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POINT SOURCE POLLUTION IN THE DANUBE BASIN

COUNTRY TECHNICAL REPORTS
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VOLUME III

WATER AND SANITATION FOR HEALTH PROJECT

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COUNTRY TECHNICAL REPORTS

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B. Czech and Slovak Republic

Part I - Slovakia, by Hydrotest, Bratislava

Part II - The Czech Republic, by Hydropol, Bratislava

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PREFACE TO VOLUME III, COUNTRY TECHNICAL REPORTS

Preface

The five technical reports in this volume have been prepared by subcontractors retained by the WASH Team. The subcontractors are consulting firms located and operating in the countries that are the subjects of the respective reports.

The reports were prepared in a language not the authors' own, and have not been edited for style or English grammatical correctness. They contain valuable information and insights, and have been drawn on extensively in the preparation of the main text of the WASH Team's report.

The reports were prepared with the support and assistance, particularly in the area of data provision, of the pollution control agencies of the four governments. However, the views included are the responsibility of the authors and do not necessarily reflect those of their governments nor those of the WASH Team or of the Government of the United States.

BULGARIA

TECHNICAL REPORT

CAMP DRESSER & McKEE INTERNATIONAL INC.

WATER AND SANITATION FOR HEALTH (WASH) PROJECT
TASK NO. 271
Danube Emissions Management Decision Support Project

Primary Problems of Water Pollution Control in the Bulgarian Part of the Danube River Basin

TECHNICAL REPORT

WATER ENGINEERING LTD.
35 Christo Beltchev (Gavril Genov) Street
Sofia 1000, Bulgaria

D.E.M.D.E.S.P.

Danube Emissions Management Decision Support Project

TECHNICAL REPORT

BULGARIA

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Country Technical Report

BULGARIA

1. Assessment of the Water Pollution in the Bulgarian Part of the Danube River Basin.

1.1. Description of the River and its Tributaries.

1.1.1. Danube River

The Bulgarian reach of Danube river is 471 km. It stretches from the Timok river - km 845^{+300} up to the eastern part of the town of Silistra - km 375^{+500}. The mean annual water discharge of this part of the river increases from 5 727 cu.m/sec. at the village Novo Selo up to 6 300 cu.m/sec. at the town of Silistra. In some seasons the mean annual water quantities vary from 1 700 cu.m/sec. up to 16 000 cu.m/sec. The catchment area of the river includes almost the whole part of North Bulgaria and the Sofia region.
Directly from the river are utilized about 1×10^9 cu.m. water for irrigation, industrial needs and energy producing sources.

The turbidity of the river water decreased after the construction of Iron Gate dams I and II. This has activated the erosion and abrasion processes of the river bed and of the Bulgarian bank of the river. The frequent changes of the water levels and the daily variation of the water quantities with several thousand cubic meters caused a quick worsening of the biological cycles of the bottom flora and fauna and the fish population considerably decreased. That leads to degradation of the wet lands along the river banks and increases the duration of the minimal water levels.

For industrial needs are used annually 260×10^6 m^3 river water by direct river intakes and by wells from the river terrace. For potable water supply are used 6 m^3/s only. Along the river are constructed 330 km dikes and many draining systems. The industrial fishing is decreasing from 1200 tons during the year 1960 to 300-350 tons in 1990.

The forests along the river banks and on the islands are 11 137 ha. The vegetation has important protective, recreative and ecological functions.

The annual run-off of the Bulgarian part of the Danube river is 170×10^9 m^3. The contribution of the tributaries from this part is 154 m^3/s - 3.8% of the mean water quantity. After the construction of Iron Gate dams I and II some problems for Bulgaria arose due to the disturbance of the natural flow of Danube river. Iron Gate I dam is 100 km up stream the Bulgarian border. Its total dam lake capacity is 2.4×10^9 m^3 and the power station operates with a water quantity up to 10 000 m^3/sec. Iron Gate II dam is 17 km upstream the Bulgarian border only. Its total dam lake capacity is 0.8×10^9 m^3 and the power station operates with a water quantity up to 8 500 m^3/s.

The operation of the power station creates the following problems:

- strongly is disturbed the natural river flow;
- during autumn and winter the daily water levels vary up to 100 cm and the daily water quantities up to several thousands cubic meters;
- the duration of the minimal water levels is increased which causes serious problems to the navigation;
- the solid river flow is detained;
- the sand and gravel river deposits are not restored;
- the erosion and the abrasion processes are activated and Bulgarian territory is washed out. The abrasion processes are observed on a length of about 130 km along the Bulgarian bank and 55 km along the islands.

At accidental discharges from Iron Gate I power station, the river flow may reach up to 20 000 m^3/s. This could flood some lowlands, settlements and industrial factories.

1.1.2. Small Tributaries from North-Western Part of Bulgaria.

The following small tributaries cross the regions of Vidin and Michailovgrad:

- **Topolovets** river - length - 63 km and catchment area - 934 sq.km;
- **Voinishka** river - length - 50 km and catchment area - 276 sq.km;
- **Archar** river - length - 55 km and catchment area - 365 sq.km;
- **Skomlia** river - length - 36 km and catchment area - 162 sq.km;
- **Vidbol** river - length - 58 km and catchment area - 330 sq.km;
- **Lom** river - length - 93 km and catchment area - 1 123 sq.km;
- **Tsibritsa** river - length - 64 km and catchment area - 934 sq.km.

The total catchment area of the rivers mentioned above is 3 858 sq.km and the total mean annual water flow is 566×10^6 cu.meters and 350.0×10^6 cu.m. in dry (75%) year. The region is mainly agricultural, without big settlements and industries.

1.1.3. Ogosta River

Ogosta is the main river in the north-western part of Bulgaria. Its source is in the northern slope of the Balkan mountain. The river flows across Michailovgrad and Vratsa regions and disgorges into the Danube at the town of Oriahovo. Its length is 144 km, the catchment area is 4 231 sq.km and the mean inclination of the river bed is 13$^{o}/_{oo}$. The river mean annual water flow is 813 x 10^6 cu.m. and 529.0 x 10^6 in dry year. Ogosta has about 40 nos tributaries. The more important are: Barzia - length - 35 km and catchment area - 241 sq.km; Botunia - length - 61 km and catchment area - 731 sq. km; Skat - length - 161 km and catchment area - 1 074 sq.km. Control of the water quality is ensured on the waters of Ogosta, Botunia and Skat only.

1.1.4. Iskar River

Iskar river is the longest Bulgarian river which flows entirely across Bulgarian territory. Its source is in Rila mountain. Its length is 363.4 km and the catchment area includes part of the regions of Sofia, Vratsa, Lovetch and Pleven, with a total area of 8 641 sq.km. The river mean annual water flow is 1 763 x 10^6 cu.m. and 1 356 x 10^6 cu.m. in dry (75%) year. The mean inclination of the river bed is 19 $^{o}/_{oo}$.

1.1.5. Vit River

Its source is in the Balkan mountain in the vicinity of the town of Teteven. The river flows into the Danube at the town of Somovit. Its length is 189 km, the catchment area is 3 225 sq.km and the mean inclination of the river bed is 9.6 $^{o}/_{oo}$. The mean annual water flow of the river is 486 x 10^6 cu.m. and 333 x 10^6 cu.m. in dry year.

1.1.6. Osam River

The river takes its name after the feeders Beli and Tcherni Osam flow together. Its length is 314 km, the catchment area is 2 824 sq.km and the mean inclination of the river bed is 5.7 $^{o}/_{oo}$. The mean annual water flow is 533 x 10^6 cu.m. and 361 x 10^6 cu.m. in dry year.

1.1.7. Iantra River

Its source is in the Balkan mountain in the vicinity of Hadji Dimiter peak. It flows across the regions of Gabrovo, Veliko Tarnovo and Russe till it reaches the Danube river. Its length is 285 km, the catchment area is 7 862 sq.km and the mean annual water flow is

1 506 x 10^6 cu.m. and 973 x 10^6 cu.m. in dry year. The mean inclination of the river bed is 5‰. The main feeders of Iantra river are:

- Rositsa river - length - 164 km and catchment area - 2 265 sq.km;
- Lefedja river - length - 92 km and catchment area - 2 424 sq.km and
- Djuliunitsa river - length - 85 km and catchment area - 892 sq.km;

1.1.8. Russenski Lom River

The river takes its name after the feeders Beli and Tcherni Lom flow together. It flows across the north-eastern part of Bulgaria through the regions of Targovishte, Razgrad and Russe and disgorges in the Danube river at the town of Russe. Its length is 197 km, the catchment area is 2 947 sq.km. The mean annual water flow is 222 x 10^6 cu.m. and 117 x 10^6 cu.m. in dry (75%) year.

River	Catchment Area km^2	Length km	Annual Discharge x 10^6 m^3
Ogosta	4231	144	813
Iskar	8641	364	1763
Vit	3225	189	486
Osam	2824	314	533
Iantra	7862	285	1506
Russenski Lom	2947	197	222

1.2. Water Quality of Danube River

Danube river is of great importance for Bulgaria in ecological aspect. The constructed irrigation areas up to the year 1986 are 212 000 ha, which represents 37% from all irrigated areas in the region. The total water quantity used for irrigation is about 100 m^3/sec. - about 2% of the mean annual flow of the river.

In the near future it is envisaged to be constructed additionally 22 400 ha so that the total irrigated area from the Danube river will increase up to 234 400 ha.

To study the pollution load in the Bulgarian reach of the Danube river, data were collected from 96% of the polluters which discharge waste waters in the fiver and its tributaries. They were classified in two groups:

- directly discharging in the Danube river - about 90 nos enterprises;
- discharging industrial waste waters through the sewage networks of the settlements;

The water quality is checked at 11 points since the year 1978. The study of the analyses results shows:

- the basic components of the water quality are formed up to the Bulgarian reach of the river.
- due to the small inflow from the tributaries and the directly discharged waste waters in the Bulgarian reach of the river, the influence on the pollution is small and stretches near the river bank only.
- the maximum pollution by biogenic elements is during the spring due to the melting snow waters washing down the fertilized areas.
- pollution due to oil products is a result of the river traffic and is found after bigger towns. Accidental pollution is observed frequently.

The water quality analyses of the Bulgarian part of the Danube river - from Novo Selo up to the town of Silistra show that the water quality is fairly constant. Slight tendency of increasing the organic pollution (phenols and COD) and heavy metals is observed up to the town of Silistra. Manganese is found periodically in high concentration near Silistra. In the Bulgarian part of the Danube river frequent deviations are observed in the following parameters:

- dissolved solids (TDS) - at the towns Nikopol , Svishtov and Russe;
- cyanides - after Iskar river;
- iron - downstream after the towns Nikopol, Svishtov and Russe;
- H_2S - downstream after the towns Lom and Silistra;
- ammonia - after the town of Russe;
- nitrates - downstream the towns Russe, Tutrakan and Silistra;
- organic pollution - after Iskar river up to the town of Svishtov;
- oil - after the town of Russe.

A tendency exists, that the total pollution increases downstream the town of Nikopol and this of nitrates and oil products - downstream of the town of Russe. On Table 1.2.1. are indicated the main annual values of some parameters for the years 1988/1989 measured at Novo Selo and at Silistra.

Based on the results of the water quality analyses performed from the year 1978 up to the year 1990 the following conclusions can be made:

- the results of the water quality analyses from Novo Selo and Silistra show that the main components of the water quality in the Bulgarian part of the Danube river is formed upstream the Bulgarian border;

- due to the big water quantities in the Bulgarian part of the Danube river, the flow of the tributaries and the directly discharged waste waters influences slightly the degree of the pollution mainly near the river bank.
- besides the pollution from the tributaries, the water quality of the Danube river is additionally worsened mainly by the municipal and industrial waste waters of the towns Vidin and Russe and of the feed lots.
- the contents of oxygen, mineralization, biogenic and specific toxic substances from time to time exceed the standards. The same problem creates the accidental oil pollution.
- the maximal rates of pollution with biogenic elements occur during the spring high waters - April and May. This can be explained by the washing down of the fertilized areas.
- pollution with oil, solid wastes and sewage waste water caused by ships is observed also.
- there is a substantial difference in the degree of water pollution along the Bulgarian river bank at the midstream and Romanian river bank as they are polluted from waste waters discharged from Rumania.
- the Iron Gate I and II dams and power stations lead to a considerable reduction of the water turbidity. In comparison to the year 1971, at present the turbidity at the town of Svishtov is reduced to 40%.
- the Kozlodui Nuclear Power Station uses for cooling 150 m^3/sec. recycling water from the Danube river. This water is discharged back in the river with about 7 to 10 degrees higher temperature.

The balance shows that a considerable part of the pollution load of the Danube river is due to its tributaries. The maximal pollution load is that of Iskar river, followed by the rivers Vit, Ogosta, Iantra, Russenski Lom, Osam, etc.

The BOD_5 load is indicated on a diagram for each river (Annex 16). For the Iskar river it is - 52 318.7 kg/d, for the Vit river - 33 951.0 kg/d, for the Ogosta river - 26 293.5 kg/d, for the Iantra river - 23 919.7 kg/d and for the Russenski Lom river - 17 365.04 kg/d.

The suspended solids load (SSM) is indicated on a diagram (Annex 17). For the Iskar river it is 114 941.0 kg/d, for the Ogosta river - 50 964.1 kg/d, for the Iantra river - 40 383.8 kg/d, for the Osam river - 26 261.8 kg/d and for the Russenski Lom river - 25 273.9 kg/d.

The total pollution load of the Bulgarian part of the Danube river is indicated on a diagram - Annex 8. Relatively the maximal percentage belongs to the dissolved solids (TDS) - 52.92%, suspended solids (SSM) - 21.03%, BOD_5 - 12.52% and COD - 9.34%.
The relative contribution to the pollution load of different sources is indicated on Table 1.2.2.

Table 1.2.2. Pollution loading from different sources

Pollution sources	BOD_5	SSM	COD	TDS
1. Municipal discharges	39.17	36.33	10.69	21.53
2. Feed lots	30.25	24.72	19.88	9.82
3. Sugar industry	12.08	8.06	33.36	25.72
4. Food industry	5.96	3.87	14.24	8.04
5. Others	12.54	27.02	21.83	34.89

1.3. Water Quality of the Tributaries

About 900 nos industrial factories discharge their waste waters in the tributaries of the Danube river. This is taken into account in the pollution load balance of the particular rivers. The study includes 13 Nos tributaries.

1.3.1. Small Tributaries from North-Western Part of Bulgaria.

The pollution of the small tributaries from the north-western part of Bulgaria is a diffuse one, caused mainly by the agricultural activities and the water quality of these rivers does not arise problems.

1.3.2. Ogosta River /Annex 9/

Because of the considerable inclination of the river bed the water quality of the upper section of Ogosta river is good up to Michailovgrad dam. The dam is polluted by the waste waters of the mines located in the region. The main source of pollution down stream are the waste waters of the town of Michailovgrad. After the village Kobiliak the main pollution sources are the waste waters of the Chemical Factories near the town of Vratsa, containing ammonia. Other pollution sources are the domestic and industrial waste waters of the towns Berkovitsa, Boichinovtsi, Biala Slatina and Mizia.

The distribution of the pollution load by parameters is as follows:

- dissolved solids (TDS) - 44.67%
- suspended solids (SSM) - 24.90%
- BOD_5 - 12.85%
- COD - 6.09%
- NH_3 - 11.09%

For this river the relative maximal load is of ammonia (11.09%).

1.3.3. Iskar River /Annex 10/

According to the degree of pollution of the water the river can be divided into several sections :

- upper section, up to Iskar dam which is the main potable water source of Sofia and its region.
  The water pollution of this section represents about 3% of the total river water pollution. The main pollution source is the waste waters discharge of the town of Samokov.

- Sofia region section
  In this section the discharges from Sofia agglomeration and Iskar's feeders, Blato and Lesnovska form about 78% of the total river pollution. Thirty percent of it is eliminated by the Sofia sewage treatment plant.

- Iskar gorge up to the town of Roman
  In this section 8% of the total river water pollution is accumulated. The main pollution source is the feeder Malak Iskar the waters of which are polluted by the waste waters of the town of Botevgrad and its region.

- from the town of Roman up to the Danube river - the longest section.
  This section accumulates 11% of the total river pollution caused mainly from domestic and industrial waste waters of the towns Kneja, Lukovit, Tcherven Briag and Koinare.

The distribution of the pollution load by parameters is as follows:

- dissolved solids (TDS) - 62.78%
- suspended solids (SSM) - 20.64%
- BOD_5 - 9.40%
- COD - 3.19%
- NH_3 - 1.41%

1.3.4. Vit River /Annex 11/

Up to the village Iasen the river water quality is good although the influence of the domestic and industrial waste waters of the town of Teteven is traced. The main pollution sources of the river waters are the waste waters of the town of Dolna Mitropolia with its industries as well as the Food factories located in the region which worsen the water quality up to the

- for Drianovska river - the waste waters of the town of Drianovo and the other towns in the upper section: Triavna, Elena, Omurtag and some smaller settlements as Suhindol, Polski Trambesh, Strajitsa, Voneshta Voda etc.

The distribution of the pollution load by parameters is as follows:

- dissolved solids (TDS) - 36.56%
- suspended solids (SSM) - 26.83%
- BOD_5 - 15.89%
- COD - 9.41%
- NH_3 - 1.30%

For this river the relative maximal pollution load is of heavy metals and oil products;

The pollution load of the rivers Lom and Russenski Lom are indicated on the diagrams - Annexes 14 and 15, respectively.

The waters of Beli Lom are highly polluted by the waste waters of the town of Razgrad and the Pharmaceutic Factory, while the waters of Tcherni Lom are polluted by the waste waters of the town of Popovo which has no sewage treatment plant but highly developed industry.

1.4. Groundwater

The river terrace of the Bulgarian part of the Danube River is rich in ground water. The width of the terrace is from 3 to 5 km. The depth of the gravel layer is 5 - 20 m and of the loess 8 - 10 metres.

The water holding layers are of compacted clay or limestone. The ground waters are fed by Danube River and wells type "Raney" are constructed as water intakes. Ground waters are fed rarely by drained slope waters mainly in the northern part of Bulgaria and around Silistra town. The water quality of the ground waters is almost the same all along the river with the exception at Svishtov, Riahovo and Aidemir in the Dobritch region. There are some problems with the content of nitrates in the ground water around village Popina caused by agricultural activities. It was found that by a long period of operation of the intake facilities the nitrate content falls down and there is no need for construction of treatment plant. Treatment plants in the Danube River Basin, with the exception of Svishtov treatment plant, have not been constructed. Treatment plants are designed for the Batan and Riahovo water supply systems and that of Aidemir in the Dobritch region is already under construction. The treatment plant shall eliminate turbidity, nitrates, manganese and ferrous. The ground waters of the whole terrace are considered as suitable for drinking water after

proper treatment. The capacity of the constructed water intakes are constructed taking into consideration the varying water level of the river during different seasons of the year. Some intakes are constructed in proximity of the river like those at Vidin - east, Popina and Aidemir. During operation silting up of some water facilities was observed.

The total water quantity of Danube waters utilized to cover the potable water demand of settlements and the industries is Q_t= 19.5 m^3/sec

1.5. Impacts of Water Quality on Uses

Danube River because of its big water capacity offers unlimited possibilities to be used as water source as follows:

- to cover the water demand of settlements;
- for industrial needs;
- for irrigation;
- for water transport;
- for power production;

Because of the water quality this enormous water source can't be utilized neither by constructing river intakes nor by ground water intakes. Almost all water supply systems utilizing ground waters from Danube River terrace have problems to eliminate ammonia, manganese, ferrous and other polluters which need the introduction of new complicated technologies, considerable capital investments and the operation needs great maintenance costs.

1.5.1. Urban Use.

Most of the settlements along the right bank of the Danube River in the Bulgarian part of the river have designed and constructed water supply facilities on the Danube River terrace, using the ground waters as water source. These settlements are water supplied by the following facilities:

- **Kula** - 8 nos drainage wells Q_t= 90 l/s, constructed near Bregovo.

From constructed "Raney" type wells are water supplied:

- **Vidin (west)** - 4 nos, Q_t= 1000 l/s depth 18 m, constructed on west of the town. The water quality meets the requirements of WHO's recommendations;

- **Vidin (east)** - 6 nos, Q_t= 1100 l/s, depth 16 m; The water quality meets WHO's recommendations for potable water;
- **Dunavtsi** - 2 nos, Q_t= 400 l/s, depth 18 m, part of the Kula water supply system; The water quality meets WHO's recommendations for drinking water; designed but not reconstructed up to now;
- **Lom** - 2 nos, Q_t= 700 l/s, depth 22 m, constructed near village Dobri Dol; the water quality meets WHO's recommendations for drinking water;
- **Vratsa and Michaelovgrad** - 10 nos to be constructed, Q_t= 2000 l/s, depth 20 m; poor water quality. It is envisaged a treatment plant to be constructed to eliminate manganese and ferrous. At present only the preliminary design is available. The "Raney" type wells are envisaged to be constructed at the village Sitanevo;
- **Kozlodui** - 4 nos, Q_t= 800 l/s, depth 20 m are constructed; the water quality meets WHO's recommendations for drinking water. It shall cover the water demand of drinking water of the Nuclear Power Station also;
- **Oriahovo** - 1 no, Q_t= 120 l/s, depth 14 m and 4 nos boreholes Q_t= 160 l/s, constructed near the village Silanovtsi. The water quality meets WHO's recommendations for drinking water.
- **Belene** - 4 nos, Q_t= 1000 l/s, depth 22 m, the intake facilities are constructed only. It is envisaged a treatment plant to be constructed to eliminate manganese and ferrous.
- **Svishtov** - 4 nos, Q_t= 100 l/s, depth 22 m. A treatment plant to eliminate manganese and ferrous is constructed and operates properly.
- **Bardim** - 2 nos, Q_t= 400 l/s, depth 22 m., the water intake facilities are constructed only. It is envisaged a treatment plant to be constructed to eliminate manganese and ferrous;
- **Svishtov** - 2 nos, Q_t= 400 l/s, depth 20 m, constructed as part of Batin water supply system, meeting the water demand also of some settlements in Svishtov, Veliko Turnovo and Russe districts.
- **Russe** - 8 nos, Q_t= 1800 l/s, depth 20 m, constructed near the village Slivo Pole. The water quality meets WHO's recommendations for potable water.
- **Riahovo water supply system** - 15 nos, Q_t= 3200 l/s, depth 22 m; 1600 l/s of the total water quantity meet WHO's recommendations for drinking water. The rest has to be treated to eliminate Mn and Fe. Stage I of the system is constructed. The towns Razgrad, Popovo, Turgovishte, Shumen, Kubrat as well as the villages along the main pipelines are water supplied already. At stage II a treatment plant to eliminate Mn and Fe is envisaged to be constructed.
- **Tutrakan** - 3 nos, Q_t= 480 l/s, depth 18 m. The water quality meets the WHO's recommendations. It is envisaged an additional water intake to be constructed and thus Q_t to reach up to 600 l/s in order to meet the water demand of the settlements up to Nova Tcherna.

- **Popina water supply group** - 2 nos, Q_t= 600 l/s, depth 22 m. The water quality meets WHO's recommendations for potable water. The water supply system is constructed up to Shumen district at the village Velino.
- **Dobritch water supply system** - 10 nos, Q_t= 1600 l/s, depth 23 m, constructed at the village Aidomir, Silistra district. It shall water supply also all villages located along the main pipelines.
- **Silistra** - 9 nos, Q_t= 2000 l/s, depth 22 m. The water quality meets WHO's recommendations for potable water. The source shall water supply the towns Silistra, Alfatar and Dulovo as well as the settlements along the main pipelines.
- **Silistra Wood Processing Factory**, an individual water source, 5 nos Q_t= 1200 l/s, depth 20 m, water quality meets requirements for industrial needs only.

Summary of the constructed and investigated water intakes and water supply systems along the Bulgarian Part of Danube River

Raney type wells	constructed	84 nos	Q_t= 17.4 m^3/sec
Raney type wells	investigated	10 nos	Q_t= 2.0 m^3/sec
Wells	constructed	9 nos	Q_t= 0.1 m^3/sec
			Q_t= 19.5 m^3/sec

Water Supply Systems - 19 nos
designed - 19 nos
constructed - 16 nos

Treatment Plants - 7 nos (mainly to eliminate Mn and Fe)
designed - 7 nos
constructed - 1 no
under construction - 2 nos

1.5.2. Ecosystems and Fisheries

Danube fisheries had a great economic significance in the past. From ancient times settlements on Danube River as Vidin, Svishtov, Tutrakan and Oriahovo were well known fishing centers. From Danube River and the adjacent marshes in 1897 the fish draught was 197 tons. In the same year the fish draught at Svishtov has been 529 tons and at Tutrakan 319 tons. Due to economic reasons as well as to the worsening of the conditions caused by pollution of the waters fishing started to fall. There was fishing at the periods of shoals only. In the year 1925 the fish draught at the town of Svishtov was 126 tons and in the year 1929 - 117 tons only. After the annexation of South Dobrudja to Bulgaria in the year of 1940, the fish draught at Tutrakan and Silistra reached its maximum - 1820 tons in the year of 1941.

After the Second World War and the draining of the marshes along the Danube River substantial changes took place. Consequently sand and coarse aggregates began to be drawn out which destroyed the fishing areas. The pollution intensity of Danube River by industrial wastes, containing poisonous substances was increasing constantly. The water transport has increased several times which caused additional pollution and hindrances to fishing.

The industrial fish draught from 1200 tons during 1960 fall down up to 300-350 tons at the eighties.

All above said disturbed the ecological balance of Danube River and have a negative influence for its environment. As a result the fishery fall down and some fish species even died out.

There is not any industrial fishing along the tributaries of Danube River.
Exceptionally from time to time there is on a large scale fishing for economic needs in some dam lakes. The problems with the toxic metals contained in the waters of Michailovgrad dam at present don't influence the fish resources. Prior to each fishing season, the fish is tested wether it contains toxic substances. With some exceptions in the upper and middle waters of the Danube River tributaries fish sporting is practiced.

The total forest area of the river banks and the islands is 11 136.8 ha. The flora has important protection, recreational, ecological and other functions.

Along the river-sides of the Danube River are biotopes of a number of endemic species of the European flora and fauna, and the wetlands are the habitat of rare species of the ornitofauna. The combination of water, sand, forest, historical and cultural monuments, reserves and other sites on the river and the islands makes the Danube attractive for the domestic and international tourism.

1.5.3. Other Uses

Danube River waters are used for:

- irrigation purposes - 70% of the irrigated areas of North Bulgaria use Danube River water;
- industrial needs. The Nuclear Power Station at Belene is water supplied from the Danube River also;
- water transport;

2. Emissions and Discharges

2.1 Overview

The trends of the urban development are as follows:

- construction of sewage systems shall continue
- operating conditions of the water supply facilities shall be substantially improved. Special efforts shall be made to minimize the leakage in the water supply pipelines.
- people shall be educated to economize drinking water
- the real price of water shall be determined, the state should not subsidize the cost of water any more. The higher price shall lessen the water consumption.
- up-to-date technologies with small consumption of water shall be implemented in the industries
- in agriculture biological preparation shall be used against pests
- by cattle breeding the manure shall not be biologically treated but used mainly as fertilizer. This shall lead to lower costs and increase of income.

On Table 2.1.1 are indicated pollution loads from some main industries.

2.2 Municipal Discharges and Operating Treatment Plants

Taking into consideration the waste waters the settlements are classified as follows:

- settlements with operating waste water treatment plants.
- settlements with designed but not yet constructed treatment plants
- settlements with not yet designed treatment plants

On Table 2.2.1 are indicated the constructed utilities of the settlements and the pollution loads.

In the Danube river basin 12 nos waste water treatment plants are in operation. Their technology is a classic one and the duration of their construction was from 5 to 15 years. Most of them are with an out-of-date equipment and some are largely overloaded as those in Vratsa, Varshetz. Some are underloaded as those in Sofia, Gabrovo, Razgrad due to the insufficient sewage networks. In all of them the problem is the treatment of the sludges and their use after drying. The sludges of the big towns have a considerable amount of heavy metals and can not be used as a fertilizer. Others create a secondary pollution being accumulated on the municipal solid waste deposition site.

One of the first priority objective of the Management Program is to reach the designed efficiency of all treatment plants in operation.

The main characteristics of the waste water treatment plants in the Danube river basin are shown on Table 2.2.2.

Pollution Loads from Main Indusries

Table 2.1.1.

	BOD_5 kg/day	COD-Cr kg/day	TDS kg/day	SSM kg/day	NH-3 kg//day	NO-3 kg/day	Cl kg/day	SO-4 kg/day	H_2S kg/day	Oil kg/day	Phenols kg/day	Fe kg/day	Mn kg/day	P kg/day	Cr(6+) kg/day	As kg/day	Pb kg/day	Cu kg/day	Zn kg/day	Other ppms kg/day
1. Coal Mining																				
2. Ore Mining & Dressing	349	2811	90359	12073	1.7					2526	18	200.4					0.87			
3. Mineral Mining & Processing	6.8	243	9841	1342				8		70										
4. Petroleum & Gas Extraction	4065	1231	3627	1593	2	2.5	60		0.00	1243										
5. Chemical Industries	6766	8662	169742	25149	6745	23	1829	34	0.05	2322	27	188			1.34					
6. Machinery	1716	3132	33845	7884	375	26	2601	1852	0.70	606	2.1	12	1.91	0.41	30.7	0.48	0.43	0.41	3.71	
7. Electrotechnic & Electronics	106	280	4277	937	45		70	70				2.14			12.67			175	0.20	0.59
8. Energy Generation (incl. NPS)	4.7	77	2904	2484																
9. Transportation	2793	3210	8101	5778	110		136	78		666		0.33								
10. Construction	930	452	9088	1813	29		160	1.1		122		0.17								
11. Timber products	264	1244	7636	686	6.5		6.6	1.5		0.01	0.00				0.06					
12. Builders Papers	432	640	8445	29667	22090		310	76	1.34	88.5		5.84								
13. Fruits & Vegetables		1.3	137	0.3																
14. Miscellaneous Food & Beverages	13958	24066	78693	16262	2645	1.82	2316	679	47.7	176	2.45	0.09	20.83							
15. Sugar Industry	28286	56362	264474	31671	341	7.53	22.8	431	11.68			0.24								
16. Textile Industry	1062	1606	8270	3289	40		528	378	0.08	6.64		5.8								
17. Animal Farms	70777	31476	44041	97195	4105	291	123	33	4.7			2.72	35.83	0.55	2.83					
18. Meat Products & Rendering	3412	5172	27030	13028	1264	258	277	79	1.96	1095										
19. Dairy	6016	5284	19591	4681	74	0.09	772	313	0.67	927.5										
20. Leather Tanning & Shoes	1661	5957	26660	3200	36.5		482	1453		599	55.18									
21. Ecarissage	13.5	303		56	5.6															
22. Communal	93553	18839	214783	160933	12453	0.02	1459	2344	0.35	6742	16.07	1.17		3188	22.12					0.1
23. Fuels																				
24. Forest Cut																				
25. Others																				
TOTAL	238141	188467	1023620	407208	50273	611	11209	5722	69	17136	121	419	59	3189	70	1.36	0.43	182.51	3.92	0.69

WASTE WATERS OF SETTLEMENTS
in the Bulgarian Part of the Danube River Basin

Table 2.2.1.

Item	RIVER BASIN SETTLEMENT	Population number inhabitants x 10^3	Constructed Utilitiy Streets km	 Sewers km	Constructed Sewers/ Streets Ratio %	Inhabitants serviced by sewers % number x 10^3		Pollution concentration BOD_5 kg/d	 Susp. Solids (SSM) kg/d
1	2	3	4	5	6	7	8	9	10
1.	**Small rivers of N/W Bulgaria tributaries of Danube river - Total**	212.40							
1.1.	Topolovetz river - total	25.00							
	Villages	25.00				3.0	0.750	40.50	48.75
1.2.	Voinishka river - total	17.00							
	Villages	12.00				3.0	0.360	19.44	23.40
	Kulia town	5.00	33.0	8	24.2	44.0	2.200	118.80	143.00
1.3.	Vidbol river - total	14.50							
	Villages	14.50				3.0	0.435	23.49	28.28
1.4.	Archar and Skomlia rivers - total	24.90							
	Villages	15.50				3.0	0.465	25.11	30.23
	Belogradchik town	7.30	17.0	9	52.9	68.0	4.964	268.06	322.66
	Dimovo town	2.10	16.0			10.0	0.210	11.34	13.65
1.5.	Lom river total	75.00							
	Villages	40.70				3.0	1.221	65.93	79.37
	Lom town	32.20	97.0	11	11.3	21.5	6.923	373.84	450.00
	Brusartsi town	2.10	25.0			10.0	0.210	11.34	13.65
1.6	Tsibritsa river - total	56.00							
	Villages	49.50				3.0	1.485	80.19	96.53
	Valchedrum town	6.50	60.0			10.0	0.650	35.10	42.25
2.	**Ogosta - Skat river basin - total**	313.00							
2.1.	Tchiprovtsi town	3.30	20.0			10.0	0.330	17.82	21.45
2.2.	G. Damianovo village	0.95	7.5			10.0	0.095	5.13	6.18
2.3.	Berkovitsa town	16.45	75.0	30	40.0	60.0	9.870	532.98	641.55
2.4.	Michailovgrad town	52.26	94.0	53	56.4	72.0	37.627	2031.86	2445.76
2.5.	Vratsa town - waste waters treatment plant	75.5				5.0	3.775	203.85	245.38
2.6.	Krivodol town	4.3	43.0			5.0	0.925	49.95	60.13
2.7.	Varshetz town - waste w. treatment plant	7.59				10.0	0.760	41.04	49.40
2.8.	Boichinovtsi town	2.55	28.0			10.0	0.260	14.04	16.90
2.9.	Hairedin village	9.09	41.0	3	8.0	16.0	1.454	78.52	94.51

Table 2.2.1. (cont'd)

1	2	3	4	5	6	7	8	9	10
2.10.	Butan village	4.00	76.0	5	6.50	13.0	0.520	28.08	33.80
2.11.	Biela Slatina town	16.10	56.0	23	41.10	60.0	9.660	521.64	627.90
2.12.	Borovan village	3.60	62.0			10.0	0.360	19.44	23.40
2.13.	Mizia town	5.20	33.0			3.0	0.260	14.04	16.90
2.14.	Villages	112.11				3.0	3.363	181.60	218.60
3.	Iskar river basin - total	1600.00							
3.1.	Borovets - waste waters treatment plant	6.00	20.0	6	30.00	50.0	3.000	162.00	195.00
3.2.	Samokov town - waste w. treatment plant	47.12	71.0	52	78.80	40.0	18.850	1017.90	
3.3.	Sofia town - waste waters treatment plant	1201.48	2461.0	1557	77.40	16.0	192.27	10382.6	12497.6
3.4.	Gorna Malina village	8.36	18.0	4	22.20	40.0	3.340	180.36	
3.5.	Elin Pelin town	0.84	40.0	12	37.50	55.0	0.460	24.84	
3.6.	Elin Pelin Railway Station - waste w. tr. pl.	1.56	22.0	4	22.70	5.0	0.080	4.32	5.20
3.7.	Dragoman town	4.1	32.0	9	31.25	50.0	2.050	110.70	
3.8.	Slivnitsa town	8.75	39.0	28	71.80	80.0	7.000	378.00	
3.9	Kostinbrod town	12.60	62.0	5	9.67	25.0	3.150	170.10	
3.10.	Bankia town	7.85			8.80	25.0	1.960	105.84	
3.11.	Novi Iskar town	14.30			8.80	25.0	3.575	193.05	
3.12.	Svoge town	8.40	40.0	8	22.50	42.0	3.530	190.62	
3.13.	Mezdra town	13.70	27.0	9	44.40	64.0	8.770	473.58	
3.14.	Roman town - waste w. treatment plant	4.30	20.0	1	5.00	10.0	0.430	23.22	
3.15.	Etropole town	11.60	49.0	19	44.89	65.0	7.540	407.16	
3.16.	Pravetz town - waste w. treatment plant	4.00	60.0	16	26.60	5.0	0.200	10.80	
3.17.	Iablanitsa town	3.40	25.0			3.0	0.102	5.51	
3.18.	Botevgrad town - waste w. treatment plant	22.50	42.0	36	95.20	50.0	11.250	607.50	
3.19.	Tcherven Briag town	18.20	66.0	26	40.90	61.0	11.100	599.40	
3.20.	Lukovit town	10.35	43.0			10.0	1.040	56.16	
3.21.	Koinare village	6.15	65.0	6	9.23	20.0	1.230	66.42	
3.22.	Pelovo town	5.00	30.0			10.0	0.500	27.00	
3.23.	Kneja town	14.00	85.0	1	1.17	15.0	2.210	113.94	
3.24.	Villages	164.74				3.0	4.940	266.76	
4.	Vit river basin - total	258.00							
4.1.	Teteven town	12.80	53.0			10.0	1.280	69.12	83.20
4.2.	Ugartchin town	4.20	36.0	3	8.33	16.0	0.672	36.18	43.68
4.3.	Dolni Dabnik town	6.00	38.0			3.0	0.180	9.72	11.70
4.4.	Pleven town - waste waters treatment plant	130.00	170.0	146	85.88	5.0	6.500	351.00	422.50
4.5.	Dolna Mitropolia town	4.00	24.0			3.0	0.120	6.48	7.80
4.6.	Trastenik town	5.80	43.0			3.0	0.174	9.40	11.31
4.7.	Guliantsi town	4.50	31.0			5.0	0.225	12.15	14.63
4.8.	Villages	90.70				3.0	2.720	146.78	176.80

Table 2.2.1. (cont'd)

1	2	3	4	5	6	7	8	9	10
5.	**Osam river basin - total**	192.50							
5.1.	Troian town	26.10	57.0	17	29.82	49.0	12.790	690.76	831.35
5.2.	Lovetch town	49.00	88.0	44	50.00	65.0	31.850	1719.90	2070.25
5.3.	Letnitsa town	4.70	32.0	31	96.87	98.0	4.610	248.94	299.65
5.4.	Pordim town	2.80	31.0			3.0	0.084	4.54	5.76
5.5.	Levski town	13.50	49.0	39	79.59	85.0	11.480	639.92	746.20
5.6.	Slavianovo town	5.60	44.0			3.0	0.168	9.07	10.92
5.7.	Villages	90.80				3.0	2.720	146.82	176.80
5.8.	Barata river - total	64.00							
	Villages	64.00				3.0	1.920	103.68	124.80
6.	**Iantra river basin - total**	541.00							
6.1.	Gabrovo town - waste w. treatment plant	81.50	183.0	74	48.10	10.0	8.150	410.10	
6.2.	Platchkovtsi town	3.10	28.0	1	1.40	10.0	0.310	16.74	
6.3.	Triavna town	13.00	53.0	20	43.40	60.0	7.800	421.20	
6.4.	Drianovo town	10.30	37.0	17	48.60	65.0	6.700	361.80	
6.5.	Kilifarevo town	3.00	24.0			10.0	0.300	16.20	
6.6.	Debeletz	4.70	19.0			5.0	0.240	12.96	
6.7.	Veliko Ternovo town - waste w. tr. plant	70.00	106.0	73	81.00	30.0	21.000	1134.00	
6.8.	Gorna Orishovitsa town	40.70	78.0	64	88.50	90.0	36.630	1978.00	
6.9.	Lieskovetz town	9.80	31.0	17	67.70	75.0	7.350	396.90	
6.10.	Dolna Orishovitsa town	4.40	42.0			3.0	0.130	7.02	
6.11.	Elena town	7.60	31.0	13	41.90	55.0	4.180	225.70	
6.12.	Zlataritsa town	3.20	35.0			10.0	0.320	17.28	
6.13.	Omurtag town	10.00				5.0	0.500	27.00	
6.14.	Stragitsa town	5.40	31.0	4	16.10	26.0	1.400	75.60	
6.15.	Sevlievo town	26.60	47.0	37	87.20	90.0	23.940	1293.00	
6.16.	Suhindol town	2.80	36.0			5.0	0.140	7.56	
6.17.	Pavlikeni town	14.20	41.0	34	90.20	93.0	13.210	713.34	
6.18.	Biala Tcherkva town	3.50	28.0			3.0	0.105	5.67	
6.19.	Polski Trambesh town	6.80	46.0	8	21.70	40.0	2.720	146.88	
6.20.	Biala town - waste waters treatment plant	11.00	47.0	11	25.50	5.0	0.550	29.70	
6.21.	Villages	209.40				3.0	6.282	339.23	
7.	**Russenski Lom river basin - total**	210.00							
7.1.	Popovo town	21.00	64.0	34	59.40	70.0	14.700	793.80	
7.2.	Opaka village	3.90	31.0			10.0	0.390	21.06	
7.3.	Razgrad town - waste w. treatment plant	49.50	126.0	51	48.40	5.0	2.475	133.65	
7.4.	Senovo town	3.40	42.0			10.0	0.340	18.36	
7.5.	Vetovo town	5.53	60.0	4	6.00	15.0	0.830	44.82	
7.6.	Hlebarovo town	5.45	30.0	9	30.00	50.0	2.725	147.15	
7.7.	Villages	117.22				3.0	0.586	31.64	

Table 2.2.1. (cont'd)

1	2	3	4	5	6	7	8	9	10
8.	**Danube river - direct intflow - total**	507.80							
8.1.	Vidin town	82.70	80.0	39	66.20	80.0	50.160	2708.64	
8.2.	Dunavtsi town	3.60	36.0			25.0	0.900	78.60	
8.3.	Lom town	32.20	97.0	6	11.30	20.0	6.440	347.76	
8.4.	Kozlodui town	12.70	67.0	4	5.90	25.0	3.180	171.72	
8.5	Orishovo town	7.40	44.0	6	20.4	45.0	3.330	179.72	
8.6.	Nokopol town	5.30	22.0			25.0	1.330	71.82	
8.7.	Belene town	9.20	39.0	1	5.10	25.0	2.300	124.20	
8.8.	Svishtov town	32.00	47.0	34	76.60	85.0	27.200	1468.80	
8.9.	Russe town	184.00	311.0	143	59.80	78.0	143.52	7750.08	
8.10.	Tutrakan town	12.10	49.0	26	71.40	85.0	10.290	555.66	
8.11.	Silistra town	53.60	66.0	44	93.90	95.0	50.920	2749.68	
8.12.	Villages	94.40				5.0	4.720	254.88	

TREATMENT PLANTS IN OPERATION
of Towns in the Bulgarian Part of the Danube River Basin

Table 2.2.2.

Item	River basin / Towns with Treatment Plants	Population number, census 1986, x10³ inh.	Waste water quantities, x10³ m³/d	Treatment Plant Characteristics: Waste water quantity: Total treated water Q m/d x10³ m³/day	Municipal water x10³ m³/day	Industr. and others x10³ m³/day	Designed capacity of Treatment plant x10³ m³/day	Influent: BOD5 kg/day	Influent: Suspended solids (SSM) kg/day	Effluent: BOD5 kg/day	Effluent: Suspended solids (SSM) kg/day	Methods of waste water treatment	Constructed Facilities: Streets length km	Sewerage length km	Constructed Sewers/Streets Ratio %	Inhabitants Serviced by Sewers %
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1.	Small rivers of N/W Bulgaria incl. Ogosta and Skat river basins															
1.1	Vratsa	75.526	69.12	41.47	22.72	18.75	43.2	9580	8565	995	1804	mechanical and biological methantanks, gasholder	107	79.7	74.48	94.68
1.2	Varshets	11.576	8.64	5.62	4.66	0.96	3.8	776	731	343	326	mechanical and biological methantanks, rapid sand filter and drying areas	53	34.5	65.0	80.0
2	Iskar river basin															
2.1	Borovetz	8.000	1.48	1.8	1.8	-	1.48	270	216	27	27	mechanical and biological	20	6.0	30.00	35.0
2.2	Samokov	47.117	17.97	12.54	5.52	7.02	13.0	1487	784	203	209	mechanical and biological	71	68.0	96.0	85.0
2.3	Sofia	1201.479	520.0	511.14	306.69	204.45	500.0	61337	51117	21468	30668	mechanical and biological methantanks	2461	1818.1	73.88	88.0
2.4	Elin Pelin (incl. Lesnovska river basin.)	4.300	4.29	0.518	0.345	0.173	0.69	109.7	1766	20.1	26.5	mechanical and biological, drying beds	22	15.7	71.36	75.0
2.5	Pravetz	4.000	1.242	-	-	-	-	-	-	-	-	mechanical and biological filters	60	16.0	26.60	
2.6	Botevgrad	22.500	16.0	6.9	2.3	4.6	6.9	-	-	-	-	mechanical	42	38	95.2	

Table 2.2.2. (cont'd)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
3.	Vit river basin															
3.1	Pleven	140	60.9	28.084	11.77	16.254	108.0	10590	7400	535	2539	mechanical and biological methantanks	170	147.9	87.0	90.0
4.	Iantra river basin															
4.1	Gabrovo	89.994	39.573	29.722	12.48	17.24	79.229	4756	5291	305	432	mechanical and biological methantanks	183	96.6	52.80	80.0
4.2	Veliko Tarnovo	93.679	47.520	21.701	16.49	5.21	45.619	4080	6337	464	770	mechanical and biological methantanks	106	79.5	75.00	98.0
5.	Russenski Lom river basin															
5.1	Razgrad	49.458	25.92	25.92	13.48	12.44	43.2	5215	8735	4789	3566	mechanical and biological methantanks	126	61.74	49.0	80.0

Annex to Table 2.2.2

Problems Of The Operating Treatment Plants

Note: The item numbers correspond to the numbers in the table.

1.1. ***Vratsa Treatment Plant***
The spillway in front of the biobasin can let to pass 470 l/s. Water quantity above that figure overflows in the pass channel. By normal water supply of the town in the treatment plant enter Q=800 l/s. It is evident that the treatment plant should be extended to assure effective treatment of mean daily quantity of Q=330 l/s.

1.2. ***Varshets Treatment Plant***
The treatment plant is overloaded. There is an urgent need for reconstruction, extension and implement an up-to-date technological scheme.

2.1. ***Borovets Treatment Plant***
The operating treatment plant is with a capacity for 3600 equivalent inhabitants. At present a new treatment plant is designed for 7000 equivalent inhabitants which shall be constructed in the region of Iaitseto. After the second treatment plant is put into operation the upper waters of Iskar river shall be pure.

2.2. ***Samokov Treatment Plant***
The operating treatment plant is overloaded. Its capacity is Q_{md}=150 l/s. The extension which is designed at the moment shall have a capacity of Q_{md}=510 l/s. After its construction the problems shall be solved.

2.3. ***Sofia Treatment Plant***
The treatment plant is overloaded; 2 nos tanks for active sediments, 2 nos for decomposed sediments, the mechanical section for water draining of the sediments and the steam boiler are out of operation. The above said causes the worsening of the indices for BOD_5 and SSM. There is urgent need for reconstruction and expansion of the station and implementation of up-to-date technology. Enormous capital investments are needed.

2.4. ***Elin Pelin Treatment Plant***
The station is overloaded. The possibility for an extension to be constructed and including the waste waters of some nearby settlements is studied but the needed funds for designing and capital investments for the construction are not available. At present from the town of Elin Pelin only waste waters, Q=359 m^3/day, are discharged without treatment.

2.5. ***Pravets Treatment Plant***
The station is equipped with Italian equipment but is not yet put in operation.

2.6. ***Botevgrad Treatment Plant***
The operating plant has the capacity to treat 40% of the waste waters of the town. Extension is urgently needed as well as additional construction of sewers to complete the sewage network.

3.1. ***Pleven Treatment Plant***
At the moment tests are performed to put the plant in operation. Now the plant shall treat 22.5% of the designed capacity waste water only. The reason for the above said is that 6 nos main collectors are not yet constructed. The control over the local treatment plants of the factories has to be improved.

4.1. ***Gabrovo Treatment Plant***
The plant which is in operation is loaded with 50% of the designed capacity. The construction of the sedimentation and gas sections should be finished and put in operation. When the treatment plant starts operating with its designed capacity the overflow drain in front of the biobasins should be reconstructed.

4.2. ***Veliko Turnovo Treatment Plant***
Since 1983 the plant is in operation with 50% of its designed capacity. The pre-sedimentation is not in operation and the mineralization and the feeding of the drying beds with the active sediments is not operating with full capacity. The partial use of the drying beds puts the limit to treat up to Q=200-220 l/s waste waters. The waste waters over this limit flow into an open channel.

5.1. ***Razgrad Treatment Plant***
The main trouble for the operating plant is caused by the highly polluted biologically and chemically waste waters of antibiotic factory. At present the local treatment plant of the factory is under construction. The design for the extension and reconstruction of the town treatment plant is ready but the needed capital investments are not available.

2.3. Industrial Dischargers

The implementation of new up-to-date technologies in the industry shall change the quantity and quality of the discharged waters.

The trend in the industry is to construct small and middle size factories with up-to-date technologies which diminish the influence of the old big factories which discharge highly polluted waste waters.

On Table 2.3.1 are indicated the industrial waste water dischargers.

INDUSTRIAL WASTE WATERS

Table 2.3.1.

Item	RIVER BASIN FACTORY	WATER INTAKE	Waste Water QUANTITY $x10^3$ m^3/day	POLLUTION BOD_5 kg/day	SSM kg/day	OTHER g/m^3	WASTE WATER TREATMENT FACILITIES IN OPERATION	NOTE
1	2	3	4	5	6	7	8	9
	Voinishka River							
1.	Rubber-ware Factory - Kula town	Kula dam	1.84	10.10	172.8	-	Treat. Plant - biolog. step	
	Ogosta River							
2.	Ore Dressing Factory - Tchiprovtchi town	Bukovetz river	1.27	-	60.7	Fe = 0.6; Mg = 0.17; Cd = 0.003; Pb = 0.03 Arcenic = 0.03; Cu = 0.02 Ni = 0.01; Zn = 0.08	Tailings pond	
3.	Marble Factory - Berkovitza town	Berkovitza river	1.65	-	82.5	-	Tailings pond	
4.	Dairy Factory - Michaelovgrad town	town collector	1.20	8.8	61.0	Oil products - 120	Treat. Plant - mech. step	inefficient operation ; no town treatment plant;
5.	Paultry Slaughtery House - Michaelovgrad town	town collector	0.42	43.7	37.4	-	Oil separator	no town Treat. Plant
6.	Oil Factory - Boitchinovtsi town	Ogosta river	0.09	0.86	7.65	-	natural sedimentation	
7.	Canning Factory - Boitchinivtsi town	Ogosta river	0.35	3.11	19.03	-	Treat. Plant - mechanical & bilogocal steps	reconstruction is needed
8.	Floatation Factory	Tcherna river	4.0	-	4000	Mn < 7kg/day; Cu < 13.2kg/day; Pb < 2.16kg/day	Tailings pond	
9.	Chemical Factory -Vratsa town	Dubnika river	24.0	480	2400	ammonia - 50-150kg/day	-	fines are paid
10.	Cement Factory - Beli Izvor	Leva river	2.35	437.1	526.4	-	Treatment Plant	
11.	Mining Section - Monastirishte vill.	Ogosta river	0.52	-	259	-	Settling tank	
12.	Canning Factory - Butan village	Ogosta river	2.34	117	819	-	Settling tank	
13.	Paper Factory - Mizia town							
	- hydro transport	Ogosta river	2.81	84.4	2812	pH = 9-11	Slime settler	
	- production waters	Skat river	21.6	6588	21600	pH = 9-11	Treat. Plant - mech. step	reconstruction and expansion is needed
14.	Dairy Factory - Biala Slatina town	Skat river	0.31	226	203.2	Oil contence < 200kg/day	Treatment Plant	
	Iskar River							
15.	Metallurgical complex - "Kremikovtsi"							
	- metallurgical production	Lesnovcka river	189.6	-	4395	cyanides - 0.075; Fe = 4.96 oil products -13.79	Treat. Plant - mech. & physic.-chemical steps	
	- communal waste waters	Lesnovcka river	26.8	417	429	Fe = 4.06	Treatment Plant	
	- tailings pond	Lesnovcka river	43.2	-	1555	Mn = 0.61	Tailings pond	
	- ash depository	Lesnovcka river	24.6	-	886	-	Ash depository	

Table 2.3.1. (cont'd)

1	2	3	4	5	6	7	8	9
16.	Wood-fibre-board Factory - Slivnitsa town	Slivnitsa river	0.67	26.8	119.36	COD = 38.6	Ash depository	There is a Treat. Plant after which the water is used for hydro transport and after that is discherged in the Ash depository.
17.	Chemical Factories - Kostinbrod town	Belitsa river	1.75	-	31.5	Oil products - 10.2 Nitrogen = 4.64 COD = 114	Treatment Plant	
18.	Paultry Slaughtery House Kostinbrod town	Tcherna river	0.58	-	140	ammonia - 15 H_2S = 26.6	settlers - 3 nos; oil separator;	the oil separator is not in operation since July 1991
19.	Dairy Factory - Svoge town	Oskar river	0.25	10-53	-	Animal oil - 10-150; COD = 20 - 160	-	-
20.	Meat-processing Factory Etropole town	Maluk Iskar river	0.11	6	-	oil - 126; COD = 457.6 pH = 6.93	-	-
21.	Leather Tanning Factory Etropole town	Maluk Iskar river	0.64	-	153.6	Fe = 273; oil- 36.6; pH = 5.95 H_2S = 4.2	Treatment Plant	
22.	Floatation Factory - Elisaina town							
	- floatation	Iskar river	8.46	-	8456	Pb < 5.16 kg/day; Fe < 8.8 kg/day; Arsenic < 225;	Tailings pond	
	- communal waste waters	Iskar river	0.43	80	96		-	
	- granulation	Iskar river	2.58	-	1290	Pb < 5.05 kg/day Mn < 1.85 kg/day Fe < 119 kg/day arsenic < 12 g/m^3	Settling tank	
	- from the wet dust separation	Iskar river	0.043	-	6.15	arsenic < 750 g/m^3	reversible	sanctions have been made
23.	Canning Factory - Mezdra town							
	- production waters	Moravishka river	0.77	38.8	268	-	-	
	- communal waste waters	Moravishka river	0.18	34.2	41.2	-	-	
24.	"Sanitext" Factory - Mezdra town							
	- production waters	town collector	1.84	367.2	918.0	pH = 8-12	Local Treatment Plant	No Town Treatment Plant
	- communal waste waters	town collector	0.35	64.2	77.2	-	-	
25.	Brewery - Mezdra town							
	- - production waters	town collector	1.53	610.4	763.0	-	-	
	- communal waste waters	town collector	0.07	12.8	15.5	-	-	
26.	Rock materials Processing Factory							
	- production waters	Iskar river	1.73	-	1730	-	Tailings pond	
	- communal waste waters	Iskar river	0.19	35.3	42.6	-	-	
27.	"Metizi" Factory - Roman town							
	- production waters	Iskar river	4.20	-	2100	pH = 2-7	shaft + slime depository	New installation for drying of slime is under construction
	- communal waste waters	Iskar river	2.07	385.8	464.6	-	Treatment Plant	
28.	Canning Factory - Kneja town							
	- production waters	Gostilia river	2.1	105.0	735.0	-	Settling tanks	
	- communal waste waters	Gostilia river	0.003	0.6	0.67	-	-	

Table 2.3.1. (cont'd)

1	2	3	4	5	6	7	8	9
29.	Dairy Factory "Serdika" Kneja town	Gostilia river	0.31	61.2	153.0	Animal oil < 200 g/m^3	-	-
30.	Starch Factory - Tcherven Briag	Iskar river	0.30	306	632	-	settlers	
31.	"Beta" Factory - Tcherven Briag							
	- galvanizing department	Zlatna Panega river	6.60	46.2	277	Fe = 0.98 oil products - 13.2	-	Treatment Plant under construction
32.	Meat Processing Factory - Tcherven Briag	Zlatna Panega river	0.50	237.5	48	Animal oil	-	
	Vit River							
33.	"P. Abadgiev" Factory - Teteven town	Vit river	0.60	8	20	oil products - 18.5	mud and oil separators	Treatment Plant under construction
34.	Auto-service - Teteven town	Vit river	0.03	0.58	9.6	oil products - 16.6	mud and oil separators	
35.	Paultry Slaughtery House Pleven town	town collector	0.90	340	1440	Animal oil - 48	movable screens	Treatment Plant under construction
36.	Meat Processing Factory Pleven town	town collector	1.80	720	5580	Animal oil - 180	Treatment Plant	in reconstruction
37.	Chemical Factory "Plama"- Pleven	town collector	9.50	90	636	Fe = 0.44; oil products.- 1.7	Treat. Plant - biolog. step	
38.	Sugar Factories - Dolna Mitropolia town	town collector	2.70	383	156	nitrogen - 21.72	Settlers, mud drying beds	
39.	"Zvezda" Factory - Dolna Mitropolia town	town collector	2.0	140	240	oil - 13.70	Oil separator	
40.	Ecarisage - Bivolare village	Vit river	0.33	31	26	Animal oil - 26.0	-	Treatment Plant under constr
41.	Slaughtery House - Guliantsi village	Vit river	0.12	53	18.6	Animal oil - 63.4	Mud and oil separators	
	Osam River							
42.	"Elprom" Factory - Troian town	town collector	2.40	-	974	Oil products - 19.6	-	No Treatment Plants in this river valley
43.	Chemical-Pharmaceutic Factory Troian town	town collector	2.16	-	75	Oil products - 7.4	-	Local Treatment Plant under construction
44.	Meat Processing Factory - Troian	town collector	0.24	35	27	Animal oil - 66.4	Treat. Plant - mech. step	
45.	Wood processing Factory Troian town	town collector	3.50	6020	1351	nitrogen (ammonia)	Treat. Plant - biolog. step	No Town Treatment Plant
46.	Dairy Factory "Primalakta" Lovetch town	town collector	0.65	28.6	65	Animal oil - 27.4	Treat. Plant - biolog. step	No Town Treatment Plant
47.	"Balmo" Factory - Lovetch town - galvanizing shop	Osam river	0.14	2.3	13.3	Fe - 0.24	Treat. Plant - chemical treat.	
48.	Canning Factory "Malta" - Lovetch	town collector	1.10	-	116	-	Mud and oil separators	No Town Treatment Plant
49.	Meat Processing Factory - Lovetch	town collector	0.45	-	553	Animal oil - 34.8	-	No Town Treatment Plant
50.	Leather Tanning Factory "Velur" - Lovetch town	town collector	2.25	229	135	Phenols; oil	Local Treatment Plant	No Town Treatment Plant
51.	Paultry Slaughtery House - Levski town	town collector	0.28	20	27.7	Animal oil	-	No Town Treatment Plant
52.	Meat Processing Factory - Levski	town collector	0.80	100	674	Animal oil	-	No Town Treatment Plant

Table 2.3.1. (cont'd)

1	2	3	4	5	6	7	8	9
53.	Milk Processing Factory - Levski t.	town collector	0.15	2.2	151.5	Animal oil - 24.0	-	No Town Treatment Plant
54.	ZMK - Tcherkvitsa	Osam river	15.50	204	2123	Heavy metals	-	Treat. Plant under constr.
	Iantra River							
55.	"Uzana" Factory - Gabrovo town	Iantra river	1480	600	500		Oil separator	Industrial waste waters
56.	"Luv" Factory - Gabrovo town	Iantra river	4900	3920	1470	oil -300	Oil separator; settler;filter press	Industrial waste waters
57.	"St. Peshev" Factory - Sevlievo t.	Rositsa river	190	13.3	19	Fe - 1.5; oil - 10	Cr, Ni settlers	Industrial waste waters
58.	Canning Factory "Selvi" - Sevlievo	Rositsa river	1730	200	100		Trash-rack; settler	Industrial waste waters
59.	Dairy Factory - Sevlievo town	Rositsa river	220	700	1000		No equipment	Industrial waste waters
60.	"Sevko" Factory - Sevlievo town	Rositsa river	850	680	510	Fe - 15; oil - 400; H_2S - 0.3	Oil separator; settler;	Industrial waste waters
61.	Meat Processing Factory - Sevlievo	Rositsa river	270	2000	1700		No equipment	Industrial waste waters
62.	"Lenatex" Trievna town	Drianovska river	900	160	100		Trash-rack;Settler	Industrial waste waters
63.	"Trema" - Trievna town	Drianovska river	500	25	15	Fe - 0.7; oil - 5	Settler; Drying beds	Industrial waste waters
64.	Machine Manufacturing Factory - Belitsa village	Belitsa river	150	3	15	Oil - 70	Reactor ; filter press	Industrial waste waters
65.	"Strinava" Factory - Drianovo town	Drianovska river	315	500	300		Treat. Plant under construction	Industrial waste waters
66.	Dairy Factory "Mlekimpex" - Elena	Ivanovka river	40	8	12	Animal oil - 250	Trash-rack; Oil separator	Industrial waste waters
67.	Meat Processing Factory - Elena t.	Ivanovka river	75	45	75	Animal oil - 150; H_2S - 0.3	Trash-rack; sand catcher; Oil separator	Industrial waste waters
68.	Textile Factory - Elena town	Ivanovka river	72	5.76	8.6	Fe - 1.5; oil - 30;	Trash-rack; settlers	Industrial waste waters
69.	"Interior" Factory - Elena town	Zlataritsa river	140	10.6	16.8	Fe - 1.2; oil - 8; NH_4 - 1.0	Vertical settlers; drying beds	Communal waste waters
70.	Meat Processing Factory - Gorna Oriahovitsa town	Iantra river	129	38.7	64.5	Oil - 50; H_2S - 0.7	Oil separator	Industrial & communal waste waters
71.	Chemical Factory - Gorna Oriahovitsa town	Iantra river	432	23	20.2	Fe - 2.4; oil - 6; S ions - 3.0;	Settler; Filter press	Industrial waste waters
72.	Railway Station Headquarter - Wagons department - G.Oriahovitsa	Iantra river	240	24	38	Fe - 1.0; oil - 3.0	No equipment	Industrial waste waters
73.	Railway Station Headquarter - Engines department - G.Oriahovitsa	Iantra river	24	0.48	3.6	Fe - 10; oil - 10.0;	Mud and oil separators	Industrial waste waters
74.	Sugar Factories - Gorna Oriahovitsa	Iantra river	12000	8400	4800	H_2S - 0.3	Sand catcher; settlers	Industrial & communal waste waters
75.	"Briliant" Factory - Krusheto village	Rositsa river	560	28	23.5	oil - 20	No equipment	Industrial waste waters
76.	"Arkus" Factory - Lieskovetz town	a small river	1300	30	90	Fe - 0.5; oil - 30	Cian,Zn,Ni -reactor; drying beds; Oil seperator;	Industrial waste waters
77.	"Diplomat" Factory - Djulunitsa v.	Lefedja river	756	90.7	378	oil - 30	No equipment	Industrial waste waters
78.	"Riti" Factory - Suhindol town	Vodeshnitsa river	470	15.5	6.8	Fe - 5.0; oil - 6.0;	drying beds; settler;	Industrial & communal waste waters
79.	Winery Factory - Pavlikeni town	town collector	960	96	144	oil - 15; H_2S - 0.5	Sand catcher; vertical settlers; mud separator	Industrial waste waters
80.	"Pavlikeni Factory" - Pvlikeni town	town collector	110	66	99	oil - 300	Oil separator	Industrial waste waters

Table 2.3.1. (cont'd)

1	2	3	4	5	6	7	8	9
81.	"Prima M-90" - P.Trambesh town	Iantra river	60	60	18	Oil - 130; H_2S - 0.9	Oil separator	Industrial waste waters
82.	Dairy Factory - P.Trambesh town	town collector	170	68	20.4	Oil - 150	Oil separator	Industrial waste waters
	Russenski Lom River and its Tributaries							
83.	Pharmaceutic Factory "Antibiotic" Razgrad town	Beli Lom river	8035	5246.8	6026		Settler and after that discharge into the town Treatment Plant	Production & communal waters
			432					conventionally pure water
84.	Meat Processing Factory - Razgrad	town collector	2088	250.6	536.6		Treat. Plant - mech. step and Oil separator	Industrial & communal waste waters
85.	"Diamand" State Factory - Razgrad	Beli Lom river	1780	15.5	65.8		Mechanical & biological treatment	Industrial & communal waste waters
86.	"Kaolin" Factory - Senovo village	a dry small river bed	2160				mech. treated waters pass through Tailings pond and are used again	Communal waste waters
			208	10.37	1112.4			Industrial waste waters
87.	"Kaolin" Factory - Vietovo town	Beli Lom river	6052	12.1	157.3		Tailings pond, after which the waters are recycled	Industrial & communal waste waters
88.	"Bazovetz" - Bazovetz village	Banski Lom	1000	244	612		Oil separator	Industrial & communal waste waters
89.	Canning Factory - Kresen village	Rusenski Lom	1065	28.75	268.38		Clorinating shaft; Oil separator	Industrial & communal waste waters
90.	"Prisba Factory" - Russe town	Russenski Lom	10725	2498.9	1158.3	Fe - 4.5	Treat. Plant - mechanical-chemical step	Industrial & communal waste waters
91.	Silk Factory "Dunavska koprina" - Russe town	Russenski Lom	2577	551.4	932.8	pH = 10-11		Industrial & communal waste waters
92.	"Sirma-Prista" Factory - Russe town	Russenski Lom	1980	19.8	95	oil - 7.8	Oil separator	Industrial & communal waste waters
93.	Winery Factory - Russe town	Russenski Lom	650	568.7	770.25		No treatment	Industrial & communal waste waters
94.	"G.Ganov" Factory - Russe town	Russenski Lom	5781	439.4	173.4	oil - 300.6	Settlers - 2 nos	Industrial & communal waste waters
	Danube River Valley							
95.	Winery Factory "Vinprom" - Russe	Danube river	2100	306.6	105		Neutralizing shaft	Industrial & communal waste waters
96.	Railway Engine Repair Plant - Russe town	Danube river	2131	38.36	89.5		Oil separator	Industrial & communal waste waters
97.	Railway Engine Depot - Russe	Danube river	428	30.68	197.4	Oil products - 515		communal & wash waters
98.	"Hlebna maia" - Russe town	Danube river	8629	8629	1035			communal w. waters & organic pollution
99.	Meat Processing Factory - Russe	Danube river	1440	338.4	570		Treat. Plant - screens - 2nos	Industrial & communal waste waters
100.	"Bimas" Factory - Russe town	Danube river	6500	279.5	1131	Oil - 261	Treat. Plant - phys.-chemical	Industrial & communal waste waters

Table 2.3.1. (cont'd)

1	2	3	4	5	6	7	8	9
101.	Sugar Factory "Zaharbil" - Russe t.	Danube river	21338	27643	101099			Industrial & communal waste waters
		Danube river	543	174	74		Oil separator	Industrial & communal waste waters
102.	Steam Power Plant - Russe town	Danube river	21872	74	1706	Fe - 1.0	Neutralizing shaft	Industrial waste waters
103.	"Izoma" Factory - Russe town	Danube river	2397	13764	134	Phenol - 540	Treat. Plant ; Oil separator	Industrial & communal waste waters
104.	"G.Genov" Factory - Russe	Danube river	2220	324	111			Industr.& communal w.waters
105.	Steam Power Plant - Russe town waters after Ash depository	Danube river	17280	51.84	1002	Fe - 0.17	Ash depository; Settlers	Industrial & communal waste waters
106.	Machine Manufacturing Factory - Russe town	Danube river	4163	14.57	91.51	Oil - 15.2	Treatment Plant	Industrial & communal waste waters
107	"Ambrozia" Factory - Slivo Pole v.	Danube river	984	30.5	43.29			Industr.& comm. w.waters
108.	Fish Canning Factory "Slavianka" - Tutrakan town	Danube river	1970	233	77			Industrial & communal waste waters
109	"Lesil" Factory - Silistra town	Danube river	5170	10402	2715		Mechanical treatment	Industrial & communal waste waters
110.	State Ecarisage - Silistra town	Beshovska river	289	35	39			communal waste waters
111.	"Mekom" - Silistra town	Danube river	984	274	295	Oil - 181.5 mg/l	Treat. Plant - mech. step	communal waste waters + organic pollution
112.	Dairy Factory "Milksi" - Silistra	town collector	2830	2822	801	Oil - 284 mg/l		communal waste waters + organic pollution
113.	"Dunav-57" Factory - Silistra	town collector	852	26	75	Oil - 26.4 mg/l		communal waste waters + organic pollution
114.	"Orgtechnica" - Silistra town	town collector	1622		44	Fe - 0.98; Cu - 6.3	Treat. Plant - chem. tr.	Industr & comm. w.waters
115.	"Ellia" Factory - Nikopol town galvanizing shop	Danube river	25	1	4.4	Cr - 7.5; Oil - 6.0	Neutralizing shaft	Industrial waste waters
116.	"Bateria" Factory - Nikopol town	Danube river	36	0.64	4.7	Fe - 0.8		Industrial waste waters
117.	Machine Manufacturing Factory - Belene town	Danube river	90	0.96	2.9	Fe - 0.36; N- 29.3; oil - 0.4	Mud and oil separators	Industrial waste waters
118.	Chemical Factory "Sviloza" - Svishtov town	Danube river	152000	29336	26144	Fe- 3.0; Zn- 5.0; Oil- 42.0 S^+ - 400;	Mixing tanks	Industrial waste waters
119.	Canning Factory - Svishtov town	Danube river	7600	2280	5320	Oil- 50; H_2S- 1.2;	Trash-rack; Oil separator	Industrial waste waters
120.	Winery Factory - Svishtov town	Danube river	212	46.8	62.4		No equipment	Industrial waste waters
121.	Meat Processing Factory - Svishtov town	town collector	264	92.4	264	Animal oil - 300	Trash-rack; Oil separator	Industrial waste waters
122.	Dairy Factory - Svishtov town	town collector	106	84.8	74.2	Animal oil - 200	Trash-rack; Oil separator	Industrial waste waters
123.	Nuclear Power Station "Kozludui"	Danube river	1300	241.8	291		Treatment Plant	Communal waste waters
124.	"Izgrev" - Orishovo town	town collector	18	0.9	3.6		Treatment Plant	Industrial waste waters
125.	"Izgrev" - Orishovo town	town collector	36	6.7	8.06		Treatment Plant	Communal waste waters
126.	Meat Processing Factory - Lom town	Danube river	3110	385.6	2065		Settlers	Industrial & communal waste waters
127.	Canning Factory - Lom town	Danube river	3200	594	939			
128.	Sugar Factory - Lom town	Danube river	3456	63.59	916.9		Settlers	
129.	Electrocars Factory - Lom town	Danube river	803.2	38.7	483.8			

2.4. Agricultural And Animal Husbandry

The main pollution sources are the big stock-breeding farms which treat with water big quantities of manure.

