CHAPTER 6

STUDY ON BALANCE BETWEEN WATER SUPPLY AND DEMAND

CHAPTER 6 STUDY ON BALANCE BETWEEN WATER SUPPLY AND DEMAND

6.1 General

Balance between water supply and demand was studied, dividing the supply water into surface water and groundwater.

In case water is supplied from surface water, the major demand is by agricultural sector to be followed by municipal and industrial water. For this case, a basin model was prepared, in which the national land was divided into seven river basins consisting of 26 sub-basins as shown in Figures 6.1 and 6.2 (See details of the basin model in Volume IV Supporting Report 2).

In case water is supplied from groundwater, the major demand is by municipal and industrial water. For this case, the balance was studied for each municipality (the former division). The balance for the present conditions was referred to answers to the supplemental interview survey for communal enterprises carried out in October to December 1998.

6.2 Balance Calculation for Surface Water

6.2.1 Basic Conditions of the Calculation

The water balance calculation was conducted with the following conditions:

(1) Quantities of demand and supply used in the calculation are not on a monthly average basis but on a 10-day average one, as required by the agricultural water use.

(2) Demands of municipal and industrial, and agricultural water are converted to those of 10-day. Demands of municipal and industrial water are further divided into their surface and groundwater components including springs (surface water demand only was adopted in the calculation), while that of the agricultural water is only by surface water.

(3) Natural flow adopted in the calculation is on a daily basis for the period of 36 years from 1961-1996. The supply quantity by natural flow is converted to 10-day average one.

(4) One station is selected, in principle, for each sub-basin except the sub-basin of B4-2, where the natural flow of two stations is combined as the flow for the sub-basin. 12 stations are situated just on the gauging station node in the model. 14 stations are situated upstream of the boundary of sub-basins, and hence their natural flows are adopted after adjusting by the ratio of the catchment area of their location and the area of each sub-basin.

6.2.2 Current Water Demand and Supply Circumstance

The current water supply circumstances were taken in the water balance calculation as follows.

(1) Municipal Water Requirement

Water supply by communal enterprises (CEs) was derived for each municipality, of which abstractions were assumed to be applied near the main center in each municipality, namely the principal city. These abstractions were subdivided into their surface and groundwater components and the surface water component was, therefore, allocated to a municipal water intake node, one for each municipality, located on the nearest main water course adjacent to the principal city.

Groundwater components were excluded from the water balance calculation because they were assumed to be abstracted outside the surface water system. However, a part of the groundwater component was assumed to enter the surface water system at these nodes as return flow.

The surface water demand component included all surface water abstractions by CEs for domestic households, communal and commercial uses as well as potable water supply to industry (supplies for raw industrial process water were separated from municipal water). According to an information obtained from selected CEs, the municipal demands vary about 0.7 of the mean annual demand in winter to 1.3 of the mean in summer. Thus the surface water demands were applied across the year as a sinusoidal distribution with a coefficient of variation of 1.3.

(2) Agricultural Water

The agricultural water requirement was allocated to agricultural water intake node, amounting to 41 nodes in total in the basin model.

In the balance calculation in a large area, the return flow from upstream irrigation systems are taken for the downstream systems. The rate of return flows varies depending upon various conditions of the area such as the meteorology, vegetation, surface soil, hydrogeology, etc. It would correlate to the amount of water loss caused out of the taken water. In other words, a high return flow rate would be caused in case of a low irrigation efficiency. The return flow rate was estimated at 0.30 from paddy fields only and zero from other crops system.

Considering the current condition of the low irrigation efficiency in the actually irrigated area, namely in the workable part of the irrigation system, that is estimated to be 0.58 composed of the conveyance efficiency of 0.8, the distribution efficiency of 0.9 and the field application efficiency of 0.8 (Ref. Table 37 in FAO Irrigation and Drainage Paper 24 revised 1977 Crop Water Requirements).

As for livestock and fishery waters, the return flow is not considered in the

calculation because of its negligible small quantity.

(3) Industrial Water

Although data was available for industrial water demands by type of activity from the Statistical Office, there was no national data available giving the geographic distribution of total industrial demand across the country. Resources were therefore made to use sample data from selected industrial information obtained from the industrial water utilization survey carried out from December 1997 to March 1998.

From this sample data it was possible to derive a geographical distribution for industrial demands and hence deduce the industrial water demand for each municipality. This was achieved firstly by amalgamating the sample data from selected industries with that from the water utilization survey and, after eliminating duplicated data, deriving an approximate distribution of industrial demand by type of activity across each municipality.

This distribution was then applied to the data from the Statistical Office. The sample data accounted for about 80% of the total industrial demand at national level and, therefore, the resulting geographic distribution was considered reasonable.

After estimation of the industrial water demands for each municipality, the abstractions were assumed to be applied near the main urban center in each municipality, in the same way as the municipal demands. These industrial abstractions were also subdivided into their surface and groundwater components, with the surface water component being allocated to the water demand node, located on the nearest main water course adjacent to the principal city.

Groundwater demands were excluded from this balance calculation as these were assumed to be abstracted outside the surface water system, but included the calculation for groundwater. A part of the groundwater component was, however, assumed to enter the surface water system at these nodes as return flows together with the surface water return flows.

Industrial water demands were generally constant throughout the year, with the possible exception of certain agricultural processing industries. However, the demands from such seasonal industries were small compared to principal industrial and hence a coefficient of variation of 1.0 was assumed.

6.2.3 Results of Balance Calculation for Current Conditions

Water balance calculation for the current situation was conducted with use of current water requirements and river flow data for 36 years from 1961 to 1996 on 10-day basis.

As the results of the calculation, among seven river basins, three basins of the

Vardar main stream except the lower reach, Treska and Crn Drim rivers have little water shortage through the 36 years, while the remaining four basins like the Pchinja, Bregalnica, Crna and Strumica rivers and the lower reach of the Vardar river experience the shortage in the dry season.

The high shortage occurrence in each sub-basin obtained through the calculation is represented by the following:

High Shortage Occurrence in Each Sub-basin

River Basin Description	Pchinja (B3-3)	Bregalnica (B4-2)	Crna (B5-3)	Strumica (B6-2)+(B6-3)
1. Main Municipality	Kumanovo	Kochani	Kavadarci	Strumica
2. Seasonal Deficit Period (monthly base)	April - October	April - October	June - October	April - October
3. Shortage Water	Municipal/ Agricultural	Municipal/ Agricultural	Irrigation	Municipal/ Agricultural
1. Shortage of Water (average : 1961-1996 in 10^6m^3/year)	- 89	-239	-112	-76
7. Existing Dam	Glazhnja Lipkovo	Kalimanci Gradche Ratevska	Tikvesh	Turrija Vodocha
8. Net Capacity of Dams ($10^6 m^3$) : Total	24 1.75 25.75	120 2 9 131	360	45 25.1 70.1

The Crna river basin has been supplied from the Tikvesh reservoir in the dry season, while other basins such as the Pchinja, Bregalnica, and Strumica might have water shortage, which was not covered by the existing reservoirs in some years during the 36 years.

In case of Tikvesh area (the Crn river basin B5-3), the shortage amount in the severe drought of 1995 is estimated at around $130x10^6m^3$, which is within the net capacity of the Tikvesh reservoir. Through the information and study results for water-related problem identification, however, the basin was said to have water shortage. It is considered that the reservoir was not filled to the normal water level due to the drought.

In addition to the above, in the basin of Valandovo and Gevgelija (B1-5) on both banks of the most lower reach of the Vardar River, seasonal water shortage is calculated in the months July to September with an average shortage of around 25 $x10^6m^3$/3 months.

6.2.4 Results of Balance Calculation for Future Conditions

The results are also mostly same as that in the balance calculation for the current conditions; that high shortage was estimated in the river basins of the Pchinija, Bregalnica, Crna and Sutrumica rivers as well as the most lower reach of the Vardar river. The shortage of mostly agricultural water estimated on an average of 36 years against the future demands in 2005, 2015 and 2025 together with that in the

current condition is tabulated below (the supply water is a drought which happens every 4 years, or is guaranteed with a duration of 75% in a certain period):

High Water Shortage in Each River Basin

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

River Basin	Current Condition (1996)	2005	2015	2025
1. Vardar River				
B1-5 : Valandovo and Gevgelija	-38.5	-72.6	-70.7	-71.3
2. Pchinja River				
B3-2 : Kriva Palanka	-0.5	-1.5	-126.4	-140.7
B3-3 : Kumanovo	-88.9	-78.1	-72.6	-72.1
3. Bregalnica River				
B4-2 : Kochani, Vinica, etc.	-238.5	-249.1	-249.5	-260.4
4. Crna River				
B5-1 : Prilep	-33.3	-27.3	-26.2	-162.7
B5-3 : Tikvesh	-111.5	-107.4	-102.0	-101.2
5. Strumica River				
B6-2 : Turija	-75.8	-66.5	-62.5	-61.1
B6-3 : Strumica	-42.3	-38.4	-36.0	-35.8

Figures 6.3 to 6.18 show 10-day water balance between demand and supply in the sub-basins, which have high water shortage in the current conditions and will have those in the future in 2025.

In the sub-basin of the Pchinja (B3-2), the shortage will be 126.4 x 10^6m^3/year, which will be due to increase of irrigation water in the system (22,000 ha) assumed to be developed on Vakuf in 2006 to 2015.

In the sub-basin of the Crna (B5-1), the shortage will be 162.7 x 10^6m^3/year, which will be due to increase of irrigation water in the system (27,000 ha) assumed to be developed on Pelagonia in 2016 to 2025.

6.3 Balance Calculation for Groundwater

6.3.1 Water Balance in Current Condition

Groundwater is used as sources of municipal and a part of industrial water supplied by CEs. Referring to answers to the supplemental interview survey for communal enterprises, one municipality (Veles) experiences water shortage throughout a year, and 17 municipalities (Skopje, etc.) have seasonal water shortage, while no water shortage is in 12 municipalities (Kichevo, etc) as tabulated below:

Water Shortage of Municipal and Industrial Water (Current Condition)

No.	Municipality/CEs	(1) Period (month/year)	(2) Municipal Water (10^6m^3)	(3) Industrial Water (10^6m^3)	Remarks
1	Skopje	2	1.6	9.3	
2	Gostivar/Mavrovi Anovi	4	0.3	0.6	
3	Tetovo	8	2.2	3.5	

4	Kichevo	0	0	+	No shortage
5	Makedonski Brod	1	0	0	Negligible
6	Kumanovo	4	2.1	2.8	
7	Kratovo	3	0.8	1.5	
8	Kriva Palanka	4	0.3	0.5	
9	Veles	12	2.0	4.5	
10	Sveti Nikole	5	0.5	1.1	
11	Shtip	3	0.2	0.9	
12	Probishtip	3	0.3	0.5	
13	Kochani	0	0	0	No shortage
14	Vinica	4	0.3	0.5	
15	Delchevo	2	0.2	0.2	
16	Berovo	0	0	0	No shortage
17	Demir Hisar	0	0	0	No shortage
18	Krushevo	0	0	0	No shortage
19	Bitola	0	0	0	No shortage
20	Prilep	0	0	0	No shortage
21	Kavadarci	4	0.5	1.0	
22	Negotino/Demir Kapija	6	0.8	1.5	
23	Valandovo	0	0	0	No shortage
24	Gevgelija/Bogdanci/ Star Dojran	5	0.7	1.0	
25	Ohrid	0	0	0	No shortage
26	Struga	3	0.8	1.2	
27	Debar	0	0	0	No shortage
28	Resen	2	0.2	0.3	
29	Radovish	3	0.4	0.7	
30	Strumica	+	0	0	No shortage

(Makedonski Brod has water shortage only one month per a year, which quantity is negligible small)

6.3.2 Basic Conditions of the Calculation in Future Conditions

Water balance of municipal and a part of industrial water was conducted with the following conditions:

1) Water balance is calculated for 22 municipalities, which are supplied municipal and a part of industrial water from not surface water (reservoir and/or river intake) but groundwater (remaining eight municipalities were excluded in the calculation) exploited up to date.

2) Quantities of demand and supply used in the calculation are on a 10-day average ones, to calculate the seasonal condition.

3) Seasonal fluctuation of demand of municipal water ranging from 130% against the annual average in summer to 70% against the annual one in winter.

4) No seasonal fluctuation is considered for demand of industrial water (fluctuation of portable water, which occupies about 30% of the industrial water, is not considered) Seasonal fluctuation of supply water is referred to the fluctuation in the Rashche spring as described in Section 4.3.

6.3.3 Results of Balance Calculation for Future Conditions

The results of the calculation for municipal water only is tabulated below, together

with that in the current condition:

Results of Water Balance Calculation for Municipal Water

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

No.	Municipality	Current	2005	2015	2025
1.	Skopje	+	+	+	+
2	Gostivar	+	+	+	+
3	Tetovo	-9,1 (Y)	-10.7 (Y)	-13.2 (Y)	-15.6 (Y)
4	Kichevo	+	+	+	+
5	Makedonski Brod	+	+	+	+
6	Kumanovo	(reservoir)	(reservoir)	(reservoir)	(reservoir)
7	Kratovo	(reservoir)	(reservoir)	(reservoir)	(reservoir)
8	Kriva Palanka	-1,3 (Y)	-1.2 (Y)	-1.3 (Y)	-1.3 (Y)
9	Veles	(river)	(river)	(river)	(river)
10	Sveti Nikole	(reservoir)	(reservoir)	(reservoir)	(reservoir)
11	Shtip	-3,5 (Y)	-3.8 (Y)	-4.2 (Y)	-4.6 (Y)
12	Probishtip	-0.6 (Y)	-0.6 (Y)	-0.7 (Y)	-0.8 (Y)
13	Kochani	-0.3 (S)	-0.5 (S)	-0.7 (S)	-1.0 (S)
14	Vinica	(reservoir)	(reservoir)	(reservoir)	(reservoir)
15	Delchevo	-0.2 (S)	-0.3 (S)	-0.6 (Y)	-0.8 (Y)
16	Berovo	(reservoir)	(reservoir)	(reservoir)	(reservoir)
17	Demir Hisar	- 0.2 (S)	- 0.2 (S)	- 0.2 (S)	- 0.2 (S)
18	Krushevo	+	+	+	+
19	Bitola	(reservoir)	(reservoir)	(reservoir)	(reservoir)
20	Prilep	+	+	+	+
21	Kavadarci	- 0.4 (S)	- 0.6 (S)	- 0.8 (S)	-1.1 (S)
22	Negotino	- 1.7 (Y)	- 2.4 (Y)	- 2.6 (Y)	-2.9 (Y)
23	Valandovo	+	- 0.1 (S)	- 0.1 (S)	-0.2 (S)
24	Gevgelija	+	+	+	+
25	Ohrid	+	+	+	+
26	Struga	+	+	+	+
27	Debar	- 0.7 (Y)	- 1.0 (Y)	- 1.3 (Y)	-1.6 (Y)
28	Resen	- 0.2 (S)	- 0.2 (S)	- 0.2 (S)	- 0.3 (S)
29	Radovish	- 1.7 (Y)	- 1.9 (Y)	- 2.2 (Y)	-2.5 (Y)
30	Strumica	(reservoir)	(reservoir)	(reservoir)	(reservoir)

(+ : no water shortage, (Y) : Water shortage through a year, (S) : Seasonal shortage)

Further, combining the municipal water with industrial water, of which resources are from groundwater, the results of the calculation are tabulated below, together with that in the current condition:

Results of Water Balance Calculation for Municipal and Industrial Water

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

No.	Municipality	Current	2005	2015	2025
1.	Skopje	- 0.3 (S)	- 5.6 (S)	- 16.1 (S)	- 43.5 (Y)
2	Gostivar	+	+	+	+
3	Tetovo	-11.6 (Y)	-13.3 (Y)	-15.8 (Y)	-19.2 (Y)
4	Kichevo	+	+	- 0.4 (S)	- 2.5 (Y)
5	Makedonski Brod	+	+	+	+
6	Kumanovo	(reservoir)	(reservoir)	(reservoir)	(reservoir)
7	Kratovo	(reservoir)	(reservoir)	(reservoir)	(reservoir)
8	Kriva Palanka	-1.7 (Y)	-1.6 (Y)	-1.8 (Y)	-1.9 (Y)
9	Veles	(river)	(river)	(river)	(river)
10	Sveti Nikole	(reservoir)	(reservoir)	(reservoir)	(reservoir)
11	Shtip	-7.5 (Y)	-8.8 (Y)	-10.8 (Y)	-14.1 (Y)
12	Probishtip	-1.7 (Y)	-2.0 (Y)	-2.4 (Y)	-3.1 (Y)

13	Kochani	-0.6 (S)	-0.9 (S)	-1.3 (Y)	-1.7 (Y)
14	Vinica	(reservoir)	(reservoir)	(reservoir)	(reservoir)
15	Delchevo	-0.4 (S)	-0.6 (S)	-0.9 (Y)	-1.2 (Y)
16	Berovo	(reservoir)	(reservoir)	(reservoir)	(reservoir)
17	Demir Hisar	- 0.2 (Y)	- 0.3 (Y)	- 0.3 (Y)	- 0.3 (Y)
18	Krushevo	+	+	+	+
19	Bitola	(reservoir)	(reservoir)	(reservoir)	(reservoir)
20	Prilep	+	+	+	+
21	Kavadarci	- 1.1 (Y)	- 1.5 (Y)	- 1.8 (Y)	-2.2 (Y)
22	Negotino	- 2.5 (Y)	- 3.1 (Y)	- 3.4 (Y)	-3.7 (Y)
23	Valandovo	+	- 0.1 (S)	- 0.2 (S)	- 0.3 (S)
24	Gevgelija	+	+	+	+
25	Ohrid	+	+	+	+
26	Struga	+	+	- 0.3 (S)	-0.7 (S)
27	Debar	- 1.0 (Y)	- 1.3 (Y)	- 1.6 (Y)	- 2.0 (Y)
28	Resen	- 0.4 (S)	- 0.5 (Y)	- 0.6 (Y)	- 0.7 (Y)
29	Radovish	- 1.7 (Y)	- 2.1 (Y)	- 2.4 (Y)	-2.7 (Y)
30	Strumica	(reservoir)	(reservoir)	(reservoir)	(reservoir)

