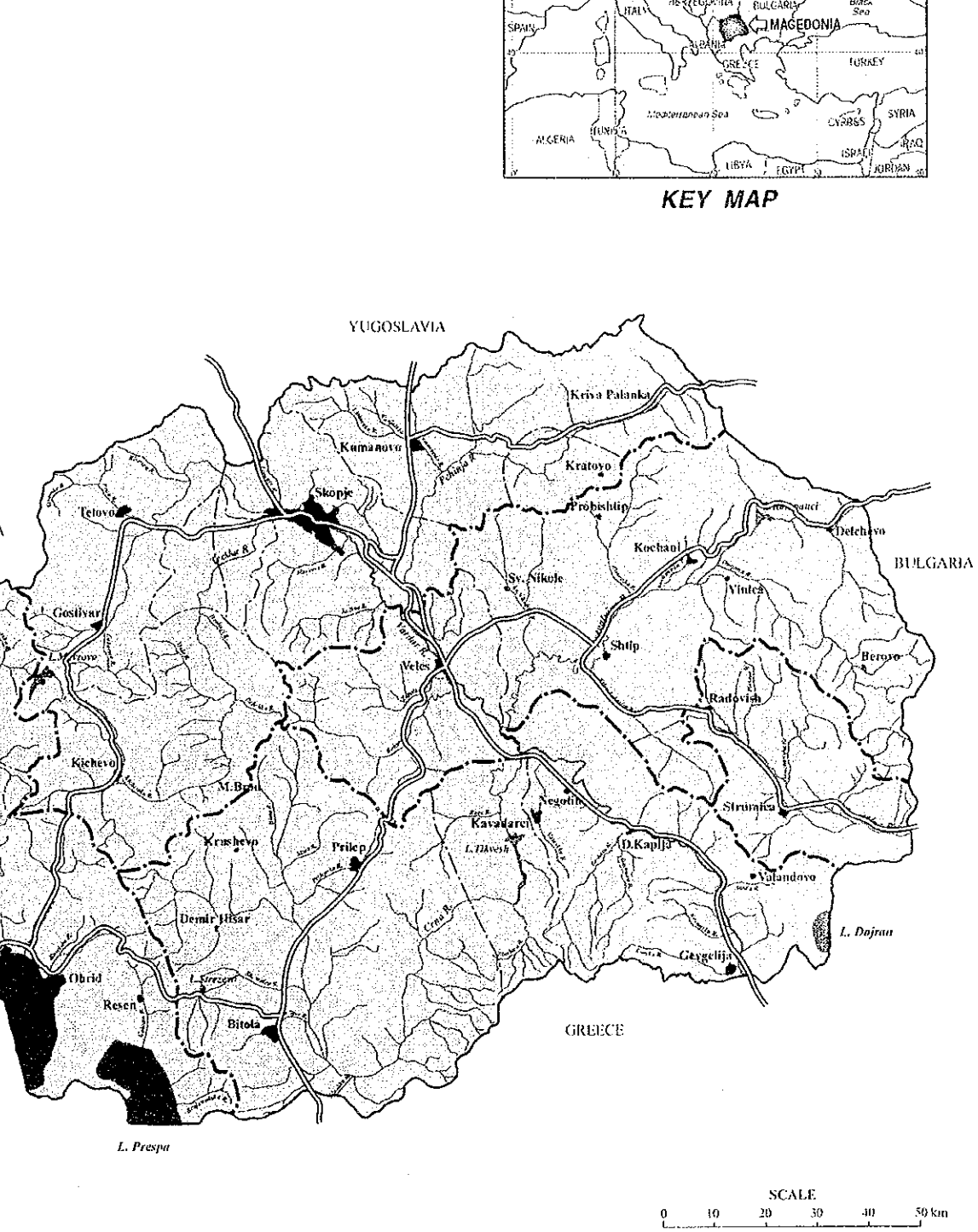
Very truly yours,

K. Hashimoto

Kazuharu HASHIMOTO
Team Leader
Study on Integrated Water
Resources Development and
Management M/P in FYROM



KEY MAP



Location Map

THE STUDY
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FINAL REPORT

ABBREVIATIONS AND ACRONYMS

ACU	-	Aid Coordination Unit
a.s.l	-	above sea level
BOD	-	Biological Oxygen Demand
CE(s)	-	Communal Enterprise(s)
DO	-	Dissolved Oxygen
EBRD	-	European Bank for Reconstruction and Development
ECM	-	Electric Power Company of Macedonia
EC	-	European Community
EL	-	Elevation
EU	-	European Union
FRY	-	Federal Republic of Yugoslavia
FYROM	-	The Former Yugoslav Republic of Macedonia
GDP	-	Gross Domestic Product
GEF	-	Global Environment Facility
GNP	-	Gross National Product
GOJ	-	Government of Japan
GOM	-	Government of Macedonia
GTZ	-	Deutsche Gesellschaft für Technische Zusammenarbeit
HMI	-	Republic Hydrometeorological Institute
I/R	-	Interim Report
IEE	-	Initial Environmental Examination
IBRD	-	International Bank for Reconstruction and Development
IDA	-	International Development Association
IMR	-	Infant Mortality Rate
JICA	-	Japan International Cooperation Agency
JUS	-	Jugoslavian Standards
MAFWE	-	Ministry of Agriculture, Forestry and Water Economy
MCIC	-	Macedonian Center for International Cooperation
MKS	-	Macedonian Standards
MOD	-	Ministry of Development
MOE	-	Ministry of Economy
MOH	-	Ministry of Health
MUPC	-	Ministry of Urban Planning and Construction
MOEn	-	Ministry of Environment
MOS	-	Ministry of Science
MOFA	-	Ministry of Foreign Affaires
NDS	-	National Development Strategy 1997
NEAP	-	National Environmental Action Plan 1997
NEHAP	-	National Environmental Health Action Plan
NGO(s)	-	Non Governmental Organization(s)

ABBREVIATIONS AND ACRONYMS (Continued)

ODA	-	Official Development Assistance
O&M	-	Operation and Maintenance
PCM	-	Project Cycle Management
PDM	-	Project Design Matrix
PHARE	-	Pologne et Hongri Aide a Reconstruction Economique (Poland and Hungary Aid for Economic Reconstruction)
PIP	-	Program for Public Sector Investment in the Republic of Macedonia 1998-2000
P/R	-	Progress Report
PWME	-	Public Water Management Enterprise
RIHP	-	Republic Institute for Health Protection
S/W	-	Scope of Work
SS	-	Suspended Substances
SFRY	-	Socialist Federal Republic Yugoslavia
UNDP	-	United Nations Development Program
UNESCO	-	United Nations Educational, Scientific and Cultural Organization
UNICEF	-	United Nations Children's Fund
WHO	-	World Health Organization
WDI	-	Water Development Institute
WMO(s)	-	Water Management Organization(s)
WUA(s)	-	Water Users' Association(s)

WEIGHTS AND MEASURES

Metric System

mm	-	Millimeter(s)	ha	-	Hectare (100m x 100m)
m	-	Meter(s)	l	-	Liter(s)
m^2	-	Square meter(s)	lit/sec (l/sec)	-	Liter per second
km^2	-	Square kilometer(s)	m^3	-	Cubic meter(s)
lpcd	-	litre/capita/day	m^3/sec (m^3/s)	-	Cubic meter(s) per second
			p.e.	-	population equivalent

CURRENCY

MKD	-	Macedonian Denar	DM	-	Deutsche Mark
USD	-	United States Dollar	JPY	-	Japanese Yen

CHAPTER 1

SCOPE OF THE STUDY

CHAPTER 1 SCOPE OF THE STUDY

1.1 Background of the Study

The Former Yugoslav Republic of Macedonia (FYROM), which is located in the central part of Balkan Peninsular, has limited rainfall that ranges from 400 to 1,000mm per annum with a rather high difference among each region. The western part of the country, Macedonia, has relatively more rainfall of approximately 1,000mm than the other regions. However, the regions located from the central to the southeastern part of the country have been suffering from seasonal water shortage due to limited rainfall of 400 to 700mm in the dry season in summer. People experienced droughts almost every year during the period from the end of 1980s to 1994 (since then, 1995 was a wet year and 1996 was a dry year).

In urban areas, where people have faced seasonal water shortage, the shortage of drinking water is especially serious in summer, and it can not be overcome with the actual water sources including groundwater, springs, etc. Rural areas face problems of poor hygiene as well as seasonal drought. This is because the water sources have been polluted by untreated municipal wastewater and no guideline for safety standard has been prepared, and so on, which leads to high occurrence of waterborne diseases among infants and schoolchildren in the communities.

In addition, the population living in the mountain and boundary areas have suffered from poor accessibility to safe drinking water. This has inhibited the people from improving their living conditions and promoting economic activities including agricultural production. These conditions have contributed to increased overpopulation in metropolitan areas and depopulation of rural areas.

Furthermore, the three major rivers of the Vardar, Crn Drim and Strumica Rivers in the country are international rivers, which flow down to neighboring countries. Harmony with environment is essential in implementing development projects in Macedonia, and it is also important to take countermeasures for reduction of pollutant load which will be increased with development projects and be influenced to three countries located downstream of Macedonia. Consequently, establishment of water resources management system considering harmony with environment is urgently required for keeping good diplomatic relations with the neighboring countries.

These issues relating to water resources development and management have not been solved fundamentally, because they have not been dealt with by a middle/long term master plan, but just temporary measures and/or a master plan which does not cover the whole area of Macedonia. Under these circumstances, formulation of a long-term master plan on nationwide integrated water resources

development and management of FYROM is urgently required and the Government of Macedonia (GOM) requested to the Government of Japan (GOJ) in October 1996 to extend technical cooperation programs for carrying out the Study on Integrated Water Resources Development and Management Master Plan (the Study).

In response to the official request from GOM, GOJ decided to conduct the Study. Accordingly, the Japan International Cooperation Agency (JICA), the official agency responsible for implementation of technical cooperation program of GOJ, commenced the Study with dispatch of the Study Team to Macedonia on December 14, 1997.

The field works in Macedonia by the Team were carried out four times, the first for three months from December 14, 1997 through March 13, 1998, the second for two months from May 21 through July 25, 1998, the third for three and half months from September 10 through December 23, 1998 and the fourth for a half month from March 10 through March 24, 1999 in good cooperation and understanding with the Macedonian side.

1.2 Objective of the Study

1) to formulate an integrated water resources development and management master plan for the target year 2025 in the whole area of the country

2) to transfer technology to the Macedonian counterpart personnel in the course of the Study

1.3 Study Area

The Study area covers the whole area of the country as shown in the Location Map. The total area of FYROM is 25,713km^2. The major rivers draining the Study area are the following three in order of watershed area (WA):

1) the Vardar River flowing down to the southeast and to Greece (WA=20,546km^2),

2) the Crn Drim River flowing out from Lake Ohrid, down to the northwest and to Albania (WA=3,355km^2), and

3) the Strumica River flowing down to the east and to Bulgaria (WA=1,520km^2)

1.4 Scope of the Study

Phase I : [Survey/investigation, water demand forecast, and analysis of water resources development potential]

The present status of water resources development and management in FYROM was studied through analyses of collected data/documents and field investigations.