On table 2.4.1 are listed the stock-breeding farms situated in the Bulgarian part of the Danube River basin and their pollution loads.

WASTE WATERS OF FEEDLOTS

Situated in the Bulgarian Part of the Danube River Basin

Table 2.4.1.

Item	RIVER BASIN SETTLEMENT HAVING FEED LOTS	Number of animals	Waste waters	POLLUTION				EXISTING WATER TREATMENT FACILITIES	Pollution loading		Pollution concentration	
				BOD_5	Susp. Solids (SSM)	BOD_5	Susp. Solids (SSM)		BOD_5	Susp. Solids (SSM)	BOD_5	Susp. Solids (SSM)
		x 10^3	m^3/d	kg/d	kg/d	equiv./inh	equiv./inh		kg/d	kg/d	mg/l	mg/l
1	2	3	4	5	6	7	8	9	10	11	12	13
1.	Small rivers of N/W Bulgaria tributaries of Danube river											
1.1.	Topolovetz river											
	Cattle Farm - Boinitse village	200	5.00	70.0	540.0	1400	8400	settling tanks - 2 nos	42.0	162.0	8400	32400
	Pig Farm - Gradetz village	4500	180.00	1192.5	2520.0	22500	38700	settling tanks - 5 nos	715.5	756.0	3975	4200
	Pig Farm - Ts. Petrovo village	500	20.00	132.5	280.0	2500	4300	settling tanks - 2 nos	79.5	84.0	3975	4200
	Pig Farm - Biala Rada village	15000	600.00	3975.0	8400.0	75000	129000	sewage treatment plant	2385.0	2520.0	3975	4200
1.2.	Voinishka river											
	Pig Farm - Dunavtsi village	24842	993.68	6583.1	13911.5	124210	213641	tr. plant - out of operation	6583.1	13911.5	6625	14000
	Pig Farm - Kula town	634	25.36	168.0	355.0	3170	5452		168.0	355.0	6625	14000
	Cattle Farm - Bukovetz village	500										
1.3.	Vidbol river											
	Pig Farm - Rakovitsa village	350	14.00	92.8	196.0	1750	3010	settling tanks - 2 nos	65.0	58.8	3975	4200
	Cattle Farm - Makresh village	1000	30.00	350.0	2700.0	7000	42000	compost collectors - 2 nos				
	Cattle Farm - Toshevtsi village	500	12.50	175.0	1350.0	3500	21000	settling tanks - 2 nos	150.0	405.0	8400	32400
	Pig Farm - Gramada town	1200	48.00	318.0	672.0	6000	10320	settling tanks - 2 nos	190.8	201.6	3975	4200
1.4.	Archar and Skomlia rivers											
	Pig Farm - Ostrokamtsi village	200	8.00	53.0	112.0	1000	1700		53.0	112.0	6625	14000
	Pig Farm - Dimovo village	300	12.00	80.0	168.0	1500	2580		80.0	168.0	6625	14000
	Cattle Farm - Vartop village	325	26.00									
	Pig Farm - Archar village	930	37.20	246.5	528.0	4650	7998	settling tanks - 2 nos	147.9	156.2	3975	4200

Table 2.4.1. (cont'd)

1	2	3	4	5	6	7	8	9	10	11	12	13
1.5.	Lom river											
	Cattle Farm - Borovitsa village	400	20.00	240.0	1880.0	4400	28800	settling tanks	144.0	564.0	7200	28200
	Cattle Farm - Bialo Pole village	400	15.00	140.0	1080.0	2800	16800	compost collectors - 3 nos	126.0	924.0		
	Poultry Farm - Medovnitsa village	15000	40.00	300.0	594.0			compost collectors - 3 nos				
	Cattle Farm - Medovnitsa village	200	5.00	70.0	540.0	1400	8400	settling tanks - 2 nos	42.0	162.0	8400	32400
1.6.	Tsibritsa river											
	Pig Farm - Dr. Iosiffovo village	1250	50.00	331.3	700.0	6250	10312	settling tanks - 2 nos	198.8	210.0	3975	4200
	Pig Farm - Valtchedram village	14500	580.00	3842.5	8120.0	72500	119625	settling tanks - 5 nos	2305.5	2436.0	3980	4200
	Pig Farm - Resovo village	1200	48.00	318.0	672.0	6000	9900	settling tanks - 2 nos	190.8	201.6	3980	4200
	Pig Farm - Komoshtitsa village	584	23.36	154.8	327.0	2920	4818	settling tanks - 2 nos	92.9	98.1	3980	4200
	Pig Farm - Botevo village	2300	92.00	609.5	1288.0	11500	18975	settling tank	365.7	386.4	3980	4200
2.	**Ogosta river**											
2.1.	Pig Farm - Elovitsa village	350	14.00	93.0	196.0	1750	3010	settling tanks	65.0	69.0	4640	4930
2.2.	Cattle Farm - G.Tserovene village	420	43.00	147.0	1134.0	2940	17640	settling tanks - 2 nos	103.0	397.0	2400	9230
2.3.	Cattle Farm - Kraitchene village	500						settling tanks - 2 nos				
2.4.	Pig Farm - Studeno Butche village	35000	1400.00	9275.0	19600.0	175000	301000	ettling tanks and drying beds -3	6493.0	6860.0	4040	4890
2.5.	Cattle Farm - Erden village	200	34.00									
2.6.	Cattle Farm - Gabrovitsa village	300	86.00					settling tanks - 2 nos				
2.7.	Pig Farm - Vladimirovo village	3800	152.00	1007.0	2128.0	19000	32680	settling tanks - 3 nos	705.0	745.0	4640	4900
2.8.	Pig Farm - Kobiliak village	3200	128.00	848.0	1792.0	16000	27520	settling tanks - 2 nos	594.0	627.0	4640	4900
2.9.	Pig Farm - Lehtchevo village	3300	132.00	875.0	1848.0	16500	28380	settling tanks - 7 nos	613.0	647.0	4640	4900
2.10.	Pig Farm - Madak village	3300	132.00	875.0	1848.0	16500	28380	settling tanks - 4 nos	613.0	647.0	4640	4900
2.11.	Pig Farm - Septemvriitsi village	440	18.00	117.0	246.0	2200	3784		117.0	246.0	6500	13670
2.12.	Ogosta river feeders											
	Pig-disease Institute - Vratsa town	2000	760.00					sewage treatment plant				
	Cattle Farm - Vratsa town	750	130.00					settling tanks				
	Cattle Farm - Beli Izvor village	400	45.00					concrete settling tanks				
	Pig Farm - Manastiritshte village	2760	110.40	731.4	1546.0	13800	23736	settling tank	512.0	541.0	4640	4900
	Pig Farm - Glogene village	3350	134.00	888.0	1876.0	16750	28810	settling tank	622.0	657.0	4640	4900
	Pig Farm - Vraniak village	1200	48.00	318.0	672.0	6000	10320	settling tanks	223.0	235.0	4650	4900
	Cattle Farm - Biala Sletina town	4697	1230.00					settling tanks				
	Pig Farm "East"- Tarnava village	1100	44.00	292.0	616.0	5550	9546	settling tank	204.0	216.0	4640	4900
	Pig Farm "North"- Tarnava village	1113	44.00	295.0	623.0	5565	9572	settling tank	207.0	218.0	4700	4900
	Pig Farm - Altimir village	1560	63.00	413.0	874.0	7800	13416	settling tank	289.0	306.0	4600	4900
	Pig Farm - Borovan village	2565	103.00	680.0	1436.0	12825	22059	settling tank	476.0	503.0	4620	4900

Table 2.4.1. (cont'd)

1	2	3	4	5	6	7	8	9	10	11	12	13
	Pig Farm - Rogozen village	9200	368.00	2438.0	5152.0	46000	79120	compost collectors	1707.0	1803.0	4640	4900
	Pig Farm - Rogozen village	35335	1414.00	9364.0	19788.0	176675	303881	treatment plant - 2 biolog. parts				
	Poultry Farm - Mizia town	200000						compost collector				
3.	Iskar river											
3.1.	Cattle Farm - Iarlovo village	800	20.00	250.0	2160.0	4200	32600	drying beds - 5 nos	150.0	664.0	750	4320
3.2.	Cattle Farm - Popoviane village	100	5.00	60.0	440.0	110	7200	drying beds - 2 nos			1200	8800
3.3.	Cattle Farm - Osoitsa village	3000	75.00	1050.0	7100.0	21000	126000	compost collectors - 4 nos				
3.4.	Cattle Farm - Kazitchane village	700	35.00	420.0	3080.0	7700	50400	drying beds	252.0	1232.0	720	3500
3.5.	Cattle Farm - Lokorsko village	2000	100.00	1200.0	8800.0	22000	144000	settling tanks	840.0	3520.0	840	3520
3.6.	Cattle Farm - Aldomirovtsi village	700	27.50	265.0	2470.0	6500	41400	drying beds	159.0	988.0	580	3600
3.7.	Pig Farm - Slivnitsa town	3000	120.00	795.0	1680.0	15000	25800	drying bed (tr.pl. under constr.)	477.0	672.0	3980	5600
3.8.	Cattle Farm - Petartch village	230	75.00	138.0	1012.0	2530	16560	drying beds	83.0	405.0	1110	5400
3.9.	Cattle Farm - Herakovo village	240	12.00	144.0	1056.0	2640	17260	drying beds - 4 nos	86.0	422.0	720	3520
3.10.	Cattle Farm - Proteska village	240	12.00	144.0	1056.0	2640	17260	drying beds - 3 nos	86.0	422.0	720	3520
3.11.	Cattle Farm - Podgumer village	6200	155.00	2170.0	16740.0	43400	180000	compost collector				
3.12.	Cattle Farm - Dobroslavtsi village	360	18.00	216.0	1584.0	3960	2592				1200	8800
3.13.	Cattle Farm - Gorna Kremena village	900	22.50	315.0	2430.0	37800	6300	concrete settling tanks				
3.14.	Cattle Farm - Kameno pole village	400	20.00	240.0	1760.0	4400	28800	concrete settling tank				
3.15.	Cattle Farm - Gabare village	900	45.00	540.0	3960.0	9900	64800	concrete settling tanks				
3.16.	Pig Farm - Kneja town	21298	1064.90	12778.8	47215.6	183163	106490	tretment plant - mech. part	8945.0	14165.0	8400	13300
3.17.	Pig-reproducing Farm - Kneja town	10000	400.00	2650.0	5600.0	50000	86000	sewage treatment plant			30	80
3.18.	Pig Farm - Koinare town	2600	104.00	689.0	1276.0	13000	21760				6630	12270
3.19.	Cattle Farm - Pravetz town	400	10.00	140.0	1280.0	2800	16800	drying beds - 4 nos	84	768	810	7680
3.20.	Pig Farm - German village	1500	60.00	397.5	840.0	7500	12900		397.5	840.0	6625	14000
3.21.	Pig Farm - Pet Mogili village	9600	384.00	2544.0	5376.0			pit	1780.8	2150.4	4637	5600
3.22.	Pig Farm - Pet Mogili village	1000	40.00	265.0	560.0			pit	185.5	224.0	4637	5600
3.23.	Pig Farm - Pet Mogili village	8000	320.00	2120.0	4480.0			pit	1484.0	1792.0	4637	5600
3.24.	Pig Farm - Suhodol village	2500	100.00	662.5	1400.0			drying beds - 5 nos	397.5	420.0	3975	4200
3.25.	Pig Farm - Suhodol village	1500	60.00	397.5	840.0			drying beds - 3 nos	238.5	252.0	3975	4200
3.26.	Cattle Farm - Goliamo Malovo village	1240	31.00	434.0	3346.0			drying beds - 2 nos	260.0	1340.0	8710	43220
3.27.	Cattle Farm - Dragotintsi village	800	20.00	280.0	2160.0			drying beds - 3 nos	168.0	824.0	8400	41200
3.28.	Cattle Farm - Galabovtsi village	400	20.00	270.0	1760.0			drying beds - 2 nos	162.0	704.0	8100	35200
3.29.	Cattle Farm - Tcherna Bara village	200	5.00	70.0	540.0			drying bed	42.0	216.0	8400	43200
3.30.	Cattle Farm - Kostinbrod town	400	10.00	140.0	1080.0			drying beds - 2 nos	84.0	432.0	8400	43200
3.31.	Cattle Farm - Kostinbrod town	100	5.00	60.0	440.0			drying bed	36.0	176..0	7200	35200
3.32.	Cattle Farm - Petartch village	420	21.00	252.0	1848.0			drying beds - 3 nos	151.0	739.0	7190	35200
3.33.	Cattle Farm - Bogiovtsi village	400	10.00	140.0	1080.0			drying bed	84.0	432.0	8400	43200
3.34.	Cattle Farm - Novatchene village	1200	30.00	420.0	3240.0			drying beds - 7 nos	252.0	1296.0	8400	43200

Table 2.4.1. (cont'd)

1	2	3	4	5	6	7	8	9	10	11	12	13
3.35.	Cattle Farm - Vidrare village	300	7.50	105.0	810.0			drying beds - 2 nos	63.0	324.0	8270	43200
3.36.	Cattle Farm - Kostenetz village	400	20.00	240.0	1760.0			drying beds - 2 nos	144.0	701.0	7200	35200
3.37.	Cattle Farm - Reliovo village	100	5.00	60.0	440.0			drying beds - 2 nos	36.0	176.0	7200	35200
3.38.	Cattle Farm - Verinsko village	100	5.00	60.0	440.0			drying bed	36.0	176.0	7200	35200
3.39.	Cattle Farm - Tsarkvishte village	400	10.00	140.0	1080.0			drying beds - 2 nos	108.0	432.0	10800	43200
3.40.	Cattle Farm - Mirkovo village	400	10.00	140.0	1080.0			drying beds - 2 nos	108.0	432.0	10800	43200
4.	**Vit river**											
4.1.	Pig Farm - Bukovlak village	5500	220.00	1458.0	3080.0	27500	47300		1458.0	3080.0	6630	14000
5.	**Osam river**											
5.1.	Pig Farm - Troian town	4500	180.00	1193.0	2520.0	22500	38700	drying bed	835.0	882.0	4640	4900
5.2.	Pig Farm - Ablenitse village	1500	60.00	398.0	840.0	7500	12900	drying bed	279.0	294.0	4650	4900
5.3.	Pig Farm - Umarevtsi village	1400	56.00	371.0	784.0	7000	12040	settling shafts	260.0	275.0	4640	4910
5.4.	Pig Farm - Aleksandrovo village	1400	56.00	371.0	784.0	7000	12040	drying bed	260.0	275.0	4640	4910
5.5.	Pig Farm - Letnitsa village	2500	100.00	663.0	1400.0	12500	21500	treatment facilities	464.0	560.0	4640	5600
5.6.	Pig Farm - Levski town	32000	1280.0	8480.0	17920.0	160000	275200	sewage treatment plant	32.0	102.0	30	80
6.	**Iantra river**											
6.1.	Pig Farm - "P.Volov" Factory	1200	48.00	318.0	672.0	6000	10320		318.0	672.0	6630	14000
6.2.	Pig Farm - Biela Railway Station	3800	152.00	1007.0	2128.0	19000	32680		1007.0	2128.0	6630	14000
6.3.	Pig Farm - Biela Railway Bridge	2500	100.00	662.5	1400.0	12500	21500		662.5	1400.0	6630	14000
6.4.	Pig Farm - Voinovo village	10000	400.00	2650.0	5600.0	50000	86000	compost collectors	1590.0	1680.0	3975	4200
6.5.	Pig Farm "Tchakala"- Sevlievo town	9000	360.00	2385.0	5040.0	45000	77400	compost collectors	1431.0	1512.0	3975	4200
6.6.	Pig Farm "Hmela"- Debelets village	2000	80.00	530.0	1120.0	10000	17200	compost collectors	371.0	448.0	4640	5600
6.7.	Pig Farm - Samovodene village	7000	280.00	1855.0	3920.0	35000	60200		1855.0	3920.0	6625	14000
6.8.	Pig Farm - Resen village	2000	80.00	530.0	1120.0	200000	17200		530.0	1120.0	6625	14000
6.9.	Pig Farm - Polikraishte village	6000	240.00	1590.0	3360.0	30000	51600		1590.0	3360.0	6625	14000
6.10.	Cattle Farm - Krushevo village	1200	30.00									
6.11.	Pig Farm - Lieskovetz town	2500	100.00	662.5	1400.0	12500	21500		662.5	1400.0	6630	14000
6.12.	Pig Farm "Geran"- Lieskovetz town	8000	320.00	2120.0	4480.0	40000	68800		2120.0	4480.0	6630	14000
6.13.	Pig Farm - Keserovo village	8500	340.00	2252.5	4760.0	42500	73100		2252.5	4760.0	6625	14000
6.14.	Pig Farm "Paskalevetz'	3000	120.00	795.0	1680.0	15000	25800		795.0	1680.0	6625	14000
6.15.	Pig Farm - Mihaletz village	3000	120.00	795.0	1680.0	15000	25800		795.0	1680.0	6625	14000
6.16.	Pig-reproducing Farm - Stambolovo village	30000	1200.00	7950.0	16800.0	150000	258000	compost collectors	4770.0	5040.0	3975	4200

Table 2.4.1. (cont'd)

1	2	3	4	5	6	7	8	9	10	11	12	13
6.17.	Pig Farm - Raiko Daskalovo village	6000	240.00	1590.0	3360.0	30000	51600		1590.0	3360.0	6625	14000
6.18.	Pig Farm - D.Lipnitsa village	4000	160.00	1060.0	2240.0	20000	34400	compost collectors	636.0	672.0	3975	4200
6.19.	Pig Farm - P.Senovetz village	5500	220.00	1457.5	3080.0	27500	47300	compost collectors	874.5	924.0	3975	4200
6.20.	Pig Farm - Strahilovo village	4000	160.00	1060.0	2240.0	20000	34400	compost collectors	636.0	672.0	3975	4200
6.21.	Pig Farm - Gradina village	3500	140.00	927.5	1960.0	17500	30100	compost collectors	556.5	588.0	3975	4200
6.22.	Pig Farm - B.Slovovo village	13000	520.00	3445.0	7280.0	65000	111800		3445.0	7280.0	6625	14000
7.	**Russenski Lom river**											
7.1.	Beli Lom feeder											
	Cattle Farm - Mortagonowo village	663	38.00					drying bed				
	Pig Farm - Razgrad	2000	80.00	530.0	1120.0	10000	17200		530.0	1120.0	6630	1400
	Pig Farm "Diankovo"	25000	1000.00	6625.0	14000.0	125000	215000	sewage treatment plant			30	80
	Cattle Farm - Balkanski village	1000	57.00					compost collector				
	Pig Farm - Balkanski village	100	4.00	27.0	56.0	500	860	drying beds	19.0	20.0	4750	5000
	Pig Farm - Osenetz village	500	20.00	133.0	280.0	2500	4300	drying beds	93.0	98.0	4650	4900
	Pig Farms - Drianovetz village:											
	Pid Farm - "Svinevadstvo"	1464	60.00	388.0	820.0	7320	12590	drying beds	272.0	287.0	4530	4780
	Pid Farm - "Furagen zawod"	430	17.00	114.0	241.0	2150	3998	drying beds	80.0	84.0	4710	4940
	Pid Farm - "SSB"	625	25.00	166.0	350.0	3125	5375	concrete settling tanks	116.0	123.0	4640	4920
	Private Pig Farms	250	10.00	66.0	140.0	1250	2150	a pit for each farm	46.0	49.0	4600	4900
	Cattle Farm - Kostandenetz village	1000	57.00	350.0	2700.0			drying beds	210.0	810.0	3680	1420
7.2.	Cherni Lom feeder											
	Pig Farm - Koshov village	5000	200.00	1325.0	2800.0	25000	43000		1325.0	2800.0	6630	14000
	Pig Farm "Lonovo"	30000	1200.00	7950.0	16800.0	150000	258000	treatment plant - 2 biol. parts			30	80
	Cattle Farm - Kardam town	150	6.00					drying beds				
7.3.	Malki Lom feeder											
	Poultry Farm - Lomtsi village	30000	1200.00					drying beds				
	Pig Farm "Zareevo"	4000	160.00	1060.0	2240.0			treatment plant - mech. part	742.0	560.0	4640	3500
	Pig Farm - Sadina village	200	7.00	46.0	98.0	875	1505		46.0	98.0	6570	14000
7.4.	Farms - Russe town:											
	Pig Farm - "Dolapite" r.q.	6250	250.00	1656.0	3500.0	31250	57750		1656.0	3500.0	6620	14000
	Pig Farm - "Sredna Kula" r.q.	10000	400.00	2650.0	5600.0	50000	86000		2650.0	5600.0	6630	14000
	Cattle Farm - "Sredna Kula" r.q.	550	32.00	330.0	2585.0	6050	39600		330.0	2585.0	10312	80781
	Pig Farm - Milk-processing factory	250	10.00	66.3	140.0	1250	2150	drying bed	39.8	42.0	3975	4200
	Pig Farm - "I. Dimitrov" Plant	200	8.00	53.0	112.0	1000	1720		53.0	112.0	6625	14000

Table 2.4.1. (cont'd)

1	2	3	4	5	6	7	8	9	10	11	12	13
8.	**Danube river - direct intflow**											
8.1.	Pig Farm - Guliantsi village	25000	1000.00	6625.0	14000.0	125000	215000	treatment plant - mech. part	4637.5	4200.0	4637	4200
8.2.	Pig Farm - Moreve village	6000	240.00	1590.0	3360.0	30000	51600		1590.0	3360.0	6625	14000
8.3.	Pig Farm - Brashlian village	35000	1400.00	9275.0	19600.0	175000	301000	treatment plant - mech. part	5565.0	5880.0	3975	4200
8.4.	Pig-reproducing Farm - Biala Rada village	20000	800.00	5300.0	11200.0	100000	172000	treatment plant - mech. part	3180.0	3360.0	3975	4200
8.5.	Pig Farm - G.Vrenovo village	20000	800.00	5300.0	11200.0	100000	172000	treatment plant - mech. part	3180.0	3360.0	3975	4200
8.6.	Pig Farm - Iudelnik village	20000	800.00	5300.0	11200.0	100000	172000	treatment plant - mech. part	3180.0	3360.0	3975	4200
8.7.	Pig Farm - Srebarna village	25000	1000.00	6625.0	14000.0	125000	215000	treatment plant - mech. part	3975.0	4200.0	3975	4200
8.9.	Pig Farm - Popina village	15000	600.00	3975.0	8400.0	75000	129000	treatment plant - mech. part	2385.0	2520.0	3975	4200

3. Conclusions And Recommendations

3.1 Summary Conclusions On Conclusions And Trends

3.1.1 Water Quality And Its Impacts

As it was already mentioned for the big quantities of available water the water quality is of great importance.

The content of oil products, ammonia, heavy metals, chemical and biological polluters in the water requires treatment before its use for drinking water and irrigation.

The ground waters of the Danube River terrace are polluted also with ammonia, manganese and ferrous. A tendency is observed the concentration of the polluters to be increased. The above said shows that the ground waters can not be used without proper treatment also.

3.1.2. Water Quality and Emissions Monitoring and Control

The Bulgarian streams are classified according to the water quality into four classes:

First class - water meeting the drinking water requirements; waters to be used as source for water supply of settlements and for the Food and other industries.

Second class - waters meeting the requirements for agricultural uses, for water sport complexes, for cultural needs and fish-farming.

Third class - waters meeting the requirements for irrigation and industrial water supply.

Fourth class - highly polluted waters good for water transport only.

Instruction No 7 of the Ministry of Environment issued in 1986 regulates the maximal permissible concentration of different substances by minimal design water inflow in the water facilities. For retained waters and sea water there are not yet Bulgarian standards for maximal permissible concentrations of polluting substances. With a fair approach to accuracy for the retained waters the existing standards for flowing waters could be used until the needed standards are approved.

The periodicity of the observations and control of the surface waters is defined by the daily, weekly, seasonal and annual alteration of the indices.

Control is spread over 15 nos main river valleys: Ogosta, Iantra, Iskar, Vit, Osam, Russenski Lom, Provadeeska, Kamchia, Aitoska, Veleka, Tundja, Maritsa, Arda, Mesta and Struma. Special control, as required by the international regulations for the countries along Danube River, is performed over Danube River. The controlled river valleys cover 93.4% of the water quantities of the rivers and 79.3% from the whole area of the country, which makes their characteristics reliable.

The locations of the control stations for the surface waters are chosen taking into consideration the following requirements:

- to offer possibility to determine the influence of antropogenic activity over the water conditions and its alteration due in the course of time.
- to offer possibility to ascertain each substantial alteration of the surface water quality due to the discharge of pollution substances in retaining facilities and to determine the cause of the alteration.
- to carry out control over the main pollution sources and the effective operation of the treatment facilities.
- the distances between the control stations has to catch each substantial alteration of the water quality and give the possibility to determine the pollution sources.
- the different pollution sources have to be controlled according to their specific characteristics.

The surface water control stations network at present includes 150 nos control stations. Additional information for the water quality is collected from 5200 nos pollution sources which are controlled once per year.

The controlled indices of the surface water quality at this stage are as follows: water quantity, water temperature, active reaction, electric conductivity, hydrogen sulfide, soluble and insoluble substances, soluble oxygen, ferrous, manganese, nitrogen (ammonia), phosphates, BOD, COD, lead etc.

Quarterly data for the state of the surface waters is published in the bulletin issued by the Ministry of Environment. The control network has 21 nos control stations on Danube River and 88 nos stations on its tributaries. In connection with the Bucharest Declaration, in its part for the water quality control, Bulgaria and Rumania carry out joint control at the two border settlements Novo Selo and Silistra.

3.1.3 Emissions And Dischargers

The emissions and the dischargers are listed in the annexes NoNo 16 and 17.

3.1.4 Key Difficulties

The main problem and difficulties for the effective utilization of the Danube River waters is the quality of the Danube River water as well as the quality of the ground waters of its terrace.

Additionally to the above said the following difficulties should be mentioned also:

- the constructed water supply systems shall be supplied with the needed treatment plants. The needed capital investments for the construction, operation and maintenance of the treatment plant are not available.
- the already constructed treatment plants have to be reconstructed, new up-to-date technologies have to be implemented to follow the changes of the water quality of the Danube River.
- uncertainty in the water quality which is envisaged to supply the settlements, the industry and to be used for irrigation because of continuous change of the quality of the water of the Danube River.

3.2 Recommendations

3.2.1 Pollution Management Actions Needed

At present the economic development of Bulgaria is carried out without taking into consideration the negative effect which the antropogenic activity exerts on the environment. The ecological requirements have to be included in the criteria to achieve a stable economic development. The influence of the economy upon the environment depends on many factors. Leading part has the economic structure, the standard of the productive forces, the degree of utilization of the natural resources and the pollution of the environment. The above said requires to develop purposeful ecological policy which in its strategic plan shall ensure an ecological and stable economic development.

It is necessary the structure of the economy to be developed by taking into consideration the ecological requirements as follows:

- to restrict the rate of development of coal and ore output
- to reach a new correlation between the production and processing industries
- to close down some inefficient productions.

The above said shall reduce the antropogenic influence over the national economy.

- it is needed to improve the legal and the economic regulators to utilize the natural resources in the conditions of open market.

- introducing a new economic system of taxes and sanctions which shall ensure the needed funds to finance the activities in the field of protecting the environment in the conditions of open market.
- preparation and development of new laws and regulations and amendment of laws in force at present, according to a Program
- preparation and standardization of laws and instructions now in force up to the end of 1992. The amendments have to meet the requirements of European community (requirements for water quality of the main water sources, standards for the water quality of the surface, flowing, ground and retained waters; permissible content of harmful substances in the waste waters of industries)
- to ensure effective control over the design works as well as over the operation and maintenance of the treatment plants.
- information systems have to be established for the management, utilization and protection of the environment. The information shall be used to have at any time correct data on the conditions of the environment, to make analyses and evaluation, develop long-term programs on regional and national level.

3.2.2 High Priority Pollution Reduction Improvements Needed

3.2.2.1 Without Investments.

- Urgent adoption of the Environment Law and the Water Utilization Regulations;
- Strong system of strict sanctions against polluters and financial stimulations for pollution decrease below the norms.
- Implementation of tax for the use of natural water resources and discharge of waste waters in the natural water courses which shall be used to raise a national fund for the need of drinking water supply, sewerage systems and waste waters treatment.
- Structural improvement of the management and the use of the water resources.
- Improvement of water pollution control by the regional services of the Ministry of Environment and involvement of the industries in the chemical analyses.
- Control and decrease of the use of fertilizers.

3.2.2.2 Investments Planned by the Government.

At present, Bulgaria is in a period of transition from centrally planned economy to an open competitive market.

The state industry, which represents 95% of the whole, operates inefficiently, makes almost no profit and is not able to ensure depreciation allowances to the state budget. In some cases the national factories are state aided.

- the investments planned by the government are insignificant because of the lack of finance.
- investments planned by municipalities are insignificant also by the same reason.
- attempts are made to implement a new form of construction of water supply and sewage facilities, as well as for treatment plants by accumulating share funds for investments from the users of the facilities.

From the above said it is evident that the budget has no possibilities to ensure the needed investments for treatment of waste waters and drinking water supply.
It is evident that investments should be sought from other sources to achieve the following objectives:

- introducing less water consuming and dry technologies.
- maximal use of wastes from food and canning industries, animal waste and solid wastes.
- improvement of existing and implementation of new technologies, meeting the requirements of the Environment law.
- training of pollution control officials and provide the pollution control stations with up-to-date equipment.
- reducing water consumption for irrigation by introducing up-to-date technologies - as sprinkling and water-drop irrigation.

3.2.2.3 Evaluation of pollution components.

- inventory of the pollution sources emissions.
- inventory of the potential sources of accidental pollution and the risk assessment of additional polluters.
- inventory of the industrial, municipal and dangerous solid wastes deposition sites near drinking water supply sources.
- working out models of the river basins with all the characteristics of pollution and use and defining the optimal variant from technical and financial point of view.
- defining the main tools for solving high priority ecological problems for selected river basins and regions (highly polluted by industrial polluters, feed lots and domestic waste waters).

3.2.2.4 Improving the control efficiency of treatment facilities in operation.

An additional step to ensure efficient control and management of the treatment facilities should be the installation of automated stations for water quality analyses in real time.

3.2.2.5 Improvement of the technological conditions and the level of discipline.

Priority measures should be taken in the Management Program to ensure the effect of all waste water treatment plants in operation:

- improvement of treatment plants operation to reach their designed capacity (Sofia, Vratsa, Veliko Tarnovo, Razgrad, Gabrovo).
- reconstruction, extension and implementation of up-to-date technologies in some existing town treatment plants - Varshetz, Samokov, Sofia, Vratsa, Botevgrad, Elin Pelin; factories treatment plants - Sugar Factory at Lom, Steel Factory at Kremikovtsi, Oil Refinery at Pleven, Antibiotic Factory at Razgrad and some smaller meat-canning and dairying factories; pig farms at Rogozen, at the town of Levski and some others.
- construction of additional collectors and sewers in towns with already constructed treatment plants as Samokov, Sofia, Gabrovo, Razgrad and some other.
- construction of some local treatment plants of factories polluting water sources and some sewerage networks of towns which have not treatment plant, yet.
- construction of waste waters treatment plants with priority to ensure reduction of pollution in most endangered regions as:
    - Ogosta river basin - Michailovgrad sewage treatment plant and treatment facilities for some big feed lots in the vicinity.
    - Iskar river basin - sewage treatment plants at Borovetz, Slivnitsa, Kostinbrod, Botevgrad, Etropole, Mezdra, Tcherven Briag and Kneja.
    - Vit river basin - sewage treatment plant at the town of Teteven.
    - Osam river basin - sewage treatment plants at the towns Troian and Lovetch.
    - Iantra river basin - sewage treatment plants at the towns Triavna, Drianovo, Sevlievo, Pavlikeni, Gorna Oriahovitsa and Omurtag; treatment facilities for the pig farms - modular stations from 1000 up to 4000 animals (the farm of "Panaiot Volov" factory, the Biala railroad station farm and pig farms at the towns Russe, Liaskovetz, Paskalevetz, Samovodene, Polikraishte, Geran-Liaskovetz and the villages Resen, Keserevo and Bulgarsko Slivovo.)
    - Russenski Lom river basin - sewage treatment plant at Popovo; modular stations for private farms from 100 up to 1000 animals.

3.2.2.6 Treatment of waste waters.

The first priority is the construction of waste water treatment plants for the big settlements in the zones of drinking water supply sources and in the recreation areas. As Bulgaria is with scarce water resources and agriculture shall be developed with priority, the waste water treatment technology has to ensure the quality of treated water to meet the requirements of the irrigation.

The big towns usually are surrounded by vegetable gardens and it is recommended to reach the requirements for fresh consumed vegetables irrigation.

The following stages of water treatment are recommended:

- mechanical;
- biological;
- additional treatment to eliminate phosphorus, nitrogen and traces of oil products;
- treatment of sludges in methane tanks to obtain biogass;
- mechanical dehydration of the sludges and use of coagulants.
- the utilization of the treated sludges as a fertilizer in the agriculture in the case the heavy metals are eliminated.

Some bigger towns have a great number of galvanizing factories. It is more efficient to construct for all of them one pre-treatment plant for concentrated waste waters and get rid of the heavy metals before their entry in the municipal sewage system.

3.2.2.7 Treatment of natural waters for potable water use.

The technology of natural waters treatment to meet WHO's recommendations for potable water used in the stations in operation is mechanical treatment with or without coagulation, filtration and chlorination. In some special cases ozonizing is envisaged for drinking ground waters polluted with iron and manganese in the terrace of the Danube river.

3.2.2.8 Pollution reduction of the water sources by reducing the raw water demand.

A. Reconstruction of existing industrial factories and implementation of up-to-date technologies.

The priority reconstructions and the consequent change of the existing technology should be aimed at:

- optimal use of recycled water;
- implementation of technologies needing small water consumption;
- utilization of treated waste water for industrial needs. Specially the Steel Works at Kremikovtsi can reduce the raw water consumption up to 50% by implementing up-to-date technologies of production, reconstruction of the water supply system and reduction of leakages;
- the implementation of dry cleaning in the feed lots. The consumption of raw water could be reduced significantly and the manure shall be used as a fertilizer without treatment;

B. Modernization of Bulgarian agriculture.

The most spread technology of irrigation is by furrows which leads to a high raw water consumption with low efficiency and a substantial degradation of the soil structure.

Up to now the sprinkling irrigation was restricted but the reconstruction of almost all irrigated areas is envisaged. This process is hampered by lack of funds and the future privatization of the land use.

The water-drop technology is implemented as an experiment only.

C. Development of town facilities.

At present the water supply networks are constructed with asbestos-cement or steel pipes. In almost all towns the pipes are amortized. The pipeline losses in some drinking water supply networks are up to 50%. The quality of the sanitary equipments in the buildings is also unsatisfactory and is the cause of significant losses of drinking water. One of the basic handicaps of the water management in towns is the lack of home water-meters and the low cost of the drinking water. It is envisaged to use cement coated cast iron pipes for the construction of water supply networks and it shall be effective to organize their production in Bulgaria.

The sewage systems are not sufficient and can not cover the small towns and villages. A shortage of large diameter pipes and the lack of government funding hampers the extension of the sewage systems.

3.2.2.9 On Table 3.2.2.1 are indicated the high priority projects for execution

High Priority Projects for Execution

Table 3.2.2.1.

River Basin	Section of Critical Pollution	POLLUTER	High Priority Improvements for Execution
1	2	3	4
1. Ogosta River			
1.1.	Bukovetz river up to Micheilovgrad Dam	Ore-dressing plant at Chiprovtchi; Pollution with heavy metals	Up-to-date treatment plant
1.2.	Dubnika river - the place of the gorging into Leva river	Chemical factories at Vratsa and Stock-breeding farms at Vratsa	Construction of treatment plant
1.3	Skat river - downstream from village Saraevo	Paper Factory; Pollution with industrial waste waters Stock-breedin farms - organic pollution	Reconstruction and extension of existing Paper Factory treatment plant. Construction of local treatment plants for the farms
2. Iskar River			
2.1.	Downstream Samokov	Inefficient operation and maintenance of Samokov and Borovetz treatment plants	Reconstruction and extension of Samokov treatment plant. Construction of additional treatment plant in the region of Iaitseto for the waste waters of Borovetz
2.2.	Downstream of Novi Iskar	Inefficient operation and maintenance of Sofia and Kremikovtsi treatment plants Sofia treatment plant is overloaded	Extension of the sewage network in the western part of Sofia. Extension of Sofia treatment plant and implementation of uo-to-date technology. Improvement of the operation and ensuring high level maintenance.
2.3.	Malak Iskar river	Downstream Etropole; Pollution with heavy metals and organic one;	Construction of Etropole treatment plant. Improvement of operation and maintenance of local treatment plants
2.4.	Downstream Elisaina	Ore-dressing plant - pollution with SSM and heavy metals	Construction of treatment plant
3. Vit River			
3.1.	Vir river, downstream Dolna Mitropolia	Inefficient operation of the overloaded Pleven treatment plant. Pollution from Paper and Sugar factories and from waste waters of Stock-breeding farms	Construction of 6 nos main collectors and addotional sewers in Pleven. Construction of a treatment plant.

Table 3.2.2.1. (cont'd)

1	2	3	4
4. Osam River			
4.1.	Osam river, downstream Troian	Domestic and industrial waste waters.	Construction of Troian treatment plant. The local treatment plant of Chemical-Pharmaceutic Plant to be put in operation.
5. Iantra River			
5.1.	Iantra river downstream Gabrovo.	Gabrovo sewage network not comleted. Gabrovo treatment plant not operating with full capacity.	Completion of the construction of the sewage network - especially the collectors. The sedimentation section of Gabrovo treatment plant to be put in operation.
5.2.	Iantra river, downstream Gorna Orishovitsa	Inefficient operation of Veliko Turnovo treatment plant. Pollution of domestic and industrial waste waters of Gorna Orishovitsa and Lieskovetz.	Construction of the needed main collectors in Veliko Tarnovo and putting in operation its treatment plant with full capacity. Construction of one treatment plant for Gorna Orishovitsa and Lieskovetz. Modernization of the Sugar factory local treatment plant.
5.3.	Rossitsa river, downstream Sevlievo	Domestic and industrial waste waters of Sevlievo.	Construction of Sevlievo treatment plant.
5.4.	Rossitsa river, downstream Pavlikeni	Domestic and industrial waste waters of Pavlikeni	Construction of Pavlikeni treatment plant.
6. Russenski Lom River			
6.1.	Beli Lom river, downstream Razgrad	Inefficient operation of Razgrad treatment plant; Pollution with the waste waters from the Antibiotic Factory.	Reconstruction and extension of Razgrad treatment plant. Completion of the Antibiotic Factory treatment plant and putting it in operation.
6.2	Tcherni Lom river, downstream village Kardam	Domestic and industrial waste waters of Popovo	Construction of Popovo treatment plant.
6.3.	Russenski Lom river, downstream Russe	Pollution from domestic and industrial waste waters and of Stock-breeding farms.	Construction of local treatment plant.

3.2.3 Main Recommendations

3.2.3.1 Adoption by the Parliament and the Government the legal basis for an effective water quality protection and water resources management, in order to:

- Install administrative arrangements for a river basin management base on a regional financial independence.
- Establish fees for the use of surface and ground waters as a natural sources and for the discharge of waste waters in the natural water courses, sufficient to form special financial funds on a regional and on a national level for investment in the drinking water supply systems, the sewage systems and the waste water treatment plants.
- Adopt a set of norms, regulation and standards, harmonized with those of the European Community, for the rational use of water resources, the emission of pollutants, the water quality in the rivers, the lakes and the underground waters on the basis of the ecosystem approach.
- Establish fines for the infraction of the emission regulations, sufficiently high to represent an effective financial tool, which shall be accumulated in the funds on regional and national level for investments in water protection facilities.

3.2.3.2 Reduction of the consumption of natural raw water, by means of:

- Implementation of sprinkling technology of irrigation.
- Reconstruction of the water supply networks in towns, replacement of the asbestos-cement and steel pipes with cast iron pipes for the reduction of the losses in the network.
- Implementation of up-to-date low water consumption or dry technologies in the industries and the feed lots.
- Local production of domestic sanitary equipment of high quality.

3.2.3.3 Creation of the resources basis for the production of equipment for waste water treatment plants, for treatment of sludges, for the decrease of construction duration, for the production of chemicals by means of:

- Conversion of some of the military factories with high-tech equipment, possibilities for high quality production and qualified personnel.
- Joint-venture companies with foreign companies having considerable experience and good references.

3.2.3.4 Creation of a national center for training and post graduate specialization in water resources management, for drinking water supply system management, for efficient waste water treatment plant operation, for strong water quality control.

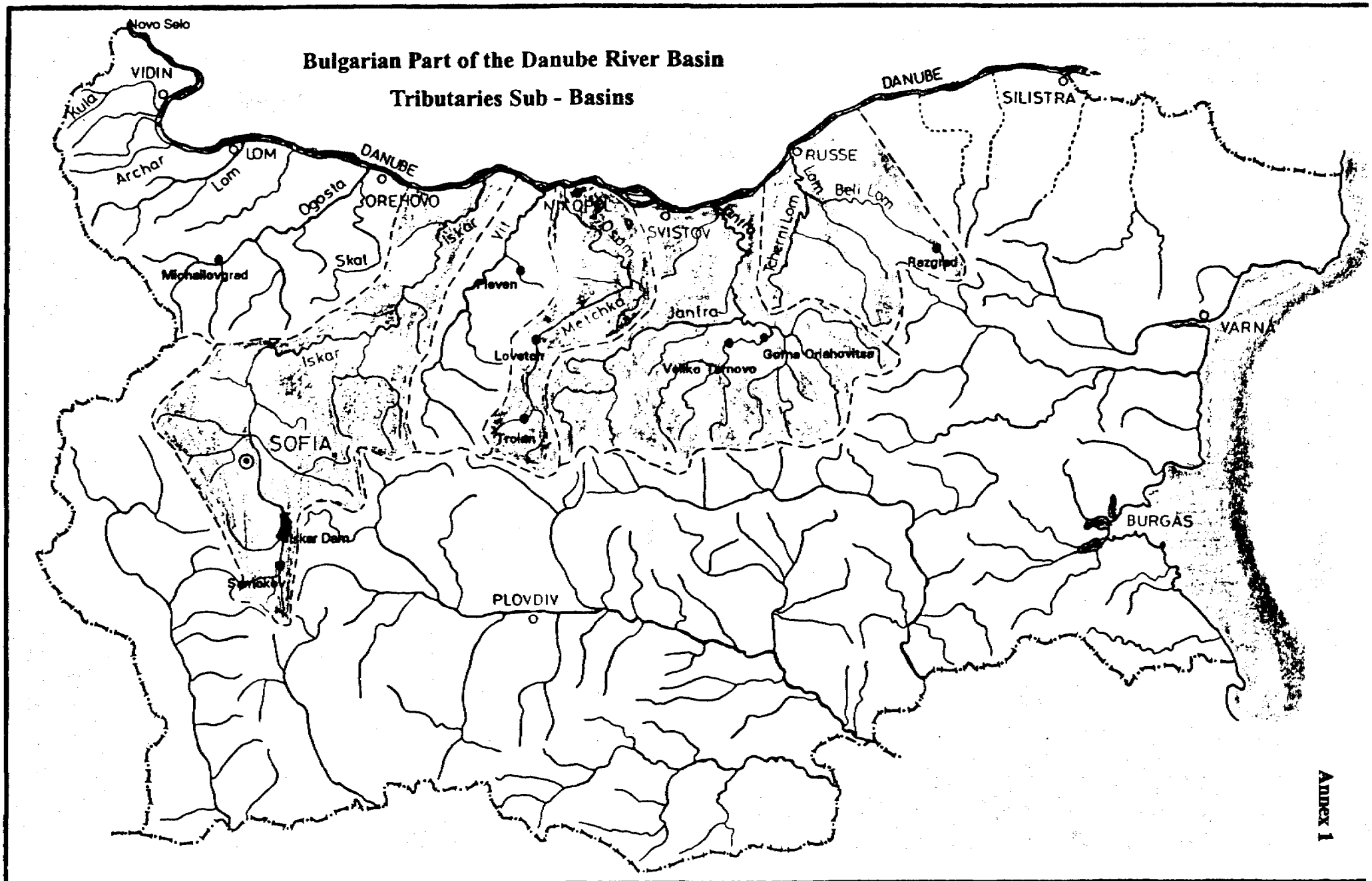
3.2.3.5 Implementation on a regional and national level of a strategy for reducing the quantity of the waste waters discharged in the natural water courses and to improve their quality, by means of:

- Introducing in the industries the recycling of the waste water and the use of treated waste waters for irrigation.
- Creating a local production of water-meters of all ranges and their installation for each user, both for the raw or drinking water supply and for the waste water.
- Reconstruction of the treatment plants in operation to achieve their designed effectiveness.
- Completion in priority the waste water treatment plants under construction.
- Determination by computer models the most polluted reaches of the rivers and the emissions with maximum influence on the water quality, in order to install there treatment facilities with an instant effect.
- Reduction of the use of chemical fertilizers in the agriculture and increase the use of manure from the breeding farms.
- Creation of up-to-date deposition sites for wastes, classified and separated by the kind of wastes, with treatment facilities for their drainage waters.

3.2.3.6. Construction Priority of Treatment Plants at Stage I

We propose treatment plants to be constructed in the following order:

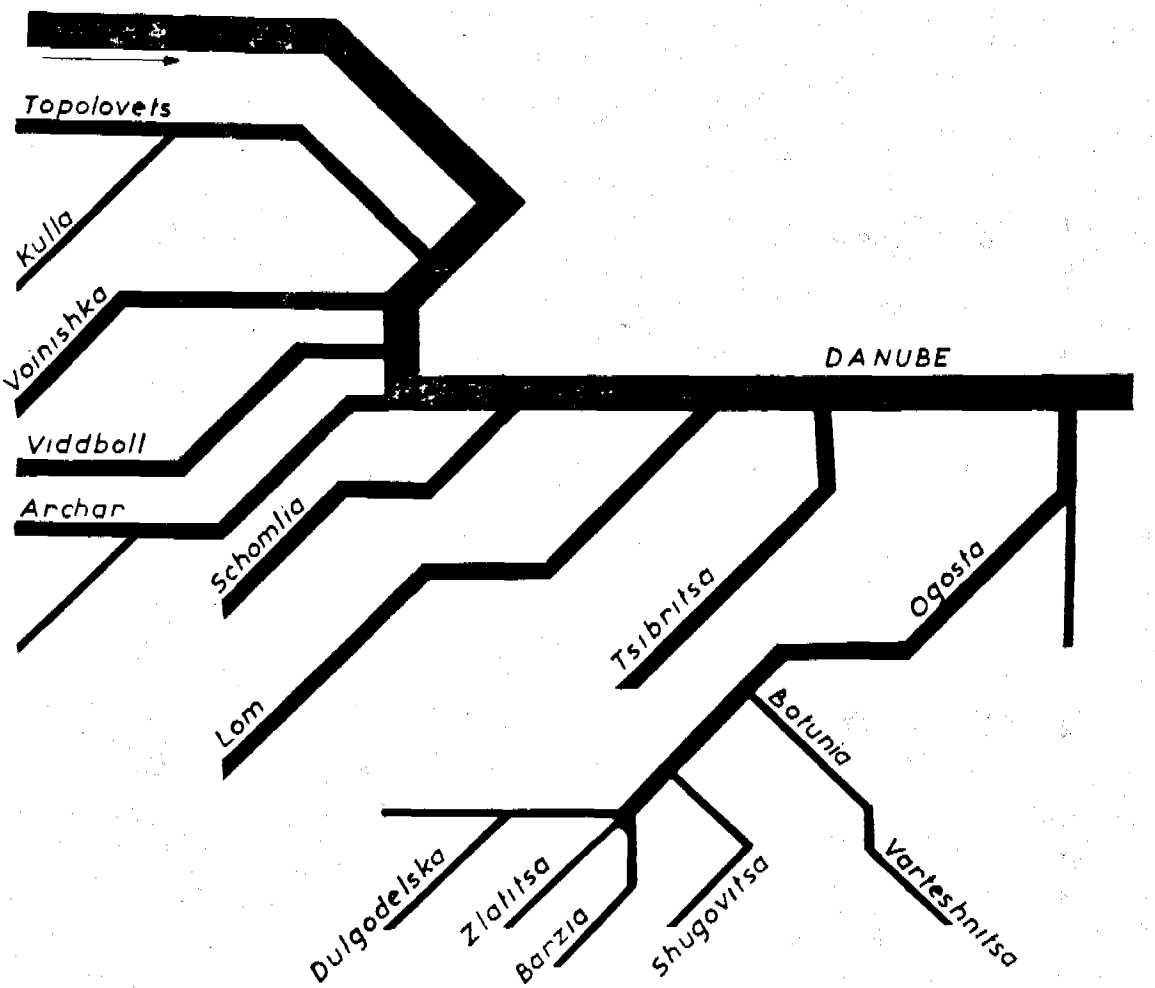
1. Sofia-Samokov Treatment Plant
2. Gorna Oriahovitsa Treatment Plant
3. Lovetch Treatment Plant
4. Trojan Treatment Plant
5. Michailovgrad Treatment Plant
6. Pleven Treatment Plant
7. Razgrad Treatment Plant
8. Veliko Turnovo Treatment Plant
9. Gabrovo Treatment Plant


Bulgarian Part of the Danube River Basin
Tributaries Sub - Basins
Novo Selo
VIDIN
Kula
Archar
Lom
LOM
DANUBE
Ogosta
OREHOVO
Skat
Iskar
Vit
NIKOPOL
Osam
SVISTOV
Yantra
Tcherni Lom
Lom
Beli Lom
RUSSE
SILISTRA
Rezgrad
Pleven
Melchka
Jantra
VARNA
Lovetch
Gorna Orlahovitsa
Veliko Tarnovo
Iskar
SOFIA
Troian
Iskar Dam
Sarlakov
PLOVDIV
BURGAS

