# *CHAPTER 3*

# *PROBLEM IDENTIFICATION OF WATER RESOURCES DEVELOPMENT AND MANAGEMENT*

# CHAPTER 3 PROBLEM IDENTIFICATION ON WATER RESOURCES DEVELOPMENT AND MANAGEMENT

## 3.1 Overview of Existing Water-related Problems

### 3.1.1 General

Water-related problems have been identified through (i) information, interview and study results, (ii) current water balance calculation, (iii) PCM workshop, (iv) interview survey for Communal Enterprises, and (v) viewpoints of institutions and legal system.

Among the problems identified, those relating to drinking water are the most severe followed by those of agricultural water, industrial water, and so on. Therefore, the problems relating to drinking water are presented first in general, and detailed together with other water-related problems.

### 3.1.2 Drinking Water-related Problems across Macedonia

Drinking water-related problems in Macedonia are summarized as follows:

1) Seasonal/through a year water shortage in quantity;

2) Leakage loss in water supply networks;

3) Insufficient service facilities;

4) Pollution of water in quality;

5) Poor access to safe drinking water.

Regarding the leakage loss, all water companies or communal enterprises (CEs) investigated, with the exception of Skopje, reported problems with deteriorating water supply networks and consequently high leakage rates.

This is attributed in most cases to the materials used in construction. Asbestos-cement was original material used and later galvanized steel was introduced. The asbestos-cement pipes have deteriorated through age and the locally produced galvanized steel pipes have suffered severe corrosion. On the other hand, Skopje used imported ductile iron pipe work, for which it was criticized at the time, however subsequent events have justified their earlier decision.

More recently plastic pipes have been introduced, however, the majority of networks are still mainly composed of asbestos-cement or galvanized steel.

The national land of Macedonia is divided into five regions from geomorphological viewpoints. Drinking water-related problems are, therefore, presented generally in each regions as follows:

**Drinking Water-related Problems across Macedonia**

| River Basin / Description | (1) Vardar River upper reach/ Treska/Pchinja | (2) Vardar River middle reach/ Bregalnica | (3) Vardar River lower reach/ Crna | (4) Crn Drim River | (5) Strumica River |
|---|---|---|---|---|---|
| 1. Part in Macedonia | West/central-north/east/ north-east | Central-south/ east | Central/ Southwest/ east | Central/ southwest | Southeast |
| 2. Major Municipality (the former one) | Skopje<br>Gostivar<br>Tetovo<br>Kichevo<br>M. Brod<br>Kumanovo<br>Kratovo<br>Kriva Palanka | Veles<br>S. Nikole<br>Shtip<br>Probishtip<br>Kochani<br>Vinica<br>Delchevo<br>Berovo | Demir H.<br>Krushevo<br>Bitola<br>Prilep<br>Kavadarci<br>Negotino<br>Valandovo<br>Gevgelija | Resen<br>Ohrid<br>Struga<br>Debar | Radovish<br>Strumica |
| 3. Topography (Altitude ) | Mountain/valley/hill<br>(El.240-2,500 m) | Mountain/ valley/hill<br>(El.270-2,000 m) | Mountain/ highland/hill<br>(El.50-1,400 m) | Mountain/ valley/ highland<br>(El.670-2,700 m) | Mountain/ hill<br>(El.220-1,700 m) |
| 4. Annual Rainfall | 640 mm | 500 mm | 560 mm | 740 mm | 500 mm |
| **Problems :** | | | | | |
| 1) Water shortage (Seasonal) | Skopje<br>Gostivar<br>Tetovo<br>Kichevo<br>M. Brod<br>Kumanovo<br>Kratovo<br>Kriva Palanka | Veles (all year)<br>S. Nikole<br>Shtip<br>Probishtip<br>Kochani<br>Vinica<br>Pehchevo<br>Delchevo | Demir Hisar<br>Krushevo<br>Prilep<br>Kavadarci<br>Negotino<br>Valandovo<br>Gevgelija | Resen<br>Struga | Strumica<br>Radovish |
| 2) Leakage loss | 27 – 40% | 20 – 35% | 32 – 40% | 35% (Struga) | 30 – 40% |
| 3) Insufficient Service facility | – | – | Demir Hisar<br>Valandovo | Ohrid | – |
| 4) Water pollution in river | Skopje<br>Gostivar<br>Tetovo<br>Kumanovo<br>Kratovo<br>Kriva Palanka | Veles<br>Shtip<br>Kochani<br>Vinica | Bitola<br>Prilep<br>Kavadarci<br>Negotino<br>Valandovo<br>Gevgelija | Ohrid | Radovish<br>Strumica |
| 5) Poor access to safe drinking water in rural area | Mountainous area and border with FRY and Albania | Mountainous area and border with Bulgaria | Mountainous area and border with Greece, and area between the Vardar and Dojran | Mountainous area and border with Albania | Mountainous area and border with Bulgaria and Greece |

## 3.2 Problems Identified by River Basin

### 3.2.1 Problems Identified in Vardar River Upper Reach

(1) Problems Relating to Municipal and Industrial Water

(a) Skopje and Kumanovo

Skopje is currently supplied exclusively by groundwater, primary from the Rashche springs and augmented by wells in the summer. It is reported that there is surplus flow from the springs at night, which is spilled to the Vardar, and a shortage during the day - hence the need appears to augment supplies from wells during the peak. This indicates there is insufficient service capacity. Current capacity is about 33,000m$^3$, but this must double. There are also plans to sink new wells in the vicinity of parks for irrigation of green areas, thus saving the higher quality spring water for potable water consumption.

Grand Skopje has seasonal water shortage also considered because of rapid population growth as well as seasonal increase of water demand. This is also a problem in Kumanovo. Having 2 reservoirs of Lipkovo and Graznja for their population, Kumanovo has serious problems of drinking water shortage in the dry season during the period of peak irrigation demand. This is considered due to lack of the appropriate planning of basic infrastructure for the water distribution. There is approximately 400,000 people in Grand Skopje and 100,000 in the city of Kumanovo.

Further, wells in/around Grand Skopje, are being polluted by untreated wastewater discharged by the population as well as by various types of industries such as metal, ferrous metallurgy, petroleum and chemical, paper industries concentrated in the metropolitan area.

For the future, it is looking to develop surface water resources. Two multi-purpose reservoir projects have been identified. One is the Kozjak project (currently under construction) which would supply water for industry (principally the steel smelter, currently out of commission, that used to be supplied from Rashche springs), and the other is the Kadina project which would supply water for municipal use, industry, and irrigation.

To reduce water shortage in Kumanovo, a third reservoir at Slupchane for municipal and irrigation use is being envisaged.

The central-western part of this region located at the skirts of Vodno and Suva Planina mountains faces problems of water shortage due to lack of sufficient water supply facilities. During summer season, rainwater gathered from roofs and supply service by a tank lorry are also utilized to meet the demand. Some of the villages located in the mountain area have poor accessibility to safe drinking water.

(b) Tetovo

Tetovo is supplied from 4 high-elevation mountain springs located in the vicinity of the Popova Shapka ski area. However, as temperature at this elevation can fall to –15°C in February, these springs are subject to freezing. Consequently Tetovo experience water shortage in winter. The possibility of intercepting further high-elevation springs has been investigated, however, these would also be susceptible to freezing. Another alternative would be a connection to the existing mini-hydro intake at Pena, but runoff is negligible in winter for the same reason. However, it is generally agreed that a more satisfactory option would be to abstract groundwater locally, over this critical period, for which wells have been already been developed at Studena Voda, but have not yet to be connected.

(c) Kratovo and Kriva Palanka

The problems of the eastern parts such as Kratovo (current source is from river intake) and Kriva Palanka (current source is from springs) areas are characterized by severe shortage of safe drinking water during the dry season due to low water in the river for Kratovo and insufficient water supply system for Kriva Palanka.

Kriva Palanka supplied from high-elevation springs like Tetovo suffers also from freezing in winter.

There are also ecological problems caused by untreated wastewater by the mining industries. Only limited number of development projects have been inputted so far in this area of the country.

Kratovo has already constructed a river intake upstream of the Zletovska river, currently abstracting 50 l/sec. and the addition of a service reservoir should overcome daily peak supply problems during summer.

(d) Kichevo and Makedonski Brod

These municipalities are supplied by the Studencica system, which is allocation of springs located near Kichevo. This system experiences a major water shortage crisis in 1990. Several solutions have been proposed for the Studencica system joined with Krushevo and Prilep as mentioned hereinafter.

(e) Mountainous area in this region and border areas with FRY and Albania

The problems in some villages of these areas are limited accessibility to safe water. In those villages, occurrence of waterborne disease is common among the infants and school children.

(2) Problems Relating to Agricultural Water

There are the problems caused by irrigation water shortage, especially in the Polog field in Tetovo, because of insufficient irrigation systems for their active fruit production in spite of their abundant water resources from spring. The World Bank project for irrigation system rehabilitation has been conducted targeting the Polog field.

3.2.2 Problems Identified in Vardar River Middle Reach

(1) Problems Relating to Municipal and Industrial Water

(a) Veles

Originally, Veles with population of 75,000, of whom 50,000 persons live in urban areas, was supplied by groundwater from wells near the Vardar River. However, since these wells have become polluted and might have some sanitation problems, municipal supplies are now provided from an intake on the Topolka River, an unpolluted tributary of the Vardar, although the original wells are having to be used to augment supply in the summer. To keep the water quality, network facilities after the processing plant need to be rehabilitated.

There is seasonal water shortage during the summer, due to low water in the Topolka River. To solve the problem, water from both the wells and springs is being utilized, and the solution proposed for the long term is the Lisiche dam on the Topolka River, which is currently under construction, however present financial constraints have effectively halted progress.

Veles is also characterized by its concentrated industrial activities including a zinc and lead smelter, porcelain, textile, construction equipment and leather factories. These factories are widely scattered in the town area; their wastewater is being discharged without any treatment, which causes deterioration of surface water quality and leads to health problems among the employees and inhabitants.

Although a project of constructing wastewater treatment plants has been implemented with the financial assistance from the government of Japan (Japanese Special Fund), it covers limited number of factory. Therefore, further countermeasures to cope with all the wastewater problems in this city are required. Based on the present situation, it would be very difficult to relocate these existing factories into one place for efficient wastewater treatment.

(b) Sveti Nikole, Shtip and Probishtip

These municipalities in the east of Macedonia often experience serious water shortage during summer, due to limited quantity of water from the reservoir for Sveti Nikole(the country's most driest area with annual rainfall of 385 mm), wells near the Bregalnica River for Shtip and pumped wells from alluvium for Probishtip.

The proposed solution is to construct a multi-purpose reservoir at Knezevo on the Zletovska River, a tributary of the Bregalnica. The proposal reservoir would provide additional water supplies to these municipalities as well as irrigation, with an optional mini-hydro cascade development.

However, the cost of the reservoir is high and an alternative solution might be to defer construction of the dam to a later stage and construct river intakes, filter stations and service reservoir as a first stage.

As mentioned in Subsection 3.2.1, Kratovo has already constructed a river intake, currently abstracting 50 l/sec, and the addition of a service reservoir should overcome daily peak supply problems during summer.

Probishtip would require an intake with an initial capacity of 100 l/sec, filter station and service reservoir to meet the current peak of 150 l/sec.

Sveti Nikole is supplied by the Marvovica reservoir which experiences shortage in summer, however, during these periods abstractions are made from the Bregalnica irrigation canals.

Shtip is currently supplied by groundwater, although it is reported water quantity is insufficient and the quality is poor. However, an initial assessment of groundwater quality indicates that chlorination could solve the problem.

(c) Kochani and Vinica

At Kochani, municipal supplies are met by groundwater which has become polluted by agricultural pesticides. Nearby, Vinica is supplied mainly by surface water from an intake on the Gradecka River which is augmented by groundwater in summer, however the resources are insufficient. There is a plan to provide additional wells and a small reservoir for daily regulation on the Gradecka for Vinica. An alternative solution for the long term would be to construct a reservoir at Recani in the Orizarska River, which would solve the water supply problems of both Kochani and Vinica. The first stage of the project would include a river intake and carriers to Kochani and Vinica. The second stage would include Rechani dam and a possible hydropower development.

(d) Delchevo and Berovo

To overcome water shortage in the summer around Delchevo, where source of water supply is wells, a new intake and filter station is currently under construction.

Pehchevo, a town near Berovo, where water is supplied from the Pechevska Reka, experiences water shortage in the summer and requires a new intake and filter station. Belgian aid is assisting with this project.

(e) Mountainous area in this region and border areas with Bulgaria

The problems in some villages of these areas are limited accessibility to safe water. In those villages, occurrence of waterborne disease is common among the infants and school children.

(2) Problems Relating to Agricultural Water

Areas in the Bregalnica River basin have problems of irrigation water shortage instead of their potentials in further agricultural development. The irrigated area is limited and the existing irrigation system needs to be rehabilitated to increase the irrigation efficiency.

The World Bank project for irrigation system rehabilitation is being implemented covering a part of this area.

### 3.2.3 Problems Identified in Vardar River Lower Reach

This region is subdivided into two groups; one is the Pelagonija area including former municipalities of Demir Hisar, Krushevo, Bitola and Prilep, and the other is the Vardar River lower basin includes Negotino, Valandovo, Gevgelija and Kavadarci, which is situated in the Crna River basin.