Phase II : [Formulation of Master Plan on Integrated Water Resources Development and Management]

An integrated water resources development and management master plan was formulated, which includes a supplemental environmental survey for Initial Environmental Examination (IEE) and evaluation of priority projects and preparation of a preliminary implementation program and study of fund raising for the project. The overall work schedule of the Study is shown in Figure 1.1.

1.5 Implementation Organization

The Ministry of Development (MOD) acts as the counterpart body to the Study Team. The Steering Committee of the Macedonian side was organized in December 1997, consisting of representatives from MOD, Ministry of Foreign Affairs (MFA), Ministry of Agriculture, Forest and Water Economy (MAFWE), Ministry of Urban Planning, Construction and Environment (the former MUPCE, divided into Ministry of Urban Planning and Construction-MUPC and Ministry of Environment-MOEn in December 1998), Ministry of Economy (MOE), and other related organizations. A total 11 members of counterpart personnel was formed to support data collection, field reconnaissance and interviews throughout the Study. The list of counterpart personnel and Steering Committee members are presented in Table 1.1

The JICA Study Team is headed by a Team Leader who is responsible for maintaining close liaison with MOD, JICA, and other agencies concerned. He is also responsible for planning activities and monitoring progress of the entire Study for ensuring its timely and efficient completion. Members of the Study Team and Advisory Committee of the Japanese side participated in the Study are tabulated in Table 1.2. The organization established for conducting the Study is shown in Figure 1.2.

1.6 Study Schedule and Activities

Phase I of the Study was conducted from December 1997 to September 1998. Following submission of the Interim Report, Phase II was conducted from September 1998 to May 1999.

The following field surveys were carried out on a subcontract basis:

1) Water utilization survey (February to March 1998)

2) Water quality survey (February to March 1998)

3) Environmental survey (1) (February to March 1998)

4) Groundwater quality survey (2) (June to July 1998 during the normal water season)

5) Environmental survey (2) (June to July 1998)

6) Groundwater quality survey (3) (September to November 1998 during the low water season)

7) Topographic survey (October to November 1998)

8) Supplemental Environmental Survey for IEE (October to November 1998)

Transfer of technology activities consist of the on-the-job-training and seminars to the counterpart personnel.

The first seminar was conducted on September 21, 1998 during the third fieldwork in Macedonia for the following subjects:

1) Explanation of the progress and general findings of the Study

2) Planning method of the water resources development and management

3) Planning through the PCM method and outputs of workshops in Macedonia

4) Analysis method and findings of the groundwater study

In parallel with a series of discussion on the Draft Final Report during the fourth fieldwork in Macedonia, the second seminar was conducted on March 17, 1999 for the following subjects:

1) Key issues on the Integrated Water Resources Development and Management Master Plan (the present Study)

2) Current condition on water utilization in Japan and comprehensive water resources management in the Tone River basin

3) Water resources development considering symbiotic relationship with natural environment and current activities of flood control in Japan

Table 1.1 List of Steering Committee and Counterpart Personnel

Name	Position	Ministry	Field of Expertise
(1) Steering Committee			
1. Tahir Shakiri	Undersecretary	Ministry of Development	Chairman
2. Ana Trajkovska	Director for Asia, Australia and New Zealand	Ministry of Foreign Affairs	Member
3. Vanja Mihailova	Assistant Minister	Ministry of Finance	Member
4. Ilija Petrushevski	Undersecretary	Ministry of Health	Member
5. Ilija Levkov	Advisor to the Director	Ministry of Agriculture, Forestry and Water Economy	Member
6. Zvezdana Georgievska	Advisor to Director of the Institute for International Technical and Scientific Cooperation	Ministry of Science	Member
7. Magdalena Manusheva	Advisor to Minister	Ministry of Economy	Member
8. Strahinja Trpevski	Undesecretary	Ministry of Urban Planning and Construction (Former MUPCE)	Member
9. Eftim Micevski	Hydrogeologist	Geohydroproject	Member
10. Slavko Kirovski	Chief of Ecology Division	Republic Hydrometeorological Institute	Member
(2) Counterpart Peresonnel			
1. Tahir Shakiri	Undersecretary	Ministry of Development	Team Leader
2. Hakif Ismaili	Senior Advisor	Ministry of Development	Development Planning
3. Nikola Cherepnalkovski	Assistant Minister	Ministry of Economy	Energy and Industry
4. Kostadin Jovanov	Hydrogeologist	Geohydroproject	Groundwater Development Planning
5. Josif Milevski	Hydrogeologist	Republic Hydrometeorological Institute	Hydrology
6. Done Vlashki	Undersecretary	Ministry of Development	Regional Development Plannin
7. Bozidar Stojchev	Senior Advisor	Ministry of Urban Planning and Construction (Former MUPCE)	Water Demend Projection (Domestic and Industry)
8. Zoran Karamanolev	Engineer	Republic Hydrometeorological Institute	Water Quality
9. Zoran Jordanovski	Senior Advisor	Secretariat of Legislation	Legislation
10. Vencislav Arsov	Assistant Minister	Ministry of Development	Project Evaluation
11. Ilija Levkov	Civil Engineer	Ministry of Agriculture, Forestry and Water Economy	Water Demand Projection

Table 1.2 Member of the Study Team and Advisory Committee

Name	Work Assignment
(1) Study Team	
1. Kazuharu HASHIMOTO	Team Leader / Water Resources Development Planner
2. Yoshihiro MOTOKI	River Engineer / Watershed Management Planner
3. Yasuo IWASAKI	Dam Planner
4. Masao HIGUCHI	Groundwater Development Planner / Hydrogeologist
5. Hassan Hany IBRAHIM	Hydrologist
6. Atsushi CHITOSE	Regional Development Planner
7. Simon L.S. BAILEY	Water Demand Projection Expert (Domestic and Industrial Water)
8. Kuninobu NODA	Water Demand Projection Expert (Agricultural Water)
9. Mujahid IQBAL	Environmental Analyst / Water Quality Expert
10. Tetsuya ISHII	Legal and Institutional Expert
11. Yoko ISHIDA	Socio-economist / Project Evaluator
12.Shuhei NISHIOKA	Geologist
13. Tomoyasu KITA	Coordinator
(2) Advisory Committee	
1. Yoshiyuki KAWAKAMI	Chairman
2. Hiroshi YAMAUCHI	Member
(3) Others	
1. Aleksandar Radevski	Person in charge and coordinator of MOD in the application in 1996, and an advisor to the Study Team after retirement

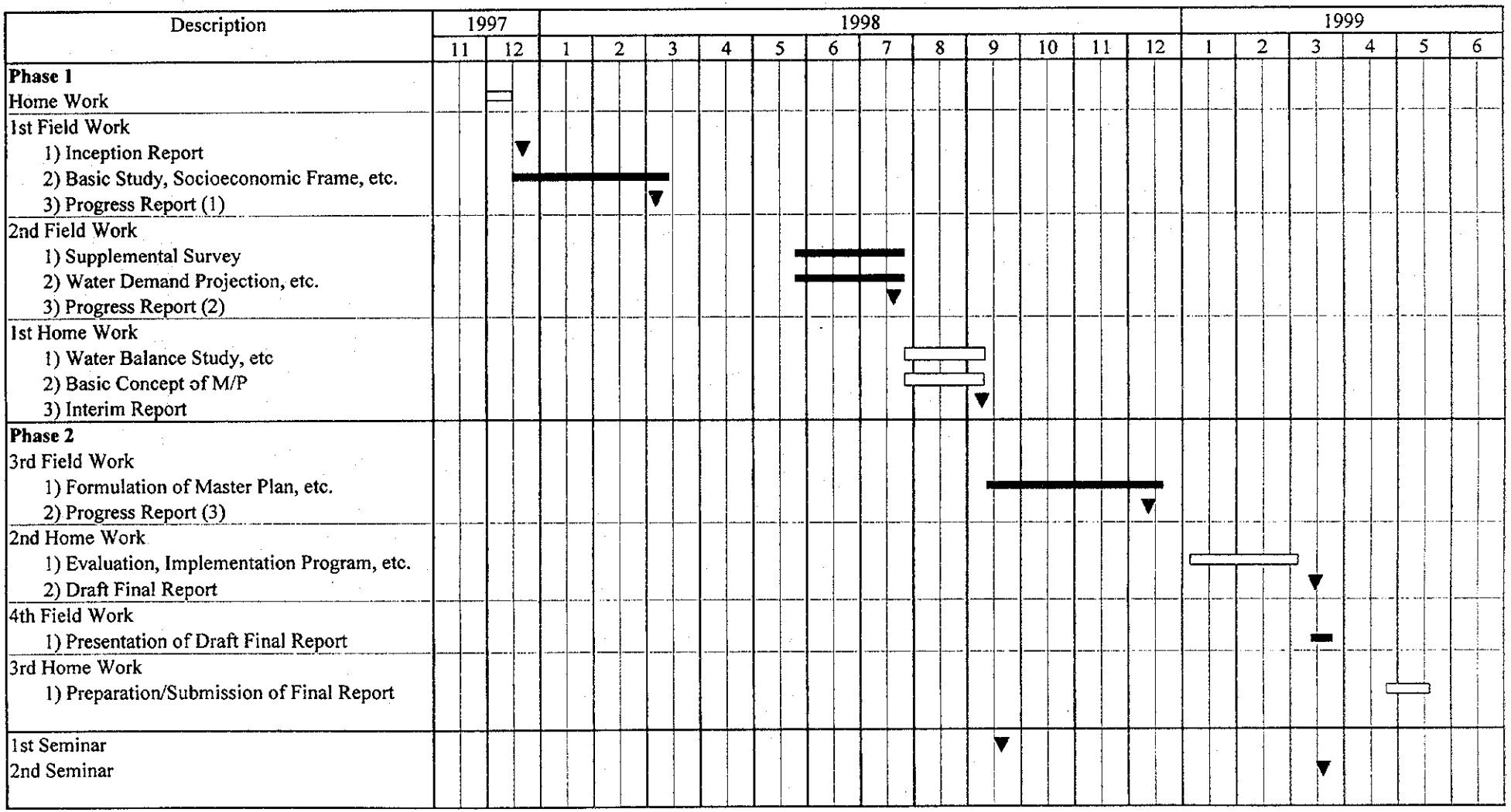
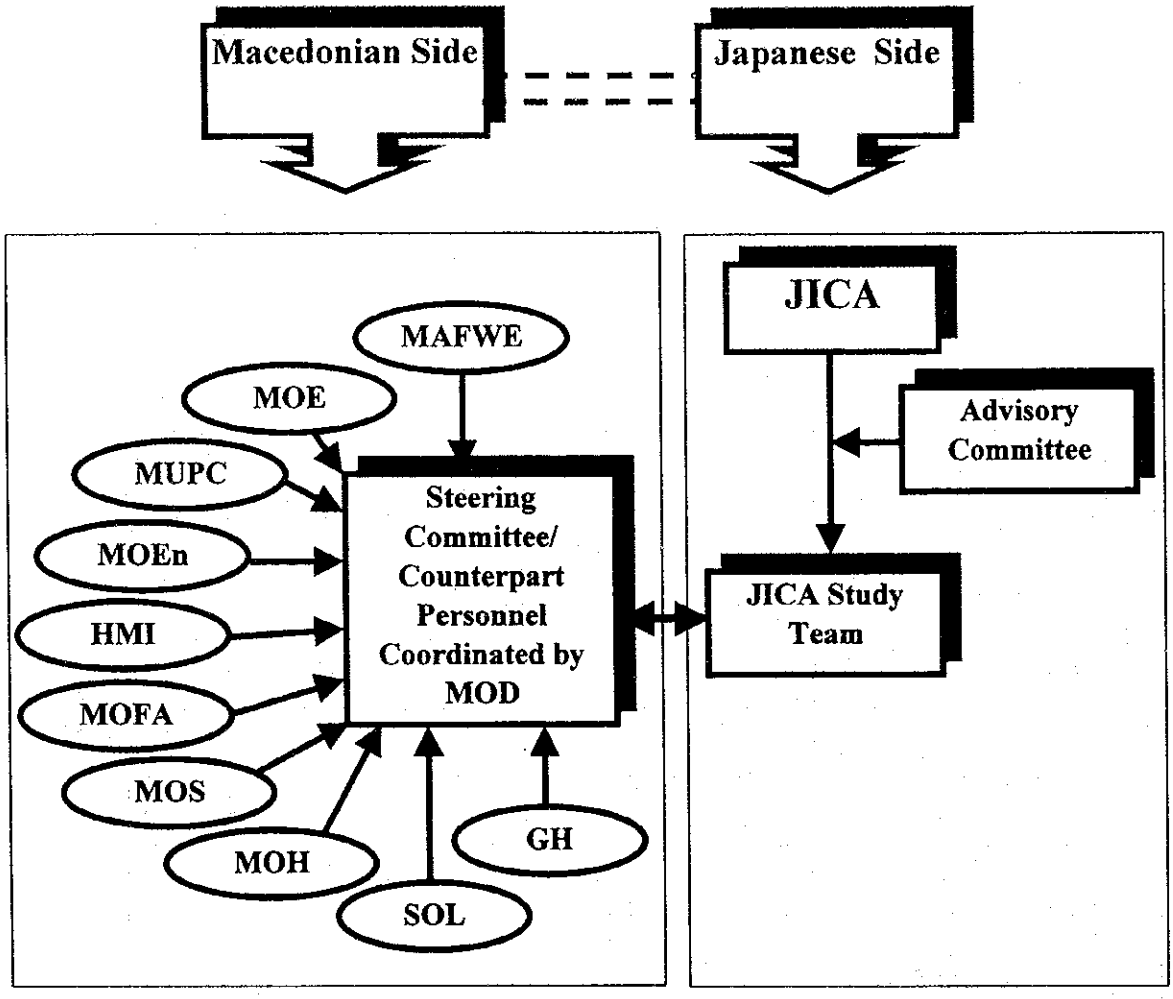