Annex 1

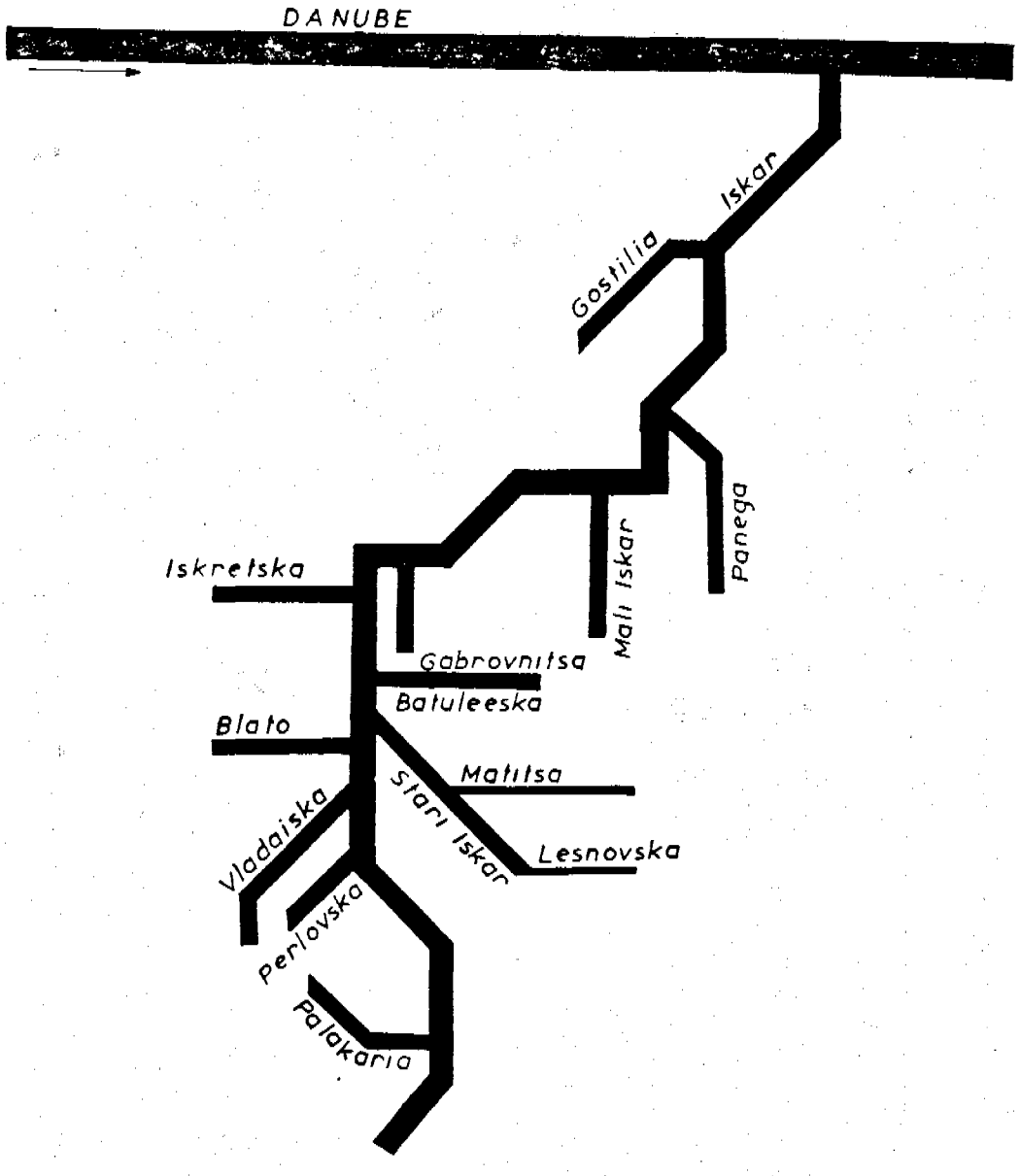
Annex 2

Ogosta River and N/W Small Rivers Basins



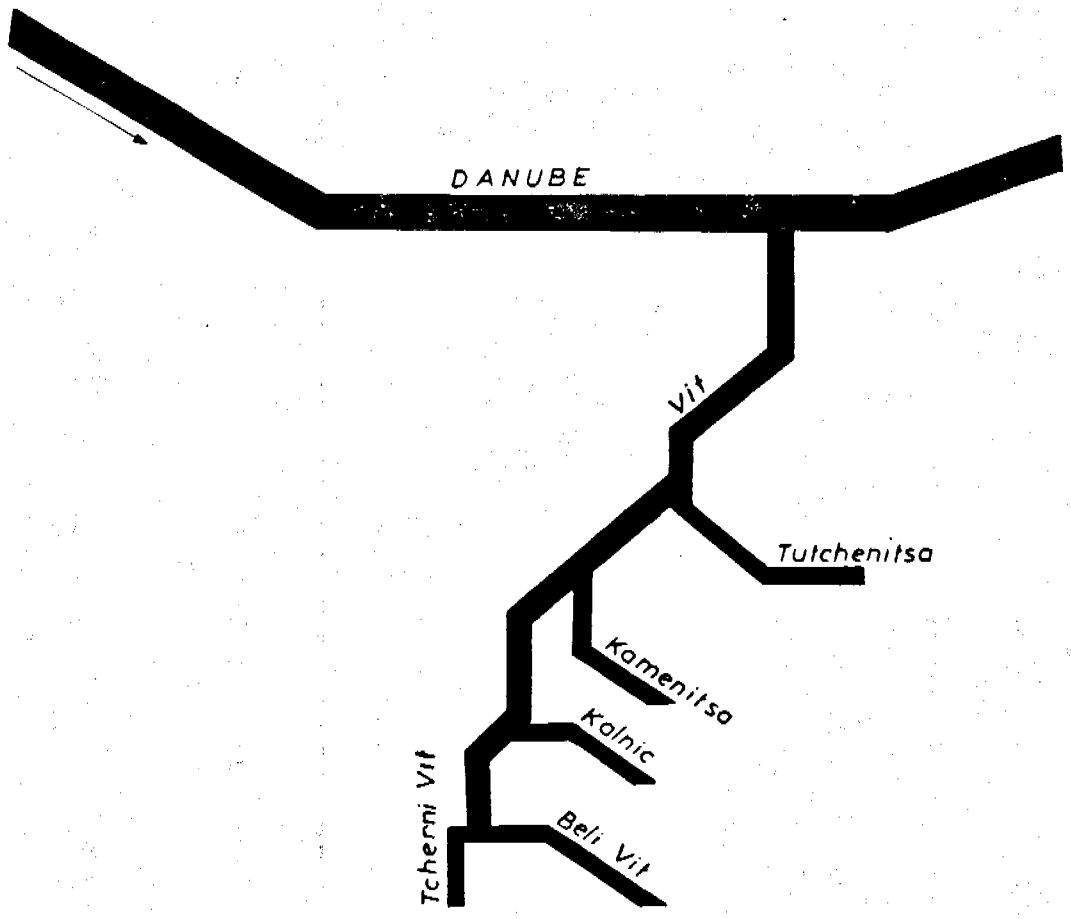
Annex 3

Iskar River Basin



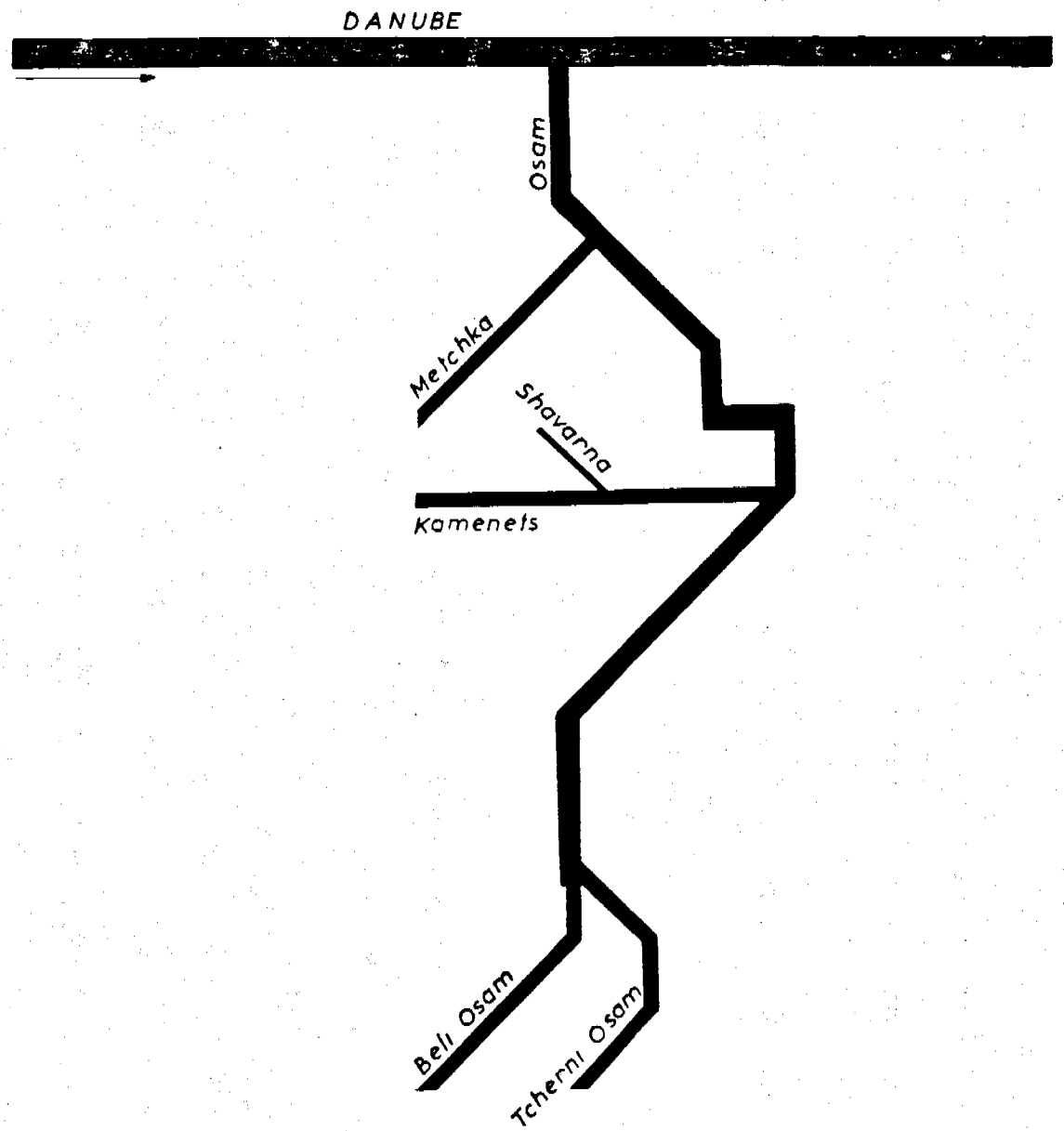
Annex 4

Vit River Basin



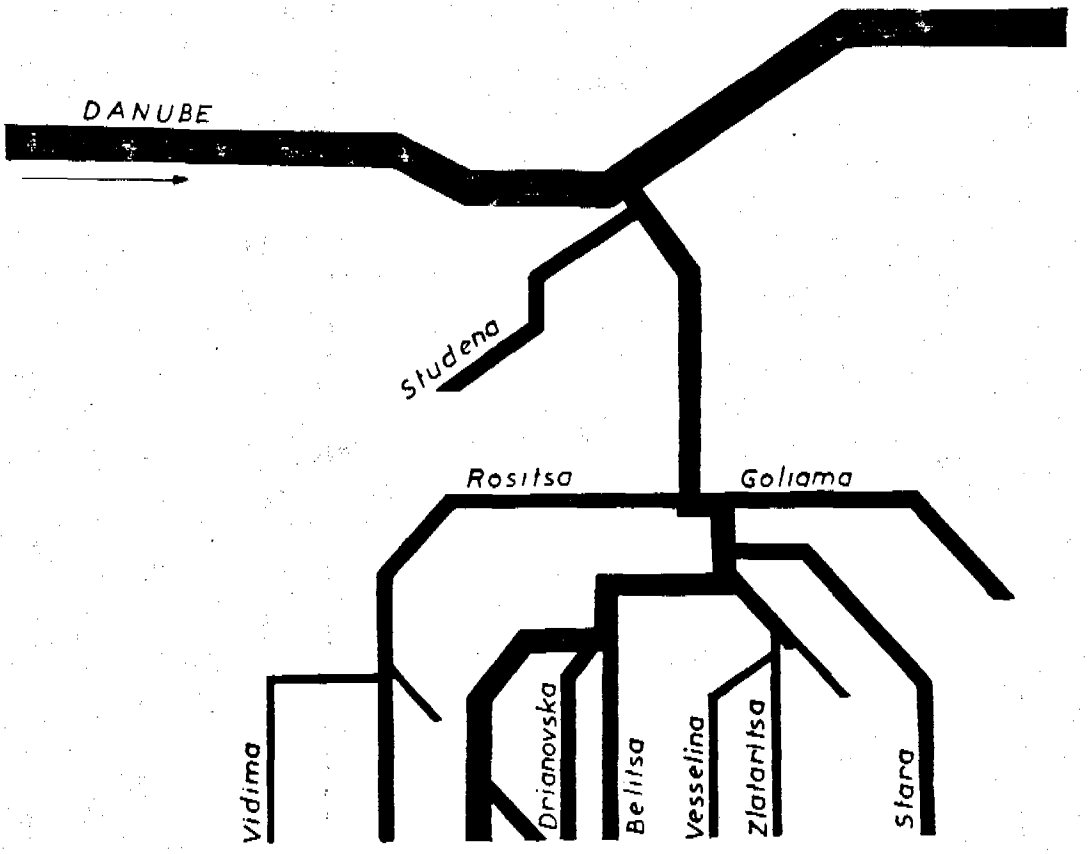
Annex 5

Osam River Basin



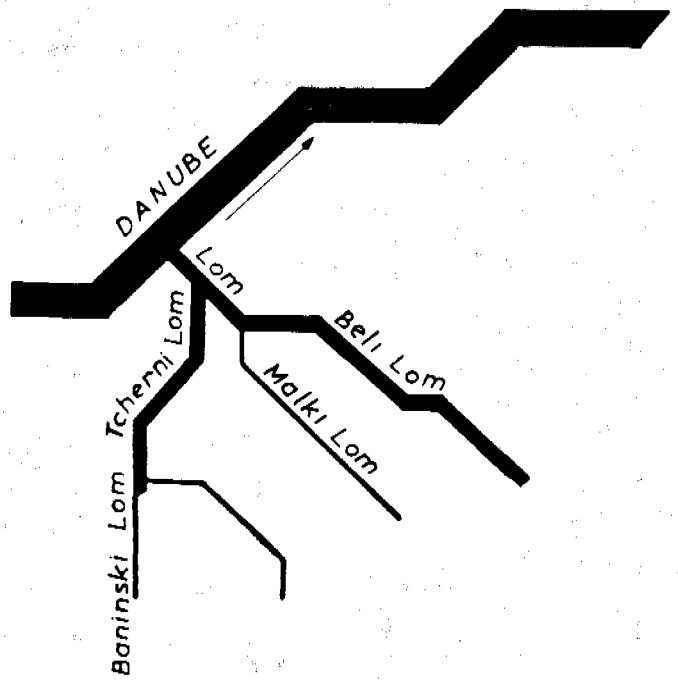
Annex 6

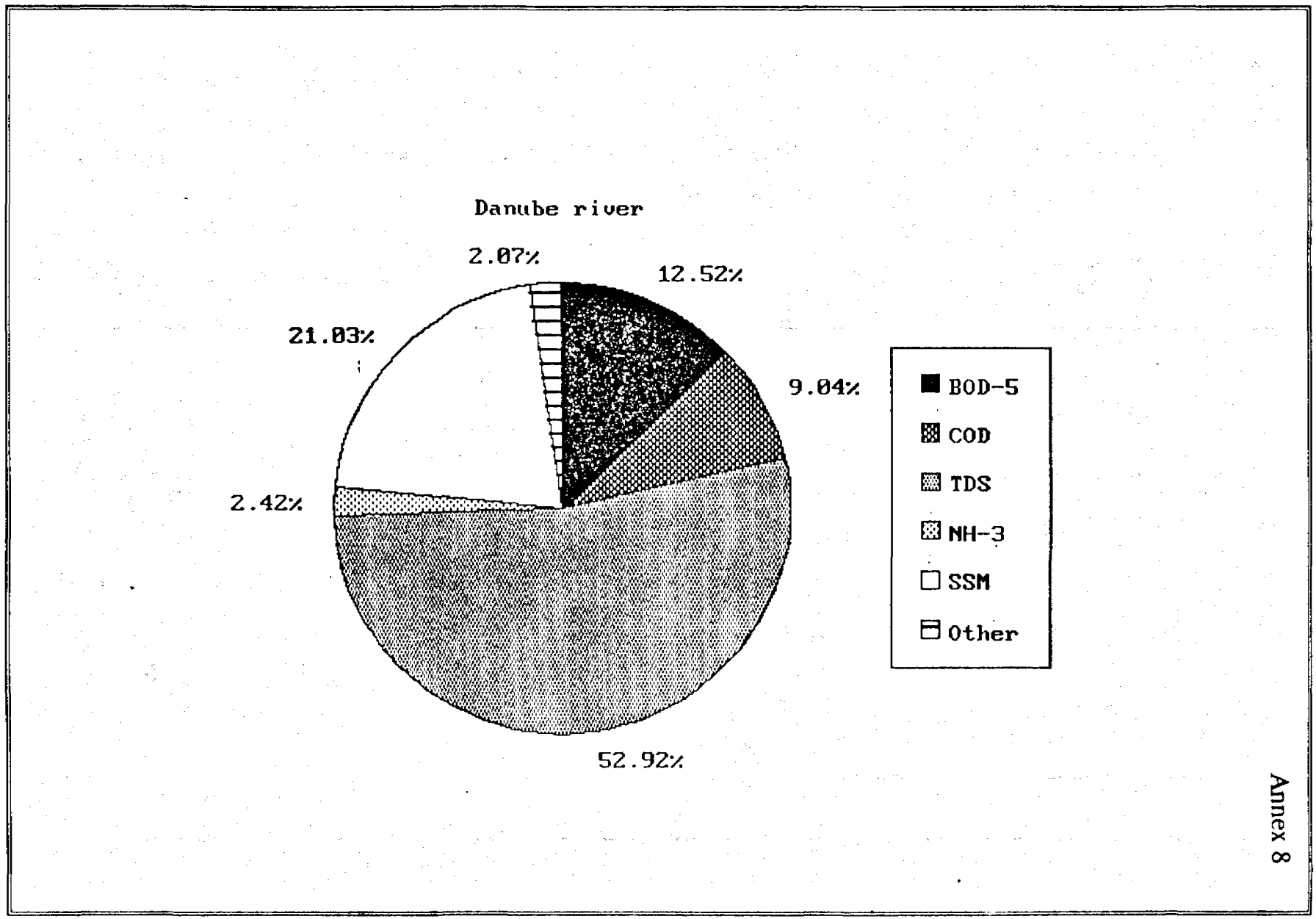
Iantra River Basin



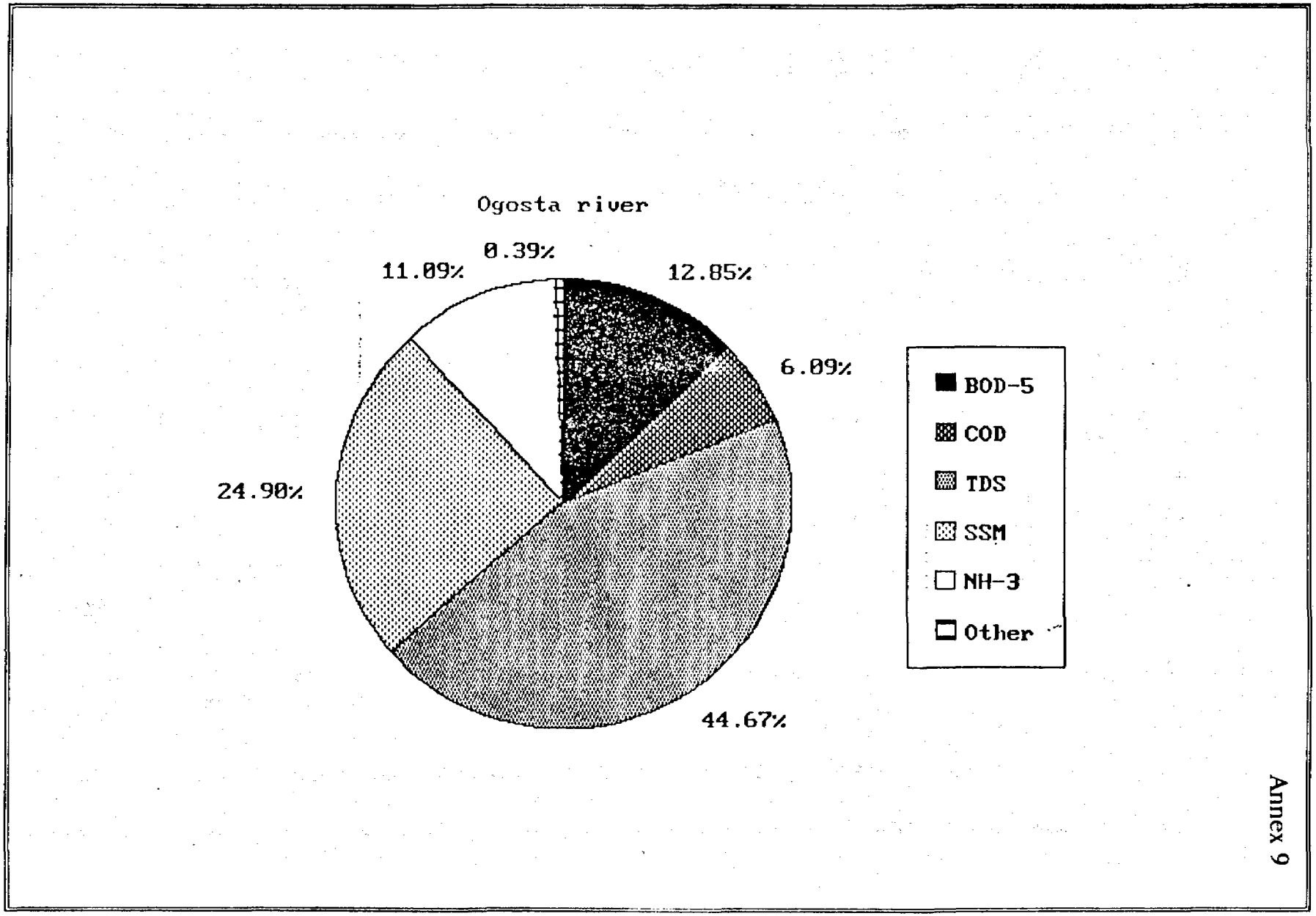
Annex 7

Russenski Lom River Basin

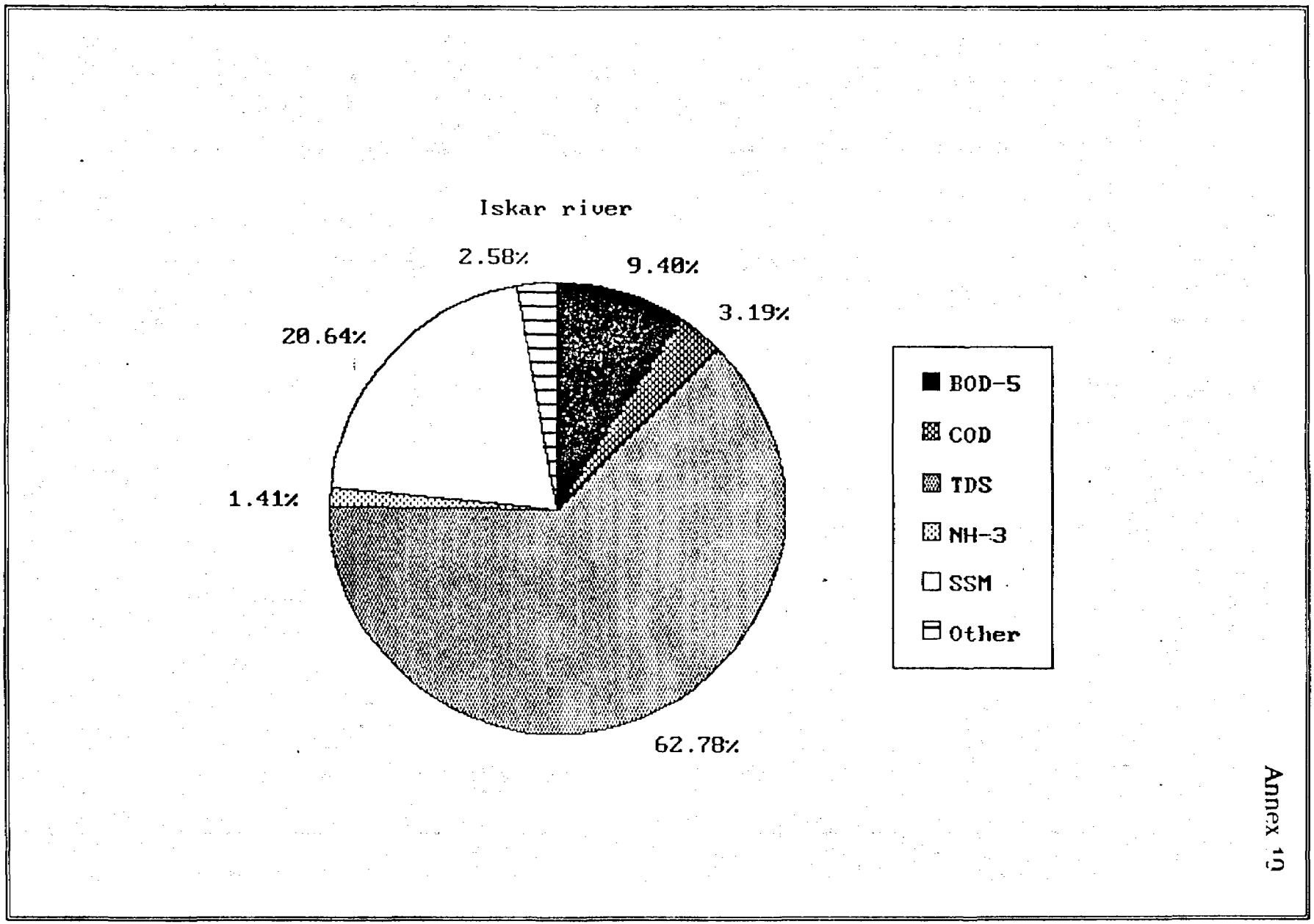



Danube river
2.07%
12.52%
21.03%
9.04%
2.42%
52.92%
BOD-5
COD
TDS
NH-3
SSM
Other

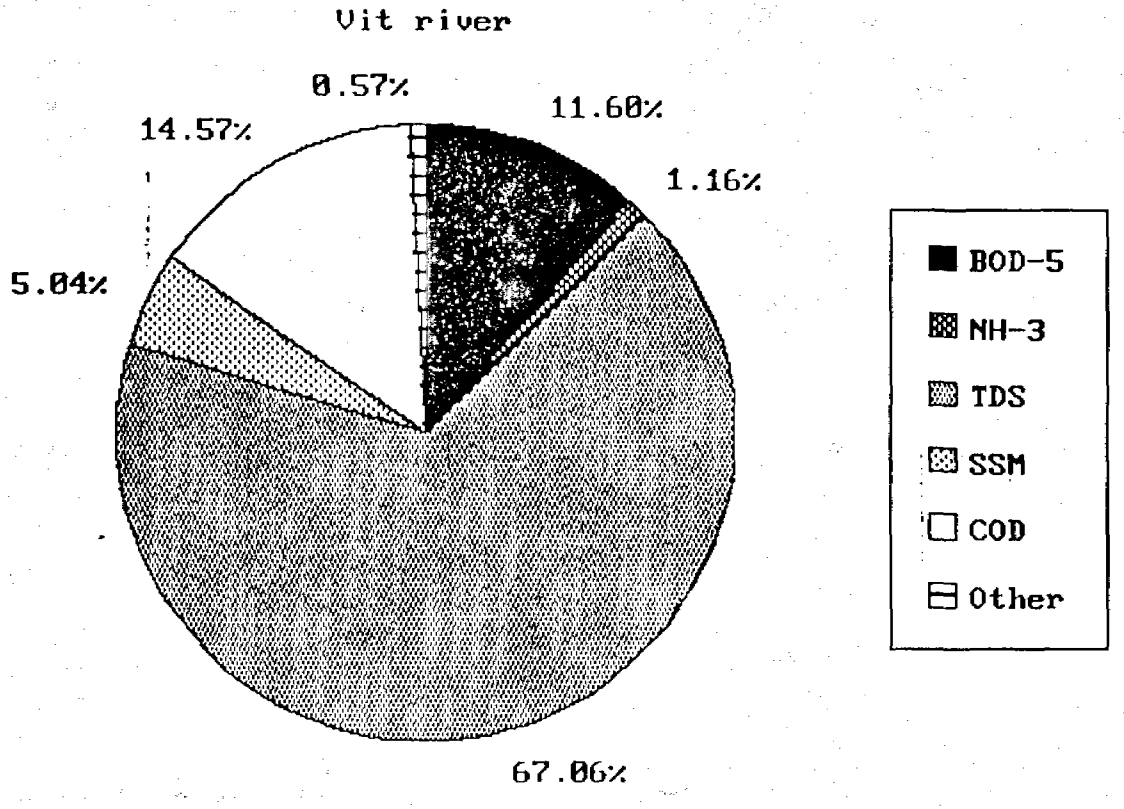
Annex 8


Ogosta river
0.39%
11.09%
12.85%
6.09%
24.90%
44.67%
BOD-5
COD
TDS
SSM
NH-3
Other

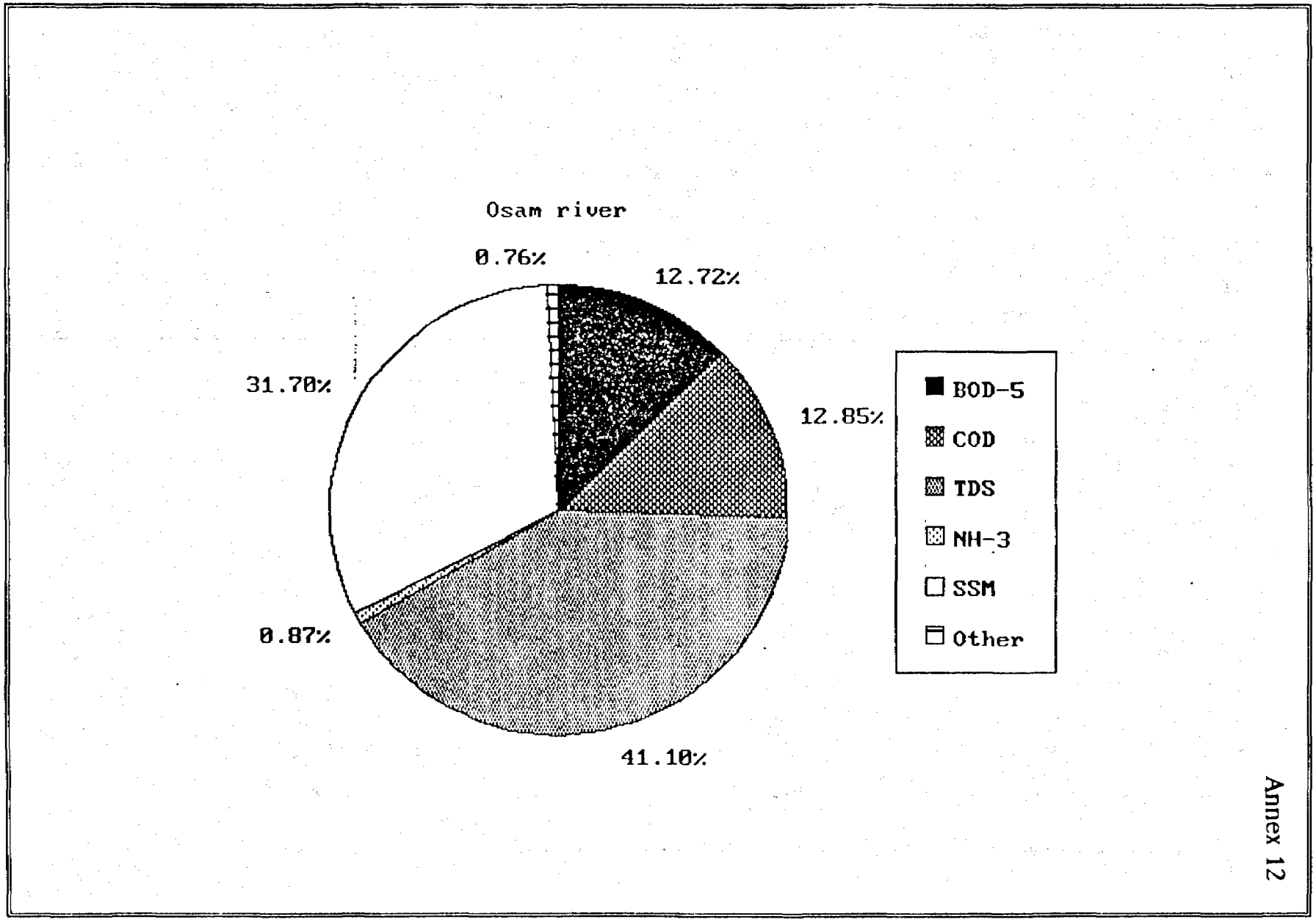
Annex 9


Iskar river
2.58%
9.40%
3.19%
20.64%
1.41%
62.78%
BOD-5
COD
TDS
NH-3
SSM
Other

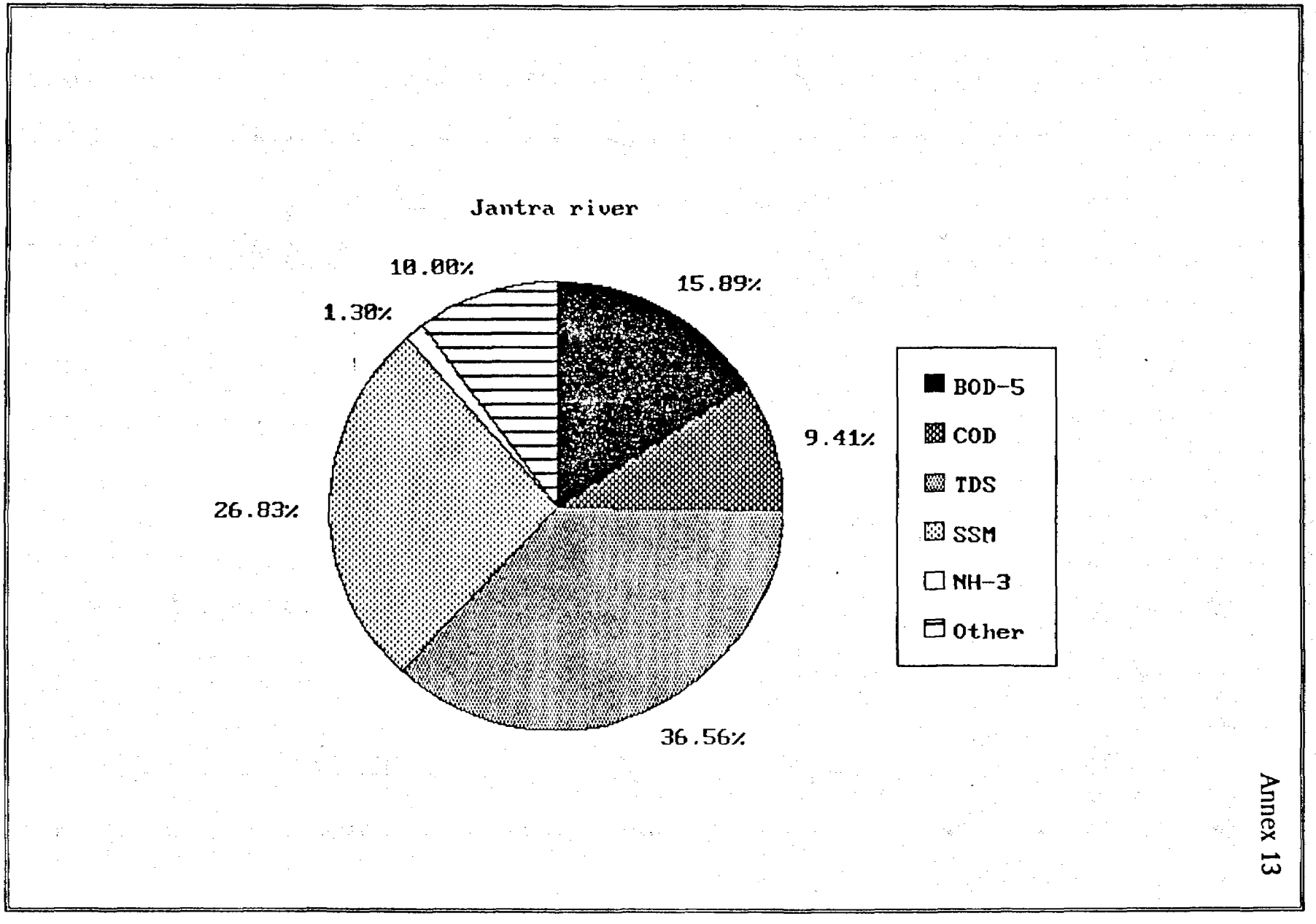
Annex 10


Vit river
0.57%
11.60%
14.57%
1.16%
5.04%
67.06%
BOD-5
NH-3
TDS
SSM
COD
Other

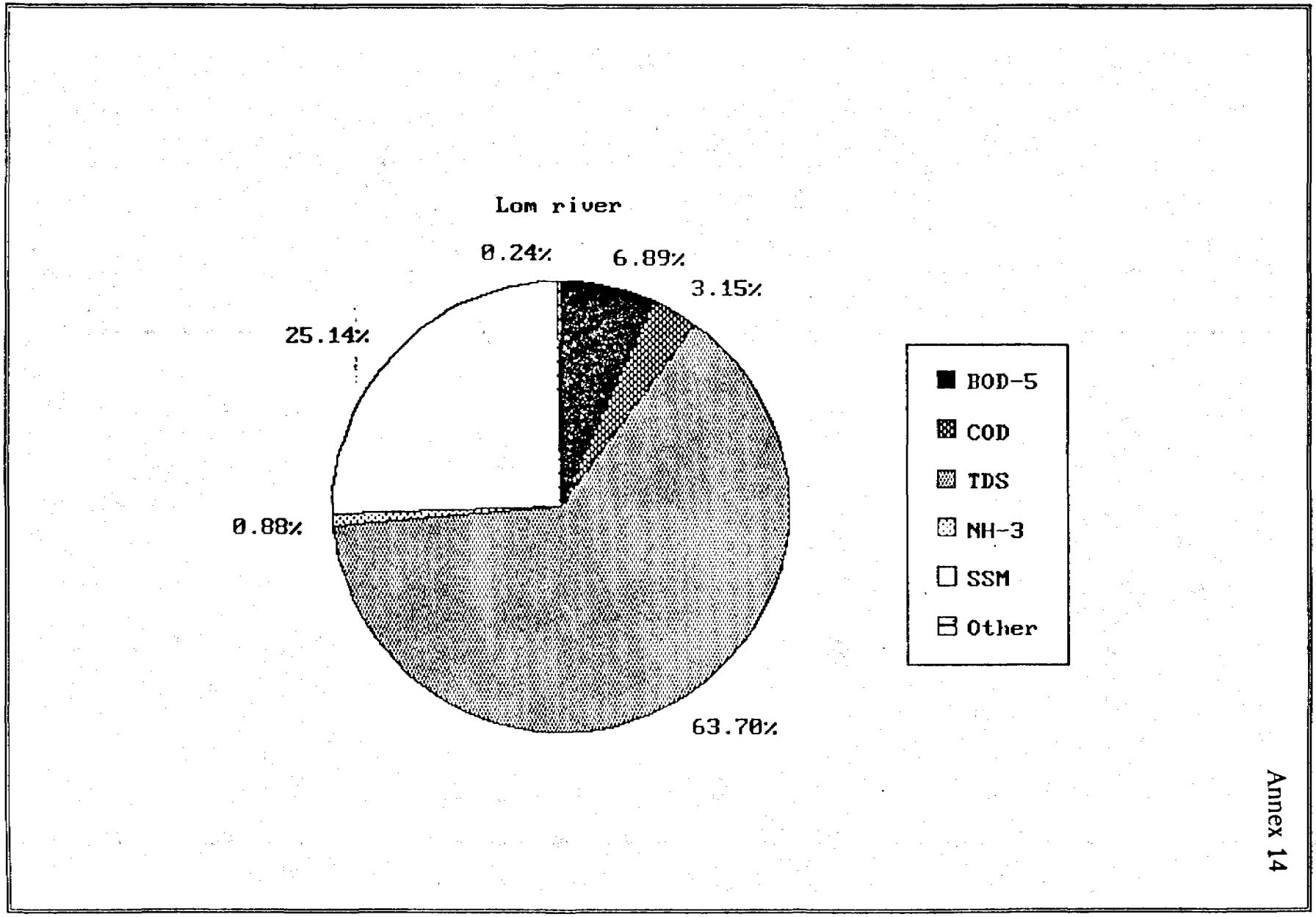
Annex 11


Osam river
0.76%
12.72%
31.70%
12.85%
0.87%
41.10%
BOD-5
COD
TDS
NH-3
SSM
Other

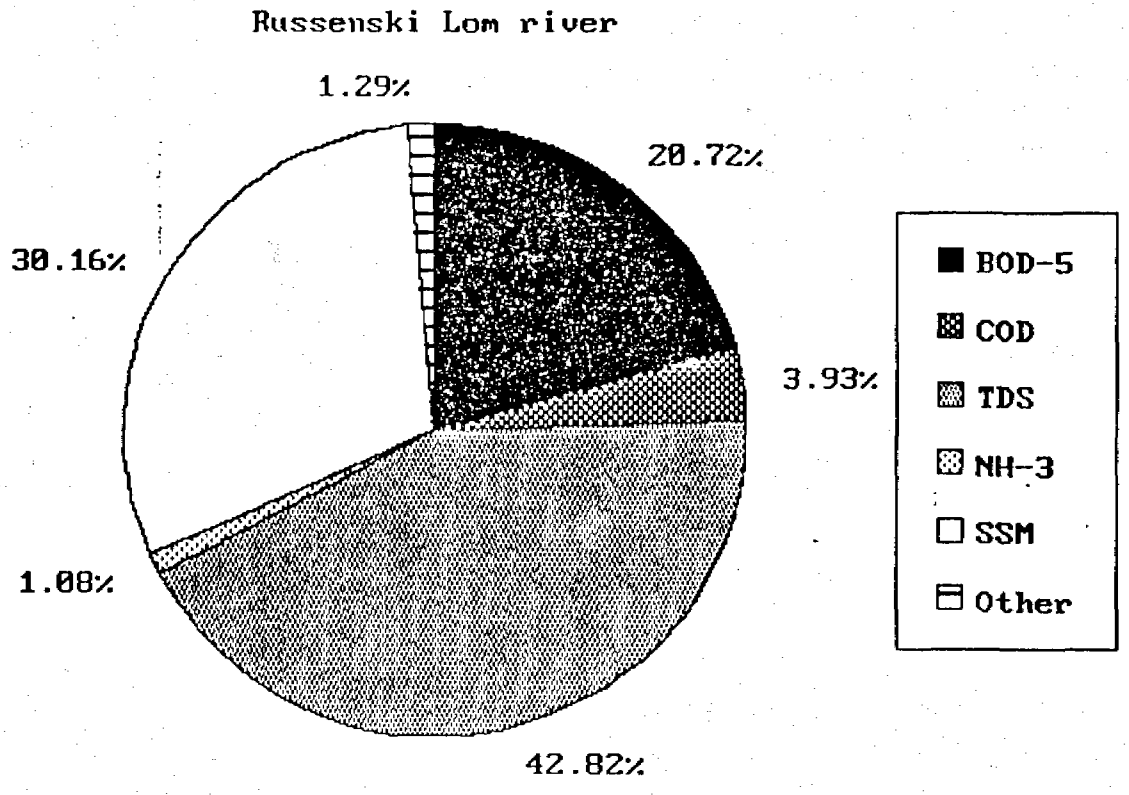
Annex 12


Jantra river
10.00%
15.89%
1.30%
9.41%
26.83%
36.56%
BOD-5
COD
TDS
SSM
NH-3
Other

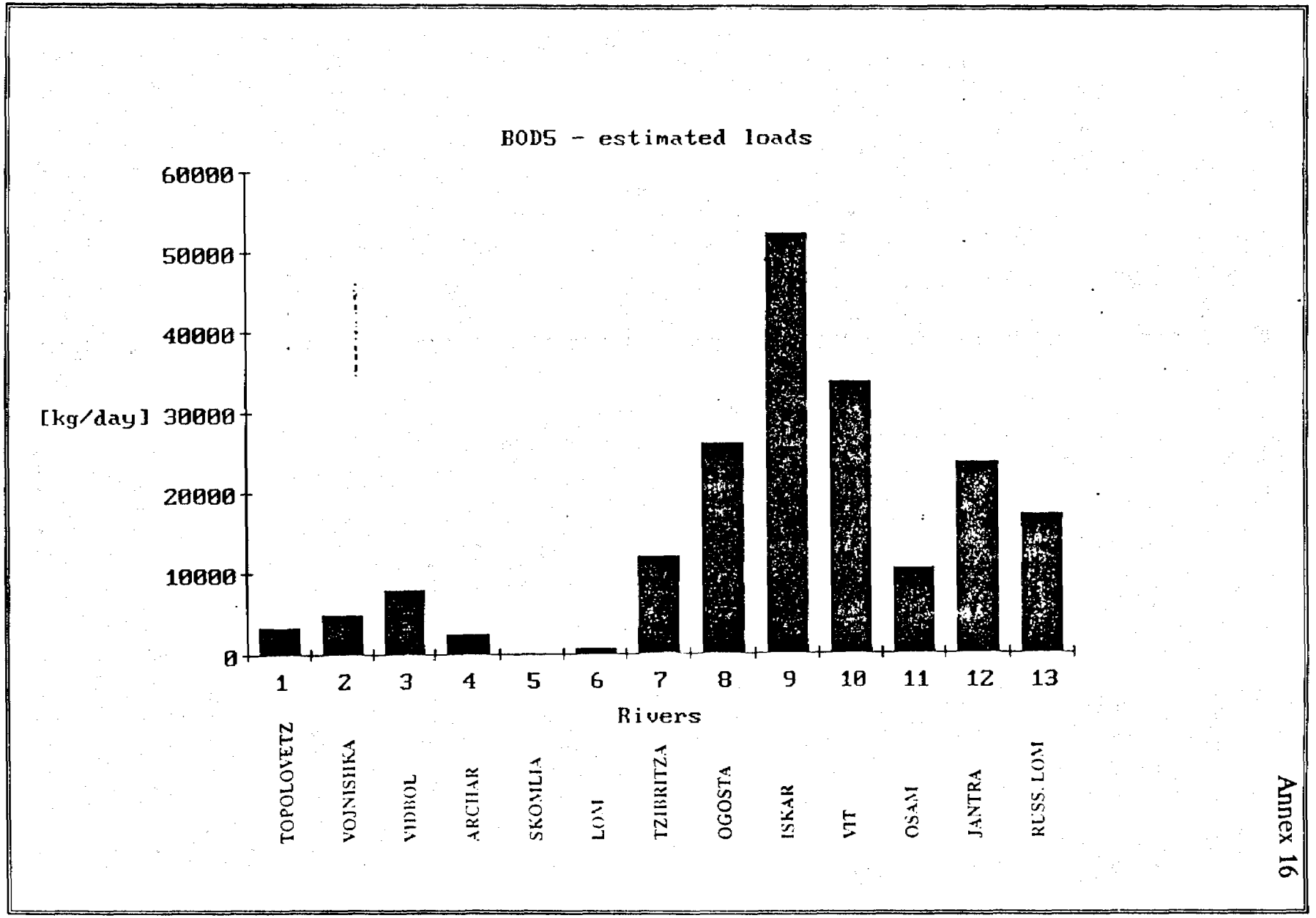
Annex 13



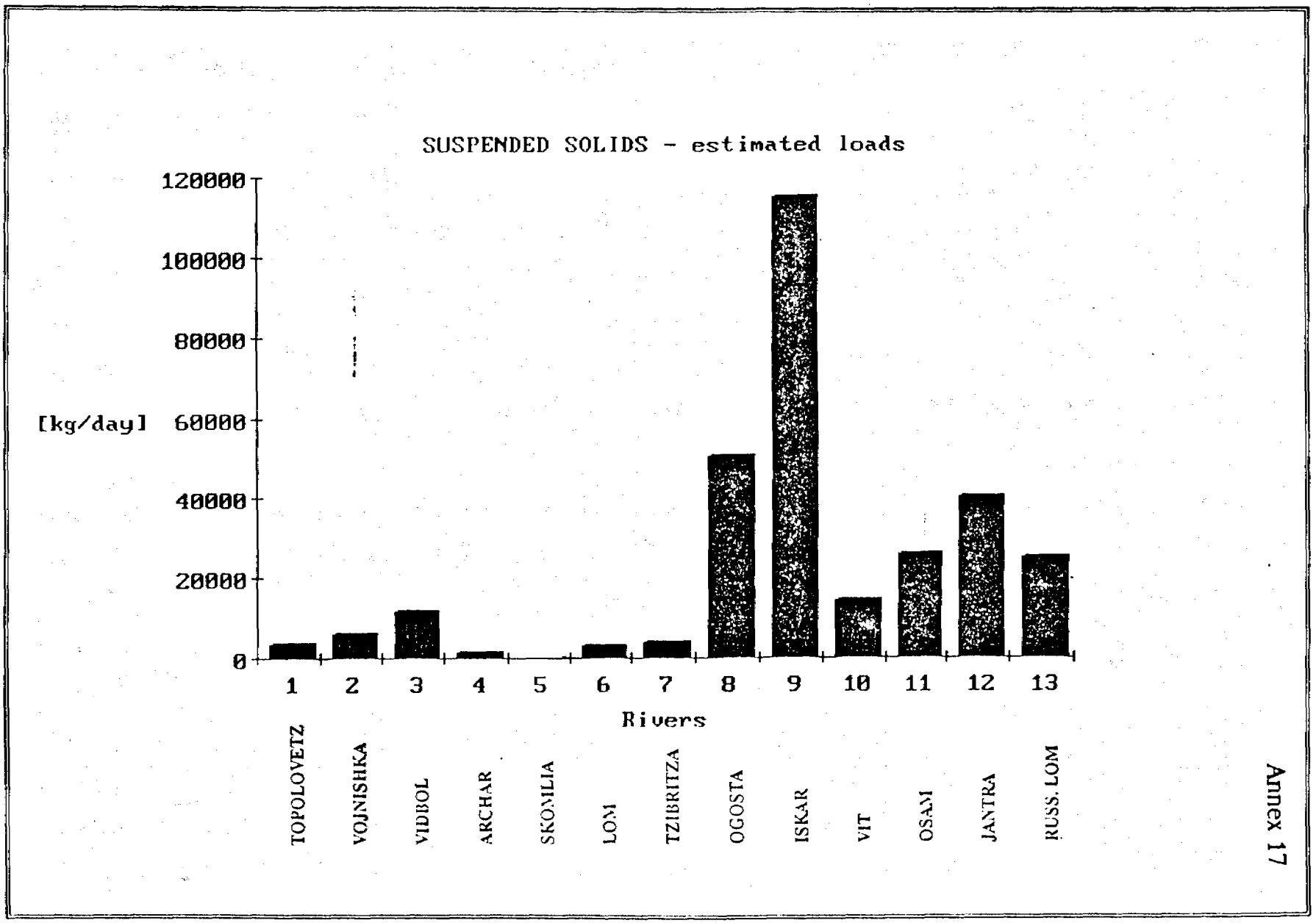
Annex 14


Russenski Lom river
1.29%
20.72%
30.16%
3.93%
1.08%
42.82%
BOD-5
COD
TDS
NH-3
SSM
Other

Annex 15


BOD5 - estimated loads
60000
50000
40000
[kg/day] 30000
20000
10000
0
1
2
3
4
5
6
7
8
9
10
11
12
13
Rivers
TOPOLOVETZ
VOJNISHKA
VIDBOL
ARCHAR
SKOMLIA
LOM
TZIBRITZA
OGOSTA
ISKAR
VIT
OSAM
JANTRA
RUSS. LOM

Annex 16


SUSPENDED SOLIDS - estimated loads
120000
100000
80000
60000
40000
20000
0
[kg/day]
1
2
3
4
5
6
7
8
9
10
11
12
13
Rivers
TOPOLOVETZ
VOJNISHKA
VIDBOL
ARCHAR
SKOMLIA
LOM
TZIBRITZA
OGOSTA
ISKAR
VIT
OSAM
JANTRA
RUSS. LOM

Annex 17

C.S.F.R.

CZECH AND SLOVAK FEDERAL REPUBLIC

TECHNICAL REPORT

PART I: SLOVAKIA

TECHNICAL REPORT

Water and Sanitation for Health Project

DANUBE RIVER STUDY

for the Slovak water catchment area

1992

CONTENT

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1. ASSESSMENT OF WATER POLLUTION IN PART OF THE DANUBE RIVER BASIN

The prevailing part of the Slovak territory, covering an area of 47 061 km2, belongs to the Danube river basin. See Fig. 1. In addition to the proper interbasin of the river Danube on our territory there are also other contributory sub-catchments of the rivers Morava, Vah, Nitra, Hron, Ipel, Slana, Bodrog, and Hornad. They are illustrated in Fig. 2. Tab. 1 shows the basic characteristics of respective river basins. The average annual runoff from the territory amounts to 11. 956 million m3 of water.

The main part of the Danube basin is on the left side of our territory, and only a small part lays on the right side. The Danube flows to our territory from Germany and Austria. The present Danube is formed by the confluence of two streams, the Grigach and Grag, originating in the Schwarzwald Mountains in Germany. The Danube flows through a reach of 2 857 km, the total drainage area being 817 000 km2. Its Slovak interbasin covers an area of 3165 km2, the length of the watercourse being 172 km. Downstream of Bratislava the Danube is separated into three branches. One of them, the Little Danube, branches north, forming the Little Danube Island, with an area of 1200 km2, and after about 100 km joining the main river again at Komarno.

Within the territory of the Danube basin occur the most abundant supplies of fresh groundwater not only in CSFR but also in central Europe. Thus, the Danube has an immense importance with respect to the protection of the environment and improvement of the quality of life. The groundwater supplies of the Little Danube Island, available for abstraction of drinking water, amount to 16-22 m3/s. It is a volume, which is continuously recharged by bank infiltration from the Danube river channel. During low discharges about 30 m3/s. groundwaters, at higher water levels it is up to 210 m3/s. The quality of the Danube water is even nowadays relatively good. Within the Danube river channel and its flood plain a system of islands had been created, being also an important resource of groundwater. The first municipal water supply system in Bratislava was constructed in 1886 on the Sihot Island and even at present about 1200 l/s of

good quality drinking water have been abstracted from this resource. The town Komarno is supplied in the same way.

The territory of the Danube island will experience a significant economic development. The industry has been concentrated chiefly in Bratislava, in a smaller extent in Komarno, Sturovo and Dunajska Streda. The territory represents the large agricultural region with a developed agricultural industry. A drainage canal network has been constructed, draining the internal waters of the Danube Island into the drainage pumping station (11 pumping stations).

1.1 Description of the river and its tributaries

1.1.1 The River Danube

The Danube enters our territory at the confluence with the river Morava at the Devin-Gate below Devin Castle (km 18888.2), and leaves it at the mouth of the river Ipel (km 1708,2). The main tributaries of the Danube on our territory - the rivers Morava, Vah, Hron and Ipel - will be evaluated separately in the following chapter. Also the tributaries Slana, Harnad, Bodva and Bodrog, have been evaluated. They spring on our territory, flow through it, but enter the Danube outside our territory.

The Danube forms the Austrian-Czechoslovak border on a reach 172 km long, its length in our territory is only 7.5 km. The catchment area is 3165 km2.

According to geomorphological conditions the river basin is divided into the flat-land section (the Danube Lowland), and mountainous section. The highest slope-from 0.4 to 0.35 o/oo-has been recorded from the fault gab through the Alpine-Carpathian flysh zone upstream of the Devin Gate down to Palkovicovo. Then the gradient decreases, at the mouth of the river Ipel being only 0.06 o/oo. The turning point occurs at Palkovicovo, where due to decreasing flow rate considerable sediment volumes are deposited causing formation of fords and ramifications. About 450.1003m3 of gravel and sand are deposited annually in this reach. The Danube has a large specific runoff rate (at Bratislava 15.61/s) due to its Alpine character upstream of Bratislava. The periodicity of

flood water occurrence is shown in the following table:

Tab. 2

	Flood water returning once in:					
	1	5	10	20	50	100
	years					
The Danube at Sturovo	4450	5900	6650	7400	8400	9100
	(in m3/s)					

The long-term average discharge of the Danube in the cross-section Bratislava is 1993 m3/s. and in Komarno 2290 m3/s. Fifty percent of the annual runoff volume occurs in the in the second half of the year, mostly in summer months. The maximum discharge fluctuation in Bratislava is 1:19, and in Komarno 1:13. The lowest discharges occur in winter months, the lowest discharge measured in Bratislava was 570 m3/s. (December 28th, 1948). Flood waters occur on the Danube regularly in the summer. The highest flood with a flow rate of 10,400 m3/s. was recorded in 1954 (July 15th, 1954).

The completion of the construction of water schemes on the Danube will change the hydrological features of the region, and the river channel itself.

The catchment of the Czecho-Slovak reach of the Danube represents an irreplaceable natural treasure. It provides abundant water resources of relatively good quality drinking water, irrigation water for large-area irrigation projects, and for agricultural production and also water for extensive industry. The Danube is our largest waterway. Though, it conveys annually tons of gravel and sand.

1.1.2 The major Danube tributaries in Slovakia

The Morava River

The catchment of the lower Morava on the Slovak territory covers an area of 2283 km2, the length being 114.0 km. The slope of the Morava is relatively even and small, about 0.3 o/oo, down

to the mouth 0.18 o/oo. Following tributaries join the Morava in Slovak territory: Chvojnica, Myjava, Rudava, Malina. The highest discharges occur usually in March, the lowest in June and September.

The reservoirs were constructed in this catchment (Kunov and Bukova), and 15 ponds.

The River Vah

The river Vah is the longest water course on the Slovak territory. The total length is 403 km, catchment area 11,625 km2 and the bottom slope about 4.5 o/oo. The Vah catchment has a prolonged shape and significant differences in height. The highest point is at the altitude 2494 m, the lowest at 107 m. The afforestation of the catchment amounts to 43%. Seventy-six gauging stations are in operation monitoring the water stages and measuring water discharges in the catchment. The Vah upstream of Zilina is completely trained, downstream of Zilina a cascade of water schemes - hydropower plants had been constructed. Fourteen reservoirs were built in the catchment.

The Nitra River

The drainage area of the Nitra is 5,144 km2, the water course length being 197.7 km, and the mean bottom slope 2.83 o/oo. The average annual discharge in the mouth is 25.0 m3/s. The month with the highest streamflow rate is March, and with the lowest one is September. There are 21 gauging stations in operation. The flood waters occur mostly in the spring. The highest flow rates were measured in February 1946, namely 145 m3/s.

The Hron River

The Hron springs at the altitude of 934m and enters into the Danube at 102.9 m. With respect to geomorphology the catchment is divided into the upper mountainous part, with a gradient of 7.6 o/oo, and the lowland part, with a slope of 0.9 o/oo. In its

lower reach the river has a flatland character.

The Ipel River

The drainage area of the Ipel is 5,151 km2, from which 3,649 km2 are in Slovak territory. The Ipel catchment contains the smallest resources of surface and groundwater. The flow rates are low and very unsteady. In its upper course the Ipel is a torrent stream, having a slope of 3.5-50 o/oo, though in the lowland it is only 1.8 o/oo.

The Slana River

The catchment of the Slana covers a total area of 11,900 km2, 3,181 km2 in Slovakia, with the area of the river Bodva catchment 920 km2. The length of the river down to the national border is 110 km. There are 19 gauging stations in operation for monitoring.

The Bodva River is a tributary of the Slana and their confluence is in Hungarian territory. A considerable part of the Bodva's catchment is situated in a region formed by limestone-karat layers, thus influencing the total water-bearing capacity, minimum discharges, and the whole regime of surface and ground waters.

The Hornad River

The Hornad issues in Slovakia and is 193 km long in our territory, with a catchment area of 4,403 km2. It leaves our country at the national border at an altitude of 160m. The Hornad flows in Hungary into the Slana and then into the Tisza river.

The catchment is characterized with considerable differences in height, the highest point being at the altitude 1946m. The afforestation of the basin is 45%. In the upper part of the basin are favorable slope conditions, in the lower part is a small longitudinal slope. The monitoring is performed by means of 27 gauging stations.

The Bodrog River

The Bodrog arises from the confluence of the Latorica, Ondava and Labrec rivers. The Bodrog extends for a length of about 16km in our country, then leaving it and entering the river Tisza in Hungary.

From the total catchment area of 11,356km2 only 7,217 km2 occur in Slovak territory. The river system of the Bodrog has a mighty fan shape, thus influencing unfavorably the flood water runoff. The height-zoning of the catchment is rather moderate. The tributaries Uh and Latorica convey to our territory 57 m3/s of water. The highest discharges occur in March, the lowest in September. Thirty-five gauging stations monitor the water stages.

1.2 Water quality of the Danube River

The quality of the Czechoslovak section of the Danube is formed mostly outside of our territory. According to the oxygen consumption this section falls into the Ist-IInd quality class. Though respective parameters show differences in the cross-section of the stream. It is natural due to the water bearing capacity of the Danube and the length of the course, needed for mixing of water, influenced by tributaries or discharges of wastewaters.

On the left side of the river bank upstream of Bratislava the effect of the Morava waters is visible, having higher mineralization, and during the campaign considerable pollution with sugar factory wastewaters. On the right river bank the effect of wastewaters from Vienna has been recorded. In recent years this effect is decreasing, the O2 concentrations and percentage of O2 saturation are more uniform, the average BOD5 and COD-Cr values are better. Over the section Hrusov-Komarno the water quality is steady, showing a lower percentage of O2 saturation - belonging mostly to the class II. In the shorter left side section downstream of Komarno the quality is deteriorating due to the effect of the Vah and of the wastewaters of the city of Komarno. Though, in Radvan the quality gets

stabilized again reaching the class I. A further local quality decreasing occurs at Sturova (south Slovakia Paper and Pulp Industry) to class II. The Danube water quality flowing to Hungary is again stabilized, as far as organic pollution is concerned, to Ist and IInd Class. According to the basic chemical composition pursuant the CSN 830602 the Danube is classified into III-IV class only with respect to its concentrations of solids. The other parameters of the group meet the conditions of the Ist class.

Considerable bacteriological contamination of the whole Czechoslovak Danube reach, indicated by coliform bacteria, falls steadily within the range of III and IV class. Petroleum products are also present permanently (sources outside our territory, Slovnaft, navigation, city of Bratislava). Specific contamination, monitored on a regular basis, represent phenols (within reach of Hrosov-Komarno II-III).

Significant sources of pollution on the Czechoslovak reach are: Bratislava, with the public sewerage system of the residential area Petrzalka without wastewater treatment, Istrochem (insufficient mechanical-chemical treatment of a broad range of polluting specific organic substances i wastewaters), Slovnaft with a very well operated chemical-biological wastewater treatment plant, municipalities Komarno and Sturova. For the Danube river, a water body of a high waterbearing capacity, the cities Komarno and Sturova are not of great importance with respect to the water quality regime. From the Hungarian territory flow into the Danube probably wastewaters from the petroleum industry Szony, bauxite industry Almasfuzio paper industry Labata, factory Viscoza in the complex Ostrihom (actual information are not available) (see Annex 2 and 3).

Owing to the importance of the whole Bratislava complex, the largest pollution producer, discharging into the receiving waters 9,800 tons BOD5 in 1990 (in addition to specific contaminants, present in wastewaters from extensive industrial production) it is urgent to complete the biological stage of the wastewater treatment plant in Istrochema, to decrease the contamination of cooling waters from Slovnaft (receiving stream the Little Danube), to interconnect all collectors of the left side part of

the residential area to the central wastewater treatment plant at Vrakuna (receiving stream the Little Danube) and last but not least to complete the construction of the wastewater treatment plant for the urban area Petrzalka.

The qualitative regime of the Danube calls for the extraordinary attention not only as an international water course, but also with regard to its prime role as the source of bank infiltration into groundwaters.

1.3 Water Quality of the Tributaries

The quality regime of the Slovak section of the Morava, continually influenced by pollution sources in Bohemia and Austria, together with left side tributaries, is unfavorable (III-IV class). Main pollution sources are situated on the tributaries of the Morava - residential agglomerations Myjava, Malacky and Senica, with dominant industrial-municipal pollution. The receiving stream, taking directly wastewaters from Senica - the brook Teplica - has the characteristics of a sewer. In spite of considered measures (new municipal wastewater treatment plant, reconstruction of the existing wastewater treatment plant in the factory Slovensky hodvah (Slovak silk), the water quality in the Teplica brook would not attain adequate water quality.

In the sub-basin of the Vah is decisive the effect of 10 industrial-residential regions, discharging chiefly organic pollution, from which the wastewaters discharged from Ruzomberok, Zilina, Trencin and Hlohovec, with the factory Slovlik (distillery) in Leopoldov, cause that about 50% of the monitored streams fall into the quality class III-IV. The worst water quality in the Vah was determined in the section Trencin-Nove Mesto n/Vahom (IV), and extremely contaminated are the tributaries of the lower Vah - the Trnavka, Dudvah, and Cierna Voda. In the last year a slight improvement of water quality had been recorded in the upper reach of the Vah, where the limitation of pollution from Ruzomberok and Zilina had a positive effect. The Vah upstream of Liptovsky Mikulas has an unfavorable quality falling into the Ist class. The municipality of Lipt. Mikulas has an unfavorable effect on the water reservoir Liptovska Mara

(2,406 tons of BOD5/year), though it does not influence the change in quality class (in the profile Liskova the organic contamination remains within the level of the Ist quality class). Due to their good self purification capacity the streams Orava and Kysuca may be considered as less polluted, falling prevailingly into the Ist class, only with local deterioration to IInd class. The city of Trnava and the sugar factory at Sladkovicova have a decisive impact on the extraordinarily low quality of the Trnavka and lower Dudvah. Low bearing capacity of recipients in this region cannot safeguard a potential improvement of water quality to an adequate level. The topmost priority in restriction of the pollution of streams in the Vah catchment area is placed upon highly effective operation of the wastewater treatment plant in Zilina, the solution of treatment of wastewater coming from the right-side part of Trencin, construction of wastewater treatment plant for the city Hlohovec (potential treatment of wastewaters from Slovlik, Leopoldov), and abatement to a tolerable level of the pollution in the region Trnava, Sala, Galanta.

Among all the subcatchments of Slovakia the water quality in the subcatchment of the Nitra river is the worst. All monitored streams are polluted to the IIIrd-IVth quality class. To the standard organic and bacteriological pollution in the main course from Novaky to the river mouth a high content of dissolved solids is added (II,IV class), having an increasing trend in the flow direction (concentration of residential areas and agricultural activity).

For the whole river Nitra the most urgent is a complex treatment of wastewaters from the chemical industry (Novaky) and construction of the wastewater treatment plant for the tanning industry at Partizanska, enlargement of the wastewater treatment plant in Nitra and Nove Zamky.

The subcatchment of the river Hron - has as a whole a good quality according to the oxygen consumption (mostly I-II class). Though, the bacteriological pollution is extraordinarily high (sometimes at the level of IVth class). Evident, though having a decreasing tendency, is the content of petroleum products, namely downstream of Petrochema, Dubova, as well as downstream of

large residential areas (Banska Bystrica, Zvolen). Very good discharge conditions of the main stream enable the compensation of the organic pollution, though that is not a reason for neglecting the adequate treatment (including the completion of the sewerage systems construction), especially for such important cities as Banska Bystrica and Zvolen. (In Banska Bystrica 15 sewage overflows flow into receiving waters without any treatment). The cities Kremnica and Ziar nad Hrnom are not provided with a wastewater treatment plant for the public sewerage system.

As an example of an extraordinarily high stream pollution in this catchment may be mentioned the stream Podluzianka (IV class), the receiving stream of wastewaters coming from the city Levice.

The subcatchment of the river Ipel does not belong among heavily polluted ones, especially as far as the organic load is concerned. More unfavorable is the situation on its tributaries (low water bearing capacity of receiving streams and discharging of wastewaters without treatment from residential areas Banska Stiavnica and Krupina), IV class downstream the cities. Improvement of the oxygen regime brought the Krivansky brook into the III class downstream of Lucenec. Though, the bacterial pollution and iron content (washings) are decisive for the total classification (III-IV class). The increase of nitrogen compounds concentrations is also obvious.

The subcatchment of the river Slana - the main stream is classified as IVth class and will remain there until the discontinuance of the cellulose production in Gemerska Morka. After introduction of the substitution program of production (envisaged after 1991) a potential water quality improvement should take place. The Slovak Chemical Industry at Hnusta-Likier is the decisive source of pollution of the Rimava stream. Downstream of the municipality Hnusta, which is not yet provided with sewerage system and wastewater treatment plant, the stream Rimava is in the IVth class. Due to the Rimavica tributary and effect of the self-purification upstream of the city Rimavska

Sobota - the second main source of pollution - the oxygen regime is in the IInd class. Though, this is later deteriorated to IVth class due to this residential area, and its untreated wastewater. In the mouth the river had in 1989 the quality class II-III.

The subcatchment of the river Bodva - has no significant point resources of contamination, but an increased amount of nitrogenous substances, with peak occurrences in the spring were determined. The oxygen regime is in the range of I-II class.

The subcatchment of the river Hornad - The main stream is down to the city Spisska Nova Ves of Ist class quality as far as the oxygen regime is concerned. The water quality as far as the oxygen regime is concerned. The water quality is indirectly influenced in unfavorable way to the public sewer system of Spis. Nova Ves, then by specific substances (heavy metals) from the ore processing industry Krompachy, (the city Krompachy is not provided with wastewater treatment plant). Wastewaters from the ore mining industry contaminate the brooks Rudniansky and Slovinsky (III-IV). The most heavily polluted streams of this catchment are the Torysa (wastewaters from the city Presov), downstream of Presov to the mouth of the Hornad IV-III class, and the brook Sokolinsky (receiving part of the wastewaters from the Iron and Steel Works Kosice) IV class. The residential and industrial complex of Kosice also has a negative effect on the water quality in the river Hornad (according to oxygen regime only II class, though with respect NH4+, Fe and bacterial count III-IV class). As to improving the qualitative regime of streams in the Hornad catchment it is necessary to give priority to the solution of pollution sources Presov, Kosice, Spisska Nova Ves and Krompachy.

The subcatchment of the Bodrog river. According to the organic matter affecting the oxygen regime the most unfavorable qualitative conditions are in the lower sections of the river Lavorec and Ondava (III class), and in streams with low water-bearing capacity. In the Trnavka stream (receiving wastewaters from the complex Trevisov), in Somotor canal

(receiving wastewaters from Kralovsky Chlmec) the water quality belongs to the IVth class. Significant sources of pollution represent the municipalities Hmenne, Michalovce, Trebisov and for the upper section of the river Topla-Bardejov. Special emphasis should be placed on the industry with specific pollution - i.e. Bukoza, Branov and Chemko, Strazske (Chemko influences through the brook Kyjov also the quality of the Ondava river).

1.4 Groundwaters

1.4.1 Evaluation, quantity, and utilization of groundwaters

Groundwater is defined as water filling the cavities and voids of the waterbearing rocks. In current water-management practice the term groundwater resources means groundwaters, utilizable technically and economically, or from other reasons, as drinking and process water supply. As far as legislation is concerned those resources are treated within the scope of the Directions of the Water Act. No. 138/73 zb., in contrast to water resources being managed pursuant to Act No. 41/57 Zb. on mineral resources utilization (mine waters), and pursuant to Act No. 20/66 zb. on public health (mineral waters).

The essential precondition for groundwater utilization is detailed information on its occurrence based on the results of hydrogeological research. Therefore, the data concerning occurrence of groundwater and its capacity for use vary in the course of time depending on the level of knowledge and verification of the abundance and quality of groundwaters, as well as their utilization.

The basic unit for evaluation of groundwater resources is the hydrogeological region. It is a territory defined from the viewpoint of geology, structural geology and hydrogeology as a whole, in which prevails the uniform circulation of groundwater of a certain type. Since 1981 a new regionalization is valid, according to which 140 hydrogeological regions are defined. The regions composed of Quaternary, Neogene, Crystallinicum, Mesozoic, Poleogene system and others are involved.

The state-of-the-art about the completed hydrogeological

survey of groundwaters in all hydrogeological regions has been processed annually. One of the input data of this processing are the utilizable supplies of groundwaters for respective hydrogeological regions. The utilizable portion of groundwater supplies, determined in each region, represents the quantities approved by the Commission for the Supply classification (KKZ) in corresponding category (in CSFR the categories C2, C1, B, A). The other supplies belong to the category of the professional assessment. The supplies qualified according to the professional assessment are processed on the basis of hydrogeological surveys and their results, which have not been submitted yet for approval to KKZ, on the basis of general knowledge of hydrogeological conditions. This processing of utilizable supplies provides an image of the distribution of groundwaters over the territory based on the present level of knowledge about hydrogeological conditions and the feasibility of their utilization in water management.

The utilizable supplies of groundwater within the Danube catchment area in Slovakia represent the following quantities:

supplies approved by the Commission 35,070 l/s
qualified assessment 35,492 l/s
total in the territory 72,562 l/s

The groundwater resources are distributed rather unevenly over the Slovak Danube catchment area. Their quantity and potential exploitation are given by the character of existing geological formations, their area spreading; the thickness and permeability create more or less favorable conditions in the hydrogeological structure for the formation and accumulation of groundwater.

From the point of view of water supply engineering the quaternary groundwaters are of major importance. They represent, together with the limestone-dolomitic complexes (Mesozoic) the main resource of utilizable groundwater for drinking water supply. From the total amount of utilizable groundwaters in quaternary hydrogeological regions they represent 50% of groundwater, and hydrogeological regions of Mesozoic formations 12%. The most significant supplies of groundwater occur within

the Danube Lowland, chiefly in the central part of the Danube Island. Those groundwaters are in the upper part of the Island recharged with waters infiltrating from the Danube river banks. The quantity of groundwaters of the Danube Island amounts to 16.0 m3/s of the category C1, that is 22% from the total amount of groundwaters.

Neogene sediments cover in Slovakia rather significant areas, in which alternating permeable and impermeable layers enable the accumulation of artesian waters. Though, the artesian waters do not occur in sufficient quantities, as to be utilized for larger water supply systems. They are used for the local drinking water supply.

In regions composed of neovolcanic rocks and in places of tectonic breaches a more significant groundwater accumulation occurs. Those groundwaters are used only for the local water supply.

About a quarter of all utilizable groundwaters are waters originating from limestone-dolomitic complexes. For collective water supply following regions may be estimated as suitable: Little Carpathians, Brazov Hills, Cachtice Hills, Povazsky Inovec, Tribca, Strazov Hills, Low and High Fatra, Low Tatra, Choc Mountains, Muran Plateau and Slovak Karst Mountains.

The lay-out of utilizable groundwaters does not always comply with water demands. In some regions there is shortage of groundwater resources, in others the assessed groundwater supplies are not utilized.

The hydrogeological survey has been, therefore, coordinated and regulated into regions with deficient groundwater supplies. Though, in spite of the fact that the hydrogeological survey cannot keep pace with the requirements of the water management. At present, the regions with a lower groundwater accumulation characteristics have been investigated. They are composed of neovolcanic, crystallinic, Paleogene, and Neogene formations. The higher financial costs ensuing from this hydrogeological research are evident.

The groundwater quality is more stable than that of surface waters and therefore they are used mainly for drinking water supply. The groundwater abstractions are six times higher than

those from surface waters. Table 3 demonstrates the abstractions from surface and groundwaters with respect to individual consumer groups. The estimation of groundwater abstractions creates the main basis for a rational water resources development. The Slovak Hydrometeorological Institute has been monitoring groundwater abstractions pursuant to the Direction (Public notice) No. 170/75 Zb. According to this notice the organizations withdrawing monthly more than 1250 m3 of groundwater, are required to announce the quantity of withdrawn water. Total withdrawals from groundwaters amounted in 1989 to 21,367 l/s, i.e. 684.1 million m3/year. The balance concerning respective consumer groups is as follows:

withdrawals for drinking water supply 15,637 l/s withdrawals for industry 4,029 l/s

withdrawals for agriculture 1,701 l/s

total 21,367 l/s

Selected utilized groundwater resources are designated in Fig. 6.

According to the hydrogeological regions occurring in quaternary formations, the water withdrawals amounted to 10,785 l/s, in karst formations 4,650 l/s.

1.4.2 Quality of groundwaters

The majority of groundwaters originating from quaternary sediments is of good drinking water quality with respect to the chemical-physical and biological composition.The groundwater quality is usually deteriorated by the presence of Fe and Mn and by locally increased contents of nitrates and sulfates. However, since the water bearing layers are shallow, and usually unprotected, the groundwater quality is often adversely influenced by industrial and agricultural wastewaters.

The well waters in all hydrogeological regions are of good quality and may be used fro drinking water supply without any treatment. Their mineralization fluctuates according to the contact with the medium. They often contain aggressive carbon dioxide. Waters from karst regions are exposed to contamination.

The quality of artesian waters is usually good, if higher concentrations of Fe or H_2S do not occur. The temperature undergoes changes with the changing depth of the resource.

Taking into account the Czechoslovak Standard (CSN) 83 06 11, the groundwater of Mesozoic karst formations are of high quality, suitable for drinking water supply, provided they are not negatively influenced by antropogenic effects.

1.5 Impacts of Water Quality on Uses

1.5.1 Drinking water-supply and public water-supply networks

Supplying of population with drinking water from public water-supply systems has a direct influence on the standard of living and the development of the environment.

The number of supplied inhabitants amounted in 1988 to 3,836,000 - 73.1% of the total number of inhabitants. The total water delivery from public water-supply systems increased in 1988 by 19 million m3. The most significant increase was recorded for the supply of population. The proportion of water delivery for households is constantly increasing, reaching in 1988 58.8% of the total water delivery from public water-supply networks.

The delivery of water from public water-supply systems for the industry is decreasing and is at present about 19%.

The development of public water-supply as well as other selected indicators are shown in Table 4.

Table 4

Indicator	Measuring Unit	1985	1990	2000
Total number of population	thousand	5,160	5,331	5,641
Number of supplied inhabitants from public water-supply	thousand	3,591	3,976	4,809
Proportion of supplied inhabitants from public water supplies	%	69.6	74.6	85.2
Length of the water-supply network	km	16,392	18,750	22,100

In accordance with conceptual intentions the following aims are to be followed:

1. To obtain in all cities surpassing 20,000 inhabitants a 100% concentration of supplied population by 2000;

2. to increase in other cities, where public water-supply systems have been provided, the proportion of supplied inhabitants from present 86% to between 92 and 95% by 2000.

On the basis of the attained state of supplying population with drinking water it is required that the average increment of supplied population be higher as the average increment of the total number of population, if more than 88% of inhabitants should be supplied from public water supply systems in 2005.