The Pelagonija having total irrigable area at present of 29,000 ha suffers from insufficient supply of irrigation water and poor drainage network for irrigation. Tobacco production is the main economic activities in this area; it is required to strengthen their income generation activities through diversifying agricultural products.

In the Vardar lower basin including Kavadarci on the Crna River basin, agriculture specially wine and vegetable/fruits production is the main economic activities, and wine is the major product. There are various food processing industries, besides winery, production of juice, sauce preserved tomatoes, etc, especially in Gevgelija.

(1) Problems Relating to Municipal and Industrial Water

(a) Demir Hisar

Demir Hisar, which is located in a mountainous area and provided water supply from springs, has the problem of seasonal shortage of drinking water. This is because of limited water resources, poor networking systems, and inefficient utilization of water resources.

(b) Prilep and Krushevo

Both municipalities are supplied by the Studencica system, which is a collection of springs located near Kichevo. This system experienced a major water shortage crisis in 1990, and the following alternative solutions have been proposed, incorporating municipalities of Kichevo and Makedonski Brod:

1) Additional service reservoirs for Prilep and Kichevo,

2) Provision of alternatives surface water supplies for the Oslomej thermal power plant, and

3) Development of additional springs at Pitran

(c) Bitola

Bitola has three sources of municipal supply, groundwater, surface water from 4 mountain stream intakes, and the Strezevo reservoir on the Shemnica River. Of them, since completion of the Strezevo reservoir, abstraction of groundwater has ceased to save pumping costs. The Strezevo reservoir provides sufficient supplies for municipal, industrial (including the Bitola thermal power plant) and irrigation usage and there is no requirement for further expansion at present.

(d) Vardar lower basin including Kavadarci on the Crna River basin

There is drinking water shortage from May to October in Negotino. For example, a 12-hour restriction is sometimes carried out (this is also reported on agricultural water).

There is plenty of water resource in the Tikvesh reservoir solely for irrigation, however, it has not been effectively utilized. Especially, the distribution network of drinking water needs to be rehabilitated. There are some villages in this area without any water supply system as well as on the opposite bank of the Vardar like Valandovo, Bogdanci, etc.

Villagers sometimes use water from the Vardar River, which causes sanitation problems.

(e) Mountainous area in this region and border areas with Greece

The problem in some villages of these areas is no accessibility to safe drinking (and irrigation) water, which has inhibited income generation activities of the inhabitants and led to a large number of migrating population from these villages to urban areas.

(2) Problems Relating to Agricultural Water

Facilities in the Tikvesh irrigation system are deteriorated, resulting in lowering of irrigation efficiency. In July 1995, Kavadarci-Negotino area was visited by a catastrophic flood. The flood caused huge damages of agricultural products. Improvement of regulation and facilities are being planned.

The World Bank project for irrigation system rehabilitation is being implemented in the northern part of Kavadarci.

(3) Other Problems

Lake Dojran has the problem of deterioration of environment at lake shore due to decrease of water level. There is bank erosion along the Vardar River approximately 20 km upstream from Gevgelija.

3.2.4 Problems Identified in Crn Drim River Basin

(1) Problems Relating to Municipal Water

(a) Ohrid

Ohrid was originally supplied from minor springs and after they became fully developed an intake was constructed to abstract water from Lake Ohrid. However, the intake filters repeatedly become blocked by plankton and PHARE program has recently funded a project to supply new filters, however initial reports indicate the problem is still not solved. An alternative solution, that has been investigated, would be to develop another springs system 32km from Ohrid at Sveti Naum.

(b) Struga

Struga is also located by the side of Lake Ohrid, but takes its water for municipal use from 2 systems of springs. Water shortages are experienced during summer, especially during the height of the tourist season. The municipality is reluctant to abstract water from the lake in view of the problems experienced by Ohrid and instead has proposed a two stage solution. The first stage would be to construct two service reservoirs to overcome the peak supply problem in summer. In the long term, the second stage would intercept high-elevation springs located to the northwest of Struga. The concept is similar to that currently in use in Tetovo, except that it is understood that the Struga springs are not susceptible to freezing. There is also a two-stage hydropower component to this project.

This project has started but has run into financial difficulties. The yield from this project could resolve the problems of both Struga and Ohrid, at least in the medium term, and serious consideration should therefore be given to completing this project as a joint Struga/Ohrid endeavor.

(e) Mountainous area in this region and border areas with Albania

The problems in some villages of these areas are limited accessibility to safe water. In those villages, occurrence of waterborne disease is common among the infants and school children.

(2) Problems Relating to Agricultural Water in Resen

Around Resen, insufficient supply of irrigation water has become a constraint in agricultural development in this area. Rehabilitation of the country's oldest existing irrigation system is needed in order to improve their production efficiency of early grown vegetables for export.

(3) Other Problems

(a) Environmental protection of Lake Ohrid

Environmental protection of Lake Ohrid is the main issue around this area. For example, it has suffered from decrease of fish catch and change of macrophytic vegetation at the estuary of the Sateska River. Several donor projects are being implemented to protect the water quality and environmental conditions of the area.

Under the Global Environment Facilities (GEF), the Macedonia-Albania joint project for conservation of the Lake has been prepared in cooperation with World Bank, GTZ, and Switzerland Government. The project comprises four components: improvement of water quality monitoring system, preparation of watershed management taskforce, registration and reinforcement system improvement and promotion of public awareness.

(b) Inundation near the confluence of the Sateska River

Near the confluence of the Sateska River (old channel), there exists the problems of frequent occurrence of inundation, due to lowly undulating terrain, which negatively influence on living conditions and agricultural activities in the communities.

### 3.2.5 Problems Identified in Strumica River Basin

(1) Problems Relating to Municipal and Industrial Water

At Radovish, municipal water supplies are met by groundwater, however, shortage is experienced in urban areas in summer and the source of water supply has become polluted. Strumica, on the other hand, is supplied from the Turija reservoir, which suffers irrigation water shortages in summer, thus affecting municipal water supplies to urban areas of Strumica.

Deterioration of water quality caused by discharging untreated wastewater and poor maintenance of water supply system is also getting more conspicuous.

The proposal here is for a joint multi-purpose reservoir on the Oraorica and Plavia Rivers to supply both Radovish and Strumica, as well as providing additional supplies for river maintenance flow and for irrigation. An alternative for Radovish would be additional spring development plus a surface water intake. Strumica experiences probably the most serious shortage of not only municipal but also irrigation water.

(2) Problems in Mountainous and Border Areas with Bulgaria and Greece

The problems in some villages of these areas are limited accessibility to safe water. In those villages, occurrence of waterborne disease is common among the infants and school children.

(3) Problems Relating to Agricultural Water

In the rural areas, insufficient irrigation water is serious especially in the Strumica field. Here, agricultural production is also a main player of the economy; limited area with irrigation system as well as poor maintenance of the existing irrigation system negatively affects further development.

## 3.3 Problems with Institutions and Legal Systems

### 3.3.1 In the Policy-making Level

(1) Limited Coordination System

In the sector of water resources development and management in Macedonia, several ministries are involved including three major executing ministries: MAFWE, MUPCE (divided into MUPC and MOEn in December 1998), and MOE. MOD has made coordination among these water-related ministries and agencies in planning development projects. However, the coordination system has not practically functioned yet. Each ministry and agency has made a development plan and implemented a project separately, although harmonization among them is essential for effective and efficient development and management of limited water resources in this country.

No ministries or agencies have grasped the entire picture of the development projects being planned and/or implemented in the water resources sector. Follow-up and monitoring activities about budgeting and construction progress for individual projects have not been well organized and then the information on the projects is not being gathered or managed in a system. In some projects, large-scale construction had started before guaranteeing the entire budget and the construction has been suspended due to lack of fund in spite of the strong needs from the inhabitants. Comprehensive guidance in the planning stage needs to be provided about planning of project implementation and budget management. In addition, monitoring system for project implementation should be established.

(2) Lack of Practical and Effective Standards and Regulations

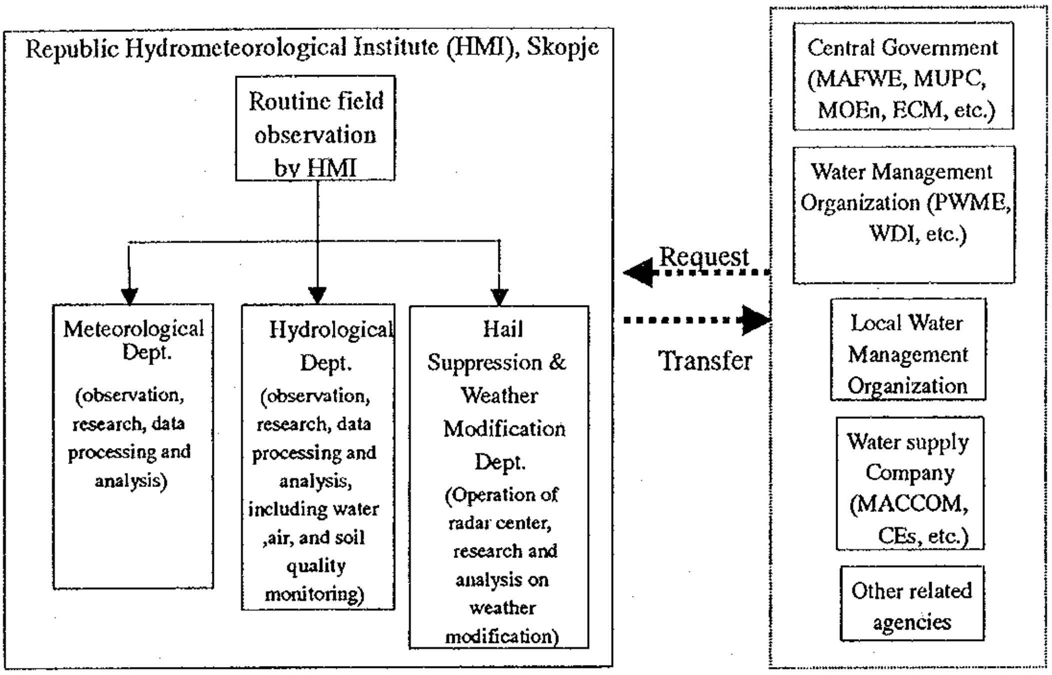
As for the new Water Law, it is too soon to discuss its effectiveness. However, preparation of practical and effective standards and regulations for wastewater discharge, water quality, environment protection etc. as well as establishment of a strong enforcement system are strongly and urgently required. The Law specifies that MAFWE is responsible for river basin management, control of water quality of water sources, and water quantity management, MUPCE for control of wastewater discharge and environment conservation, and MOH for control of drinking water quality. However, there are no concrete measures for promoting economical use of water resources

(3) Disorganized Technical Information System

No effective system of technical data collection, processing and utilization has been established yet. Data has been collected and kept by individual agencies. For example, for hydrometeorological information, HMI is the sole responsible agency in the country to perform monitoring of climate, river flow and water, air, and soil quality. There are three departments, that is Meteorological, Hydrological, and Hail Suppression & Weather Modification Department, which have responsibility of the routine observations over the national territory.

All of the observed data are gathered and stored at HMI main office in Skopje. Data processing and converting to the digital records into the computer system as well as scientific analyses are one of their main tasks. No regular publishing and disseminating system of compiled data has been established yet. Thus, any kind of annual or monthly review of climate and hydrology is not available to public.

In case other Ministries or Agencies require the hydrometeorological data, they must inform their intention and extent/details of necessary data to HMI. After receiving the request, HMI will confirm availability of the data and release them if this is acceptable. The system can be summarized in the following figure:




**Hydrometeorological Data Distribution System in HMI**

Considering no existence of data dissemination system on hydrometeorological information, it should be noted that, firstly, publishing of the annual monthly reports on main climatological/ hydrological parameters by HMI is quite essential. Secondly, it is recommended that formation of data dissemination system among concerned Ministries/Agencies is organized immediately. Without such kind of system, keeping consistency of the planning criteria and timely updating of the specific development projects become difficult.

### 3.3.2 In the Executing Agency Level

#### (1) Needs of Early Functioning of the PWME System

Since the establishment of the PWME headquarters in Skopje in May 1998, a new water resources management system has been formed. Restructuring of regional water management systems is still under consideration, especially on how the current decentralized WMO system should be converted into the new PWME centralized system. It may take another couple of years before the PWME system will fully function.

The Statute of PWME describes the functions, however, it does not specify the exact roles of PWME in water resources development and management, background and objectives of its establishment, and activities. Additionally, provisions prepared from the aspects of improvement of services for water users are not included. Water charges from water users and Water Fund are expected to become major financial sources of PWME, although the branches continue to be allowed to conduct their diversified profit-making activities, which have no direct relationship with water supply.

(2) Many Constraints of Communal Enterprises

Drinking water supply has been provided by Communal Enterprises (CEs), which is supervised by the municipal governments. The quality and contents of their services are quite diversified. They have promoted their businesses individually in cooperation with the municipal governments and the WMOs in the same coverage areas. Most CEs have faced various problems with seasonal water shortage, polluted water quality of drinking water, aged water supply facilities, and financial constraints due to low collection rate of water charges.

(3) Low Collection Rate of Water Charges

There are differences by area in the collection rate of water charges. Many areas have suffered from low collection rate of agricultural water charges, which is mostly less than 50%, since the independence of the country. This is firstly because sufficient irrigation water is not provided due to the aged and deteriorated facilities, and secondly because income of farmers is reduced due to loss of big market in the Former Yugoslavia.