(+ : no water shortage, (Y) : Water shortage through a year, (S) : Seasonal shortage)

Water balance in eight municipalities, of which source of water is surface water/reservoir, was reviewed by comparing the demand of municipal water with a net capacity of each reservoir for municipal water use as follows:

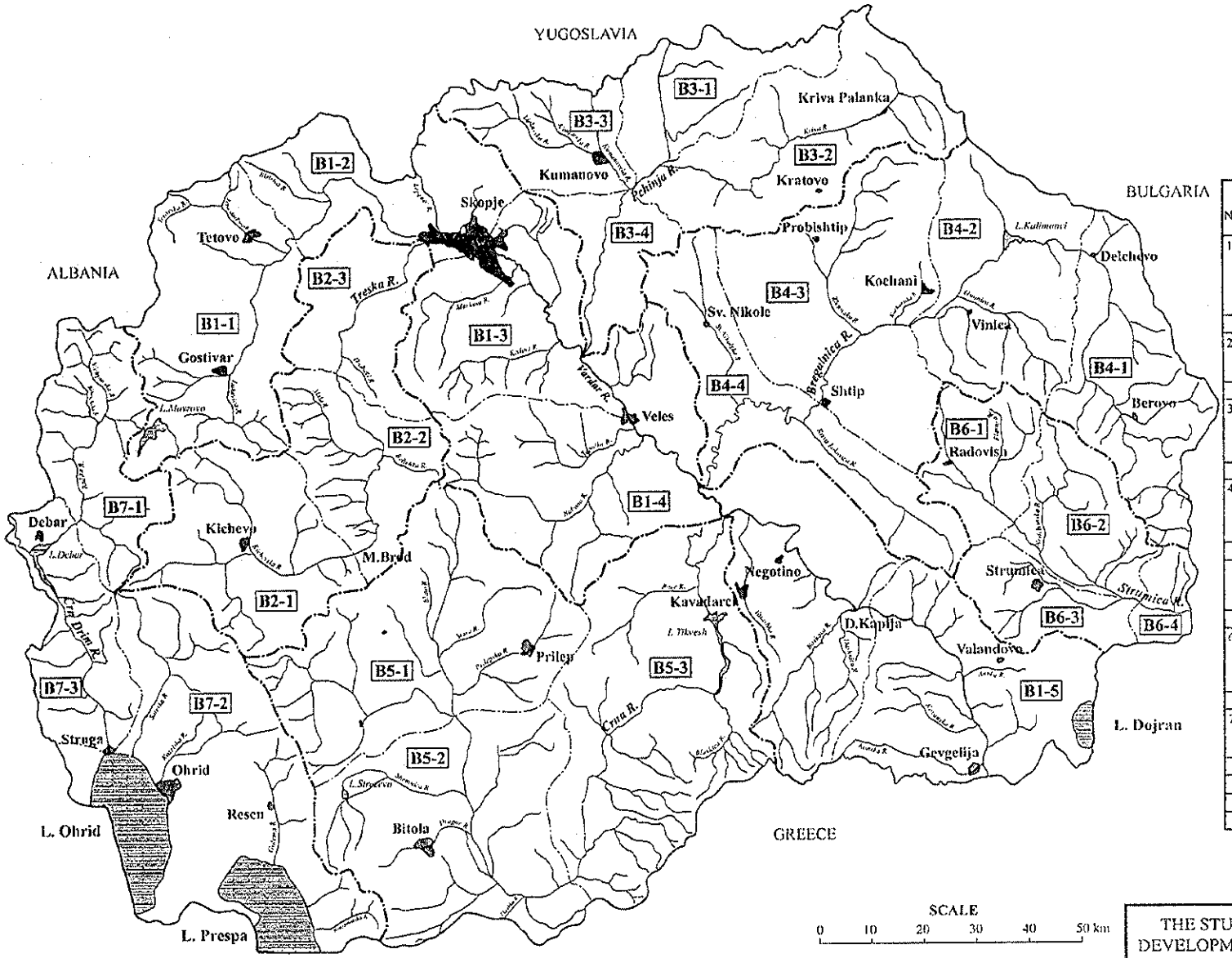
Demand of Municipal Water and Reservoir Net Capacity

No.	Municipality	Reservoir	Net Capacity (10^6m^3)	Water Demand (10^6m^3/year) Current(1996)	2025
6.	Kumanovo	Glaznja	24.00*	11.6	14.8
7.	Kratovo	(Zletovia)	1.58	1.0	1.0
9.	Veles	(Lisiche)	23.00	6.3	7.3
11.	Sveti Nikole	Mavrovica	2.52*	2.0	2.1
14.	Vinica	Osojnica	-	1.7	2.2
16.	Berovo	Ratevska	9.00*	1.7	2.0
19.	Bitola	Strezevo	99.50*	10.3	11.6
30.	Strumica	Turija Vodoca	45.00* 25.12*	8.1	10.8

(Kratovo is supplied from the intake constructed just upstream of the proposed Knezevo damsite/reservoir with a volume of 50 lit/sec (or 1.58 $x10^6m^3$/year). According to the outflow records of the Graznja reservoir, which is the main source of municipal and industrial water for Kumanovo, the periods while sufficient water has been supplied to meet the current water demand (11.6×10^6 m^3/year in 1996) were only for 6 years in the last decade (from 1989 to 1998). Out of the period, for 4 years, there have been shortages of municipal and industrial water. Therefore, it can be noted water shortage has been occurred once a two or three years in Kumanovo.)

*: commonly used with irrigation water supply.

Figure 6.19 shows municipal and industrial demand and groundwater potential (2025). As far as it refers to the above comparison, eight municipalities have no water shortage with an assumption that every reservoir is filled with water before the dry season. It is reported they suffered from seasonal water shortage in the recent drought years like 1993, 1994, etc. It is also reported that water is supplied to Vinica through a Tyrolean intake in the Osojnica River with a supply capacity of 100 lit/sec (or 3.16 $x10^6m^3$/year). Vinica has also no water shortage in case of the sufficient water in the river.



Catchment Area of Sub-basin for Water Balance Study

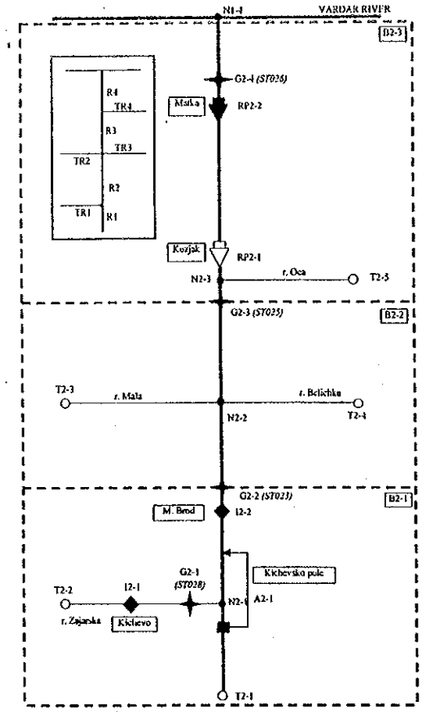
Name of No. sub-basin	Code	Catchment area			
		Macedonia (km²)	Basin out of Macedonia (km²)	Area for trans-basin (km²)	Total (km²)
1 Vardar mainstream	B1-1	1,083.0		+210.5	1,083.0
	B1-2	809.0	690.0		1,499.0
	B1-3	1,326.0			1,326.0
	B1-4	2,333.0			2,333.0
	B1-5	1,262.0			1,262.0
Subtotal		6,813.0	690.0		7,503.0
2 Treska	B2-1	886.0			886.0
	B2-2	719.0			719.0
	B2-3	463.0			463.0
Subtotal		2,068.0			2,068.0
3 Pchinja	B3-1	400.1	471.0		871.1
	B3-2	1,003.4			1,003.4
	B3-3	459.8			459.8
	B3-4	509.7			509.7
Subtotal		2,373.0	471.0		2,844.0
4 Bregalnica	B4-1	845.6			845.6
	B4-2	1,768.4			1,768.4
	B4-3	283.0			283.0
	B4-4	1,410.0		-180.0	1,410.0
Subtotal		4,307.0			4,307.0
5 Crna	B5-1	1,618.5			1,618.5
	B5-2	1,451.5	905.0		2,356.5
	B5-3	1,915.0			1,915.0
Subtotal		4,985.0	905.0		5,890.0
6 Strumica	B6-1	520.0		+180.0	520.0
	B6-2	461.0			461.0
	B6-3	350.0			350.0
	B6-4	189.0			189.0
Subtotal		1,520.0			1,520.0
7 Cm Drim	B7-1	751.0		-210.5	751.0
	B7-2	1,801.0			1,801.0
	B7-3	803.0			803.0
Subtotal		3,355.0			3,355.0
Grand total		25,421.0	2,066.0		27,487.0
Others		292.0			
Total		25,713.0 (National territory)			

Legend : B1-1, No. of Sub-basin

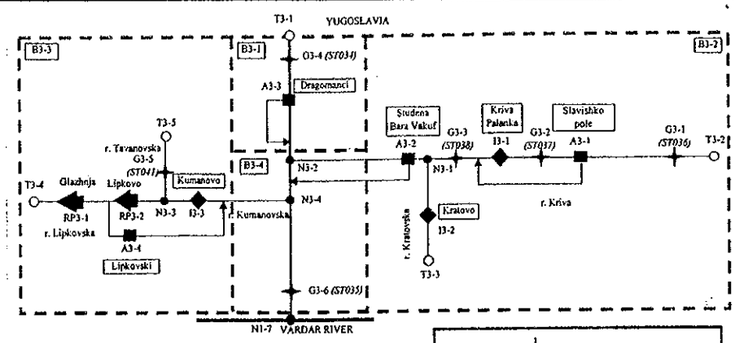
Figure 6.1 Location Map of Basin Division for Water Balance Study

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

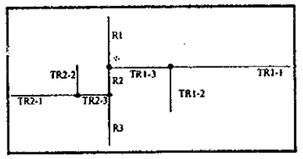
JAPAN INTERNATIONAL COOPERATION AGENCY

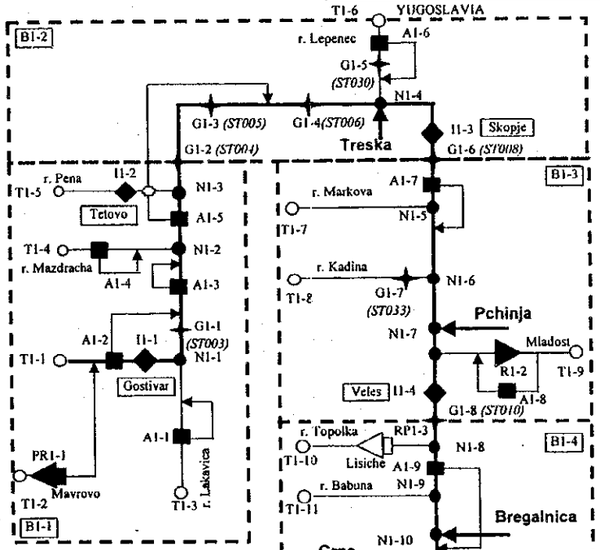


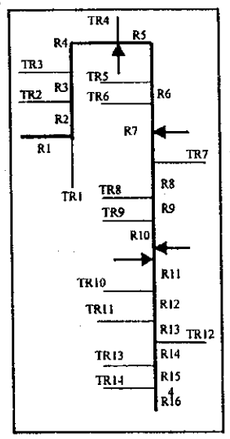
TRESKA RIVER



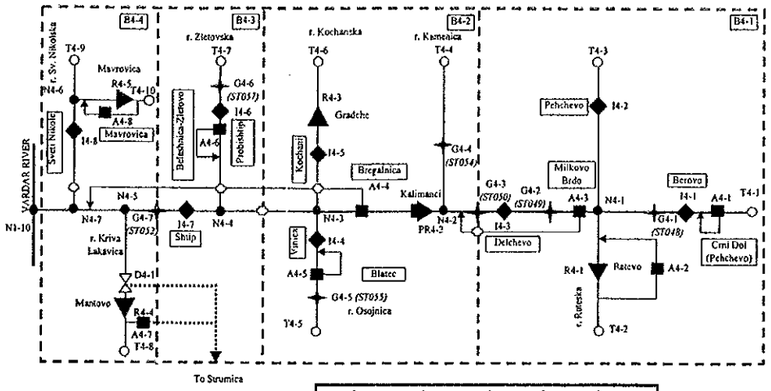
PCHINJA RIVER



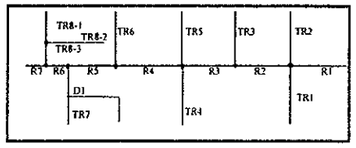


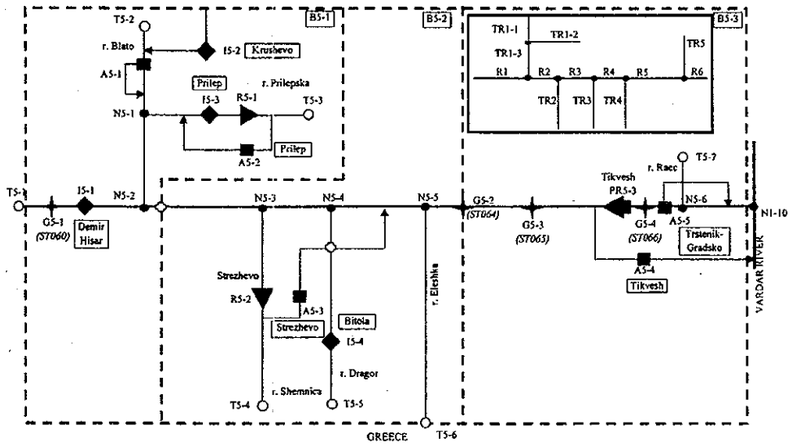


VARDAR MAINSTREAM

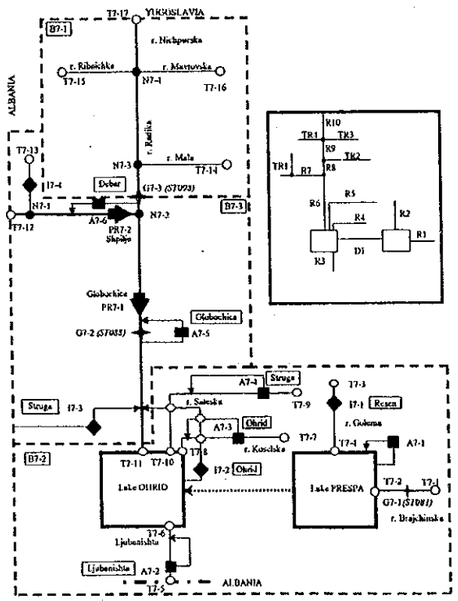


BREGALNICA RIVER

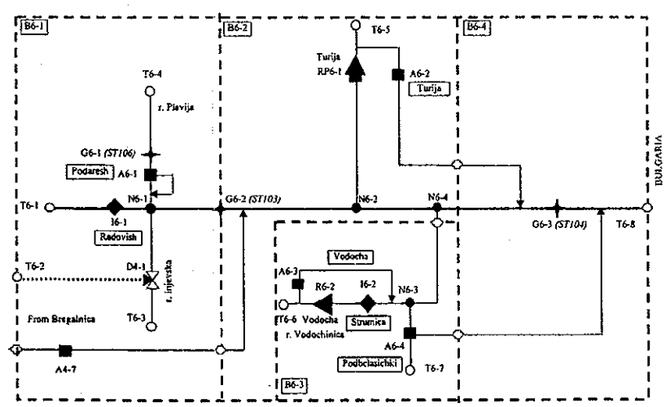




CRNA RIVER



CRN DRIM RIVER



STRUMICA RIVER

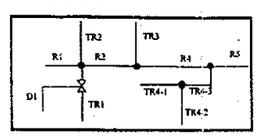


Figure 6.2 Schematic Diagram of Water Balance Elements for 7 Major River Basins

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

JAPAN INTERNATIONAL COOPERATION AGENCY

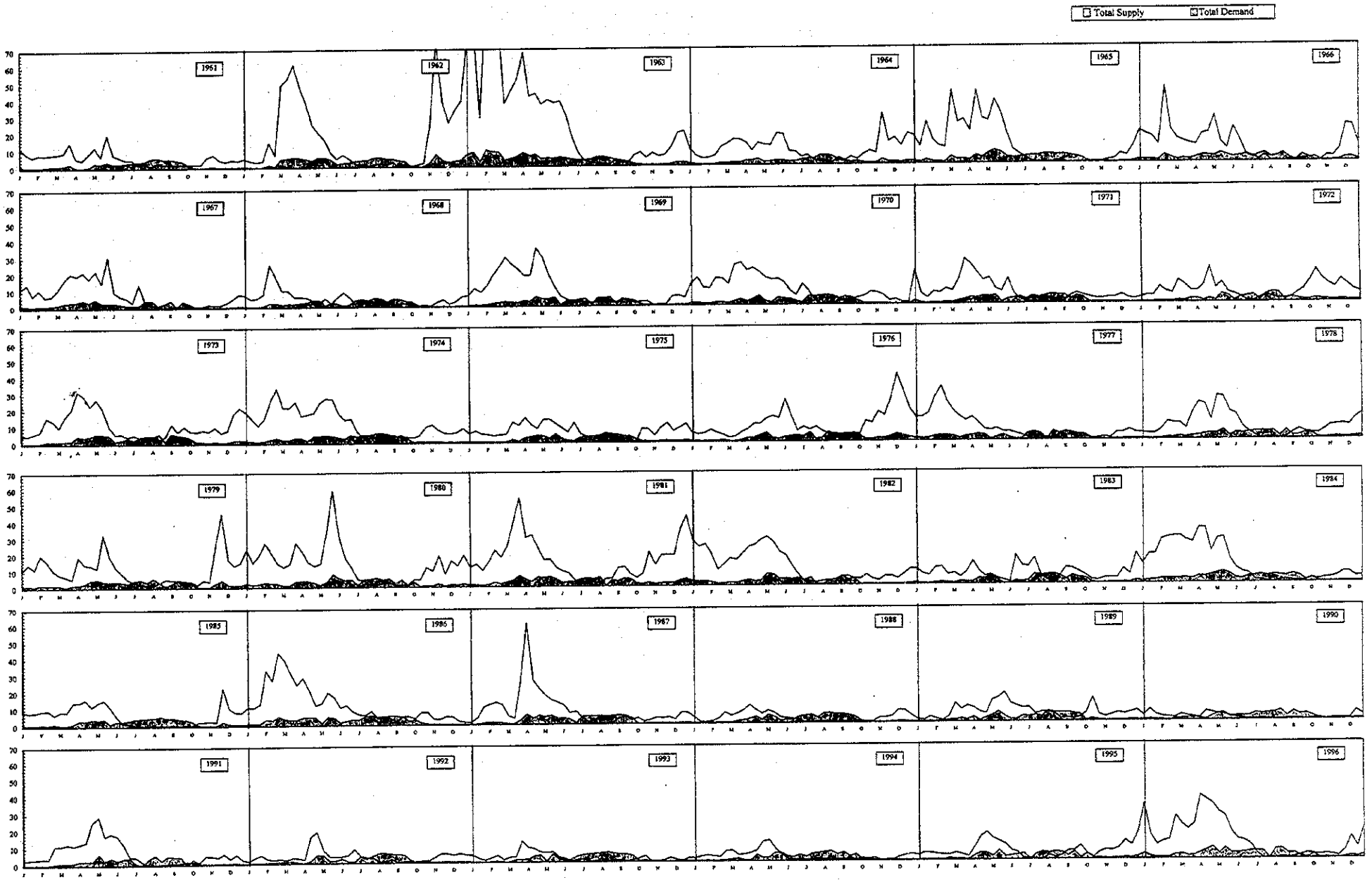


Figure 6.3 10-Day Water Balance between Demand and Supply based on Current Condition in 1996 (Vardar River Sub-Basin B1-5)