The demand for water for public water-supply systems is ever increasing as a consequence of population growth. In 1985 the water extraction volume was 523.0 million m3, in 1990 600 million m3, and the projected water consumption for 2000 is 775 to 700 million m3. At present the major part of the water demand is covered by the available groundwater (86%). This trend is likely to continue in the future.

The development of the drinking water demand is influenced chiefly by:

- population growth and increasing proportion of inhabitants supplied from public water-supply systems,
- increasing of the specific demand of drinking water,
- urbanization,
- requirement of drinking water for industry,
- requirement of drinking water for agriculture.

The computation of drinking water demand up to the year 2000 shows a demand of 11,500 l/s as compared with presently utilized resources.

One thousand two hundred and ninety-six public water supply systems were in operation in Slovakia in 1986; 931 water-supply systems were managed by the enterprises "Water and Sewage Works," 365 water supply systems were managed by local national committees.

The population of Slovakia is supplied with drinking water originating from ground and surface waters. The major part creates the water produced from groundwater 450,102,000 m3 in 1986 (i.e. 85% from the total produced volume). Water produced from surface waters amounted to 78,784,000 m3. Average water production falling to one supplied inhabitant was 396

liters/inhabitant/day, the average household consumption was 188 liters/inhabitant/day.

Due to the uneven distribution of water resources over the territory with respect to the lay-out of residential areas and cities, a successive interconnection of respective water supply systems occurred, creating larger operational units - the group water supply and waterworks systems.

1.5.2 Water resources for public water supply systems

a) Groundwater resources

According to present knowledge of hydrogeological conditions the groundwater resources are divided into two categories: verified and undeveloped water resources and potential water resources. It is to be emphasized that the level of the survey of hydrogeological conditions is not in respective regions equal. The uneven distribution of available water supplies is connected in the prevailing part of the territory with a limited possibility of adequately meeting the drinking water demand from local resources. Therefore, a successive construction of long-distance water supply systems has been realized. Available volumes of groundwater resources designed and envisaged for utilization up to 2000 amount to 12,992 l/s.

b) Surface water resources

On the basis of the water demand balance, utilized and suggested groundwater resources for respective water supply systems, or group water supply systems the requirements for surface water resources have been computed.

Following water-supply reservoirs are in operation: Hrinova on the Slatina river, Klenova on the Klen. Rimava, Nova Bystrica on the Bystrica, Bukovec on the Ida, Starina on the Cirocha. The following reservoirs are under construction: Nova Bystrica and Melinec. For potential future use, six water reservoirs have been investigated and designed for realization.

1.5.3 Development of public water-supply systems

According to the solution of respective group water-supply systems and waterworks systems it is possible to meet the consumption demands usually only by means of long-distance water supply systems., in various periods and from different resources. In Slovak territory eleven territorially and technologically delineated water-supply systems are in question, which will supply 3.6 million inhabitants with water by the year 2000. They are as follows:

1. Municipal water supply system of Bratislava (see Annex 4)
2. Danube water supply system
3. Little Carpathian water supply system
4. Trencin water supply system
5. Northern Slovakia water supply system
6. Vah river-basin water supply system
7. Upper Vah water supply system 8. Central Slovakia water supply system
9. Tu nieco chyba
10. Roznava water supply system
11. Bodrog basin water supply system

In territories which are not included in any water supply systems, the communities would be supplied by local water supply systems.

For meeting demands, posed by the public water-supply systems, there are at the disposal stores of water in water resources, though, they have to be protected with regard to their quality and amount. Also the conditions of their exploitation are to be specified.

The development of the public water-supply systems in a part of the Slovak territory is presented in Fig. 14.

1.5.4 Conditions for the realization of conceptual intentions

1. A decisive condition for safeguarding the adequate, uninterrupted supplying of population from the public water supply systems is to build, together with the investment construction, also the missing capacities of water resources, new

sources of accumulation, to perform reconstruction of existing resources capacities as to reach a higher technological level. It is necessary to develop water management capacities, taking into account the further development, the occurrence of extreme hydrological conditions and unfavorable water quality development.

The worked-out investment program for the development of public water supply and sewage works systems is based on the following investment costs:

Table 5

Structure	Volumes in millions of Kcs		
	1991-1995	1996-2000	2001-2005
Water supply systems	6,388	6,744	7,690
Sewage systems	8,005	6,437	5,852
from that wastewater treatment plants	4,685	3,372	2,283
Total	14,393	13,181	13,542

The submitted investment cost corresponds to price relations in 1989. Due to inflation of the Czecho-Slovak currency it is necessary to consider higher costs.

2. EMISSIONS AND DISCHARGERS

2.1 Overview

The qualitative regime of surface waters is significantly affected by the hydrological conditions of the respective stream and by antropogenic impacts represented by multitude of substances originating from point and areal sources of contamination.

Within the Danube basin considerably contaminated sections of streams were observed only downstream of larger industries on the rivers Vah, Nitra, Hron and Little Danube in the period 1948-1954.

Over the period 1954-1960 successive deterioration of water quality in streams was observed due to the growth of industrial

production without adequate disposal of pollutants contained in wastewaters.

In the 1960s after a slight decrease in the pollution growth (already constructed wastewater treatment plants and legislation contributed to some improvement), again a progressive deterioration was observed due to municipal and industrial pollution sources and developing agricultural production. This trend was slowing down in the first half of the 1980s due to partial reduction of pollution discharged from some large industrial plants (Slovnaft, Slovak Paper and Pulp Industry, Ruzomberok, Petrochema, Dubova, Biotika, Slov. Lupca), though the contamination from municipal sources increased (development of public sewage systems, including connection of industrial sources belonging to the residential areas).

The period after 1985 may be generally characterized by a steady unfavorable conditions as far as organic pollution of streams is concerned pursuant to the evaluation of the CSN 830602, expressed by means of oxygen regime indexes. From a length of about 3400 km of evaluated streams about 28% fall into the quality class III-IV according to the organic pollution.The increasing of bacterial contamination is also evident, resulting from the concentrated municipal wastewaters namely in streams downstream of large residential areas (IV quality class). Over a longer period (10 to 15) also the increase of nitrogenous compounds - nitrates was determined, the surface waters falling prevailingly into the I to II quality class by that time.

The total pollutant load of streams originating from wastewaters, expressed by means of quality indexes (e.g.. BOD5, solids coliform bacteria), is according to the CSN 830602 always extraordinarily high.

Since in the past the estimation of surface water quality was based on the criteria of the CSN 830602 it is purposeful to continue in this way also in the following discussion on the qualitative regime of the Danube basin. Only for illustration the Annex 1, giving the classes of water quality in selected profiles for the years 1985 and 1989, shows also the evaluation according to the CSN 75 7221 for the period 1989 to 1990.

A partial orientation in the surface water quality classification according to the both standards enables the following characteristic of quality classes, though the methods of evaluation and ranges of indexes are different:

CSN 830602 - quality classes CSN 757211 quality classes

I.a very clean water I.
I.b clean water II.
II. contaminated water III.
III. heavily contaminated water IV.
IV. extremely contaminated water V.

The dependence of the qualitative stream regime on the point source of pollution is important - i.e. producers of wastewaters, having a negative impact on surface water quality. It is, therefore, necessary to focus attention also to this phenomenon in characterizing water quality of streams.

The following table shows the total amounts of wastewater and harmful substances expressed in standard indexes - of pollution - influencing negatively the resources and the quality of streams in the Danube basin.

Table 6

INDEX	Measuring unit	1985	1989	1990
Volume of discharged wastewater	mil. m3	1192	1257	1178
BOD5 produced discharged	thousand ton "	249 142	244 97	- 97
COD-Cr produced discharged	" "	528 265	539 233	- 235
Solids produced discharged	" "	1111 151	488 103	- 97
Dissolved inorganic salts discharged	"	-	-	550

The discharged pollutants contributed to the fact that in 1985, 2528 km of streams were contaminated to the quality class

III-IV, (water quality according to oxygen regime shown in Fig. 3), and 2663 km of streams in 1989 (water quality according to the group of indexes of the CSN shows Tab. 7.

Table 7

Index	Water quality classes according to CSN 830602			
	Total length of streams (in km), 1989			
	I.	II.	III.	IV.
Oxygen regime	1139	1067	735	405
basic chem.comp.	242	706	1261	1137
specific	166	717	1117	1346

Main producers, discharging in 1990 into the surface waters pollution expressed by the amount of 200 t. BOD5, 400 t. COD-Cr, and 300 t. solids, and their concentration in selected localities of Slovakia are given in Fig. 4 and Annex 5.

The classification of selected profiles according to all 3 groups of indexes of the CSN 830602 for the years 1985 and 1989 is in Annex 1.

The effect of pollution according BOD5, discharged into streams in 1989 by selected producers of wastewaters show the diagrams - schematic longitudinal profiles - Fig. 5. At the same time they indicated the degree of urgency to impose limits to the negative effects of those sources, influencing the quality regime of respective receiving streams. The prognosis of water quality improvement, provided the realization of effective wastewater treatment, is also presented.

Note: the symbols "d" and "e" used in the longitudinal profiles mean:

d - insufficient water bearing capacity of the stream e0 - water supply stream

e1 - effect on groundwaters

e2 - effect on reservoirs

e3 - water utilization for irrigation

e4 - border stream

e5 - utilization of water for industry

e6 - utilization of water for recreation

2.2 Municipal Dischargers

Development of public sewage systems is one of the basic preconditions for the accelerating and increasing urbanization, for surface and groundwater protection, improvement of water quality in water resources and water courses, for healthy residential areas and environmental protection.

The development of public sewage works in 1985 (expressed as the proportion of users of public sewage works) attained 46.2% of the total number of inhabitants, showing a considerable lag behind the needs. The development of sewage works has always been delayed as compared with the development of public water supply systems Tab. 8.

Review of the delayed development of public sewage systems as compared with public waterworks in (%)

Table 8

Indicator	1985	1990	2000
Proportion of supplied inhabitants	69.6	74.6	85.2
Proportion of inhabitants connected to sewage drains	46.2	50.3	61.3
Delay	23.4	23.4	23.9

The development of public waterworks and water supply systems proceeded always ahead of that of sewerage systems, since the demands for drinking water-supply were always more urgent. The structures of ecological characters, which should have followed, were always postponed, not having such priority (sewerage networks and wastewater treatment plants). The length of the sewage network was 4,684 km in 1985, that means, that to one user of public sewage system falls -1.97 m of canalization mains. The development of the public sewage networks is given in Table 9.Mostly combined sewage systems prevail in cities. Some smaller cities have group sewage scheme together with the

wastewater treatment plants. With increasing number of people connected to the public sewage system also the volume of wastewaters discharged into the public sewage system is increasing. In 1985 it amounted to 441.6 million m3/year. Larger industrial plants began to discharge their wastewaters into the public sewage system and at the same time they started with construction of common wastewater treatment plants (Ruzomberok, Zilina).

Characteristics of selected indicators of the development of public sewerage systems

Table 9

Indicator	measuring unit	1985	1990	2000
Number of inhabitants in houses connected to public sew. systems	thousand	2,382	2,683	3,460
Proportion of inhabitants-users of pub. sew. sys.	%	46	50	61
Volume of wastewaters discharged into publ. sewerage system	mil.m3/year	441	486	695
Volume of treated wastewaters	mil.m3/year	339	420	628
Length of the sewage network	km	4,684	5,163	6,189

The portion of treated wastewaters has an increasing trend, though, the treatment efficacy is low. Only 30% of wastewaters are treated with adequate efficacy. In 1985 there were 160 municipal wastewater treatment plants in operation, 118 of them with the biological treatment stage. From the total number of regional cities (77), fifteen were not provided with wastewater treatment plants in 1985. Themajority of treatment plants are overloaded and cannot meet the required values of pollution removal. The terms of wastewater treatment plants construction are not held.

The public sewage network is one of the point pollution sources. Since the growth of contamination in recent years was

not accompanied with the parallel construction of waste-water treatment plants the public sewage systems contribute to the considerable deterioration of water quality in streams and thus also to the degradation of the environment. The contribution of public sewage networks to the discharge of pollution was about 40%.

Solution of the development of public sewage systems

The further development of public sewage systems is to be carried out with the aim to decrease the time lag, experienced up to present in construction, as compared with that of waterworks and water supply systems. It is necessary to pay attention to the liquidation of decisive pollution sources, to provide the drainage and treatment of wastewaters for the complex residential construction and to ensure the development of public sewage networks also in smaller but significant cities.

A program of construction of selected structures of public sewage systems and municipal wastewater treatment plants has been drafted, containing all suggested activities, with the year of starting the construction, and its completion, and necessary funds. The investment costs are given in Table 15 (the chapter about the development of water supply network). These investment costs are at the price level of 1989. With respect to the inflation of our currency they are not representative.

2.3 Agricultural and Animal Husbandry Emissions

2.3.1 Areal pollution

In 1980-1985 the water research institute, Bratislava had dealt with the research task concerning the close relationship between the intensive agricultural production (chemization, concentration of plant and animal production as well as food industry) and the quality of surface and groundwaters.

The survey and research was carried out for three representative regions (the sample catchments on the Moldava Lowland, of the river Ipel, and of the lower Zitava river), the

different soil types being taken into consideration so as to be able to apply the results also for other regions of Slovakia.

Based on the research results individual realization outputs were worked out:

- Unified methods for monitoring the effect of agricultural contamination on the quality of surface and groundwaters,
- Guidelines concerning the application of agrochemicals in Slovak territory with respect to water quality protection,
- Introduction of the control of water contamination caused by agricultural production.

From the basic nutrients N, P, K, the washing out of phosphorus and potassium has only a minimum share in the negative impact on the hydrosphere (K is washed out only in a minimum extent, P is not washed out at all, it is firmly found to the soil-sorption complexes).

The decisive share in hydrosphere pollution by areal agricultural production have nitrates due to their inadequate application and high dosage of nutrients into soil.

While the elutriation of nitrates from organic fertilizers does not exceed the value 5%, the elutriation of nitrates from mineral fertilizers is usually considerably higher and is dependent upon several decisive factors (i.e. organic matter percentage in soil, soil type, its physical and chemical characteristics, crop rotation, quantity, and periodicity of fertilizers application as well as the season of the year, moisture and temperature condition, etc.).

Released nitrates are washed into surface waters (the process is effectively enhanced by surface areal erosion), or infiltrate into groundwaters.

The results of the evaluation, as well as the comparison of the intensities of nitrate/nitrate/accessibility show that it is an ecologically very sensitive soil characteristic, and any regulation with nitrogen fertilizers is to be performed with respect to soil-ecological conditions. Essentially that means, the localities with lower fertility need application of more nitrogen fertilizers for plant nutrition than highly productive localities. Though, very often those aspects are not taken into

account in agricultural practice and excessive amounts of fertilizers are applied causing heavy pollution of surface and groundwater.

Over a period of four monitored years in three localities an overdose of nitrogen application was determined in the range from 21 kg/ha to 146 kg/ha (locality Dvory n/Zit).

When the fertilization with nitrogen is managed in this manner, surplus amounts of nitrogen in soil are accumulated, which the soil is not able to accept into the organic mass and preserve in the form of stores for a further growing period.

In 1982 - 1984 the hygienic service of Slovakia found in drinking waters up to 200 mg/l of nitrates and in some regions more than a half of the samples surpassed the value laid down by the standard, 50.0 mg/l. Also the standard for nitrites (0.1 mg/l) was exceeded, in some cases even five times.

On the basis of survey and research results it may be stated:

- The highest nitrate concentrations occur in drainage waters in spring, 5 to 20 times higher than the natural background.
- The largest amount of nutrients (nitrates) get into surface waters (washing out, erosion processes), and groundwaters (infiltration) in the spring (the end of February - April). Usually the concentration of nitrates in surface waters increases proportionally with the discharge flow rate (so with the increasing discharge does not occur a dilution, but a concentration increase due to more intensive washing away).
- Surface water contamination increases in the downstream direction (increased concentrations of soluble salts of nitrates, ammonia, organic matter).
- Decisive factors influencing the intensity of salts elutriation from soil (especially nitrates) and also washing away of materials (erosion processes), are the fertilizer doses, intensity and distribution of precipitation, irrigation, zoning and gradient of the terrain, crop rotation, type of crops etc.
- Groundwaters in the studied sample catchments showed high concentrations of nitrates (over 50 - 120 mg/l), due to the long-term infiltration processes and application of high doses of mineral fertilizers.

The investigation of the occurrence of heavy metals - trace elements (Hg, Pg, Cd, Cu, Zn, Cr) revealed that they occur in lower concentration in water as stated by the CSN 83 0611, or by the Direction No. 30/1975 Zb. for Surface waters. Though, the results showed an increase of cadmium (Cd) in the stream sediments, in soil and crops, it is therefore desirable to pay attention to the concentrations of those substances in the future.

It is evident that the methods of cultivation and application of nitrogenous fertilizers in agriculture are to be reevaluated. Testing of various crops showed, that highest losses of nitrogen fertilizers occur in cases of clean cultivated crops (25-28%). Lower losses occur in cases of cereals (6-15%), and minimum losses were recorded in cases of sodded areas.

From results obtained it may be concluded that concentrations of the majority of pesticides (in current agricultural practice) is low.

The study of pesticide penetration, their residue or products of decomposition, into surface and groundwaters enable to make provisions concerning agrotechnical methods requiring meeting of more stringent criteria in land cultivation and treatment of crops with pesticides in areas significant with respect to water resources development:

- In cases of shallow and permeable soils it is necessary to avoid the application of pesticides easily soluble in water and rapidly moving through the soil (especially phenoxycarbonic acid), nitrated phenols, etc.).
- In areas with higher erosive soil ablation (higher than 5.1 mm annually) it is advisable to avoid application of preemergent herbicides.
- In areas where the erosive soil ablation is in the range 1.6 to 5.0 mm annually, the regulated application of pesticides may be allowed only when simultaneously adequate antierosive measures are provided.

It is desirable to formulate more stringent conditions for pesticide application and to establish in practice effective

control, namely as far as the protected water management regions is concerned.

2.3.2 Point pollution

Agricultural large-scale animal production - animal farms - may have in certain circumstances (inadequate waste disposal and lay-out of farms and farmyards) a seriously negative effect on surface and groundwaters pollution.

The content of ammonia and nitrates in waters may be increased, the oxygen regime deteriorated. Simultaneously also the microbiological contamination, namely in surface waters, may increase, followed by only slight degradation. This contamination is dangerous also for groundwaters, especially in permeable alluvial sediment deposits of rivers. This problem is remarkably serious in cases of large-scale farms, where harmless liquidation of excrements and liquid manure is not adequately provided. New large-scale farms are provided with adequate stable arrangements and already existing have been reconstructed and produce manure, which should be stored on impermeable soils. Within the territory of the Danube basin 3279 animal farms are in operation.

3. CONCLUSIONS AND RECOMMENDATIONS

3.1 Summary Conclusions on Conditions and Trends

The territory of Slovakia with its geologic-morphological character and hydrological structure has relatively unfavorable conditions with regard to water storage. The major part of the territory is situated in the Danube basin.

Precipitation constitutes the source of all kinds of water. The average annual precipitation total on the territory is 743 mm and the average annual runoff is 11,956 million m3 of water.

The majority of Slovak rivers issue on the Slovak territory and flow into the Danube on our territory (the Vah, Hron, Ipel), or they leave it and empty into the Danube in Hungarian territory (the Slana, Bodrog). The river Danube represents within the river network the most abundant water resource. Some streams flowing to our territory from the neighboring countries increase the water capacity of Slovak rivers - e.g. the Tisza (385 m3/s), Morava (111 m3/s), Uh (24 m3/s), Latorica (33 m3/s), amounting together with the Danube waters to 2,546 m3/s.

The richest accumulations of groundwaters occur in alluvial plains along the rivers. The groundwater supplies are estimated at 72 m3/s.

Surface and groundwaters are utilized for supplying population, industry and agriculture with drinking water. In 1990, water produced for those purposes amounted to a volume of 593.0 million m3, 15% of which from surface waters and 85% from groundwaters. The drafts for supplying population with drinking water and for draining the residential areas have been worked out for the whole territory, but they are continually updated and supplemented. The realization of envisaged activities calls for considerable funds, which are not available at present.

The quality of the Danube water is influenced by he pollution coming from the upstream countries. According to the oxygen regime parameters the Czechoslovak Danube reach may fall in the quality class I-II. Considerable is the bacteriological contamination, due to which is the quality class III-IV. Petroleum products are also permanent constituents. Significant

sources of pollution is the Slovak capital Bratislava, with the public sewage system of the residential area Petrzalka, Istrochem, Slovnaft, and the complex Komarno-Sturovo. See Annex 2,3. Water quality of the Slovak rivers has been described in section 1.3 and is fully dependent upon the sources of pollution discharging their wastewaters in many cases without any treatment. In 1990 the discharged wastewaters amounted to 492 million m3, from which 87.2% were treated.Current state of treatment plant capacities is inadequate and the solution of this problem would require about 25.0 billion Kcs. As to ensure the most effective utilization of financial costs, envisaged to be spent for the elimination of pollution sources, the Slovak Commission for Environment prepared a draft of priorities in wastewater treatment plan construction for the decisive sources of pollution. (Annex 6) The draft contains 60 most important industrial and municipal pollution sources according to their urgency, though in some cases changes may occur with regard to present development in our country.

In addition to the standard expression of pollution using BOD5, the COD-Co, COD-Mn belong also to characteristic indicators, evidencing, for instance along the river Vah downstream of the city Ruzomberok, a decisive effect of residual pollution originating from the paper and pulp industry (IVth class according to CSN 75 7221), together with the presence of S2-. Similar situations occur in the river Ondava downstream of the plant BUKOZA Vrancov, and until the first of January 1992 also in the river Slana (Cellulose Industry Gemerska Horka).

As an example of the unfavorable antropogenous effect may be considered the pollution of the river Nitra (Cl-, dissolved matter, Ca2+) caused by the Chemical Industry Nitra; in the upper Nitra catchment area also as occurs, in the lower reach of the river the major pollutants (Vth class) being nitrogenous substances (N-NH4+, N-NO2-).

In the regions of ore mining (IVth to Vth class) also presence of Hg, As, Zn has been identified (tributaries of the rivers Hron and Hornad).

Presence of phenols as the evidence of industrial pollution occurs in the rivers Rimava and Hornad downstream of Krompachy

and Kosice.

Non-polar extractable substances are present practically downstream of all larger residential areas and mainly downstream of petroleum processing industry (PETROCHEMA Dubova, SLOVNAFT Bratislava).

Water quality classification is affected in a large extent by bacteriological pollution (coliform and psychrophilic bacteria), originating from public sewerage systems, agricultural production, and natural washing off from soils.

Finally it may be recommended, that with regard to the protection and utilization of water resources attention should be given to:

- systematic monitoring and evaluation of water quality,
- quantity and quality of wastewaters from the municipalities, industries and agriculture,
- areal pollution originating from agricultural production,
- elimination of the pollution by means of construction and intensification of wastewater treatment plants operation, new technologies and updating of the production,
- the effectiveness and degree of compliance of legislation and directives as well as their amendments.

3.1.1 Systematic survey of surface water quality

Since 1963 systematic monitoring of water quality in streams has been carried out. The network of observation profiles is ever increasing, aimed at the systematic control of quality pursuant the values set up by the CSN 830602 (estimation of the surface waters quality and its classification). While in 1985, 196 profiles were monitored, in 1989 the quality was evaluated in 252 profiles and on 96 streams made possible to characterize the qualitative regime of water over the length of about 3,400 km of streams belonging to the Danube basin.

The density of control profiles is not sufficiently uniform until present, the monitoring is concentrated chiefly on the main streams of subcatchments and also as far as the extent of quality parameters is concerned, to be met pursuant to CSN 757221, in force from 1.7.1990 (Classification of surface water quality),

the optimization of the control network requires up-to-date laboratory equipment, skilled personnel and ensuing costs.

3.1.2Systematic investigation of Groundwater quality

Systematic monitoring of the groundwater quality aimed at the study of the groundwater quality development, has been carried out since 1982 in selected water resources development areas. Water sampling is carried out from selected sites twice a year (in spring as to record the spring maximum and in autumn, as to record the fall minimum).

The monitoring of the groundwater quality is performed in 24 regions according to their significance for water resources development and the degree of potential contamination. Following regions are monitored:

1. The Danube Island
2. Stream sediment deposits of the Nitra river from Novaky to Nove Zamky
3. Stream sediment deposits of the Varinka stream from Terchova and sediment deposits of the Vah from the mouth of the Varinka down to Hlohovec
4. Stream sediment deposits of the Cirocha from Snina and of the Laborec from Humenne to Budkovce
5. Stream sediment deposits of the Ondava from Domasa to Hran
6. Stream sediment deposits of the Hron from Hlinik to Zeliezovce
7. Neovolcanic formations - Podzamcie, Dobra Niva
8. Strazov Hills
9. Reservoir Solosnica - Pernek
10. River sediment deposits of the Bodrog and Slovak Karst
11. River sediment deposits of the Ipel-Mikusovce
12. The valleys of the Kropinica and Litava
13. The river sediment deposits of the Roznava, interbasin of the Bodrog
14. River sediment deposits of the Hornad from Kosice down to the national border
15. River sediment deposits of the Poprad
16. Riverine zone of the Danube - Kravany - Sturova

17.River sediment deposits of the Ondava from Svidnik to Domasa
18.River sediment deposits of the Torysa from Porezovicka to Presov
19.River sediment deposits of the Hornad from Smizany to Drozstevna n/Hor.
20.Turcianska Hollow
21.Mesozoic of Low Tatras, river deposits of the Hron-Brezno-Dubova, southeastern part of High Fatra
22.River sediment deposits of the Slana-Safarikovo-Stranska--Chanava
23.River sediment deposits of the Vah upstream of Liptovsky Hradok and in the Bela stream catchment
24.Kysuce Hollow

From this survey it may be seen that there are mostly quarternary formations in question, where the groundwaters are the most sensitive to pollution. Each region is estimated respectively. The list of monitored structures concise evaluation of the surface water quality, the hydrogeochemical assessment of the region, and the estimation of water quality as compared with the CSN 75 7111 "Drinking Water" is used for this evaluation. The above mentioned standard was substituted by the CSN 83 06 11. The results of laboratory analyses of groundwater are evaluated according to CSN 75 7111 within the scope of the components given in the mentioned standard.

The main criterion of the size of groundwater contamination is the determination of the pollution within the evaluated region. As to be able to compare respective regions this value is given as the percentile part of the region on which the exceeding of threshold values occurred.

The results of the monitoring groundwater quality obtained up to the present enable to gain the image on the conditions and development of the groundwater quality in respective regions. In each of the monitored regions certain physical-chemical composition of groundwaters may be characterized, dependent on the composition of the geological medium and intensity of antropogenic pollution. The groundwater quality over the territory of the Danube basin is unfavorable and it may be stated

that it is getting progressively worse. The exceeding of values set by the CSN takes place usually in case of Fe, Mn, NO3-, NG4+ and non-polar of extractable matters. The balance of nitrates has significantly increased due to the increasing application of mineral fertilizers. The number of samples not meeting the standard exceeded 80%. In this connection annual reports of groundwater quality are (annually) published on a regular basis.

The managers of those resources - the enterprises Water and Sewage Works, follow the water quality development on their territory.

3.1.3 Groundwater quality of selected utilized water resources

Evaluation of the water quality of groundwater. From the selected groundwater resources utilized over the period 1980-1989 it may be stated that springs mostly have better quality than the wells, situated in river sediment deposits (Fig 7). This quality deterioration is evident from the increased hardness (Fig. 8), corresponding to the progressing antropogenic effects.

The content of nitrates, demonstrating the effect of agriculture, is shown i Fig. 9. At present 726 l/s of supplied water does not comply with the set up limit values for nitrates and up to 2,320 l/s of water may be dangerous for little children. The general trend of nitrates increasing was assessed in further 1,050 l/s of water.

The evaluation of water resources utilized by the enterprises Water and Sewage Works (VaK) over the period 1980-1989 is based on data of 974 water resources representing 85% of utilized water resources with a bearing capacity about 19.65 m3/s.

From the total number of groundwater resources 510 are situated in river sediment deposits.

The total water quality decreasing in river deposits is expressed also in the deterioration of the oxygen regime of groundwaters and increased content of Fe and Mn. This situation is illustrated in Fig. 10. From the total amount of utilized water 1700 l/s having a higher Fe and Mn content, about 1060 l/s

is treated. Increased content of Mn has been determined in resources with a capacity of 3100 l/s, from which almost 2300 l/s are treated and the rest is delivered without treatment.

A relatively better quality of groundwater occurs in northern parts of the territory.

Bacteriological contamination of groundwaters presents a serious problem. While in 1983 this contamination was found in 44% of resources, in 1989 58% were contaminated. This contamination occurs practically only in the northern-mountainous parts of the country (Fig. 11). This is evidently due to the conditions of the groundwater cycle in rocky media and shorter detention time, as compared with lowland regions.

The evaluation of water quality in groundwater resources revealed that only less intensive deterioration of water quality has been taking place. The dynamics of water quality decreasing and groundwater resources deterioration is more moderate. The trend of the development of water quality standards exceeding pursuant the CSN 83 06 11 is illustrated in Fig. 12.

Since 1991 the new CSN 75 7111 "Drinking Water " has been in force. In this connection an evaluation and comparison of water quality in 159 groundwater resources was carried out with respect to the new standard. The study was performed for selected specific organic substances, having a direct or delayed toxic effect. Of the studied resources 18% did not comply with the CSN 75 7111. Petroleum products were found in the largest number of resources. It may be stated that water quality with regard to specific organic matters usually meets the mentioned standard, except for petroleum products. Even if the data obtained give an image on the quality of groundwater resources in selected localities over the whole territory, and predominantly in regions easily influenced, it is urgent to extend those studies to all utilized and envisaged water resources.

The resources situated in alluvium are the main groundwater resources. However, those resources are supplied chiefly from the river bank infiltration, thus being directly dependent on the surface water quality. Even if certain specific conditions are not valid the respective regions have many common

characteristics. Shallow water bearing layers are more intensively influenced by antropogenic activity, expressed in their qualitative variations, as compared with deep water bearing horizons with a steady regime. However, also the deeper water bearing horizons may be excluded for a longer periods from utilization for drinking water supply due to their water quality deterioration.

The groundwater quality development within the Danube Island had been studied since 1979 within the scope of the individual research works. Since 1982 the water quality in this region has been studied within the scope of a systematic water quality monitoring.

The riverine zone of the Danube has been studied and evaluated in more details also within scope of works estimating the influence of the Water Scheme Gabcikovo on the groundwater quality. The chemism of the groundwaters within the riverine zone of the Danube is under the direct influence of the river. Research results obtained from the studies over the period between 1987 and 1990 show that in the course of the studied period the basic chemism of the groundwater has not changed. An increase of NO_2^-, NH_4^+, Fe^{2+}, Mn^{2+} ions, was determined, as well as the decrease of O_2. Insufficient O_2 content contributes to anoxic conditions, supporting the processes of reduction of chemical substances containing oxygen.

3.2 Recommendations

3.2.1 Measures for surface water quality protection

To improve the present unfavorable state of water quality, emphasis should be placed on:

- construction of wastewater treatment plants with high treatment efficacy, extending and reconstruction of existing wastewater treatment plants,
- increasing the level of maintenance and operation of wastewater treatment plants
- extending the network of control profiles for monitoring water quality,

- meeting legal aspects and measures,
- keep exact water management evidence of data on produced and discharged pollution,
- decreasing the pollution originating from agricultural production.

3.2.2 Measures and recommendations for the protection of groundwater quality

The hazard of groundwater deterioration is imminent wherever the potential contamination of groundwater can take place and where no measures are provided for the protection against endangering water pollution. The accidents and splits during the transportation of harmful materials (petroleum products, toxic substances), the pumping, processing and handling and disposal of dangerous wastewaters in the vicinity of groundwater resources represent a major threat to them.

From the above mentioned the importance of the water resources protection against contamination and depreciation is evident. It is necessary to consistently control the implementation of all measures and rules notified for the protection of groundwaters.

It is urgent to optimize the application of fertilizers and pesticides in agricultural production, to ensure the safe disposal of animal production wastes (farmyards), as well as industrial and municipal waste waters.

It is also necessary to solve the task of the protected water supply areas, to continually study the regime and qualitative conditions o water conservancy in concrete protected water management areas. They are represented in Fig. 13.

Incidentally and simultaneously with the production of new goods and accompanying materials, dangerous to waters, it is necessary to study permanently the relationships between the environment, pollutants, and water, the transport and dynamics of variations of specific water components within the medium, and their effects on water quality development.

In addition to regional protection which is not represented by protected water supply regions, it is necessary to focus the

attention to already established zones of hygienic protection of actual groundwater resources, which should conserve those resources and the whole hydrological catchment.

The established zones of hygienic protection of water resources are to be successively re-evaluated in order to identify their proper purpose, as well as their effect on water quality within the water resource. The results obtained should enable to draft in due time corrective measures which would improve the quality and quantity of the water resource.

As to ensure the preventive protection of groundwater resources it is necessary to provide a systematic control of groundwater quality, aimed at hydrological, physico-chemical and bacteriological parameters and specific indicators of the industrial and agricultural pollution.

It is therefore necessary to take steps to complete the equipment of hydrochemical laboratories, affiliated to the water management industry, with up-to-date instrumentation and trained personnel.

It i important to control on a regular basis the operation and production installations and industry, where harmful materials are used, endangering the groundwater quality. In addition to wastewater treatment it is necessary to adopt and realize a program of measures, including the reconstruction of operation and production facilities, which do not provide the protection of groundwaters.

In connection with the enforcement of the new CSN 75 7111 it is compulsory to check all utilized and designated water resources with regard to the content of specific organic matters mentioned in this Standard.

With regard to water treatment technology it is desirable to consider the present state of water quality and the potential occurrences of new pollutants; to optimize the water treatment plant operation and draw up supplemental technologies of treatment aimed at elimination of those pollutants; to optimize the operation of treatment plants serving small water resources, since in this case the negative economic aspects of continuous operation result in a failure to meet qualitative parameters in the treated water; to increase the professionalism of the

personnel of water works and waste water treatment plants.

The problems connected with accidental spills and other emergency events on water, in water treatment plants and water distribution are also to coped with.

A central data bank is to be established dealing with the data on quality of raw water, water processed and delivered as drinking water, with the aim of obtaining a general view of the quality of groundwater resources.

ANNEX 2.

Industrial-residential complex Bratislava

The solution involved balances of wastewaters and pollutants from 13 sources of pollution and evaluation of the water quality in 9 control profiles on wastewater receiving streams.

From the complex an average BOD5 pollution load of 281.7 g/s is discharged (2.1% into the Morava, or its tributaries, 32.5% into the Little Danube, and 65% into the Danube). The most significant pollution producers are: public urban sewer systems of Bratislava, Slovnaft and Chemical Works. From the total amount discharged from the agglomeration Bratislava above-mentioned sources bring 99.4% BOD5 and 94.4% of petroleum products. The enterprise Slovnaft operates a mechanical-chemical-biological wastewater treatment plant for its chemical wastewaters with adequate capacity and efficacy, discharging into the Danube. The enterprise Waterworks and Sewage Systems operates with adequate efficacy the Central Wastewater Treatment Plant at Vrakuna for treatment of wastewaters of the left-side part of the city and residential areas Dolne Hory and Podunajske Biskupice. The public urban sewage system of Bratislava has serious problems with its waste waters (wastewaters from the residential area Petrzalka are untreated - the term of starting the operation of at least mechanical treatment was already imposed by the "government exception" - the temporary permission to discharge wastewaters devious from the law on waters (Water Act) - was not observed, as well as the completion of the construction of the wastewater treatment plant Devinska Nova Ves. Permanent is combined sewer overflowing from the left side of the city, the currently valid sewage order is obsolete or nonexisting as well as the methods of wastewater measurements. Waterworks and Sewerage Systems do not monitor petroleum products in wastewaters, etc.).

The mechanical-chemical treatment of wastewaters from the Chemical Works is insufficient (construction of the biological treatment stage together with wastewaters segregation is envisaged in 1995).

Slovnaft: performs the best wastewater treatment in its mechanical-chemical-biological wastewater treatment plant. The waste-waters are then discharged into the Danube, the cooling waters, polluted by petroleum products are discharged into the Little Danube (6.3 m3/s and 6 g/s of petroleum products). Those wastewaters, together with the residual pollution from the Central Wastewater Treatment Plant Vrakuna would in the future (after realizations of ecological measures in the Slovnaft and full-capacity operation of the Central treatment plant) negatively influence the water in the Little Danube.

The impact of pollution sources on the Danube water quality is, at present, manifested mainly in the riverine zones of the river (right bank with prevailing pollution from the urban sewerage system Petrzalka, left bank with prevailing industrial pollution). Bacterial pollution would prevail also in the future in the profiles upstream and downstream of Bratislava. After the completion of the wastewater treatment plant at Petrzalka, effective biological final treatment of wastewaters from the Chemical Works including elimination of the whole left side part of the city to the Central Wastewater Treatment Plant (including necessary reconstructions of the sewage system), the effect of the complex of Bratislava would become negligible and tolerable also at variations of the hydrological regime in the river downstream of Bratislava (the reservoir Hrusov). The quality of the Morava will be influenced by the pollution sources of Bratislava only then, when its quality gets substantially improved already upstream of the brook Mlaka. By means of successive connection of smaller pollution sources to the public sewage system also the quality of indirect tributaries of the Little Danube, with low bearing capacity, will improve.

ANNEX 3.

Industrial-residential complex of Komarno

On the average 27.7 g/s of BOD5 flows from the sources of Komarno into the river Vah, more than 50% falling on the pollution from the public sewage system. Converting the load of BOD5 discharge to the Vah, which already upstream of Komarno does not meet according to c90 the admissible criteria pursuant the Government Direction No. 30/75 zb. the passive balance for Q355 has even increased to BOD5 = 9.9 mg/lO2. It is evident, that the city Komarno has only negligible effect on the water quality. The Vah with Komarno decrease the quality in a short left side section of the Danube (organic pollution only within the Ist class of the CSN 83 0602). If the construction of a new mechanical-biological wastewater treatment plant, which will empty into the Danube, would take place in the future, the effect of the Vah would disappear and the impact of pollution from Komarno would become negligible. With respect to stream pollution, Komarno is not an important city. The designed envisaged solution (the new mechanical-biological wastewater treatment plant) is recommendable from an ecological point of cview.

The following recommendations may be presented for dealing with the problems and shortcomings found in solving both complexes:

- for Bratislava the topmost priority is enhanced realization of actions, providing the decreasing of Danube river pollution, mainly in connection with the potential influence of the water quality on the Hrusov reservoir.
- the prime objective is to safeguard the consistent measuring of the amount of wastewaters in pollution sources - namely in the more important ones (incorrect data misrepresent the balance expression of the pollution)
- equally important is the measurement of flow rates in the receiving stream of wastewaters (at present there are no data available for specific streams like the Little Danube),
- it is necessary to extend the register of observed parameters

of water quality for the needs of evaluation pursuant the CSN 757221 on the one hand, and for the identification of specific pollution on the other,

- to improve the level of documentation of the primary and continually-updated data on pollution sources is highly desirable,
- to coordinate the actual handling with wastewaters with respective legal decisions.

ANNEX 4.

The municipal waterworks system of Bratislava

As to meeting the drinking water demand of the Slovak capital Bratislava, a waterworks system has been progressively developed. Ten localities of resources are utilized for water supply, eight of them being within the city area with water delivering capacity 2,060 to 2,410 l/s, two localities (Kalinkovo and Samorin) are outside the city area and deliver 750 and 500 l/s to the Bratislava municipal waterworks system. The water demand Qmax for the municipal waterworks system of Bratislava until the year 2000 is 4,648 l/s. To meet this demand it is necessary:

- to expand the water resources in the locality of Rusovce-Ostrovne Lucky to 2,640 l/s by the year 2000. Also in this locality, the application of new technology for water treatment and the construction of a water treatment plant are necessary. In the locality Samorin the water resources should be extended by 1,000 l/s by the year 2000.

The total water bearing capacity of resources utilized in this system would reach 6,450 to 6,800 l/s by the year 2000.

All waterworks systems in Slovakia are worked out in a similar way.

Annex 1

Water quality in selected cross-sections of streams belonging to the Danube basin on the Slovak Territory

No.	Stream	Profile	Quality class according to parameters										
			ČSN 83 0602						ČSN 75 7221				
			1985			1989			1989-90				
			a	b	c	a	b	c X	A	B	C	D	E XX
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Morava	Brodské	III.	IV.	IV.	III.	IV.	IV.	IV.	V.	V.	-	V.
2	Myjava	Kúty	III.	III.	IV.	II.	III.	IV.	IV.	V.	IV.	-	V.
3	Morava	Dev.N.Ves	III.	III.	IV.	III.	IV.	IV.	IV.	V.	IV.	-	V.
4	Dunaj	Bratislava nad I.breh	II.	III.	IV.	II.	III.	IV.	III.	V.	IV.	-	IV.
5	Dunaj												
6	Malý Dunaj	Jelka	III.	III.	IV.	II.	III.	IV.	III.	V.	V.	-	V.
7	Malý Dunaj	Kolárovo	IV.	III.	IV.	II.	III.	IV.	III.	V.	IV.	-	V.
8	Dunaj	Štúrovo - stred	II.	III.	IV.	II.	IV.	IV.	III.	V.	IV.	-	V.
9	Váh	Okoličné	I.	II.	II.	I.	III.	II.	II.	III.	I.	II.	V.
10	Váh	Lisková	I.	II.	II.	I.	III.	II.	II.	IV.	II.	II.	V.
11	Revúca	Ružomberok	III.	IV.	II.	III.	IV.	II.	V.	V.	V.	V.	V.
12	Váh	Hubová	IV.	IV.	IV.	III.	IV.	III.	IV.	IV.	IV.	III.	V.
13	Orava	Kraľovany	I.	III.	II.	I.	IV.	II.	III.	V.	V.	III.	V.
14	Turiec	Vrútky	III.	III.	II.	III.	IV.	IV.	III.	V.	V.	III.	V.
15	Váh	Žilina nad	IV.	III.	IV.	II.	IV.	II.	IV.	IV.	IV.	IV.	V.
16	Kysuca	Považ.Chlmec	I.	III.	II.	I.	IV.	II.	III.	V.	V.	III.	V.
17	Rajčianka	Žilina	I.	III.	II.	I.	IV.	II.	III.	IV.	V.	III.	V.
18	Váh	Hričov pod nádr.	IV.	III.	II.	III.	IV.	II.	V.	V.	IV.	III.	V.
19	Váh	Nové Mesto nad Váhom	IV.	II.	III.	IV.	II.	IV.	V.	IV.	II.	I.	V.
20	Váh	Selice	II.	II.	II.	III.	II.	II.	IV.	V.	V.	I.	V.
21	Nitra	Nováky nad	III.	III.	IV.	II.	III.	IV.	IV.	IV.	II.	I.	V.
22	Nitra	Chalmová	III.	IV.	IV.	IV.	IV.	IV.	V.	V.	V.	V.	V.
23	Nitra	Lužianky	II.	IV.	IV.	III.	IV.	IV.	V.	V.	III.	-	V.
24	Žitava	Dol.Ohaj pod	IV.	IV.	IV.	III.	IV.	II.	IV.	V.	V.	-	V.
25.	Nitra	Nové Zámky	IV.	IV.	III.	IV.	IV.	IV.	V.	IV.	III.	-	V.
26	Hron	Šalková	III.	IV.	IV.	II.	IV.	IV.	III.	III.	V.	-	V.
27	Hron	Zvolen	II.	II.	IV.	II.	IV.	IV.	III.	V.	I.	V.	V.
28	Hron	Žiar n/Hr.	II.	II.	III.	II.	IV.	III.	III.	V.	I.	-	V.
29	Hron	Kamenín	II.	III.	IV.	II.	IV.	IV.	III.	IV.	II.	-	V.

1.	2.	3	4	5	6	7	8	9	10	11	12	13	14
30	Ipeľ	Holiša	II.	III.	IV.	IV.	IV.	IV.	IV.	V.	II.	-	V.
31	Ipeľ	Slov.Ďarmoty	II.	IV.	IV.	II.	IV.	III.	III.	V.	II.	-	V.
32	Slaná	Čoltovo	IV.	IV.	IV.	IV.	III.	IV.	V.	III.	II.	-	V.
33	Slaná	Lenartovce	IV.	IV.	IV.	IV.	II.	III.	V.	III.	II.	-	V.
34	Rimava	Vlkyňa	II.	IV.	IV.	II.	III.	III.	III.	IV.	II.	-	V.
35	Bodva	Hosťovce	I.	IV.	III.	I.	IV.	II.	II.	V.	IV.	-	IV.
36	Hornád	Spiš.N.Ves - pod.	II.	III.	III.	III.	IV.	IV.	III.	V.	II.	-	V.
37	Hornád	Krompachy pod	II.	IV.	IV.	II.	IV.	IV.	III.	V.	IV.	V.	IV.
38	Hnilec	prít.do VN Prečín	I.	III.	III.	I.	IV.	IV.	II.	V.	II.	II.	IV.
39	Hornád	Ťahanovce	I.	IV.	III.	I.	IV.	II.	II.	V.	III.	V.	III.
40	Torysa	Košické Oľšany	III.	IV.	IV.	III.	IV.	III.	IV.	V.	III.	-	V.
41	Hornád	Ždaňa	III.	IV.	IV.	II.	IV.	IV.	III.	V.	IV.	-	V.
42	Cirocha	ústie	I.	IV.	III.	I.	III.	III.	II.	III.	II.	-	V.
43	Laborec	Petrovce	III.	IV.	III.	III.	IV.	III.	V.	V.	IV.	V.	V.
44	Laborec	Ižkovce	III.	IV.	III.	III.	IV.	III.	IV.	V.	IV.	V.	IV.
45	Latorica	Leles	I.	III.	III.	I.	IV.	III.	III.	V.	IV.	-	IV
46	Ondava	M.Domaša	I.	III.	II.	I.	IV.	II.	II.	V.	I.	-	III.
47	Topľa	Vranov	II.	IV.	III.	III.	IV.	IV.	IV.	V.	I.	-	IV.
48	Ondava	Brehov	III.	IV.	IV.	III.	IV.	IV.	V.	V.	III.	-	V.
49	Bodrog	Streda n./B.	II.	IV.	IV.	II.	IV.	III.	III.	V.	IV.	-	V.

+According to the ČSN 83 0602

a, b, c, represent the groups of water quality parameters

a - oxygen regime /BOD_5, COD-Mn, free H_2S, biological condition/

b - basic chemical composition /Cl^-, SO_4^{2-}, Ca^{2+}, Mg^{2+}, dissolved and undissolved matter/

c - special parameters /NH_4^+, NO_3^-, pH, Fe, Mn, fenols, coliform bacteria/

++According to the ČSN 75 7221 - in force since 1.July 1990

A - oxygen regime indicator /O_2, BOD_5, COD-Mn, COD-Cr, TOC, S^{2-}/

B - basic chemical indicators /pH, dissolved solids, Fe, Mn, nitrogenous substances: $N\text{-}NH_4^+$, $N\text{-}NO_2^-$, $N - NO_3^-$, N-org., tptal P/

ANNEX 2. Industrial-residential complex Bratislava

The solution involved balances of wastewaters and pollutants from 13 sources of pollution and evaluation of the water quality in 9 control profiles on wastewater receiving streams.

From the complex an average BOD_5 pollution load of 281,7 $g.s^{-1}$ /2,1 % into Morava,or its tributaries, 32,5 % into the Little Danube and 65 % into the Danube/ is discharged. The most significant pollution producers are: public urban sewer system of Bratislava, Slovnaft and Chemical Works. From the total amount discharged from the agglomeration Bratislava abovementioned sources bring 99,4 % BOD_5 and 94,4 % of petroleum products. The enterprise Slovnaft operates a mechanical-chemical-biological wastewater treatment plant for its chemical wastewaters with adequate capacity and efficacy, discharging into the Danube. The enterprise Waterworks and Sewerage Systems operates with adequate efficacy the Central Wastewater Treatemnt Plant at Vrakuňa for treatment of wastewaters of the left-side part of the city and residential areas Dolné Hony and Podunajské Biskupice. The public urban sewage system of Bratislava has serious problems with its waste waters /wastewaters from the residential area Petržalka are not treated - the term of starting the operation of at least mechanical treatment was already imposed by the "government exception" - the temporary permission to discharge wastewaters devious from the law on waters /Water Act/ - was not observed, as well as the completion of the construction of the wastewater treatment plant Devínska Nová Ves. Permanent is combined sewer overflowing from the left-side of the city, the currently valid sewerage order is obsolete or nonexisting as well as the methods of wastewater measurements. Waterworks and Sewerage Systems do not monitor petroleum products in wastewaters,etc./

The mechanical-chemical treatment of wastewaters from the Chemical Works is insufficient /construction of the biological

ANNEX 3. - Industrial-residential complex of Komárno

On the average 27,7 $g.s^{-1}$ of BOD_5 flows from the sources of Komárno into the river Váh, more than 50 % falling on the pollution from the public sewerage system. Converting the load of BOD_5 discharge to the Váh, which already upstream of Komárno does not meet according to c_{90} the admissible criterion pursuant the Government Direction No.30/75 zb. the passive balance for Q_{355} has even increased to BOD_5 = 9,9 $mg.l^{-1}O_2$. It is evident, that the city Komárno has only negligible effect on the water quality. The Váh with Komárno decrease the quality in a short left-side section of the Danube /organic pollution only within the Ist class of the ČSN 83 0602/. If the construction of a new mechanical-biological wastewater treatment plant, which will empty into the Danube, would take place in the future, the effect of the Váh will disappear and the impact of pollution from Komárno will be negligible. With respect of stream pollution is not Komárno an important city. The designed envisaged solution /the new mechanical-biological wastewater treatment plant/ is from the ecological point of viem recommendable.

Following recommendations may be presented for dealing with the problems and shortcomings found in solving the both complexes:

- for Bratislava the topmost priority is to be placed to the enhanced realization of actions, providing the decreasing of the Danube river pollution namely in the connection with the potential influencing of the water quality in the reservoir Hrušov,
- the prime objective is to safeguard the consistent measuring of the amount of wastewaters in the pollution sources - namely in the more important ones/incorrect data misrepresent the balance expression of the pollution/

ANNEX 4

Municipal waterworks system of Bratislava

As to meet the drinking water demand of the Slovak capital Bratislava a waterworks system has been successively developed. Ten localities of resources are utilized for water-supply, 8 of them being within the city area with delivering water capacity 2 060 - 2 410 $l.s^{-1}$, two localities /Kalinkovo and Šamorín/ are outside the city area and deliver 750 and 500 $l.s^{-1}$ to the Bratislava municipal waterworks system. The water demand Q_{max} for the municipal waterworks system of Bratislava until 2000 is 4 648 $l.s^{-1}$. To meet this demand it is necessary:

- to expand the water resources in the locality Rusovce-Ostrovné Lúčky to 2 640 $l.s^{-1}$ until 2000. Also necessary in this locality will be the application of new technology of water treatment and construction of the water treatment plant. In the locality Šamorín the water resource should be extended by 1 000 $l.s^{-1}$ until 2000.

The total water bearing capacity of resources utilized in this system would reach until 2000 6 450 - 6 800 $l.s^{-1}$.

All waterworks systems in Slovakia are worked out in a similar way.

Annex 5

Main sources of pollution within the Danube river basin on the Slovak territory - 1990

No	Municipality	Main sources of pollution	Receiving waters	Discharged pollution /t.year^{-1}/ according to			Other kind of pollution	Methods of wastewater treatment
				BOD_5	COD-Cr	Solids		
1	2	3	4	5	6	7	8	9
1.	Senica n/Myj.	VK, Slov.hodváb	Teplica	412,2	1305,1	262,5	SO_4^{-2}, Zn	MB, MCHB
2.	Malacky	VK	Bohno- Maline	248,5	540,4	289,5		MB
3.	Bratislava	VK, Slovnaft, Istroches	Mlékn, Dunaj, M.Dunaj	9767,1	22760,1	12817,4	rop.l.chem. org.l.	MB, M, MCUB, MCH
4.	Dunajská Streda	VK	kanál Gabčíkovo- Topoľníky	405,3	861,2	506,6		MB
5.	Komárno	VK	Váh	476,0	1232,0	420,0		M
6.	Štúrovo	VK, Juhosl.celul.a pap.	Dunaj	7109,0	21268,2	9595,0	špecif.l.z výr.celul.	Ø, MCHB
7.	Lipt.Mikuláš	VK /napoj.kožiar.priemysel/	Váh- VN Liptov.Mara	2406,2	4018,3	3825,8	chróm	MB
8.	Ružomberok	VK, Severoslov.celul. a pap.	Váh Revúca	2161,4	6641,0	5178,3	lignín. sulf., rop.l.	MB, MCH
9.	Istebné- Široké	Kovohuty	Orava	372,0	100,0	2399,0	kovy	MB, Ø
10.	Martin-Vrútky	VK, ZTS, Teplráreň	Turiec, Váh	1240,2	1916,0	1085,3	Zn, Cr	MB, MB, NS, M
11.	Žilina	VK /napoj.Chemicel, čistoťne PCHZ/	VN Hričov, Váh	1748,9	5408,7	2892,2	lignín sulf. l., rop.l.	MB
12.	Čadca	VK	Kysuca	149,5	441,2	167,9		MB
13.	Považ.Bystrica	VK /napoj.Považ.stroj.	VN Nosice	366,3	933,4	493,5	ťažké kovy	MB
14.	Dubnica n./Váh.	VK	Nosický kanál	172,3	498,5	193,5		MB
15.	Trenč-Teplá	VK /Tr.Teplá. N.Dubnica, Tr.Teplice/	Teplička	322,3	552,2	201,7		MB
16.	Trenčín	VK l.breh, VK pr.breh	Váh, Zlatovský pot.	5204,5	9462,0	897,6		MB, Ø
17.	Nové Mesto n./V.	VK	Biskupický kanál	1090,2	2125,0	621,0		MB
18.	Piešťany	VK	Dubová	461,6	892,0	427,9		MB
19.	Hlohovec - Leopoldov	VK, Slovlik	Váh, Siladický Dudváh	10103,0	21961,0	1943,0		
20.	Jaslov.Bohunice	Atom.elektráreň	Manivier	76,9	540,6	301,5	Možnosť RA nesledovaná	MMB
21.	Sereď	VK, Cukrovar	Váh- VN Kráľová	674,7	1265,3	337,0		MB, M
22.	Šaľa	Duslo, VK	Váh, Šárd	1402,7	2667,0	957,3	rop.l.dus. látky	MCHB, MB
23.	Trnava	VK, Cukrovar, TAZ	Trnávka, Parná	3496,0	7215,3	3170,0		MB, M, MB a NS
24.	Sládkovičovo	Cukrovar	Dolný Dudváh	824,7	1662,3	700,7		M
25.	Galanta	VK	Derna	474,6	802,5	309,0		MB
26.	Prievidza-Nováky	VK, Nitr.chemické závody	Handlovka, Nitra	1933,5	4187,0	1017,3	chlór.organické deriváty, RAS	MB, M
27.	Partizánske	VK	Nitra	630,8	1458,2	448,8	rop.látky	Ø
28.	Bošany	koželužne	Nitra	272,3	624,9	167,1	Cr, S^{-2}	MB
29.	Topoľčany	VK	Nitra	1176,0	1991,0	5o2,6		MB
30.	Nitra	VK, cukrovar	Nitra	1786,1	3431,6	964,2	rop.látky	MB, M
31.	Dol.Ohaj	Slov.škrobárne	Žitava	313,2	530,7	73,5		M
32.	Nové Zámky	VK	Nitra	1214,4	2530,7	888,3		MB
33.	Brezno	VK	Hron	422,5	905,4	362,1		MB
34.	Podbrezová	Železiarne	Hron, Vajskovský pot.	46,2	146,7	315,4		M
35.	Dubová	Petrochema	Hron	562,6	1750,5	260,5	rop.látky	MCHB
36.	Sloven.Lupča	Biotika	Hron	241,9	982,8	75,6		MB
37.	Harmanec	Harmanecké papiere	Bystrica	196,0	540,3	101,4		MB
38.	Ban.Bystrica	VK	Hron, Selčian.p., Malachovský potok	3045,0	7406,3	2263,0	rop.látky	MB
39.	Zvolen	VK, Bučina	Hron, Zolná, Sletina	4543,4	1140,4	646,0		MB, B
40.	Kremnica	VK	Kremnický potok	321,6	662,2	160,0		Ø
41.	Žiar n/Hronom	VK, Závod SNP	Lutilský p., Hron	478,0	1370,0	1470,0	rop.lát, Zn	Ø, MB, NS
42.	Levice	VK, Levitex	Podlužianka	1195,0	2703,0	810,7		MB, MCH
43.	Lučenec	VK	Krivánsky potok	3o9,2	1109,0	554,5		MB
44.	Krupina	VK, konzervárne	Krupinica	260,0	653,4	148,2		Ø M
45.	Ban.Štiavnica	VK	Štiavnica	209,9	519,8	297,2		Ø
46.	Kolárovo	VK	Slaná	254,7	545,8	280,8		MB
47.	Gemer.Horka	Gemer.celul.a papierne	Slaná	2395,0	12206,7	1104,8	org.lát.z výr.celul.	M

1	2	3	4	5	6	7	8	9
48.	Jelšava	Slov.magnezit.závody	Muráň	26,1	199,4	774,6		Ø
49.	Hnúšťa	Slov.lučobné závody	Rimava	469,0	380,0	155,2	fenoly	M
50.	Rimav.Sobota	VK	Rimava	600,1	1653,9	549,3		MB
51.	Spiš.Nová Ves	VK /napoj.škrobárne/	Hornád	185,4	883,0	794,7		MB
52.	Levoča	Frukona	Levočský potok	178,9	456,4	54,7		Ø
53.	Košice	VK,VSŽ,Tepláreň	Hornád,Sokolianský p.	3361,5	13375,5	4104,3	fenoly, rop.l.,Fe	MCHB,M,M
54.	Prešov	VK	Torysa	1097,1	3054,2	939,7	ropné lát.	
55.	Humenné	VK /napoj.Chemlón/	Laborec	945,0	3547,8	1410,1	keprolakt.	MB
56.	Snina	VK	Cirocha	206,0	542,2	305,0		MB
57.	Strážske	Chemko	Laborec	433,5	2853,7	1427,5	urotropín formaldehyd	MCHB
58.	Michalovce	VK	Laborec	825,6	2251,6	525,3		MB
59.	Svidník	VK	Ondava	165,5	496,6	413,9		Ø
60.	Vranov	Bukóza	Ondava	971,5	6811,5	2868,0		MB
61.	Bardejov	VK	Topľa	507,6	2157,0	738,0		MB
62.	Trebišov	VK	Tisavka	170,2	425,7	283,8		MB
63.	Kráľ.Chlmec	VK	odpad.kan.Krčava	227,0	567,6	189,2		MB
	Main pollution sources - total :			83 343,0	205 122,0	78 438,0		

VK = public sewerage system
MB = mechanical-biological treatment
MCHB = mechanical - chemical- biological treatment
MCH = mechanical- chemical treatment
M = mechanical treatment

Fig.4 presents the sources of pollution

Annex 5

Main sources of pollution within the Danube river basin on the Slovak territory - 1990

No	Municipality	Main sources of pollution	Receiving waters	Discharged pollution /t.year^{-1}/ according to			Other kind of pollution	Methods of wastewater treatment	Discharge $m^3 s^{-1}$
				BOD_5	COD-Cr	Solids			
1	2	3	4	5	6	7	8	9	10
1.	Senica n/Myj.	VK, Slov.hodváb	Teplica	412,2	1505,1	262,5	SO_4^{-2}, Zn	MB, MCHB	0,134
2.	Malacky	VK	Bahno- Malina	248,5	540,4	289,5		MB	0,071
3.	Bratislava	VK, Slovnaft, Istrochem	Mláka, Dunaj, M.Dunaj	9767,1	22760,1	12817,4	rop.l.chem. org.l.	MB, M, MCUB, MCH	8,214
4.	Dunajská Streda	VK	kanál Gabčíkovo- Topoľníky	405,3	861,2	506,6		MB	0,160
5.	Komárno	VK	Váh	476,0	1252,0	420,0		M	0,161
6.	Štúrovo	VK, Juhosl.celul.a pap.	Dunaj	7109,0	21268,2	9595,0	špecif.l.z výr.celul.	Ø, MCHB	0,953
7.	Lipt.Mikuláš	VK /napoj.kožiar.priemysel/	Váh- VN Liptov.Mara	2406,2	4018,5	3825,8	chróm	MB	0,544
8.	Ružomberok	VK, Severoslov.celul. a pap.	Váh Revúca	2161,4	6641,0	5178,5	lignín. sulf., rop.l.	MB, MCH	1,229
9.	Istebné- Široká	Kovohuty	Orava	372,0	100,0	2399,0	kovy	MB, Ø	0,299
10.	Martin-Vrútky	VK, ZTS, Tepláreň	Turiec, Váh	1240,2	1916,0	1085,3	Zn, Cr	MB, MB, NS, M	0,438
11.	Žilina	VK /napoj.Chemicel, čiastočne PCHZ/	VN Hričov, Váh	1748,9	5408,7	2892,2	lignín sulf. l., rop.l.	MB	1,026
12.	Čadca	VK	Kysuca	149,5	441,2	167,9		MB	0,102
13.	Považ.Bystrica	VK /napoj.Považ.stroj.	VN Nosice	566,3	933,4	493,5	ťažké kovy	MB	0,369
14.	Dubnica n./Váh.	VK	Nosický kanál	172,3	498,5	193,5		MB	0,156
15.	Trenč-Teplá	VK /Tr.Teplá.N.Dubnica, Tr.Teplice/	Teplička	322,3	552,2	201,7		MB	0,151
16.	Trenčín	VK l.breh, VK pr.breh	Váh, Zlatovský pot.	5204,5	9462,0	897,6		MB, Ø	0,244
17.	Nové Mesto n./V.	VK	Biskupický kanál	1090,2	2125,0	621,0		MB	0,171
18.	Piešťany	VK	Dubová	461,6	892,0	427,9		MB	0,183
19.	Hlohovec - Leopoldov	VK, Slovlik	Váh, Siladický Dudváh	10103,0	21961,0	1943,0			0,149
20.	Jaslov.Bohunice	Atom.elektráreň	Manivier	76,9	540,6	301,5	Možnosť RA nesledovaná	MB	0,381
21.	Sereď	VK, Cukrovar	Váh- VN Kráľová	674,7	1265,3	337,0		MB, M	0,136
22.	Šaľa	Duslo, VK	Váh, Šárd	1402,7	2667,0	937,3	rop.l.dus. látky	MCHB, MB	0,099
23.	Trnava	VK, Cukrovar, TAZ	Trnávka, Parná	3496,0	7215,3	3170,0		MB, M, MB a NS	0,402
24.	Sládkovičovo	Cukrovar	Dolný Dudváh	824,7	1662,3	700,7		M	0,040
25.	Galanta	VK	Derna	474,6	802,5	309,0		MB	0,098
26.	Prievidza-Nováky	VK, Nitr.chemické závody	Handlevka, Nitra	1933,5	4187,0	1017,3	chlór.organické deriváty, RAS	MB, M	0,265
27.	Partizánske	VK	Nitra	630,8	1458,2	448,8	rop.látky	Ø	0,218
28.	Bošany	koželužne	Nitra	272,3	624,9	167,1	Cr, S^{-2}	MB	0,138
29.	Topoľčany	VK	Nitra	1176,0	1991,0	502,6		MB	0,154
30.	Nitra	VK, cukrover	Nitra	1786,1	3431,6	964,2	rop.látky	MB, M	0,417
31.	Dol.Ohaj	Slov.škrobárne	Žitava	313,2	530,7	73,5		M	0,009
32.	Nové Zámky	VK	Nitra	1214,4	2530,7	888,3		MB	0,371
33.	Brezne	VK	Hron	422,5	905,4	362,1		MB	0,191
34.	Podbrezová	Železiarne	Hron, Vajskovský pot.	46,2	146,7	315,4		M	0,304
35.	Dubová	Petrochema	Hron	562,6	1750,5	260,5	rop.látky	MCHB	0,066
36.	Sloven.Lupča	Biotika	Hron	241,9	982,8	75,6		MB	0,536
37.	Harmanec	Harmanecké papiere	Bystrica	196,0	540,3	101,4		MB	0,101
38.	Ban.Bystrica	VK	Hron, Selčian.p., Malachovský potok	3045,0	7406,3	2265,0	rop.látky	MB	0,658
39.	Zvolen	VK, Bučina	Hron, Zolná, Slatina	4543,4	1140,4	646,0		MB, B	0,401
40.	Kremnica	VK	Kremnický potok	321,6	662,2	160,0		Ø	0,392
41.	Žiar n/Hronom	VK, Závod SNP	Lutilský p., Hron	478,0	1370,0	1470,0	rop.lát, Zn	Ø, MB, NS	0,527
42.	Levice	VK, Levitex	Podlužianka	1195,0	2703,0	810,7		MB, MCH	0,303
43.	Lučenec	VK	Krivánsky potok	309,2	1109,0	554,5		MB	0,181
44.	Krupina	VK, konzervárne	Krupinica	260,0	653,4	148,2		Ø M	0,034
45.	Ban.Štiavnica	VK	Štiavnica	209,9	519,8	297,2		Ø	0,047
46.	Rožňava	VK	Slaná	254,7	545,8	280,8		MB	0,148
47.	Gemer.Horka	Gemer.celul.a papierne	Slaná	2395,0	12206,7	1104,8	org.lát.z výr.celul.	M	0,432

1	2	3	4	5	6	7	8	9	10
48.	Jelšava	Slov.magnezit.závody	Muráň	26,1	199,4	774,6		Ø	0,087
49.	Hnúšta	Slov.lučobné závody	Rimava	469,0	380,0	155,2	fenoly	M	0,013
50.	Rimav.Sobota	VK	Rimava	600,1	1653,9	549,3		MB	0,186
51.	Spiš.Nová Ves	VK /napoj.škrobárne/	Hornád	185,4	883,0	794,7		MB	0,196
52.	Levoča	Frukona	Levočský potok	178,9	456,4	54,7		Ø	0,032
53.	Košice	VK,VSŽ,Tepláreň	Hornád,Sokolianský p.	3361,5	13375,5	4104,3	fenoly, rop.l.,Fe	MCHB,M,M	2,583
54.	Prešov	VK	Torysa	1097,1	3054,2	939,7	ropné lát.		0,362
55.	Humenné	VK /napoj.Chemlón/	Laborec	945,0	3547,8	1410,1	kaprolakt.	MB	0,253
56.	Snina	VK	Cirocha	206,0	542,2	305,0		MB	0,116
57.	Strážske	Chemko	Laborec	433,5	2853,7	1427,5	urotropín formaldehyd	MCHB	0,636
58.	Michalovce	VK	Laborec	825,6	2251,6	525,5		MB	0,226
59.	Svidník	VK	Ondava	165,3	496,6	413,9		Ø	0,049
60.	Vranov	Bukóza	Ondava	971,5	6811,5	2868,0		MB	0,062
61.	Bardejov	VK	Topľa	507,6	2157,0	738,0		MB	0,138
62.	Trebišov	VK	Tisavka	170,2	425,7	283,8		MB	0,090
63.	Kráľ.Chlmec	VK	odpad.kan.Krčava	227,0	567,6	189,2		MB	0,020
	Main pollution sources - total :			83 343,0	205 122,0	78 438,0			

VK = public sewerage system
MB = mechanical-biological treatment
MCHB = mechanicel - chemical- biological treatment
MCH = mechanicel- chemical treatment
M = mechanical treatment

Fig.4 presents the sources of pollution

Annex 6

Priorities of removal of significant sources of pollution in Slovakia /industry and public sewerage systems/.