The reasons of the low collection rate of municipal water charge, which is around 50%, are; a) water supply services are not stable due to the seasonal shortage; b) a system for water charge collection has not been well established; and c) regulations for non-payers of water charges have not been developed.

The low and still decreasing collection rate of water charges has a negative influence on the financial status of WMOs and CEs, which leads to reduced quality of facility operation and maintenance. These circumstances have formed a vicious circle.

(4) Little Publicity of ACU

The concept of establishment and role of the Aid Coordination Unit (ACU) is not always recognized as the coordinator of donors to Macedonia.

## 3.4 Problems Identified through PCM Workshop

### 3.4.1 General

The PCM*[1] Workshops were held in Skopje, Radovish, Krushevo, Kochani, and

*[1] The PCM (Project Cycle Management) method is a tool for managing the entire cycle of a development project by means of a project format termed the PDM (Project Design Matrix): which has been introduced for its project planning and monitoring and evaluation by JICA (Japanese International Cooperation Agency).
A PCM workshop, which consists of five steps of planning: participation analysis, problem/objective/alternative/analyses and PDM formulation, provides a place for discussing and analyzing existing problems and formulating projects through participatory approach.

Gevgelija during the second and third field surveys. The main purposes of the Workshops are to understand actual local problems, to identify local needs, potentials and available resources, and to improve awareness of project ownership and importance of active participation through a participatory planning method.

The major problems and needs clarified in the Workshops, which are utilized one of the criteria of the project evaluation for the master plan formulation, can be summarized as follows:

### 3.4.2 Output from the Workshops

#### (1) Skopje Workshop

The urban area of Skopje has problems that are common to rapidly growing and overpopulated urban areas, while the rural area has problems caused by lack of basic infrastructure. The population in the urban area do not seriously suffer from the shortage of drinking water and their main concern is the growing possibility of polluted water sources. This is mainly caused by untreated wastewater due to many industrial polluters, poor enforcement system of laws and regulations, poor respect to laws, and insufficient inspection services.

In the rural area, limited access to the safe drinking water is the biggest problem. Shortage of irrigation water is another serious problem. Various effects are caused this problem such as occurrence of a wide range of epidemic diseases, occurrence of communicable (waterborne) diseases among primary school students, poor hygiene situation in individual houses and public places, etc.

#### (2) Radovish Workshop

The main concern among the population is seasonal shortage of drinking water in towns, low water quality, and lack of irrigation water. Limited volume of developed water sources, inefficient use of water resources, and poor management of water facilities were pointed out as the reasons of seasonal drinking water shortage and bad water quality.

Irrigation water shortage is mainly caused by poorly maintained irrigation system and the need of preparation of agriculture production plan was clarified. Eventually, these problems have caused growing tendency of migration from the villages in this area.

#### (3) Krushevo Workshop

No accessibility to safe drinking water in mountain villages, serious water shortage in urban areas and insufficient quantity of irrigation water were identified as the major problems in this area. The local problems and needs were concentrated especially on the irrigation water shortage, because this area has the potentials of agricultural development (tobacco, fruits etc.).

Irrational use of water resources, limited irrigation systems, poorly developed drainage system, and low collection rate of water charges were considered to be the major causes of these problems.

(4) Kochani Workshop

Seasonal shortage of drinking water and irrigation water, lack of water supply facilities, and low water quality were pointed out as the main problems in this area. The seasonal shortage of irrigation water supplied from the Kalimani reservoir has been caused by the low temperature of water in the reservoir, great water loss, and insufficient capacity of water supplying facilities. Institutional problems such as including poor management of existing pumps and poor maintenance of irrigation system were one of the biggest reasons for these problems. In addition, rice production might cause the irrigation water shortage; the existing irrigation system mainly designed for rice may lead to irrational use of water resources.

As for the problem of water quality, poor health and sanitary conditions among inhabitants were mentioned as the effects. Deteriorated water supply network, shortage of water treatment facilities, and insufficient hydrogeological research were listed up as the causes from the technical viewpoints. At the same time, there are institutional problems related to poorly-organized regulation enforcement system.

(5) Gevgelija Workshop

In the Gevgelija workshop, limited irrigation water and seasonal shortage of drinking water were pointed out as the major problems. For the population in this area, irrigation water shortage is more serious due to its big potential of agriculture production such as vegetables and fruit.

The main causes of irrigation water shortage are insufficient equipment and facilities; lack of hydro-system, irrigation network, and irrigation equipment; obsolete channel network and irrigation pump; and great distance between the connections in the network. In addition, it was pointed out that the natural conditions including high temperature in summer and strong wind caused drought and other negative effects, which led to lack of surface water. In addition, institutional matters were also selected as the causes: such as inefficient land division, improper cropping pattern, low level of farming technology, old irrigation method, low collection rate of water charge, poor facility maintenance, and limited protection of water quality in the rivers.

# *CHAPTER 4*

# *DEVELOPMENT POTENTIAL*

## CHAPTER 4 DEVELOPMENT POTENTIAL

### 4.1 General

Development potential of water resources is estimated by multiplying an annual balance between precipitation and evapotransipration, into the national land area. Among them no data was obtained for snowfall and evapotranspiration.

From these circumstances, the development potential was studied based on the potential of surface water and groundwater, and the potential was compared with the annual rainfall amount.

### 4.2 Surface Water

Potential of surface water is regarded as the total of discharge in the Vardar River and its tributaries of the Treska, Pchinja, Bregalnica, and Crna rivers, the Crn Drim River, and the Strumica River. Flow duration in major rivers is tabulated below:

**Flow Duration in Major Rivers**

(unit : $10^6 m^3$/year)

| River Basin | Catchment Area ($km^2$) | Average Discharge | 97% (355 days) | 75% (265 days) | 50% (175 days) | 25% (90 days) |
|---|---|---|---|---|---|---|
| 1. Vardar | 22,301 | 4,289 (136.0) | 691 (21.9) | 1,958 (62.1) | 3,157 (100.1) | 5,557 (176.2) |
| 2. Treska | 1,880 | 735 (23.3) | 164 (5.2) | 303 (9.6) | 558 (17.7) | 1,006 (31.9) |
| 3. Pchinja | 2,794 | 375 (11.9) | 25 (0.8) | 110 (3.5) | 259 (8.2) | 517 (16.4) |
| 4. Bregalnica | 2,897 | 353 (11.2) | 35 (1.1) | 123 (3.9) | 218 (6.9) | 407 (12.9) |
| 5. Crna | 4,526 | 706 (22.4) | 57 (1.8) | 164 (5.2) | 419 (13.3) | 984 (31.2) |
| 6. Crn Drim | 1,899 | 738 (23.4) | 303 (9.6) | 628 (19.9) | 697 (22.1) | 842 (26.7) |
| 7. Strumica | 1,401 | 120 (3.8) | 3 (0.1) | 28 (0.9) | 60 (1.9) | 136 (4.3) |

(Figures in ( ) show discharges ($m^3$/sec))

At the gauging station of Gevgelija sited on the most lower reach of the Vardar River in the territory of Macedonia (with a catchment area of 22,301 $km^2$ – covers 87 % of 25,713 $km^2$), the annual amount of an average discharge is estimated at 4,289 x $10^6 m^3$/year. Summing up the discharge in the Vardar River (4,289 x $10^6 m^3$/year), that in the Crn Drim River (738 x $10^6 m^3$/year), and that in the Strumica River (120 x $10^6 m^3$/year), the total potential of surface water on an average is estimated at 5,147 x $10^6 m^3$/year, approximately 5,000 x $10^6 m^3$/year.

## 4.3 Groundwater

### 4.3.1 Groundwater Resources

The development potential of groundwater consists of that of groundwater used and /or to be used through wells and that of spring water.

The potential is estimated at 30.47$m^3$/sec, that is 960.9x$10^6$$m^3$/year, which is summarized and tabulated below:

1) Total exploited volume of groundwater in unconsolidated sands and gravels aquifer (used/to be used through wells) amounts to 1.99$m^3$/sec, that is 62.8x$10^6$$m^3$/year and the potential of groundwater in the aquifer amounts to 6.32$m^3$/sec, i.e. 199.3x$10^6$$m^3$/year.

2) Total exploited amount of groundwater in faults and fractured zones(categorized to groundwater/spring depending on the situation) is as small as 0.05$m^3$/sec, that is 1.6x$10^6$$m^3$/year and the potential of groundwater in the zones amounts to 0.16$m^3$/sec, that is 5.1x$10^6$$m^3$/year.

3) Total exploited volume of groundwater in karst limestone and marble aquifer amounts to 7.73$m^3$/sec, that 243.8x$10^6$$m^3$/year and the potential of groundwater in the aquifer amounts to 23.99$m^3$/sec, that is 756.5x$10^6$$m^3$/year. The amount of groundwater in the karst limestone and marble aquifer is estimated to be almost yield of springs.

4) The total exploited volume of groundwater amount to 9.77$m^3$/sec, that is 308.2x$10^6$$m^3$/year, which is equivalent to 32.0% of the potential of groundwater.

5) The amount of the groundwater, of which explorations have been already finished and evaluated properly, is calculated to be 1.98$m^3$/sec, that is 62.4x$10^6$$m^3$/year, which is equivalent to 6.5% of the potential of groundwater.

6) The amount of the groundwater, which some explorations have been done but not yet evaluated properly, is calculated to be 18.72$m^3$/sec, i.e. 590.3x$10^6$$m^3$/year, which is equivalent to 61.5% of the potential of groundwater.

**Groundwater Resources**

| Aquifer/Zone | Amount | | | | |
|---|---|---|---|---|---|
| | (1) Exploited (under use) $m^3$/sec | (2) Exploration finished $m^3$/sec | (3) Exploration level $m^3$/sec | (4) Total (1 to 3) $m^3$/sec | Potential (Annual Base) $10^6m^3$/year |
| Unconsolidated sands & gravels ($10^6m^3/year$) | 1.99<br>(62.8) | 0.79<br>(24.9) | 3.54<br>(111.6) | 6.32<br>(199.3) | 199.3 |
| Faults & fractured zones($10^6m^3/year$) | 0.05<br>(1.6) | - | 0.11<br>(3.5) | 0.16<br>(5.1) | 5.1 |
| Karst limestone and Marble ($10^6m^3/year$) | 7.73<br>(243.8) | 1.19<br>(37.5) | 15.07<br>(475.2) | 23.99<br>(756.5) | 756.5 |
| Total ($m^3/sec$)<br>($10^6m^3$/year)<br>( % ) | 9.77<br>308.2<br>(32.0%) | 1.98<br>62.4<br>(6.5%) | 18.72<br>590.3<br>(61.5%) | 30.47<br>960.9<br>(100%) | -<br>960.9<br>(100%) |

### 4.3.2 Groundwater Used/to Be Used through Wells

Amounts of exploited and potential groundwater used/to be used through wells by river basin/valley are calculated below:

**Exploited and Potential of Groundwater by River Basin/Valley**

(Unit: $10^6m^3$/year)

| River Basin/Valley | Exploited | Potential |
|---|---|---|
| Polog valley | 6.31 | 25.23 |
| Skopje valley (Upper) | 7.88 | 25.23 |
| Skopje valley (Lower) | 7.88 | 26.81 |
| Kichevo valley | 0.32 | 3.78 |
| Pchinja River | 2.84 | 8.20 |
| Kriva Reka. | 0.32 | 4.10 |
| From Pchinja to Veles with Babuna & Topolka | 2.52 | 5.68 |
| Berovo-Delchevo | 2.21 | 4.73 |
| Kochani-Shtip | 6.31 | 16.71 |
| Zletovska River | 0.95 | 1.89 |
| Kriva Lakavica River | 0.63 | 0.95 |
| Ovche Pole valley | 1.26 | 3.78 |
| Upper part of Crna River, Pelagonija | 3.78 | 15.77 |
| Low part of Crna River | 3.15 | 9.46 |
| Lower Vardar | 9.78 | 18.92 |
| Radovish | 0.63 | 4.73 |
| Strumica | 1.58 | 6.31 |
| Crn Drim | 4.42 | 17.03 |
| Total | 62.77 | 199.31 |

### 4.3.3 Spring Water

According to the study of "The Water Economy Basis of Macedonia", there are 4,414 registered springs with various yields observed by the nationwide spring surveys in the summer seasons (mainly July & August) of 1975 and 1976 as shown in Figure 4.1. The information on the springs is composed of 17 items including spring name, location, geology, present condition, yield, etc., which is stored in a database.

Number of yield data and yield of free flowing spring water, which will be developed from now on, are assumed to be 2,347 and 434.8 x $10^6 m^3$/year), respectively. Tapped springs are located along various roads and are used for micro-scale water supply because of their low yield (mainly less than 1 l/sec). Captured springs are utilized for large-scale water supply of cities and villages. The total number and yield of tapped and captured springs are 1,918 and 195.2 x $10^6 m^3$/year, respectively.

Number and yield of springs are categorized by type of present usage and summarized in the following table.

**Number and Yield of Tapped and Captured Springs**

| Present usage | Total number of springs | No. of springs with yield data | | Total yield ($x10^6 m^3$/year) | |
|---|---|---|---|---|---|
| (1) Free Flowing | 2,389 | 2,347 | (55%) | 434.8 | (69%) |
| (2) Tapped | 1,645 | 1,630 | (38%) | 22.1 | (3.5%) |
| (3) Captured | 380 | 288 | (7%) | 173.1 | (27.5%) |
| Subtotal (2+3) | 2,025 | 1,918 | | 195.2 | (31%) |
| Total (1 to 3) | 4,414 | 4,265 | (100%) | 630.0 | (100%) |

Numbers of springs and yields by river basin are categorized in the following table.