Horizontal Axis Represents 10-days Time Step Shown in Monthly Basis
Vertical Axis Represents Total Demand and Total Supply Flow Rate (m^3/sec/10days)

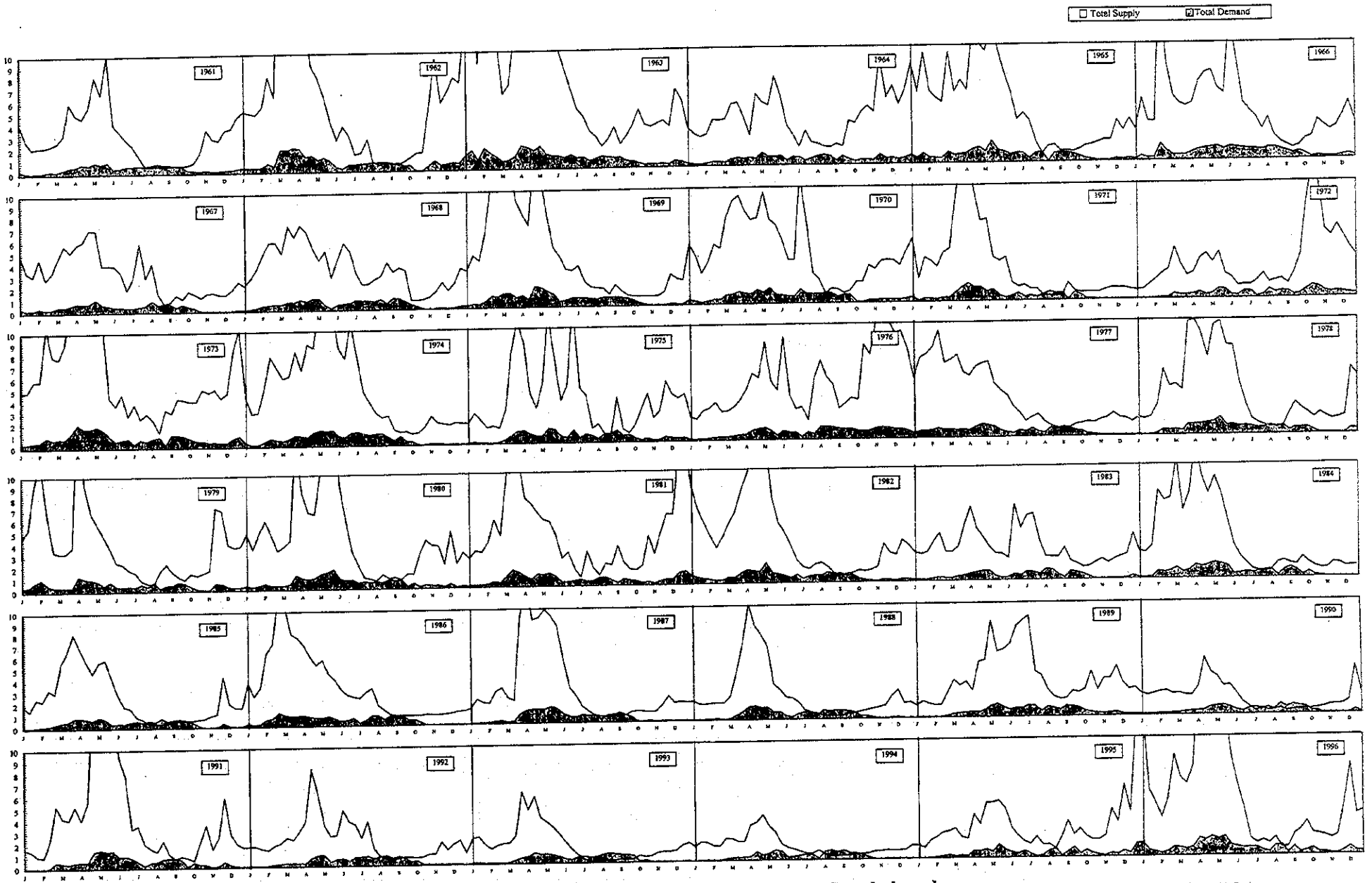


Figure 6.4 10-Day Water Balance between Demand and Supply based on Current Condition in 1996 (Pchinja River Sub-Basin B3-2)

Horizontal Axis Represents 10-days Time Step Shown in Monthly Basis
Vertical Axis Represents Total Demand and Total Supply Flow Rate (m^3/sec/10days)

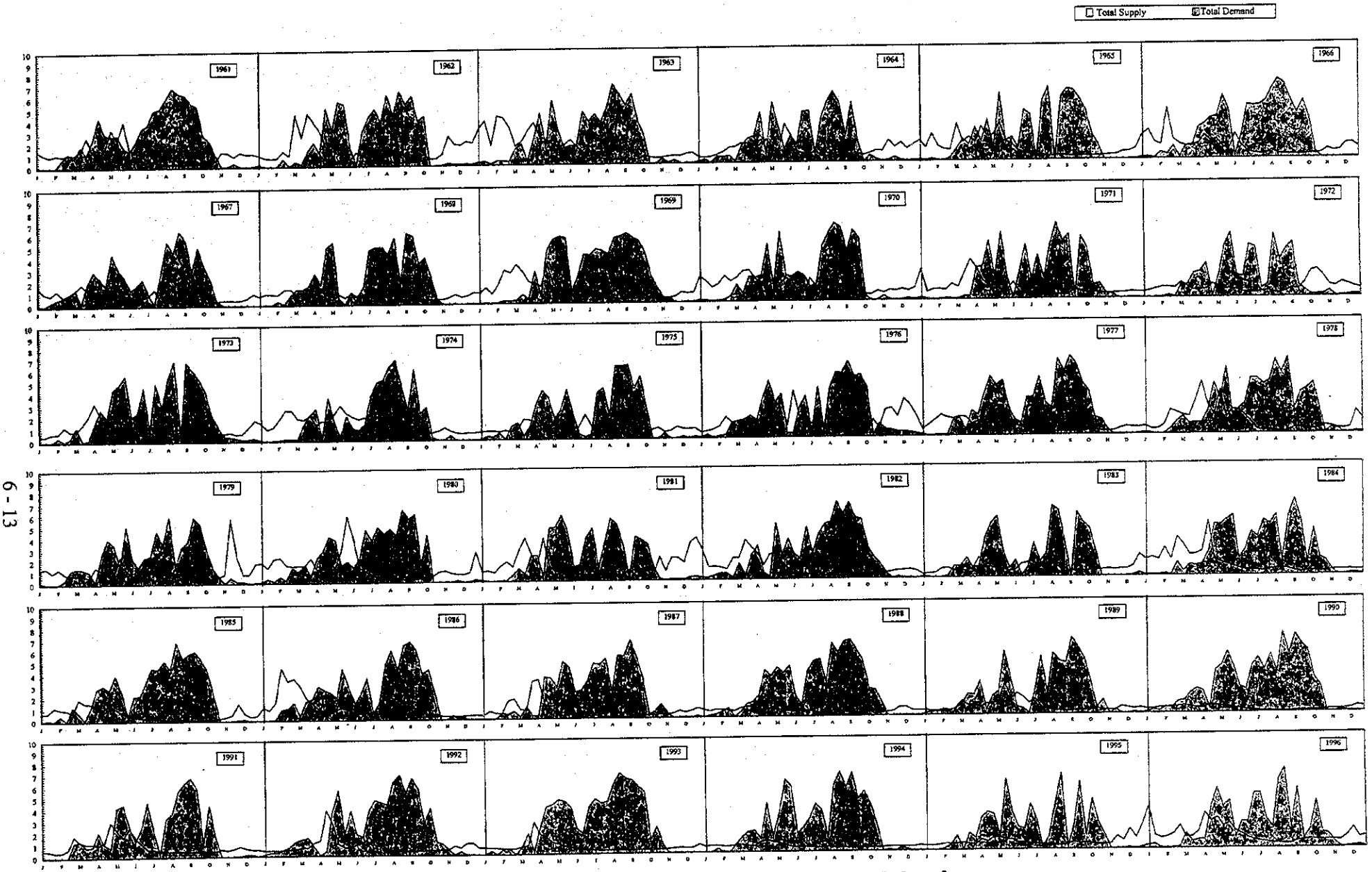


Figure 6.5 10-Day Water Balance between Demand and Supply based on Current Condition in 1996 (Pchinja River Sub-Basin B3-3)

Horizontal Axis Represents 10-days Time Step Shown in Monthly Basis
, Vertical Axis Represents Total Demand and Total Supply Flow Rate (m^3/sec/10days)

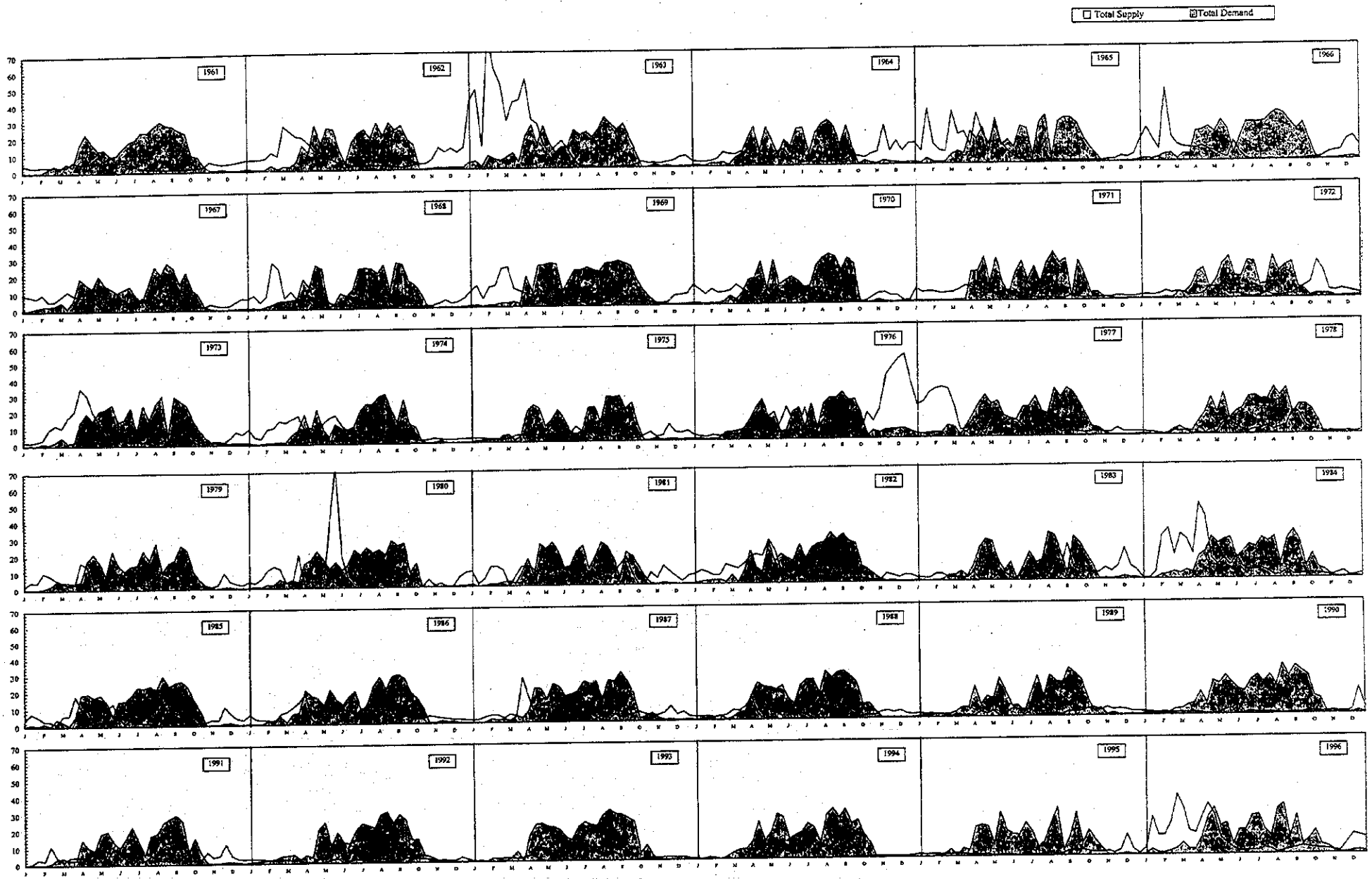


Figure 6.6 10-Day Water Balance between Demand and Supply based on Current Condition in 1996 (Bregalnica River Sub-Basin B4-2)

Horizontal Axis Represents 10-days Time Step Shown in Monthly Basis
Vertical Axis Represents Total Demand and Total Supply Flow Rate (m^3/sec/10days)

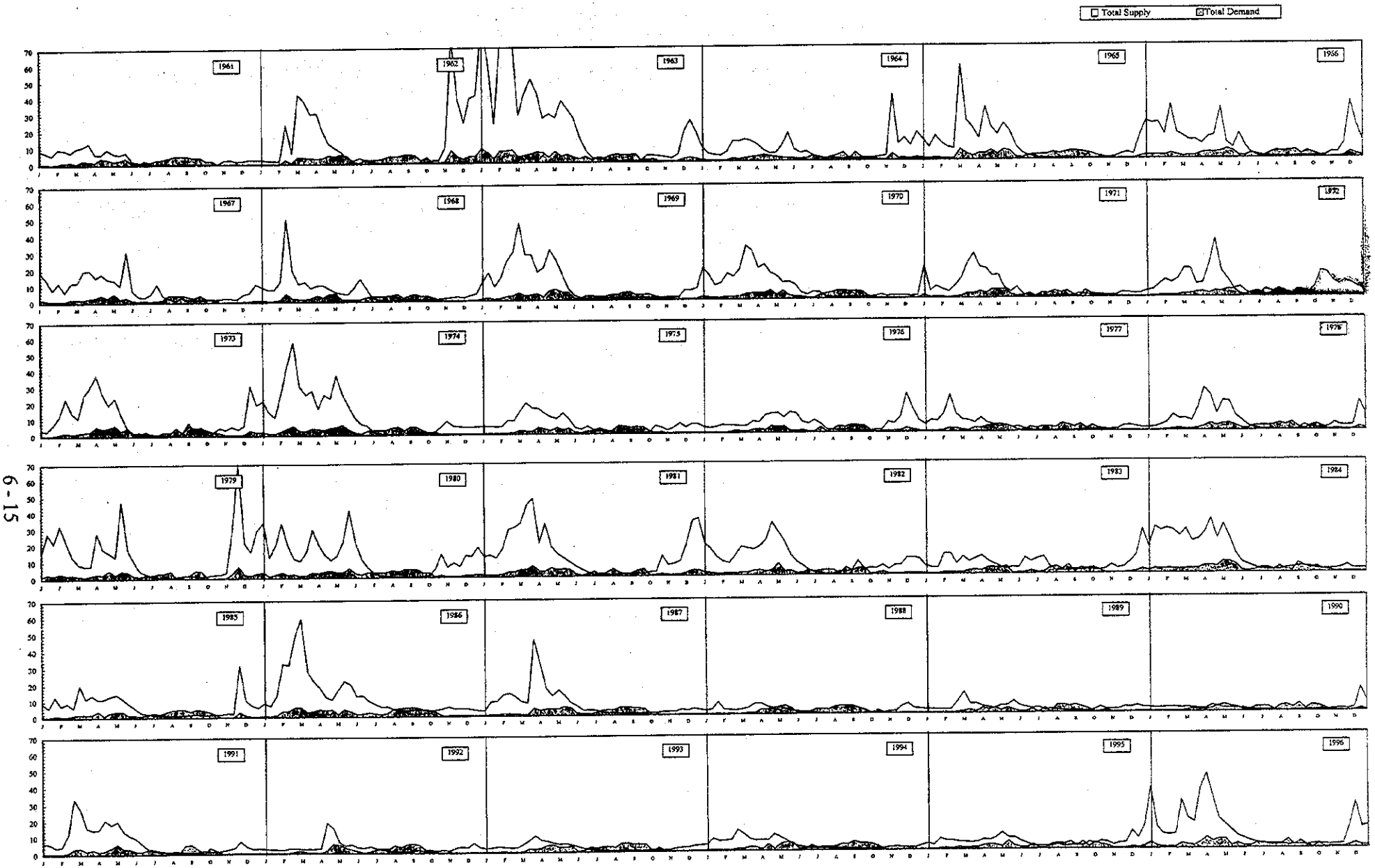


Figure 6.7 10-Day Water Balance between Demand and Supply based on Current Condition in 1996 (Crna River Sub-Basin B5-1)