No	N a m e	No	N a m e
1	Istrochem /CHZJD/ Bratislava	34	Bukóza Vranov
2	VK Trenčín, pravý breh	35	VK Snina
3	SH Senica	36	VK Malacky
4	VK Hlohovec	37	Cukrovar Nitra
5	VK Stropkov	38	PK droždiareň Trebišov
6	Koželužne Bošany	39	VK Kráľovský Chlmec
7	VK Nitra	40	Duslo Šaľa
8	VK Trebišov	41	VK Šaľa
9	Slovnaft Bratislava, chlad.vody	42	VK Šamorín
10	VK Čadca	43	VK Kremnica
11	VK Krupina	44	Slavoš.papierne Slavošovce
12	VK Rimavská Sobota	45	VK Michalovce
13	VK Myjava	46	VK Spiš.Nová Ves
14	VK Rožňava	47	VK Sabinov
15	VK Kys.Nové Mesto	48	JCP Štúrovo
16	VK Zvolen	49	VK Šaca
17	VK Nové Mesto n./Váhom	50	VK Bánovce n./Bebravou
18	PCHZ Žilina	51	VK Žiar n./Hronom
19	VK Nové Zámky	52	VK Topoľčany
20	VK Bardejov	53	VK Jelšava
21	VK Galanta	54	SCP Ružomberok
22	VK Ružomberok	55	VK Považ.Bystrica
23	VK Senec	56	VK Trenč.Teplá
24	VK Trenčín, ľavý breh	57	VK Púchov
25	Škrobárne Dol.Ohaj	58	VK Štúrovo
26	Škrobárne Boleráz	59	VK Komárno
27	Cukrovar Trnava	60	VK Šahy
28	VK Handlová		
29	VK Lučenec		
30	Bučina Zvolen		
31	VK Pezinok		
32	Cukrovar Sládkovičovo		
33	VK Krompachy		

VK = Public sewerage system

Tab. 1

Charakteristic data of subcatchments

Sub-catchment	Area of the basin km^2	Long-term average of annual precipitation		Specific runoff rate $l.s^{-1}.km^{-2}$	Average long-term annual runoff $mil.m^3$	Minimum annual runoff with 90% probability of exceedance
		mm	$mil.m^3$			
4-17 dower Morava	2283	651	1486	4,16	300	170
4-20 Dunaj	3165	574	1817	0,80	80	43
4-21 Váh	11625	1006	11695	13,41	4920	3725
4-22 Nitra	5144	706	3632	4,67	756	417
4-23 Hron	5464	864	4721	10,02	1728	1079
4-24 Ipeľ	3649	692	2525	5,06	583	239
4-31 Slaná	3191	811	2588	6,83	688	341
4-30 Bodrog	7217	764	5514	7,48	1704	1080
4-32 Hornád	4403	760	3346	7,33	1018	615
4-33 Bodva	920	734	675	6,11	177	93
Danube Basin total	47 061	812	38214	8,29	11 956	7 802

Water withdrawals in the Slovakia in 1989 for consumer groups
Average annual in $l.s^{-1}$

Tabble 3

Basin	Surface water				Groundwater			
	publio water supply netw	industry	agricult	total	publio water supply netw	industry	agricult	total
Morava	0	135	123	258	527	76	42	645
Dunaj	0	6975	485	7460	4438	1779	219	6436
Váh	359	6306	1843	8508	2961	1059	201	4221
Malý Dunaj	0	405	3071	3476	908	269	608	1785
Nitra	0	1256	183	1439	1271	184	116	1571
Hron	331	1810	417	2558	2263	135	92	2490
Ipeľ	0	92	126	218	184	28	85	297
Slaná	355	751	45	1151	369	27	62	458
Bodva	302	14	0	316	619	4	21	644
Hornád	342	2433	14	2789	1105	325	97	1527
Bodrog	830	13807	175	14812	992	143	158	1293
SR	2519	33984	6482	42985	15637	4029	1701	21367
%	5,9	79,0	15,1	100	73,2	18,8	8,0	100

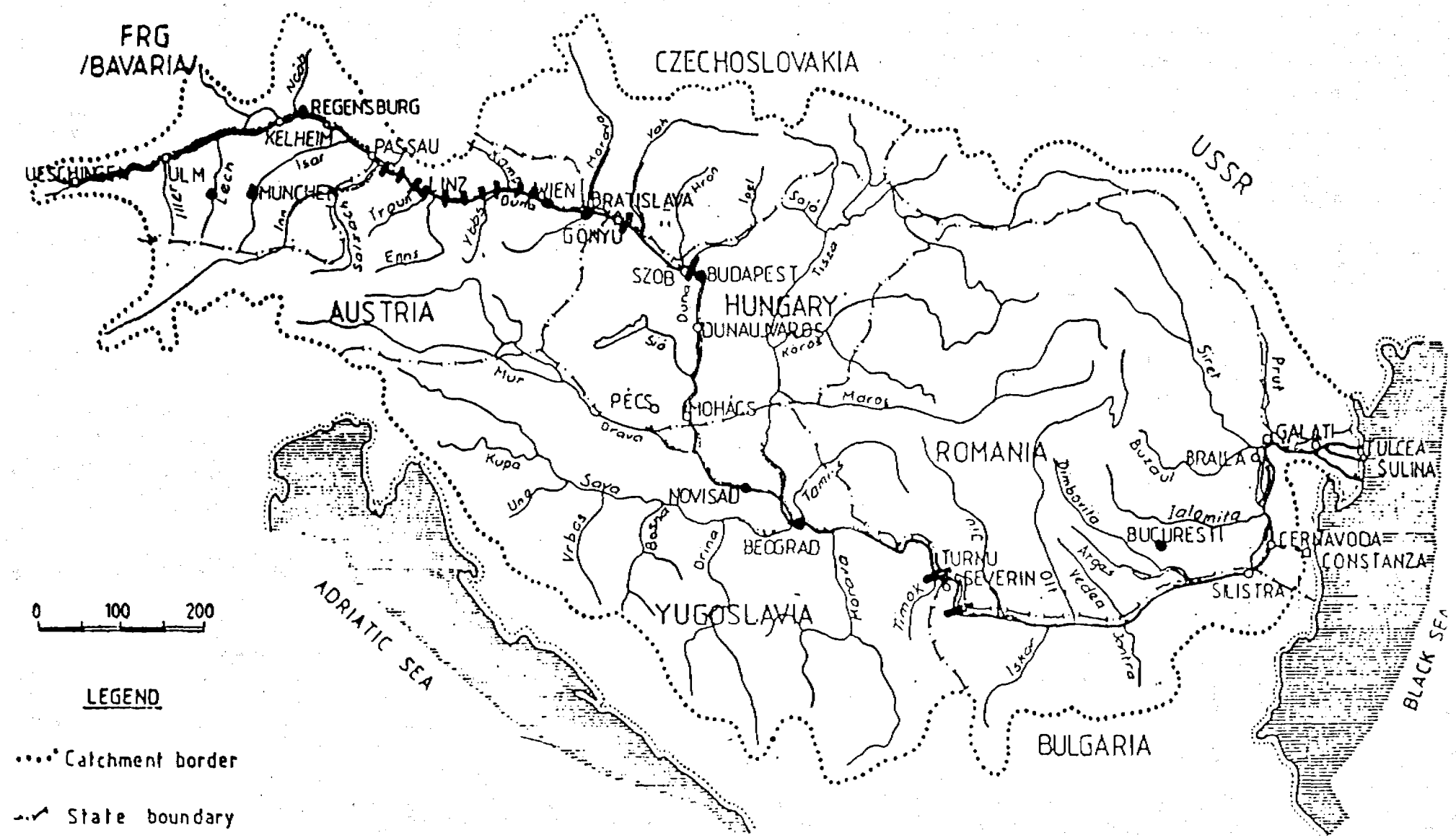


Fig. 1 The Danube Catchment (817000 km^2)

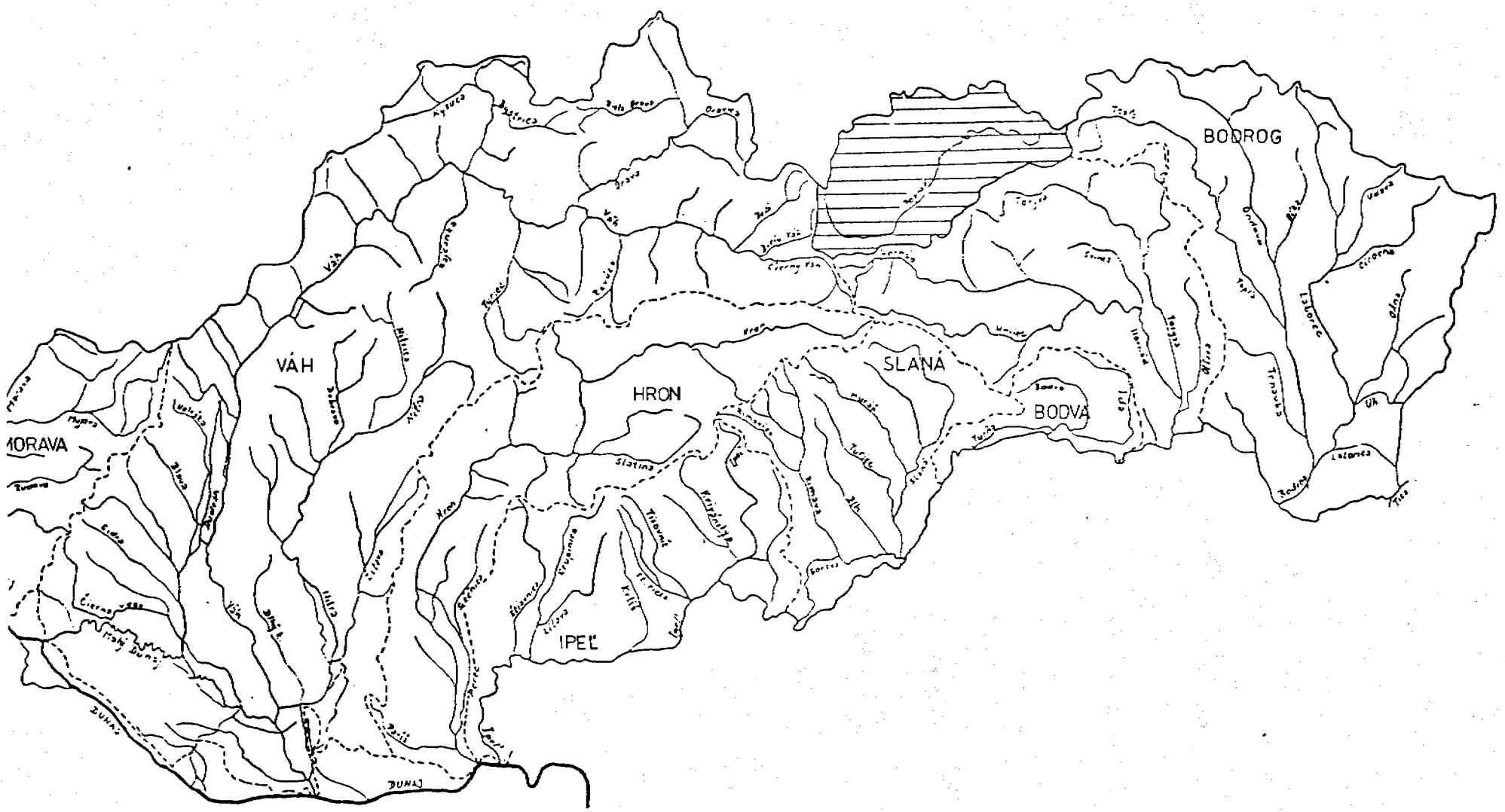


Fig. 2 Subcatchments of the Danube river on the Slovak territory

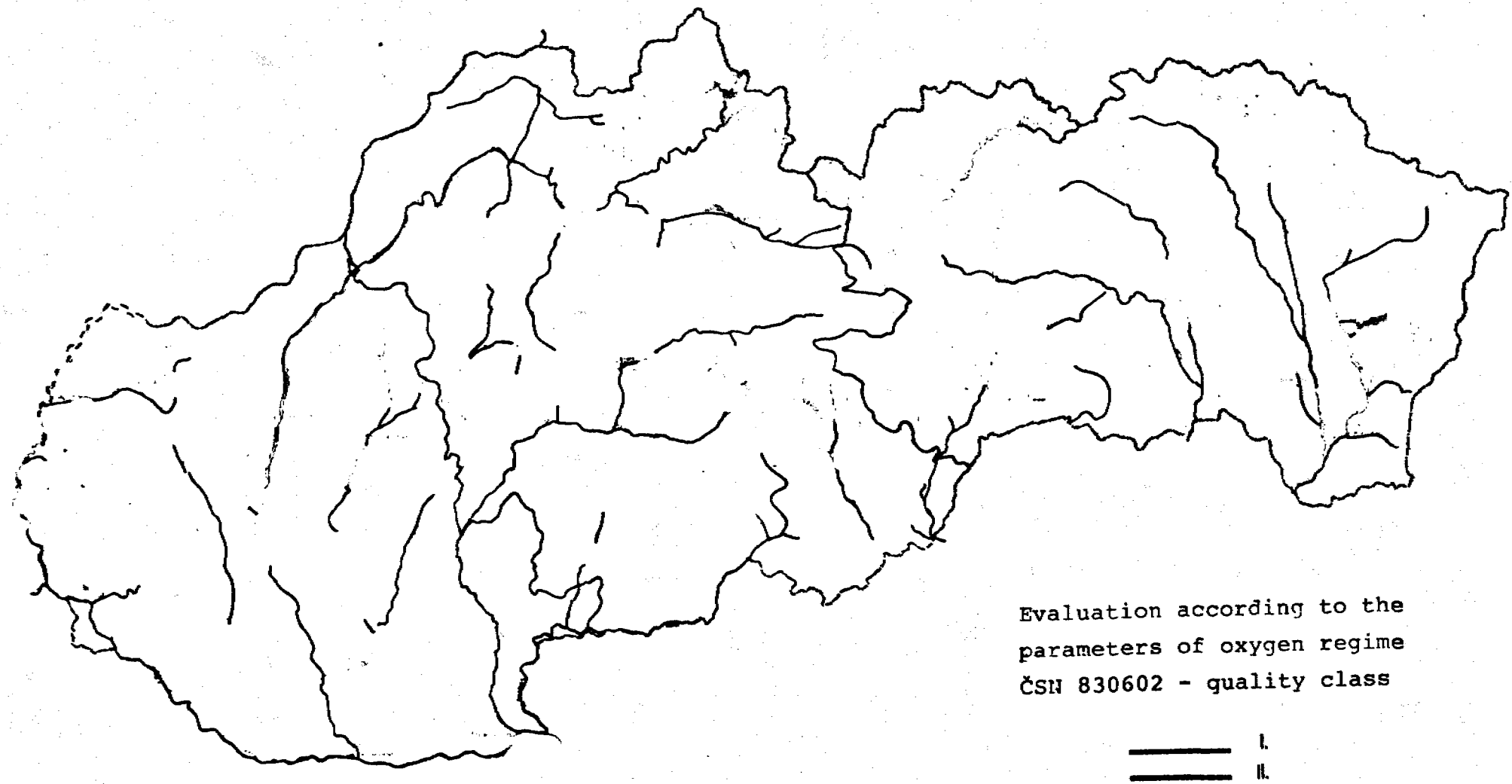


Fig. 3 Water quality in Slovak streams in 1985

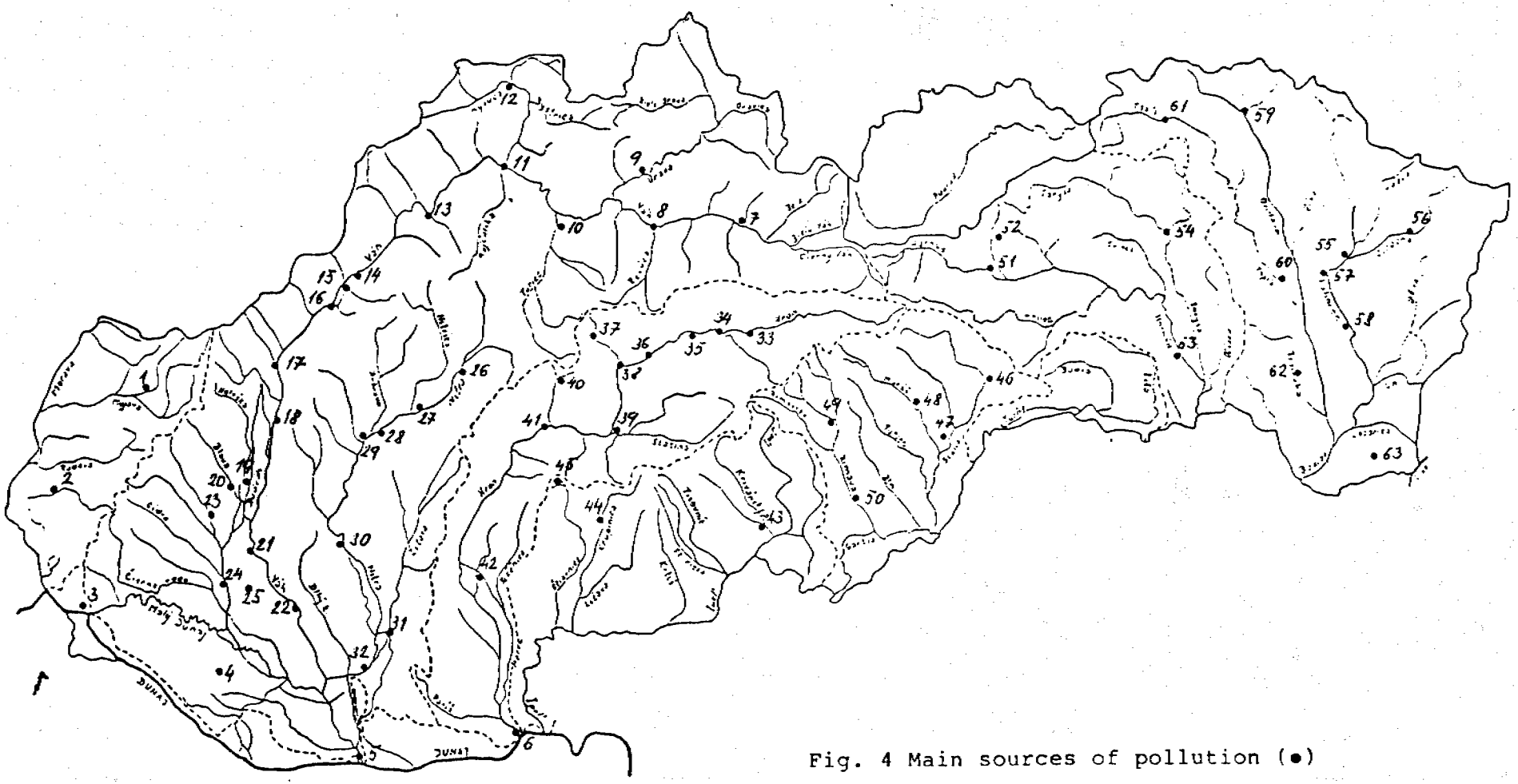


Fig. 4 Main sources of pollution (•)
corresponding to ANNEX 5

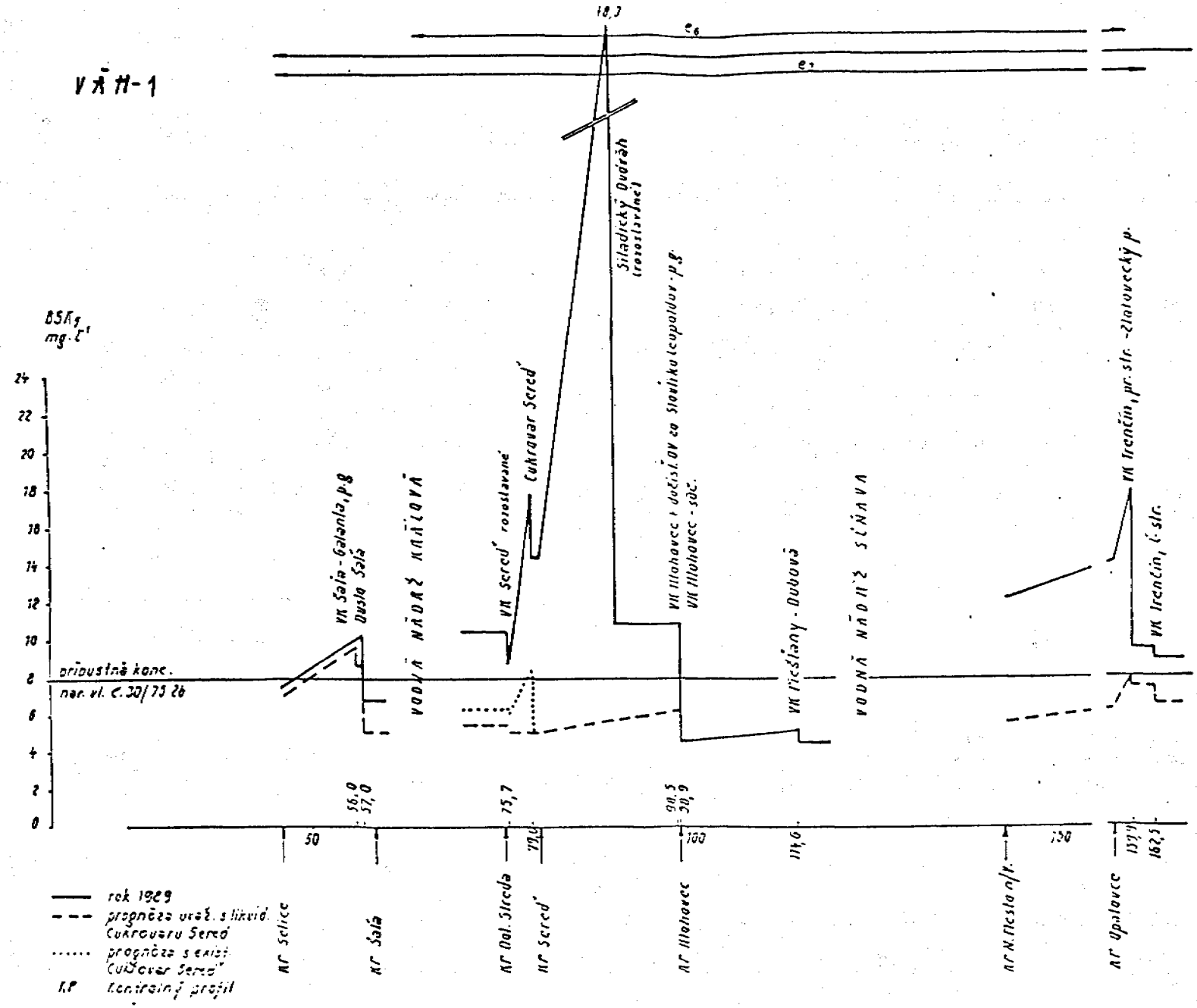


Fig. 5/a

Fig. 5 Schematic longitudinal profiles

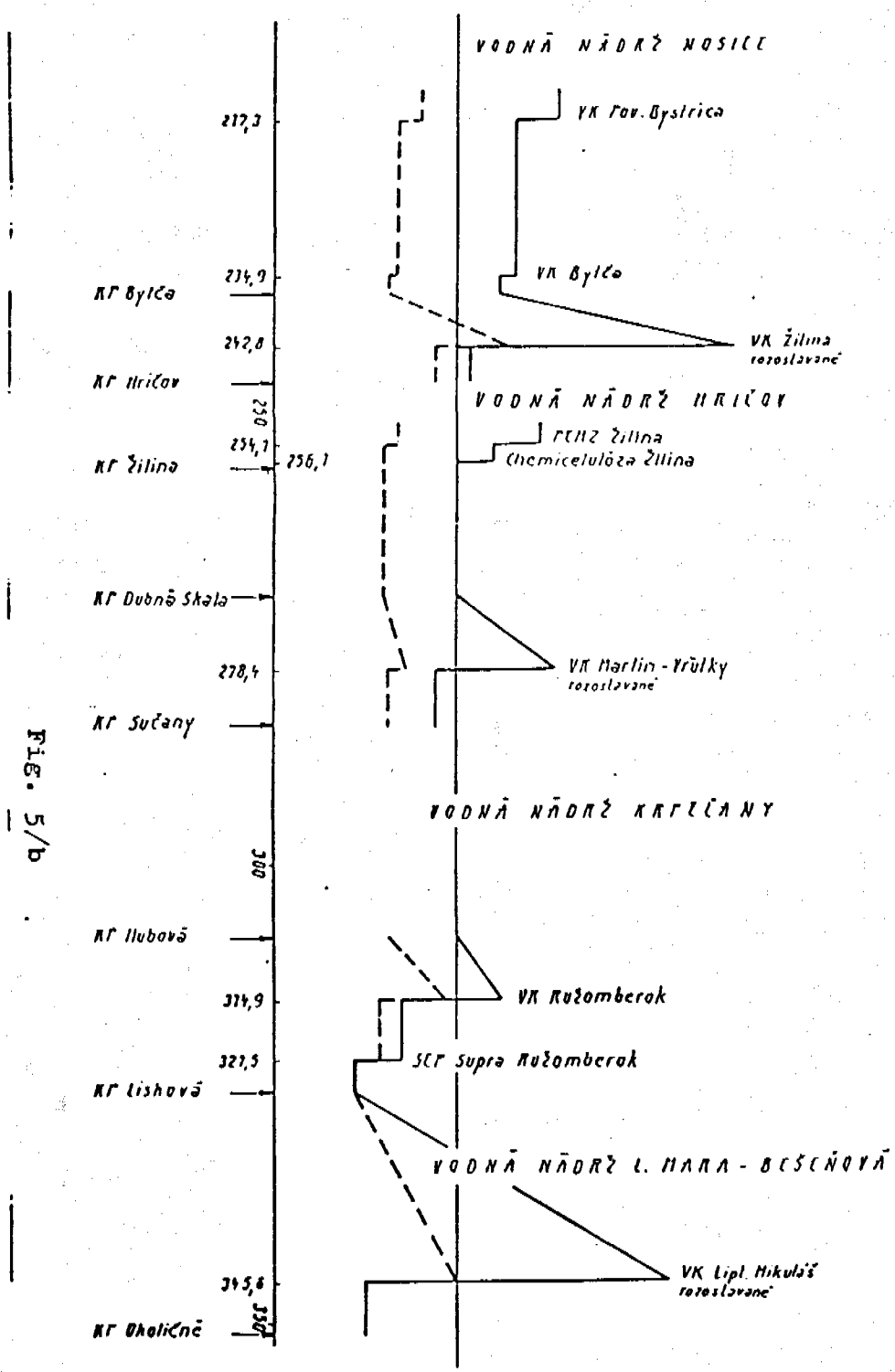

VÁH-2
VODNÁ NÁDRŽ NOSICE
VK Rov. Bystrica
VK Bytča
VK Žilina rozostavané
VODNÁ NÁDRŽ HRIČOV
ZSNP Žilina
Chemicelulóza Žilina
VODNÁ NÁDRŽ KRÁĽOVÁ
VK Ružomberok
SCP Supra Ružomberok
VODNÁ NÁDRŽ L. MARA - BEŠEŇOVÁ
VK Lipt. Mikuláš rozostavané
217,3
234,9
242,8
250
254,1
256,1
278,4
300
314,9
321,5
345,8
350
KP Bytča
KP Hričov
KP Žilina
KP Dubná Skala
KP Sučany
KP Hubová
KP Lisková
KP Okoličné

Fig. 5/b

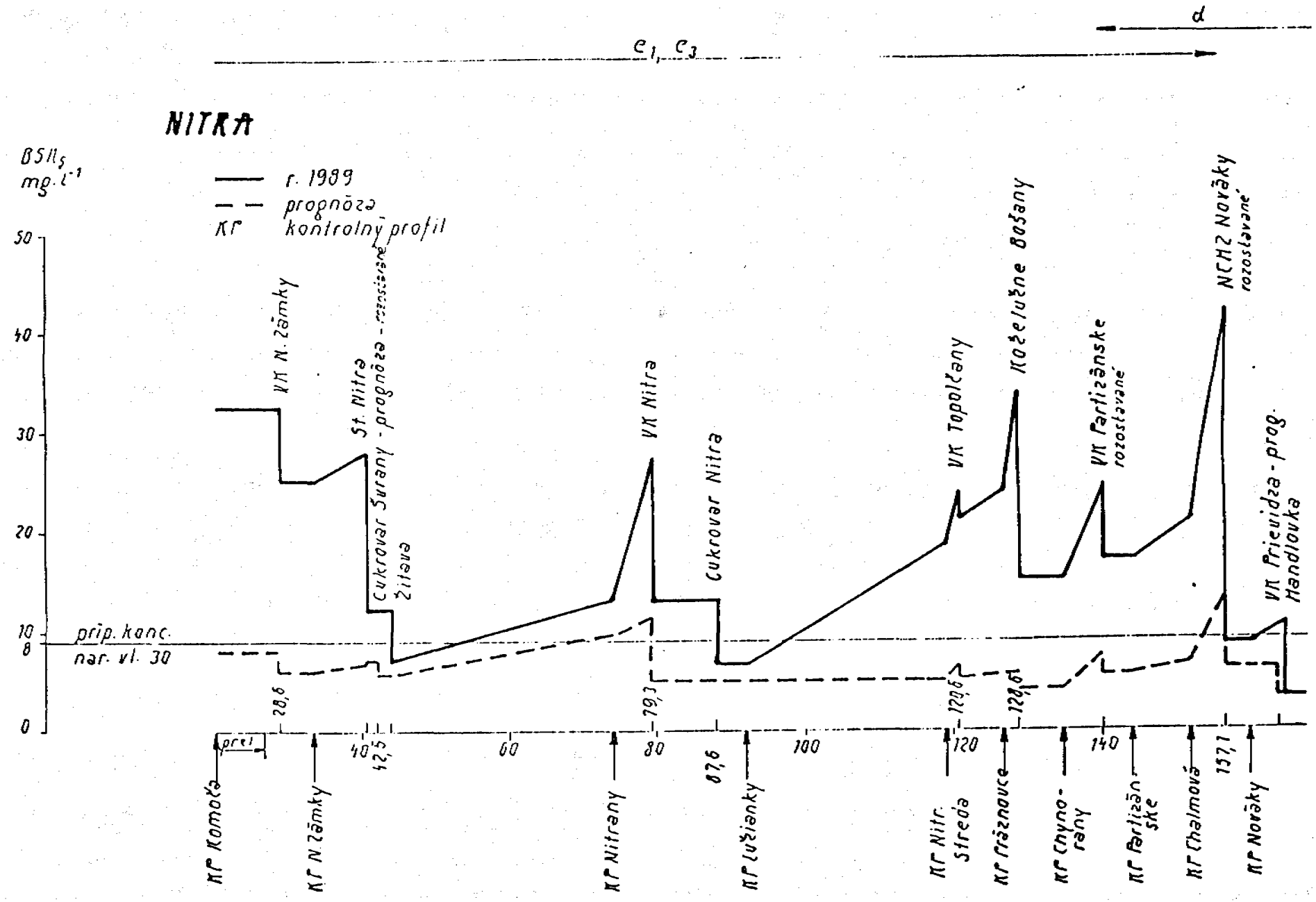

d
e1, e3
NITRA
BSK5 mg.l-1
r. 1989
prognóza
KP kontrolný profil
50
40
30
20
10
8
0
prip. konc.
nar. vl. 30
VK N. Zámky
St. Nitra
Cukrovar Šurany - prognóza - rozostavané
Žitava
VK Nitra
Cukrovar Nitra
VK Topoľčany
Rožeľušne Bošany
VK Partizánske rozostavané
NCHZ Nováky rozostavané
VK Prievidza - prog.
Handlovka
28,6
79,3
129,6
129,61
prel
40
42,5
60
80
87,6
100
120
140
157,1
KP Komoča
KP N. Zámky
KP Nitrany
KP Lužianky
KP Nitr. Streda
KP Rázsnovce
KP Chynorany
KP Partizánske
KP Chalmová
KP Nováky

Fig. 5/c

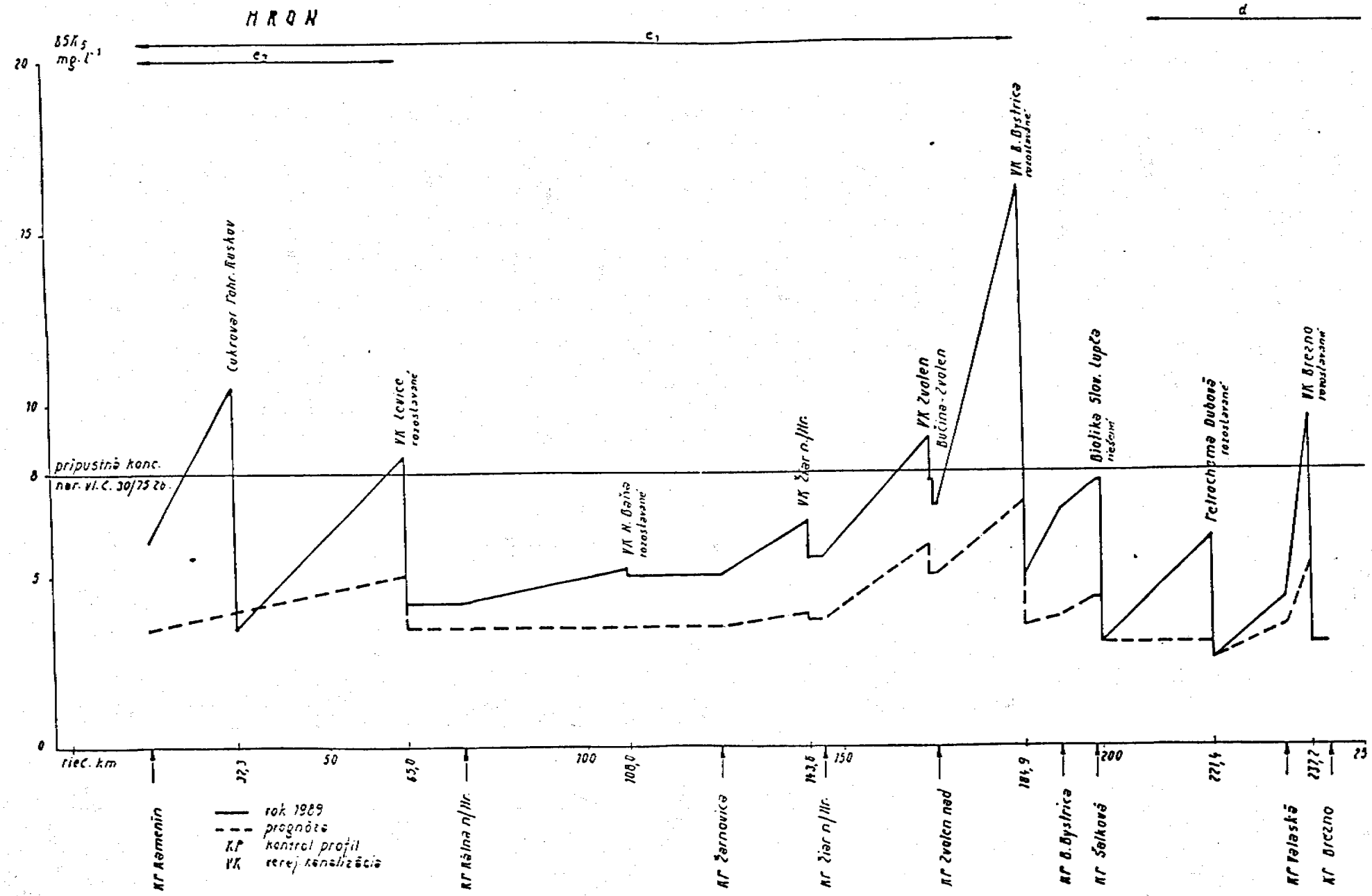

HRON
d
BSK5 mg.l-1
c1
c2
20
15
10
8
5
0
Cukrovar Tohr. Ruskov
VK Levice rozostavané
VK N. Baňa rozostavané
VK Žiar n./Hr.
VK Zvolen
Bučina-Zvolen
VK B.Bystrica rozostavané
Biolika Slov. Lupča nefunk.
Telrochema Dubová rozostavané
VK Brezno rozostavané
pripustná konc.
nar. vl. č. 30/75 Zb.
rieč. km
32,3
50
65,0
100
108,0
142,8
150
181,9
200
221,4
227,2
250
KP Kamenín
KP Kalná n/Hr.
KP Žarnovica
KP Žiar n/Hr.
KP Zvolen nad
KP B.Bystrica
KP Šalková
KP Valaská
KP Brezno
rok 1989
prognóza
KP kontrol profil
VK verej kanalizácia

Fig. 5/d

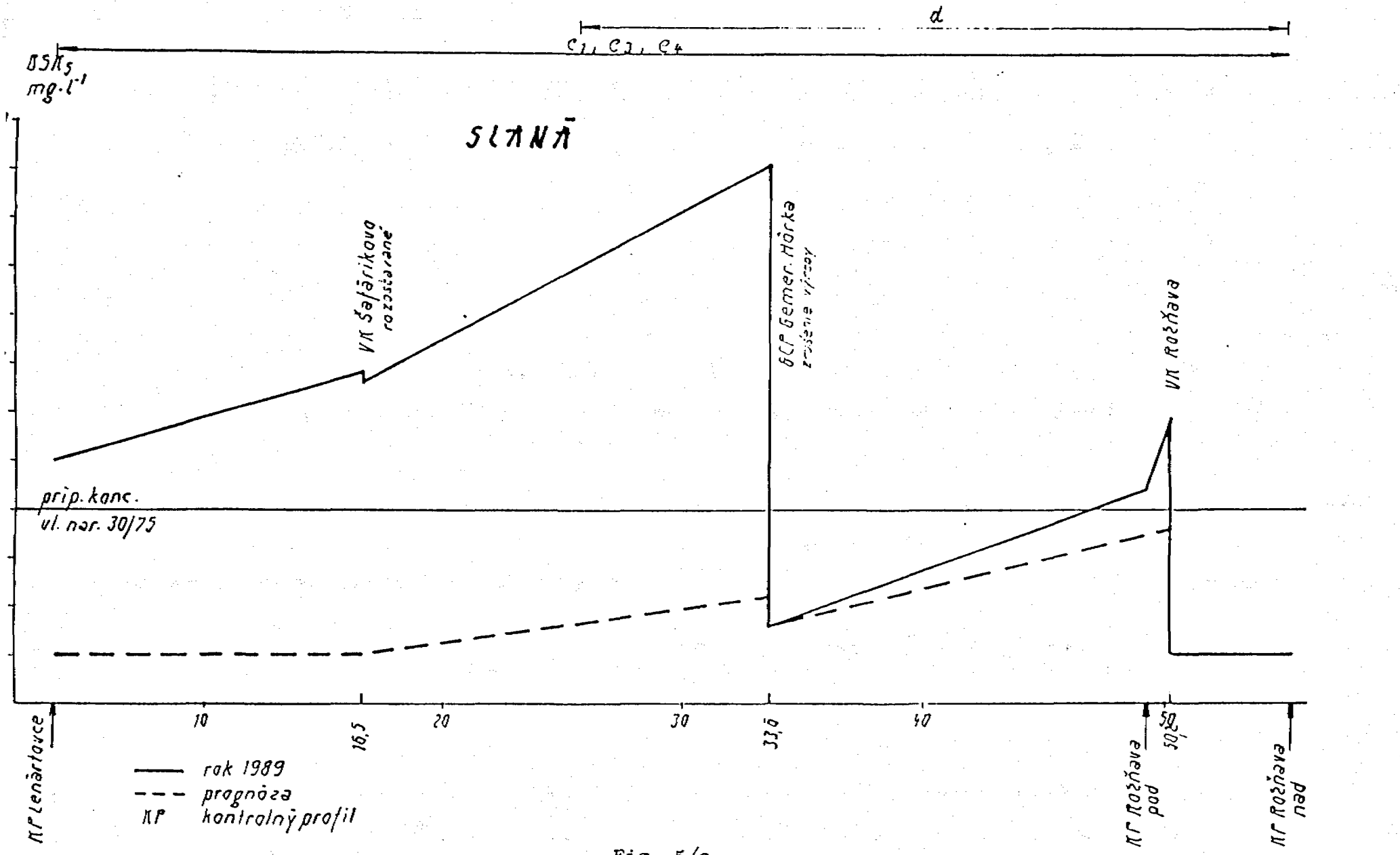
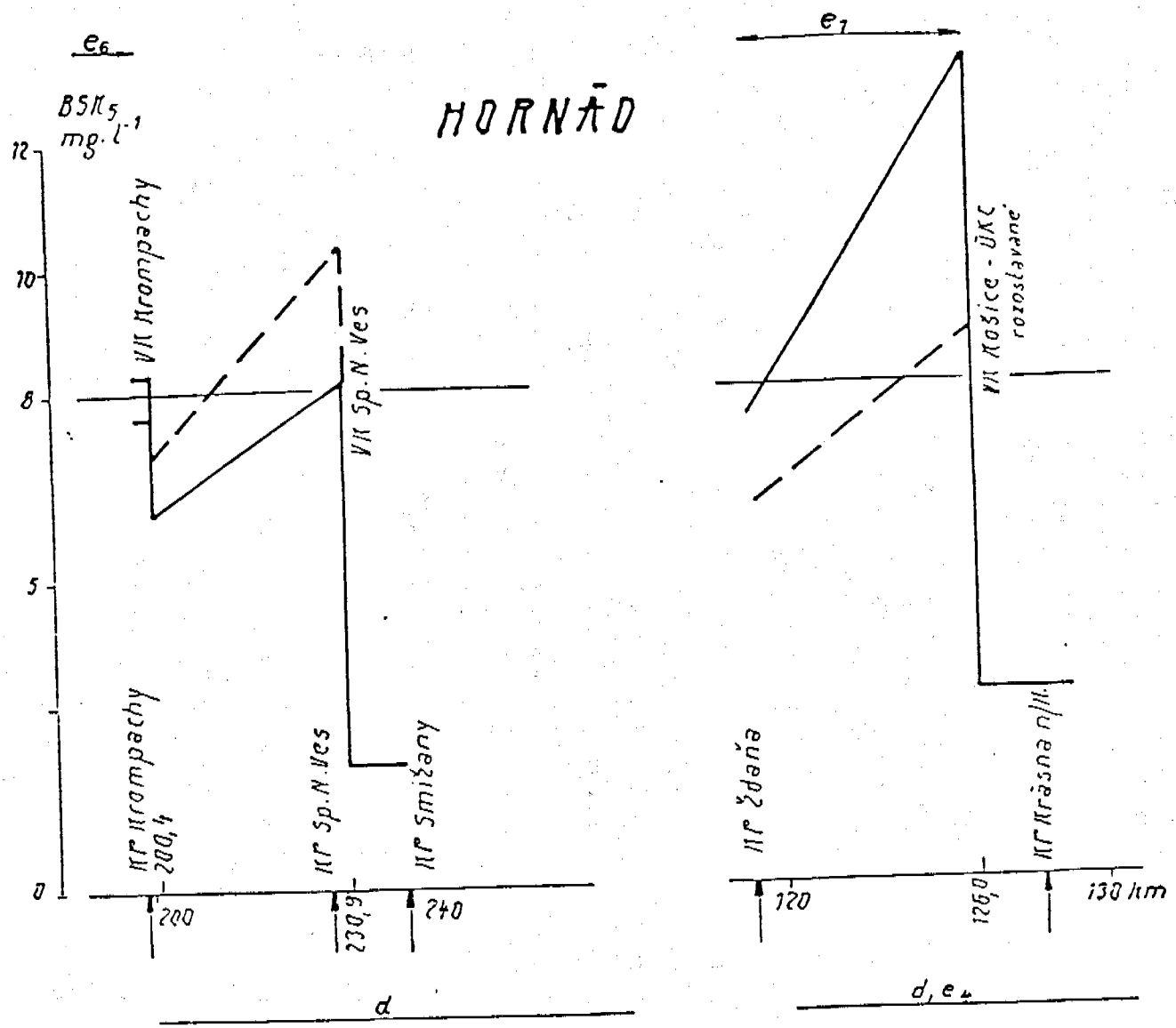

d
c1, c2, c4
BSK5
mg.l-1
SLANÁ
VN Šafárikova
rozšírenie
BČP Gemer. Hôrka
VN Rožňava
prip. kanc.
vl. nar. 30/75
10
16,5
20
30
33,0
40
50
50,2
KP Lenártovce
KP Rožňava pod
KP Rožňava nad
rok 1989
prognóza
KP kontrolný profil

Fig. 5/e


e6
BSK5 mg.l-1
HORNÁD
12
10
8
5
0
VII Krompachy
VII Sp.N.Ves
VII Smižany
HP Krompachy
200,4
HP Sp.N.Ves
HP Smižany
200
230,9
240
e7
VII Košice - ÚKC
rozostávané
HP Ždaňa
HP Krásna n/H.
120
126,0
130 km
d, e4

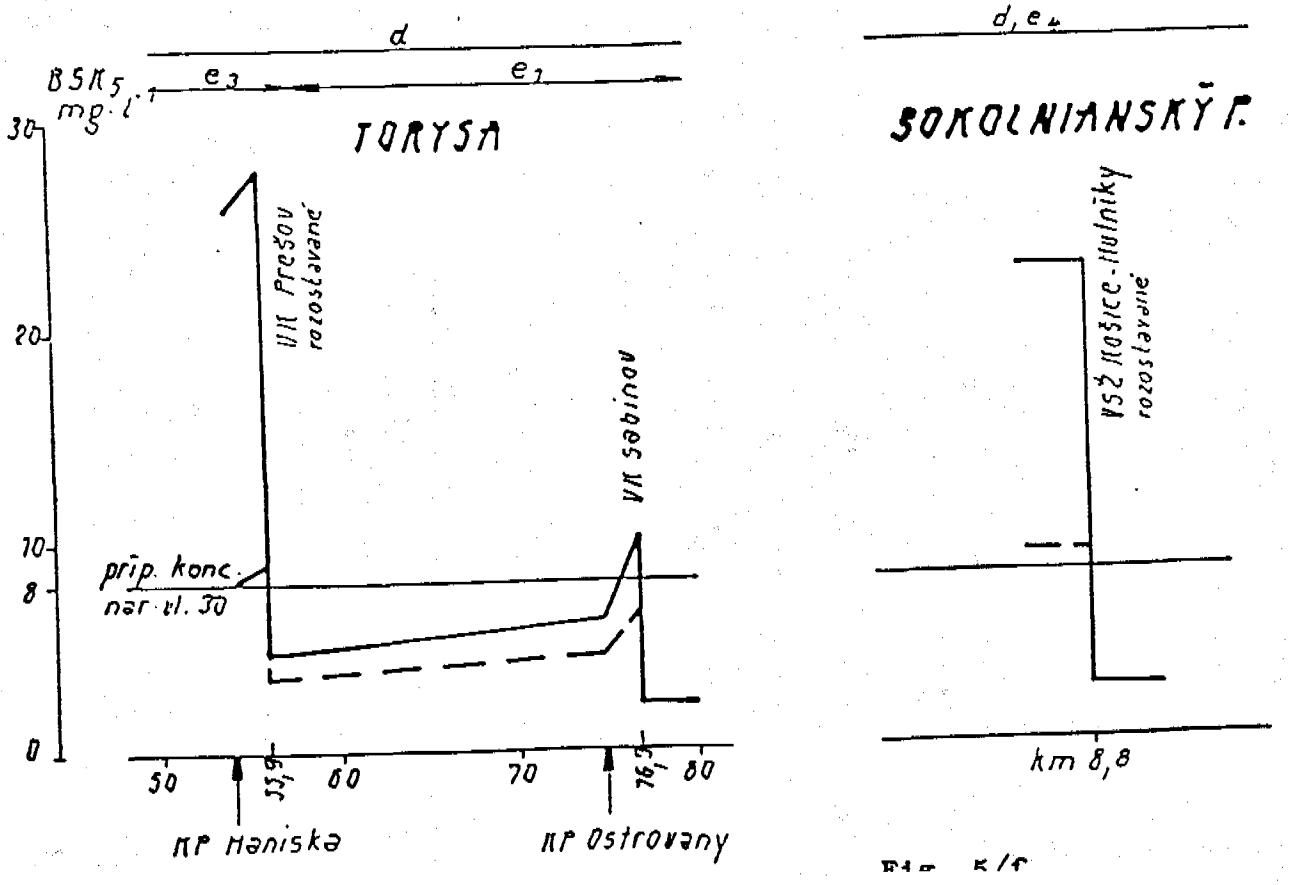
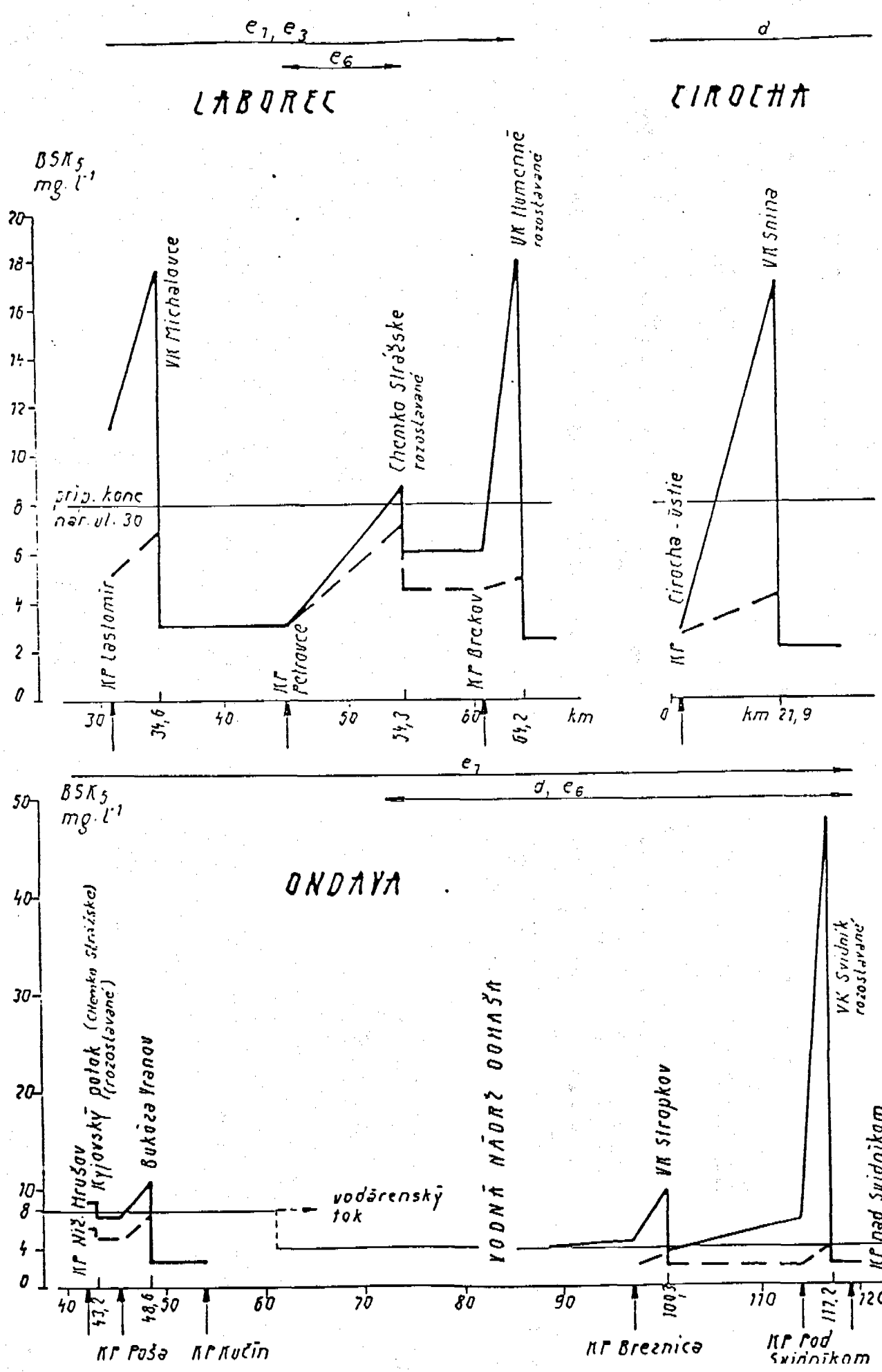

d
e3
e1
BSK5 mg.l-1
TORYSA
SOKOLNIANSKÝ P.
30
20
10
8
0
VII Prešov
rozostávané
VII Sobinov
prip. konc.
nar. kl. 30
VŠŽ Košice-Hulníky
rozostávané
50
55,9
60
70
76,5
80
HP Haniska
HP Ostrovany
km 8,8

Fig. 5/f


e1, e3
e6
d
LABOREC
CIROCHA
BSK5 mg.l-1
20
18
16
14
12
10
8
6
4
2
0
prip. konc nar. ul. 30
VK Michalovce
Chemka Strážske rozostavané
VK Humenné rozostavané
VK Snina
Cirocha - ústie
KP Laskomír
KP Petrovce
KP Brekov
KP
30
34,6
40
50
54,3
60
64,2
km
0
km 21,9
e7
d, e6
BSK5 mg.l-1
50
40
30
20
10
8
4
0
ONDAVA
Hrušov Kyjovský potok (Chemka strážska) (rozostavané)
Bukóza Vranov
vodárenský tok
VODNÁ NÁDRŽ DOMAŠA
VK Stropkov
VK Svidník rozostavané
KP Nižný
KP Pača
KP Kučín
KP Medzilaborce
KP Breznica
KP pod Svidníkom
KP nad Svidníkom
40
43,2
48,6
50
60
70
80
90
100,3
110
117,2
120 km

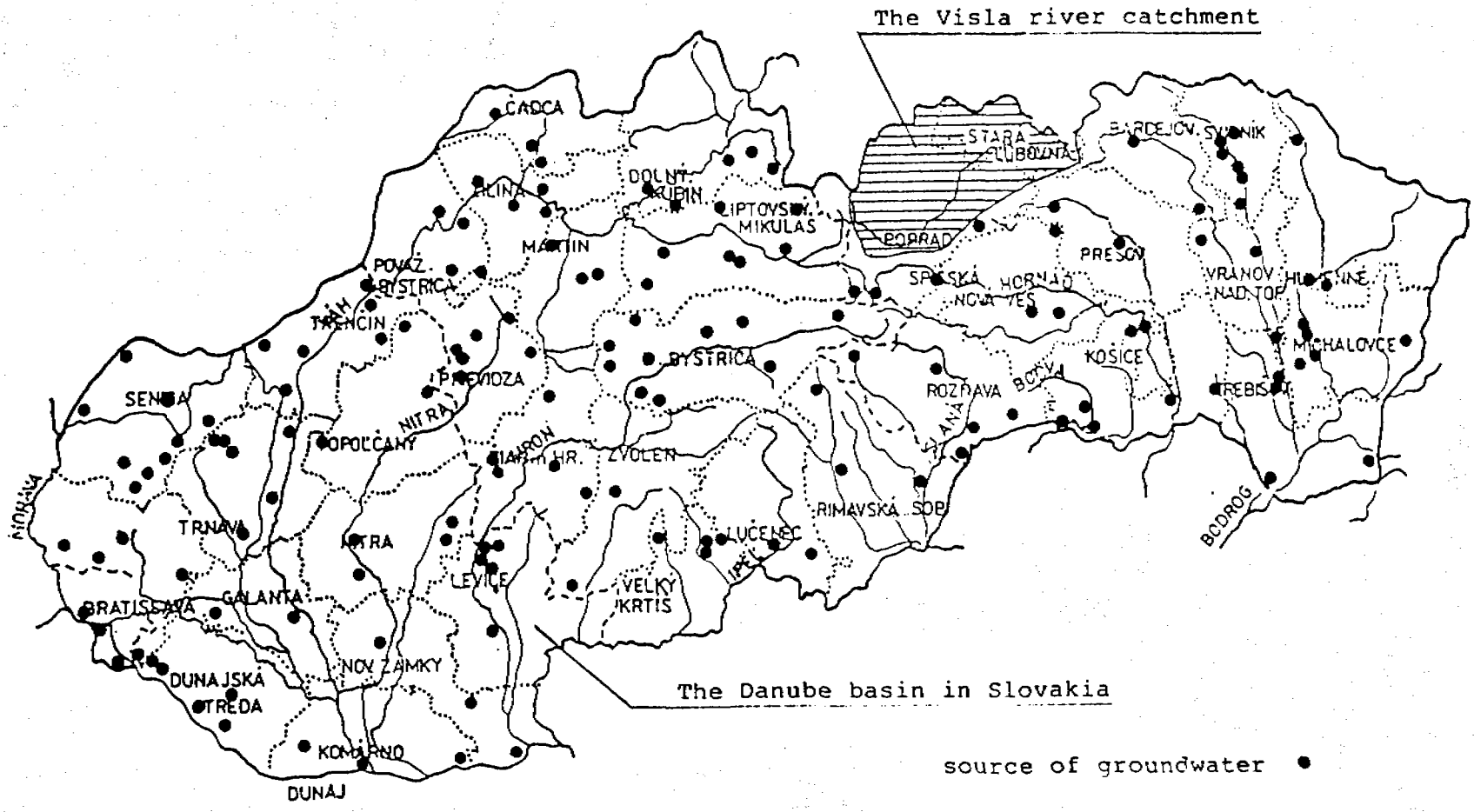


Fig. 6 Selected utilized groundwater resources on the territory of the Danube in Slovakia

Fig. 7a

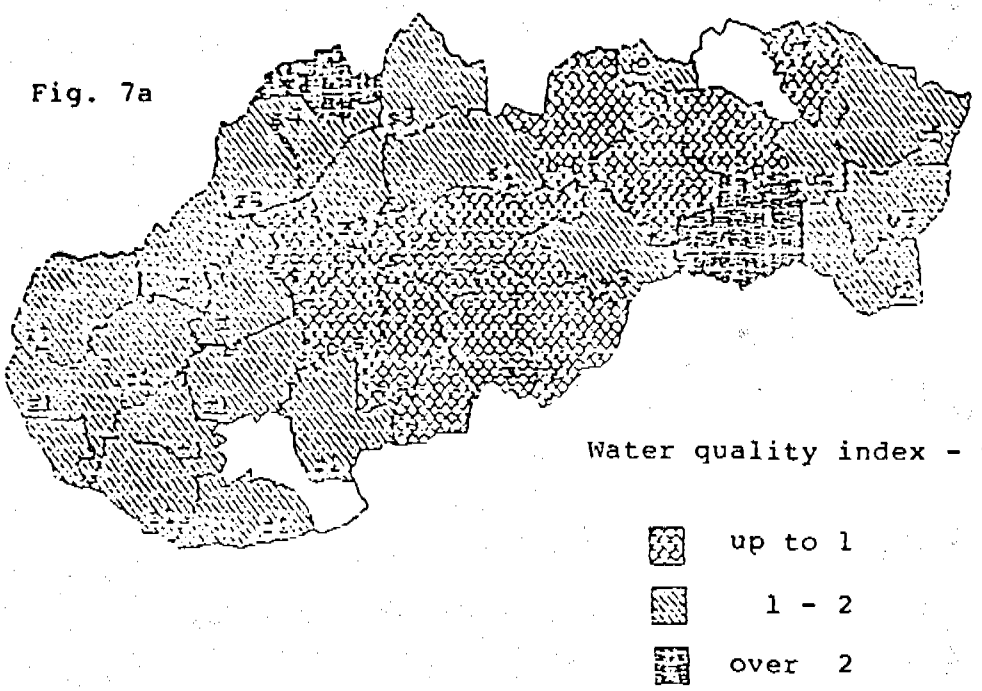


Fig. 7b

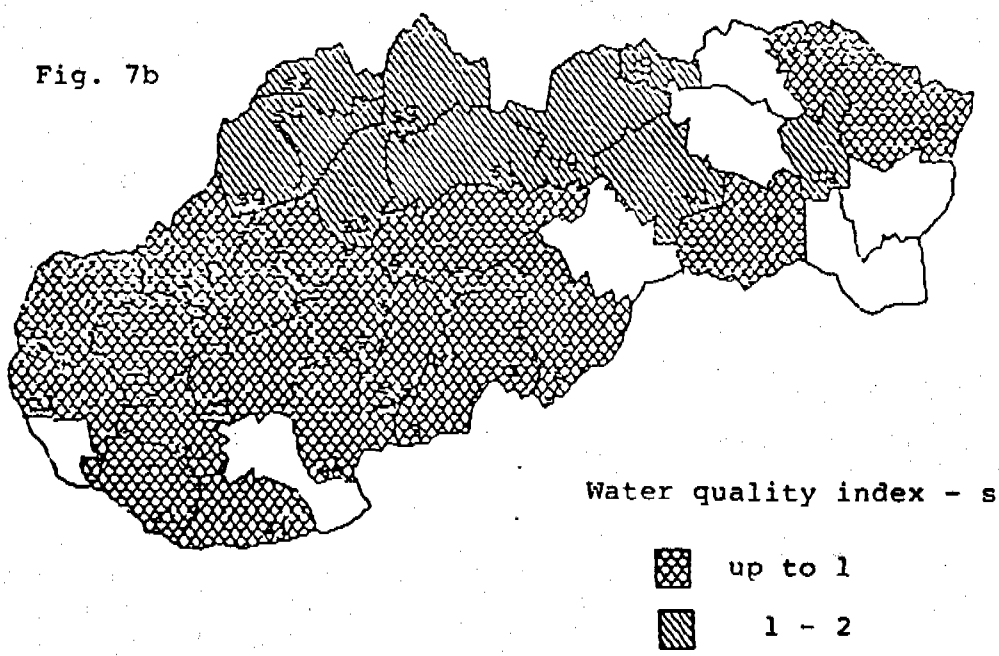
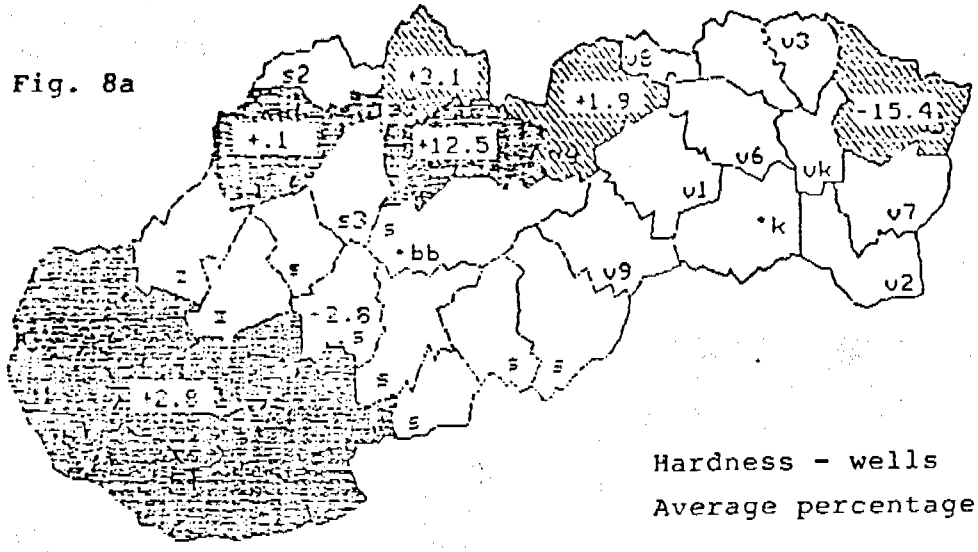


Fig. 7 Water quality state of Slovak water resources
absolute values of the water quality index

Fig. 8a



Hardness - wells

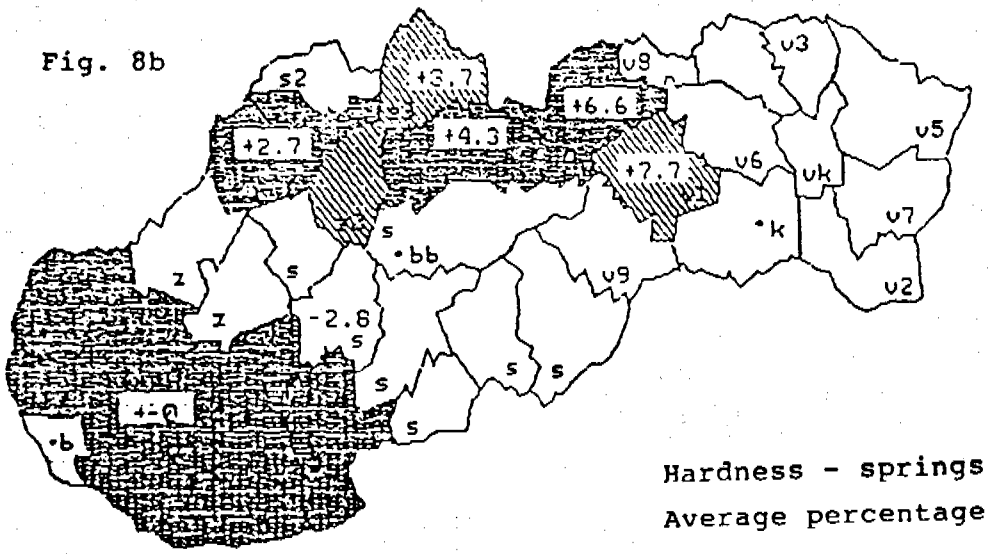
Average percentage of exceering

10 - 30 %

30 - 60 %

60 - 100 %

Fig. 8b



Hardness - springs

Average percentage of exceeding

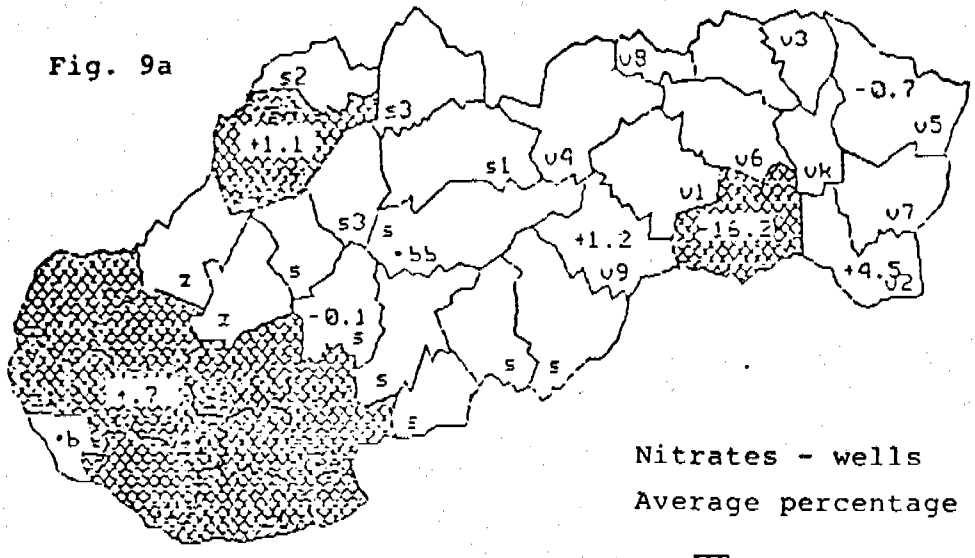
10 - 30 %

30 - 60 %

60 - 100 %

Fig. 8 Water quality state of Slovak water resources
average percentage of hardness exceeding