**Number of Springs and Yields by River Basin**

(Unit: $10^6 m^3$/year)

| River Basin | Number | Average | Total | Free Flowing | Tapped & Captured | Maximum |
|---|---|---|---|---|---|---|
| Polog | 180 | 0.467 | 84.06 | 51.45 | 32.62 | 30.13 |
| Treska | 183 | 0.390 | 71.38 | 67.92 | 3.46 | 40.18 |
| Kichevo | 220 | 0.478 | 105.10 | 98.20 | 6.90 | 16.07 |
| Skopje (upper) | 132 | 0.918 | 121.15 | 11.77 | 109.38 | 104.26 |
| Skopje (lower) | 273 | 0.034 | 9.23 | 8.45 | 0.79 | 0.70 |
| Veles | 147 | 0.025 | 3.68 | 2.64 | 1.04 | 0.35 |
| Pchinja | 379 | 0.010 | 3.76 | 2.64 | 1.12 | 0.36 |
| Kriva Reka | 221 | 0.009 | 2.04 | 0.93 | 1.11 | 0.44 |
| Ovche Pole | 83 | 0.010 | 0.84 | 0.06 | 0.78 | 0.20 |
| Kriva Lakavica | 129 | 0.009 | 1.18 | 0.79 | 0.39 | 0.41 |
| Zletovo | 81 | 0.009 | 0.70 | 0.45 | 0.25 | 0.18 |
| Shtip-Kochani | 240 | 0.026 | 6.22 | 4.11 | 2.11 | 0.56 |
| Delchevo | 168 | 0.014 | 2.43 | 1.82 | 0.61 | 0.28 |
| Crna (upper) | 645 | 0.094 | 60.64 | 54.98 | 5.66 | 23.50 |
| Crna (lower) | 183 | 0.025 | 4.54 | 3.39 | 1.15 | 0.82 |
| Gevgelija | 319 | 0.078 | 24.80 | 19.19 | 5.61 | 4.64 |
| Radovish | 80 | 0.008 | 0.61 | 0.47 | 0.14 | 0.07 |
| Strumica | 145 | 0.039 | 5.59 | 4.16 | 1.43 | 1.00 |
| Dojransko | 18 | 0.013 | 0.23 | 0.08 | 0.15 | 0.04 |
| Cironska | 12 | 0.002 | 0.03 | 0.01 | 0.02 | 0.01 |
| Crn Drim* | 427 | 0.285 | 121.78 | 101.30 | 20.48 | 168.94 |
| Total | 4,265 | | 630.01 | 434.81 | 195.20 | |

Note : * The spring of Sveti Naum is excluded from the calculation, because it is a kind of river flow.

Only 59 springs (1.4%) have a discharge greater than 100 l/sec. and those with a discharge greater than 10 l/sec are 326 in number (7.6%), which are mostly distributed in the western parts like the Shara Mountain of the Vardar River basin, the Treska River basin and the Crn Drim River basin.

880 springs (20.6%) have a discharge between 1 l/sec and 10 l/sec. and remaining 3,000 springs (70.4%) have a discharge less than 1 l/sec. Theses are scattered in all the land.

The total annual amount of free flowing spring water is 434.8 x $10^6 m^3$/year. The annual combined total amount of tapped and captured spring water is 195.2 x $10^6 m^3$/year.

### 4.3.4 Total Amount of Groundwater and Spring Water

Total amount of groundwater and spring water is summarized as follows:

**Total Amount of Groundwater and Spring Water**

(Unit: $10^6 m^3$/year)

| Situation | Groundwater (wells) | Spring Water | Total |
|---|---|---|---|
| 1. Exploited (under use) | 64.4(=62.8+1.6) | 195.2-243.8 | 259.6-308.2 |
| 2. Potential (available for development from now on) | 140.0(=136.5+3.5) | 434.8-512.7 | 574.8-652.7 |
| Total | 204.4(=199.3+5.1) | 630.0-756.6 | 834.4-960.9 |
| NDS 1997 | 520 | 420 | 940 |

(For spring water, the former figure shows that by the spring inventory, while the latter by the groundwater analysis)

The exploited quantity and potential for development of groundwater and spring water were divided and allocated for each of the former municipalities. The results are presented in Table 4.1.

Figure 4.2 illustrates the total development potential of the groundwater and spring water.

The potential of groundwater (960.9 x $10^6 m^3$/year) is equivalent to 18.7% of that of surface water or river water resources (5,147 x $10^6 m^3$/year), while quantity of groundwater in NDS 1997 is 940 x $10^6 m^3$/year which is equivalent to 18.3% of that of surface water or river water resources(5,147 x $10^6 m^3$/year).

Seasonal yield fluctuation is generally recognized. In order to clarify the fluctuation, regional (basin level) spring surveys have been carried out twice a year, autumn (September to December) and spring-summer (April to July), since 1982. The number of observed springs is 1,379 in total. The ratio of the yield in autumn to spring-summer (April to July) is calculated to be 0.64.

Monthly fluctuation is referred to that of the Rashche spring yield as described below.

### 4.3.5 Yield Fluctuation of Rashche Spring

Communal Enterprises supply municipal water including potable water from groundwater (spring and well) amounting to 147 x $10^6 m^3$/year(4.7 $m^3$/sec) for the most desirable water source, except 8 municipalities of Kumanovo, Kratovo, Sveti Nikole, Veles, Berovo, Bitola, Vinica, and Strumica.

The yield fluctuation of the Rashche spring, the largest one in Macedonia located about 15 km west of Skopje and at the foot of the mountain of Zeden, has been observed as follows for these 10 years from 1989 through 1998 (See Figure 4.3):

**Monthly Average Yield Fluctuation of Rashche Spring**

| Month | Yield ($m^3$/sec) |
|---|---|
| January | 3.7 |
| February | 3.7 |
| March | 3.8 |
| April | 4.0 |
| May | 4.4 |
| June | 4.2 |
| July | 3.9 |
| August | 3.8 |
| September | 3.7 |
| October | 3.6 |
| November | 3.5 |
| December | 3.6 |
| Average | 3.8 |

From the above,

1) Average yield : 3.8 $m^3$/sec
2) Maximum yield : 4.4 $m^3$/sec (May)
3) Minimum yield : 3.5 $m^3$/sec (November)

The maximum yield is estimated at 116% of the average yield, while the minimum is 92% of the average one.

Yield fluctuation among springs in each municipality differs, and also yield in wells show different fluctuation from that of springs. However, the yield fluctuation of the Rashche spring shown in Table 4.2 and Figure 4.4 is adopted as the typical pattern of yield fluctuation of spring water taking the availability of data at the present into consideration.

## 4.4 Potential of Water Resources

The total potential of surface water on an average is estimated at approximately 5,000 x $10^6 m^3$/year.

On the other hand, the potential of groundwater is estimated at approximately 834 x $10^6 m^3$/year, consisting of that of wells (204 x $10^6 m^3$/year) and springs

($630 \times 10^6 m^3$/year).

Combining the potential of surface water and groundwater, the total potential of water resources in Macedonia on an average is estimated at approximately $6,000 \times 10^6 m^3$/year.

The annual rainfall ranges regionally, that is 1,000mm or less in the western, around 700mm in the eastern and around 500mm in the central part. In the whole land area, it is estimated at around 600mm. Therefore, the annual amount of rainfall in Macedonia is roughly estimated at $15,000 \times 10^6 m^3$/year (=25,713 $km^2$ x nearly 600 mm/year). Comparing the amount with the total potential of surface water on an average ($5,000 \times 10^6 m^3$/year), the loss rate is estimated at around 30%.

Further it is estimated at around 40%, when the amount is compared with the total potential of water resources on an average ($6,000 \times 10^6 m^3$/year).

## Table 4.1 Potential of Groundwater and Spring Water

| | Former municipality | A Exploited (under use) ($10^6m^3$/year) | | | B Potential for further exploitation ($10^6m^3$/year) | | | C=A+B Total potential ($10^6m^3$/year) |
|---|---|---|---|---|---|---|---|---|
| | | Groundwater | Spring | Subtotal | Groundwater | Spring | Subtotal | |
| 1 | Skopje | 16.40 | 107.46 | 123.86 | 38.09 | 13.11 | 51.20 | 175.07 |
| 2 | Gostivar | 0.82 | 35.74 | 36.56 | 2.46 | 59.07 | 61.53 | 98.09 |
| 3 | Tetovo | 5.49 | 5.20 | 10.69 | 16.46 | 30.11 | 46.57 | 57.26 |
| 4 | Kichevo | 0.32 | 6.93 | 7.25 | 3.46 | 78.93 | 82.39 | 89.64 |
| 5 | Makedonski Brod | 0.00 | 2.02 | 2.02 | 0.00 | 86.88 | 86.88 | 88.90 |
| 6 | Kumanovo | 1.58 | 0.95 | 2.53 | 4.57 | 1.99 | 6.56 | 9.09 |
| 7 | Kratovo | 0.47 | 0.22 | 0.69 | 1.37 | 0.17 | 1.54 | 2.24 |
| 8 | Kriva Palanka | 0.47 | 0.89 | 1.36 | 1.37 | 0.93 | 2.30 | 3.66 |
| 9 | Veles | 2.52 | 1.39 | 3.91 | 3.16 | 2.75 | 5.91 | 9.82 |
| 10 | Sveti Nikole | 1.26 | 0.74 | 2.00 | 2.52 | 0.06 | 2.58 | 4.58 |
| 11 | Shtip | 1.58 | 0.72 | 2.30 | 2.32 | 0.70 | 3.02 | 5.32 |
| 12 | Probishtip | 0.95 | 0.23 | 1.18 | 0.94 | 0.34 | 1.28 | 2.46 |
| 13 | Kochani | 3.72 | 0.74 | 4.46 | 6.14 | 1.10 | 7.24 | 11.70 |
| 14 | Vinica | 1.26 | 0.19 | 1.45 | 2.08 | 0.63 | 2.71 | 4.17 |
| 15 | Delchevo | 2.08 | 1.07 | 3.15 | 2.38 | 2.69 | 5.07 | 8.22 |
| 16 | Berovo | 0.13 | 0.32 | 0.45 | 0.14 | 1.86 | 2.00 | 2.45 |
| 17 | Demir Hisar | 0.54 | 3.01 | 3.55 | 1.14 | 47.30 | 48.44 | 51.99 |
| 18 | Krushevo | 0.29 | 0.3 | 0.59 | 0.61 | 0.86 | 1.47 | 2.06 |
| 19 | Bitola | 3.76 | 1.34 | 5.10 | 8.02 | 1.91 | 9.93 | 15.03 |
| 20 | Prilep | 2.17 | 1.12 | 3.29 | 7.80 | 6.44 | 14.24 | 17.53 |
| 21 | Kavadarci | 0.19 | 3.96 | 4.15 | 0.76 | 12.98 | 13.74 | 17.89 |
| 22 | Negotino | 3.28 | 0.32 | 3.60 | 3.06 | 0.99 | 4.05 | 7.65 |
| 23 | Valandovo | 0.02 | 1.2 | 1.22 | 0.02 | 6.02 | 6.04 | 7.26 |
| 24 | Gevgelija | 6.48 | 0.79 | 7.27 | 6.07 | 1.00 | 7.07 | 14.34 |
| 25 | Ohrid | 2.60 | 6.45 | 9.05 | 7.41 | 23.19 | 30.60 | 39.66 |
| 26 | Struga | 0.08 | 7.81 | 7.89 | 0.22 | 36.82 | 37.04 | 44.93 |
| 27 | Debar | 0.63 | 1.53 | 2.16 | 1.79 | 7.67 | 9.46 | 11.62 |
| 28 | Resen | 1.12 | 0.37 | 1.49 | 3.19 | 3.99 | 7.18 | 8.67 |
| 29 | Radovish | 1.00 | 0.44 | 1.44 | 4.29 | 1.03 | 5.32 | 6.76 |
| 30 | Strumica | 1.58 | 1.48 | 3.06 | 4.73 | 3.22 | 7.95 | 11.01 |
| | Total | 62.79 | 194.93 | 257.72 | 136.57 | 434.74 | 571.31 | 829.05 |