Figure 1.1 Overall Work Schedule



MOD	Ministry of Development
MAFWE	Ministry of Agriculture, Forestry and Water Economy
MOE	Ministry of Economy
MUPC	Ministry of Urban Planning and Construction
MOEn	Ministry of Environment
MOFA	Ministry of Foreign Affairs
MOS	Ministry of Science
MOH	Ministry of Health
HMI	Republic Hydrometeorological Institute
SOL	Secretariat of Legislation
GH	Geohydroproject - Skopje
JICA	Japan International Cooperation Agency

Figure 1.2 Organization Chart for the Study

CHAPTER 2

PRESENT CONDITIONS OF THE STUDY AREA

CHAPTER 2 PRESENT CONDITIONS OF THE STUDY AREA

2.1 Natural Conditions

The Former Yugoslav Republic of Macedonia (FYROM) is a land-locked country surrounded by four countries, i.e. Bulgaria on the east, Federal Republic of Yugoslavia (FRY) on the north, Albania on the west and Greece on the south, located in the central part of Balkan Peninsular. The country lies between longitudes 20°21'31'' and 23°02'12'' east, and latitudes 40°51'16'' and 42°22'21'' north, extending to east-west direction of 210 km and to south-north of 160 km with a border line of 850 km in total and an area of 25,713 km^2.

2.2 Socioeconomic Conditions

Socioeconomic conditions in Macedonia mainly related to the sector of water resources development and management are summarized below. The national and municipal demographic data and socioeconomic data are shown in Tables 2.1 (1/3) to (3/3) and 2.2.

2.2.1 General Information

The table below outlines the socioeconomic situations in Macedonia. The detailed explanation provided in the following Sub-sections.

Summary of Socioeconomic Data of Macedonia

1	Population	1,945,932	(1994 Census)
2	Population Density (person/km^2)	76	(1994 Census)
3	Annual Growth Rate of Population	0.77%	(1994-1997)
4	% of Urban Population	59.4%	(1994 Census)
5	Main Towns	(Population in '000) Skopje Bitola Kumanovo Prilep Tetovo Veles	(1994 Census) 444.2 77.5 71.9 68.1 50.3 46.8
6	Languages	Macedonian	
7	Currency	Temporary government coupons were replaced by the denar on May 10th 1993. The National Bank of Macedonia fixes daily the exchange rate of the denar against the major currencies Average exchange rates in 1996: MKD40 : US$1 Exchange rates as of January 15th 1999: MKD52.00 : US$1.00	
8	Fiscal Year	Calendar year	
9	Ethnic Composition ('000)	Macedonians Albanians Turks Romanies (Gypsies) Serbs	1,296 (1994 Census) 441 78 43 40
10	Infant Mortality Rate	16 deaths/1,000 live births	
11	Number of Doctors	3.2 per 1,000 of population	(1994)

12	Elementary School Enrollment Rate	over 95%
13	Adult Literacy Rate	94%
14	Per Capita Nominal GDP	US$1,580 (82,850MKD) (1997)
15	Real GDP Growth	0.8% in 1995 1.5% in 1996

2.2.2 Population

Macedonia had an official total population of 1,945,932 according to the latest Census in 1994. The average annual growth rate of the population from 1994 to 1997 was 0.77%. Based on the 1994 Census data, the population density is 76 inhabitants per square kilometer (km^2); the average family size is 3.9 members/household. The former municipality of Skopje has the greatest population with 545,228 persons or 28.0% of the total population and a density of 293 inhabitants/km^2. Out of the total population in 1994, 1,161,226 persons (59.7%) live in urban areas and 784,706 persons (40.3%) in rural areas.

2.2.3 New Administration System of Local Self-government

Since January 1997, a new division of the administrative district has been introduced. In the new system, there are 123 municipalities, while the former system divided the country into 30 municipalities. The main purposes of this change was to clarify economically underdeveloped areas through reducing the municipality sizes and then to promote the improvement of those areas more effectively and efficiently.

2.2.4 Macroeconomic Conditions

Macedonia is currently in the process of transition from a centralized economy to a market economy. The country's economy is characterized by relatively higher social stock and lower flow income. Higher social stock is reflected in moderately provided basic infrastructures such as road networks and water and electricity supply systems as well as the higher level of human resources (indicated by higher literacy rates and school enrolment rates). Lower income is illustrated by lower per capita GDP (estimated at about US$1,580[*1])

Per capita nominal GDP in 1996 was estimated to be MKD82,850 or US$1,580. After independence in 1991, the nation's output fell substantially. The real GDP in 1995 was equal to three-quarters of the 1990 level. In 1996, GDP

[*1] In Macedonia, aggregate output was measured by gross social product (GSP) during the Former Yugoslavia era. The GDP measurement was introduced after the independence. Currently, there are three methodologies for measuring GDP: 1) PARE (price adjusted rate of exchange), 2) MER (market exchange rate, and, 3) WA (World Bank atlas conversion rate). Also, purchasing power parity (PPP) has been employed in some cases. The number of US$ 1,580 for GDP per capita during the period 1995-1996 was calculated using PARE method with 1994 as a base year.

actually grew positively after the successive negative growth during the first half of 1990s; however, its level remained much lower than the pre-independence level.

The composition of GDP across sectors has greatly changed since independence. In 1990, industry and mining contributed to 32% of GDP; however, its share fell to 23% in 1996. On the other hand, during the same period, agriculture and fisheries raised their share in GDP from 6.7% to 9.2%. The sector that achieved the most significant growth is financial, technical, business and insurance services.

The changes in the share of GDP across sectors indicate the changes in the nation's economic structure. Industry and mining output fell drastically; the output level in 1996 was 55% of that in 1990. This stems from an inefficient use of resources, characterized by low capacity utilization or under-utilization of capital in enterprises. The loss of access to international markets for both input materials and final goods also was responsible for a substantial decline in industrial production. This market constraint was brought about by the blockade of the northern and southern borders. Agricultural production increased its GDP share; however, its production level actually remained almost unchanged. This indicates that the role of agriculture in the nation's economy has become important because its production structure was more stable against the external shocks than industry and mining and other activities .

The external sector plays an important role in the Macedonian economy. Total volume of trade (the sum of exports and imports) accounted for over 70% of GDP in 1996. Current account deficit was US$288 million, with trade deficit equivalent to US$317 million. This large trade deficit was offset by current transfers (US$213 million in net) such as official transfers (including foreign assistance) and private transactions (i.e., remittance, cash deposits and purchased foreign currencies).

2.2.5 Regional Economy

Income disparity is distinct across former municipalities. According to per capita national income (GSP minus depreciation of assets) in 1995, Skopje showed the highest level at as much as MKD100,000, while M. Brod and Debar recorded less than MKD20,000. The average per capita net income was MKD57,000, and its mode was only MKD38,000 among 30 former municipalities. This indicates that Skopje is dominant in the nation's economy and that over half of municipalities had only 40% of income level of Skopje. Municipalities with lower per capita income are located in the western part of the country (Debar, Gostivar, Struga, Krushevo and Demir Hisar) and in the eastern part (Probishtip).

The Agency for Economically Underdeveloped Areas under MOD is responsible for implementing regional development program by which to improve rural living conditions. An ultimate objective of this program is realization of well distributed population across regions for an efficient utilization of the nation's resources as well as the reinforcement of national defense. Its short-run goal is viewed as avoidance of population concentration in Skopje. The main component of the regional development program is provision of social infrastructure for economically underdeveloped areas, which are identified by MOD based on several criteria, where the social and economic infrastructure has not been well developed, migration to the other areas has increased, etc. Most of these areas are located in 1) mountain areas, 2) boundary areas, and/or 3) anywhere underdeveloped areas.

2.2.6 Health and Sanitary Conditions

The infant mortality rate (IMR) is a priority health problem in spite of its reduction in recent years. In 1994, 16.4 infants died for every 1,000 born alive. This is mainly caused by limited access to safe water supply, lack of maternal and child health care services, and poor access to health facilities in small villages scattered in highland and mountainous areas. Among the municipalities (the former division), Krushevo (39.8 deaths per 1,000 born alive), Sveti Nikole (31.7 -do-), Debar (30.2 -do-), Veles (31.7 -do-), and Makedonski Brod (31.7 -do-) have the higher IMRs.