Fig. 9a



Nitrates - wells

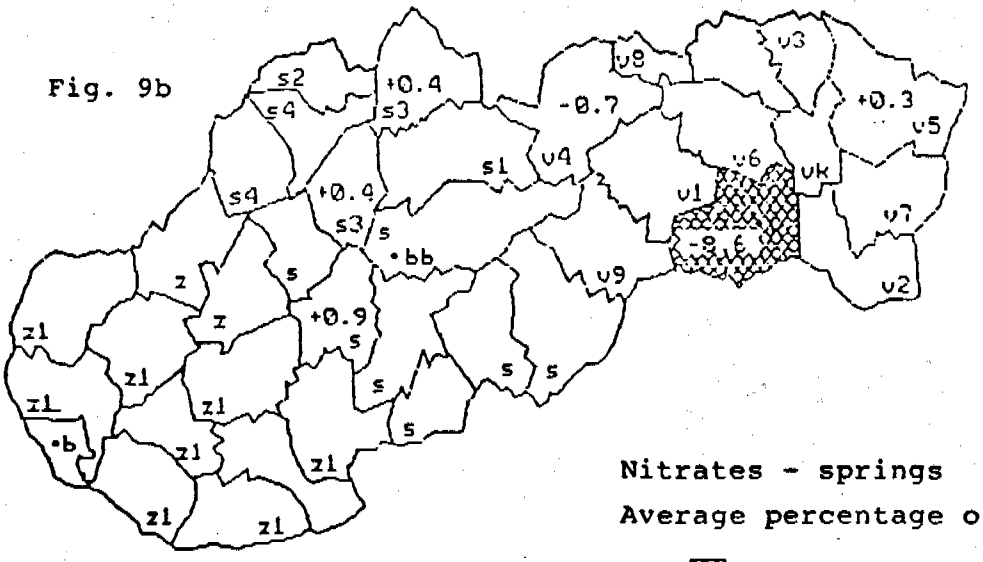
Average percentage of exceeding

10 - 30 %

30 - 60 %

60 - 100 %

Fig. 9b



Nitrates - springs

Average percentage of exceeding

10 - 30 %

30 - 60 %

60 - 100 %

Fig. 9 Water quality state of Slovak water resources
average percentage of exceeding of nitrates content

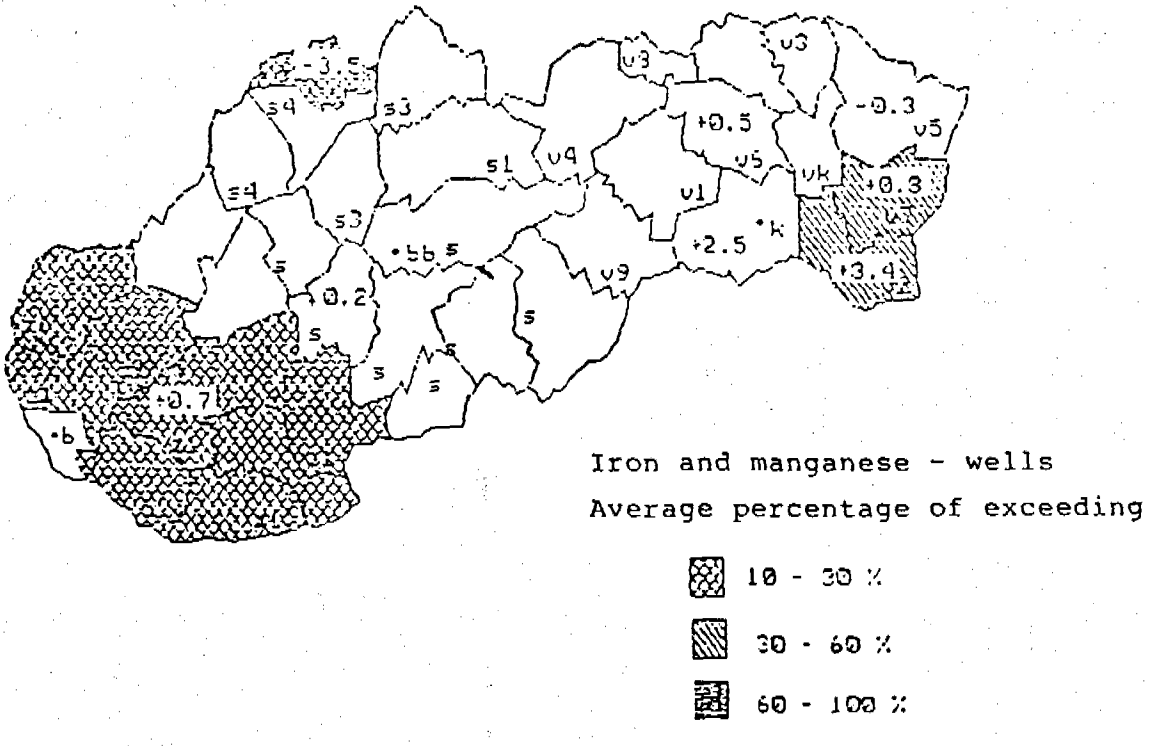
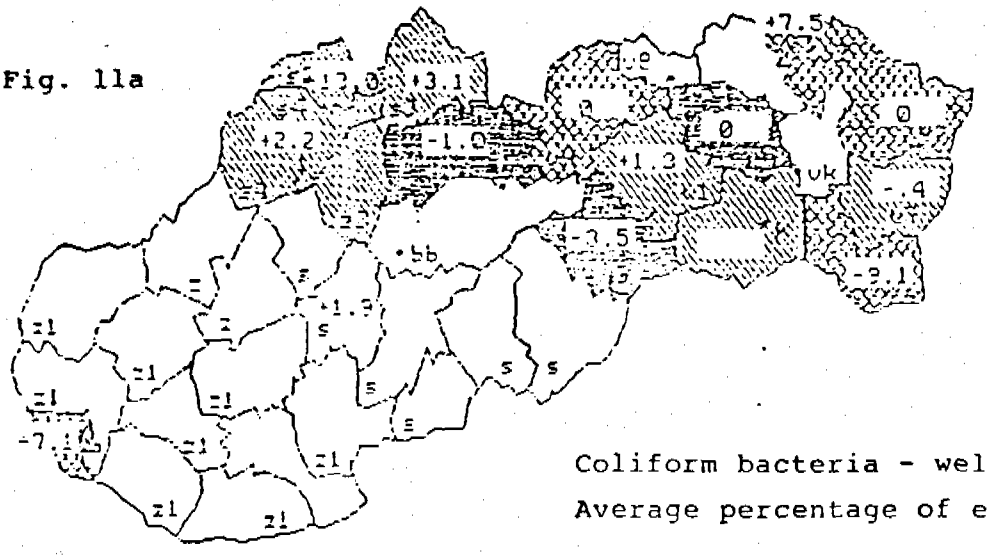


Fig. 10 Water quality state of Slovak water resources average percentage of exceeding the content of iron and manganese

Fig. 11a



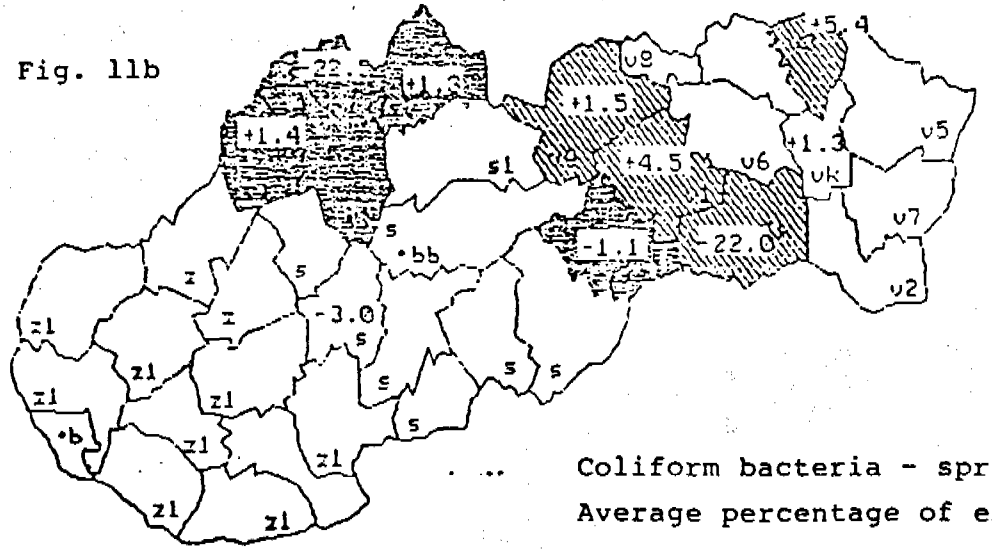
Coliform bacteria - wells
Average percentage of exceeding

10 - 30 %

30 - 60 %

60 - 100 %

Fig. 11b



Coliform bacteria - springs
Average percentage of exceeding

10 - 30 %

30 - 60 %

60 - 100 %

Fig. 11 Water quality state of Slovak water resources
average percentage of exceeding of the Coliform count

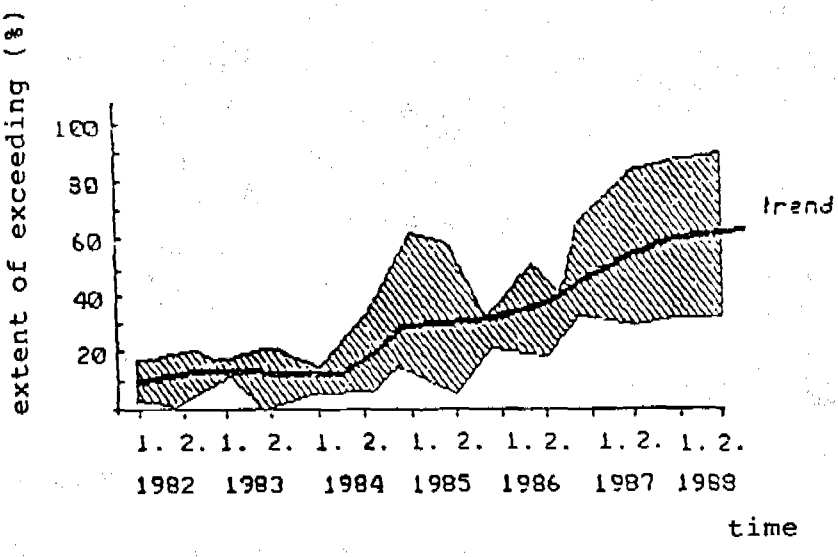


Fig. 12 Development of the extent of exceeding of maximum admissible concentrations (ČSN "Drinking Water") within the most important watermanagment regions of Slovakia. Evaluated characteristics of water quality: mineralization, nitrates, sulphates, chlorides, chemical oxygen demand.

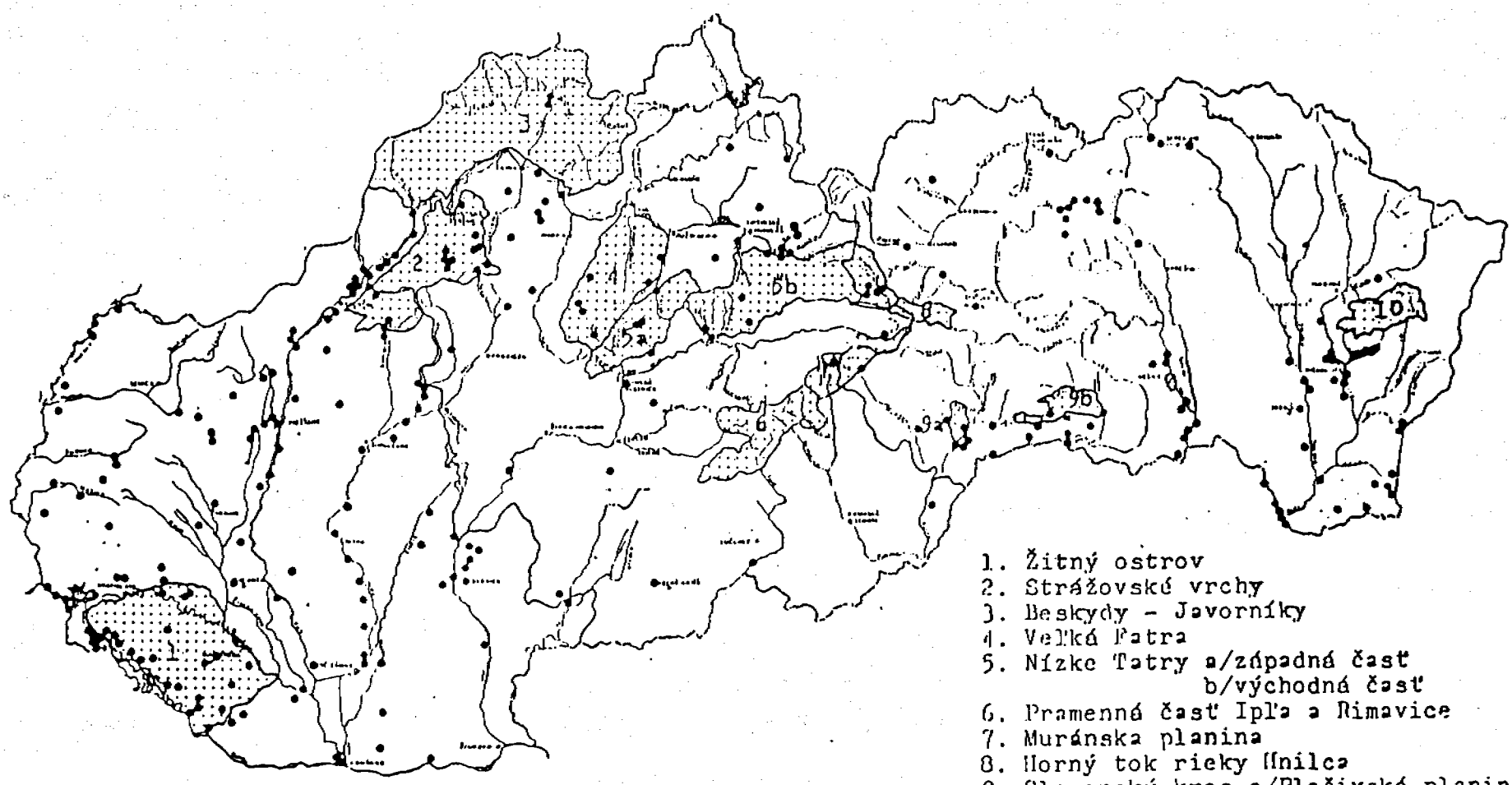


Fig. 13 Protected watermanagment regions in Slovakia and groundwater resources with capacity over 30 $l.s^{-1}$

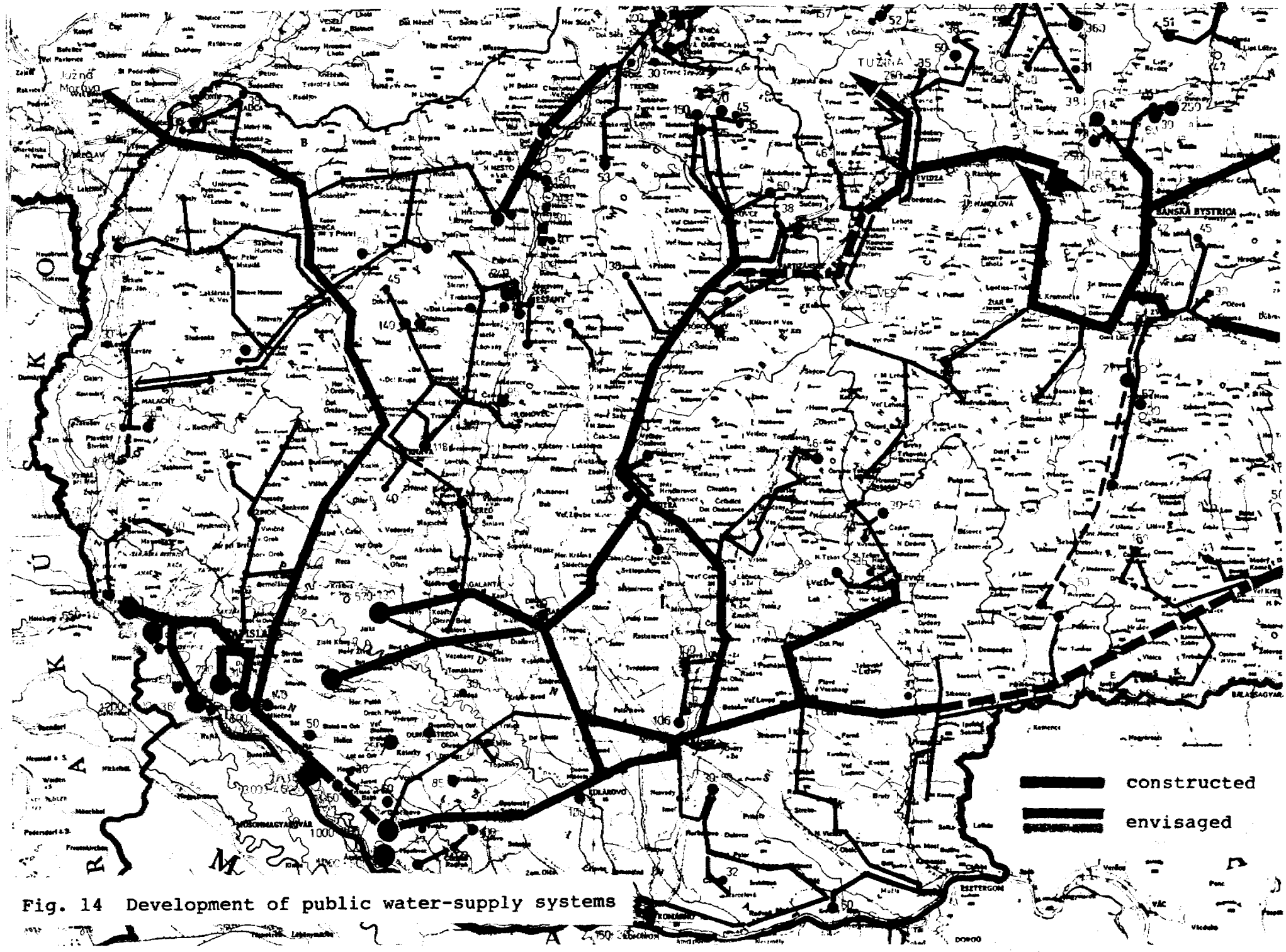


Fig. 14 Development of public water-supply systems

ANNEX 7 - C.S.F.R WATER QUALITY STANDARDS

1. The difference between the Czechoslovak Standard /ČSN/ 83 06 02 Classification of Surface Water Quality /valid until 30.6.1990/ and the Standard ČSN 75 7221 Classification of Surface Water Quality /valid from 1.7.1990/ is as follows:

   - the number of classification groups in the new standard is 5, meanwhile there were only four groups of classification in the former standard.
   - there is a more extensive number of parameters of pollution in the new standard as compared with the old one; which had 3 groups of parameters, the new one having 6 groups of parameters; they are:

     A - oxygen regime,
     B - basic physical and chemical parameters,
     C - supplemental chemical parameters,
     D - heavy metals,
     E - biological and microbiological parameters,
     F - radioactivity.

Also the number of parameters in respective groups is higher and more detailed as compared with the former standard. For instance in the group of the oxygen regime also COD-Cr and TOC are included /organic carbon/.

   - the parameter group D - heavy metals is new as well as the group F - radioactivity;
   - in the group B the attention has been focused on nutrients /N, P/;
   - in the group C nonpolar extractable substances NEL /petroleum products/, and extractable organic chlorine /EO Cl/ are included;
   - the method of classification is different: the old standard prescribed the most unfavourable average values from 12 samplings over the year. The new standard is based on a

set of 24 values measured in the course of one year, or two years and on the basis of those values the 90% of non-exceeding is computed.

2. The producers have been monitoring the amount and composition of wastewaters from their industry according to the Regulation on the evidence and balance evaluation of surface- and groundwater supplies and their quality.

   The river boards carry out the control of wastewater composition for the Waterconservancy Inspection.

3. The flow rate /discharge/ of wastewaters in $cu^3 . s^{-1}$ at the most important pollution sources is presented in the Annex 5 - column 10.

PART II: CZECH REPUBLIC

TECHNICAL REPORT

H Y D R O P O L, Estónska 22, 821 06 B r a t i s l a v a

WATER POLLUTION IN THE DANUBE RIVER BASIN ON THE CZECH REPUBLIK TERRITORY

I.Bernardová, P.Kříž, J.Sochorec, M.Škollová, M.Štamberová

translation: D.Josef

Mai 1992

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Water Pollution in the Watershed of the Danube on the Territory of the Czech Republic

1 The Character of the Watershed of the Morava River

The Morava River is one of the most important tributaries of the Danube in the central part of its stream.

The watershed of the Morava is situated predominantly on the territory of the Czech Republic (24,109.5 km^2). Just the watershed of the Lower Morava (2,283 km^2) is a part of the Slovak Republic (see Fig. 1). The whole watershed is divided into several partial watersheds according to the most important tributaries (see Fig. 2), the distribution and basic characteristic data about the watershed are given in Table 1; complementary data about individual watersheds are given in Section 1.1.

1.1 Basic data

The Morava River has its source under Kralicky Sneznik (mountain) 1,360 meters above sea level 1,360m. From the source on as far as the inlet of the Desna it has the character of a torrent, in the middle part the average slope (gradient) is about 0.1% and gradually it sinks down to the value 0.02% at the mouth of the Dyje (Thaya). During the year is the usual highest average through flow per month in March, the lowest in July and in October. The values of characteristic m-day and n-year through flows are given in the table 1a.

From the economic point of view is in the upper part of the watershed the relation between industry and agriculture more or less balanced, in the central part of the stream where the Morava flows through the Upper Moravian and Lower Moravian valley, the territory has an explicitly agricultural character. The industry is concentrated in larger towns - Olomouc, Prostejov, Uherske Hradiste and Zlin. From the water management point of view the quality of water is negatively influenced by the foodstuff industrial plants especially the sugar mills.

The river section of the Morava from the inflow of the Dyje as far as the mouth into the Danube — the so-called Lower Morava — is treated within the scope of the watershed of the Danube.

The Becva

The river Becva is the most important left hand side tributary of the Morava. It brings the water from the territory strongly covered with woods, from places (localities) rich in rainfall. The whole river system of the watershed of the Becva has the character of mountainous streams with the slope (gradient) 0.75%, which sinks to the value 0.12% in the lower part of the watershed. The months being the richest in waterare March and April, with the driest month July.

From the point of view of water management it has the character of industrial and agricultural river with agriculture predominating. Numerous industrial plants are just in the lower part of the watershed.

The Svratka

The Svratka as the largest tributary of the Dyje has on the whole a favorable quantity of water and the orographic arrangement and geological relations give the possibility of economic exploitation by valley reservoirs. The Svratka with its most important tributary the Svitava drains the water from the large part of Western Moravia. In the lower part of the stream from Brno to the estuary into the Dyje the Svratka has the character of a lowland stream with a small gradient (slope). In the watershed the industry is predominating over the agriculture especially in the Brno agglomerations.

The Jihlava

The Jihlava and its main tributaries the Oslava and Rkytna drain a considerable part of the territory of Western Moravia. The watershed is from the point of view of discharge quite important as the Jihlava, the Oslava and Tokytna belong to the poorest streams in the quantity of water in the watershed of the Morava. The Jihlava — as much the same as the Svratka — flows into the Kyje or into the central reservoir of the Nove Mlyny reservoir. The average relative slope (gradient) of the Jihlava is that of 0.27% and the torrent character is preserved just on its upper stream.

The watershed of the Jihlava is from the economic point of view of agricultural character with a smaller share of arable and wooded land. From the point of view of industrial usage the watershed

of the Jihlava is not an important area and individual plants are on the whole uniformly spread all over the whole watershed with a larger concentration in Jihlava, Trevic and in Velde Mezirici.

The Dyje (the Thaya)

The Dyje drains the waters from the western and eastern parts of the Czech-Moravian Highlands and from the part of northern Austria. The most important tributaries of the Dyje are the Jihlava, the Svratka, the Pulkava and the Jevisovka. The river Dyje is the largest tributary of the Morava and it is even longer than the Morava if we take into account the length of both rivers from the confluence to their sources. There is however less water in it as the rainfall area of the Czech-Moravia highlands has a smaller tributary. The annual average rate of flow of the Dyje considerably increase the quantity of water of the Morava under the confluence. The average slope ()gradient) of the Dyje is 0.16%.

The watershed of the Dyje is of the agricultural character, especially in the lower dale part of the watershed. The most important industry here is food production.

1.2 The Quality of Water in the Streams

1.2.1 The Regular Investigation of the Quality of Water

The permanent and regular investigation of the quality of surface waters in selected observation profiles has been occurring since 1963. The samples of water are taken once a month.

At present there are on the territory of the watershed of the Danube in the Czech Republic together fifty of these observation spots, from among them directly on the stream of the Morava 10, on the stream of the Dyje 5, and the others on their tributaries. In the samples taken from the streams there are determined approximately twenty basic chemical indicators and the contents of bacteria. The determination of heavy metals and specific organic matters is not permanently carried out in these profiles. Such analyses of the surface waters are carried out just for certain purposes, when preparing various studies and projects. Since 1991 when the new standard for the quality of drinking water is valid these special matters are analyzed to a larger extent on the spots of samplings of the surface water for its preparation to the quality of drinking water.

The regular samplings of the surface waters and their chemical analysis are carried out by the authority being in charge of the stream — the enterprise "The Watershed of the Morava."

The obtained data are registered and evaluated by the Czech Hydrometeorological Institute and by the Water Research Institute. The evaluation is carried out annually and in five year periods. Even if the systematic analysis of the quality of surface waters is perhaps not sufficient as far as its extent is concerned it is considerably demanding as far as its capacity and finances are concerned. One of the limiting factors on further extension of regular monitoring is also its insufficient equipment of laboratories with levorotary technology needed.

As a complement of chemical monitoring the regular biological monitoring in the Czech Republic has been used since 1976. In the watershed of the Morava there are selected approximately 500 analyzed profiles in such a way as to catch the quality of water in the stream above and under each larger pollution. From the results of the analysis of the biological sample there is calculated especially the saprove index so that this system of biological monitoring gives a sufficiently detailed image about the pollution of streams by organic matters.

In the map on the Fig. 3, is drawn the situation of organic pollution of streams during the period 1986-90 found out on the basis of biological monitoring. On the next map there are indicated the spots of regular chemical monitoring.

In case of need there are for some streams constructed detailed longitudinal profiles of qualitative indicators. In Fig. 4 is given the example of the longitudinal profile of the river Morava in the Section Husovice Spytihnev according to BOD by low levels of water (Q350/day) constructed for the condition from 1988. Into the calculation are integrated the point sources of pollution and also the most important tributaries. The starting data were represented by the values of concentration BOD_5 in permanently analyzed profiles. In the calculation the self-pollution in the stream was considered as well. In the figure is given also the outlook-perspective ideal longitudinal profile. It was constructed on the basis of the longitudinal profile of the contemporary situation and the perspective data dealing with the pollution being discharged after the construction of all water treatment plants needed. Further input data were the values of natural pollution that represent during the calculations the limit of not underestimating. It also starts from the precondition that the loading of the stream by the area pollution will not increase.

1.2.2 The Analysis of the Quality of Water in the Streams

For the analysis and estimation of the quality of water in the streams and for the classification of the streams according to the cleanliness (purity) we use in Czechoslovakia the standard CSN 757211, which has been valid since 1990. In Table 3 there are some profiles in the Morava watershed and their evaluation in selected indicators according to this standard from 1986 through 1990. The classification into the classes of purity is carried out according to this standard on the basis of characteristic value with 90% probability of not surpassing.

The largest problem of the quality of water in the watershed of the Morava until now is the loading of streams by means of organic matters from point sources with insufficient or zero water treatment of waste waters. In autumn and winter periods the quality of water is further worsened by seasonal operation of sugar mills. Therefore there are given in Table 3 also the values for the period outside the sugar mill period.

The territory being analyzed is charged by waste waters from other states with the exception of the river Dyje which flows partially through Austrian territory and partially along the border.

The main stream flow of the river Morava has a relatively good quality of water in the upper part as far as to the profile Hanusovice, where the construction of a water reservoir is being considered.

In further section as far as the confluence with the Desna the quality is worsened especially due to several plants of the paper mill industry. Under Desna the quality of water is negatively influenced by the town Sumperk and further communities. An important improvement of the quality of water occurs in the section Litovel-Olomouc, where the stream was maintaining its natural character with numerous dead channels and meanders in the zone of meadow-land woods.

Under the town Olomouc the river is considerably devastated by the pollution from this agglomerations having not a sufficient capacity water treatment plant. Under Olomouc the character of the watershed is also being changed — as far as the confluence with the Dyje it is the question of an intensively agriculturally cultivated landscape with a high density of inhabitants. The quality of water in the river Morava is deteriorated not only by the local community's pollution, but by agriculture as well and by the food stuff factories.

The most important tributary of the Morava is the river Becva. From the point of view of the oxygen regime and the basic chemical indicators it is in a relatively good condition along its whole length of flow, especially due to the finished construction of important water treatment plants but also due to sufficient quantity of water and favorable natural conditions. At present great attention is paid to the contents of heavy metals both in water and in the river sediments and in biomass. The reason of the increased contents of the materials could be the electrotechnical and glass industries in the watershed, partially it may be the question of the increased natural backgrounds being in connection with geological structure of the spring area (the chain of mountains the Beskydy).

Other tributaries of the river Morava in the central part of the watershed have a very bad quality of water. Some tributaries have the oxygen regime even in the not seasonal period in 5th class of quality and also further basic chemical indicators including the contents of nutrients are on a high level.

The river Valova is a water stream with very little quantity of water which cannot balance the pollution from the town Prostejov in spite of the fact that this town disposes of relatively well-working water treatment plant. The river Drevnice is loaded with wasted waters from the town Zlin and Otrokovice, the Hana, the Blata and further streams are devastated by waste waters from the sugar mills.

The river Dyje has a relatively good quality of water with regard to natural conditions and due to the fact that it flows through border land near the frontier of Moravia. This area is not very developed. The part of the area above the Nove Mlyny reservoirs is however devastated under the influence of the Austrian brook Pulkava and of the plants in Pernhofen. This source of pollution caused in the past catastrophic situations on the Upper Nove Mlyny reservoir.

From among the tributaries of the Dyje the most important is that of the Svratka — on the Svratka is situated the largest town of the whole area — Brno. The watershed of the Svratka above Brno has mostly a favorable quality of water with the exception of partial sections under more important sources of pollution. Some indicators of the quality of water are not however satisfactory with regard to the fact that water from the reservoir of Vir is used for the supply with drinking water.

An important potential source of water pollution in the watershed of the Svratka above Brno is represented by the radioactive wastes from Uranium Mines at Dolni Rozinka. The river Svratka under Brno including its tributaries — first of all that of the Litava — are in the traditional indicators

of water quality one of the worst affected areas in the Czech Republic. The river Svratka has not water enough for thinning the remnant pollution from the Brno waste water treatment plant. In this way the influence of Brno is obvious as far as to the reservoirs of Nove Mlyny.

The *Litava* river flows through intensively exploited landscape; very few communities here however dispose of corresponding waste water treatment plants.

In the watershed of *the Jihlava* — having a relatively good quality of water — there is situated on the river Oslava the reservoir Mostiste. The reservoirs on the river Jihlava by Mohelno supply with water the nuclear power plant Dukovany. The radioactivity of the river is constantly analyzed in the profile Mohelno and Jihlava — monthly.

The above mentioned evaluation of the quality of water starts from the systematic monitoring as it is mentioned in the chapter 1.2.1. In the analyzed profiles there are the data dealing just with the basic indicators, the evaluation does not cover the matters as tenzids, raw oil materials, fenols etc as they are watched and analyzed constantly. This situation should be improved as early as possible as various industrial plants including the chemical industry and a large usage of various preparations in agriculture indicate — in the same way as the results of partial investigations — that the values of these indicators may be in the streams rather high.

1.3 Underground Waters

1.3.1 Evaluation, Quantity and Exploitation of Underground Waters

The importance of underground water as a permanent and most suitable source for the supply of drinking water is considerable, especially from the point of view of sanitary and economic situation. It is therefore the interest of the society to exploit these sources in an economic way, to reserve them with priority for the supply with drinking water for the inhabitants and to secure their protection against pollution.

Under the term "the sources of underground water " we understand in common water management practice those underground waters that may be first of all exploited for the purposes of supplies of drinking water and of service water.

The hydrogeological region is limited from the points of view of geology, structural geology and hydrogeology as a whole in which the uniform circulation of underground water of a certain type

prevails. The region limited in this way is at the same time the basic unit for the balance of the sources of underground water and it may be articulated into further parts according to local conditions.

On the territory of the watershed of the Morava there are limited 29 hydrogeological rayons; from them 20 rayons are situated withy their whole area in partial watersheds of the watershed of Morava and 9 rayons partially cover the neighboring partial watersheds. The general survey of the hydrogeological rayonization on the territory of the watershed of the Morava is given in the enclosure (Fig. 5).

The proper evaluation of the exploitable sources of the underground water lies both in the appreciation of the exploitable sources on the basis of the results of the hydrogeological investigation and in the performance of water management balances on the basis of the documentation of the sampling of underground water. In the evaluation of the sources of underground water we start from the limited hydrogeological rayons as the basic balance unit.

The results of the general hydrogeological investigation of the territory of the watershed of the Morava are rather irregular and in spite of considerable number of works performed there exist — for the time being — the documents for the evaluation of exploitable sources of underground water of heterogeneous character (Fig. 5, Table 4).

In the watershed of the Morava the interest of hydrogeological investigation is concentrated mostly on the sources of the underground water in Tertiary and in Quartiary deposits. A part of sources being interesting and important from the hydrogeological and water treatment point of view is bound to the area of the Czech chalk reaching with its projections the territory of the watershed of the Morava.

The sources of the underground water are always evaluated in categories characterizing the detailed sort of evaluation. For the balance of underground waters from the point of view of water management the starting point is the documentation of registration of the level of hydrogeological investigation and the sources are classified in categories A, B, C1, C2. In cases when the documentation does not satisfy these categories, the sources are indicated as "prognostic." Individual degrees of the level of investigation are characterized in this way:

Category A — a complete clarification of conditions of the deposit of layers is secured. Also is secured the explanation of the structure and pressure conditions of watered horizons, of the quality

of water, of filtration properties of pervious rocks, the connection of underground water s being evaluated with the waters of the other watered horizons and surface waters.

Category B — there are explained the main peculiarities of the conditions of the deposits, structure and saturation of watered horizons, of the quality of water and mutual relations between the surface and underground waters.

Category C1 — there is secured a rough explanation of the structure of the quality of water, the conditions and deposit of watered horizons.

Category C2 — the provisions fixed on the basis of general geological-hydrological conditions, approved by the investigation of the water saturated horizon from different points of view or analogies with sections having been investigated.

At present we have investigated:

in cat. A	50 l/s
in cat. B	73 l/s
in cat. C1	873 l/s
in cat. C2	7684 l/s
prognostic sources	3030 l/s

The above mentioned total values of the evaluated quantities involve the present sampling and a part of the sources that cannot be exploited under present conditions either for technical-economic reasons or for unsuitable conditions of quality (for the reason of the protection of the agricultural fund of soil, for increased contents of some hard removable chemical matters or for increased radioactivity of water).

A survey of samplings of the underground water in the watershed of the Morava is as follows:

public water-mains 224	mil.m³/year
supplies from domestic wells 10	−"−
agriculture-animal production 7	−"−
industry and the others 28	−"−
The Watershed of the Morava in total 269	**mil.m³/year**

The sources of the underground water fixed by law dealing with waters with priority use for the supplies of drinking water play at present in the watershed of the Morava in the present degree of development of public water-mains an important part. The exploitable richness of underground

sources represents 55% of all sources of drinking water. In spite of this fact the watershed of the Morava as a whole cannot be considered as a territory being especially rich in sources of underground waters,. The occurrence of hydrogeologically suitable structures with the possibilities of catching larger quantities of underground water is distributed in the relation to the needs in a very unequal way and it is concentrated on a relatively small territory. Important sources of underground water occur in hydrogeological rayons of Quartiary sediments of larger streams (especially of the Morava, the Dyje, the Svratka, the Becva) and in the rayons of chalky racks in the north-eastern part of the watershed. Very unique is the occurrence of more important sources in the rayons of neogenneous deposits. A specific phenomenon from the point of view of exploitable quantity of water is the catching area of the Brno water-mains by Muzlov and Brezova in chalky formations. The source has been used since 1913 in the quantity 300 l/s and in 1975 another catching with an average richness of 750 l/s was started. The water being caught corresponds in its quality to the drinking water; it will be however necessary to pay great attention to the problems of the protection of the infiltration zone of the source against the pollution, especially from the part of agricultural production.

The predominant part of the territory of the watershed of the Morava formed by crystalline rocks (the Czech Massive) and by flysh (the Carpathian system) has a lack of underground water and the sporadic sources of low richness may be taken into account just for individual supplying of a low number of inhabitants.

1.3.2 The investigation of the Quality of Underground Water

Drinking water is defined in CSN 75 7111 as innocuous from a sanitary point of view, water which — even when used constantly — provokes neither disease nor health defects by the presence of microorganisms or materials influencing acute, chronic or later health effects of inhabitants, and its sensually catchable properties do not prevent its consumption.

Individual indicators of the standard are structured according to the hygienic importance, which enables a detailed differentiation of importance of the failure to satisfy the standard and first of all the determination of the order of emergency of correcting measures.

The exploitation of sources in Quarternary sediments — about 45% of the totally evaluated exploitable richness of underground sources in the watershed is found in the Quarternary periods of the river Morava — bringing problems dealing with the long-term changes of the quality and with the decrease of the water being caught, with the increased danger of pollution of water saturated environments and conflicts with the interests in exploitation of the territory — especially in agriculture. (Fig. 6) All these influences were considered in the evaluation of exploitation of individual sources. As a general phenomenon with the locally changeable intensity of its course appears here the increase of the contents of iron and manganese in the water being caught and sampled. This may provoke the increasing need for treatment , a permanent decrease and sinking of the richness by chemical colmatation and in extreme cases the necessity of abandoning the sampling (catching) locality. These factors appear in the most considerable way in the catching territories in the lower stream of the Morava and the Dyje, i.e. in the districts of Hodonin and Breclav.

By the non-favorable factor of chemical coagulation are potentially threatened all underground sources with catching with boreholes and wells; the relevance is given by the acceptable length of the cycle of the necessary reconstruction of the catching equipment. From the point of view of the effect of the colmatation process it is very advantageous to use the localities of used gravel-pits. The gravel-pits used in the watershed of the Morava since 1961 as water treatment plant sources offer just relatively large capacities, but with a very good quality of water they enable to a certain extent even impact changes of the quantities of accumulated volume of water being caught. The method of water sampling may be chosen either directly from the reservoir (Kvasice, Tovacov) or by means of the well feeder in the embankment (Naklo) or in a combined method (Ostrozska Nova Ves).

The exploitation of underground waters in quaternary deposits is always coming in discrepancy with the intensive human activity in other economic fields. This activity is also in a high degree concentrated in favorable conditions of valley meads of streams. For increasing the exploitation of underground waters the important factor is represented by the extent by which are the interests of agriculture influenced by the occupation of the territory with quality soil or by limiting measures for the protection of quality. For the water treatment plant exploitation it is therefore necessary to aim only at the localities where water may be caught concentrated on the maximum area. The connections to intensive agricultural production are important, especially in the case of the following sources: Lesnice and Mohelnice in the Sumperk district; Pnovice, Naklo, and Senice in the Olomouc

district; Hrdiborice and Smrzice in the Prostejov district; Tovacov in the Prerov district; Brest, Postoupky, and Hulin in the Kromeriz district; Ostrozska Nova Ves in the Uherske Hradiste district; and Bzenec in the Hodonin district.

In connection with the danger of water pollution of water-saturated underground water is the great concentration of settlement and economic exploitation of the territory in valley meads of streams. The most relevant are those types of pollution that cannot be liquidated by means of natural processes. Examples of these are pollution by raw oil and its products and pollution by chemical matters that may decompose only by artificial methods. The sources of pollution are represented by industrial plants using the following materials: raw oil pipe lines, product lines, dumping places, and airfields. At present the territory in the Prerov district between Bochor and Zarici is seriously attacked by the pollution by raw oil matters and chemical wastes. In this case, the assanation measures result in the decrease of the exploiting capacity and also in the sampling and catching areas of Brest and Chropyne. The catching territory of Holesov situated in the direct neighborhood of the aerodrome and the fuel tanks is also potentially serious threatened. The suitability of the underground water for supplying water for the inhabitants in the watershed of the Morava River is illustrated in the enclosure (See Fig. 7).

According to the investigations carried out, 33.9% of the water produced does not satisfy the standard in its full extent. In the evaluation of hygienically considerable criteria, 21.4% do not satisfy the conditions; in the evaluation of the most relevant criteria, only 5.2% of water produced do not satisfy the conditions.

In the total European comparison the satisfaction of the standard of quality of water is average. The backwardness of developed European states, where the standards are unsatisfactorily indicated 1 - 50%, is not too expressive. (see Fig. 7b and 7c.)

The main reasons for not satisfying the required quality of water are represented by the deterioration of the quality of raw water in the sources, increased demands on the quality of drinking water, inadequate technological equipment of water treatment plants, the level of performance and operation, and maintenance of water treatment plants and similar plants and hydraulic overloading of water treatment plants.

To reach a satisfactory level of water supply is a long-term and quite demanding task which includes measuring the fields of hygienic control, increasing operational discipline, changing of the

organizational structure, and approaching of the population. But, first of all, it represents high financial demands.

For the improvement of the present situation in supplying water, it is necessary to choose a differentiated approach according to the fixed order of priorities. The extent of the health threat to the population is to be considered as the most relevant criterion. For this reason, it is necessary to consider improved water quality in individual sources a high hygienic priority.

In a series of cases, the solution would require enormous investments and operational costs or the correction of the water quality is outside the contemporary possibilities of water treatment technology. In the interest of the health of the population the only alternative is to quickly change the contemporary conception of quality water supply for drinking water and to pass alternative solutions. At the present, this is represented by the preparation of the production and the distribution of packed table and suckling water.

1.4 The Effects of Water on the User

1.4.1. Drinking water supply and public water-mains

At present in the watershed territory of the Morava River, 2,062,079 inhabitants (i.e. 75.4% of the total number of residents) are supplied with drinking water. 536 water-mains administered by the plants "Vodovody a kanalizace" (Water-mains and Sewerage) and 57 administered by the local authorities supply the consumers with 249,382.10^3m^3 per year^{-1} of drinking water. The specific need represents 331 L ob^{-1}-d^{-1}. From the total amount of drinking water produced, actually 46% is used in households, 20% is taken by industries, 4% by agriculture, 10% by other consumers, and 20% represents water without bills (i.e. performance/operation and losses).

The development of some selected indicators characterizing the drinking water supply in the watershed of the Morava River is given in Table 5.

The development curve of the total drinking water consumption shows, according to the latest pre-conditions, a short-term sinking trend. By the year 2000, there will be a slight increase. The development of water consumption for households will have a parallel course with the development with the total need for water. The perspective need for water for industry will decrease as a result of the exploitation of new technology and re-circulation of water. The underground sources add a

capacity of 5,460 $l.s^{-1}$ to the supply of drinking water for consumers. Surface sources of water contribute 3,150 $l.s^{-1}$. In future perspective, the share of exploitation of the surface water increases to the detriment of the underground water. (See Tab. 5)

For the quality of drinking water, we have the standard CSN 75 7111 which is in effect since January 1, 1991, and is in accordance with world standards for the quality of drinking water.

1.4.2. The Sources of Water for Public Water-mains

a) The Underground sources

The greatest riches of underground sources are situated in the valley mead of the Morava River in its Quaternary deposits. These sources may be exploited for the water treatment plants with out costly treatment. The area of chalk in the watershed of the Svitava has quality drinking water as well. The areas of crystalline in the north and southwest of the watershed of Morava are characterized sources with low richness (in the region of Jihlava, enriched Ra). Southern Moravia has underground waters which, though rich in richness, demand more treatment to improve their quality. Even the gravel pits are exploited with advantage for water treatment plant purposes--these gravel pits are usually adjacent to the stream of the Morava River. They enable the balance between the vacillating character of catchments and samplings.

b) The Surface Sources

Even in this area the water treatment plant reservoirs, and to a smaller extent, the diversion form free streams are exploited for the supplies with drinking water to the population. The reservoirs with a good quality of water are in operation-- (e.g. Vir on the Svratka; Vranov on the Dyje; Znojmo on the Dyje; Mostiste on the Oslava; Slusovice on the Drevnice; Opatovice on the Mala Hana; Karolinka on the Stanovnice;) and smaller reservoirs where the quality of water samples often bring operational problems during the course of the year. To these reservoirs belong: Hubenov on the Marsovice brook; Korycany on the Kyjovka; Bojkovice on the Kolenac; Ludkovice on the Ludkovice brook; Frystak on the Frystak brook; Nemilka on the Nemilka; Boskovice on the Bela; Nova Rise on the Olsany brook.

In the far future, construction of water treatment reservoirs at Strizov on the Brtnice and a multipurpose work at Hanusovice on the Upper Morava are being considered.

1.4.3. The Solution of the Development of Public Water-mains

The distribution of sources suitable for water treatment plant exploitation is considerably unequal. Therefore, the increasing and growing supply net of group water-mains integrates with the water treatment plant systems. In the watershed of Morava the success of the conceptual solution of supplying drinking water to the population from the nearest perspective, will be in cooperation with water treatment plant systems projected: Western Moravia, Brno water treatment plant system; Southern Moravia, the territory along the Morava River and Northern Moravia, the water treatment plant group Vsetin. Due to insufficient capacity of the sources in the watershed of Morava mainly because of their insufficient saturation during the period of hydrological minimums, it will be necessary to subsidize from the watershed of the Odra (the reservoir Slezska Harta) by the year 2000. In the far future, the supply of water will also be augmented from Zitny ostrov (Rye Island).

The design of the development of the water treatment plant systems in the Morava watershed is given in Picture 8.

1.4.4. The Conditions of Realization of Conception Aims

In the present economic situation the first class task for the continuous supplies of population with drinking water is the reduction of losses of water due to maintenance and reconstruction of the equipment already in use. Further, it is the increased protection of richness of sources for the present and future exploitation by the preparation of operational manipulation regulations and greater effectiveness of their influence by the collaboration of individual water-mains or water treatment plant groups. The underground sources must be thoroughly protected against antropogennous activities by individual sources by means of already mentioned protecting zones, by the control of the activity in the protected areas of natural accumulation of waters, and by common protection of sources within the frame of the protection of the living environment. The construction of new sources and feeders will be connected with these measures.

2. Emissions

2.1. Communal Pollution and Waste Waters from Industry

In the section 1.2.2. the quality of water in the streams in the Czech part of the watershed of the Danube is documented. The antropogenneous influences as represented by a quantity of polluting matters from point and area sources prevail even if the qualitative regime of the surface waters is influenced by various natural influences such as the hydrological relations.

In the watershed of Morava there are 2,740,000 inhabitants and from them 72% are connected to the public sewage. This situation corresponds to the average situation in the Czech countries. This public sewerage, however, has often erected waste water treatment plants so that their construction brought just the concentration emission of pollution into one place and in this way, brought a deterioration of the influence on the stream.

Approximately 1,300,000 inhabitants (about 48% of the total) of the watershed analyzed are connected to public communal water treatment plants. A smaller percentage of inhabitants discharge waste into the industrial water treatment plants. (Veverska Bityska, Napajedla). The waste water from other inhabitants is pre-treated in domestic waste water pits or is discharged without being treated. The requirement of the authorities to construct the domestic cesspools without an outlet of waste water in communities and without communal water treatment plants is not often respected by the inhabitants.

At present practically all important communities have prepared studies or even projects of finishing the sewerage network and construction of water treatment plants. The realization of these buildings is, however, postponed several years because of the lack of capital. The water treatment plants what currently in operation or under construction are largely in the mechanical stage of pre-treatment and biological activation. Just some of these water treatment plants are also directed at removing nitrogen by means of nitrification and denitrification. The technology for the reduction of phosphorus in communal water treatment are not used in practice, even if, with regard to the content of nutrients in the streams, it would be necessary.

In Table 6 the registered sources of pollution which discharge more than 100 t BSK^5 per year are given. The two largest sources (the towns of Brno and Olomouc) are nearer characterized from

the point of view of liquidation of waste waters in Complements 1 and 2. It is a common practice that industrial plants in the given locality are connected to the communal water treatment plant.

From the outline it is seen that besides the communal sources the foodstuff industry belongs to the most relevant polluting agents of organic pollution which is discharged. A great problem of the rivers in South Moravia is that of seasonal work of sugar mills.

In the past, during the autumn months the Morava River--from Olomouc to where it joins with the Dyje--was a dead stream because of its lack of oxygen. In more recent years, an express improvement occurred after the reconstruction of the sugar mill in Hodonin and after the construction of the water treatment plant in the sugar mill in Brodok of Prerov. The greatest water quality improvement is represented by the stopping of some sugar mill services.

The pollution of streams by easily removable organic matters (indicated by the value BOD_5) is the best mapped sort of pollution in our country. Therefore this indicator could serve as one of the most important criteria in the determination of the order of urgency in the construction of water treatment plants as outlined in section 2.2. This order was constructed during the five-year evaluation by the Ministry of Living Environment of the Czech Republic of water economy/conservation. There are also other reports about the need for construction of water treatment plants based on local conditions and relations without regard to the general impact on the watershed.

As in the case of monitoring the streams, it would be necessary to continue the investigation and documenting further indicators of the quality of the water being discharged. Even if water management decisions are for some industrial polluters determined the limits especially for heavy metals, the summarized values of discharged quantities of these matters are not available. It is as in the case of the nutrients that the contents of phosphorus is analyzed just in a few water treatment plants. The most unexplainable facts exist in the discharge of specific organic matters (e.g. chlorinated hydrocarbons--whether from chemical, paper mill, textile, or other industry)

An important economic factor forcing polluting plants to construct water treatment plants is represented by fines payable for discharge into streams. These fines go into the State fund of the living environment and in this way, become the source for providing financial support for constriction of water treatment plants. The fine is charged for pollution included in the BOD_5 category, insoluble matters, raw oil material, diluted inorganic salts, and obvious acidic or alkaloidal composi-

tions. The administration of these fines brings in verifiable data for balancing the sewage being discharged. The data for 1990 is given in Table 7.

2.2 The Order of Urgency of the Construction of Water Treatment Plants in Critical Areas form the Point of View of the Quality of Water.

Within the scope of the protection of the quality of waters, one of the main tasks may be indicated in the determination of the optimum order of the planned assanation measures, which in a narrower sense may be understood as the determination of the order of urgency of the construction of water treatment plants. The goal of solution of this problem is to place the investment means for the reduction of the loading of recipients from the decisive sources of pollution in such a sequence which would be from the point of view of elimination of critical sections of the streams most effectively.

In the Czech Republic in the past ten years the model for objectively proceeding in the evaluation uses the knowledge from the field of evaluating analysis. The multicriterial method being used has first of all the advantage that in the interpretation of the results the deciding factors have a survey about the used factors and according to the need they can reevaluate their importance. The proposed system of evaluation consists of the criteria selected with the effort to obtain the broadest ecological access. The importance of the criteria is in the decisive process expressed by means of the so-called balances of criteria constructed by the team of experts with the application of Fuller's method of deciding analysis.

One of the main priorities of the above mentioned proceeding is that it does not lie only on not sure data about the waste being discharged but it starts first of all from the measured values of pollution of recipients. The determination of the degree of pollution of streams starts from a detailed saprobiological documentation of streams. The treatment (solution) is directed to the fields with an expressively unfavorable quality of water from the point of view of organic pollution as characterized by the index of saprophytic. By means of the above mentioned proceeding just the influence of the whole nodes of pollution is evaluated. This pollution may be created even by a group of polluting actors resulting in several not very far localities. Within the scope of the ten used criteria the decisive point of view is considered to be the worsening of the quality of water in the stream under

the polluting actor. Then follows the criterion preferring the recipients with water treatment plan samplings. The third criterion in the order prefers the sources of pollution in streams being more rich in water, in the further one there is evaluated the total length of the stream with the quality of water being worse than it corresponds to natural situation. In the fifth criterion the total further use of water from the negatively influenced part of the stream including the special protection of certain areas is evaluated. The evaluation of the present and perspective contribution of pollution from the sources represents the contents of another two criteria. From the last three "ecological" the highest relevance is that of the influence of the canalization of streams on the situation of biocenoses being expressed in the reduction of self-cleaning processes in the river. Another criterion characterized the changes of the self-cleaning ability in the relation to the size and equality (uniformity) of the slope (gradient). The last criterion characterizes the influence of the area pollution.

The resulting order of urgency of the construction of the water treatment plants for the territory of the watershed of the Morava is given in Table 8.

2.3 Aerial (planar) pollution resulting from agricultural production

The agricultural production is until now expressively visible in the changes of water, first of all in connection with the application of a high quantity of agrochemicals for the land. The used method of large area agricultural economy in the past thirty years influenced on principle first of all the increase of concentration of nitrides and together with unsuitable intensification of animal production contributed to the total increase of eutrization of waters. The treatment of the water management problems of agriculture is based on collecting information about the agricultural activities in partial watersheds (subwatersheds) and their parts (application of industrial fertilizers, the composition of agricultural products, the numbers of animals, etc.).

The potential threatening of the watershed by water erosion is evaluated as well. The obtained information about the agricultural production is completed by the set of data about monitoring the quality of water and the removal of nutriments. The evaluation is directed to the sorting and indicating of spots being critical from the point of view of pollution.

At present the transformation occurs in the agricultural section. We expect of it that — besides the changes of the owners rights and the transition to a more rational method of economy in the

landscape — even the share of agricultural pollution will appear in its reduction in a considerable way. E.g. already in 1991 when the high-principled reduction of financial supports in agriculture occurred the decrease of use of industrial fertilizers occurred as well. The removals of mineral nitrogen were decreased immediately too.

3. Summary

The river Morava being one of the largest tributaries of the Danube on it's central part of stream and draining the important part of the Czech Republic is evidently negatively influenced both by the municipal and industrial effluents and by the agriculture activities. Permanent investigation of the quality of surface waters has been occurring since 1963, complementary saprobiological monitoring started 13 years later. One of limiting factors of further extension of monitoring is above all insufficient equipment of laboratories.

The largest problem of the quality of water in this watershed until now represents the organic pollution coming from point sources of pollution with insufficient treatment. In autumn period the quality of water is further worse caused by seasonal operation of sugar mills. The worst pollution of the river Morava is observed downstream the town Olomouc where the river is considerably devastated by the pollution from this agglomeration.

In spite of the fact that exploitable richness of underground sources of water represents 55% of all sources of drinking water the watershed of the Morava cannot be considered as a territory being especially rich in these sources. The most dangerous pollution is that caused by raw oil and by chemical materials that may be decomposed with problems only. The sources are represented by industrial plants, raw oil pipelines and dumping places. According to the investigation 33.9% of the water produced does not satisfy the standard in its full extent. The main reasons for it are represented by the deterioration of the quality of raw water and non-adequate technological equipment of treatment plants. Substantial improvement represents continuous supply of population with drinking water is the reduction of losses of water and increased protection of richness of sources.

Out of 2.7 million inhabitants in the watershed of the Morava, 72% are connected to the public sewer system and about 48% to the public water treatment plants. At present all important commu-

nities have prepared the study or project of sewerage network or water treatment plant, the realization is however postponed for the lack of investment means.

Aerial pollution has been evidently influenced by the used method of large area agriculture economy. The increased concentrations of nitrites contributed to the total increase of eutrophization of waters. The present transformation in the agricultural section promises besides of the changes of the owners a more rational method of economy followed by the decrease of agriculture pollution.

There have been prepared many materials and documents that would enable the state administrators to make decisions in the field of water quality management. As an example of this activity is presented the order of urgency of hot spots assanation in the Morava watershed. Water management and water quality management has in the Czech countries a long tradition. Although the basic technological processes have been known in Czechoslovakia the evident development of ecological equipment for the economic reasons has not come yet.