## Table 4.2 Yield Fluctuation of Rashche Spring (Average 10-day Basis)

(unit : $m^3$/sec)

| Month | 10 days | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | Average | Proportion |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan. | 1st | 0.00 | 3.56 | 3.22 | 3.56 | 3.12 | 3.29 | 3.60 | 4.20 | 4.20 | 4.30 | 3.67 | 0.96 |
| | 2nd | 0.00 | 3.50 | 3.22 | 3.50 | 3.07 | 3.31 | 3.59 | 4.40 | 4.40 | 4.10 | 3.68 | 0.97 |
| | 3rd | 3.22 | 3.38 | 3.24 | 3.42 | 3.08 | 3.43 | 3.59 | 4.70 | 4.62 | 3.80 | 3.65 | 0.96 |
| Feb. | 1st | 3.25 | 3.28 | 3.24 | 3.40 | 3.11 | 3.52 | 3.58 | 4.76 | 4.56 | 3.80 | 3.65 | 0.96 |
| | 2nd | 3.30 | 3.24 | 3.26 | 3.36 | 3.16 | 3.58 | 3.57 | 4.70 | 4.50 | 3.86 | 3.65 | 0.96 |
| | 3rd | 3.32 | 3.16 | 3.40 | 3.36 | 3.12 | 3.62 | 3.50 | 4.66 | 4.42 | 4.05 | 3.66 | 0.96 |
| Mar. | 1st | 3.50 | 3.20 | 3.70 | 3.36 | 3.05 | 3.64 | 3.45 | 4.68 | 4.39 | 4.20 | 3.72 | 0.98 |
| | 2nd | 3.60 | 3.26 | 4.00 | 3.36 | 2.98 | 3.66 | 3.42 | 4.82 | 4.20 | 4.30 | 3.76 | 0.99 |
| | 3rd | 3.70 | 3.30 | 4.20 | 3.40 | 3.25 | 3.72 | 3.47 | 5.00 | 3.96 | 4.40 | 3.84 | 1.01 |
| Apr. | 1st | 3.72 | 3.36 | 4.24 | 3.46 | 3.60 | 3.83 | 3.52 | 5.22 | 4.00 | 4.42 | 3.94 | 1.03 |
| | 2nd | 3.76 | 3.42 | 4.26 | 3.60 | 3.66 | 3.96 | 3.60 | 5.50 | 4.10 | 4.41 | 4.03 | 1.06 |
| | 3rd | 3.78 | 3.54 | 4.32 | 3.70 | 3.70 | 4.08 | 3.70 | 5.76 | 4.20 | 4.40 | 4.12 | 1.08 |
| May | 1st | 3.85 | 3.62 | 4.50 | 3.72 | 3.76 | 4.00 | 3.80 | 6.00 | 5.00 | 4.42 | 4.27 | 1.12 |
| | 2nd | 3.90 | 3.72 | 4.70 | 3.77 | 3.79 | 3.90 | 4.00 | 6.18 | 5.48 | 4.44 | 4.39 | 1.15 |
| | 3rd | 3.95 | 3.76 | 4.76 | 3.79 | 3.80 | 3.80 | 4.02 | 6.10 | 5.50 | 4.46 | 4.39 | 1.15 |
| June | 1st | 4.02 | 3.66 | 4.64 | 3.78 | 3.78 | 3.73 | 3.92 | 6.00 | 5.40 | 4.42 | 4.34 | 1.14 |
| | 2nd | 4.10 | 3.60 | 4.60 | 3.77 | 3.70 | 3.70 | 3.80 | 5.80 | 5.10 | 4.30 | 4.25 | 1.11 |
| | 3rd | 4.18 | 3.45 | 4.50 | 3.72 | 3.60 | 3.69 | 3.68 | 5.60 | 4.90 | 4.20 | 4.15 | 1.09 |
| July | 1st | 4.10 | 3.16 | 4.26 | 3.63 | 3.47 | 3.71 | 3.60 | 5.30 | 4.60 | 4.20 | 4.00 | 1.05 |
| | 2nd | 3.90 | 3.06 | 4.10 | 3.58 | 3.38 | 3.78 | 3.52 | 5.00 | 4.36 | 4.24 | 3.89 | 1.02 |
| | 3rd | 3.75 | 3.08 | 3.90 | 3.52 | 3.20 | 3.80 | 3.48 | 4.70 | 4.42 | 4.28 | 3.81 | 1.00 |
| Aug. | 1st | 3.76 | 3.18 | 3.70 | 3.51 | 3.09 | 3.74 | 3.44 | 4.58 | 4.50 | 4.10 | 3.76 | 0.99 |
| | 2nd | 3.80 | 3.28 | 3.60 | 3.50 | 3.20 | 3.62 | 3.42 | 4.60 | 4.62 | 4.00 | 3.76 | 0.99 |
| | 3rd | 3.86 | 3.30 | 3.40 | 3.50 | 3.28 | 3.56 | 3.42 | 4.65 | 4.90 | 3.90 | 3.78 | 0.99 |
| Sep. | 1st | 3.84 | 3.46 | 3.20 | 3.48 | 3.40 | 3.56 | 3.44 | 4.62 | 4.50 | 3.72 | 3.72 | 0.98 |
| | 2nd | 3.80 | 3.48 | 3.30 | 3.44 | 3.46 | 3.57 | 3.48 | 4.50 | 4.20 | 3.60 | 3.68 | 0.97 |
| | 3rd | 3.72 | 3.42 | 3.40 | 3.42 | 3.40 | 3.60 | 3.50 | 4.20 | 4.05 | 3.56 | 3.63 | 0.95 |
| Oct. | 1st | 3.62 | 3.36 | 3.44 | 3.42 | 3.25 | 3.62 | 3.46 | 3.90 | 4.00 | 0.00 | 3.56 | 0.94 |
| | 2nd | 3.58 | 3.32 | 3.46 | 3.40 | 3.15 | 3.63 | 3.41 | 3.85 | 4.10 | 0.00 | 3.54 | 0.93 |
| | 3rd | 3.46 | 3.44 | 3.48 | 3.38 | 3.10 | 3.62 | 3.38 | 3.82 | 4.20 | 0.00 | 3.54 | 0.93 |
| Nov. | 1st | 3.39 | 3.54 | 3.48 | 3.36 | 3.07 | 3.59 | 3.34 | 3.81 | 4.22 | 0.00 | 3.53 | 0.93 |
| | 2nd | 3.38 | 3.62 | 3.40 | 3.32 | 3.10 | 3.58 | 3.32 | 3.80 | 4.16 | 0.00 | 3.52 | 0.92 |
| | 3rd | 3.38 | 3.62 | 3.37 | 3.31 | 3.16 | 3.60 | 3.30 | 3.80 | 4.04 | 0.00 | 3.51 | 0.92 |
| Dec. | 1st | 3.70 | 3.50 | 3.32 | 3.28 | 3.20 | 3.60 | 3.50 | 3.82 | 4.26 | 0.00 | 3.58 | 0.94 |
| | 2nd | 3.50 | 3.40 | 3.58 | 3.21 | 3.24 | 3.62 | 3.80 | 3.90 | 4.40 | 0.00 | 3.63 | 0.95 |
| | 3rd | 3.56 | 3.36 | 3.62 | 3.18 | 3.25 | 3.61 | 3.94 | 4.00 | 4.56 | 0.00 | 3.68 | 0.96 |
| | Average | 3.68 | 3.41 | 3.78 | 3.49 | 3.33 | 3.66 | 3.57 | 4.75 | 4.47 | 4.14 | 3.81 | 1.00 |
| | | (3.64) | (3.38) | (3.77) | (3.50) | (3.31) | (3.66) | (3.57) | (4.76) | (4.48) | (4.09) | (3.82) | |