Horizontal Axis Represents 10-days Time Step Shown in Monthly Basis
Vertical Axis Represents Total Demand and Total Supply Flow Rate (m^3/sec/10days)

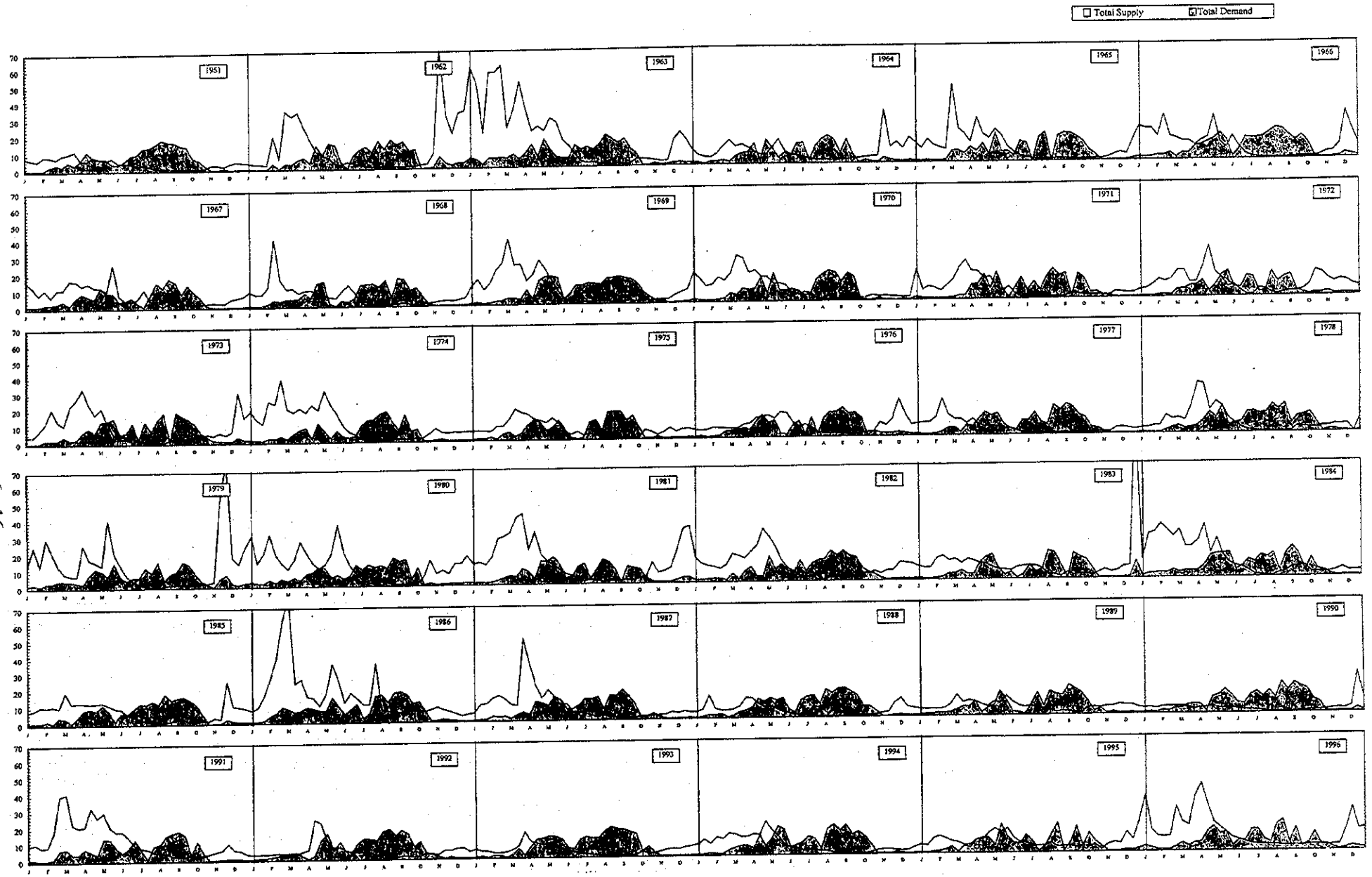


Figure 6.8 10-Day Water Balance between Demand and Supply based on Current Condition in 1996 (Crna River Sub-Basin B5-3)

Horizontal Axis Represents 10-days Time Step Shown in Monthly Basis
Vertical Axis Represents Total Demand and Total Supply Flow Rate (m^3/sec/10days)

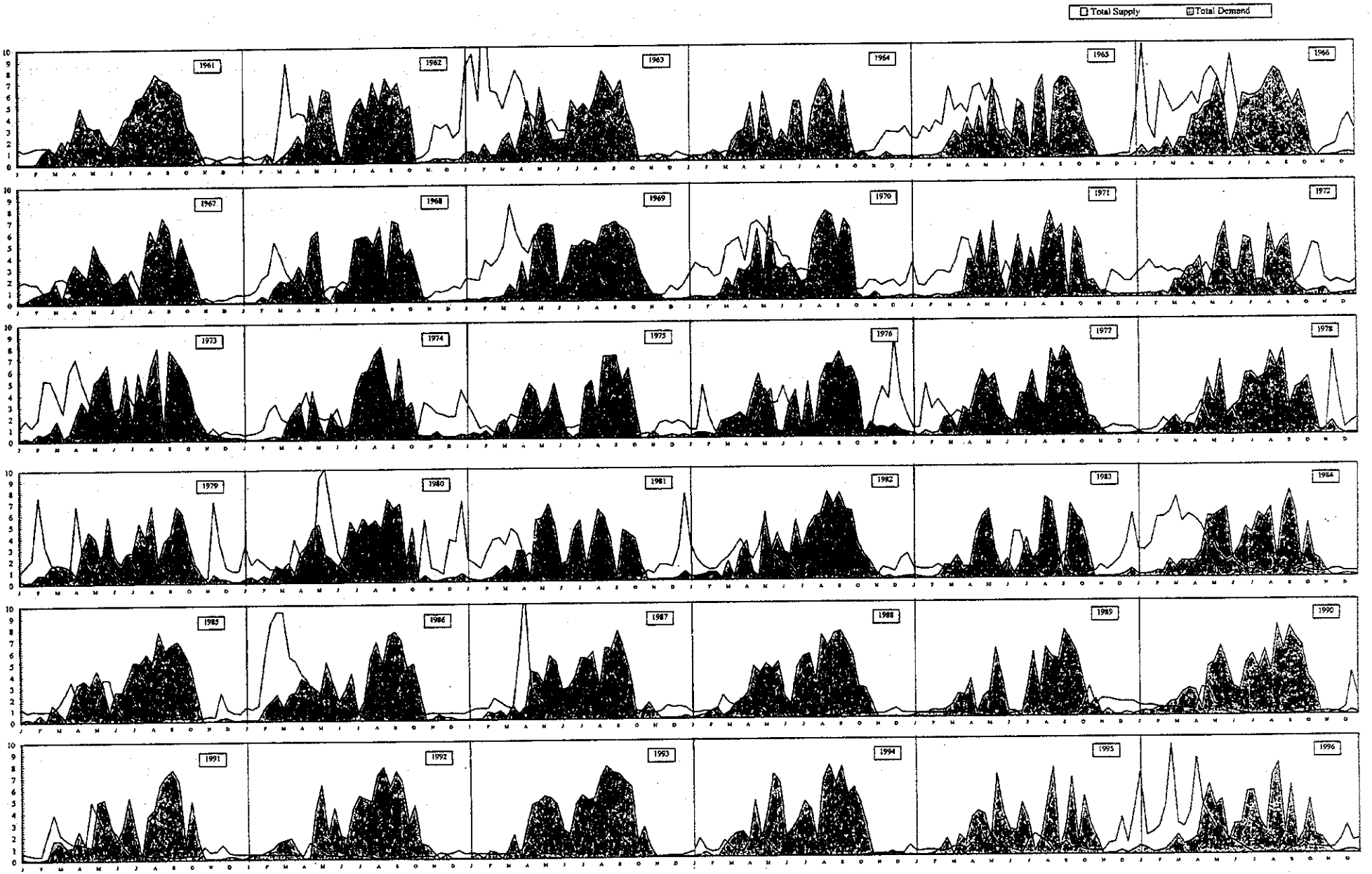


Figure 6.9 10-Day Water Balance between Demand and Supply based on Current Condition in 1996 (Strumica River Sub-Basin B6-2)

Horizontal Axis Represents 10-days Time Step Shown in Monthly Basis
Vertical Axis Represents Total Demand and Total Supply Flow Rate (m^3/sec/10days)

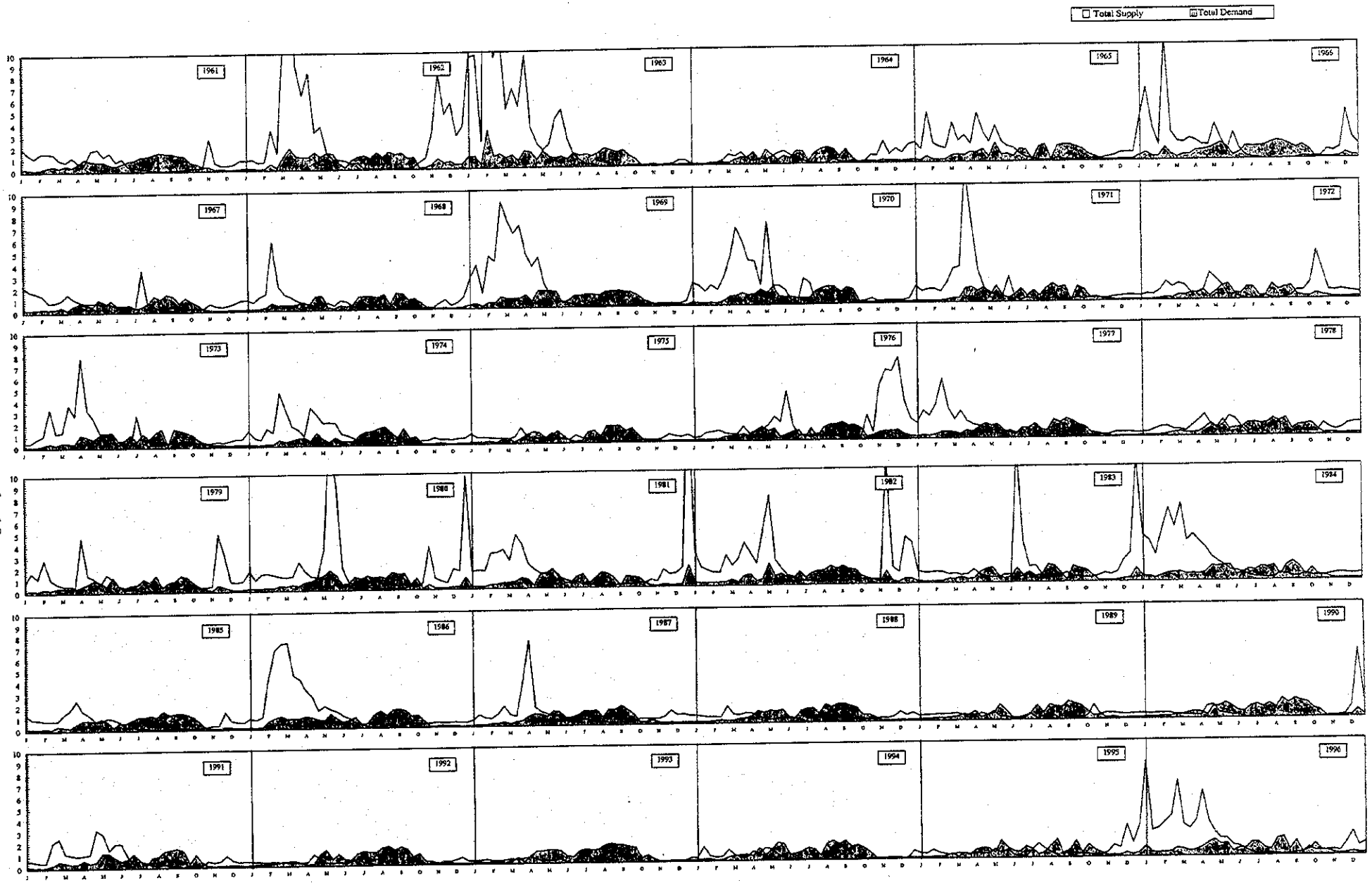


Figure 6.10 10-Day Water Balance between Demand and Supply based on Current Condition in 1996 (Strumica River Sub-Basin B6-3)

Horizontal Axis Represents 10-days Time Step Shown in Monthly Basis
Vertical Axis Represents Total Demand and Total Supply Flow Rate (m^3/sec/10days)

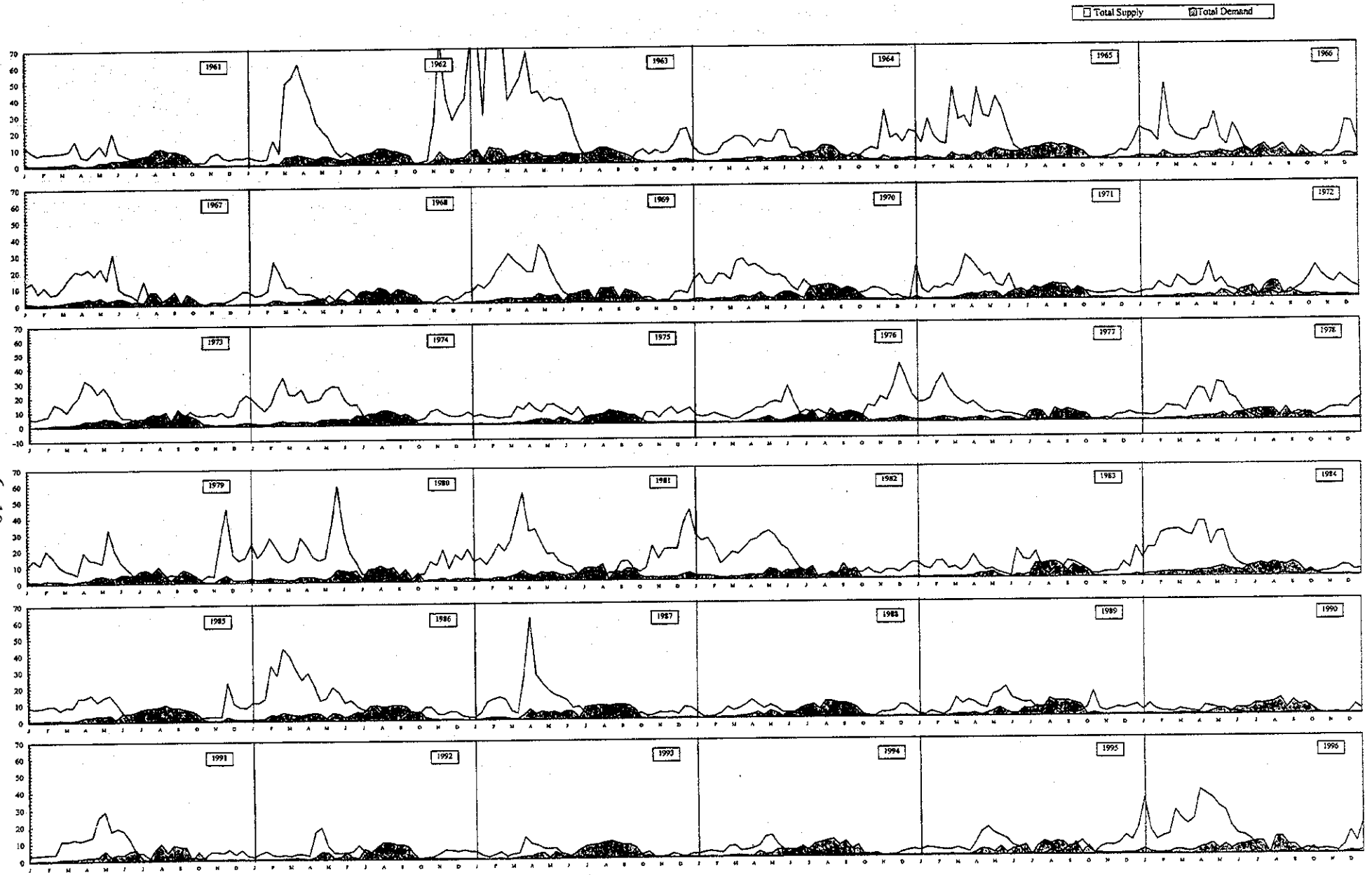


Figure 6.11 10-Day Water Balance between Demand and Supply based on Future Condition in 2025 (Vardar River Sub-Basin B1-5)

Horizontal Axis Represents 10-days Time Step Shown in Monthly Basis
Vertical Axis Represents Total Demand and Total Supply Flow Rate (m^3/sec/10days)