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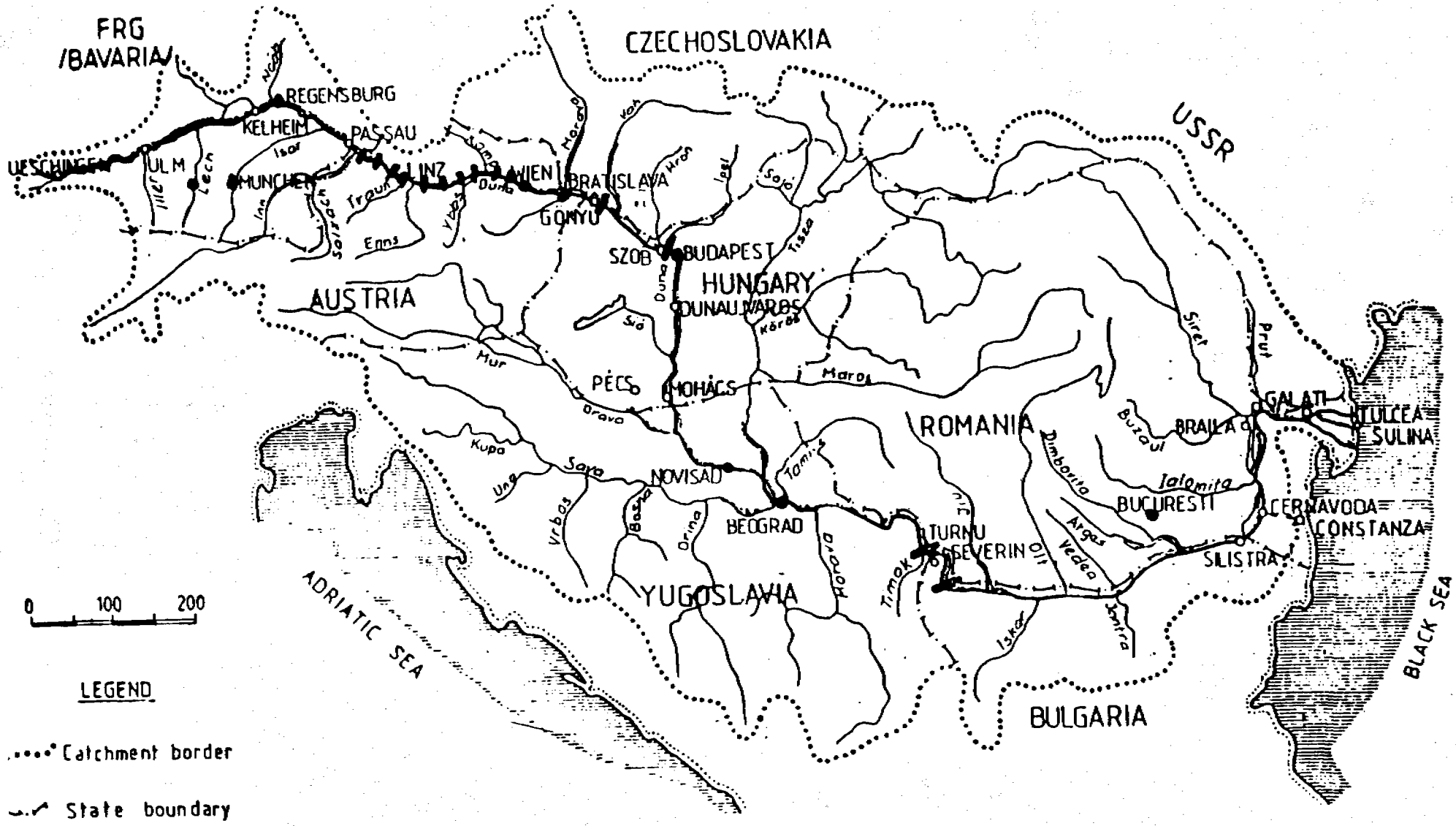
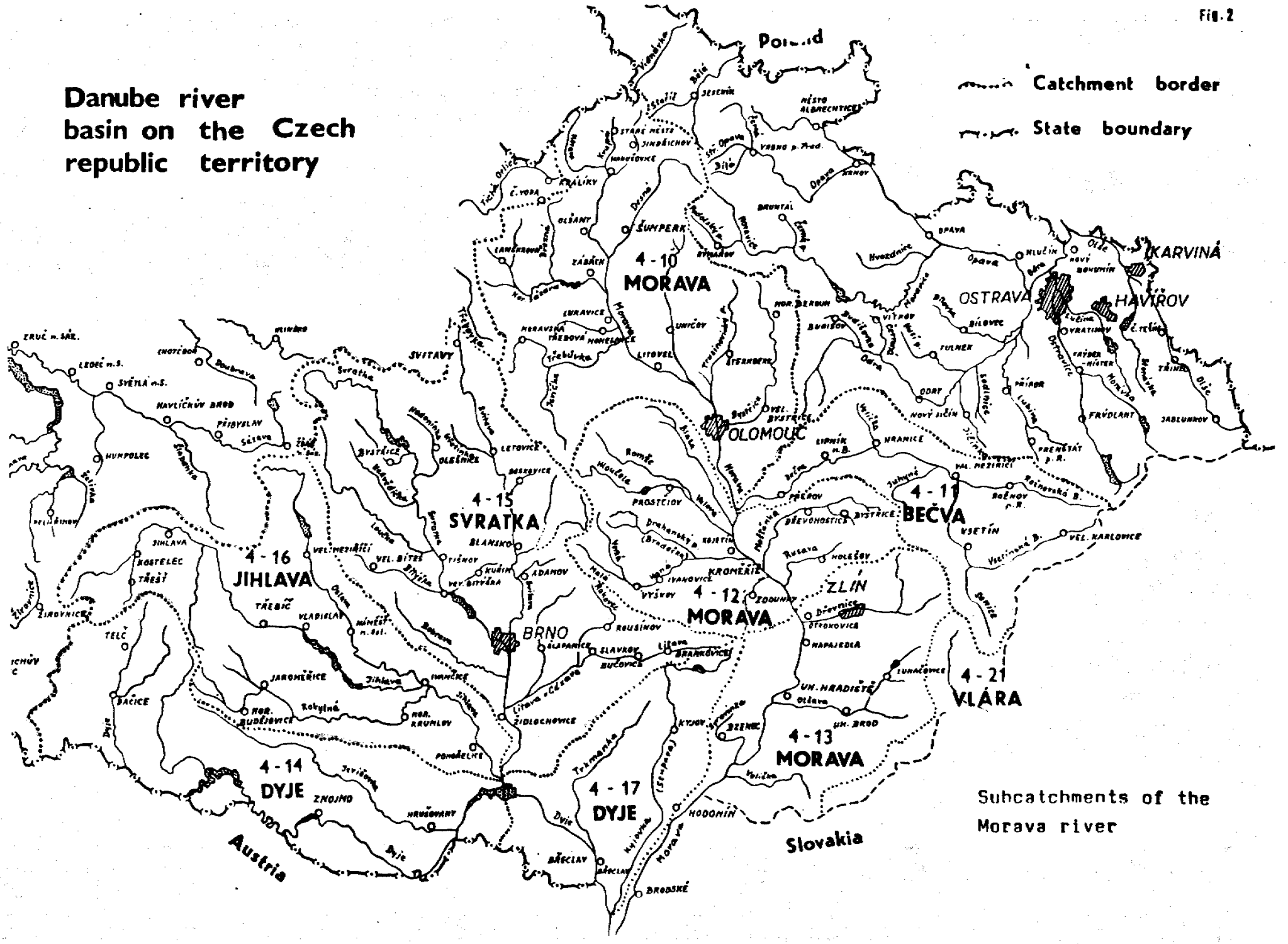


Fig. 1 The Danube Catchment (817000 km^2)

Fig. 2

Danube river basin on the Czech republic territory



Subcatchments of the Morava river

Fig. 3

Danube river basin on the Czech republic territory

Water quality in streams according to the saprobity index

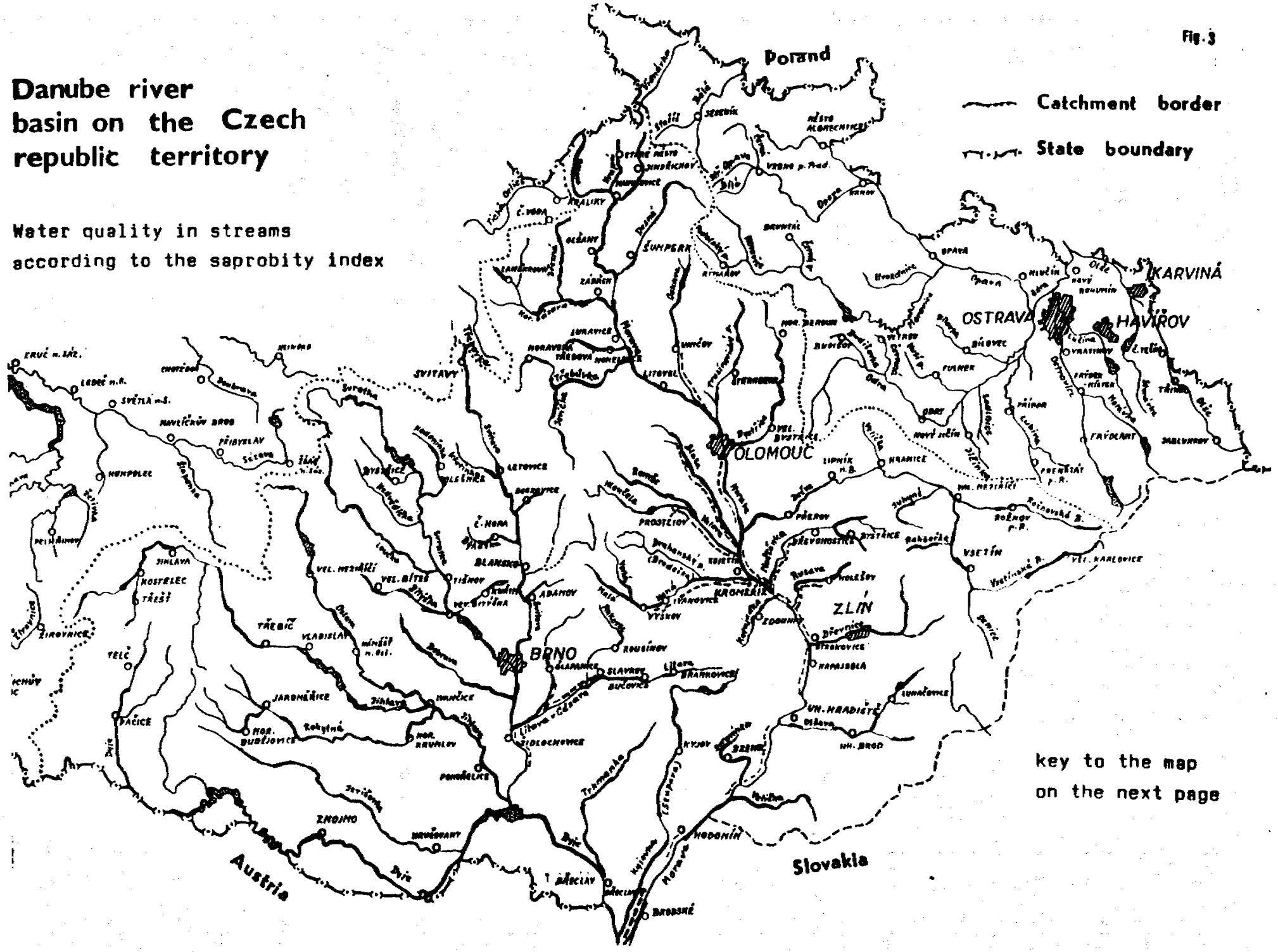
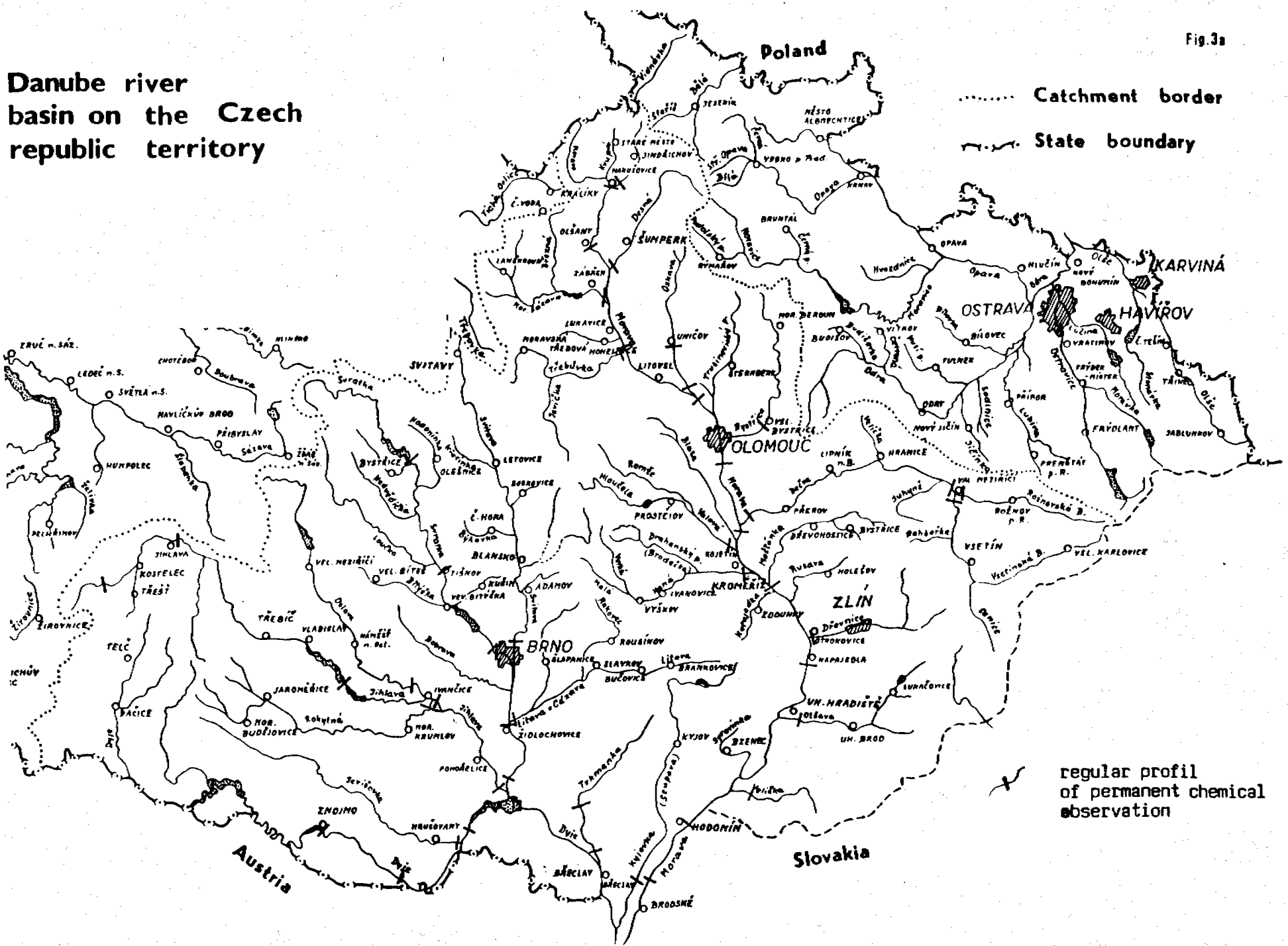


Fig.3a

Danube river basin on the Czech republic territory

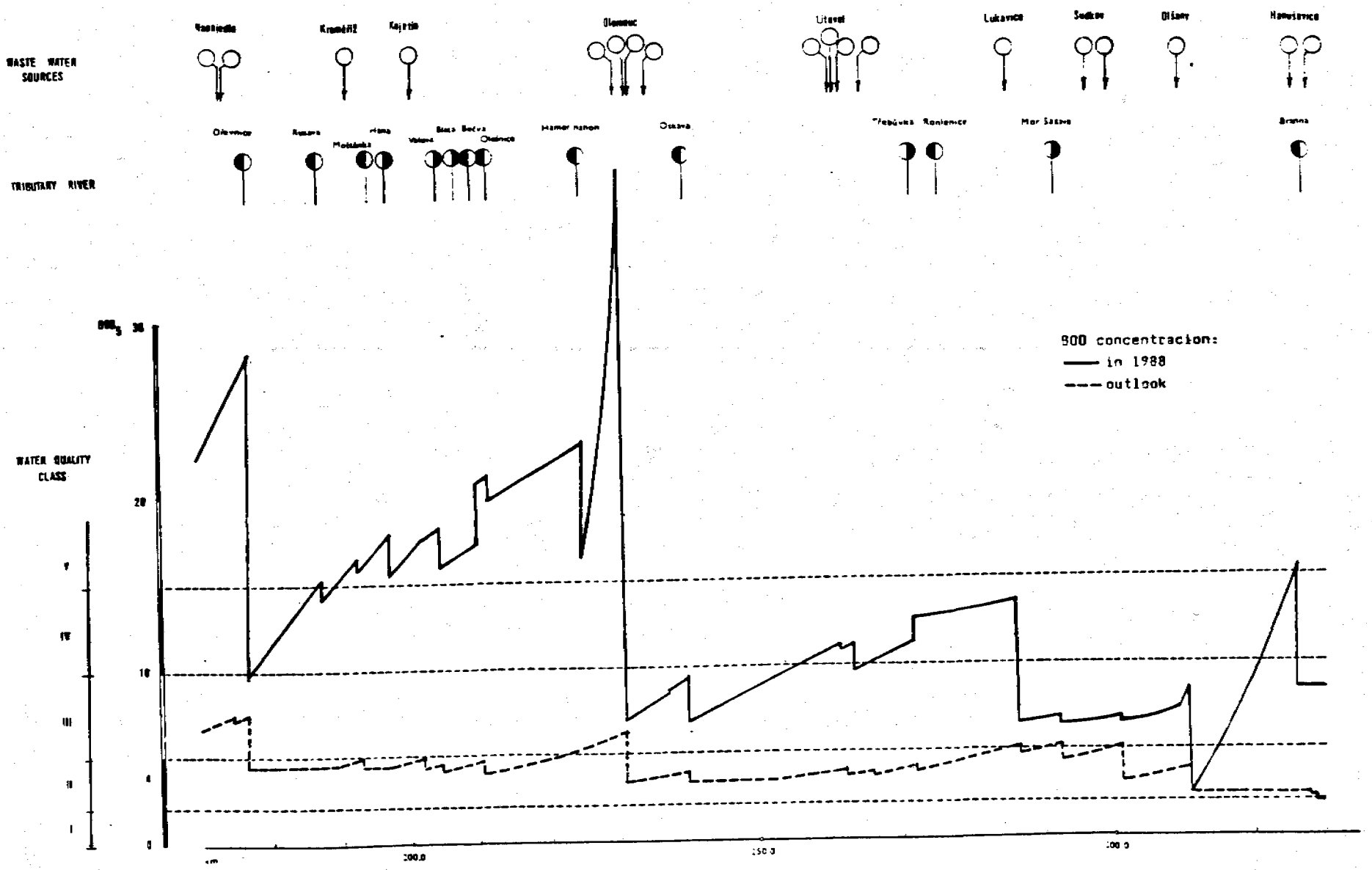


Saprobiological classification	Saprobity index	BOD_5 mg/l						COD_{Mn} mg/l					
		average		probability of not surpassing %				average		probability of not surpassing %			
		arith.	geom.	10	50	90	95	arith.	geom.	10	50	90	95
1 pure water	0 - 1,0	1,9	1,6	1	2	3	4	4,2	3,4	2	4	8	9
2 clean water	1,01- 1,5	2,3	1,9	1	2	4	6	5,3	4,4	2	5	10	11
3 very slightly polluted	1,51- 2,0	3,7	3,0	2	3	7	10	6,4	5,6	3	6	11	12
4 slightly polluted	2,01- 2,5	4,5	4,0	2	4	8	11	7,4	6,6	4	7	12	15
5 middle polluted	2,51- 3,0	6,5	5,5	3	6	11	16	8,4	7,4	4	7	13	20
6 heavy polluted	3,01- 3,5	8,3	6,4	3	7	16	25	11,3	8,6	5	8	15	34
7 very heavy polluted	3,51- 4,0	21,6	12,8	5	10	50	70	41,7	17,0	6	12	130	225
8 extremely polluted	4.01-												

Key to the Map - Fig.3

Saprobiolog. classific.	Classit.ČSN oxygen regime
1	I class
2 - 3	II
4 - 5	III
6	IV
7 - 8	V

Fig. 4

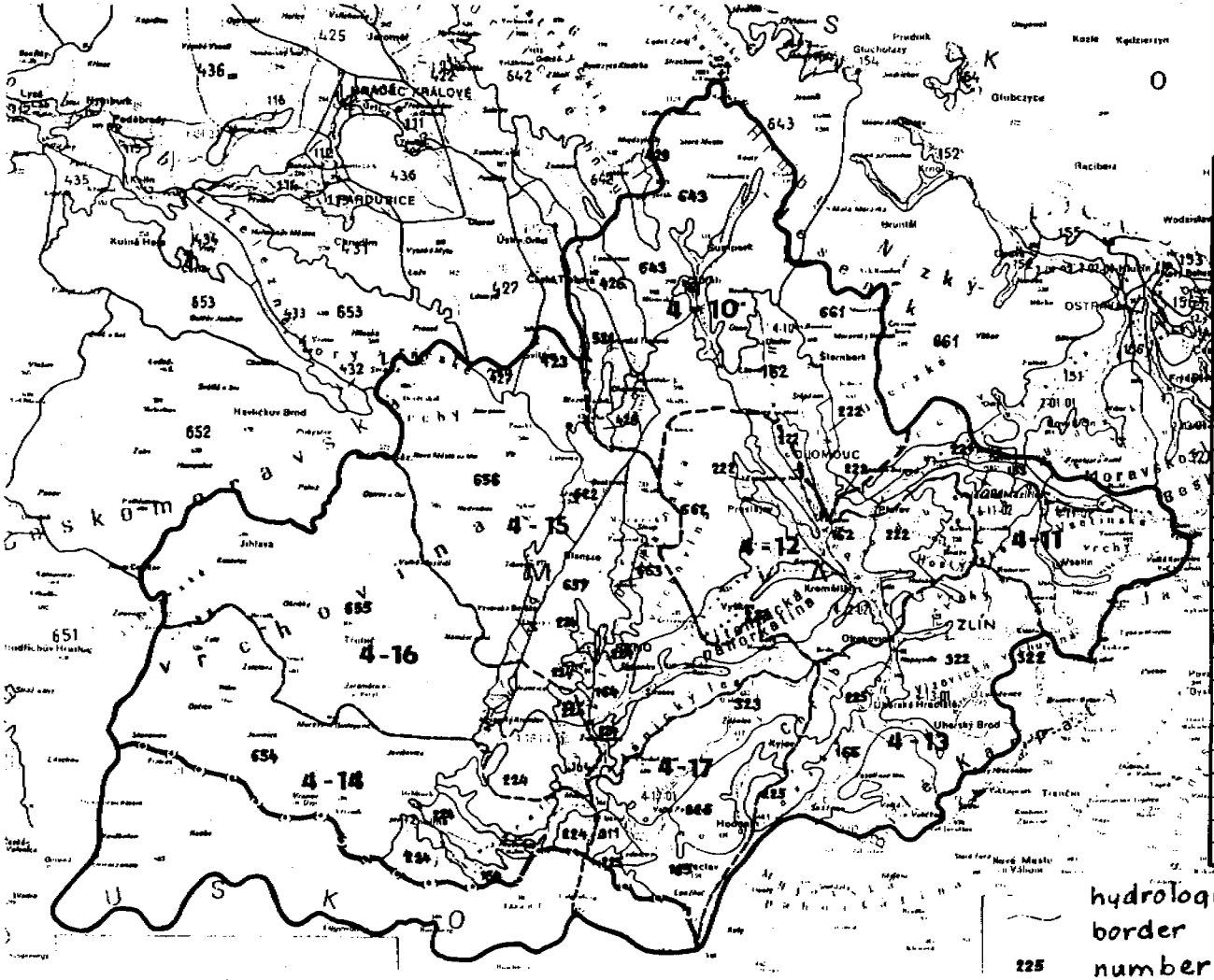


Danube river basin on the Czech republic territory

Longitudial profiles of BOD_5 concentration

Hydrogeological regions in Morava watershed

HYDROGEOLOGICKÉ RAJONY V POVODÍ MORAVY



No	Name of region
Označení	Název rajonu (subrajónu)
161	Fluviální sedimenty v povodí Horní Moravy
162	Předpleistocenní sedimenty Hornomoravského úvalu
163	Fluviální sedimenty v povodí Bečvy
164	Fluviální sedimenty v povodí Dyje
165	Fluviální sedimenty Moravy
221	Moravská brána
222	Hornomoravský úval
223	Fyšburská brána
224	Dyjskosvratecký úval
225	Dolnomoravský úval
311	Pavlovské vrchy a okolí
312	Fluviální sedimenty v povodí Moravy
313	Středomoravské Karpaty
411	Uherská synklinála
412	Hustopečská synklinála
413	Ždánický prales
414	Hustopečská synklinála
421	Pernická hrásala
422	Bučovická hrásala
512	Krystalinikum Orlických hor
513	Krystalinikum Rychlebských hor
514	Krystalinikum v povodí Dyje
515	Krystalinikum v povodí Jihlavy
516	Krystalinikum v povodí Svratky
517	Krystalinikum brněnské jednotky
611	Kulm Hrubého Jeseníku
612	Kulm Drahanské vrchoviny
613	Moravský kras

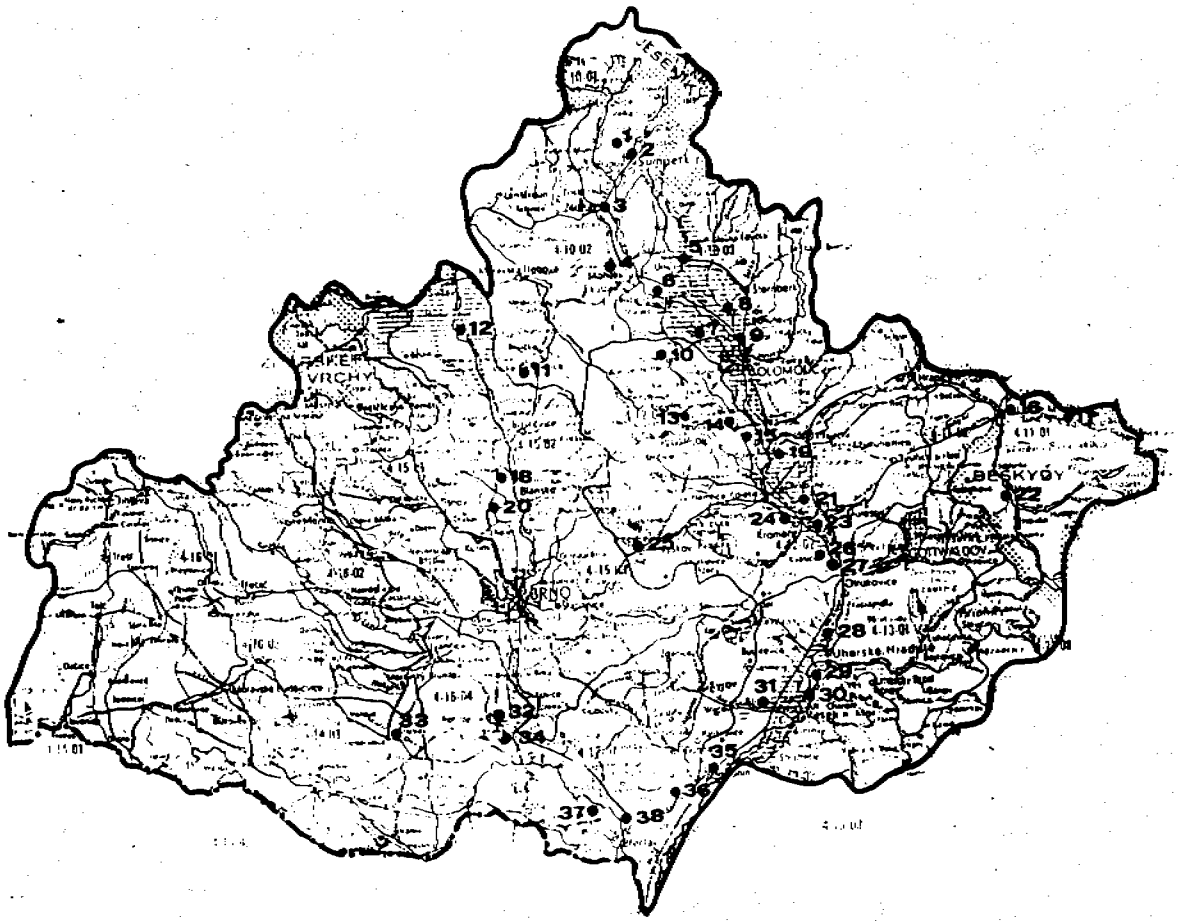
hydrological region
border
225 number
4-17 subcatchment

Obr. č. 5

VÝZNAMNĚJŠÍ VODÁRENSKÉ PODZEMNÍ ZDROJE

Important undergrond drinking water sources

No Poř. č.	Name Název zdroje	Exploitation Využ. vydatnost v $l \cdot s^{-1}$
1	Krobotova N.	65,0
2	Nikyčovice	30,0
3	Lesnice	60,0
4	Mohelnice	135,0
5	Haukovice	30,0
6	Líkovec	200,0
7	Přlovice - Náklo	210,0
8	Štěpánov	90,0
9	Čemovír	208,0
10	Šehice	50,0
11	Velké Opatovice	60,0
12	Březová I + II	1050,0
13	Smržice	60,0
14	Hrdibořice	71,0
15	Klopotovice	30,0
16	Hrachovec	70,0
17	Rožnov p. R.	60,0
18	Spešov - Doňlov	35,0
19	Troubky	90,0
20	Lažany	30,0
21	Břest	58,0
22	Kvasín - Ohrada	80,0
23	Hulín	80,0
24	Postoupky	55,0
25	Drnovice	80,0
26	Krasice	170,0
27	Tlumačov	100,0
28	Kněžpole	40,0
29	Ostr. N. Ves	240,0
30	Hlohovší	50,0
31	Bzenec	200,0
32	Ivanovice	40,0
33	Hroznová	35,0
34	Hrušky	30,0
35	Hodonín	100,0
36	Mikulčice	70,0
37	Lednice	90,0
38	Břeclav	50,0



Obr. č. 6
Fig. 6

Underground water acceptable for drinking water supply

VHODNOST PODZEMNÍ VODY PRO ZÁSOBOVÁNÍ OBYVATELSTVA

V POVODÍ MORAVY



vody I. kategorie

vody II. kategorie

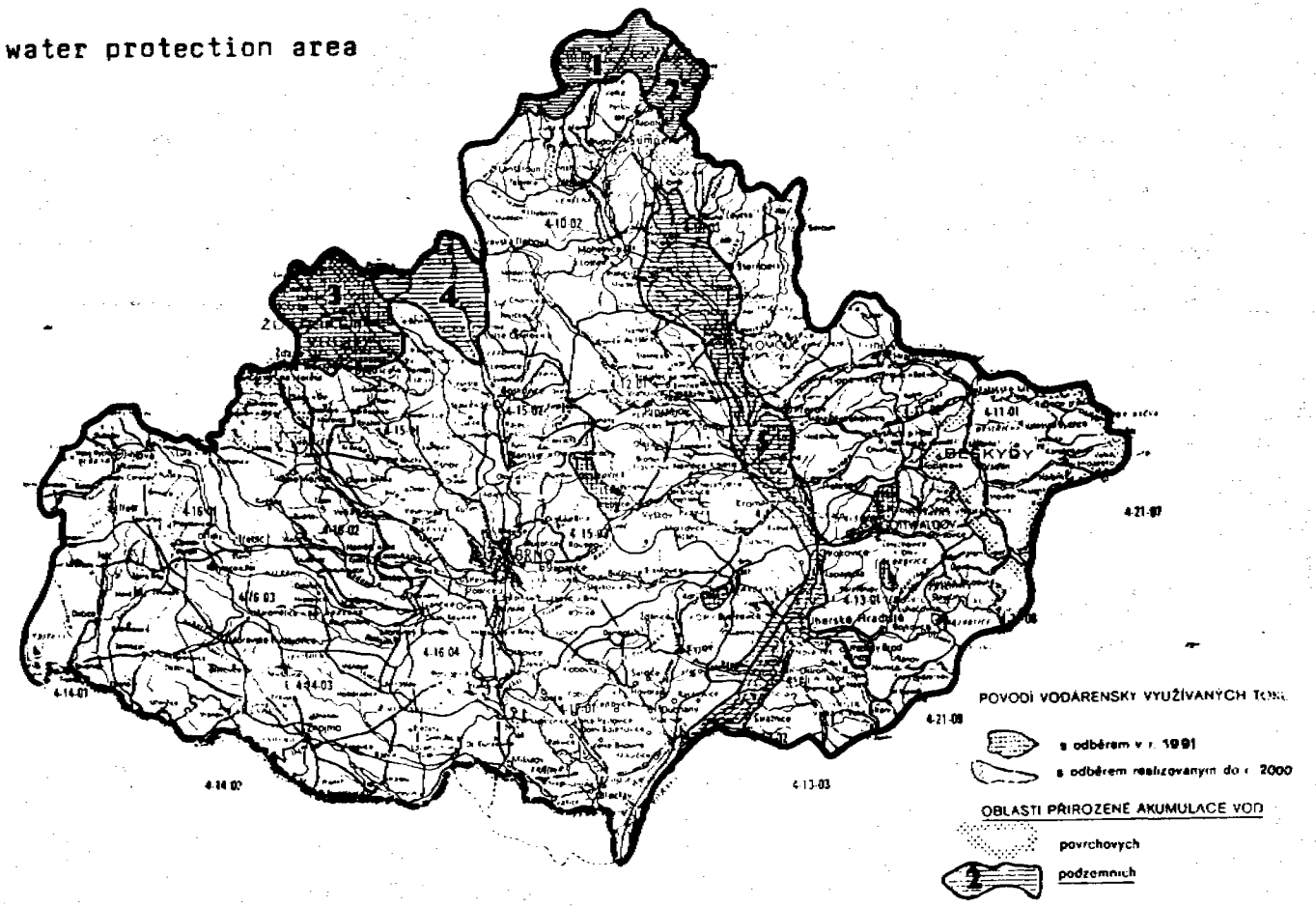
vody III. kategorie (méně vhodné či nevhodné pro zásobování obyvatelstva)
less acceptable
oblasti vyskytu podzemních vod s koncentrací dusičnanů převážně v rozmezi 25–60 mg/l
NO_3 concentration 25 - 60 mg/l

Obr. č. 7
Fig. 7

OCHRANA VODOHOSPODÁŘSKY VÝZNAMNÝCH ÚZEMÍ V POVODÍ MORAVY

Important water protection area

1 Žamberk - Králíky
2 Jeseníky
3 Žďárské vrchy
4 Východočeská křída
5 kvartér řeky Moravy



Obr. č. 7a
Fig. 7a

OBR. Č. 7b PŘEHLED UKAZATELŮ PODÍLEJÍCÍCH SE
Fig. 7b NA NEPLNĚNÍ NORMY

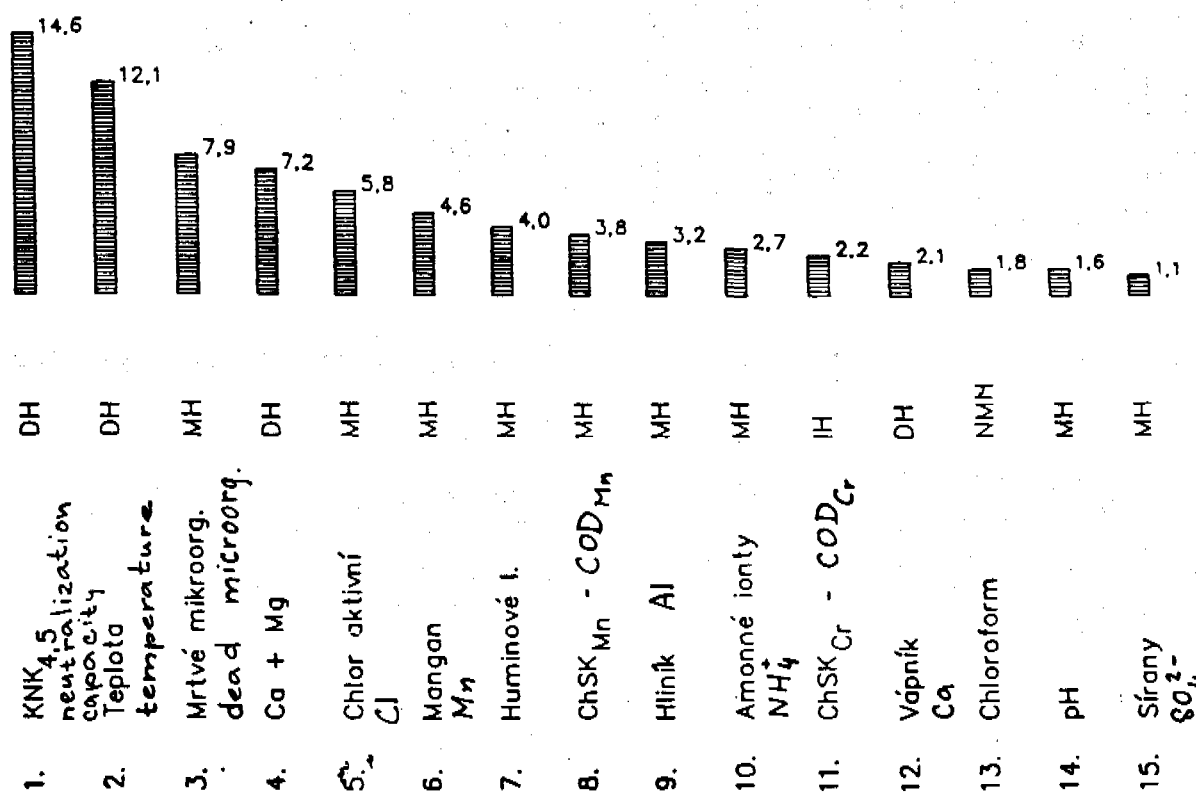
List of indicators laying out of drinking water standard

PODLE MNOŽSTVÍ VYROBENÉ VODY

according to the drinking water production

[%]

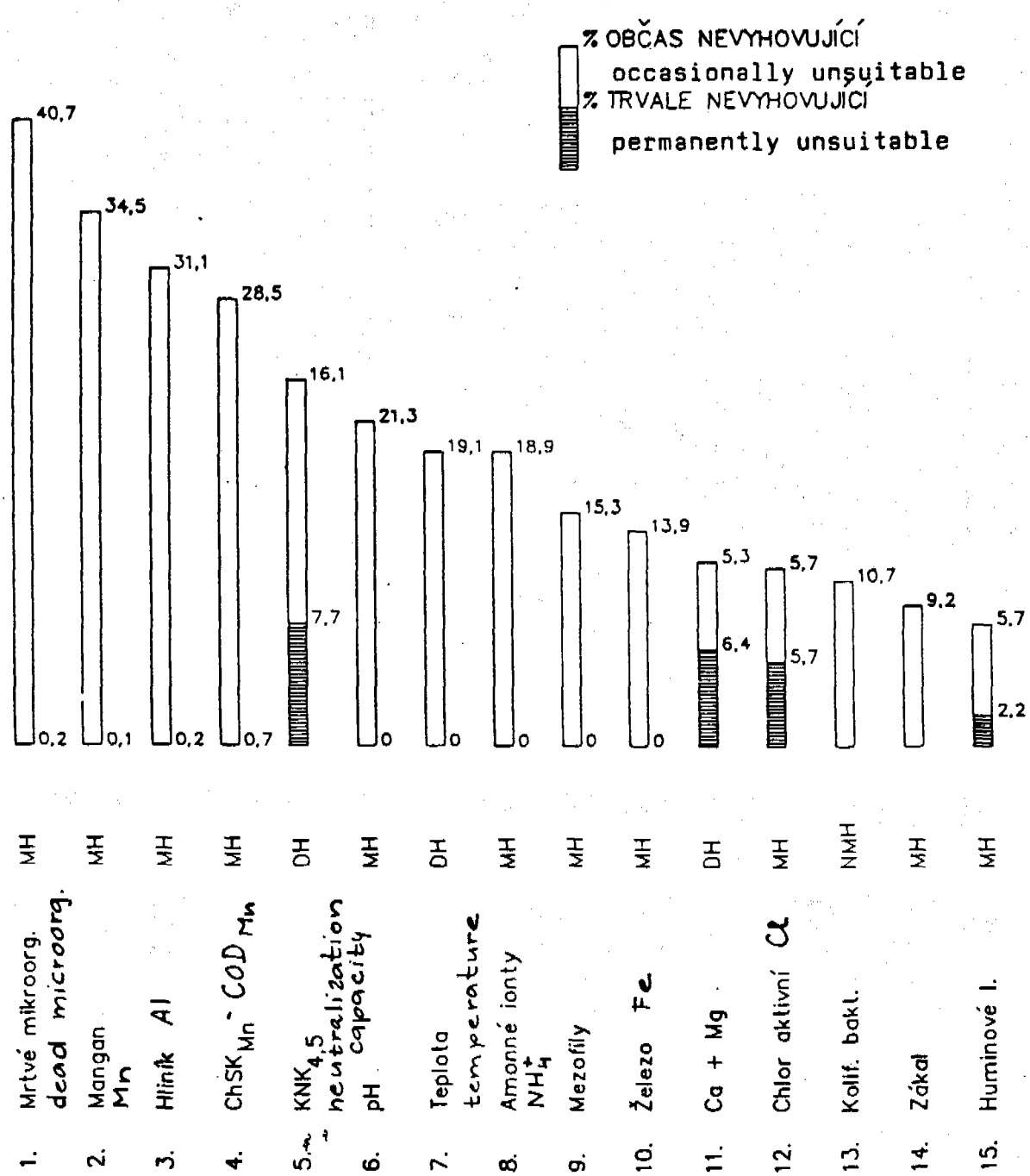
% TRVALE NEVYHOVUJÍCÍ
permanently unsuitable



OBR. Č. 7c PŘEHLED UKAZATELŮ PODÍLEJÍCÍCH SE
Fig. 7c NA NEPLNĚNÍ NORMY

List of indicators laying out of drinking water standard
according to the number of connected population

PODLE POČTU ZÁSOBOVANÝCH OBYVATEL [%]



Danube river basin on the Czech republic territory

Fig. 8 Development of public water-supply systems

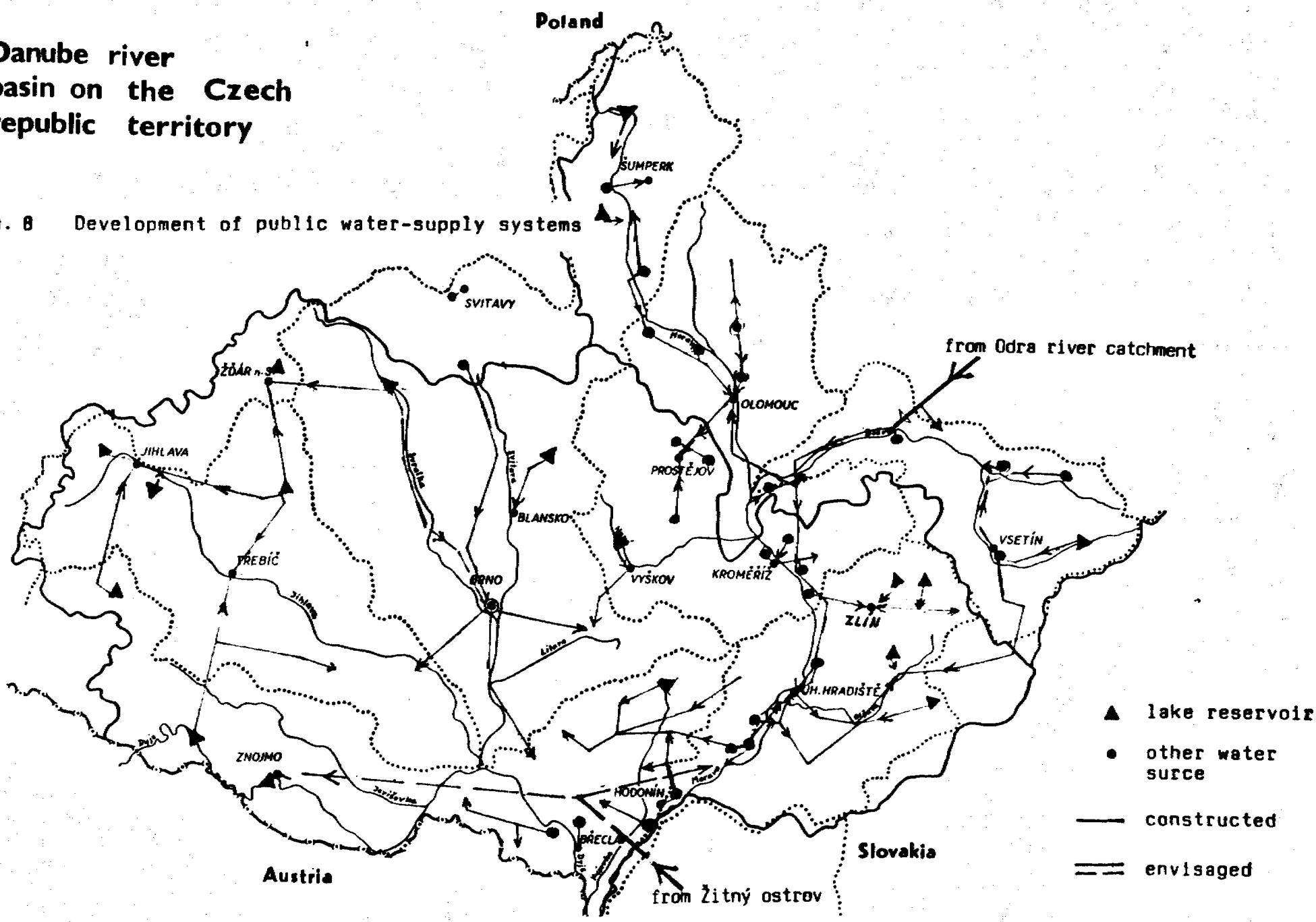
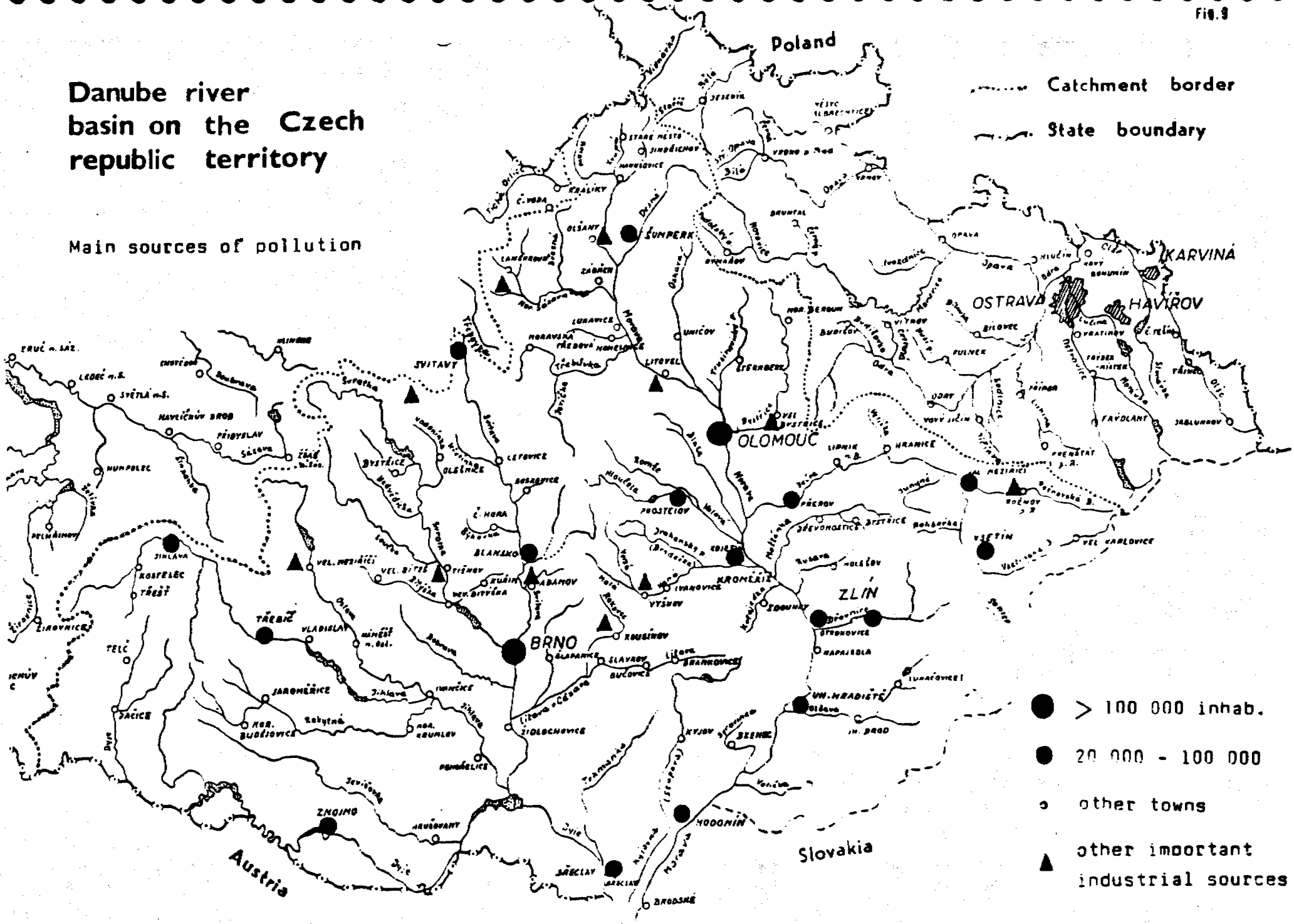


Fig. 9

Danube river basin on the Czech republic territory

Main sources of pollution



tab.1

Basic data about subcatchments

Subcatchment No	Name	Leght of main stream (km)	Drainage area (km2)	Average through flow (m3/s)	Average year outflow (mil.m3)	Average year precipit. (mm)	Average specific outflow (l/s/km2)
4-10	Upper MORAVA	78.9	2139.1	19.4		770	9.1
4-11	BECVA	119.3	1625.7	17.5	560	847	10.8
4-12	Midle MORAVA 1	174.3	7437.5	50.8		714	6.9
4-13	Midle MORAVA 2	283.6	10690.8	65.0		694	6.0
4-14	Midle DYJE	245.4	4616.3	14.5		588	3.2
4-15	SVRATKA	172.4	7140.3	18.0	480	592	3.9
4-16	JIHLAVA	184.5	3003.6	11.8	370	581	3.8
4-17	Lower DYJE	311.2	13418.7	43.8	140	585	3.2
	MORAVA in ČR	283.6	24109.5	108.0		634	4.5
	MORAVA alltogether	397.6	26579.7	120.0	3140	641	4.7

The values of characteristic through flows

tab. 1.1

Profil	m-day flow (m3/s)				n-year flood (m3/s)					
	90	270	355	364	1	5	10	20	50	100
MORAVA- -below DYJE	130	43.5	18.8	13.0	440	840	1020	1150	1345	1500
MORAVA-mouth	143	48.0	20.7	14.3	339	755	920	1030	1210	1350

Surface and underground water using in 1988 (in $l.s^{-1}$)

Tab.2

Subcatchment		Surface water				Underground water			
No	Name	public supplay system	industry	agriculture		public supplay system	industry	agriculture	
4-10	Upper Morava	176,2	541,3	46,3	763,8	1051,2	274,9	0	1326,1
4-11	Bečva	277,6	500,8	5,3	783,7	732,0	29,2	0	761,2
4-12	Midle Morava I	118,9	607,5	12,0	738,4	904,8	145,1	0	1049,9
4-13	Midle Morava II	327,0	191,3[xx]	54,6	572,9	627,4	109,4	3,0	739,8
4-14	Upper Dyje	425,8	33,5	847,8	1307,1	93,5	47,8	0	141,3
4-15	Svratka	2072,1	448,9	173,7	2694,7	1808,9	104,8	0	1913,7
4-16	Jihlava	333,4	1703,8	32,4	2069,6	244,5	40,5	0	285,0
4-17	Lower Dyje	48,4	129,1	248,7	426,2	315,1	49,5	1,5	366,1
	Morava in ČR	3779,4	4156,2	1420,8	9356,4	5777,4	801,2	4,5	6593,1
4-21	Vah tributories in ČR	25,5	14,7	0	40,2	15,7	4,3	0	.20,0

Notes: xx Without cooling water for power station in Hodonín

xxx Without forest irrigation

W A T E R Q U A L I T Y E V A L U A T I O N

tab.3

in selected indicators
according 90% probability of not surpassing
1986-1990

Observatin profil			B O D 5				C O D		Dissolved solids		N O 3		N H 4	
					outside suger mill period									
Name	River	km	mg/l	class	mg/l	class	mg/l	class	mg/l	class	mg/l	class	mg/l	class
DRAVICANY	MORAVA	272.8	13.49	4	13.49	4	22.98	4	307.92	2	28.66	3	1.13	3
ERNOVIR	MORAVA	237.0	7.50	3	5.56	3	12.00	3	341.32	2	29.66	3	1.33	3
HORYNE	BECVA	54.6	4.40	2	4.40	2	7.40	2	376.86	2	17.63	3	0.96	3
OLKOVICE	VALOVA	5.0	68.14	5	26.32	5	34.98	5	658.30	3	31.00	3	7.95	5
EZMEROV	HANA	2.0	165.32	5	30.54	5	97.98	5	921.84	4	24.66	3	5.83	4
TROKOVICE	DREVNICE	0.8	17.31	3	17.31	5	15.66	5	547.28	3	28.00	3	7.32	5
JNOVICE	OLSAVA	2.5	14.33	4	10.66	4	14.00	4	625.24	3	32.00	4	4.60	4
ANZHOT	MORAVA	81.0	11.00	4	10.83	4	14.66	4	487.62	2	27.66	3	3.57	4
NOJMO	DYJE	132.8	4.50	2	4.76	2	8.10	3	310.66	2	40.66	4	0.44	2
EVLIN	DYJE	94.6	118.98	5	38.32	5	40.00	5	521.36	3	33.52	4	3.55	4
IR	SVRATKA	112.1	4.37	2	4.37	2	5.73	3	266.96	1	35.00	4	0.61	2
ISARKY	SVRATKA	50.2	5.20	3	5.20	3	6.83	3	378.30	2	39.66	4	1.55	3
BRANY	SVITAVA	11.0	6.83	3	6.83	3	7.83	3	468.98	2	38.66	4	2.23	3
IDLOCHOV	LITAVA	0.4	123.20	5	42.98	5	34.30	5	1202.64	5	48.66	4	11.00	5
RANOVICE	SVRATKA	12.0	20.66	5	19.32	5	12.66	4	535.98	3	48.00	4	9.73	5
ERANOV	JIHLAVA	138.0	10.33	4	10.92	4	14.00	4	314.32	2	49.98	5	6.83	5
SLAVANY	OSLAVA	2.4	6.63	3	6.76	3	11.00	4	709.98	3	54.60	5	1.28	3
VANCICE	ROKYTNA	0.5	8.73	3	9.23	3	12.00	4	593.94	3	52.66	5	1.21	3
VANCICE	JIHLAVA	34.2	6.73	3	7.06	3	10.00	3	496.66	2	54.66	5	0.90	3
VAN	JIHLAVA	2.2	6.93	3	7.39	3	12.00	4	544.64	3	53.00	5	0.88	3

H Y D R O G E O L O G I C A L S I T U A T I O N tab.4

all values in % of area

Subcatchment No	Name	Permeability of rock					Hydrogeological investigation				Summary hydrogeological evaluation			
			permeable				investigated							
		impermeable	little	more	good	Kras area	full A,B	less detailed C1	in the rough only C2	uninvestigated	important area	less important	other	only local importan.
4-10	Upper MORAVA	66.7	16.7	1.7	14.9	-	-	0.2	21.7	78.1	18.8	7.7	9.3	64.2
4-11	BECVA	81.1	3.9	14.9	1.0	-	-	1.5	8.8	89.7	0.6	3.4	9.5	86.5
4-12	Midle MORAVA 1	55.8	28.2	-	16.0	-	-	7.9	6.3	85.8	18.6	36.9	-	44.5
4-13	Midle MORAVA 2	80.3	5.8	2.3	11.6	-	-	11.3	-	88.7	10.6	4.7	-	84.7
4-14	Midle DYJE	81.3	16.7	0.2	1.8	-	-	-	7.5	92.5	8.8	22.7	-	68.5
4-15	SVRATKA	56.3	30.7	0.9	9.5	2.6	2.2	-	16.5	81.3	10.3	8.3	23.4	60.0
4-16	JIHLAVA	68.5	29.5	-	2.0	-	-	-	4.4	93.6	6.3	7.2	5.1	81.4
4-17	Lower DYJE	39.1	31.8	15.0	14.1	-	-	15.9	5.0	79.1	38.6	28.8	-	32.6
MORAVA		66.4	21.2	2.9	9.0	0.5	0.7	3.6	10.0	85.7	13.1	13.0	7.5	66.4

Same indicators of development of drinking water supply

Tab.5

indicator	unit	1985	1990	2000
total population	10^3	2 729,450	2 735,086	2 779,100
population connected to distribution system	10^3	1 903,810	2 062,079	2 414,760
percent of connected population in Morava basin	%	69,8	75,4	86,9
total percent of connected population in ČR	%	79,5	83,5	87,0
drinking water production	10^3 $m^3.year^{-1}$	227 597	249 382	251 195
lenght of distribution system	km	9 203	10 824	11 894
underground water using	%	65	63	53
surface water using	%	35	37	47

tab.6

MAIN SOURCES OF POLLUTION

in the Danube River Basin in the Czech Republik

Source			Recipient		BOD5		Dissolved solids
No	Name	Specif.	Name	km	t/year	mg/l	mg/l
1	SM.PIVOVARY HANUSOVICE	fs.	MORAVA	326.55	130.8	2520.0	
2	OLSAN.PAPIRNY.OLSANY	p.m.	MORAVA	311.00	309.9	95.3	421
3	SELIKO VIKYROVICE	fs.	DESNA	13.20	11.2	994.0	
4	CESKOMOR.ETERNIT.ZAV.SUMPERK	ew.	NAHON	3.78	0.2	16.7	2537
5	SUMPERK	p.s.	BRATRUSOVSKY POTOK	0.00	117.8	15.1	300
6	NEALKO.BLUDOV	fs.	BLUDKOVSKY POTOK	2.21	25.0	632.0	
7	MEZ.POSTRELMOV	m.m.	MORAVA	300.96	2.4	8.6	2014
8	CSAO.ZABREH	m.m.	MORAVA	294.89	22.9	750.0	1847
9	TESLA.LANSKROUN	et.	OSTROVSKY POTOK				2700
10	LANSKROUN	p.s.	OSTROVSKY POTOK	0.62	216.8	212.0	709
11	ZABREH.NA.MOR	p.s.	MORAVSKA SAZAVA	2.46	167.1	41.5	437
13	SM.PIVOVARY.LITOVEL	fs.	MLYNSKY POTOK	30.40	126.2	1485.0	
14	STENBERK	p.s.	SITKA	10.37	48.4	505.0	
15	MORAVIA.HLUBOCKY	m.m.	BYSTRICE	29.24	1.9	10.0	24380
16	OLOMOUC	p.s.	MORAVA	232.93	5768.1	272.6	
17	VSETIN	p.s.	VSETINSKA BECVA	78.68	104.6	21.0	538
18	ROZNOV	p.s.	ROZNOVSKA BECVA	14.79	6.9	17.4	3740
19	URXOVY ZAVODY VALAS.MEZIRICI	m.m.	BECVA				4058
20	HRANICE	p.s.	BECVA	38.20	105.0	38.9	470
21	PREROV.CHEM.ZAVODY.PREROV	c.i.	BECVA				3276
22	PREROV-HENCLOV	p.s.	BECVA	8.10	330.3	28.8	516
23	CUKROVAR VRBATKY	fs.	BLATA	15.78	80.3	882.0	
24	PROSTEJOV	p.s.	VALOVA	15.54	201.8	22.9	563
25	CUKROVAR VYSKOV	fs.	DRNOVKA	0.40	162.6	1915.3	
26	CUKROVAR NEMCICE NA HANE	fs.	HANA	11.51	126.6	366.0	
27	KROMERIZ	p.s.	MORAVA	192.61	204.2	40.0	
28	ZLIN	p.s.	DREVNICE	6.46	693.8	49.0	573
29	SVIT.OTROKOVICE	l.	DREVNICE	0.06	1972.9	332.0	1726

Source			Recipient		BOD 5		Dissolved solids
No	Name	Specif.	Name	km	t/year	mg/l	mg/l
30	SLOKO.BABICE	fs.	JANKOVICKY POTOK	0.90	100.9	601.9	730
31	CUKROVAR UH.HRADISTE	fs.	MORAVA	156.70	367.8	301.0	
32	UH.BROD	p.s.	OLSAVA	21.90	704.8	518.0	846
33	LACRUM OSTROZSKA NOVA VES	fs.	PETRIKOVEC	2.20	15.7	1438.0	1672
34	ZELEZARNY.VESELI.NAD.MOR	m.m.	MORAVA	139.63	0.6	4.8	3581
35	SLOKO.BZENEC	fs.	SYROVINKA	8.90	202.2	1705.0	
36	JME.EHO.HODONIN	c.w.	MORAVA	98.80	283.6	2.2	755
37	ZNOJMO-DOBSICE	p.s	DYJE	126.90	121.7	26.4	558
39	PRUMYSL MASNY OLESNICE	fs.	HODONINKA	14.50	63.2	2820.0	
40	VIGONA BRNENEC	t.p.	SVITAVA	72.75	304.7	1200.1	1310
41	ADAMOVSKE.STROJIRNY.ADAMOV	m.m.	SVITAVA				2486
42	BRNO-MODRICE	p.s.	SVRATKA	39.80	2033.4	32.8	
43	JM.PRUM.MASNY KOSTELEC U J	fs.	JIHLAVA	0.50	135.6	759.0	1112
44	JIHLAVA	p.s.	JIHLAVA	140.70	231.2	36.9	
45	TESLA JIHLAVA	et.	JIHLAVA		0.2	2.8	1810
46	TREBIC	p.s.	JIHLAVA	94.80	159.3	39.0	
47	SVIT VELKE MEZIRICI	l.	OSLAVA		67.6	3758.0	8600
48	V.MEZIRICI	p.s.	OSLAVA	58.60	795.5	965.0	1570
49	MORAVSKE BUDEJOVICE	p.s.	ROKYTKA	7.80	219.3	401.0	
50	FRUTA.MIROSLAV	fs.	MIROSLAVKA	14.70	149.7	1310.7	2648
51	FRUTA VRANOVICE	fs.	RICKA	6.00	18.1	689.0	1155
52	NHKG.MOSTARNA.HUSTOPECE.U.BR	m.m.	STINKOVKA	8.80	0.3	7.3	1744
53	PODIVIN	p.s.	LADENSKA STROUHA	6.20	287.0	790.6	1420
54	BRECLAV	p.s.	DYJE	24.20	277.7	66.1	649
55	FRUTA LEDNICE	fs.	VCELINEK	4.70	101.0	482.0	982
56	FOSFA BRECLAV - HYDRAUL.CL.	c.i.	DYJE				9654
57	KYJOV	p.s.	STUPAVA	50.20	228.6	159.7	
58	SLOKO.DUBNANY	fs.	RUMZOVSKY JAREK	1.30	64.4	604.0	614

Specification: p.s. - public sewage system
fs. - foodstuff industry
c.i. - chemical industry
m.m. - metal and machine industries
l. - leatherstuff plant
c.w. - cooling water for power station
et. - electrotechnical industry

Point surces of pollution in Morava basin - 1990

Tab.7

	BOD_5		undisoved matters		oil matters		dissolved inorganic salts		acidity or alkality	
	Number	$t.year^{-1}$	Number	$t.year^{-1}$	Number	$t.year^{-1}$	Number	$t.year^{-1}$	Number	$t.year^{-1}$
Registrated surces	2231	32 320	2231	30 105	94	14	90	49 620	20	61 815
Payments taking surces	489	27 093	13	1 324	3	4	39	45 962	9	59 693

Tab. 8

The Order of Urgency of the Hot Spot's Assanation in Morava river basin determinated using the multicriterial decisive analyses method

Hot spot No	Hot spot Name	Recipient	Subcatchment	Final point evaluation
1.	Olomouc	Morava	up.Morava	252
2.	Otrokovice	Morava	m.Morava	194
3.	Brno	Svratka	Svratka	178
4.	Bučovice	Litava	Svratka	167
5.	Kyjov	Kyjovka	Dyje	166
6.	N.Město n.M.	Bobrůvka	Svratka	155
7.	Vel.Bíteš	Bitýška	Svratka	152
8.	Svitavy	Svitava	Svratka	151
9.	Nové Veselí	Oslava	Dyje	150
10.	Zlín	Dřevnice	m.Morava	149
11.	Polička	Bílý potok	Svratka	143
12.	Hustopeče	Stinkava	Dyje	143
13.	Vel.Meziříčí	Oslava	Dyje	143
14.	Šumperk	Desná	up.Morava	142
15.	Olešnice	Hodonínka	Svratka	140
16.	Bystřice	Bystřička	m.Morava	139
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HUNGARY

TECHNICAL REPORT

Danube Emissions Management Decision

Support Project

for the Hungarian water

catchment area

1992

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1. Assessment of Water Pollution in the Hungarian Part of the Danube River Basin

1.1 Description of the River and its Tributaries

(Some parts of this paragraph are excerpts from the Country Report prepared for the International Conference on Water and the Environment. Dublin. 1990)

Geographically, Hungary is situated in the lowest, predominantly flat land area of the Carpathian Basin, flanked with mountains on three sides, between the northern latitudes 45.5 and 48.5° and the eastern longitudes 15 and 23°. The surface is gently sloping southwards. The average elevation is about 100 m above sea level, only 1 % of the area surpassing the elevation of 500 m. The area of 93.000 km^2 lies completely in the Danube Basin. Rivers enter from the West, North and East. 90 % of the country's surface water resources are exported by the rivers Danube, Dráva and Tisza to downstream countries (see Fig.1.).

As for the climatic and meteorological conditions of the country, they are typical for the northern moderate zone under strong continental influence. The mean precipitation is 600-620 mm/year, but the extreme values lie between 300 and 1200 mm/year. During the vegetation period, the precipitation amount hardly reaches 300 mm. Sunshine duration is 2000 h/year.

The water resources of the country seem to be great since the annual amount of transit surface water reaches 120 km^3. However only 5 % of this volume, i.e. 6 km^3 originates from the national area. As for the spatial distribution of water resources, it is typical that 90 % of 120 km^3 is transported by the rivers Danube and Dráva and only 10 % is the share of the Tisza River, although the catchment (and impact) area of the

latter covers 50 % of the national area. As for the distribution in time of water resources, it is typical that during August, the month of peak water demands, only 5 % of the annual amount is available, hardly meeting the ecological needs of Nature. During this time, practically no water resources of local provenance are available. The annually utilizable amount of ground-water resources is also 6 km^3.

The estimated value of water consumption of the water users of the country is 7.6 km^3, consisting of the following components:

- drinking water supply	1.1 km^3/year
- agriculture,irrigation,livestock farms, fish-ponds	0.8 km^3/year
- industrial water users, including food processing and energy production	5.7 km^3/year
Total	7.6 km^3/year

About 10 or 15 % of this water volume, i.e. 0.7-1.0 km^3/year is being incorporated by Nature, or evaporated. On the other hand, 84 % of industrial water users represents only heat loading for Nature.

The Danube (see Fig.1)

The Danube is the border river between Slovakia and Hungary from Rajka (the entering point) to Szob. On this section of the river there is a sudden break in the bed-slope which causes large bed load deposition and an obstacle for navigation. The Gabcikovo (Bős) barrage and hydropower system (almost finished) would eliminate this difficulty, however, environmentalists desperately fight against the inaguration of the barrage system and at present there is an impasse as to the fate of the construction. Several large tributaries flow into the Danube from

the Slovakian side, among others the Vah (Vág) and the Hron (Garam) both intersecting major industrial districts.

The river has a 90 degree bend at Vác and turns to the south. Below Mohács the Danube leaves Hungary for Serbia. The variation of the discharges of the rivers can be seen on Fig.2 which represents the total length of the river.

Before relating the tributaries two major branches of the Danube river above and below Budapest must be mentioned. The first one is the Szentendre branch (abt 60 km length) surrounding the island of the same name. The latter branch of abt 80 km is called Soroksár or Ráckeve (after the municipalities along the river) and surrounds the Csepel island. Both river sections intersect typical recreational areas of the Budapest inhabitants. The Soroksár branch is menaced by heavy eutrophication tendencies, which is caused mainly by the polluted load from the main river.

Major Danube tributaries in Hungary

Two major tributaries flow across Hungary the Dráva (German: Drau) as a border river between Hungary-Croatia and the Tisza. The first one arises in the Alps in Austria and its pollution comes almost entirely from Austria and Yugoslavia. It has a confluence with the Danube within Serbian territory. The Tisza has its origin in the Carpathian mountains belonging (since the second World War) to Ukraine.It flows from Hungary to Serbia below the large city of Szeged and reaches the Danube downstream of Novi Sad (capital of the Vojvodina part of Serbia) on the left side of the main river (Fig.3. and 4).

The Tisza has several secondary tributaries within Hungary. Among these the most important ones are the right side Sajó (its source is in Slovakia) draining the Borsod (Miskolc) industrial area (see Fig.9),the left side Szamos,Körös and Maros

flowing from the Transsylvanian part of Romania. The latter one is heavily polluted by Romanian industrial wastewater discharges. There are two barrages on the Tisza river the upper and smaller one is at Tiszalök. The second one is upstream of Szolnok at Kisköre. This latter has a storage capacity of abt 300 million cubicmeter. Both impounded sections supply irrigation system. The major canal of this system is called Keleti Főcsatorna supplying the big city of Debrecen with drinking water, as well.

The medium flow of the river ($Q_{50\%}$ in 1901-1970) at the entering section is 140 m^3/sec and below Szeged at the border abt 700 m^3/sec (see Fig.3). However, the fluctuation at Szeged: in April 1400 m^3/sec and in October 300 m^3/sec for the same period of 1901-70. Ice cover is of considerable duration: 30-50 days with 50 % probability in different sections.

1.2 Water Quality of the Danube River

In order to check water quality on a regular basis, a network of monitoring stations was established in Hungary in the early 1960's. This so-called "basic network of water quality control", now having been in operation since 1968, includes 113 important water courses of the country's area, about 50 components are measured with frequencies of 12, 26, 52 samples a year. The number of sampling locations and sampling frequencies for Hungary's two largest river systems are shown in Table 1.

Table 1

Number of sampling stations of the network in the two major river systems

Water systems	Number of sampling stations			Total
	12	24	52	
	samples/year			
Danube	54	99	16	169
Tisza	6	52	23	81
Total	60	151	39	250

In addition to the above mentioned basic network survey regular water quality monitoring is also performed at the Hungarian stretch of the Danube and Tisza. In the recent years so-called "target oriented investigations" have been performed under different hydrometeorological conditions and the sampling was harmonized with the flow velocities.

Summary evaluations of the water quality conditions of the Danube (See Fig.1 of Hungary)

Dissolved solids

The dissolved salt content and its composition in Danube water is principally affected by the geological structure of the watershed. Dissolved solid loads caused by human activities may be estimated at about 5-10 per cent of the total load of the Danube. In respect to cations the Danube water at Rajka is of calcium-magnesium character, while according to anions it is of hydrocarbonate type. The hardness of water is in the medium range with 8-10 degrees at high flows and reaching 16 degrees at low flows. The pH varies within 7.3 - 8.6. The salt content slowly increases downstream. The increasing tendency is mainly detectable in low-flow periods, when the increment at the Hungarian reach approaches 20 %.

In spite of this increase the highest concentration of salt measured in the water is still much lower than 500 g/m^3. The variation of the conductivity is 250-600 $\mu S.cm^{-1}$, while the salt content varies between 190-400 g/m^3.

Dissolved oxygen and oxygen demand

The variation of the dissolved oxygen is between 6-15 g/m^3, the oxygen saturation varies between 60-140 %. The longitudinal dissolved oxygen profile follows two types:

= At the low water temperatures (late autumn and winter time): a decrease was detected at the Komárom-Esztergom section, then an increase occurred in Budapest area. Downstream of Budapest a decrease and at the Szekszárd-Baja section an increase was detected.

= At water temperatures between 15-20 ^{o}C (late spring and summer time) the decrease in oxygen saturation due to biodegradation have not been or only in short sections detectable. In the lower Danube reach oversaturation is frequently observed. This means that the algae mass present in the vegetation period produces more oxygen than necessary for the oxidation of organic compounds. The fluctuation of extreme values is essentially higher at Baja than at Rajka.This verifies that the dissolved oxygen content of the Danube in the vegetation period, from March to October is influenced mainly by the biomass production.

The values of oxygen consumption (COD_{Mn} by acidic $KMnO_4$ and COD_{Cr} by $K_2Cr_2O_7$) are determined by the organic load of the Danube, the organic matter produced in the river water, the advanced state of the decomposing processes and the rate of flow providing for dilution. The COD_{Mn} value varies between 4-10 g/m^3, the COD_{Cr} values are in the range of 12 to 40 g/m^3, with an average of 22 g/m^3.

The COD values of the samples taken in different periods are nearly identical in the longitudinal section, however a typical increase of 2-8 g/m^3 is detected at the Budapest area.

The time series of the monthly COD_{Mn} mean values do not show an unambiguous periodical variation as it is detected with that of the oxygen saturation.

The biomass produced in the vegetation period by the primary production is higher than the decomposed organic matter.

Thus small peaks have been detected at Rajka in the spring and early summer and at Baja in the late summer period. In winter the values at Rajka and at Baja are nearly the same, since the measurement is not interfered by algae mass.

Consequently it is supposed, that the Hungarian organic load is completely decomposed before reaching the Hungarian--Yugoslavian border even under the most unfavourable conditions, and that the increase detected in the vegetation period is the consequence of algae production.

The value of dissolved organic carbon (DOC) depends on the changes in flow rates, however it is mainly determined by the organic load. The values vary between 2-10 g/m^3, the concentrations of the polluted tributaries are rather higher. An essential difference exists between the late summer and winter samples. The organic carbon as a water quality component is a good index for the dissolved organic pollution, further it has the advantage that the organic load produced by the algae growth and its secondary polluting effect is less included in the analytical result, compared to the COD measurements.

Plant nutrients

The concentration of the ammonium (NH_4^+) ion in the Danube varies between 0.1-3.6 g/m^3, its deviation is remarkably high. The highest values are obtained in winter time at low-flow with 2-4 ^oC temperature, the small values appear at flood periods and high temperatures. In the winter samples the background values at Rajka are high and further increased by the Vah (Slovakian tributary) and the Sio confluences. The lower values measured in the warm periods are almost identical in the whole Hungarian reach. The samples at the Sio section sometimes show a peak-like pollution.The 10 years' series of monthly average values of the Rajka and Baja sections show a definite yearly periodical variation. The maximum values occur in the winter the minimum in the summer period.

The variation in nitrate ion (NO_3^-) in the Danube is generally between 3.2-10.2 g/m^3. The highest values occur at the lowest water temperature. There is a separate paragraph later dealing with the nitrate (see Appendix A).

The phosphate ion (PO_4^{3-}) values vary between 0.08 - 0.8 g/m^3. The yearly periodicity and the dependence on the vegetation, on the water temperature and solar radiation is here also detectable.