Diseases caused by polluted water have become a serious problem in some industrial and mining areas.

2.3 Topography and River System

2.3.1 Topography

The country ranges from an elevation 50m above sea level around Gevgelija in the alluvial lowland of the Vardar River near the border with Greece to the high mountainous area extending west to the border with Albania and the northwest border with FRY where the peaks range from an elevation of 2,200 to 2,700m. The country consists of 19.1% plain area and 80.9% mountainous/hilly area.

There are three major watersheds in the country: the Vardar River, the Crn Drim River and the Strumica River.

There are three major lakes remarkable in the country, Lake Prespa and Lake Ohrid located in the southwest part of the country and Lake Dojran located in the southeast. Geotectonic movements formed them more than 2 to 3 million years ago; Lake Ohrid is designated by UNESCO as a cultural heritage for its crystal water as well as scenic beauty. The water surface of Lake Prespa is at an

elevation of 853m and has a maximum depth of 54m. The surface area is 274km^2, of which 174km^2 belong to FYROM, while the remaining 100km^2 belong to Albania and Greece. The water surface of Lake Ohrid is at an elevation of 693m with a maximum depth of 286m. Two third of the surface area belongs to FYROM and the remaining belongs to Albania. Lake Dojran is crossed by the borderline with Greece. The elevation of the water surface of the lake is 148m with a maximum depth of about 10m. The lake water level has been dropping in recent years.

2.3.2 River System

(1) Division of River Basin

Almost 98 % (25,421 km^2) of the area of FYROM is divided into three main river basins of the Vardar, Crn Drim, and Strumica and four major tributaries joining to the Vardar River of the Treska, Pchinja, Bregalnica, and Crna. The remaining area (292 km^2) is divided into three small regions that include Lake Dojran, the Cironska & Lebnica River (flowing to Bulgaria), and the Juzna Morava River (flowing to FRY). A location map of the river basins is shown in Figure 2.1.

The surface areas of these regions in Macedonia are shown below:

Surface Areas of Major River Basins in Macedonia

River/Lake	Catchment Area (km^2)	% of Total Area
1. Vardar River		
Main Stream	6,813	26.5
Treska River	2,068	8.0
Pchinja River	2,373	9.2
Bregalnica River	4,307	16.8
Crna River	4,985	19.4
Subtotal	20,546	79.9
2. Crn Drim River	3,355	13.0
3. Strumica River	1,520	5.9
Subtotal (1 to 3)	25,421	98.8
4. Minor River Basin		
Lake Dojran	120	0.5
Cironska & Lebnica River	128	0.5
Juzna Morava River	44	0.2
Subtotal (4)	292	1.2
Total (1 to 4)	25,713	100.0

(2) Division of Potential Areas of Surface Water

Because the geographical location of the river basins dose not exactly coincide with the national boundaries, the amount of available water in the tributaries located in the neighboring countries can be included in the available water. With the extension of the Vardar River basin and its tributaries in the neighboring countries, three extra sub-basin areas are included from the territory

of FRY (Kosovo – the Lepenec River on the Vardar and Prohor Pchinski – the Pchinja River) and Greece (Lerin – the Eleshka River). The following table shows the surface areas of the river basins that represent the potential of surface water in Macedonia:

Potential Areas of Surface Water to Be Considered in the Study

River	Catchment Area (km^2)	Proportion of area in the national territory (%)
1. Vardar River		
Main Stream	6,813	
Lepenec River	**690**	**2.7**
Treska River	2,068	
Pchinja River	2,373	
Pchinja River (Prohor Pchinski)	**471**	**1.8**
Bregalnica River	4,307	
Crna River	4,985	
Eleshka	**905**	**3.5**
Subtotal	22,612	
2. Crn Drim River	3,355	-
3. Strumica River	1,520	-
Total (for extra sub-basin)	27,487	

On the other hand, 2 sub-basin areas of the Cironska & Lebnica River (flowing to Bulgaria) and Juzna Morava River (flowing to FRY) are excluded as their catchment areas belong to the territory of the neighboring countries. Also, the area of Lake Dojran is excluded due to its relatively small size. The basin area considered in the Study is shown in Figure 2.2.

2.4 Meteorology

2.4.1 Meteorological Observations

The Meteorological Department, Republic Hydrometeorological Institute (HMI) operates a total of 35 meteorological stations and 295 rainfall stations. The meteorological stations are divided into 14 main stations and 21 secondary stations. In general, main stations are equipped with automatic instruments, monitor more climate parameters, and have longer and denser data interval than secondary stations. Figure 2.3 indicates their location.

The rainfall stations network dates back to 1940 when the first station was established in Matka, the Treska river basin. Within the following 10 years, almost 90 % of the rainfall stations were installed. The stations are well distributed in the country with average of one station per 85 km^2.

2.4.2 Climate

Macedonia can be classified to three climatic zones, that is modified Mediterranean, mountainous, and mild continental zones. The modified

Mediterranean climate is represented in Gevgelija, Valandovo, Dojran, Strumica, and Radovish ravines. It can also include central region up to Skopje along riparian area of the Vardar River. The climate in this zone is characterized by mild and rainy winter followed by long and dry summer. The spring and the autumn are relatively short and insignificant. The annual rainfall in these regions is fairly low. The annual rainfall by the Vardar River is less than 500 mm, and it is one of the driest regions in the country. In the eastern part the average rainfall is about 600-750 mm. Snowfall is very rare in these areas.

The mountainous climate zone is located in the western part of the country. It is characterized by long and snowy winter followed by short and cool summer. The average rainfall is the highest in the country with as much rain and snowfall as 1,000 mm. The average snow period is from November to April.

The mild continental climate is most dominant in Macedonia, since it covers the most of the country. Its zone includes the northeastern, southwestern, and central western regions. It is characterized by relatively cold and humid winter followed by warm and dry summer. There are differences in the average temperatures in the regions of the mild continental climate. The average rainfall also differs ranging from 490 mm in the Ovcepole ravine to 760 mm in the Prespa ravine. Apart from rain and snow, there is also hail in these regions.

2.4.3 Rainfall

An isohyetal map was constructed as shown in Figure 2.4 using annual records in the 295 stations for 36 years from 1961 to 1996. Annual basin rainfall by Thiessen polygon network is tabulated in Table 2.3. Among the average annual basin rainfall, the Crn Drim River basin (B7) has the highest (797mm/year), while the Pchinja River basin (B3) has the lowest (519 mm/year).

Out of the 295 stations, 34 stations were selected to represent monthly rainfall variation for the main and secondary meteorological locations for 36 years from 1961 to 1996 and results are shown in Table 2.4. The minimum mean monthly rainfall of 21.1 mm was at Strumica River basin (RST044_Radovish) in August and the maximum one was 145.6 mm at Crn Drim River basin (RST013_Lazaropole) in November. The monthly variation of rainfall shows the maximum in May and the minimum in August.

2.4.4 Drought

The annual rainfall data at 38 stations that have the minimum number of records missing within the period 1961-1996 were examined to estimate the magnitude and order of the historical droughts. Annual rainfall was calculated and given a rank in ascending order as shown in Table 2.5 (1/2) and (2/2). As a result of

average calculations, the severest drought occurred in 1993 and the second severest one occurred in 1973. To show preliminarily a hydrological cycle of the annual rainfall, top 10 drought and wet years are listed in order below:

Top 10 Drought and Wet Years

Drought Years		Wet Years	
Rank	Year	Rank	Year
1	1993	1	1962
2	1973	2	1963
3	1986	3	1981
4	1977	4	1995
5	1994	5	1979
6	1990	6	1964
7	1988	7	1980
8	1992	8	1972
9	1961	9	1966
10	1984	10	1983

2.4.5 Other Meteorological Conditions

Key climate indicators based on the data at main meteorological stations in each river basin are summarized below:

Key Climatic Indicators at Major Meteorological Stations

River Basin	Station	Rainfall (mm/year)	Temp-erature (°C)	Wind (m/sec)	Sunshine Duration	Cloud-Ness (0 ~ 10)	Humidity (%)
Vardar	MST27_Gevgelija	667	14.0	1.8	6.5	4.4	70.8
Treska	MST06_S. Glava	640	-0.9	5.6	5.6	5.6	83.3
Pchinja	MST25_K. Palanka	617	10.0	2.3	6.3	5.3	68.2
Bregalnica	MST34_Shtip	467	12.6	2.1	6.4	5.0	66.9
Crna	MST11_Prilep	535	11.1	1.6	6.3	5.0	67.5
Crn Drim	MST213_Ohrid	694	11.1	1.8	6.2	5.0	70.4
Strumica	MST04_Strumica	547	12.7	1.1	6.2	4.2	74.3

Note: Rainfall is based on annual total, and other parameters are based on annual average except for sunshine duration, which is presented by hours/day.

2.5 Hydrology

2.5.1 Hydrological Observations

HMI operates 110 hydrological stations in total. Out of the 110 stations, 80 stations are located densely along the Vardar River (38 stations) and its four tributaries of the Treska (8 stations), Pchinja (8 stations), Bregalnica (12 stations), and Crna (14 stations). Figure 2.5 shows their locations. Operating conditions of the stations vary significantly, and not all of the stations are functioning now.

2.5.2 Sources of Surface Water in Macedonia

The surface water available in Macedonia is in three major river basins of the Vadar, Crn Drim and Strumica, four tributaries of the Vardar River of the Treska, Pchinja, Bregalnica, and Crna, three natural lakes of Ohrid, Prespa, and Dojran. In the Study, however, water available in the river basins was considered to formulate the Master Plan because of the following reasons:

- Lake Dojran has a limited amount of water and most of its water flows outside the country. Therefore, the catchment of Dojran lake was excluded from the Study;
- Lakes Prespa and Ohrid are said naturally connected by underground channel, and their water flows through the Crn Drim river basin;
- Considering the size of basins and extent of water use in the Lepenec, Prohor Pchinski and Eleshka Rivers, they are included in the Vardar mainstream, Pchinja and Crna River basins, respectively.

2.5.3 Long-term Flow Analysis

According to daily flow records for the period of 36 years from 1961 to 1996, almost all the stations have the maximum flow in April and the minimum one in August. Table 2.6 lists the mean monthly flow recorded at 24 selected stations. The maximum, minimum, and average discharges on monthly mean in the period for each river basin are listed below:

Maximum, Minimum and Average Discharges at Major Gauging Stations

(Unit: m^3/sec)

River Basin	Station	Maximum	Minimum	Average
1. Vardar	ST016_Gevgelija	549.7	9.6	136.0
2. Treska	ST026_Sveta Bogorodica	91.3	4.0	23.3
3. Pchinja	ST035_Katlanovska Banja	65.9	0.3	11.9
4. Bregalnica	ST052_Shtip	130.0	0.1	11.2
5. Crna	ST065_Rasimbegov	182.6	0.9	22.4
6. Crn Drim	ST088_Lozhani	72.7	6.1	23.4
7. Strumica	ST104_Novo Selo	60.6	0.0	3.8

Based on the monthly flow records for the period from 1925 to 1993 at the Gevgelija station located at the most lower reach of the Vardar River, the maximum and minimum mean annual flow were recorded in 1962 and 1993 with values of 396.4 m^3/sec and 57.2 m^3/sec, respectively. The maximum and minimum mean monthly flows were recorded in April and August with values of 264.7 m^3/sec and 40.3 m^3/sec, respectively. The absolute maximum mean monthly flow was recorded in February 1962 (989.8 m^3/sec) and the absolute mean minimum monthly flow was recorded in August 1989 (8.9 m^3/sec).