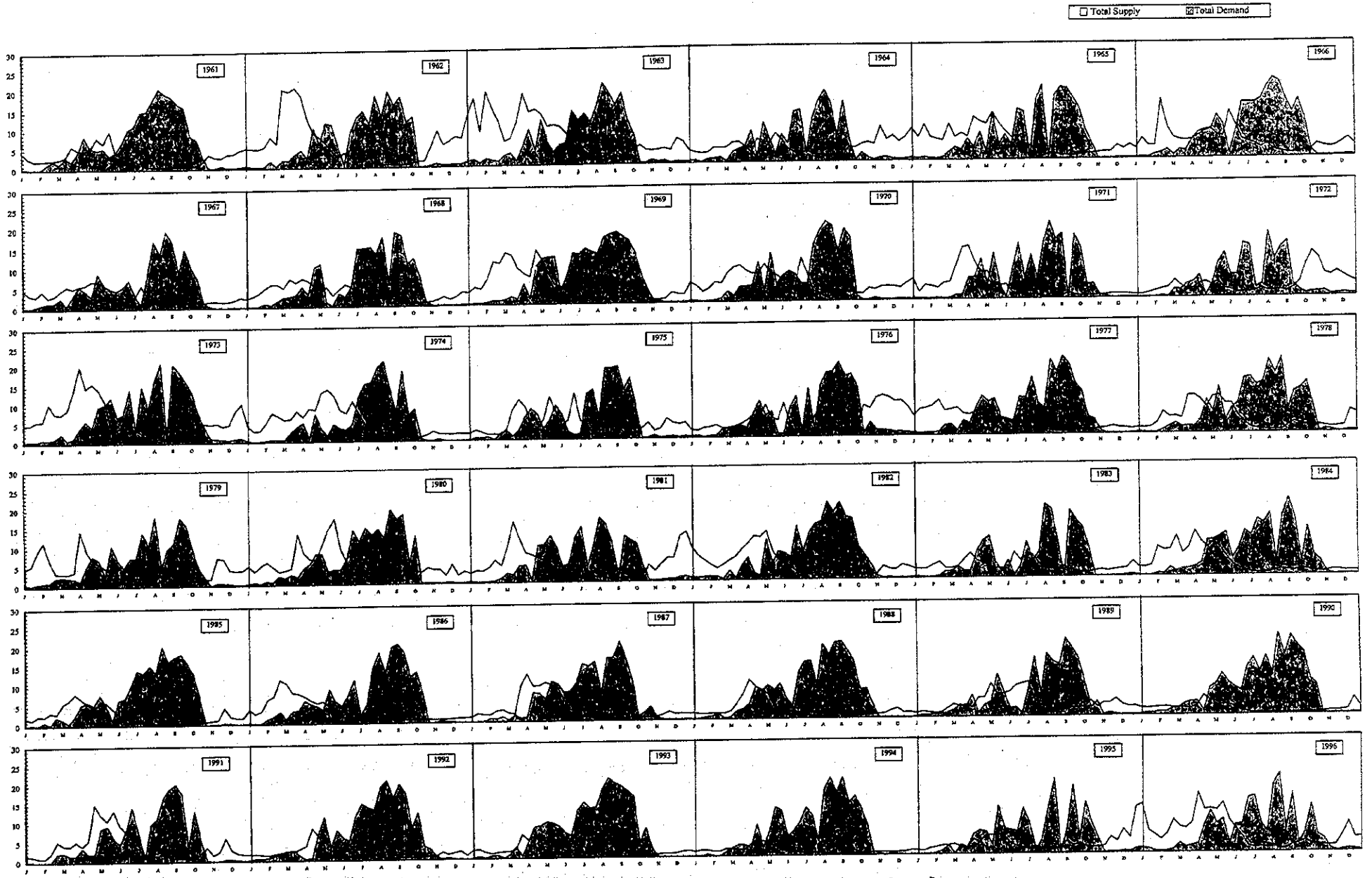


Figure 6.12 10-Day Water Balance between Demand and Supply based on Future Condition in 2025 (Pchinja River Sub-Basin B3-2)

Horizontal Axis Represents 10-days Time Step Shown in Monthly Basis
Vertical Axis Represents Total Demand and Total Supply Flow Rate (m^3/sec/10days)

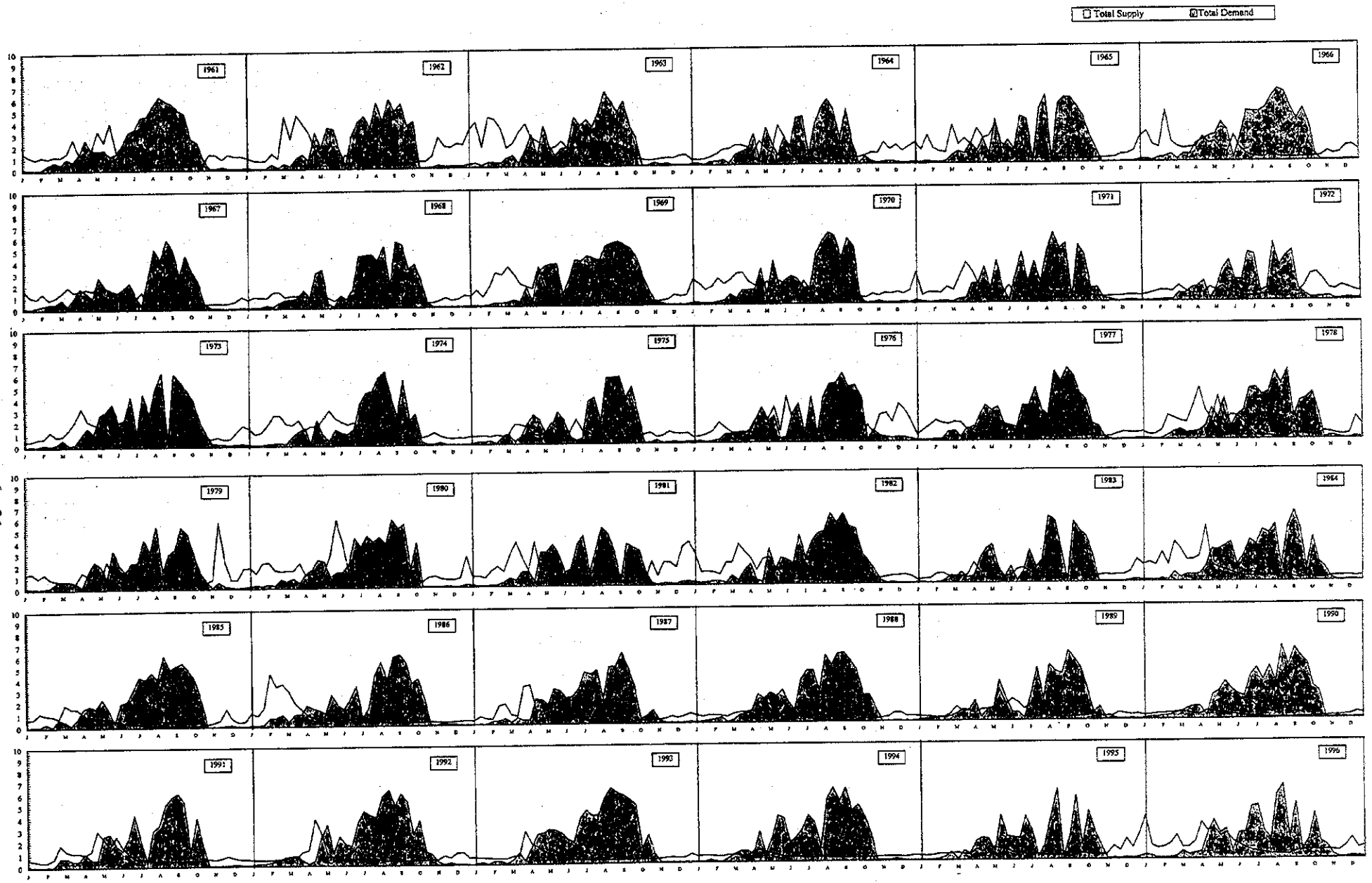


Figure 6.13 10-Day Water Balance between Demand and Supply based on Future Condition in 2025 (Pchinja River Sub-Basin B3-3)

Horizontal Axis Represents 10-days Time Step Shown in Monthly Basis
Vertical Axis Represents Total Demand and Total Supply Flow Rate (m^3/sec/10days)

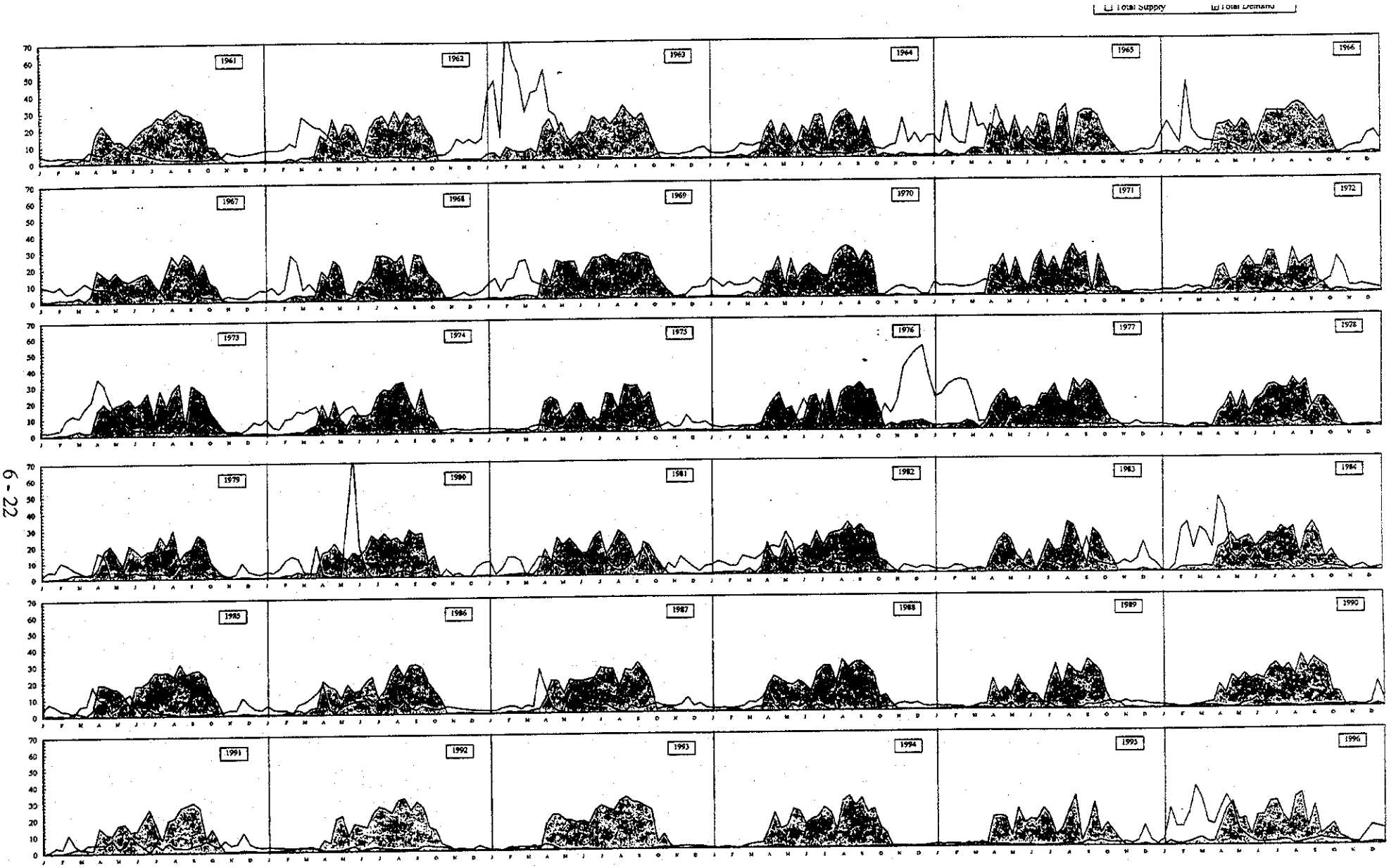


Figure 6.14 10-Day Water Balance between Demand and Supply based on Future Condition in 2025 (Bregalnica River Sub-Basin B4-2)

Horizontal Axis Represents 10-days Time Step Shown in Monthly Basis
Vertical Axis Represents Total Demand and Total Supply Flow Rate (m^3/sec/10days)

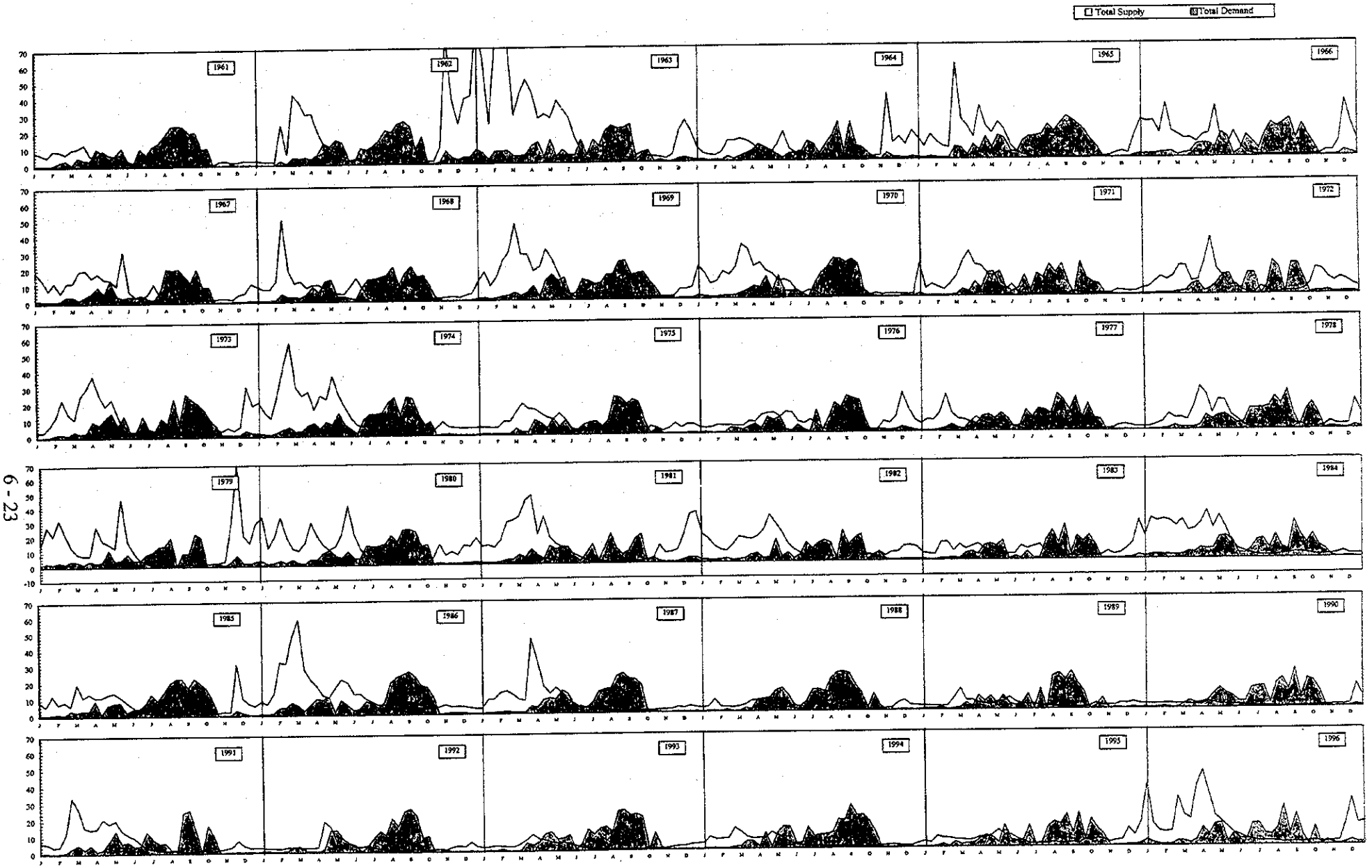


Figure 6.15 10-Day Water Balance between Demand and Supply based on Future Condition in 2025 (Crna River Sub-Basin B5-1)

Horizontal Axis Represents 10-days Time Step Shown in Monthly Basis
Vertical Axis Represents Total Demand and Total Supply Flow Rate (m^3/sec/10days)

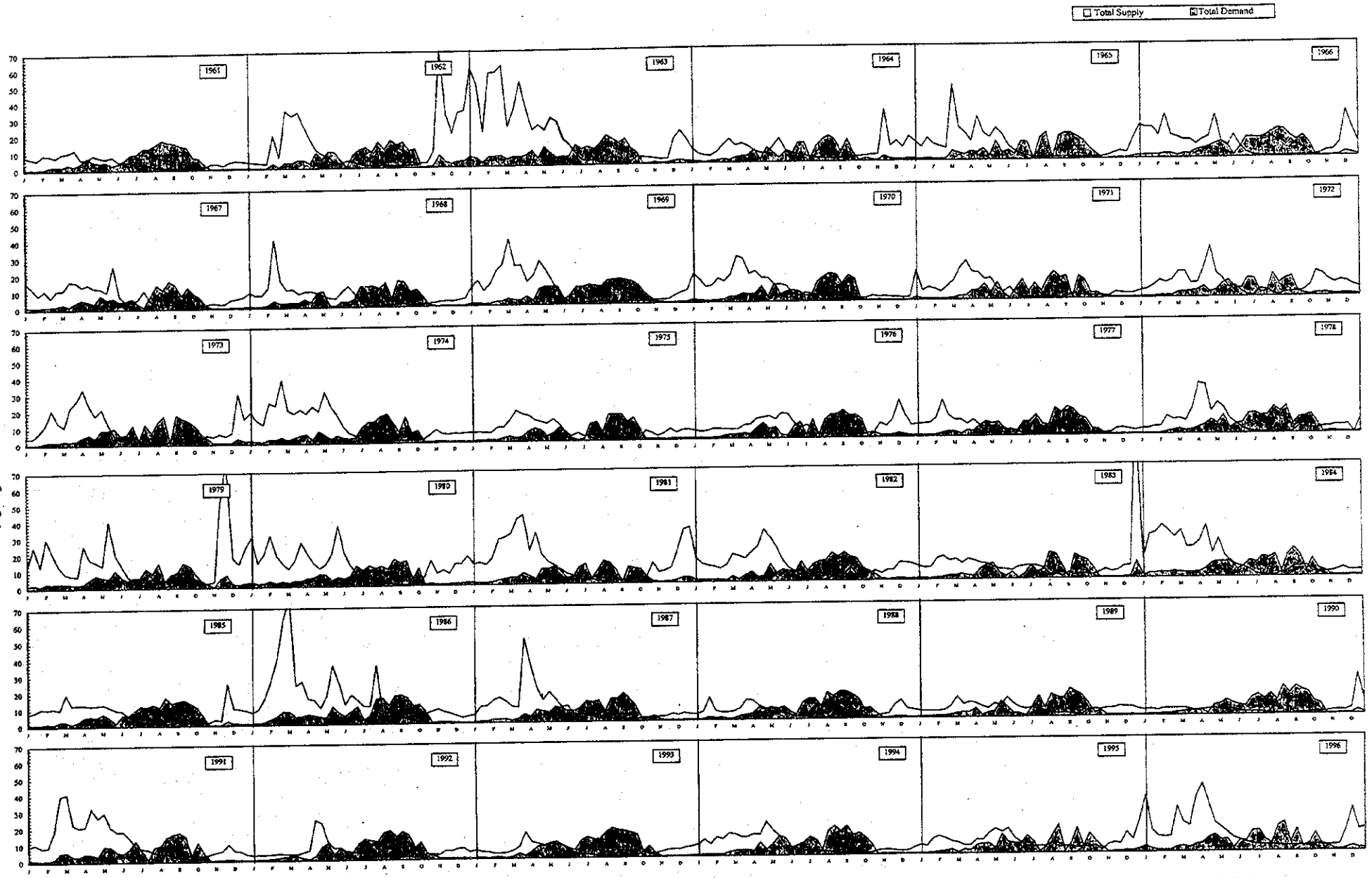


Figure 6.16 10-Day Water Balance between Demand and Supply based on Future Condition in 2025 (Crna River Sub-Basin B5-3)