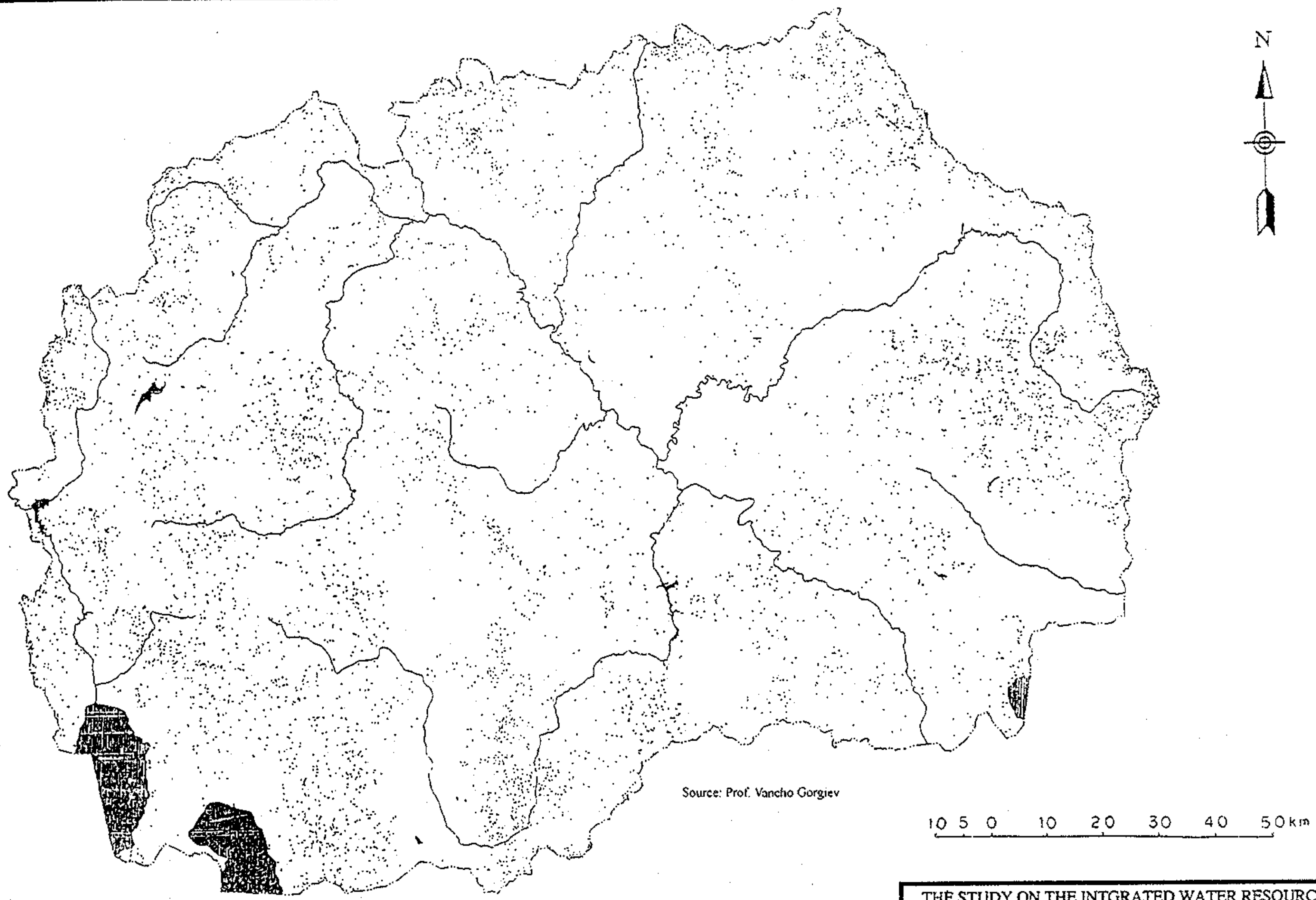



**Figure 4.1 Location of Springs in Macedonia**

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

JAPAN INTERNATIONAL COOPERATION AGENCY

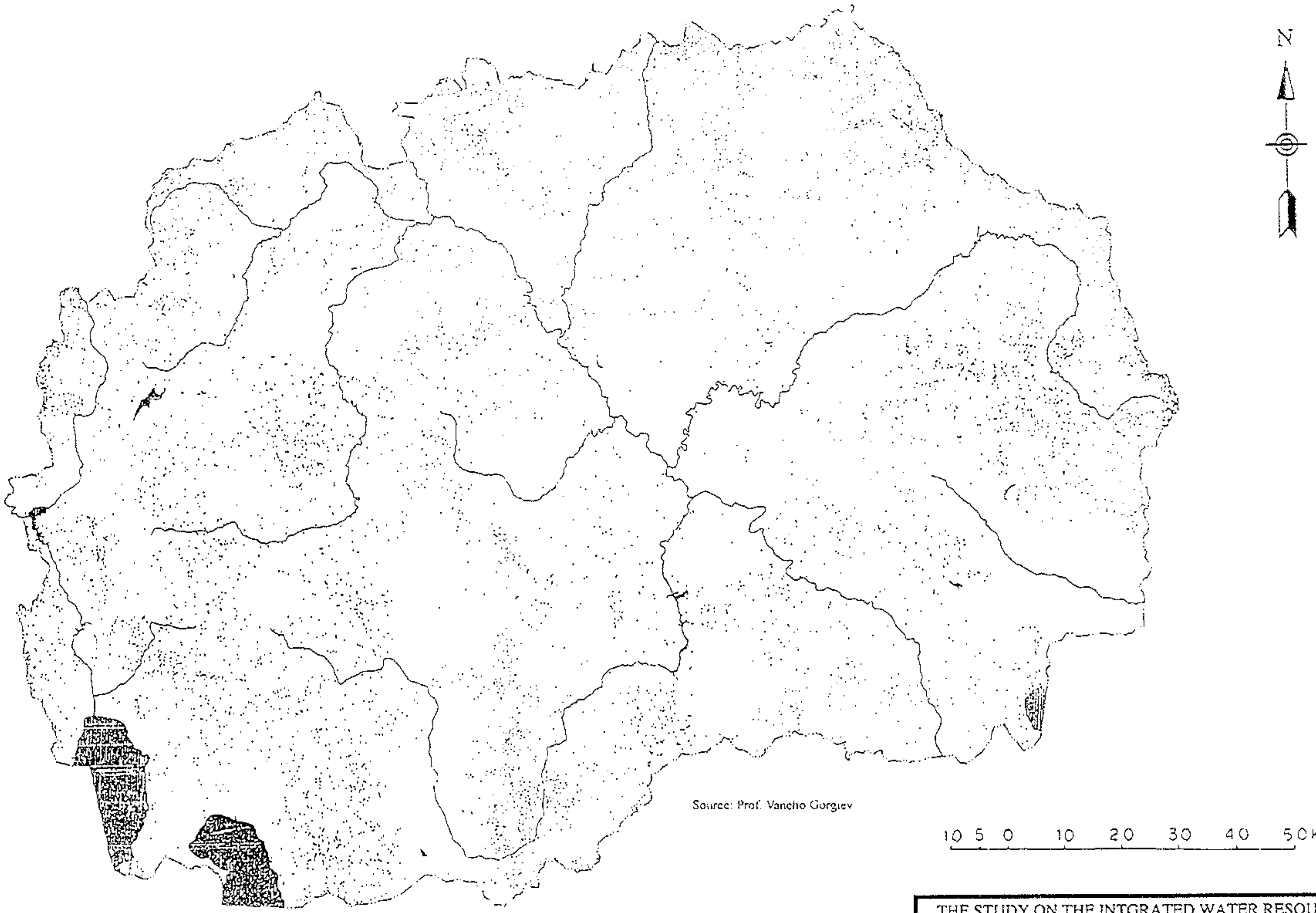



Figure 4.1 Location of Springs in Macedonia

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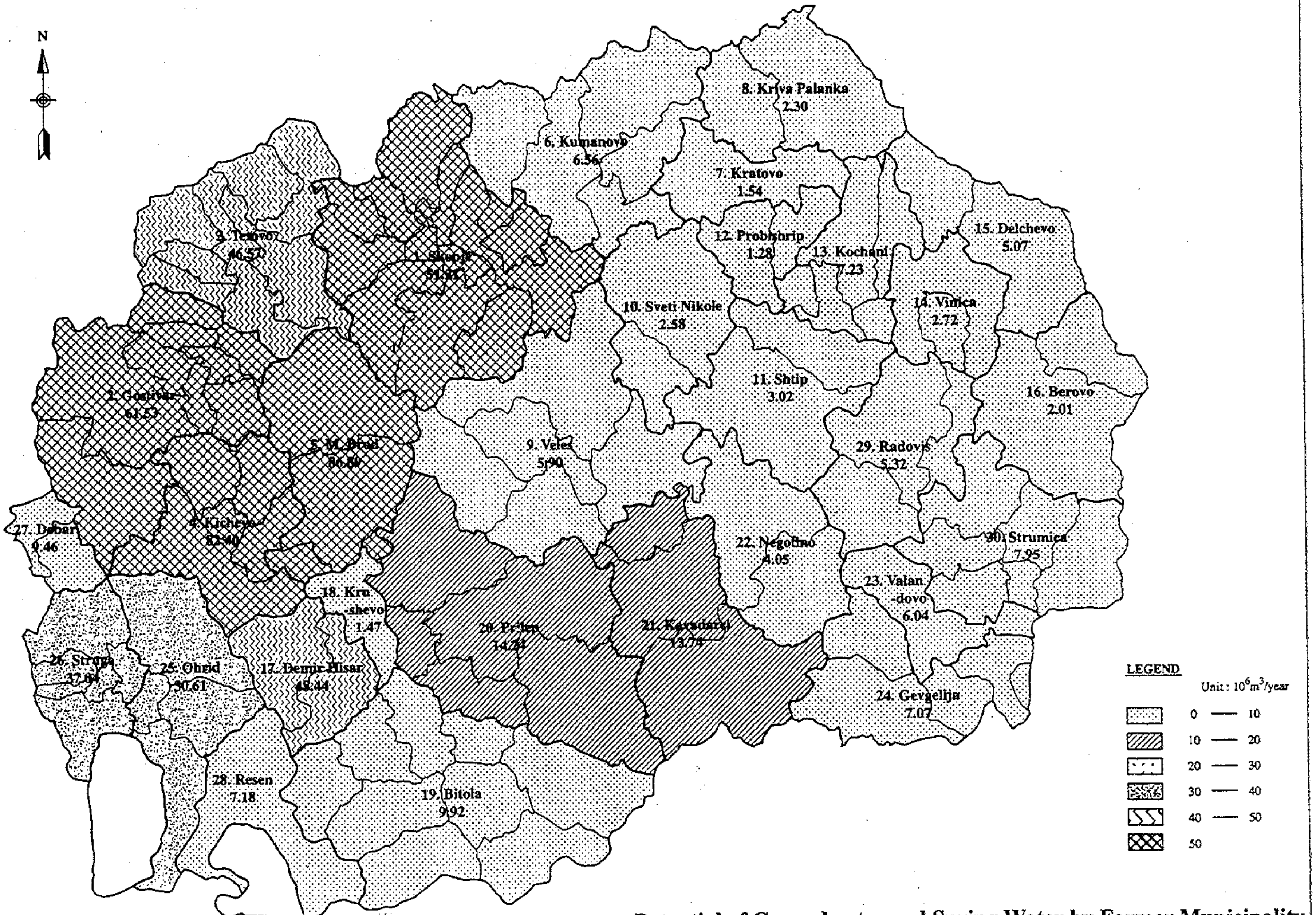