2.5.4 Low Flow Analysis

Statistical analysis of the low flow frequencies was applied to estimate low flow values for different return periods. The results of six return periods are listed below for the seven basins:

Probable Drought Discharge at Major Gauging Stations

(Unit: m^3/sec)

River Basin	Station	Return Period (year)					
		5	10	20	25	50	100
Vardar	ST016_Gevgelija	26.4	16.8	12.6	9.6	6.8	5.3
Treska	ST026_Sveta Bogorodica	4.9	3.8	3.3	3.0	2.7	2.5
Pchinja	ST035_Katlanovska Banja	0.7	0.4	0.3	0.2	0.2	0.1
Bregalnica	ST052_Shtip	1.5	0.7	0.4	0.1	0.0	0.0
Crna	ST065_Rasimbegov Most	1.7	1.1	0.9	0.8	0.6	0.6
Crn Drim	ST088_Lozhani	17.3	10.1	6.1	3.3	1.1	0.2
Strumica	ST104_Novo Selo	0.1	0.0	0.0	0.0	0.0	0.0

2.5.5 Flood Analysis

Macedonia experienced two major floods in 1962 and 1979 during this century. The flood in 1962 was the highest and most of the rivers in the country over-spilled their river banks, flooding large areas and causing great damages. Floods in the seven basins in 1962 and 1979 are listed below:

Floods in 1962 and 1979 in Major Basin

(Unit: m^3/sec)

River Basin	Station	1962	1979
Vardar	ST016_Gevgelija	2,010	1,748
Treska	ST026_Sveta Bogorodica	750	673
Pchinja	ST035_Katlanovska Banja	310	281
Bregalnica	ST052_Shtip	230	260
Crna	ST065_Rasimbegov Most	500	1,152
Crn Drim	ST098_Boshkov Most	260	185
Strumica	ST104_Novo Selo	210	82

A statistical analysis was applied to estimate probable floods for different return periods by use of instantaneous peak discharge records available at 22 stations in total for the period from 1961 to 1996. The results for ten return periods are listed below for the seven basins(The gauging stations of each river basin are same as above table):

Probable Flood Discharge at Major Gauging Stations

(Unit: m^3/sec)

River Basin	Return Period (years)								
	2	5	10	20	50	100	200	500	1,000
1. Vardar	660	1,070	1,372	1,674	2,075	2,381	2,690	3,104	3,422
2.Treska	126	242	358	509	779	1,054	1,409	2,039	2,675
3. Pchinja	153	259	310	355	409	446	481	526	558
4. Bregalnica	129	217	273	325	391	438	485	546	592
5. Crna	148	243	376	547	822	1,062	1,325	1,705	2,016
6. Crn Drim	36	80	116	155	209	252	296	356	403
7. Strumica	118	177	214	248	290	321	351	390	419

2.5.6 Flow Duration

Duration of flow at gauging stations located at lower reaches of major rivers was estimated based on the monthly discharges for 36 years from 1961 to 1996. Principal several figures with specific discharges (showing in parenthesis, $m^3/s/100km^2$) are summarized below:

Flow Duration in Major Rivers

(Unit:m^3/s)

River Basin	Catchment Area (km^2)	Average	97% (355 days)	75% (265 days)	50% (175 days)	25% (90 days)
1. Vardar	22,301	136.0 (0.61)	21.9 (0.10)	62.1 (0.28)	100.1 (0.45)	176.2 (0.79)
2. Treska	1,880	23.3 (1.24)	5.2 (0.28)	9.6 (0.51)	17.7 (0.94)	31.9 (1.70)
3. Pchinja	2,794	11.9 (0.43)	0.8 (0.03)	3.5 (0.13)	8.2 (0.29)	16.4 (0.59)
4. Bregalnica	2,897	11.2 (0.39)	1.1 (0.04)	3.9 (0.13)	6.9 (0.24)	12.9 (0.45)
5. Crna	4,526	22.4 (0.49)	1.8 (0.04)	5.2 (0.12)	13.3 (0.31)	31.2 (0.73)
6. Crn Drim	1,899	23.4 (1.23)	9.6 (0.51)	19.9 (1.05)	22.1 (1.16)	26.7 (1.41)
7. Strumica	1,401	3.8 (0.27)	0.1 (0.01)	0.9 (0.06)	1.9 (0.14)	4.3 (0.31)

2.6 Geology

2.6.1 Regional Geology and Geomorphology

The land of Macedonia is composed of bedrocks of varied ages spanning from Pre-Cambrian to Quaternary and strongly controlled by the Alpine tectonic movement of Tertiary age. It can be divided into tectonic belts of Serbo-Macedonian Massif on the east and Dinarides on the west that are elongated in the north-northwesterly direction parallel with the Adriatic coast. The Dinarides is further divided into three zones, that is, Vardar Zone, Pelagonijan Horst Anticlinorium and West Macedonian Zone, from east to west in order.

The Serbo-Macedonian Massif (SMM) is continuous from Belgrade to east of Thessaloniki and covers an area nearly a quarter of Macedonia in its eastern mountain region to the east of a Kumanovo-Lake Dojran line. It is mainly composed of Pre-Cambrian and Early Palaeozoic meta-sedimentary rocks, such as crystalline schist, gneiss, marble and metamorphosed volcano-sedimentary rocks. Further, deep fractured zones along the west margin of the SMM have contributed to rises to the ground surface of calc-alkaline magma and hydrothermal solutions to form a volcano-plutonic complex and, further, mineral deposits.

The Vardar Zone (VZ) represents plains and low hill areas developing around the

Vardar River from Skopje to Gevgelija, and is largely covered by Tertiary and younger deposits, volcanics and pyroclastic rocks. It also contains Palaeozoic sediments, Jurassic ophiolites and Cretaceous flysch rocks in parts. The Jurassic ophiolite forms a complex of gabbro and peridotite, diabase and partly diorite.

The Pelagonijan Horst Anticlinorium Zone (PHA), approximately 30 km wide belt through Prilep and the east of Tetovo, is mainly composed of Pre-Cambrian crystalline schist (largely mica schists), gneiss and crystalline limestone (marble). The crystalline limestone occupies only the northern part of the zone around Cheloica and Suva Mountains. The gneiss and schist are developed in the rest of the zone, of which southern part is largely covered by younger deposits. This zone forms a horst, an elevated landmass separated from the eastern and western adjacent areas by faults, resulting in the exposure of older bedrocks as against the neighboring zones. This up-doming was a result of the regional tectonic dislocations in Mesozoic induced by collision of African Plate and Eurasian Plate. In the present topography, this zone forms a hill and mountain area on the west (right bank) side of the Vardar plain that rises westward to culminate at Mt. Gol Korab (El. 2,753m) in the West Macedonian Zone.

The West Macedonian Zone (WM), the farthest western tectonic zone of Macedonia, is topographically characterized by highest mountain ridges in this country ranging in elevation from 2,000 to 2,753m as represented by Korab Mountains on the border line with Albania and Sar Pianina Mountains on FRY border. This mountainous zone is largely composed of Palaeozoic rock with rather limited occurrences of Mesozoics on the western border to Albania, in sharp contrast to the Pre-Cambrian rocks in the Pelagonijan Horst on the east. The Palaeozoic rock includes schists, meta-sandstone and marble. The Mesozoic rock is for the most part limestone or calcareous rocks. The Vardar River rises in this zone. It flows northeast firstly across the West Macedonian Zone and around the Pelagonijan Horst Anticlinorium, and then southeast from Skopje to Gevgelija on the Greek border through the Vardar Zone.

2.6.2 Seismicity

Macedonia is situated in an active seismic zone, as represented by the strong earthquake in Skopje on July 26, 1963, that caused serious damage to the capital. Its epicenter was identified at 42.00 °N/21.50°E with MSK intensity of IX in Skopje.

A list of significant earthquakes with epicenters within 300km from the center of Macedonia was obtained through the internet from US Geological Survey, National Earthquake Information Center. The center of Macedonia was set at 41.75 °N/21.75 °E near Veles. The list has registered 110 earthquakes since 479

B.C.

56 earthquakes with intensity 5 or more (more than 4.5) were recorded by modern observation system in 90 years from 1902 to 1992. Intensity and peak acceleration induced by each earthquake upon the location near Veles have been estimated by attenuation formulae of Cornell and Kawasumi. It shows that the highest earthquake acceleration felt in this country in the 20th century was that of the Skopje earthquake, which was 325gal according to Cornell and 329gal according to Kawasumi, less than 330 gal or 0.34g, where "g" denotes the acceleration of gravity. The earthquake data has also been used to estimate probable maximum earthquake intensities in a return period of 100 years. With some correction to cover the lack of weak earthquake data in the list of significant earthquakes, the seismicity is estimated as follows:

- Probable maximum earthquake intensity in a return period of 100 years: 9.15 (Modified Mercalli Scale)
- Peak acceleration for the above: 354 gal or 0.36g

Considering that the peak acceleration works only for a fraction of a second, it cannot cause any damage to dam structures. Acceleration enduring for a substantial period of time is of far lower value than the peak. Accordingly, the value of 0.15g is recommended for the design earthquake acceleration for rockfill dams and concrete gravity dams.

This evaluation is only to give a generalized idea of earthquake risk in Macedonia. The estimation of design criteria is to be made for every dam project actually selected for construction.

2.6.3 Damsite Geology

The land of Macedonia consists, for the most part, of old and hard bedrocks of Pre-Cambrian to Mesozoic that are generally strong enough to be foundation of high dams, and also manageable for treatment due to water-tightness except for karstified limestone.

Generally speaking, major foundation engineering problem is rarely seen in damsites in this country, except for the question of water leakage in karst limestone areas. Foundation treatment can be performed within a reasonable cost range. Table 2.7 shows geology and construction design for sites of proposed or designed dams, of which schemes are viable as far as the engineering geology or the foundation engineering is concerned.

2.7 Vegetation and Soil

The vegetation in Macedonia is classified into two, that is forest area and agricultural area, which are further divided as follows:

Classified Vegetation Areas

Vegetation	Area (1,000 ha)	
1. Forest Area		
1) Pure tree stands of deciduous trees	540	
2) Pure tree stands of conifers	79	
3) Mixed tree stands of deciduous trees	271	
4) Mixed tree stands of conifers	6	
5) Mixed tree stands of deciduous trees and conifer	57	
Subtotal (1)	953	(37%)
2. Agricultural Area		
1) Cultivable area	658	
2) Pastures	633	
3) Pond, reed beds and fishponds	1	
Subtotal (2)	1,292	(50%)
3. Other	326	(13%)
Total (1 to 3)	2,571	

The soil in Macedinia is presented by respective areas with use of seven classes, so called "Bonity class", showing the soil fertility or the nutritional contents. Class I is the most fertile and class VII is the least one. The classification and its area are as follows, including other into Class VII. The latest soil map presented in ATLAS Book (1:850,000) 1983 shows surface area by soil classes for the whole area of Macedonia as follows, of which distribution is shown in Figure 2.6.