Horizontal Axis Represents 10-days Time Step Shown in Monthly Basis
Vertical Axis Represents Total Demand and Total Supply Flow Rate (m^3/sec/10days)

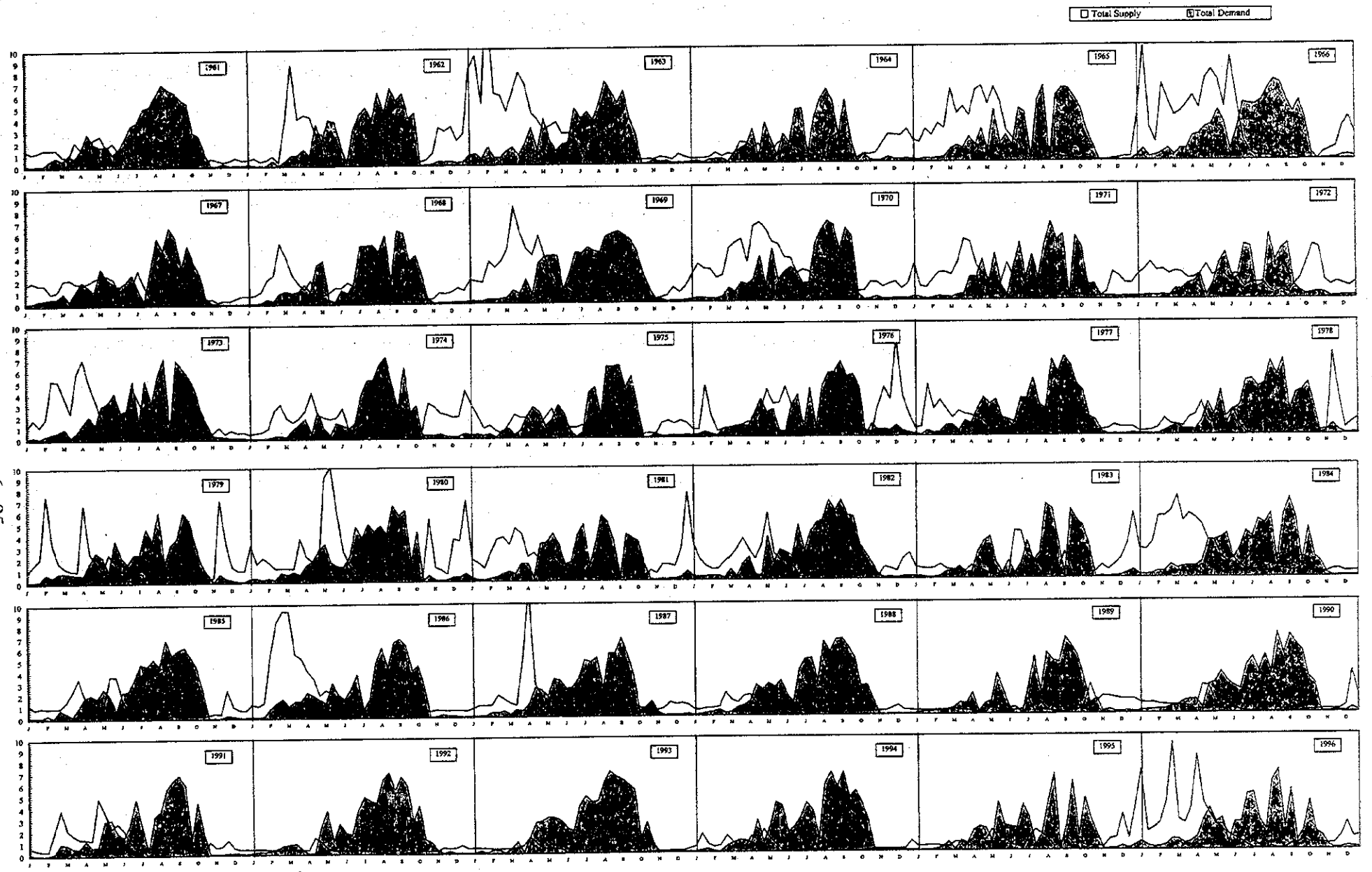


Figure 6.17 10-Day Water Balance between Demand and Supply based on Future Condition in 2025 (Strumica River Sub-Basin B6-2)

Horizontal Axis Represents 10-days Time Step Shown in Monthly Basis
Vertical Axis Represents Total Demand and Total Supply Flow Rate (m^3/sec/10days)

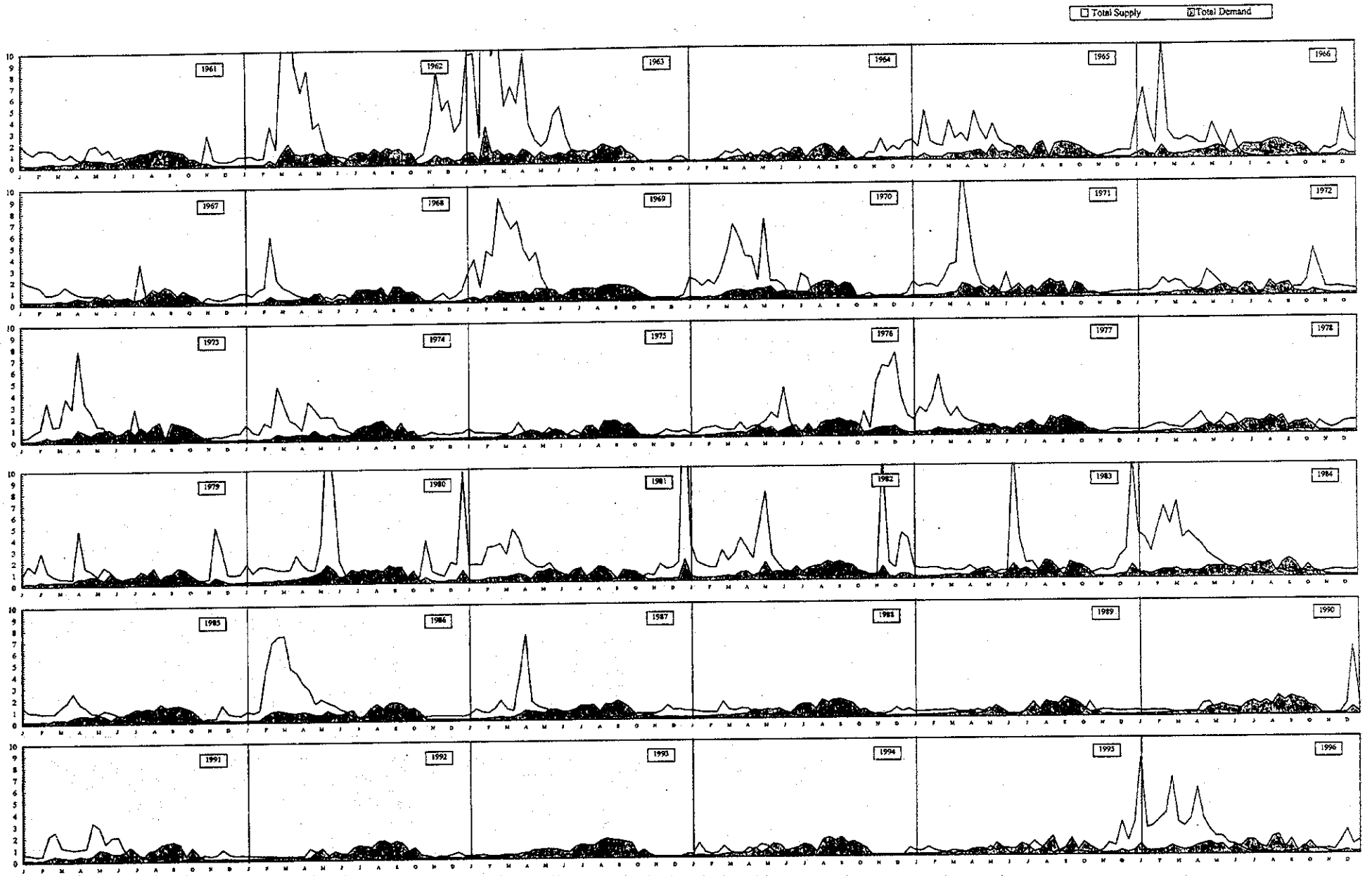


Figure 6.18 10-Day Water Balance between Demand and Supply based on Future Condition in 2025 (Strumica River Sub-Basin B6-3)

Horizontal Axis Represents 10-days Time Step Shown in Monthly Basis
Vertical Axis Represents Total Demand and Total Supply Flow Rate (m^3/sec/10days)

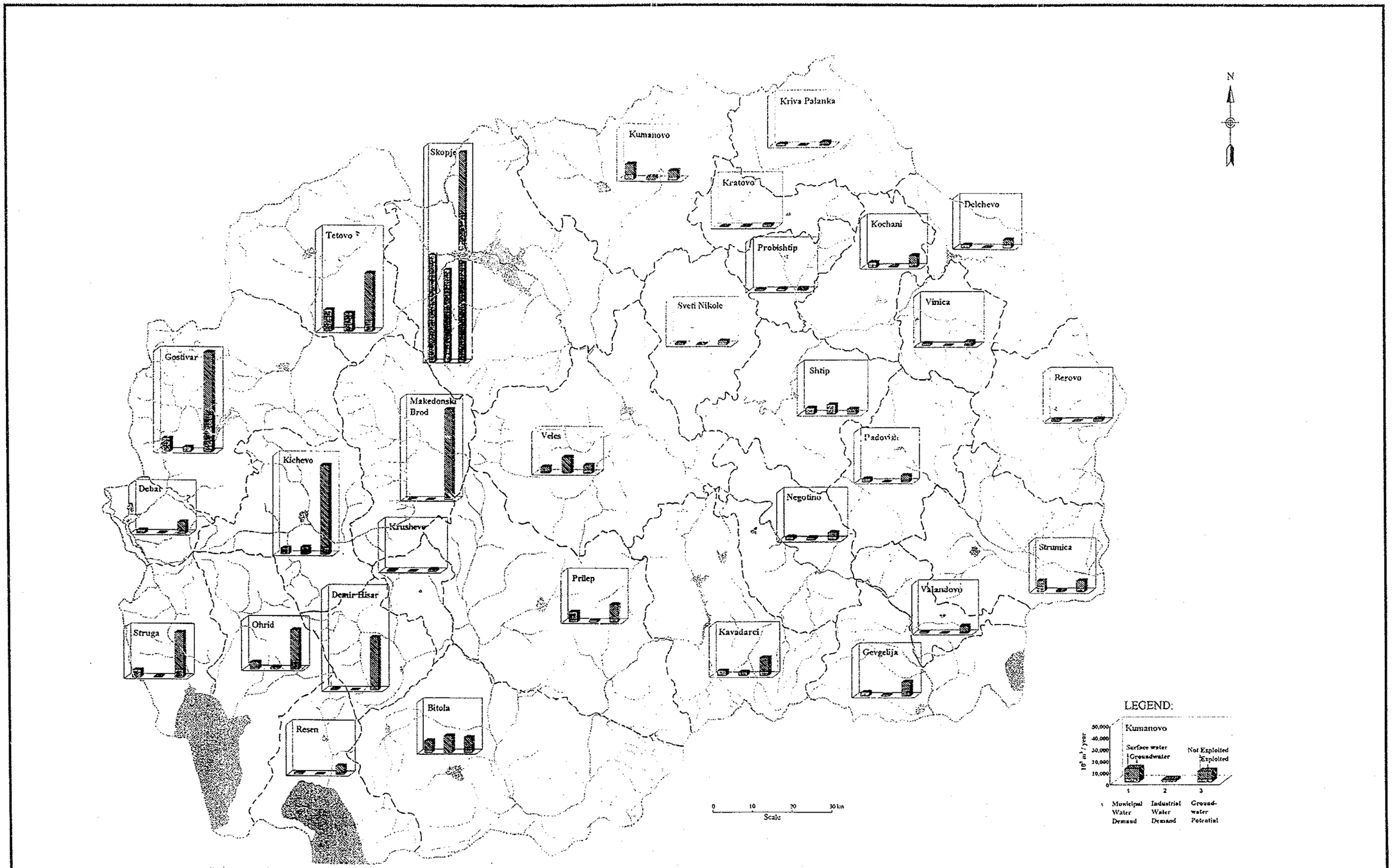


Figure 6.19 Municipal and Industrial Water Demand and Groundwater Potential

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

JAPAN INTERNATIONAL COOPERATION AGENCY

CHAPTER 7

PROCESS OF MASTER PLAN FORMULATION

CHAPTER 7 PROCESS OF MASTER PLAN FORMULATION

7.1 Basic Guidelines

The Integrated Water Resources Development and Management Master Plan in the Former Yugoslav Republic of Macedonia (the Master Plan) has been formulated according to the following basic guidelines:

1) The Master Plan aims at the well-balanced development with the basic concept of respecting environmental conservation as well as promoting effective use of water resources, in consideration of the possible negative impact on the environment, which is expected to increase with the development progress unless appropriate countermeasures are taken. Therefore, the Master Plan consists of two main components: a water resources development plan and a water resources management plan.

   i) The water resources development plan proposes the development strategy and the development projects for each region.

   ii) The water resources management plan proposes reinforcement and establishment of the efficient and effective management system.

2) The target area is the whole national area of 25,713 km^2.

3) The final target year is set as the year 2025. The 27-year period from 1999 to 2025 is divided into the following three phases: PHASE I (from 1999 to 2005), PHASE II (from 2006 to 2015), and PHASE III (from 2016 to 2025). The development direction and strategy are to be given in the Master Plan.

4) The development goal (water volume to be developed) is set-up based on the Socioeconomic Frame, which was prepared in the Study following NDS 1997, and the result of the water balance study conducted in the Study. The development goal, the Socioeconomic Frame, and the result of the water balance study were all agreed by the Macedonian side.

5) The prioritization of water use purposes is fixed basically based on the priority order set in the Water Law (Article 11) issued in January 1998. Additionally, also considered are to improve the level of satisfying Basic Human Needs (BHN) and to support the Macedonian Government's economic development policy aiming at introduction of the market-oriented economic system. The Master Plan gives priority to development of the municipal water, agricultural water, and industrial water, regarding development of hydropower generation as the accompaniment as detailed below:

i) The development plan of municipal water has two purposes; a) enhancement of water supply services in urban areas to cover the growing population and b) improvement of accessibility to safe drinking water in rural areas which are not covered by the existing water supply networks.

The target indicator of the rural water supply projects is set to increase the current coverage rate of 75% among all of villages in rural areas to 80% in the year of 2005, to 90% in 2015, and then to 100% in 2025.

The indicator was prepared in the Study and agreed by the Macedonian side.

ii) The development plan of agricultural water was designed to support NDS 1997 focusing on promotion of export product production, securing production of self-sufficiency crops, and introducing market-oriented economy. From the aspects of economic efficiency of the projects, the rehabilitation projects of the existing facilities are to be basically prioritized among the irrigation projects.

iii) The development plan of industrial water is to support the activities in the transition process from the industrial development policy, which places importance on heavy industry, to the policy giving more priority to light industry. This has been promoted under NDS 1997 having the targets of export promotion and introduction of market-oriented economy in the industrial sector. Furthermore, the development plan focuses on the wastewater treatment from the viewpoint of environmental conservation.

iv) In addition to the development plan for each water use purpose, the Master Plan includes the project for securing the minimum flow volume in the rivers for maintaining the ecological environment, especially targeting the Strumica River that is suffering from increased pollution.

7.2 Method and Procedure of Master Plan Formulation

7.2.1 General

Formulation process of the Master Plan taken in the Study is shown in Figure 7.1. The method and procedures in each step are explained below:

7.2.2 Formation of Socioeconomic Frame

As described in Section 5.3 the Socioeconomic Frame was developed with the final target year of 2025, which provides the population projection and the

development scenarios for the agricultural and industrial sectors. The Socioeconomic Frame was prepared as below:

Socioeconomic Frame

	Actual Data	Projection Based on the Previous Census Data				
Year	1994	1995	1996	2005	2015	2025
Total population	1,945,932 persons	1,960,000 persons	1,974,000 persons	2,090,000 persons	2,203,000 persons	2,304,000 persons
GDP growth rate	--	--	1.5%	3.0%	4.5%	5.5%
GDP per capita	--	--	US$1,580	US$1,790	US$2,500	US$4,000

Average annual growth rate:	During the period of 1998–2025
Per capita GDP (value term)	3 – 4 %
Industry sector (value term)	4 – 5 %
Agriculture sector (value term)	5 – 6 %

Note: The figures in the table were produced based on the analysis of the data in the "Statistical Yearbook of the Republic of Macedonia 1997" published by the Statistical Office of the Government of Macedonia.

7.2.3 Setting-up of Development Goal and Establishment of Directions

The water demand projection and the water balance study were made based on the population projection and the development targets for the economic sectors provided by the Socioeconomic Frame. The results of these analyses are introduced in the Chapters 5 and 6.

After that, development goal by region was set-up referring to water volume to be developed, as estimated above for each water use purpose. Development needs and environmental issues by region were also identified (See Tables 7.1(1/3) to (3/3)). Figure 7.2 shows those for the water supply except the rural water supply, while Figure 7.3 shows those for the rural water supply. Based on the above development goal, development needs and environmental issues, a development direction was established by region with preparation of the development curve (See Figures 5.1, 5.4 and 5.5) showing the water volume to be developed in each target year by region and by water use. The development direction and the development curve, which were prepared here, provide the bases for the development plan formulation and the project identification and selection .

7.2.4 Identification, Selection and Tentative Phasing of Development Projects

The development projects were identified and selected from the projects designed by the Study Team and from the ones which had been previously formulated by the Macedonian side, based on the development goal (water volume to be developed), the development directions, and the development curves. Physical potential of the water resources development and roughly estimated feasibility of the project were also considered as the selection criteria.