**Figure 4.2 Development Potential of Groundwater and Spring Water by Former Municipality**

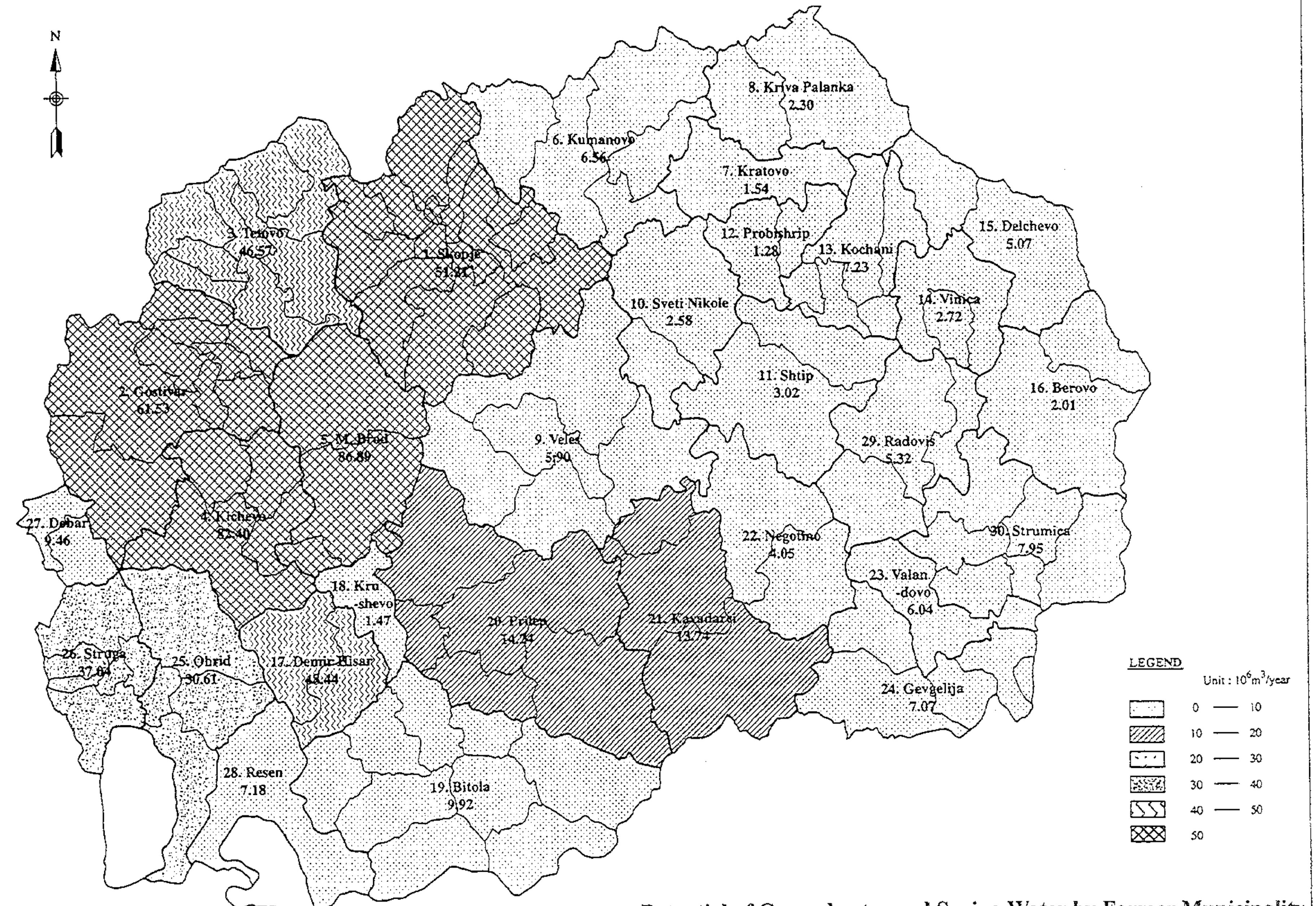



**Figure 4.2 Development Potential of Groundwater and Spring Water by Former Municipality**

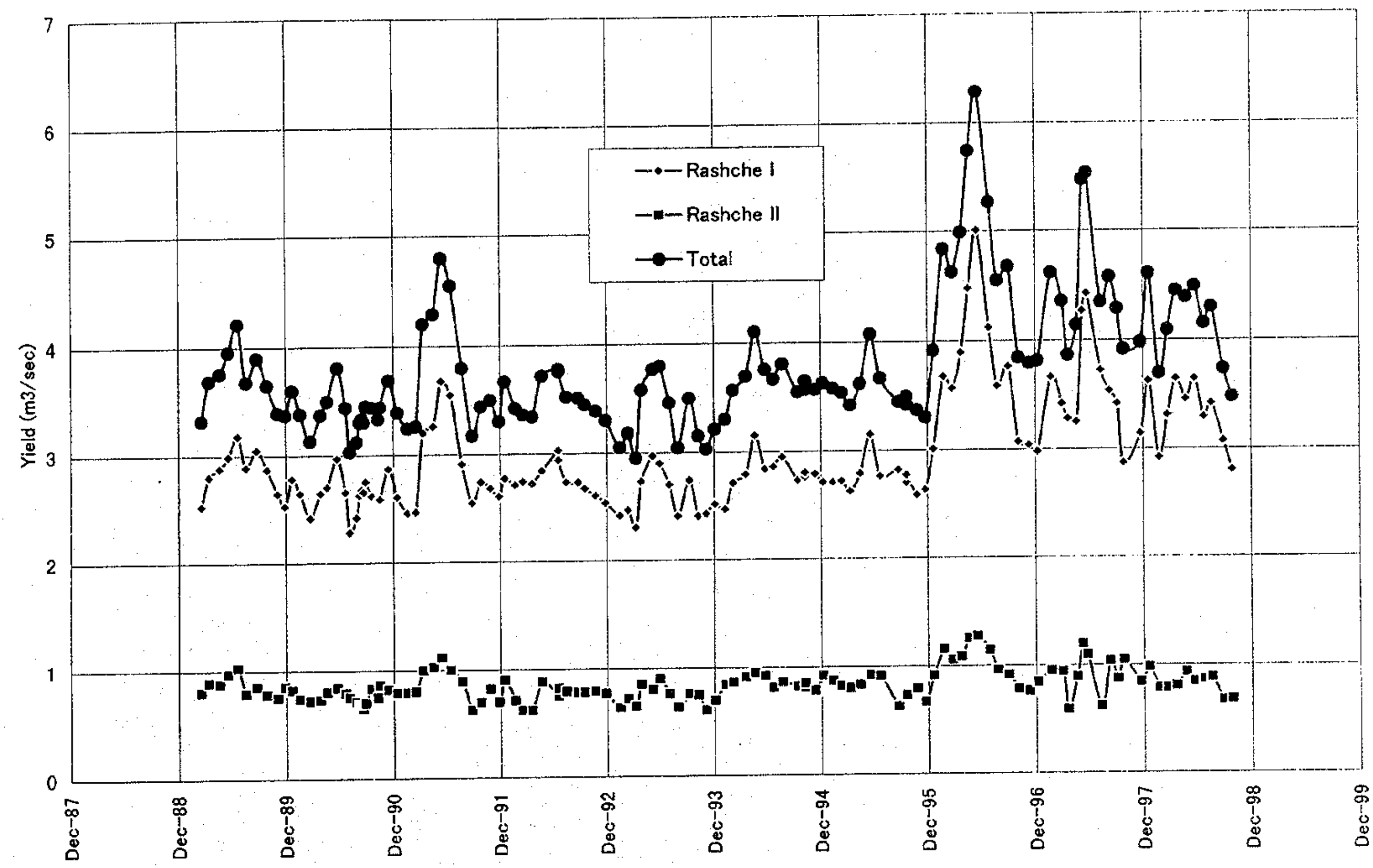



**Figure 4.3 Yield Fluctuation of Rashche Spring (1989 to 1998)**

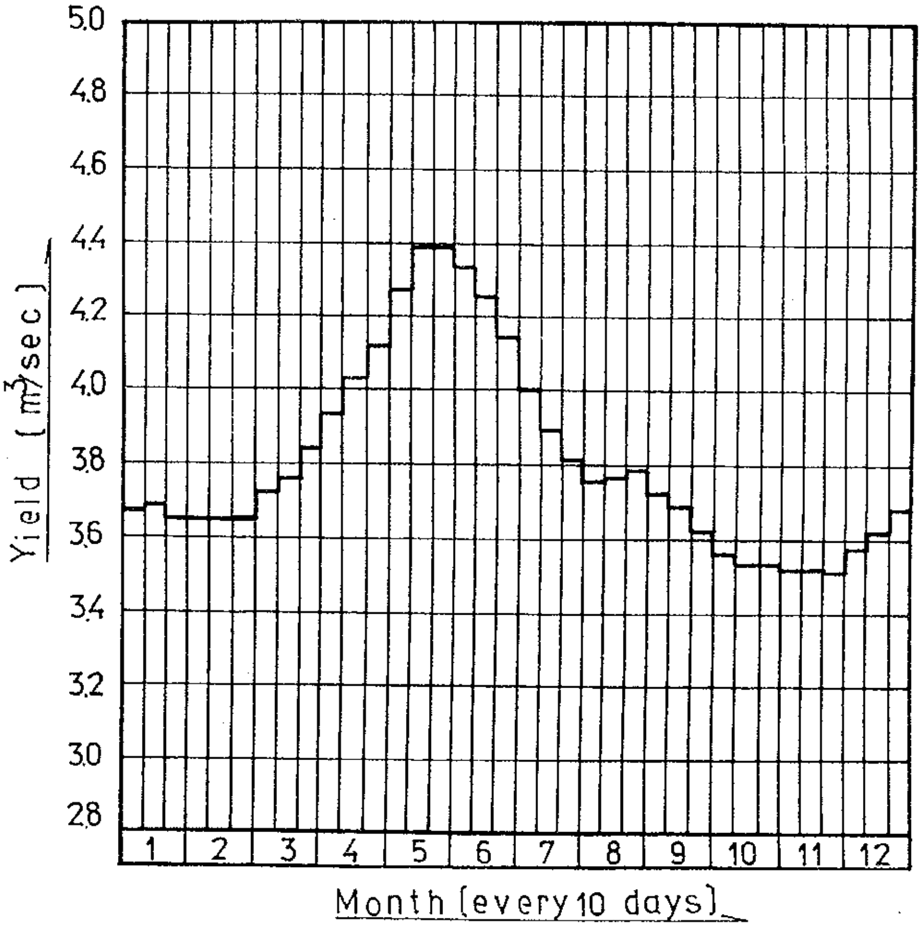



**Figure 4.4 Annual Yield Fluctuation of Rashche Spring (Average 10-day Basis)**

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

JAPAN INTERNATIONAL COOPERATION AGENCY

# *CHAPTER 5*

# *WATER DEMAND PROJECTION*

## CHAPTER 5 WATER DEMAND PROJECTION

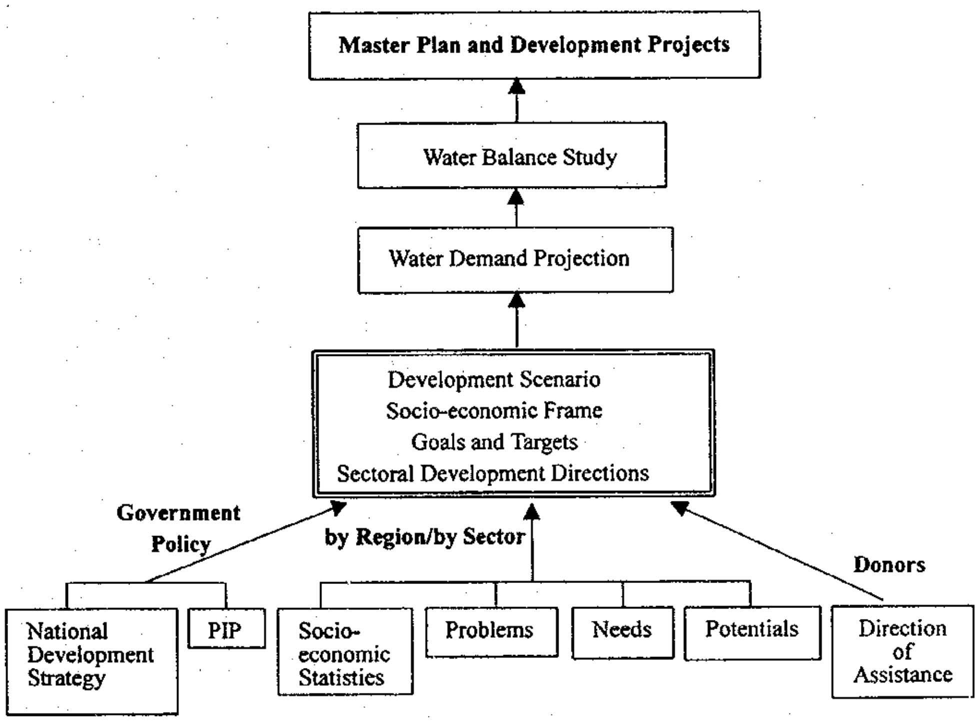
### 5.1 General

A development scenario has been prepared to provide the basis for realizing a more realistic water demand projection and for developing an optimum master plan and concrete development projects in the sector of water resources development and management.

The scenario consists of a socioeconomic frame, development directions from the macro-economic aspects as well as from the sectoral viewpoints, and development goals and targets. It covers the period until the year 2025, which is divided into three phases:

PHASE I : the short-term period until the year 2005
PHASE II : the medium-term period 2006 - 2015
PHASE III : the long-term period 2016 – 2025

The role of the development scenario can be illustrated as follows:




**Role of the Development Scenario**

The scenario was prepared based on the development policy of this country and the directions of donors' assistance. The "National Development Strategy for Macedonia", completed in December 1997 (NDS 1997), is the latest authority to gain the general view of the development policy of this country.

It is also based on the problems, needs and potentials which were identified from the key persons in this context as well as disclosed by community members during the PCM workshops.

## 5.2 Development Scenario

### 5.2.1 Population Projection

NDS 1997 estimates a projected total population of the year 2019 to be 2,219,000; the average annual growth rate is to be 0.54%*[1]. When applying this rate, the total population in 2025 is projected to be 2,292,000.

The Statistical Office lately published the population projection considering the national trend of life expectancy, mortality rate, fertility rate, and migration. It contains several pessimistic and optimistic projection cases. Among those, it seems that the one presenting the biggest figure may be the most likely considering the current population growth trend and migration situations.

The population is predicted on the assumption that the present levels of life expectancy, mortality rate, and the fertility rate will be kept and that the migration difference (between emigration and immigration) will be zero. Although it is the biggest one, this projection is still relatively conservative having an average annual growth rate of 0.49 for the period of 1995-2020. Based on this growth rate, the total population in 2020 is estimated to be 2,221,980, which is close to the number prepared by NDS 1997.

For population projection, it should be recognized that this country has many ambiguous factors that will affect the population growth, such as migration, ethnic composition, promotion of the market economy, etc. However, considering the current trends of total population and the two official population projections introduced above, it can be concluded that the current annual growth rate has become lower than in the last two decades: less than 1.0% after the year 2000.

This Study used the population census data for 1961, 1971, 1981, 1991, and 1994 to determine population trends for use in producing population projections. The census data was fitted by logarithmic regression to produce trend curves for each former municipality, which in turn were aggregated to produce figures for Macedonia as a whole. The census definition was changed in 1994 to exclude Macedonians living abroad but to include foreigners with residence permits. This definition is also better for water demand projection purposes and thus the population data was adjusted to fit the 1994 definition.

*[1] Here, in the National Development Strategy 1997, the figure of 1,936,900 is used as the total population of 1994, which does not include the estimated non-enumerated population in the municipalities of Debar and Center Zupa.

Through the projection method by the Study Team, the total population in 2020 is predicted to be 2,255,000. Considering the absence of long-term accumulation of socioeconomic data about this country and the unpredictable factors in the domestic and international environment, especially related to the migration movement, the difference between these two projected figures can be neglected. Additionally, the population projection by the Statistical Office does not have numbers by municipality, while the one by the Study Team is the aggregation of the projected figures of the former municipalities.

Therefore, the population projection done in the Study as shown in Table 5.1 was selected as the basic data for the water demand projection. The population projection has been divided into two categories of urban and rural areas.

There is some diversification in the population distribution: ranging from 81.5% of the population concentrated in urban areas in the former municipality in Skopje, and on the contrary 100% of the population live in rural areas in the former municipalities of Makedonski Brod and Demir Hisar. Tables 5.2 and 5.3 show the population projection of the urban and rural area for each former municipality, respectively, which are summarized as follows:

**Comparison of Population Projection of Macedonia**

(Unit: 1,000 persons)

| Projection | 1994 | 2000 | 2015 | 2020 | 2025 |
|---|---|---|---|---|---|
| 1. Total Population by JICA | 1,946 | 2,027 | 2,203 | 2,255 | 2,304 |
| - Urban | 1,161 | 1,212 | 1,323 | 1,355 | 1,386 |
| - Rural | 785 | 815 | 880 | 900 | 918 |
| 2. Projection by the Statistical Office | 1,946 | -- | -- | 2,222 | -- |
| 3. Projection in NDS 1997 | 1,937 | -- | -- | 2,219 (for 2019) | -- |

### 5.2.2 Economic Development

NDS 1997 has two scenarios*2 for economic growth as follows:

Optimistic Scenario:
Average annual growth rate of real GDP : 6.0%
Nominal GDP per capita in 2002: US$2,782
Average real GDP per capita growth rate in the period 1997-2002: 5.2% per annum
Pessimistic Scenario:
Average annual growth rate of real GDP : 4.2%
Nominal GDP per capita in 2002: US$2,380
Average real GDP per capita growth rate in the period 1997-2002: 3.4% per annum

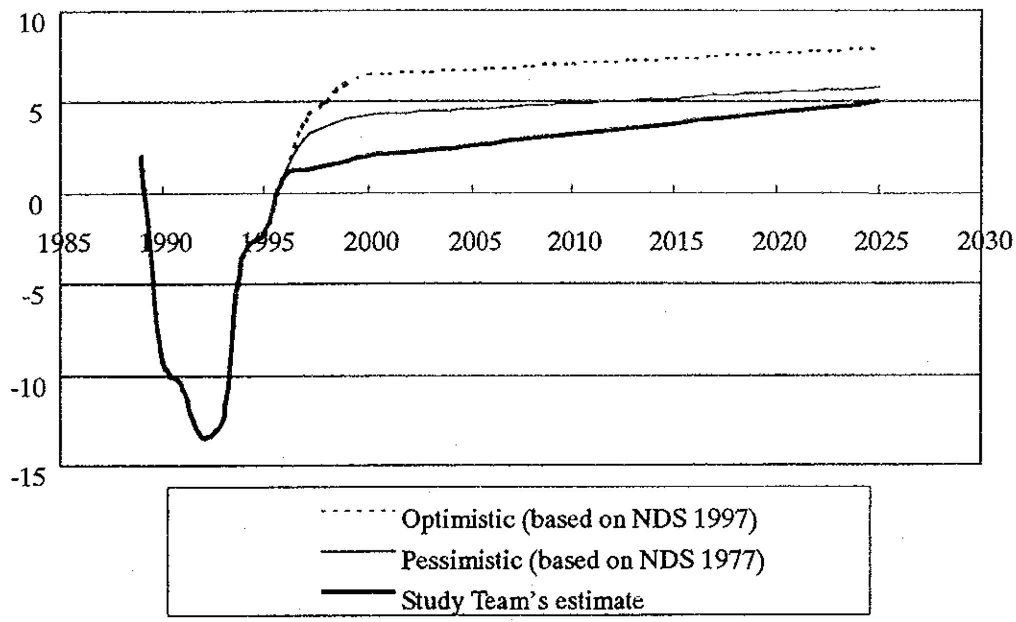
*2 In assisting the future potential economic growth rate, the Strategy considered the following assumptions:
- Initial tendency of faster growth of poor countries in comparison with rich ones, due to declining capital rate of return, such a starting position should provide higher potential capacity of production and higher economic growth of the Republic of Macedonia vis-à-vis matured market economies.
- The increase of the level of current and future national saving and foreign capital inflow.
- The geographical position of the country and the structure of natural resources

According to the economic development strategy up to the year 2010 formulated cooperatively by the government and the World Bank in 1996, the average growth rate of per capita GSP is assumed to be 1.5% till 2000, 3.5% during the period 2001-2005, and 5.5% during the period 2006-2010. Along this development path, per capita GSP in 2010 will be 1.7 times as high as the 1994 level (US$790). At the same time, however, it is noted in that report that per capita GSP of US$3,000 (corresponding to an average annual growth rate of 8.7%) would be possibly realized in 2010, if the country could fully utilize its resources.

It seems legitimate that the long-term growth rate of per capita GDP is 3-4% per year, taking into account the present and foreseeable conditions faced with the Macedonian economy. Such conditions are represented by the country's fairly high level of capital stock in both human resources and basic infrastructure as well as the increasing accumulation of the market oriented economy's experience. This development path will lead the future per capita output level to be 1.4-1.6 times the 1988 level in 2010 and 2.2-2.9 times in 2025.

Needless to say, the predicted figures for the long-term development in any sophisticated manner are subject to uncertain future events. Especially this is true under the market economy. Thus, it is fairly reasonable that the growth rate of 3-4% per annum is treated as a benchmark national economic development path for formulating the socioeconomic frame.

The real GDP growth rates projected based on the two scenarios from NDS 1997 and the one estimated by the Study Team can be shown as follows:




**Predicted Real GDP Growth Rate from 1997-2025**

Considering the present and future unclearness of the international and domestic economy, it would be difficult to get the clear future projection: and it would be safer to apply the most pessimistic scenario to the socioeconomic frame of the Study.