Classified Areas of Soil in Fertility

Class	Area (1,000 ha)	Fertility
I	190 (7%)	High
II	95 (4%)	
III	369 (14%)	
IV	231 (9%)	
V	975 (38%)	
VI	314 (12%)	
VII	397 (16%)	Low
Total	2,571	

As seen in the Figure 2.6, fertile soil classified as Class I is distributed mainly along the river courses and terrain as follows:

1) Vardar upper reach (Polog and Skopsko Pole)
2) Vardar middle reach (from Veles to Negotino, Kavadarci)
3) Vardar lower reach (Demir Kapija to Gevgelija)
4) Pchinja middle reach (Kumanovo)
5) Bregalnica middle reach (Kochani and Vinica)
6) Crna upper and middle reaches (Pelagonija)

7) Strumica middle and lower reaches

8) Northern part of Ohrid and Struga

9) Resen area of Lake Prespa

All of these areas coincide with the major irrigation areas, which have high production of various crops and sustains the agro-economy in the country.

2.8 Groundwater

2.8.1 General

Five types of groundwater occur in the country as follows:

1) Groundwater in unconsolidated Quaternary and Neogene sand and gravel layer
   i) High to medium yielding aquifers
   ii) Low yielding aquifers
2) Groundwater in fault and fractured zones
   i) Practically without aquifers
   ii) Local aquifers
3) Groundwater in the karst limestone and marble

The sediments, which are composed of the Quaternary and Neogene sand and gravel layers form high to medium yielding groundwater aquifers, are distributed in the following nine areas:

1) Polog valley (Tetovo – Gostivar),
2) Skopje valley,
3) Middle part of the Vardar River (Veles),
4) Upper part of the Bregalnica River (Berovo – Delchevo),
5) Middle part of the Bregalnica River (Kochani – Shtip),
6) Strumica valley,
7) Lower part of the Vardar River (Negotino),
8) Lower part of the Vardar River (Gevgelija), and
9) Pelagonija valley (Bitola – Prilep)

The sediments form artesian aquifers in the central and lower parts of these areas. In addition, small-scale Quaternary aquifers are formed in the Pchinja River basin and in the western part of the country, such as Ohrid, Prespa, Debar, and Kichevo. Groundwater in the sediments are used through wells.

The groundwater in the West Macedonian zone and Serbo-Macedonian massif except for the above-mentioned valleys may be locally stored in the fractured

fault zones and the basement rocks are considered to be practically impermeable aquifers. Quantity of the groundwater in the zones is very small.

The karst aquifers occur in the caves of the karst limestone and marble, which spread in the Pelagonijan Horst Anticlinorium Zone. It appears that groundwater in the karst aquifers is highly transmissive, and used as spring water.

2.8.2 Groundwater Resources

The nationwide volume of groundwater, which has been exploited amounts to 9.77m^3/sec, that is 308.2x$10^6$$m^3$/year, which is broken down below:

1) The exploited groundwater in unconsolidated sand and gravel layer amounts to 1.99 m^3/sec, that is 62.8x10^6 m^3/year;

2) The exploited groundwater in faults and fractured zones is as small as 0.05 m^3/sec, that is 1.6x$10^6$$m^3$/year;

3) The exploited groundwater in karst limestone and marble amounts to 7.73 m^3/sec, that is 243.8x10^6 m^3/year. The amount of groundwater in the karst limestone and marble is estimated to be almost equal to the yield of springs.

2.9 Watershed Management

2.9.1 Present Land Use

An intensive effort to create digitized land use map from current information is underway by MUPC with the technical assistance of PHARE Program, but no official data is available yet. The only map available to grasp practically the land use condition in the whole country is that in the ATLAS Book (1:850,000) 1983 compiled with the vegetation and soil maps as presented in the preceding subsections. According to the map, the country is classified into four categories, that is cultivated land, pastures, forests and aforestation area as shown in Figure 2.7.

2.9.2 Land Erosion and Debris Control

(1) Forest

The total forest area was 953,322 ha in 1996 (Statistical Year Book 1997) sharing 37 % of the national territory. In Macedonia, activity of forest management is being conducted by the Forest Management Organization that is supervised by the Forest Department of MAFWE. The major activities cover aforestation, control of illegal logging, and promotion of logging industry.

(2) Outline of Erosion Condition

Most of the territory of Macedonia is vulnerable to erosion. A lot of research and studies have been carried out to clarify countermeasures for attenuation of erosion in watersheds. Among them, one of the most conspicuous outcome is 1:50,000 scale erosion maps of the country prepared by the Faculty of Forest in Sv. Kiril and Methodij University, Skopje (the Skopje University) and Water Development Institute, Skopje (WDI) (referred as the "National Erosion Survey")

The National Erosion Survey began in 1980 and preparation of erosion maps covering the whole national land was completed by the end of 1997. The results of classification of erosion are compiled in a booklet published as Part I in 1993. The erodable area is classified into five major categories by intensity and process of erosion. Each class has three sub-categories concerned with the type of erosion such as deep erosion (gully erosion), mixed type erosion and minor surface erosion. According to the Survey, the area affected by erosion processes is 24,813.3km^2 or 96.5% in the country. The area classified by the five classes is as follows:

Area Classification by Erosion Process

Class	Erosion Process	Area (km^2) (%)
I	Excessive erosion (gully erosion)	688.0 (2.8)
II	Significant erosion	1,832.4 (7.4)
III	Medium scale erosion	6,893.3 (27.7)
IV	Minor erosion	7,936.1 (32.0)
V	Insignificant erosion	7,463.5 (30.1)
	Total	24,813.3 (100)

Areas classified as I to III are considered to be affected with severe erosion, which is equivalent to 9,413.7km^2 or 37.9% of the total affected area.

(3) Sediment Yield and Deposition in Watershed

The National Erosion Survey estimated the annual yield of debris in watersheds and volume of deposition of major reservoirs. It is obvious that the watersheds in the Crn Drim River have relatively small yield rates compared with ones in the Vardar and Strumica River basins. Among the reservoirs in the Vardar, the yield rate of the Kalimanci, 1.00mm/year, is significantly high. Sediment records of major reservoirs are summarized below:

Annual Sediment Yield in Catchment Area of Major Dams

River	Dam	Catchment Area (km^2)	Annual Sediment Yield (m^3/year)	Annual Sheet Erosion Rate (mm/year)
Vardar	Glaznja	101	50,911	0.51
	Lipkovo	112	5,853	0.05
	Kalimanci	1,100	1,101,923	1.00
	Mantovo	180	71,159	0.40
	Tikvesh	5,361	2,675,969	0.50
Strumica	Vodoca	76	37,327	0.49
	Turija	210	91,578	0.43

Crn Drim	Globochica	3,118	117,934	0.04
	Shpilje	4,198	807,672	0.19
	Mavrovo	322	16,580	0.05

(Source: Erosion map, WDI-Skopje)

(4) Present Debris Control Activities

MAFWE is proceeding to construct debris flow control structures such as low dams (concrete gravity or stone masonry) and screen type dams in parallel with aforestation in the watersheds. The screen dams were constructed in order to trap stone and cobbles in the Kodzadzicka, Breshtancka, and Dolgash Rivers in the Zupa mountain range, eastern side of the Debar reservoir. Further, in the Kamenica River that is one of tributaries flowing from the north to the Kalimanci reservoir, 18 concrete gravity dams in total were completed. These dams are demonstrating trapping efficiency to protect structures and channel formation downstream against the destructive debris flow.

(5) Problems of Siltation into Lake Ohrid

It should be noted that condition of macrophetic vegetation near the estuary of the Sateska River in Lake Ohrid is threatened by heavy siltation. The flow with high content of sediment discharges into the lake through the new channel excavated in the Sateska River. The Sateska River basin is located in the northern part of Ohrid in Debarca area. The catchment area and length of main stretch are 411km^2 and 37.7km, respectively.

Survey and study aimed to clarify the present status of erosion was jointly conducted by the Skopje University and WDI from 1995 to 1996. The study concluded that the sediment material from the Sateska River was diffused mainly from north to south by waves and currents in Lake Ohrid. This movement distributes the eroded deposits towards the outlet of the Crn Drim River in Struga. The watershed of the Sateska River is mostly classified in Class IV except some minor slopes classified in Class II. In order to introduce effective countermeasures in this watershed, GTZ carried out a technical research.

2.10 Water Quality

2.10.1 Present Monitoring Network of Water Quality

Based on the Water Law (1998), HMI is responsible for monitoring surface waters of the major rivers in Macedonia. HMI monitors water quality at 60 measuring stations on the river basins, and lakes; 51 measuring points of these are positioned on river courses, while nine measuring points are based on the large lakes. The monitoring records for water quality parameters in the rivers of Macedonia are not available for 1997 and 1998. The lack of monitoring for the last two years has reportedly been due to the lack of funding because of IMF

restrictions on public sectors spending in Macedonia. In addition to HMI, the other government agencies which are responsible for monitoring activities, are briefly described in the following table:

Water Quality Monitoring Activities by Responsible Agencies

Action	Activity	Responsible Agencies
Monitoring of river water	O&M of WQMPCS[1]	MAFWE, DWE[2], MOEn
	O&M of automatic water quality monitoring systems	MAFWE, DWE, MOEn
Monitoring of river bed sediment	Sampling & analysis of river bed sediment	DWE, HMI, RIHP
Pollution sources inspection	Monitoring of domestic wastewater (business activities)	DWE, HMI, RIHP
	Monitoring of domestic wastewater (dwellings)	HMI
	Monitoring of industrial wastewater	HMI
	Monitoring of agricultural wastewater (livestock houses)	HMI
	Monitoring of other sources	HMI
Preparation of inventory	Inventory survey	MUPCE, MOEn, HMI

Note: 1. Water Quality Monitoring and Pollution Control System
2. Department of Water Economy

Furthermore, the quality of surface waters used for sports and recreation purposes and tourism, on the shores of natural lakes and river beaches is monitored by the Republic Institute for Health Protection (RIHP) of the respective regions.

2.10.2 Regulations and Standards

(1) Water Law 1998 Regulations

Based on the new Water Law (No. 4/98), Article 92, HMI has an obligation to regularly monitor the conditions of water pollution, and early diagnosis of accidental discharge of hazardous and toxic material to the water bodies. HMI would carry out regular water quality and quantity analysis in all waters, such as rivers, lakes, reservoirs and groundwater as well as water used for irrigation.

(2) The Current Standards

The monitoring of all the parameters for quality of the surface water and the level of pollution in Macedonia is done according to pre-1991 Yugoslavian Standards (JUS). JUS are used because of the lack of complete new Macedonian standards. It is GOM policy to bring in all new regulations based on EU standards. In 1998, the transition was in process and some of the parameters are monitored by, newly introduced Macedonian regulations, EU standards or international standards.