Then, all the selected projects were tentatively divided into the three PHASEs based on the development goal, the development direction, the project size, etc. The projects identified/selected for project evaluation are shown in Table 7.2.

7.2.5 Project Evaluation and Tentative Prioritization

The selected projects were evaluated from the six aspects: the economic, financial, technical, social, and institutional aspects as well as the project priority previously given by the Macedonian side through PIP (See Table 7.3 for the evaluation criteria). Then, the comprehensive evaluation was conducted to understand the general trends and to detect abnormal factors through the preliminary rating of the projects based on the results of the six aspects evaluation. The selected projects were tentatively prioritized based on the results of the comprehensive evaluation (See Tables 7.4(1/2) to (2/2)).

The rural water supply projects, to be developed in a mountainous and/or border area far from urban areas, were evaluated separately from the other projects, considering their service in the interest of the public to meet needs in the communities and their relatively low-level performance of financial and economic evaluation. Further, contribution to enhancement of BHN was given the top priority in the social aspect, which is the main criteria in the evaluation.

7.2.6 Final Prioritization and Project Phasing

The tentative prioritization was reviewed and adjusted, considering the results of IEE (Initial Environmental Examination: Necessity for further environmental impact study in implementation of the projects was examined). No project was identified, which has a negative impact to the environment at that time, and all the projects were judged to clear this aspect. This result was referred to the water quality conservation plan in the Management Plan, the consistency with the output from the PCM workshop, further referring to the water quality conservation plan from an aspect to harmonize with the environment, requirements by region and by use purpose, and the relationship with the donors. The phasing of the development projects included in the water resources development plan was determined finally, which is shown in Table 7.5.

7.2.7 Formulation of the Master Plan

Based on the results of these analyses, the development plan by region was formulated. Then, considering the environmental impact which is expected to be caused by the development plan, the water quality conservation plan was developed (See Tables 8.1(1/4) to (4/4)). Additionally, the watershed conservation plan, the surface water and groundwater monitoring system improvement plan, the water-related facilities operation and maintenance

improvement plan, the institutions and legal system strengthening plan, and the human resources development plan were designed. Compiling all of these plans, the Master Plan was completed as described in Chapter 8.

The outline of the development projects, detailed method and procedures of the project evaluation, output of each step during the project evaluation, etc. are introduced in the Supporting Report 3.

Table 7.1 Development Needs and Environmental Issues by Region (1/3)

1. Vardar River Upper Reach

Municipality	Geography	Development Needs	Environmental Issue
1) Skopje 2) Gostivar 3) Tetovo 4) Kichevo 5) M.Brod 6) Kumanovo 7) Kratovo 8) Kriva Palanka	1) Catchment (33%) and population (56%) to the whole country 2) Many factories in Skopje metropolitan, industrial water (60%) to the whole country 3) Along the Vardar "Polog irrigation system (15,000 ha), along the Pchinja river "Lipkovo irrigation system (11,000 ha) ", active in agriculture production and livestock 4) New development will be required by around 2015, "Vakuf irrigation system (22,000 ha)" 5) The Vardar River upper reach located in the west with rather much rain, whole area along the Pchinja located in the east with little rain	1) New water resources development and water supply system to cope with water shortage in urban area in summer 2) Rural water supply to reduce overpopulation in urban area and depopulation in rural area, to keep access to safe water in the rural mountainous area 3) Rehabilitation of the existing irrigation system with low cost and high efficiency to meet water shortage in agricultural sector 4) New water resources development and water supply system to cope with increase of agricultural water 5) Supplemental plan to produce clean energy as an alternative of thermal power plant	1) Protection of water in wells and the Vardar River from pollution due to wastewater from household, factories, etc. 2) Protection of water in the Pchinja river from pollution due to wastewater from livestock

2. Vardar River Middle Reach

Municipality	Geography	Development Needs	Environmental Issue
1) Veles 2) S.Nikole 3) Shtip 4) Probishtip 5) Kochani 6) Vinica 7) Delchevo 8) Berovo	1) Catchment (23%) and population (13%) to the whole country 2) Factories concentrated in Veles, industrial water (20%) to the whole country 3) Along the Bregalnica river "Bregalnica irrigation system (32,000 ha)" active in agricultural production (rice etc.), livestock, and so on 4) The Vardar River middle reach located in the central/south, east with little rain	1) New water resources development and water supply system to cope with water shortage in summer and water pollution protection in urban area 2) New water resources development and water supply system to cope with future increase of agricultural water 3) Rural water supply to keep access safety water in the rural mountainous area 4) Supplemental plan to produce clean energy as an alternative of thermal power plant	1) Protection of water in wells and the Vardar River from pollution due to wastewater from household and factories around Veles 2) Protection of water in the Bregalnica River from pollution due to wastewater from mining on the upper reach 3) Protection of water in the Bregalnica River and wells from pollution due to wastewater from agriculture, livestock on the middle reach

Table 7.1 Development Needs and Environmental Issues by Region (2/3)

3. Vardar River Lower Reach

Municipality	Geography	Development Needs	Environmental Issue
1) D.Hisar 2) Krushevo 3) Bitola 4) Prilep 5) Kavadarci 6) Negotino 7) Valandovo 8) Gevgelija	1) Catchment (28%) and population (16%) to the whole country 2) Light industry factories concentrated on Pelagonija ,industrial water (17%) to the whole country 3) Along the Vardar and its tributary Crna, "Tikvesh irrigation system (20,000 ha)", and on Pelagonija "Prilep irrigation system (6,000 ha)", Strezevo irrigation system (20,000 ha)", active in agricultural production (fruits, etc.) 4) New development will be required by around 2025, "Bucin irrigation system (27,000 ha)" 5) The Vardar River located in central/south, eastern part, and southwest of the Crna River basin with little rain	1) Rehabilitation of the existing irrigation system with low cost and high efficiency to meet water shortage in agricultural sector 2) Rural water supply to continue agricultural production, to keep population, watershed conservation, to keep the view, and to keep access to safe water 3) New water resources development and water supply to cope with water shortage in urban area in summer 4) New water resources development and water supply system to cope with increase of agricultural water	1) Protection of water in the Vardar River from pollution due to wastewater from households and agricultural system on the lower reach 2) Protection of Dojran lake from water pollution due to lowering of water level

Table 7.1 Development Needs and Environmental Issues by Region (3/3)

4. Crn Drim River Basin

Municipality	Geography	Development Needs	Environmental Issue
1) Ohrid 2) Struga 3) Debar 4) Resen	1) Catchment (10%) and population (8%) to the whole country 2) Little factories except for light industry 3) Along the Crn Drim river little irrigation system, in the north of the Prespa Lake, "Asamati/Sirhan (5,200 ha)" active in cultivation of apple 4) Located in the southwest with rather much rain	1) Rehabilitation of the existing irrigation system with low cost and high efficiency to meet water shortage in agricultural sector 2) Rural water supply to continue agricultural production, to keep population, watershed conservation, to keep the view, and to keep access to safe water	1) Protection of Ohrid Lake from water pollution due to muddy flow in torrents

5. Strumica River Basin

Municipality	Geography	Development Needs	Environmental Issues
1) Radovish 2) Strumica	1) Catcment (7%) and population (6%) to the whole country 2) Light industry dominant, mining on the upper reach 3) Along the Strumica River "Mantovo irrigation system" (6,000 ha)", "Turija irrigation system (10,000 ha)", "Vodocha (4,000 ha)", active in agricultural and livestock 4) Located on southeast with little rain	1) New water resources development and water supply to cope with water shortage in urban area in summer as well as to dilute contaminated water in the Strumica River to reduce pollutant load 2) Rehabilitation of the existing irrigation system with low cost and high efficiency to meet water shortage in agricultural sector 3) As for rural water supply, common to that in the Vardar River lower reach	1) Protection of water in the Strumica River from pollution due to wastewater from households, agricultural system, industrial water and livestock

Table 7.2 Projects Identified/Selected for Project Evaluation

River Basin	No.	Code	Project Name	Purpose
(except Rural Water Supply Projects)				
1. Vardar River Upper Reach	1	A1-1	Water Supply Project for Tetovo - River Pena Intake	M&I
	2	A1-2	Studena Voda Groundwater Development Project	M
	3	A1-3	Kichevsko Pole Area Irrigation Rehabilitation Project	RI
	4	A1-4	Construction of By-pass Channel Raven - Rechica	A
	5	A1-5	Patishka Reka Water Supply Project	M
	6	A1-6	Paligrad Multipurpose Dam Project	M&I,A,P
	7	A1-7	Slupchanka Dam Project	M
	8	A1-8	Lipkovo - Glaznja Area Irrigation Rehabilitation Project	RI
	9	A1-9	Kiselichka Dam Project	M&I,A
	10	A1-10	Vakuf Multipurpose Dam Project	M&I,A,P
	11	A1-11	Pelince Dam Project	A
2. Vardar River Middle Reach	12	A2-1	Razlovci Dam Project	M&I,A
	13	A2-2	Blatec Dam Project	M&I,A
	14	A2-3	Rechani Multipurpose Dam Project	M&I,A,P
	15	A2-4	Zletovica Multipurpose Dam Project	M&I,A,P
	16	A2-5	Construction of Irrigation of Sub-system "Shtipskpo - Pole",left side	A
3. Vardar River Lower Reach	17	A3-1	Krapa Dam Project	M&I,A
	18	A3-2	Zhvan Dam Project	A
	19	A3-3	Obednik Dam Project	A
	20	A3-4	Kochiste Dam Project	A
	21	A3-5	Zhurche Dam Project	A
	22	A3-6	Konjarka Dam Project	A
	23	A3-7	Studencica Supplemental Water Supply Project	M&I
	24	A3-8	Petrushka Dam Project	A
	25	A3-9	Kovanska Dam Project	A
	26	A3-10	Konsko Dam Project	M&I,A
	27	A3-11	Valandovo Area Irrigation Rehabilitation Project	RI
4. Crn Drim	28	A4-1	Irrigation System Betterment Project in Resen	RI
	29	A4-2	Ohrid Area Irrigation Rehabilitation Project	RI
5. Strumica	30	A5-1	Podares Dam Project	M&I,A
	31	A5-2	Oraovica Dam Project	M&E
	32	A5-3	Mantovo Area Irrigation Rehabilitation Project	RI
	33	A5-4	Strumica Area Irrigation Rehabilitation Project	RI
(Rural Water Supply Project)				
1. Vardar River Upper Reach	34	B1-1	Vardar River Upper Reach Rural Water Supply Project	RS
	35	B1-2	Treska River Upper Reach Rural Water Supply Project	RS
	36	B1-3	Regional Water Supply "Petrovec"	RS
	37	B1-4	Skopje Circle Rural Water Supply Project	RS
	38	B1-5	Kriva Palanka/Kumanovo Circle Rural Water Supply Project	RS
2. Vardar River Middle Reach	39	B2-1	Bregalnica River Basin Rural Water Supply Project	RS
3. Vardar River Lower Reach	40	B3-1	Pelagonia Circle Rural Water Supply Project	RS
	41	B3-2	Regional Water Supply "Medzitlija"	RS
3/5. Vardar River Lower Reach/Strumica	42	B3-3	Vardar River Lower Reach/Strumica River Basin	RS
4. Crn Drim	43	B4-1	Southwest Mountainous Area Rural Water Supply Project	RS
-whole country-	44	B6-1	Nationwide Rural Water Supply Extension/Improvement Project	RS

Remarks : M : Municiapl, I : Industrial, A : Agricultural, P : Power, E : Environmental,
RI : Irrigation Rehabilitation, RS : Rural Water Supply

Table 7.3 Evaluation Criteria

1. First/tentative prioritization

No.	Aspect	Criteria	Class
(1)	Economical	EIRR more than 15% (8%)	A
		EIRR 8 - 15% (4 - 8%)	B
		EIRR less than 8 % (4%)	C
(2)	Financial	FIRR more than 15% (8%)	A
		FIRR 8 - 15 % (4 - 8%)	B
		FIRR less than 8 % (4%)	C
(3)	Technical	Difficulty of technique adopted in construction	A/B/C
		- judged through common sense internationally	
		recognized	
(4)	Social	1) Social contribution/Satisfying development need	A/B/C
		(except for Rural Water Supply Project)	
		2) Satisfying BHN	
		(for Rural Water Supply Project)	
(5)	Organizational	Current organization/Reinforcement/	A/B/C
		New organization/Combination of Organization	
(6)	Priority in	Listed in PIP	A/B/C
	Macedonia	(Program for Public Sector Investment 1998-2000)	

Note: Figures of EIRR and FIRR in parentheses are those for Rural Water Supply Projects.

2. Final prioritization

No.	Filter	Criteria	Class
(1)	First Evaluation	1) Results of item 1.	-
(2)	Output in	2) Consistency with output from PCM Workshop	-
	PCM Workshop		
(3)	IEE	3) Necessity of EIS for study in the next steps	-
(4)	Water Quality	4) Harmony with natural environment	-
	Conservation Plan		
(5)	Other	5) Donors' activity, and so on	-

Table 7.4 Result of Project Evaluation (1/2)

Municipal, industrial, agricultural water and hydropower development project

River Name	No.	Code No.	Project Name	Purpose	Initial Evaluation							Second Evaluation		
					Economic	Financial	Technical	Institutional	Social	Priority in Macedonia#	Overall	PCM	Environmental (IEE)	Final
Vardar River Upper Reach	1	A1-1	Water Supply Project for Tetovo - River Pena Intake	M & I	A	A	B	B	A	C	A	–	–	A
	2	A1-2	Studena Voda Groundwaer Developmenrt Project	M	B	B	A	B	A	C	B	–	–	B
	3	A1-3	Kichevsko Pole Area Irrigation Rehabilitation Project	RI	A	A	B	B	B	C	A	–	–	A
	4	A1-4	Construction of By-pass Channel Raven Rechica	A	C	C	C	B	C	B	C	–	–	C
	5	A1-5	Patishka Reka Water Supply Project	M	A	B	A	B	A	B	A	A	–	A
	6	A1-6	Paligrad Multipurpose Dam Project	M & I,A,P	B	C	A	B	A	C	B	C	–	B
	7	A1-7	Slupchanka Dam Project	M	A	B	A	A	A	C	A	A	–	A
	8	A1-8	Lipkovo - Glaznja Area Irrigation Rehabilitation Project	RI	B	B	B	B	B	C	B	A	–	B
	9	A1-9	Kiselichka Dam Project	M & A	B	B	B	B	A	C	B	A	EIS	B
	10	A1-10	Vakuf Maltipurpose Dam Project	M & I, A,P	B	B	B	C	A	C	B	A	EIS	B
	11	A1-11	Pelince Dam Project	A	C	C	C	B	B	C	C	–	–	C
Vardar River Middle Reach	12	A2-1	Razlovci Dam Project	M & I, A	B	B	B	B	A	C	B	–	–	B
	13	A2-2	Blartec Dam Project	M & I, A	C	C	B	B	B	C	C	A	EIS	C
	14	A2-3	Rechani Multipurpose Dam Project	M & I, P	C	C	B	C	A	A	B	A	–	B
	15	A2-4	Zletovica Multipurpose Dam Project (Phase I)	M & I	B	B	A	A	A	B	A	A	–	A
	16	A2-5	Construction of Irrigation Sub-system Shtipsko Pole, left side	A	A	B	B	B	B	B	B	–	–	B
Vardar River Lower Reach	17	A3-1	Krapa Dam Project	M & I, A	C	C	C	B	B	C	C	B	EIS	C
	18	A3-3	Zhvan Dam Project	A	B	B	C	C	C	C	C	A	EIS	C
	19	A3-4	Obednik Dam Project	A	C	C	C	C	C	C	C	A	EIS	C
	20	A3-5	Kochishte Dam project	A	C	C	C	C	C	C	C	A	EIS	C
	21	A3-6	Zhurche Dam Project	A	C	C	C	C	C	C	C	A	EIS	C
	22	A3-7	Konjarka Dam Project	A	B	C	C	B	C	C	C	A	EIS	C
	23	A3-8	Studencica Supplemental Water Supply Project	M & I	C	C	B	B	B	A	B	A	–	B
	24	A3-9	Petrushka Dam Project	A	B	C	C	B	C	C	C	A	EIS	C
	25	A3-10	Kovanska Dam Project	A	C	C	B	B	B	C	B	A	EIS	B
	26	A3-11	Konsko Dam Project	M & I, A	B	C	B	B	A	B	B	A	EIS	B
	27	A3-12	Valandovo Area Irrigation Rehablitaion Project	RI	A	A	B	B	B	C	A	B	–	A
Crn Drim River Basin	28	A4-1	Irrigation System Betterment Project in Resen	RI	A	A	A	B	B	C	A	–	–	A
	29	A4-2	Ohrid Area Irrigation Rehabilitation Project	RI	B	B	B	B	B	C	B	–	–	B
Strumica River Basin	30	A5-1	Podares Dam Project	M & I,	C	C	B	B	B	C	C	A	EIS	C
	31	A5-2	Oraovica Dam Project*)	M & E	B	B	A	B	A	C	B	–	–	A
	32	A5-3	Mantovo Area Irrigation Rehabilitation Project	RI	B	B	B	B	B	C	B	A	–	B
	33	A5-4	Strumica Area Irrigation Rehabilitation Project	RI	B	B	B	B	A	C	B	A	–	B

*): Aming at abatement of pollution in the international river that is deteriorating water quality and at harmonizing with river environment, the Rank B was raised to Rank A .

#, Relation with the "Program for Public Sector Investment of Macedonia 1998 - 2000".