For the prediction in this Study, the figure of US$1,580 is used as the nominal per capita GDP in 1997, according to an exchange rate adjusted to the movement of prices in the national economy, which is used as the basis of the calculation. The GDP per capita in the year 2025 has been roughly estimated as about US$4,000.

### 5.2.3 Perspectives toward Sectoral Trend

(1) Overview

Predictions of sectoral trends are restricted to those that consist of major water users in society, that is, the industrial sector (including mining), the agricultural sector (including forestry and fisheries) and the tourism sector.

Industry and agriculture are expected to sustain long-term national development by achieving balanced growth. It is presumed that the combined share of industry and agriculture to national output would be about two-thirds of GDP, although the trade and financial sectors will increase its shares in GDP as the market system is penetrated in the economy.

Given the national development path with average annual growth rates of 0.8% for population and 3-4% for per capita GDP, both sectors are required to expand their output at a relatively high growth rate of 4-6%. Considering recent growth trends, agriculture should grow faster than industry in the foreseeable future.

Note, however that the output growth rate described here is based on value, not volume. Value depends on both volume and price, thus, the output growth rate of 4-6% does not mean an equal the growth rate in the volume of output.

Although the tourism sector presently seems to occupy a minor place in the economy, its development would contribute to improvement in the nation's foreign reserve condition. Tourism is expected to develop, at least in keeping pace with the growth of industry and agriculture.

Because the role of the external sector (e.g., trade) is expected to become more important in the Macedonian economy, the sectroal development is conditioned on the success of an establishment of its international reputation in the future. Indeed, what activities will emerge as the important ones in the economy greatly depends on the degree of their integration into the world economy; i.e., availability of sufficient amount of foreign capital inflow (e.g., foreign direct investment) and their access to international markets.

The other key condition for the development of new activities is how effectively they will take advantage of the high quality of nation's human resources such as skilled workers with university qualifications that currently are inefficiently utilized.

(2) Industrial Sector

Industrial development is subject to the present production features as well as the nation's economic policy. The present structure of the industrial sector is characterized by the lower growth rate of labor productivity as an inter-sectoral feature as well as comparative advantage in production of consumer goods over that of capital goods as an intra-sectoral feature.

These characteristics, together with the outward-looking policy lead to the direction of industrial development in the foreseeable period of time. That is, the industry's share in GSP (44% in 1995) might continuously fall due to the contraction of inefficient activities' operation (e.g., heavy industry) although export-oriented consumer goods will expand in output. In fact, industry and construction together are expected to represent about 40% of GSP according to the Economic Chamber of Commerce.

Export-oriented activities are viewed as promising activities in the foreseeable period. Such activities oriented toward production of consumer goods are the following: 1) textile fibers and fabric industry, 2) leather and fur industry, 3) food product industry, 4) beverages industry, and 5) fodder industry. Although they show downward production trends, the finished textile products industry (especially ready-made clothing industry) and tobacco industry would rebound to their pre-independence level and develop further, with favorable international market environments.

Also, it should be emphasized that mineral water bottling has a great potential for exports to European countries where mineral water markets are large. The key to its export expansion is to establish the international reputation of Macedonian brand mineral water.

Promising products/services other than consumer goods include 1) generation, transmission, and distribution of electricity, 2) petroleum products, 3) non-ferrous ore mining, and 4) extraction of non-metal materials. These activities have strong upward trends in output in recent years.

Given the high level of human capital, Macedonia has a potential for activities that produce more sophisticated goods such as computer or electronic related goods under the long-term perspective*[3]. This industrial development would be realized, with promotion of direct foreign investment that will bring new technology and management skills needed for international business.

(3) Agricultural Sector

The agricultural sector will raise its share in GSP from 15-20% in recent years to about 25% in the year 2010 according to the Economic Chamber of Commerce. This would be realized by improving the utilization of land resources both quantitatively and qualitatively. This is because the large amount of resource available for agriculture has yet to be exploited and resources currently devoted to agriculture are more likely to be utilized inefficiently.

The major constraints that the agricultural development faces are the lack of modernized technology as well as the lack of the secure access to international markets. The second constraint is expected to be more important for long-term development because domestic demand for agricultural products are limited due partly to the nation's small population size and partly to lower income elasticity of agricultural products.

Thus, without access to international markets, the expansion of agricultural production is more likely to lead to oversupply domestically, which will cause a significant drop in prices, accompanied by a depression in farm economy. For the expansion of agricultural production and increases in farm incomes, a domestic marketing system covering rural areas also needs to be established because presently many farmers in rural areas cannot sell their products due to the lack of market channels.

The development perspective of agricultural products requires to be considered

*[3] These activities do not need much water in operation. This is considered in predicting the long-term water demand for industry.

bearing three distinguished groups in mind, that is, 1) domestic consumption-oriented products, 2) export-oriented products, and 3) supply as intermediate products. The first group comprises mainly cereal crops, and the second group is composed of vegetables, tobacco, fruits (including grapes for wine), and meats (beef and lamb). The major crops of the third group are fodder crops such as maize and industrial crops such as cotton, sunflowers, and sugar beets.

It is assumed that production of cereal crops would remain at almost the same level as present in the short-term, followed by a declining trend in the long-term. Although production cost of wheat currently is much higher in Macedonia than in neighboring countries (e.g., Bulgaria), wheat may need to be produced in order to maintain the moderate rate of food self-sufficiency.

This perspective is reinforced by the fact that other European countries such as France still protect their agriculture by using such instruments as tariffs even under the trade liberalization regime. Thus, the land acreage currently devoted to cereal production would be maintained in the short-run. In the long-run, however, its acreage would fall because the growth rate of land productivity for cereals is expected to be higher than that of their consumption. Despite growth in population, consumption of cereals would fall in the wake of changes in diversification of people's diet patterns.

Export-oriented products would grow at the higher output growth rate. Also, it is anticipated that production of the fodder crops will expand at a moderate rate to meet increasing demand associated with the expansion of livestock production. The prerequisite condition for supply expansion undoubtedly is to establish secure access to both domestic and international markets. Particularly, establishing and further reinforcing international competitiveness is required through improvements in product quality and in production efficiency, with the unavoidable abolition of export subsidies as in the future.

(4) Tourism Sector

With its natural lakes, springs, wonderful mountains for winter sports and classical archaeological sites, Macedonia has a big potential to attract domestic and foreign tourists, although the number of tourists has been decreasing since its independence: 585,699 persons in 1992 and 476,205 persons in 1995 (data source: Statistical Yearbook 1997). On the other hand, a turnover in the 3,400 tourist and catering units has risen slightly in the past years according to the Economic Chamber of Commerce.

Hotels, restaurants, and other catering and accommodation facilities in Skopje and tourist centers including Bitola, Struga, and Mavrovo have been built in accordance with European standards. The privatization of large hotels and tourist facilities has already been completed. The tourist capacities of Macedonia include over 80,000 beds in various types of accommodation facilities; some of the tourism facilities and services need to be renovated or upgraded in order to further this sector development.

The social product of tourism and catering has been about 2.2% over the last few years. The Government aims to stimulate the development of tourism and catering through promoting foreign capital investment. Taking into account the presence of its development potential and government policy, it is fairy feasible that the tourism sector would grow at the rate comparable to that for the industrial or agricultural sector, 5-6%.

5.2.4 Perspectives toward Local-specific Trend

Currently, major economic activities are concentrated in municipalities: Skopje and those where secondary cities (e.g., Bitola, Prilep, Tetovo and Kumanovo) are located. These areas are expected to function as core points for the nation's economic growth in the future. However, the government now assigns higher priority to regional development in economically underdeveloped areas.

Although the present project component is focused on improvement in living conditions through provision of basic social infrastructure, the regional development program will shift its mission to promotion of economic activities in rural areas. This government policy suggests that the rural economy could raise its role in national economy, preferably along with the harmonized growth path in urban and rural areas.

The target economic activities in rural areas are natural resource-related ones such as agriculture, forestry, and food and timber processing. These activities will be performed on small and medium scale. Small and medium size enterprises also are promoted in urban areas. Thus, the favorable perspective may be characterized by the harmonized development, under the dual economic structure in terms of space (urban and rural) and activity size (large, and small and medium). It is desirable that this perspective will be integrated in the process of formulating the socioeconomic frame.

Nonetheless, regional economic development is subject to the current local economic structure. It is anticipated that the idiosyncrasy trend of economic activities will last at least in the forthcoming short-term period. Thus, the remaining part is intended to identify the present characteristics of local economies. Quoting from "The Republic of Macedonia" (SIBIS, 1996), the important areas for major industrial activities are listed as follows:

(a) Ferrous metallurgy: Skopje, Jegunovce, Kumanovo, and Kavadarci.

(b) Non-ferrous metallurgy: Probishtip (lead and zinc), Radovish (copper), Veles (metallurgical and chemical combine), and Skopje (aluminum processing and copper-based products).

(c) Metal industry: Skopje (metal industry, steel structures, metal equipment), Kumanovo (steel), Bitola (steel structures), Probishtip (vehicle batteries), and Negotino (cable).

(d) Electrical industry: Bitola, Prilep, Skopje, and Ohrid.

(e) Petroleum and chemical industry: Skopje (oil refinery, chemical industry - chlorine, hydrochloric acid, detergents, polyester fiber, etc.), Veles (fertilizers), Kratovo (soft and hard polyurethane foam), Kumanovo (plastic processing), Struga (plastic processing), Strumica (plastic processing), and Bitola (plastic processing).

(f) Pharmaceuticals and cosmetics industry: Radovish, and Tetovo.

(g) Paper and cellulose industry and printing: Kochani (paper), Skopje (paper, printing), Bitola (printing), Tetovo (printing), Kumanovo (printing), and Prilep (printing).

(h) Non-metal industry and building materials industry: Strumica (feldspar and calcium carbonate, finished ceramic products), Kriva Palanka (bentonite), Bitola (crushed and micronized quartz, perlite), Veles (china, floor tiles), Skopje (ceramic items, cement, concrete panels), Gostivar (fire-resistant materials), Prilep (fire-resistant materials), Pehchevo (fire-resistant materials), and Debar (gypsum).

(i) Textile industry: Strumica (cotton thread), Shtip (cotton thread, cotton fabric, ready-made clothing), Prilep (cotton thread, cotton fabric), Gostivar (cotton fabric), Delchevo (cotton fabric), Tetovo (wood, ready-made clothing, knitted fabric), Bitola (wood, knitted fabric), Ohrid (ready-made clothing), Veles (ready-made clothing), Resen (ready-made clothing), Struga (ready-made clothing, knitted fabric), Skopje (ready-made clothing), and Kumanovo (knitted fabric).

(j) Leather and leather-processing industry: Kumanovo (footwear), Skopje (footwear), and Shtip (footwear).

(k) Tobacco processing: Prilep, Skopje, Kumanovo, Radovish, Strumica, Tetovo, Demir Hisar, and Kavadarci.

(l) Flour-milling and baking industry: Skopje, Tetovo, Kichevo, Ohrid, Bitola, Prilep, Veles, Kumanovo, Kochani, and Strumica.

(m) Beverage industry: Kavadarci (wine), Negotino (wine), Veles (wine), Stip (wine), Strumica (wine), Ohrid (wine) Kumanovo (wine, mineral water), Skopje (wine, non-alcoholic beverages), Bitola (wine), Radovish (wine), Gevgelija (wine), Prilep (non-alcoholic beverages), and Katalanovo (mineral water).

(n) Beer industry: Skopje, Bitola, and Prilep.

(o) Canning and food processing industry: Negotino (ketchup), Gevgelija (natural juice), Resen (natural juice, canning), Strumica (canning), Ohrid (canning), Kumanovo (canning), Bitola (canning), Prilep (canning), Delchevo (canning), and Skopje (canning).

(p) Confectionery industry: Skopje, Resen, Bitola, Prilep, Negotino, Kavadarci, Tetovo, and Strumica.

The regional characteristics of agricultural production depend on the natural conditions such weather, topography and soil fertility. The country's breadbaskets are several fertile plains (below 700 meters) extending over Gevgelija, Strumica, Skopje, Kocani, Ovce Pole, Kumanovo, Polog, Pelagonija, Ohrid-Struga, and Prespa. Livestock feeding (cattle and sheep) is performed in less productive land mostly located in mountainous areas.

Fishing is practiced mainly in the major lakes of Lake Ohrid, Lake Prespa, and Lake Dojan, while forestry activities are conducted across the country. The large producers for major products are summarized as follows:

(a) Wheat: Bitola, Kumanovo, Prilep, and Sveti Nikole.

(b) Maize: Kumanovo, Tetovo, Strumica, Bitola, and Gostivar

(c) Tobacco: Prilep, Radovish, Strumica, Krushevo, and Bitola.

(d) Grapes: Kavadarci, Gevgelija, Skopje, Veles, and Kumanovo.

(e) Fruits: Resen, Skopje, and Tetovo

(f) Rice: Kochani

(g) Vegetables (under thermal springs): Strumica, Kochani, Gevgelija, and Bogdanci.

(h) Timber: Berovo, Skopje, Kichevo, Ohrid, and Makedonski Brod

Note that although its share in national production is negligible, it is in smaller municipalities dominated by rural areas that production of a specific crop is very important for the local economy (e.g., tobacco for Demir Hisar). This relative importance of a crop in specific areas will be taken into account for the formulation of the socioeconomic frame.