Based on "Regulation for Classification of Waters, No, 9/84 & No.19/92", the surface water in Macedonia is categorized in four classes:

Class I: Waters that in their present state can be used for drinking and for the

production and processing of food products, and surface waters that can be used for quality fish breeding (salmon).

Class II: Waters that in their present state can be used for bathing and recreation, and for water sports, for breeding of other kind of fish (cyprinides), or that by using the usual methods of processing and conditioning (coagulation, filtration, and disinfection) can be used for drinking, and for the production and processing of food products.

Class III: Waters that in their present state can be used for irrigation, and that by using the usual methods of processing and conditioning can be used in the industry branches that do not require drinking water.

Class IV: Waters that can be used for other purposes only by previous processing.

2.10.3 Current Conditions of Water Quality

The most significant problems regarding water pollution are due to untreated wastewater discharged from mines and industrial plants as well as discharges from large settlements and livestock farms. Surface water has been polluted in the middle and lower reaches of the Vardar main stream, the Pchinja, Bregalnica, and Crna Rivers. Deterioration of the quality in groundwater used through wells has been found near cities like Skopje and Veles in particular, while spring water remains with desirable quality.

2.10.4 Present Conditions of Wastewater Treatment

(1) Current Wastewater Treatment Activities

Based upon the available data, only 6% of the wastewater in Macedonia is treated before it is discharged into the sewer systems and/or to the rivers. There are three wastewater treatment plants built in Macedonia, which are for the treatment of discharges into Lakes Ohrid (120,000 p.e.), Prespa (12,000 p.e.) and Dojran (6,000 p.e.). The Vranishte (Ohrid) plant has substantial capacity, which would be expanded to 180,000 p.e. under the ongoing GEF project. The other plants are relatively smaller.

(2) Existing Treatment Facilities and Measures for Domestic Wastewater

There have been plans for the design and construction of wastewater systems in Skopje, Strumica, Bitola and Prilep. The wastewater systems in Bitola and Prilep are in the implementation phase now, financed through a World Bank loan. A national and Skopje's wastewater treatment master plan is under preparation.

(3) Existing Wastewater Treatment in the Industry

In Macedonia, less than 20 large factories have pre-treatment plants built on the premises. Many small factories also have treatment plants, which are basic "mechanical" systems. The entire capacity provides treatment to about 6% of all wastewater generated in Macedonia. In addition, current and reliable data on their operations is very difficult to be obtained and questionable. Reportedly more than 50% of the installed systems are mostly out of order, and the factories discharge untreated wastewater into the Vardar River and other rivers.

2.11 Source of Municipal Water

Source of water of Communal Enterprises in each municipality (the former division) has been surveyed through a questionnaire survey and interviews and is summarized below:

Source of Municipal Water

No.	Municipality	Source of Water
1.	Skopje	Spring ("Rashche") and 7 wells (used in water shortage)
2	Gostivar	Spring
3	Tetovo	Spring (most of them freeze in winter)
4	Kichevo	Spring
5	Makedonski Brod	Spring
6	Kumanovo	Reservoir ("Glaznia"/"Lipkovo" : 240l/sec or 7.6 x$10^6$$m^3$/year)
7	Kratovo	River intake ("Zletovica" : 50l/sec or 1.3 x$10^6$$m^3$/year)
8	Kriva Palanka	Spring (some of them freeze in winter)
9	Veles	Well and river intake (raw water is taken from wells in Veles and from the Topolka river at the upstream of the "Lisiche" dam now under construction and led to a filter station for distribution : 50 l/sec or 1.3 x$10^6$$m^3$/year)
10	Sveti Nikole	Reservoir ("Mavrovica" with a net capacity of 2.52 x$10^6$$m^3$)
11	Shtip	Well
12	Probishtip	Well
13	Kochani	Well and reservoir (used only for the paper factory)
14	Vinica	Well and river intake
15	Delchevo	Well and river intake
16	Berovo	Reservoir ("Ratevska" with a net capacity of 9.0 x$10^6$$m^3$)
17	Demir Hisar	Well
18	Krushevo	Spring
19	Bitola	River intake and reservoir ("Strezevo" with a net capacity of 100.0 x$10^6$$m^3$)
20	Prilep	Spring ("Peshterica" situated just upstream end of the Prilep reservoir with a capacity of 23 l/sec or 0.72 x 10^6 m^3/year), and well (used in water shortage)
21	Kavadarci	Spring and river intake (assumed to be small quantity)
22	Negotino	Spring and river intake (assumed to be small quantity)
23	Valandovo	Spring and well
24	Gevgelija	Well
25	Ohrid	Spring and Lake Ohrid (used in water shortage)
26	Struga	Spring
27	Debar	Spring
28	Resen	Well and spring
29	Radovish	Well
30	Strumica	Reservoir ("Turija" with a net capacity of 45.0 x$10^6$$m^3$ and "Vodoca" with a net capacity of 25.1 x$10^6$$m^3$)

The above table is compared with the intake and quantity of water described in the National Environmental Action Plan (NEAP) Final Report as follows:

Comparison of Source of Water between JICA and NEAP Studies

No.	Municipality	Source of Water (JICA)	Source of Water (NEAP) (unit:m^3/sec) Natural source	Ground-water	Surface water	Total
1.	Skopje	Spring and 7 wells	3.3	1.24	-	4.54
2.	Gostivar	Spring	0.28	-	-	0.28
3.	Tetovo	Spring	0.505	-	-	0.505
4.	Kichevo	Spring	-	-	-	-
5.	Makedonski Brod	Spring	-	-	-	-
6.	Kumanovo	Reservoir	-	-	0.44	0.44
7.	Kratovo	River intake	-	-	0.88	0.08
8.	Kriva Palanka	Spring	0.025	-	-	0.025
9.	Veles	Well and river intake	-	0.12	0.3	0.42
10.	Sveti Nikole	Reservoir	-	-	0.15	0.15
11.	Shtip	Well	-	0.2	-	0.2
12.	Probishtip	Well	-	0.042	-	0.042
13.	Kochani	Well and reservoir (for a paper mill)	-	0.26	-	0.26
14.	Vinica	Well and river intake	-	0.025	0.035	0.06
15.	Delchevo	Well and river intake	-	-	0.038	0.038
16.	Berovo	Reservoir	-	0.4	-	0.4
17.	Demir Hisar	Well	-	0.048	-	0.048
18.	Krushevo	Spring	0.15	-	-	0.15
19.	Bitola	River intake and reservoir	-	0.6	-	0.6
20.	Prilep	Spring and well (used in shortage)	0.24	-	-	0.24
21.	Kavadarci	Spring and river	0.3	-	0.15	0.45
22.	Negotino	Spring and river	0.1	-	0.4	0.1
23.	Valandovo	Spring and well	0.005	0.04	-	0.45
24.	Gevgelija	Well	-	0.21	-	0.21
25.	Ohrid	Spring(lake)	0.09	0.7	-	0.79
26.	Struga	Spring	0.25	-	-	0.25
27.	Debar	Spring	0.2	-	-	0.2
28.	Resen	Spring and well	0.02	0.036	-	0.056
29.	Radovish	Well	0.025	0.05	-	0.075
30.	Strumica	Reservoir	-	0.25	-	0.25
31.	Dojran	-	-	0.025	-	0.025
	Total		(5.470)	(2.260)	(3.143) (10.873)	

(Ref. Table 11 in the Final Report, Skopje March 1996 for NEAP)

Points of comparison are:

1) Kichevo and Makedonski Brod are supplied from springs (Studencica system), while there is no source in NEAP,

2) A reservoir in Kochani is for supply water to a paper factory, and hence it is not included in NEAP,

3) Some wells are used as source of water in Delchevo, while there is no source in NEAP,

4) Wells are source of water in Prilep during water shortage, while it is not included in NEAP,

5) Source of water in Kavadarci is springs in JICA Study (it is considered to be the Lukar system), while NEAP lists surface water.

The source of water adopted in JICA Study and NEAP mostly coincides with each other.

2.12 Rural Water Supply

2.12.1 Data Availability

Rural water supply conditions were investigated, but only a little data was available for those obtained from the Republic Institute for Health Protection (RIHP) and the Ministry of Urban Planning and Construction (MUPC). MUPC just started the preparation of the inventory of the water supply system in the country and at the moment MUPC has only partial data for the water supply systems, received from the local communities and local self-governments.

From these circumstances, the studies on rural water supply were conducted by using data available at present such as the results of interview, information obtained through site inspections and suppositions by the Study in addition to the data of RIHP.

2.12.2 Present Conditions of Rural Water Supply

(1) Coverage Rate of Water Supply to the Public

There is no data available showing the coverage rate of water supply to the public, which is defined here by the Communal Enterprises (CEs) and Village Supplys (VSs).

Consequently the coverage rates were estimated by referring to the following papers;

1) Dr. Pavle Filjanski (RIHP) "Evaluation (of the Model) for Improvement of the Water Supply and Reflection on the Hygienic – Epidemic Condition of the Rural Population in the Republic of Macedonia for the Period 1971-1990", June 1993, Skopje.
2) NEAP Final Report, March 1996, Skopje Sectoral Report Table & (page II-5).
3) RIHP "Condition of the Water Supply in the Republic of Macedonia with Water Quality and Protection of the Resources" 1995 Seminar: page 197, Table 1

According to the above, the coverage rates were estimated as follows, and the rates for this Study were determined:

Coverage Rate of Rural Water Supply in 1991

Description	Number
Record in Rural Area in 1991:	
(1) Supply from Communal Enterprise (CE)	121,409 persons (108 villages)
(2) Supply from Village Supply (VS)	479,654 persons (660 villages)
- with meter	241,504 persons
- without (w/o) meter	238,150 persons
(3) Subtotal ((1)+(2))	601,063 persons (768 villages)
(4) Not supplied/not connected with network service (or own source)	264,742 persons (957 villages)
(5) Total ((3)+(4))	865,805 persons (1,725 villages)
Rate of above:	
(1) Supply from CE ((1)/(5))	
- person	14 %
- village	7 %
(2) Supply from VS ((2)/(5))	
- person	55 %
- village	38 %
(3) Own source ((4)/(5))	
- person	31 %
- village	55 %

Based on the above, coverage rates in rural areas were adjusted to be 20% supplied by CEs and 55% by VSs, respectively for the current condition in the Study.

In addition to the above, the following were also referred to in the estimation;

1) Rural population change in the period 1961 – 1991 (See Table 2.8 and Figure 2.8),
2) Regional characteristics of domestic migration in the period 1961-1991 (See Table 2.9 and Figure 2.9),
3) Improvement of coverage by network service at home in villages in the period 1971-1991(See Table 2.10 and Figure 2.10), and
4) Condition of rural water supply in 1991(See Table 2.11 and Figure 2.11)

According to Table 2.10, the coverage rates on the basis of population (or persons) by the network service was improved from 4.0 % in 1971 to 69.4 % in 1991. Present conditions of the rural water supply are shown in Figure 2.12.