EIS: Environmental Impact Survey to be conduced as the result of the Initial Environmental Examination (IEE)

M: Municipal, I: Industrial, A: Agricultural, P: Power, E: Environmental, RI: Irrigatin rehabilitation

Table 7.4 Result of Project Evaluation (2/2)

Rural water supply project

River Name	No.	Code No.	Project Name	Purpose	Initial Evaluation							Secondary Evaluation		
					Economic	Financial	Technical	Institutional	Social	Priority in Macedonia	Overall	PCM	Environmental (IEE)	Final
Vardar River Upper Reach	34	B1-1	Vardar River Upper Reach Rural Water Supply Project	RS	A	C	B	C	B	C	B	–	–	B
	35	B1-2	Treska River Upper Reach Rural Water Supply Project	RS	C	C	B	C	A	C	A	A	–	A
	36	B1-4	Petrovec Rural Water Supply Project*1)	RS	A	C	A	C	B	A	A	A	–	A*1)
	37	B1-5	Skopje Circle Rural Water Supply Project	RS	A	C	B	C	A	C	A	A	–	A
	38	B1-6	Kriva Palanka/Kumanovo Circle Rural Water Supply Project	RS	B	C	B	C	A	C	A	A	–	A
Vardar River Middle Reach	39	B2-1	Bregalnica River Basin Rural Water Supply Project	RS	C	C	B	C	A	C	B	A	–	B
Vardar River Lower Reach	40	B3-1	Pelagonija Circle Rural Water Supply Project	RS	C	C	B	C	A	C	A	A	–	A
	41	B3-2	Medzitlija Rural Water Supply Project*2)	RS	C	C	B	C	B	A	A	A	–	A*2)
Vardar River Lower	42	B3-3	Vardar River Lower Reach/Strumica River Basin Rural Water Supply Project	RS	B	C	B	C	B	B	B	A	–	B
Crn Drim River	43	B4-1	Southwest Mountains Area Rural Water Supply Project	RS	C	C	B	C	B	B	B	–	–	B
Nationwide	44	B6-1	Nationwide Rural Water Supply Extension/Improvement Project	RS	A	C	B	C	C	C	C	–	–	C

*1): Considering the size of the project, this is integrated in (B1-5).
(The result of the initial evaluation is "A")

*2): Considering the size of the project, this is integrated in (B3-1).
(The result of the initial evaluation is "B")

Remark 1 : For the evaluation of rural water supply project, Basic Human Need (BHN) was given more priority than economic and financial aspects taking its contribution to local communities as well as public benefit into consideration, based on a consent in the meeting with the Macedonian side.

Remark 2 : There is no difference between the Treska River upper reach rural water supply project (Code No.B1-2) and the Bregalnica River basin rural water supply project (Code No.B2-1) regarding contribution to BHN of each project. However, the former has more beneficiaries as well as low- income population than the latter, and hence the former was ranked as A, while the latter was as B.

Table 7.5 Projects in Water Resources Development

Phase	River Basin	No.	Project Name (Code)	Purpose
(except Rural Water Supply Project)				
I	1. Vardar River Upper Reach	1	Water Supply Project for Tetovo - River Pena Intake (A1-1)	M&I
		2	Kichevsko Pole Area Irrigation Rehabilitation Project (A1-3)	RI
		3	Patishka Reka Water Supply Project (A1-5)	M
		4	Slupchanka Dam Project (A1-7)	M
	2. Vardar River Middle Reach	5	Zletovica Multipurpose Dam Project (Phase I) (A2-4)	M&I
	3. Vardar River Lower Reach	6	Valandovo Area Irrigation Rehabilitation Project (A3-11)	RI
	4. Crn Drim	7	Irrigation System Betterment Project in Resen (A4-1)	RI
	5. Strumica	8	Oraovica Dam Project (A5-2)	M&E
II	1. Vardar River Upper Reach	9	Studena Voda Groundwater Development Project (A1-2)	M
		10	Paligrad Multipurpose Dam Project (A1-6)	M&I,A,P
		11	Lipkovo - Glaznja Area Irrigation Rehabilitation Project (A1-8)	RI
		12	Kiselichka Dam Project (A1-9)	M&I,A
		13	Vakuf Multipurpose Dam Project (A1-10)	M&I,A,P
	2. Vardar River Middle Reach	14	Razlovci Dam Project (A2-1)	M&I,A
		15	Rechani Multipurpose Dam Project (A2-3)	M&I, P
		16	Construction of Irrigation of Sub-system "Shtipsko Pole", left side (A2-5)	A
	3. Vardar River Lower Reach	17	Studencica Supplemental Water Supply Project (A3-7)	M&I
		18	Kovanska Dam Project (A3-9)	A
		19	Konsko Dam Project (A3-10)	M&I,A
	4. Crn Drim	20	Ohrid Area Irrigation Rehabilitation Project (A4-2)	RI
	5. Strumica	21	Mantovo Area Irrigation Rehabilitation Project (A5-3)	RI
		22	Strumica Area Irrigation Rehabilitation Project (A5-4)	RI
III	1. Vardar River Upper Reach	23	Construction of By-pass Channel Raven - Rechica (A1-4)	A
		24	Pelince Dam Project (A1-11)	A
	2. Vardar River Middle Reach	25	Blatec Dam Project (A2-2)	M&I,A
	3. Vardar River LowerReach	26	Krapa Dam Project (A3-1)	M&I,A
		27	Zhvan Dam Project (A3-2)	A
		28	Obednik Dam Project (A3-3)	A
		29	Kochiste Dam Project (A3-4)	A
		30	Zhurche Dam Project (A3-5)	A
		31	Konjarka Dam Project (A3-6)	A
		32	Petrushka Dam Project (A3-8)	A
	4. Crn Drim	-	-	-
	5. Strumica	33	Podares Dam Project (A5-1)	M&I,A
(Rural Water Supply Project)				
I	1. Vardar River Upper Reach	34	Treska River Upper Reach Rural Water Supply Project (B1-2)	RS
		35	Skopje Circle Rural Water Supply Project (B1-4)*1)	RS
		36	Kriva Palanka/Kumanovo Circle Rural Water Supply Project (B1-5)	RS
	3. Vardar River Lower Reach	37	Pelagonia Circle Rural Water Supply Project (B3-1)*2)	RS
II	1. Vardar River Upper Reach	38	Vardar River Upper Reach Rural Water Supply Project (B1-1)	RS
	2. Vardar River Middle Reach	39	Bregalnica River Basin Rural Water Supply Project (B2-1)	RS
	3/5. Vardar River Lower Reach/Strumica	40	Vardar River Lower Reach/Strumica River Basin (B3-3)*3)	RS
	4. Crn Drim	41	Southwest Mountainous Area Rural Water Supply Project (B4-1)*4)	RS
III	-whole country-	42	Nationwide Rural Water Supply Extension/Improvement Project (B6-1)	RS

Remark : M : Municipal, I : Industrial, A : Agricultural, P : Power, E : Environmental, RI : Irrigation Rehabilitation
RS : Rural Water Supply

*1) : includes Regional Water Supply "Petrovec" (B1-3)

*2) : includes Regional Water Supply "Medzitlija" (B3-2)

*3) : includes Regional Water Supply "a part of Grvgelija, Bogdanci, Dojran and Valndovo"

*4) : includes Regional Water Supply "Belchista"

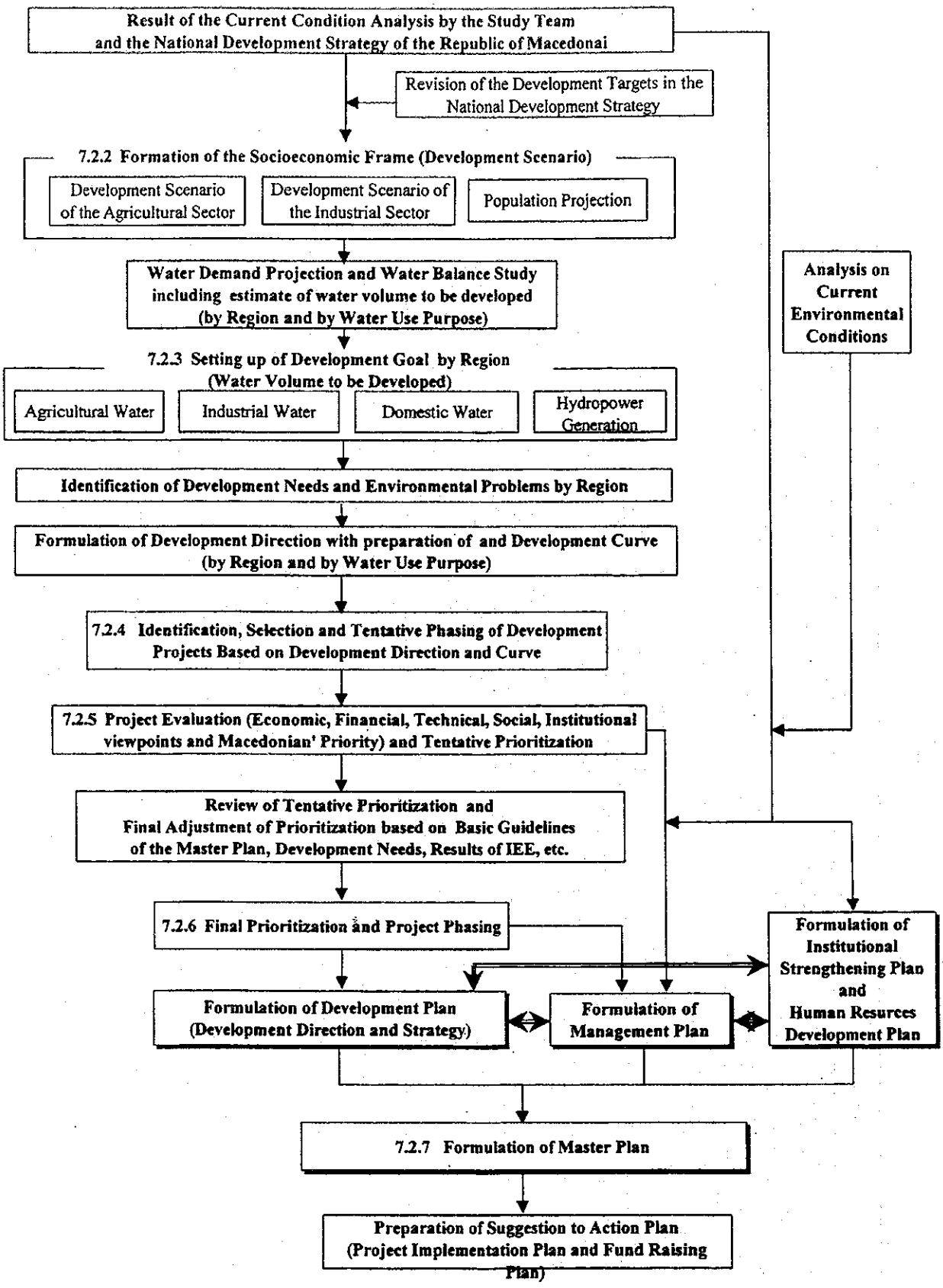


Figure 7.1 Flowchart for Process of Master Plan Formulation

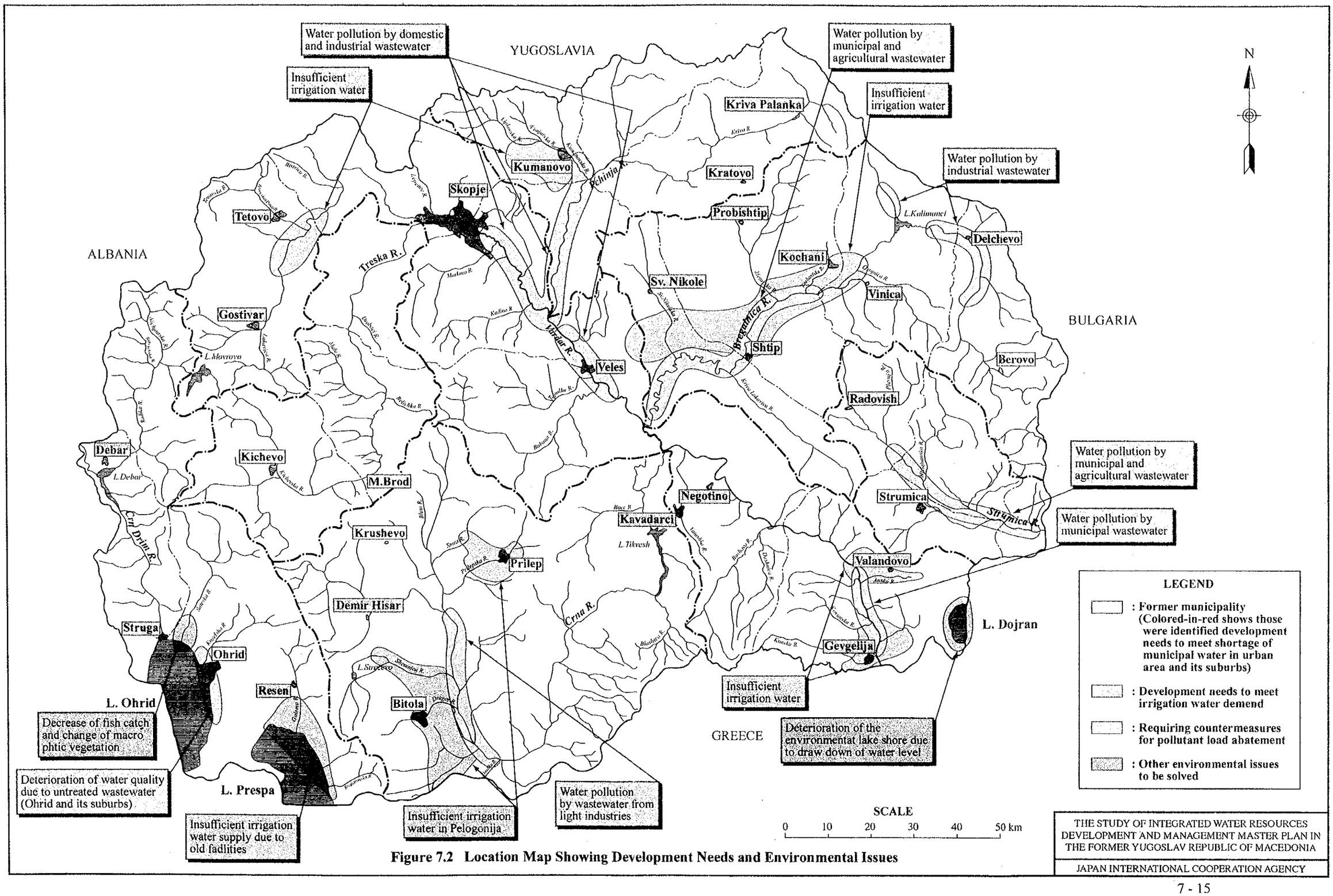


Figure 7.2 Location Map Showing Development Needs and Environmental Issues

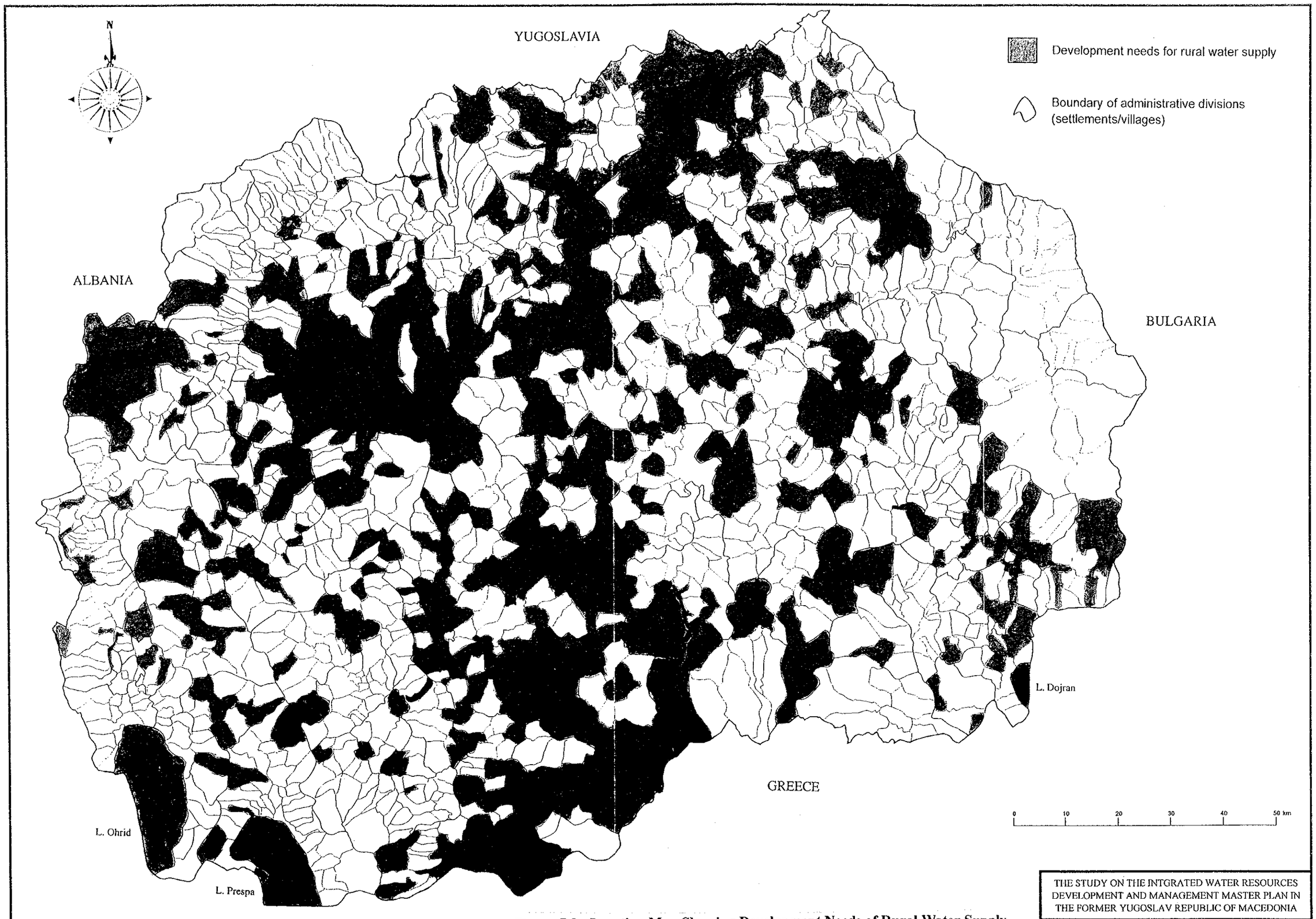


Figure 7.3 Location Map Showing Development Needs of Rural Water Supply

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

JAPAN INTERNATIONAL COOPERATION AGENCY