(2) Present Situation of Rural Settlement without Network Service

Number of villages and population required for development and improvement

in former municipalities in 1997 are tabulated in Table 2.12.

Throughout the Study, rather high and/or required development of water quantity and improvement of water quality are recognized in the region and the municipality (the former division) as shown in Tables 2.12 and 2.13 and summarized below:

Requirement for Water Quantity Development and Water Quality Improvement

Region	High Requirement		Low Requirement	
	Quantity	Quality	Quantity	Quality
1. Upper reach Of the Vardar	1) Skopje 2) Gostivar 3) Tetovo 4) Kichevo 5) M.Brod 6) Kumanovo 7) Kratovo 8) K.Palanka	1) Skopje 2) M.Brod 3) Kumanovo 4) Gostivar	-	1) Tetovo 2) Kichevo 3) Kratovo 4) K.Palanka
2. Middle reach of the Vardar	1) Veles 2) Sv.Nikole 3) Shtip 4) Kochani	1) Sv.Nikole 2) Shtip 3) Berovo 4) Probishtip	1) Probishtip 2) Vinica 3) Delchevo 4) Berovo	1) Veles 2) Vinica 3) Delchevo 4) Kochani
3. Lower reach of the Vardar	1) Bitola 2) Prilep	1) Krushevo 2) Bitola 3) Valandovo	1) D.Hisar 2) Krushevo 3) Kavadarci 4) Negotino 5) Valandovo 6) Gevgelija	1) D.Hisar 2) Prilep 3) Kavadarci 4) Negotino 5) Gevgelija
4. Reach of the Crn Drim	-	1) Ohrid 2) Debar 3) Resen	1) Ohrid 2) Struga 3) Debar 4) Resen	1) Struga
5. Reach of the Strumica	1) Strumica	1) Strumica	1) Radovish	1) Radovish

(Note: The ranking on requirement is determined based on the RIHP data, Tables 2.12 and 2.13)

(3) Economically Underdeveloped Areas

The rural water supply development in Macedonia is promoted by three agencies of (the former) MUCPE through the municipality authorities, MOD through the Agency for Economically Underdeveloped Areas, and Non-government Organizations (NGO) like MCIC.

Economically underdeveloped areas, are tabulated in Tables 2.14 (1/2) and (2/2), and shown in Figures 2.13 and 2.14. There are 726 areas in total.

(4) Projects by MCIC

MCIC (Macedonian Center for International Cooperation) has implemented/is implementing rural water supply projects since 1994 as tabulated in Tables 2.15 (1/2) and (2/2).

2.13 Institutions and Organizations

2.13.1 Present Legal and Regulatory Framework

(1) Water Law

New Water Law was issued in January 1998, replacing the Law on Water of 1981. It functions as a framework law on water resources issues in Macedonia. The Water Law provides comprehensive provisions on water resources development and management. The important new provisions are the following:

- Water Fund will be established in order to cover expenses for water resources development and management activities for public interest. The Water Fund receives its income from a tax levied on income, power generation and industries using water, water pollution charge and the annual state budget.
- Public Water Management Enterprise (PWME) is established by the Government Decision on "Establishment of Public Water Economy Enterprise" (Official Gazette No.22/98). Organizations formerly called Water Management Organizations are considered as the branches of PWME.
- Establishment of Water Users' Associations is promoted to encourage farmers to participate in operation and maintenance of irrigation facilities.
- Wastewater standards are to be established. Water Pollution Charge is applied based on the standards.
- Water Management Inspectors will be assigned for enforcing compliance with the stipulations of the Law.

Most provisions stipulated in the Law are not yet to be implemented; institutional setting for water resources development and management is still in a transitional stage. PWME was established, but its structure including the local branches has not been fixed. Similarly the Water Fund is yet to be fully functioning. Details of many provisions have to be stipulated by the government, MAFWE, and PWME.

(2) Water Right

The Water Right in Macedonia is categorized into two groups. The Water Resource Agreement is the right to construct water structures or the right to make investment for water structures (Article 27). The Water Right is the right to use water. It is required for any kind of water utilization (Article 35). Both water rights are issued by the Administration of Water Management, MAFWE (Article 30 for right to construct and Article 35 for water use right). Each local branch of PWME presents its required amount of water to its headquarters and then MAFWE approves the request. No water use license is required for the purposes of fire extinguishing, sanitation activities and/or water used in natural disasters (Article 44).

(3) Priorities of Water Use and Water Allocation

The priority of water utilization in Macedonia is the following (Article 11):

1) Municipal water use including water use in hospitals, veterinary stations, defense, food processing industry,
2) Agricultural water use,
3) Industrial water use,
4) Hydropower generation, and
5) Other uses

The water allocated for agricultural use, industrial use, hydropower generation, and other uses can be re-allocated for municipal water use, upon a decision of the Minister of MAFWE (Article 11). PWME or other legal entities responsible for water structures have the right to temporarily limit or forbid water use in accordance with the priority set above (Article 42) when water quantity can not fulfil the demands of water users.

(4) Organization of Water Supply System

The organization of the water supply system in Macedonia is illustrated in Figure 2.15. The agricultural water is supplied by PWME, while the drinking water is supplied by the Communal Enterprises, who buy the treated water from PWME. MAFWE is responsible for guiding PWME as the sector ministry for water resources development and management and irrigation water supply. MUPC is the sector ministry for drinking water and industrial water supply and the Communal Enterprises are under the municipal governments.

2.13.2 Institutional Setting

(1) Role of Relevant Ministries

MAFWE, MUPCE (divided into MUPC and MOEn in December 1998), MOE, MOD, and MOH are the main players in the sector of the water resources development and management. MAFWE has an overall responsibility for water resources development and management. It is responsible for planning and construction of river facilities with 264 staff members. MUPCE is responsible for municipal and industrial water supply, wastewater treatment and environment. It has a staff of 503.

MOE is responsible for water use by hydropower generation; it has a staff of 371 staff. MOH is responsible for municipal water quality control through standard setting and monitoring. It has 137 staff members. RIHP is also associated with MOH. RIHP has 10 regional branches. MOD is responsible for

coordination and reviewing various ministries' activities from macroeconomic points of view, and regional development planning. It has 75 staff including 10 from the Agency for Economically Underdeveloped Area and 27 from the Industrial Property Protection Office within MOD.

(2) Organization for Water Management

Following the Article 136 of the Water Law, PWME was established by the Government Decision on 4 May 1998 (Official Gazette No. 23/98). The establishment can be considered as the separation of service/operation functions (by WMOs) from regulatory functions. In order to attain the efficient and effective management of water resources, institutional strengthening of PWME and its branches is one of the most important issues.

(3) Water Supply Companies

There are 34 communal enterprises in Macedonia. The enterprises belong to each municipal government and supply municipal and industrial water to his responsible municipality. The companies form the Association for Water Supply and Sewerage (MAKKOM) to represent their interests.

(4) Other Agencies

HMI is a public institute financed by the Government. It is responsible for monitoring water resources, collection and record of river discharge, sediment, water quality and pollution. It has approximately 160 staff. Geohydroproject is a private enterprise similar to HMI but its responsibility is for groundwater. It has a staff of 25.

(5) Government Budget

The fiscal budget is huge relative to the size of national output, accounting for 20% of GDP. In 1997, total central government revenue was MKD36,310 million while its total expenditure was MKD36,001 million. Nearly 90% of the government revenue came from taxes, and taxes on good and services (sales tax and excises) were the leading contributor to total revenue with its revenue amounting to MKD17,686 million (49% of total revenue). The share of borrowing from abroad in total budget stayed below 5%. The government budget was allocated mostly to wages and salaries (39% of total expenditure) and transfers (37%), about half of which was used for transfers to individuals.

2.14 Development Strategy and Plans

2.14.1 Water-related Development Plans and Studies

There are three nationwide development plans and studies, which were reviewed

in the Study; "National Development Strategy 1997", "Study for Long-term Water Supply in the Republic of Macedonia up to 2025" and "Integrated Development of the Vardar/Axios River Basin". The outline of each plan and study is as follows:

Nationwide Development Plans

		National Development Strategy	Study for Long-term Water Supply up to 2025	Integrated Development of Vardar/Axios River
1	Publication Year	1997	1993	1979
2	Prepared by	Macedonian Academy of Science and Arts	Association of the Communal Enterprises "MAKKOM"	UNDP
3	Target Year	2020	2025	2025
4	Target Area	Nationwide	Nationwide	Varder/Axios River Basin
5	Water Quantities Available in Macedonia	$7.472 \times 10^9 m^3$	$7.8 \times 10^9 m^3$	$5.765 \times 10^9 m^3$
6	Population Projection	2,218,700 (2019)	2,547,320 (2000) 2,798,100 (2010) 3,206,000 (2025)	-
7	Water Demand Projection	$4,503.34 \times 10^6 m^3$	$1,422.95 \times 10^6 m^3$ (municipal water only)	$3,053 \times 10^6 m^3$

2.14.2 Program for Public Sector Investment

The Program for Public Sector Investment in the Republic of Macedonia (PIP) has been prepared by the MOD with the technical assistance of World Bank; the latest PIP covers the period 1998 to 2000. MOD prepares PIP following the information included in the database of development project plans formulated and submitted by the executing ministries. PIP is a short-list of development projects by sector prioritized based on criteria such as importance of the sector, level of project formulation, possibility of covering project budget by the national budget, capability of loan reimbursement of the government, etc.

2.14.3 National Environmental Action Plan

The Government of Macedonia prepared in 1996 to 97 the National Environmental Action Plan (NEAP) with the support of World Bank, and it was developed with the participation of in-country technical experts. NEAP reports that industries have continued to be the major polluters in spite of lower production levels. And the crucial environmental issues in Macedonia are: 1) poor air quality in Veles and Skopje; 2) polluted surface water due to discharge of untreated wastewater; and 3) inadequate solid hazardous waste management system.

To address wastewater problems NEAP recommends that regulations should

specify pre-treatment for industries and the water quality problem should be considered with water resource issues at a local level. A local approach to building or upgrading wastewater treatment facilities, modernization of water supply and irrigation systems, management improvements, and rational utilization of water resources should be pursued.

2.14.4 Directions of Donor's Development Plan

In the water resources development and management sector, GTZ and World Bank have been the main players. A German expert dispatched by GTZ has been working as a technical advisor for development project planning in the Administration for Water Economy of MAFWE. World Bank has commenced three irrigation rehabilitation projects including institutional strengthening in water management and six power system improvement projects including hydropower plant rehabilitation projects.

EU's PHARE Project[*2] plans to start a master plan formulation project about wastewater treatment. EBRD, which is mainly involved in promotion of private sector, has been seeking for the possibility of some environmental protection projects. Many donor-funded projects are being implemented or planned for environmental protection of Lake Ohrid and its surrounding areas, which is designated by UNESCO as a World Natural and Cultural Heritage site.

Grassroots aid projects are also underway by some donors for small size water supply facilities, etc.

[*2] The PHARE Project under the EU, which was originally planned for supporting Poland and Hungary, now provides technical support for Eastern Europe Countries having the final aim to reach a position where the partner countries are ready to assume the obligations of full membership of EU.