The nutrient load of the Danube influences indirectly the water quality through the aquatic flora and fauna. In the vegetation period 50-90 % of the nutrients are taken up by the plants, decreasing the nutrient concentration of the water. Thus, the actual concentrations can not be directly considered in the evaluation of the water quality. Beyond the vegetation period the maximum values are typical for nutrient loads.

Organic micropollutants

The content of anionic detergents varies between 0.04 and 0.20 g/m^3 showing a relatively small fluctuation. The highest values occur in the low-flow and low-temperature periods. The longitudinal section sampling has shown an irregular change in the concentration which should be considered as a consequence of an accidental waste discharge.

The concentration of phenolic compounds is characterized by a range of 0-10 g/m^3. The longitudinal investigations have shown that the actual concentrations largely depend on actual waste discharges and that the flow and temperature have small if any effect. The concentration at the downstream border is regularly lower than the inflow concentration at the Slovakian border.

Oil and oil products (expressed as extractable in carbontetrachloride) show concentrations between 0.01-1.0 g/m^3. The

average value at Rajka, Komárom, Szob, Budapest, Baja are 0.29 g/m^3, 0,32 g/m^3, 0.20 g/m^3, 0.29 g/m^3, 0.21 g/m^3, respectively.

There are several sampling points where decrease and increase of concentrations occur alternatively. At particular sources unexpected peak loads have been observed many times. Concentrations vary intensively in magnitude, time and space - a situation of shock-load pattern.

There have been a few scattered investigations on chlorinated pesticides. Only hexachlorbenzol (HCB), and lindane were detectable along the Danube. HCB was measured at the concentration range of 2-5 mg/m^3, while lindane at 2-40 mg/m^3.

Investigations on chlorinated hydrocarbons were focused on carbontetrachloride, chloroform, tetrachloroethylene and trichloroethylene. Concentration ranges of these components, measured upstream of Budapest are as follows:

- carbontetrachloride: 0,1-1,1 mg/m^3
- chloroform: 0,3-0,8 mg/m^3
- trichloroethylene: 0,1-0,2 mg/m^3
- tetrachloroethylene: 0,1-0,6 mg/m^3

Results of the sparse investigations indicated that the concentrations remained below the "desirable" threshold value.

Investigations performed with gaschromatograph-mass spectrometry (GS-MS) analysis by the Hungarian-Czecho-Slovakian laboratories (part of a co-operation on transboundary water resources) identified approximately 250 organic compounds in detectable amount, such as hydrocarbons, ftalates, triazine type herbicide atrazin, and polichlorinated biphenyls.

Metals

Measured values of metals vary generally over wide ranges with orders of magnitude differences (see Table 2).

Table 2

Heavy metal concentrations in the Danube upstream of Budapest (1682 rkm) and downstream of Budapest (1631 rkm) in a given period

Metals	River km	Minimum	Average	Maximum
Hg (µg/l)	1682	0,1	1,0	4,7
	1631	0,1	1,2	18,7
Pb (µg/l)	1682	1,0	2,4	11,0
	1631	1,0	4,2	55,0
Cd (µg/l)	1682	0,1	0,6	29,0
	1631	0,1	0,4	4,0
Fe (mg/l)	1682	0,23	0,87	3,5
	1631	0,05	0,81	10,7
Mn (mg/l)	1682	0,04	0,07	0,29
	1631	0,02	0,08	0,50

The wide range of variation indicates shock pollution loads associated with attachment to suspended solids, affecting transport and concentration conditions. Low concentrations characterize Hg, As and Cd, while Fe, Zn and Mn are represented with ranges of higher concentrations. Taste deteriorating, but non-toxic metals, iron, manganese, zinc are present in drinking water with concentrations close to or exceeding the allowable limit. Among substances that are toxic to plants (but not to humans) copper can be mentioned as a single one approaching limit value. Among metals being toxic also to humans such as As, Cr, Pb, Cd, Mg, only lead and cadmium are found in concentrations approaching the undesirable limits, but not exceeding drinking water standards.

The above statements refer to dissolved metals, but it can be stated that a large portion of iron, manganese, zink, cadmium, chromium, lead, mercury are attached to sediment particles, while nickel and copper are present mostly in dissolved form. Metals in the solid phase are attached mostly to the smallest sediment particles. These enriched concentrations are higher than those considered natural, thus unambigously indicating pollution. Average concentrations of lead, arsenic, copper and zinc in the smallest particle size fraction exceed the allowable values for soils.

Bacterial pollution

The data available on the bacteriological quality of the Danube indicate that the Danube between Rajka and Komárom and also the Mosoni Danube fall into the "polluted and heavily polluted" quality class. Between Rajka and the mouth of the Mosoni Danube, Salmonella analysis has shown that 50 % of the samples are positive. Coliform and feacal coliform are found below 100 and 10 i/ml respectively. Due to the untreated sewage of Győr, the Mosoni Danube represents a high bacterial pollution load on the Danube.

The large wastewater loads of Budapest results in "polluted quality class".The coli values rise by one order of magnitude and Salmonella branches are always present at Nagytétény, downstream of the capital. The effect of the capital can be detected mainly in the littoral current and in the plume of waste water discharges. The improvement of bacterial conditions downstream of Budapest is very fast, and at Dunaujváros the quality is better than upstream to Budapest. The bacteria count decreases further in the section Dunaujváros-Mohács.

Biological conditions

Phytoplankton, algae count and chlorophil-a content of the water are the main biological components measured regularly

The variation of chlorophil-a value is between 10-200 mg/m^3, and the algae count value is between 1000-40.000 $cell/cm^3$. The highest values have been measured in summer. The minimum values occur always in December and January. Growth starts in spring when the temperature of water reaches 4-5 ^oC and the number of sunny hours approaches the monthly 100 hours. Further increase occurs when these parameters reach 10 ^oC and 200 hours. In the vegetation period between March and October two peak values are detected. The spring peak is in April-May and the autumn peak appears in September-October. The monthly mean values are the same along the whole reach in wintertime, but in the vegetation period the downstream values at Baja are about two fold compared to the upstream values at Rajka.

The longitudinal measurements of summer period have shown similar results. From Rajka to the upstream section of Budapest a slight increasing tendency is suddenly raised downstream of Budapest, where the algae count is multiplied. This phenomenon can be interpreted by the change in the hydrological conditions. The current slows down, the suspended sediment settles, the transparency increases, improving the living conditions for the algae. An other reason is that in this reach the dominant species are multicelled green algae and small size diatoms essentially altering the quality of the algae composition. The algae production affects also other already discussed parameters. It results in decrease of nutrient concentrations (NH_4^+, NO_3^-, PO_4^-) in the vegetation period, the oversaturation of dissolved oxygen in summer and peak oxygen consumption in the autumn. It effects also the hydrogencarbonate-carbonate equilibrium, the change of which results in increasing pH-value in the vegetation period.

Finally, as to the trends in water quality, Appendix B presents data.

1.3 Water quality data of the Tisza river

(see Appendix B, as well)

Quality at Tiszabecs (entering section of the Soviet border)

At this point the quality of the river is favourable. The important components are as follows:

	average	at flood*
COD(-permanganate)	1.0-3.0 mg/l	18 mg/l
COD(-bichromate)	2.0-10 "	40 mg/l
BOD (-5 days)	0.1-1.9 "	10 mg/l

* the values include the suspended solids, as well.

Dissolved-O_2	7-13 mg/l
Dissolved-salts	200 mg/l

NH_4^+, NO_3^-, and micropollutants are negligible.

This section of the Tisza to the confluence of the Szamos river is one of the cleanest river reach of the country.

Quality of the upper reach (river km 650-330)

This river reach is characterized by the effect of the polluted tributaries, such as Szamos and Kraszna (flowing from Romania). Quality components of 50 % duration in these two rivers are as follows:

		Szamos	Kraszna
COD (bichromate)	(mg/l)	48	51
NH_4^+	(mg/l)	1,5	6,6

The unfavourable situation is aggravated by the fact that the pollution load through these secondary tributaries arrives in the form of shock-waves, very often.

The right side tributaries of Bodrog, Hernád and Sajó (all coming from Czechoslovakia) worsen the quality of the Tisza with further pollution loads. As an example: at the confluence point the COD_{cr} of the Sajó is 77 mg/l and the NH_4^+-value in the Hernád is 3,5 mg/l. The Sajó is heavily polluted in the Hungarian section as well (e.g. Kazincbarcika, BVK-chemical works, Miskolc with 240.000 population and various industries, as given in the Appendix C).

In the following table the metal-pollution of the Szamos and Sajó is given in microgramm per liter at the river mouths. (Average values of 1990 measurements).

	Zn	Cu	Pb	Cr	Hg	Cd
Szamos	277	85	64	21	2,4	3,6
Sajó	67	9,8	6,8	1,4	0,3	0,7

The middle section of the Tisza (to the Yugoslavian border)

This section is influenced positively by the Kisköre reservoir and negatively by the (mostly untreated) Szolnok waste waters. It should be mentioned that in the impounded section the suspended solids are greatly settled and together with this the majority of above said heavy metals.

In Szolnok the wastewater discharge is 0.8 m^3/sec.

The pollution load is characterized by the following figures:

COD (bichromate)	22 t/d
BOD	9 "
NH_4^-	1.3 "
ANA-detergents	85 kg/d

These respresent 1-5 % of the mass load of the river.

In the following table several average values of quality components are shown in the longitudinal section of the river.

Table 3

Some longitudinal characteristics of the Tisza

	COD_{cr}	Dissolved-O_2	NO_3^-	a-chlorofil
Tiszabecs	10	12,0	4,5	-
Tiszafüred	26	8,4	7,2	14
Kisköre	20	8,7	7,0	15
Szolnok	22	9,1	7,6	13
Tiszaug	23	8,8	7,6	13
Tiszasziget	25	8,3	11,0	-

Quality at the Yugoslavian border section

Here the major polluter is the left side tributary of Maros (flowing out from Romania). Neither the Körös nor urban settlements along the river cause any significant load to the confluence of the Maros and the city of Szeged (untreated sewage discharge, see Appendix C).

Several quality components (averages) of the Maros river with a medium flow of 110 m^3/sec are as follows:

COD_{cr}	40 mg/l
NH_4^+	3.0 "
dissolved salts	650 "
Hg	0.1 µg/l
Cd	5.0 "
Zn	500 "
Cr	700 "
Pb	90 "
Fe	8800 "

Once again the pollution arrives from Romania in a shock--load pattern, very often! In the following the characteristic values of the border section of the Tisza are presented in mg/l.

	min.	max.	average
COD (permanganate)	4.0	23	6.5
COD (bichromate)	12.0	75	25.0
BOD	1.1	21	4.3
Dissolved O_2	4.4	12	8.3
NH_4^+	0.02	5.0	0.8

Finally it should be mentioned that the phosphate ion concentrations in the Tisza are half of that in the Danube, however, this is abundant to eutrophication, which is recently quite a problem.

1.4 Groundwater

A major groundwater resource of the Transdanubian part of the country is the karstic water.

From these resources water amount surpassing the natural recharge rate has been withdrawn since 1950, partly for water supply purposes and partly in order to facilitate mining operations.

The original discharge of karstwater-fed springs was 450 m^3/min. 40 years ago it was still 300 m^3/min and today it is only 70 m^3/min. Various abundant springs and small streams have become dry. On the brim area, the total hot water discharge of the springs of world-famous Héviz spa and Budapest was 50 m^3/min, now it is only its half.

As far as groundwater pollution is concerned it should be differentiated according to the depth of water bearing layers and topographical situation.

Along the Danube the sandy-gravelly alluvial layer contains considerable water resources. This is replenished either (and mainly) from the river or (at low discharge of the river) from the adjacent groundwater.This resource is greatly utilized for drinking water supply and it will be reviewed in the next chapter (see Fig.5).

The near-surface groundwater table in the agricultural area is highly polluted by nitrate. This is pointed out at greater length in Appendix A. The pollution pattern is different below the municipal and industrial areas. While under the unsewered villages the groundwater table is unduly elevated because of the seepage of wastewater and polluted by NH_4^+ and NO_3^-. Under the sewered settlements industrial pollution is frequent.Just along the Danube the following contaminations were discovered (with-

out listing the sources): pharmaceutical chemicals, chromium, zink, kerozene, lead, oil, etc. In the Tisza catchment near the Sajó river an enormeous mercury pollution was discovered under a chemical factory. At present a PHARE-project is under way aiming the detection of groundwater pollution sources and preparing an inventory of that.

Special attention should be devoted to the great Danube islands above (Szentendre) and below (Csepel) Budapest. These are lying completely on the sandy-gravel terrace of the Danube and full with the bank filtered wells of the waterworks of Budapest and adjacent settlements. Simultaneously they are parts of the recreational area of the capital as it will be pointed out later.

The western part of the Csepel island along the main Danube branch is heavily polluted by the settled sludge of the untreated wastewaters of the capital and by communal tipping places or industrial sources (heavy metals, NH_4^+, organics). It should be mentioned that under an abandoned Soviet military area there is an enormeous fuel contaminated spot.It is planned to launch a cleaning operation by foreign firms.

1.5 Impacts of water quality for uses

1.5.1 Urban use

Drinking Water Supply in general

Out of the 3070 settlements of the country, already 2500 ones (with 91 % of the country's population) are supplied with drinking water from pipes. However, the quality of the water supplied, is behind the national quality standards in 400 settlements. The 9,5 million inhabitants supplied by waterworks,consume an average volume of 2.7-2.9 million m^3/day.The peak value

in summer time is 4.1 million m^3/day. 43 % of the latter capacity is provided by bank-filtered wells, 38 % by artesian, 7 % by karstic water resources and 3 % by the shallow ground-water. Only 9 % of drinking water demand is supplied from surface waters.

The so far installed capacity of water production is 4.8-5.0 million m^3/day. While no quantitative problems of drinking water supply are expected, difficulties with water quality may occur. In the course of further development, water supply with healthy drinking water must be provided for about 1.0 million inhabitants of 600 settlements,including the implementation of considerably great new capacities for water treatment. The deadline for solving this task is 1998, by Parliament decision. By that time,an additional water treatment capacity of 0.5 million m^3/day, a distribution network of 20,000 km, storage capacity of 0.7 million m^3 have to be constructed and the proper protection of 450 water supply areas of water production has to be secured. After that, the water supply level of the population will reach the realistic value of 97-98 %.

The gap between the degree of water supply (91%) and sanitation (51 %) is 40 % at present. It should also be noted that the sewages of a number of riverside towns - among them those in a part of the capital,Budapest - reach the recipients without any treatment, relying - with a continuously less justified reason - on the self-purification capacity of the rivers.

Reducing the gap by installments will be implemented parallel to the rearrangement of propriety conditions, taking place as a consequence of social changes in the country. The importance of private capital will increase.Concession methods adoptable under today's Hungarian conditions have to be elaborated. Possibilities for the participation of foreign capital should be secured since all these tasks cannot be solved only based on national resources.The rentability of private and foreign investments should be guaranteed.

The demand for improving life quality and for the protection of the health of the environment requires that the national standard systems should approach the European one.

Water supply situation in several large cities

In general, along the Danube the water supply is exercised mostly from the bankfiltered wells or from the sandy gravel terraces /alluvial layers/. These layers are, however, interconnected with groundwater draining agricultural land.

In the No.1. area upstream from Budapest the most important city is Győr which is supplied with drinking water entirely from above mentioned alluvial layer. However, because of the Fe- and Mn-content of the raw water it requires pretreatment before chlorination. The total capacity is 90.000 m^3/d and the investment need is rather negligible on the short run (Fig.8.)

The Regional Waterworks of DRVV produces 130.000 m^3/d once again from the bankwells and Fe-Mn-removal is restricted only for a few wells. Generally speaking the quality of the raw water is acceptable, however, NO_3^-- and NH_4^+-contamination is menacing in some places.Some of these wells had to be abandoned.

The greater Budapest area is supplied again overwhelmingly from bankfiltered wells. The total production capacity of the Metropolitan Waterworks is at present 1,260.000 m^3/d. This seems enough until the end of this decade. However from this figure abt. 300.000 m^3/d water is coming from direct-surface-water-intake treated in the classical way with some PAC-addition. The problem is mainly arising from the periodical planktonic overproduction in the Danube. Improvement of the treatment system to avoid algal contamination is under way.

The bankfiltered wells are situated mainly in the two islands upstream /Szentendre/ and downstream /Csepel/ from the city. While the upstream water gaining area produced safe water, the Csepel island wells are contaminated by the untreated wastewaters and settled sludge of the capital.Fe-Mn-removal,plus ozonization is presently applied for the water pumped from these wells, however, activated carbon filtration should be intro-

duced, as well. Due to the permanent deterioration of the old wells, yearly 2 % of those must be substituted by new ones.

There is a further problem of the increased drinking water need of the island municipalities. This means a new waterwork of the Csepel island with a capacity of 130.000 m^3/d. The estimated investment cost involved for the above works is about 5 billion Forints.

It should be mentioned that the protection of the water yielding area presents a permanent problem due to the fact that the villages are not supplied with sewerage facilities and the intensive agriculture is polluting the groundwater, as well. These protective measures involve 3 billion Forints in the Csepel island alone and more than 1.5 billion in the Szentendre island. This is, however, a general deficiency all the water yielding areas in the whole country.

Further to the south along the Danube the industrial centre of Dunaujváros should be mentioned. It receives at present abt. 50.000 m^3/d drinking water from healthy bankwells of Ercsi. The next large waterwork is the Mohács-Pécs komplex. In Mohács there is a surface water intake with clarifiers which is supported by bank-wells recently. From here two rising mains transport the mixed water to the large industrial town, Pécs. It is (in Üszög) a complete treatment with activated carbon filtration. This system supplies 40.000 m^3/d and it needs several renovative actions, such as new rising mains and ozonization. Several hundred million Forints are forecasted for the new investments.

As far as the Tisza subcatchment is concerned, first of all Miskolc should be mentioned. Here the gravel terraces of the secondary tributaries of the Sajó and Hernád are used for water supply. There are 3 waterworks out of which the one at Sajólád (capacity is 50.000 m^3/d) is now nitrate-polluted and its water production was reduced to a third of the original. Furhter ex-

tension of the supply is planned from the Tisza-terrace 20 km away with a projected cost of 1.5 billion Forints.

For Debrecen a surface water work at Balmazujváros was built with a capacity of 50.000 m^3/d /besides of old wells planted on deep aquifers/. This waterintake uses the Tisza water of the irrigation canal, Keleti Főcsatorna. Besides the classical treatment technology they adopted the ozon-technique, however, this has not yet been completed with GAC filter. An investment some of abt 250 million Forints is required.

At Szolnok the surface water work produces 70.000 m^3/d and an extension of abt. 15.000 m^3/d is forecasted. However, it would be more urgent to adopt ozon- and GAC technique due to the fact that the river is polluted with refractory organic from the Sajó and algal bloom is a problem, as well. More than 1 billion Ft is needed to all of these investments.

Finally it should be mentioned, that while in the Danube valley over 80 % of the drinking water supply uses Danube water, mainly through bankfiltered wells, in the Tisza sub-catchment /in the great Hungarian plain/ this is in the opposite way, that is more than 80 % is developed from deep aquifer.

The water supply of Szeged is fed from deeplayer aquifer (abt 100.000 m^3/d) which is acceptable both in quantity and quality. The latest waterwork was developed at Algyő with 20-25.000 m^3/d water production and it is transferred to the city. This work can be extended easily if it would be necessary later.

1.5.2 Ecosystems and Fisheries

As far as the specific ecosystem problems of the Danube in Hungary is concerned two major natural treasures should be mentioned that is first the river section between Rajka and Győr the so called "Szigetköz" and an other one near to the township of Baja the "Gemenc" game reserve.

Both are full with small river branches, old wooded and marshy areas. Great problem arised with the "Szigetköz" as a consequence of the Gabcikovo (Bős) Slovakian-Hungarian hydroproject. The debate between the environmentalists and economists is sharp and the same can be said even between the two governments of Slovakia and Hungary. The Slovakian government invested more money into the project almost completely finished than the Hungarian partner and the Slovaks want to finish and operate both the hydropower plant and shiplocks (in contrast to the Hungarians). The major issue of the differences in the attitudes of the two parties is the fear of the contamination of the great water resource in the alluvial layer under the reservoirs due to the impounded slow flow, and the uncertainties about the fate of the specific ecosystem of the Szigetköz, host of many rare species of the natural flora and fauna (gene-bank).

As far as the importance of the fishery in the Danube is concerned, sorry to say, this is decreasing in contrast to that in the Tisza. The 30-year average of the fish catch is abt 1 million kg/a. In the latter case the impounded section of "Kisköre" (see Fig.1) plays a critical role in respect the ecosystem and fishery. The problems arise from the fact that this is a major fish breeding area of the river with the many shallow bays of the impounded river section, which are menaced by water level fluctuations. The fish catch - once again in a 30 years average figure - is abt 800.000 kg/a.

As it was stated in the paragraphs of 1.2 and 1.5.1 for

both the Danube and Tisza, the nutrient load is critical and eutrophication (algal bloom) is a major impact on water uses. However, the heavy metal and refractory organic contamination is of local importance as pointed out in para 1.2 (see also Table 2). That is true that in the impounded or regulated low velocity river sections silt accumulation happens. The only markantly contaminated river section of such a character is the Danube bank downstream of Budapest along the Csepel island as it was mentioned previously.

1.5.3 Other uses

Recreational use is given under this title. For the capital the upstream Danube bank together with the Szentendre island and the eastern part of the Csepel island along the Soroksár Danube branch is important recreational area. Along the Tisza the most important recreational activity is concentrated around the Kisköre reservoir also called "Tisza-lake" (see previous para). Appendix D summarizes the most important features of the recreational areas along the Danube and the Tisza rivers.

The smaller arm of the Danube (Soroksár or Ráckeve branch) around the Csepel island (see Fig.8 and Appendix C) has been developed for recreation. Previously - and in some parts even nowadays - it was used as a summer bathing resort, as well, however, the main recreational use is sport-fishing.The tragedy is the enhanced eutrophication of this river section closed by sluice-gates at both ends and polluted by the discharge of the South Pest wastewater treatment plant, as well, contributing to the river's nutrient stock. Any improvement is hopeless as long as the pollution of the main Danube feeding the branch will not be reduced.

2. Emmissions and Discharges

2.1 Overview

The pollution figures in Table 3 are measured routinely by the inspectorate 2-4 times a year at the discharge points of the polluting agencies. This causesinaccuracy in the calculations. However, the order of magnitude of the calculated figures with the data comparison are acceptable. First the total country load is reviewed, then separately that of the capital.

Table 3

Nation-wide Pollution Load

(these data originate from the 1980-90 period)

Water-shed	Wastewater flow		Pollutants							
			COD_{cr}		Total salt		Oil-grease		NH_4^+	
	10^3 m^3/d	%	10^3kg/d	%	10^3kg/d	%	10^3kg/d	%	10^3kg/d	%
Danube	1860	70	780	78	1200	62	38	77	35	61
Dráva	70	3	50	5	100	5	1	3	2	4
Tisza	710	27	170	17	650	33	10	20	20	35
Total	2640	100	1000	100	1950	100	49	100	57	100
Bpest (out of the total)	1000	38	480	48	470	25	26	53	17	30

During the eighties the wastewater flow discharged to surface waters fluctuated between 210 and 240 million m^3 yearly. Out of this 93 % disposed in the Danube watershed. The proportion in the subwatershed of Tisza river was 57 %. Out of the total wastewaters to be treated 35 % is developed by Budapest and 10 % is produced in the county of Borsod (Miskolc and

environ). However, only 18 % of the above wastewater is "properly" treated. 69 % is partially treated and 14 % has no treatment at all. 32 % of the treated wastewater belongs to industrial establishment and 67 % is treated by the communal sewerage works.

The most recent (data from 1991) global overviews of the wastewater flow (on a daily basis) with a rate of 42 % of sewerage can be seen on Fig.6. As far as the planned development is concerned Fig.7 presents the same data to approximative time horizons of 2000 and 2010.

The characteries of the sewerage system is represented with the following figures at present (Table 4)

Sewerage figures — Table 4

System of sewerage	Length of sewers 10^3 km	%
Separate system		
- sewage	6.6	58
- precipitation	1.0	9
Combined system*	3.8	33
Total	11.4	100

*Mostly in Budapest

It is interesting to note the forecasted sewerage figures to the time horizon of 2000 and 2010, that is 17 000 and 23 000 km. The estimated investment costs are 330 x 10^9 and 520 x 10^9 Ft on the 1990 price level.

These latter cost-figures contain the wastewater treatment investments, as well (see Fig.7), however, without VAT-addition. The proportion of the sums for sewers and for treatment plants are roughly 50-50 %.

2.2 Municipal Dischargers

The Hungarian Danube Watershed
/without the Tisza river and its subwatershed/

This area consists of 3 parts:

1. The area from Rajka to Budapest (see Fig.8)
2. Budapest (see in Appendix C)
3. The Danube river-reach between Budapest and Mohács

These 3 parts do not cover that total area indicated in the title and especially not the area downstream from the capital because of the reason that the neglected sub-areas of section 3 do not exercise any reasonable point-source-pollution to the river. There are 3 major riparian industrial complexes such as Százhalombatta (oil refinery and power plant) Dunaujváros and Paks. The third one with its atomic reactor, however, causes thermal pollution only. Pécs, the large industrial city does not lay along the a.m. river section,but it is supplied with drinking water from the Danube at Mohács.

In Table 5 the major municipal polluters of the first area upstream from Budapest are listed. The total population of this area (see Fig.8) is 810.000 with 280.000 houses,flats, resp. out of the latter 246 000 are connected to piped water supply and 172 000 to public sewers.

In the followings the problems of several major cities are discussed from Rajka to Mohács.

Table 5. Pollution load* of the Hungarian Danube between Rajka and Budapest from municipalities (1985)

Cities (see Fig.8)	Population x 1000	Recipient	Wastewater flow (m^3/d)	COD (kg/d)	Oil extract (kg/d)	NH_4^+ (kg/d)	Total salt (kg/d)
Győr	127	Mosoni-Duna	80.300	47.624	3.062	2.978	64.465
Mosonmagyaróvár	30	Mosoni-Duna	6.100	1.320	77	243	10.565
Esztergom	32	Duna	6.205	2.340	89	159	4.381
Komárom	20	Duna	4.200	2.286	44	125	4.805
Lábatlan	6	Duna	2.700	559	29	42	1.812
Dorog	12	Kenyérmezei-p.	8.625	13.755	145	226	17.200
Oroszlány	21	Általér	6.600	700	42	197	4.955
Tatabánya	77	Általér	26.300	3.860	199	710	18.420
Tata	26	Általér	6.055	426	40	4	4.276
Sopron	56	Ikva	15.560	7.250	125	328	17.166
Szombathely	86	Perint	31.900	1.786	83	347	22.968
Ajka	34	Széles-p.	7.500	302	24	143	4.550
Pápa	34	Mezőlaki - p.	9.000	468	16	210	2.610
Balassagyarmat	19	Ipoly	3.500	1.253	53	124	4.200
Major polluters			119.740	83.929	4.028	5.836	182.373
Others			30.154	9.248	360	420	12.792
Total			149.894	93.177	4.388	6.256	195.165

*The significant polluters are listed only.

The problems of the major country towns along the Danube river

Győr (the Mosoni Danube branch) with a population of 127.000 and a large industry of engineering, textile, destillery, food stuff, etc. has at present 80.000 m^3/d wastewater that is only mechanically treated. The first biological stage for 40.000 m^3 and the pipeline to the Danube (Moson branch) has been constructed. They need abt 1/2 billion Ft for 1992. To the proper operation with sludge disposal, however, several more billions might be necessary - according to the present estimation.

Komárom (population 20.000) discharges at present 4,250 m^3/d wastewater. Without treatment it is introduced into the main current of the Danube. The projected full biological treatment for 6.000 m^3/d involves an investment cost of more than 1/2 billion Forints. This was planned to the year 1992,however, the finalization date is not clear at present. It is forseen to build finally a plant of 12.000 m^3/d capacity for the wastewaters of Szőny and Alsóneszmély, as well.

Esztergom (population 32.000) discharges at present 6-7.000 m^3/d wastewater untreatedly into the main current of the Danube. The mechanical (primary) stage for 12.000 m^3/d should be ready in 1992, the biological stage (1/2 billion Forints at least) is allegadely ready in 1993.

Vác (population 38.000) has a treatment plant originally constructed for 12.000 m^3/d. This can not receive the sewage increased to 18.000 m^3/d recently. The extension would cost abt 1/2 billion Forints together with a regional sludge handling and disposal facility.

It should be mentioned that in the above towns the sewerage system needs a more or less large scale extension, the cost of which is not quite clear.

Szigetszentmiklós (population 14.000) in the Csepel island needs a new treatment plant of a capacity of 10.000 m^3.

Budapest is presented in Appendix C.

Dunaujváros (population 61.000). At present the wastewater of 28.000 m^3/d is treated by a screen and sandtrap, however, there are some speculations (with the US firm Kramer) of building aerated and facultative ponds in the future.

Baja (population 40.000). In the existing mechanical (primary) treatment plant 6000 m^3/d wastewater is flowing through into the Danube. The future plan involves a regional treatment plant of 20.000 m^3/d capacity receiving the industrial discharges (food + textile) as well. Cost is unknown.

Mohács (population 20.000). No treatment at all, it is needed a biological plant of 10.000 m^3/d capacity.

The problems of the major cities in the Tisza river sub-basin

Miskolc along the Sajó river has a population of 240.000 and it hosts several industrial branches, such as metallurgical, engineering and foodstuff. At present the wastewater of about 90.000 m^3/d is only mechanically treated and the primary sludge after lime treatment is transported to agricultural land for disposal. The primary treatment system has been, however, constructed to the treatment of 140.000 m^3/d and there is the first part of the secondary (biological) stage for 70.000 m^3/d under construction, as well. For the second stage of the latter and for the sludge digestion and dewatering complex a design projet has been financed by the PHARE-programme. The plans are ready but in lack of financial support (estimated cost abt. 2 billion) the international tender and the execution of the work is suspended.

Debrecen (population 210.000) is the "capital" of the great Hungarian Plain without any surface water flow (with except of some small creek). Its wastewater of abt 80.000 m^3/d is mechanically treated only and it is at present transported to 15 km, where it is spread on open land (38 hectar of "ponding"). The primary sludge is used in agricultural land in 15-20 km distance from the plant (without stabilization or dewatering) which can not be practised for the future. The first stage of the secondary treatment plant (40.000 m^3/d) is under construction, however, the sludge handling and disposal is questionable even nowadays. The total cost projection of the treatment system is between 1.5-2 billion Forints.

Szolnok (population 80.000), at present, has no treatment plant at all. There is a plan with a capacity of 80.000 m^3/d (combined sewer system, different industries). The main sewer and the inlet pipe to the river has been constructed, however, the plant can not be built in lack of financial support. The unified sewerage system has been built to 84 % of the final stage.

Szentes (population 32.000) has at present a plant of 6600 m^3/d and it needs an extension to a capacity of 10.000 m^3/d.

Szeged (population 180.000) has a unified type sewer system (at present built abt. 46 % of the final one, only). The planned capacity of the treatment plant is 120.000 m^3/d. There are some preliminary negotiations with the Danish firm Krüger as to the building of new sewers (150 km) and a treatment plant from foreign capital. It is hardly believable to operate this plant before 1997/98.

2.3 Industrial Dischargers (see Table 6)

As it is quite understandable most of the industrial dischargers are accumulated in the major cities, in Budapest alone

Table 6 Pollution load of the 6 greatest polluting industrial branches* in 1985

Component	Dimension (per year)	Quantity of pollutant into surface water	into public sewer
COD	t	47.726	65.604
Oil, fat	t	5.254	1.543
Total salt	t	280.399	71.088
Ammonia NH_4^+	t	9.748	977
Detergent	t	193	107
Zn	kg	109.023	33.821
Cd	kg	2.744	8.430
Cr /total/	kg	21.808	42.722
Ni	kg	7.821	5.827
Pb	kg	1.793	10.968
Cu	kg	12.046	14.895
Fe	kg	5.380	5.700

*Mining, Electric energy, Metallurgy, Engineering-, Light industry

abt. 40 % of all the industries. This means that the municipal sewers are loaded with the industrial wastes. Though there are severe criteriae as to the discharges into the public sewers, most of the industries being in poor financial conditions can not observe these prescriptions, and both the sewerage systems and the existing treatment facilities are overloaded by industrial wastes dumped in without proper pretreatment. This problem in the Budapest area is also presented in Appendix C.

In the followings after a general view of the industrial pollution load (see Table 7) several individual industrial dischargers with direct (or almost direct) access to the Danube and Tisza are listed.

Along the upper region of the Hungaruan Danube Table 7 shows a list of industrial dischargers, some reaching tne Danube via tributaries.

There are in the Komárom region 3 industrial discharges above the listed ones in Table 7: AKKV (food) with 6700 m^3/d (the treatment plant is in operation) KKV (Almásfüzitõ) with 3000 m^3/d (only mechanical treatment) and aluminium oxide works with 9000 m^3/d (mechanically treated). These will join to the planned treatment plant of greater Komárom.

South from Budapest there is the oil refinery of Százhalombatta (see Fig.5). The industrial waste require a new treatment plant planned from foreign capital.

Further on downstream in the city of Dunaujváros the paper and pulp mill has a separate biological treatment plant mounted by the French firm Degremont, the remaining COD_{Cr}-load (from 60.000 m^3/d) is abt 65 t/d. There are uncertainties as to the wastewater treatment of the large metallurgical complex.

In the Tisza sub-watershed along the Sajó river (see Fig.9) there is a major chemical industrial complex:

Table 7 Pollution load* of Upper Danube industrial discharges (1985)

(see Fig.3)

Name of industry	Recipient	Wastewater flow (m^3/d)	COD (kg/d)	Oil extract (kg/d)	NH_4^+ (kg/d)	Total salt (kg/d)	Treatment at present
Győr Destillery	Mosoni-Duna	10.943	3.572	67	19	4.453	partial
Petőháza Sugar	Ikva	3.000	3.453	-	219	6.779	mechanical
Kapuvár Meat	Kis-Rába	1.600	2.521	58	58	2.695	partial
Ács Sugar	Székes-patak	2.600	694	18,5	35,4	1.235	mechanical
Lábatlan Paper	Duna	17.400	5.386	95	8	5.835	partial
Nyergesujfalu Viscosa	Duna	14.000	2.574	98	155	20.800	mechanical
KÖGYO-Dorog (Pharmaceutical	Kenyérmezei-p.	2.000	7.490	116	694	20.802	biological
Major polluters		52.163	25.790	452,5	1.188,4	62.599	
Others		25.910	16.154	309,2	291,5	35.824	
Total		78.078	41.944	761,7	1.479,9	98.423	

*A significant polluters only

Kazincbarcika (population 39.000). The town along the Sajó river is the host of the large chemical works of BVK. This work discharges 30.000 m^3/d industrial wastewater which is a two stage system (biological-chemical) and works acceptably, however, specific effluent criteria are granted by the authorities.

Just in the vicinity of the Sajó confluence with the Tisza there is an other large chemical complex (on the Fig.9 still indicated with its previous name of Leninváros) of Tiszapalkonya (population 20.000). It has a wastewater treatment plant for 8400 m^3/d, however, overloaded. Because of tertiary treatment with stabilization pond the effluent is acceptable.

Finally it should be mentioned that direct pollution load from agricultural sources is not characteristic to the great rivers (the only example is a big piggery of Nagytétény in the Budapest region). This load is of typically non-point-source character in Hungary and reviewed in para 1.4.

The piggery of Nagytétény (35.000 pigs) discharges directly to the Danube 400 m^3/d wastewater with a COD-load of 16 t/d.

2.4 Evaluation of the expected effect of the planned wastewater treatment

In Table 3 of para 2.1 the nation-wide pollution load was characterized. In the followings the polluter-mass flux arriving to the country through the 3 rivers is calculated on the basis of average concentrations and medium flow.

Table 8

Background mass flux of pollutants in the 3 rivers

Component	Danube	Dráva	Tisza	Total
River flow m^3/sec	2500	550	1250*	4300
%	58	13	29	100
COD_{cr} 10^3 kg/d	3888	864	2592	7344
%	54	12	34	100
Dissolved solids 10^3 kg/d	51840	10360	35400	97600
%	53	11	36	100
NH_4^+ 10^3 kg/d	138	20	102	260
%	53	7	40	100
BOD 10^3 kg/d	990	200	510	1700
%	57	13	30	100

*in 1980 extremely high flow

With the comparison of Table 3 and 8 the point source pollution-load of the country can be rated to the entering load of the 3 rivers. This is presented as follows:

Table 9.

Ratio of country pollution load to the river import in per cent

	Danube	Dráva	Tisza	Total
Wastewater/river flow	0.8	0.2	0.6	0.69
COD_{cr}	20	6	65	13,6
Dissolved salt	2	1	2	2
NH_4^+	25	10	19	21

Supposing full biological treatment at the point sources, the above figures are modified as follows:

Table 10

Ratio of load after biological treatment to the river import in per cent

	Danube	Dráva*	Tisza
COD_{cr}	2	6	1
Salt	2	1	2
NH_4^+	7	10	10

*Can not be calculated

The effect of Budapest

The wastewaters of the capital represent the majority of the Hungarian pollution load (see Table 3. and Appendix C), that is 38 % of all the wastewaters and 48 % of all the pollution load. Consequently treating these wastewaters is decisive in respect of the nationwide pollution abatement.

Summarizing the water quality data upstream and downstream of the capital it can be said that

-the organic load means an increase of 2-3 mg/l,
- the metal load (Hg, Pb) is significant,
- the bacteriological parameters are much worse than the chemical ones,
- the effect of pollution is greatly varying across and in depth of the river.

Supposing full biological treatment (without nutrient removal), that is an efficiency of 90 % in COD, 50 % of NH_4^+, 70 % of metals and 90 % of fecal coliforms, the remaining pollution is approximatively:

COD_{Cr}	80-100 t/d
NH_4^+	9-10 "
metals	negligable
coli	10^4/ℓ

In case of a medium flow of the Danube of 2500 m^3/sec the dilution ratio of the Budapest dry weather wastewaters is abt. 200. The mass flux of COD_{Cr} in the river is 50 kg/sec. and the same for NH_4^+ is 1.5 kg/sec. The addition to these figures of the biologically treated wastewaters 1 kg/sec, 0.1 kg/sec, respectively. With other words: while the proportion of the COD-load of the capital to the Danube mass flux is at present abt 20 %, and in respect of NH_4^+-load is 25 %, these figures of pro-

portion can be reduced to 2 %, 7 %, resp. The figures of concentration are 0.4 g/m^3 COD and 0.04 g/m^3 NH_4^+ are added to 20 g/m^3 COD and 0.6 g/m^3 NH_4^+. Even more drastic reduction can be expected - and this is the most important - in the heavy metal load. As far as bacteriological conditions are concerned in the littoral river band, that can be supposed as a lower value with one order of magnitude compared to the present one.

Similar rationale is presented in Table 11 for the Tisza river. There it is shown that after conventional biological treatment of the wastewaters of the major cities and industrial centres the conditions are still unsatisfactory in respect of N-nutrient, such as ammonia (and the same can be said for P-nutrient, though not indicated here) which means that the N- and P-removal in the new treatment plants are necessary.

Table 11

Effect of biological wastewater (w.w.) treatment in the Tisza catchment area to the quality of the river

(present w.w. discharge = 700.000 m^3/d)

Components	Mass-flux in the river kg/sec	Mass-flux from w.w. kg/sec	Mass-flux from w.w.after biol.treatment kg/sec	Mass-flux in the river after biol. treatment of w.w. kg/sec	Load increment %
COD_{cr}	30.0	16.0	0.3	30.3	1
NH_4^+	1.2	2.0	0.12	1.32	10

3. Conclusions and Recommendations

3.1 Summary Conclusions on Conditions and Trends

Projections of industrial-, agricultural- and urban development

The Hungarian industry with some exception (e.g. in the fields of pharmaceutical-, electric-, electronic branches) is obsolate, outmoded with low level of productivity.

The same can not be stated on the agricultural production (however, as to the food industry the above criticisem relates, as well). Collectivization had advantageous features in contrast to small farming on one part, and the traditional affection of the Hungarian country population to farming, on the other part, helped to the developing of an agriculture in relatively better shape than that in the industry.

At present there is a transition period in which privatization is the primary objective. Exporting goods to the "new" markets in Western Europe demands a complete reshuffling of the industry. This takes time and at present industrial production shrinks with 15-20 % yearly. There is uncertainty in the large scale animal breeding due to the curbs against import set up by the Common Market. There is a hope that the vast market potential for foodstuff of Russia and Ukraine and other federal states might help the Hungarian agriculture in the future. However, at present, the situation is confusing in this potential market, as well.

On the basis of above said uncertainties it is very hard to forecast any tendencies in the pollution problems of the industries and agricultural establishments for the next decade. The present conditions will - and must - be changed rapidly. In spite of this fact in Paragraph 2.3 an approximative list is presented on the major industrial polluters with polluting data.

Due to a.m. remarks, these data should be regarded with great care. An updating of that is necessary, however, it requires an on-site data collection of several months.

Projections of the infrastructure in water management for the year 2000 (Source: Környezetünk állapota - State of the Environment, 1989)

It is expected that the proportion of population supplied with drinking water (connected to households) will be 96 % (at present abt 80 %). The rest of the population (abt 500.000 persons) will be supplied with wells and/or flasked water. The proportion in sewerage will be abt 70 % which sill cover 60 % of the houses and flats.

This programme requires a capacity of new waterworks of abt 400 000 m^3/d a reservoir volume of abt 1 million m^3 and 23-24 thousand km pipeline.

At present 40 % of the flats are connected to sewerage systems which means abt 50 % proportion of the population and abt 400 communities. However, there are only 300 wastewater treatment plants. In figures of capacity the latter means half of that of sewered systems, that is the total sewage is abt 3.4 million m^3/d, treated 1.1 mill. m^3/d and out of the latter only 0,950 mill m^3/d is biologically treated.

There is an insufficient condition of wastewater treatment in the capital and 5 large cities where 70 % of the total wastewater flow is produced.

Some calculations show an abt 150 million m^3 yearly production of sewage stemming from unsewered communities, the overwhelming majority of which is disposed of in seepage pits, producing enormeous groundwater pollution. Half of the roughly 25-30 million m^3 sewage collected by container lorries is disposed of again inproperly.

For the above forecasted development of sewerage and wastewater treatment (in which the capital will be almost completely sewered, the large cities to an extent of 90 %, while the smaller communes to 35-40 %) 11 000 km sewer system should be built with a treatment capacity of abt 2.3 million m^3/d. Fig.7 shows the projections to the year 2010.

All of these tasks of water supply, sewerage and treatment would involve an investment programme with a projected 800 billion Forints at 1991 price level, which means 80-90 billion yearly. This sum is absolutely not available in the government budget and solutions should be sought through the following variables:

a) mobilization of local resources (local governments)
b) foreign aids (like PHARE-programme)
c) foreign loans (World Bank, IMF, etc.)
d) concessions given for local and (mainly) foreign enterpreneurs (this is considered at present for Budapest)

3.1.1 Water Quality and its Impacts

Hungary with 10.5 million inhabitants abt. 90.000 km^2 area and abt. 4000 US $/capita GNP, as a typical lowland in the Carpathian Basin lies entirely in the catchment area of the Danube river. Her surface water resources originate abroad in 96 % of the total flow. The water management, the aquatic infrastructure depends on the Danube and its tributary the Tisza river. Even the majority of the subsurface water resources for water supply are in direct interaction - through the alluvial layers - with the two great rivers or with their secondary tributaries.

The quality of the Danube is influenced by the pollution load imported from the upstream countries. However, it is

clear that the chemical and physical water quality parameters are not bad (see tendencies in Appendix 3), more problems are shown by the biological and microbiological parameters causing difficulties at surface water treatment.

The quality of the Tisza entering to Hungary from the Transcarpathian provinz of the Ukrainan republic (former Soviet Union) is at the border section excellent. Sorry to say it deteriorates rapidly by the heavily polluted tributaries of Szamos and Kraszna flowing from Romania. Further load arrives through the Sajó river polluted in both Slovakia and Hungary. In the impounded section of Kisköre, due to settling of suspended solids, some provisional improvement occurs which is rapidly "counterbalanced" by the Szolnok wastewaters. The greatest polluter is, however the Maros river importing heavy pollution from Romania.

3.1.2 Water Quality and Emissions Monitoring and Control

From the above said conditions it can be concluded that an optimalized preinvestment programme is rather easy to set up with concentrating the efforts to the relatively few large polluters. However,it is quite obvious that the data presented in this study requires updating and completing activities.

As far as monitoring of emissions is concerned this has been organized 30 years ago and the system is operated by the competent District Water Authorities. Collection, storage and retrieval of data is well set up, as well. The same can be said on the control activities of the above authorities. All of these have been presented and partly criticized under the title of "Institutional Analysis on the Water Quality Management Sector in Hungary" prepared by Aqua-Mélyépterv International Ltd quite recently.

3.1.3 Emissions and Dischargers

Budapest, the capital with 20 % of the total population and 40 % of the total industrial capacity is the greatest polluter of the Danube (Appendix C). The industrial regions of Győr and to some less extent the Százhalombatta and Dunaujváros industries can be mentioned as main contributors to the Danube pollution in Hungary. The greatest Hungarian polluters of the Tisza river are the Miskolc industrial region, the cities of Szolnok and Szeged. Concentration of the short term abatement programme to these potential polluters is urgent.

3.1.4 Key Difficulties

Uncertainties exist as to the fate of the major industrial polluters due to the present transition period towards the market oriented economic structure. Data collection is necessary with the contribution of the two ministries of Transport, Telecommunication & Water and Industry & Trade. Further, the industrial managements concerned should be also invited to the forecasting procedure mainly because of the modernization of the technologies must have great consequences to the pollution discharges. This activity is restricted to several key industries only, however, the final list of those should be put together carefully.

It is absolutely necessary to improve the present practice of industrial pretreatment and the proper disposal of the wastes removed by these procedures. Both the sewers and the central (municipal) treatment plants are overburdened by industrial wastes which contribute to the disposal problems of the sludges originating here, as well.

3.2 Recommendations

3.2.1 Pollution Management Actions Needed

1. Long term and reliable tendencies on the water quality parameters of the two rivers of the Danube and Tisza can not be elaborated without the contribution of the upstream countries. Coordination of efforts with the Slovakian and Romanian counter parts is necessary. Maybe a task force could be formed to this purpose.

2. On the long term it is necessary to include sources from the agriculture into the emissions evaluation. This is important to curb groundwater pollution and eutrophication tendencies.

3. Different technical levels of wastewater treatment, such as mechanical, chemically upgraded mechanical, conventional biological and biological combined with plant-nutrient removal should be reviewed with their pollution abatement potential and cost factors. Stepwise realization of the pollution control can not be done without these data.

4. Cost-effective upgrading of several surface water treatment plants for water supply is necessary and urgent task. To this end cost factors should be evaluated.

5. As a consequence of inflation (at present with a yearly rate of 35-37 % and forecasted to 1992 as 20-25 %) and the uncertainties of the expected rate in the future all the costs generated on the basis of 1990 (or 1991) price level must be transformed to ECU to the optimization procedure.

3.2.2 High Priority Pollution Reduction Improvements Needed

1. As far as priorities in pollution reduction are concerned far the most important is a stepwise development of the Budapest sewerage and wastewater treatment system. If within this task a special emphasis can be pointed out, this should be the sludge disposal on a short and long term basis.

The concept has been quite recently elaborated, however, this should be reviewed by foreign consultants and a feasibility study is urgently needed.

2. In the Tisza catchment the planning and construction of a wastewater treatment plant for Szolnok is of high priority.

3. In the Danube subcatchment of Northwestern Hungary the drinking water resources of the karstic geological complex should be protected by a sewerage and wastewater treatment programme. Feasibility study is urgent.

Budapest, February 12. 1992

Dr.Pál Benedek

Dr. Veronika Major

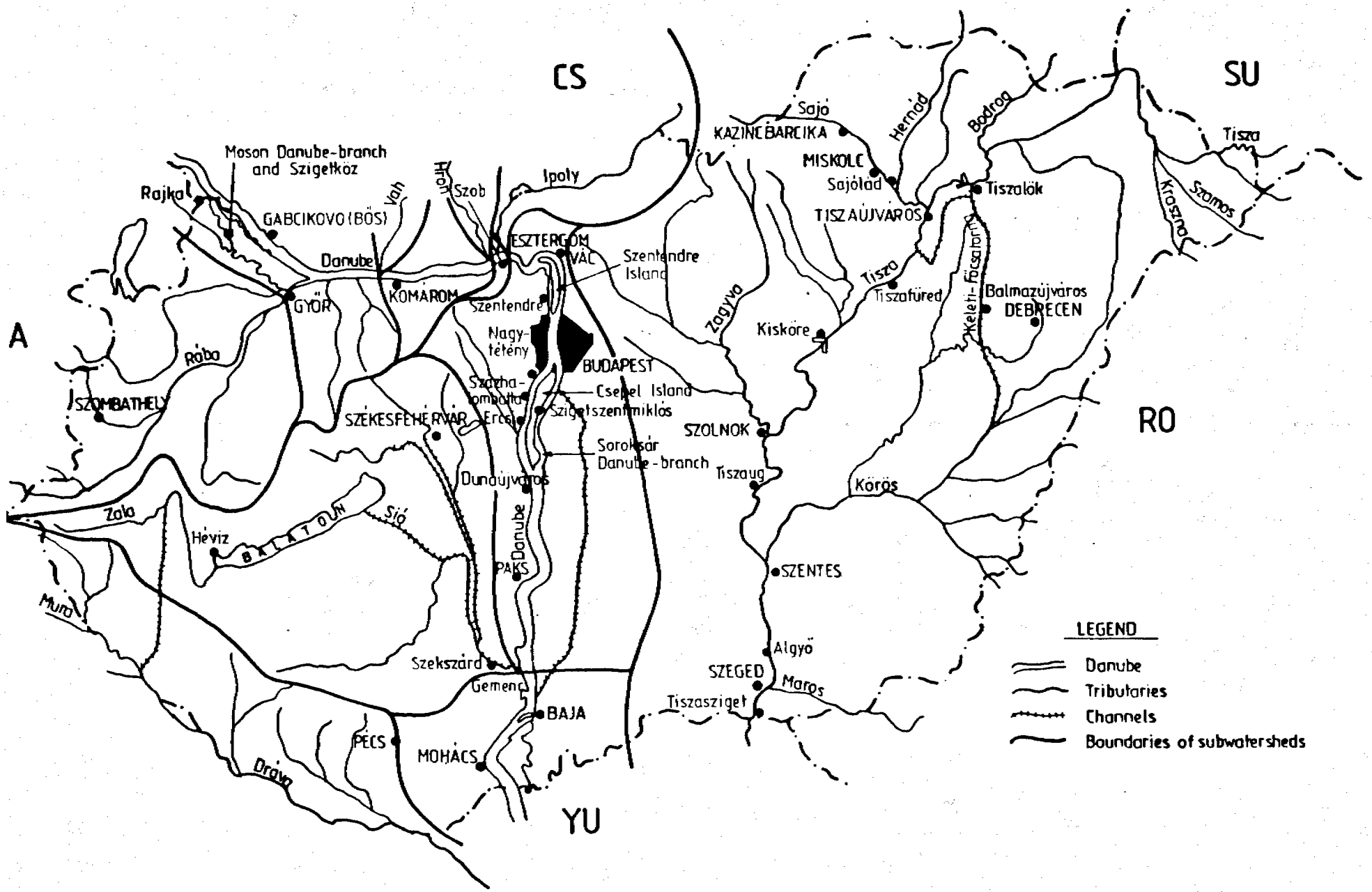


Fig. 1. Hungary (with indication of the Danube's subwatersheds)

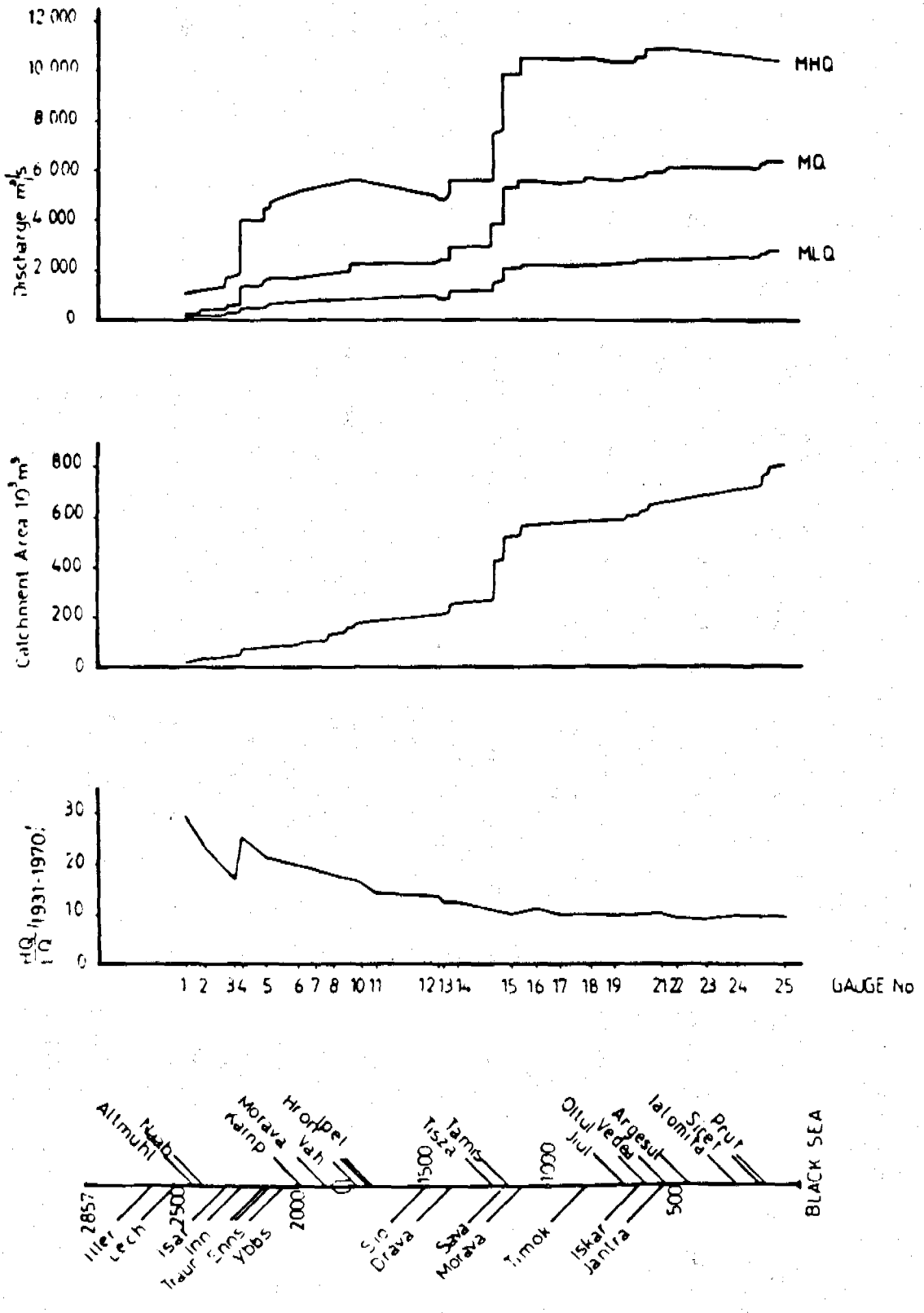


Fig. 2. Hydrological profile of the Danube from the origin to the delta

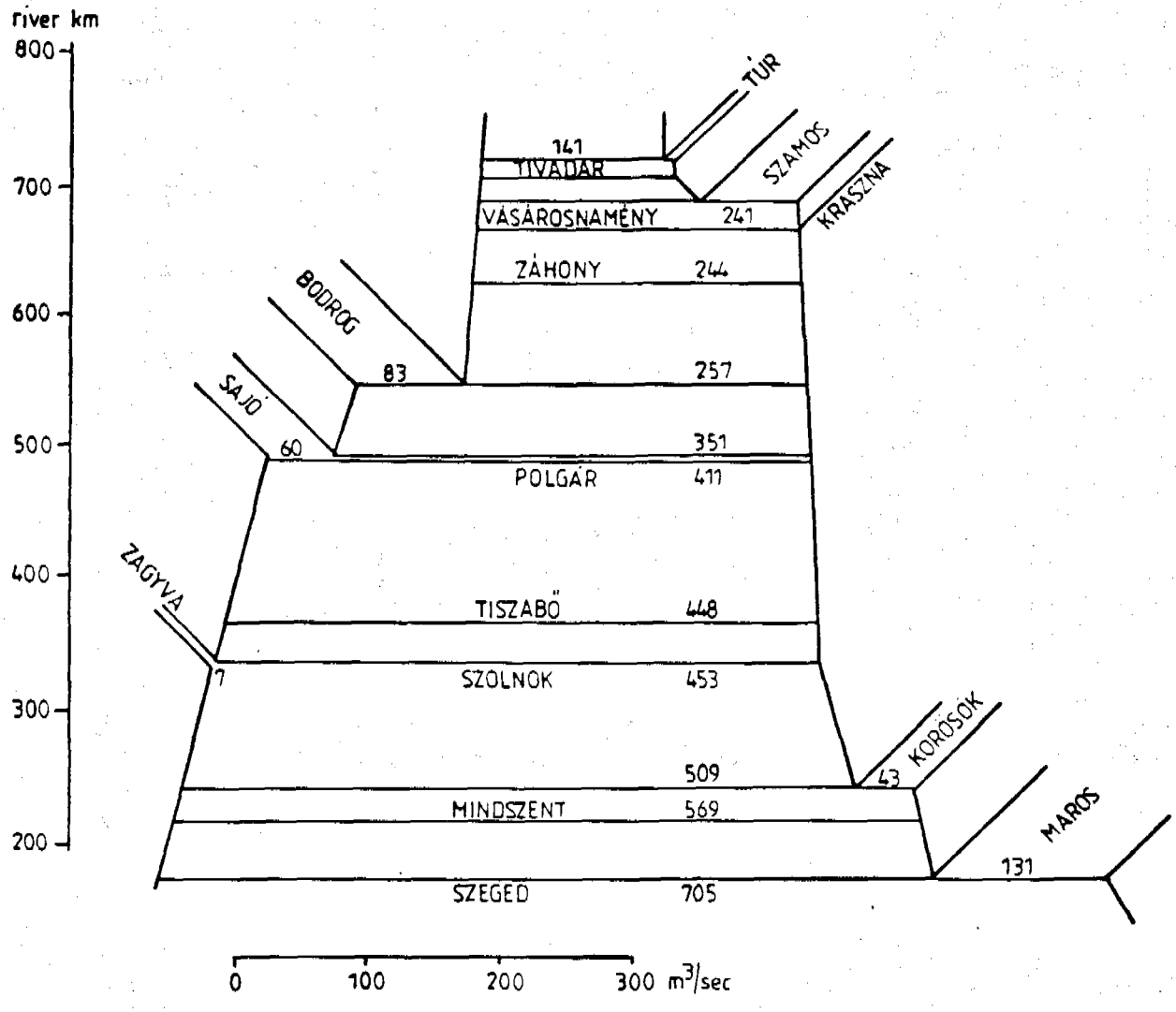


Fig. 3. Medium flows ($Q_{50\%}$) in the Tisza and its (secondary) tributaries

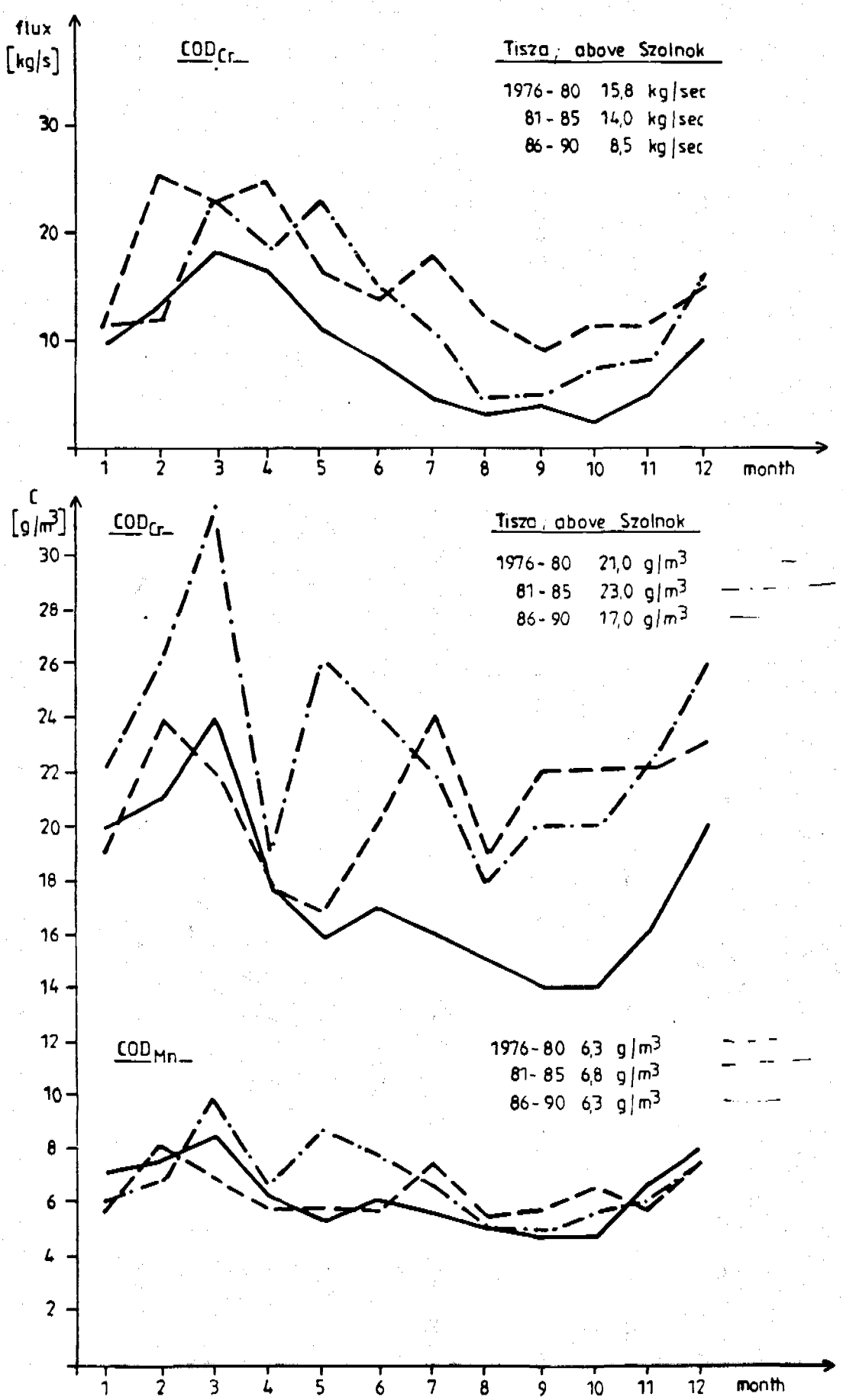


Fig. B - 3. Trends in the Tisza - river at Szolnok

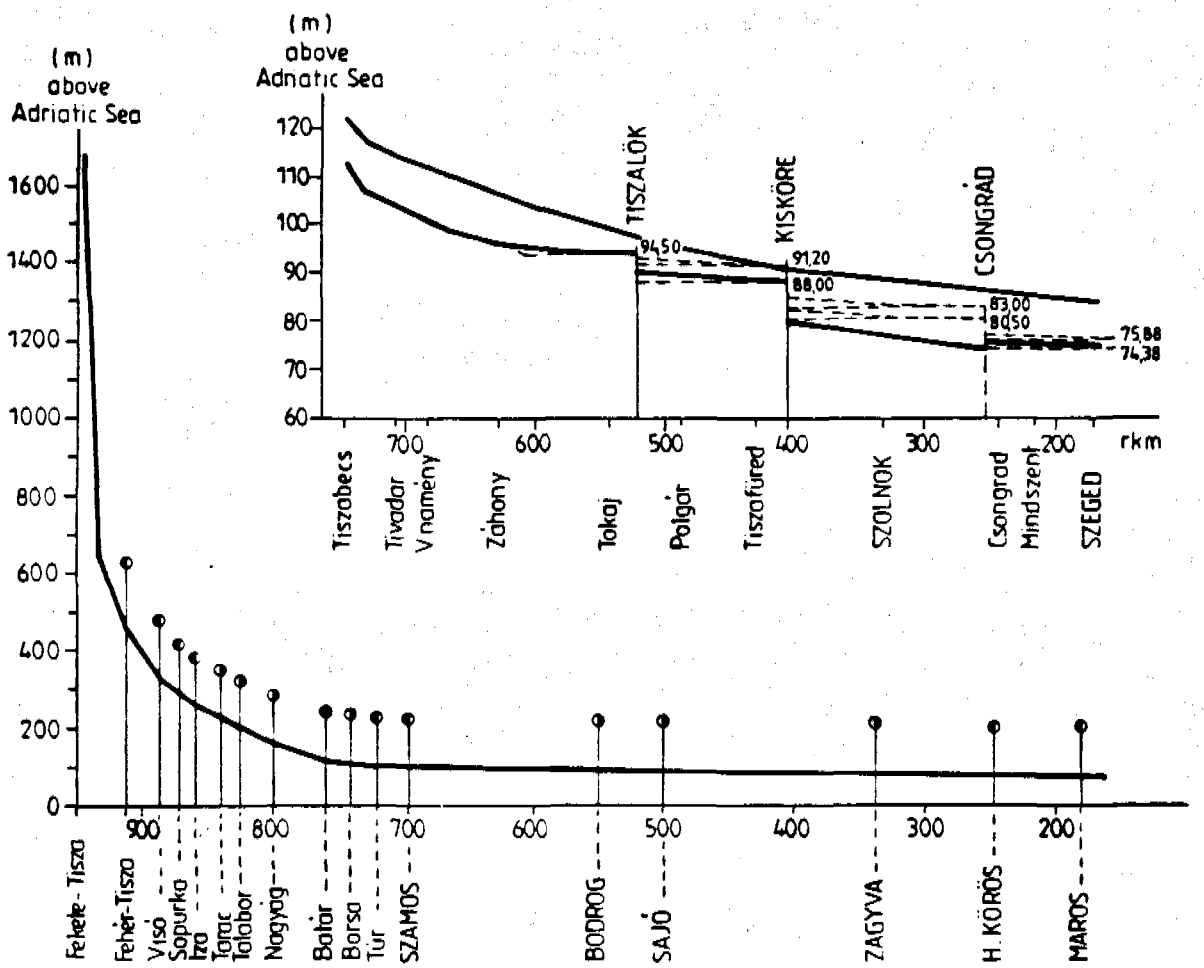
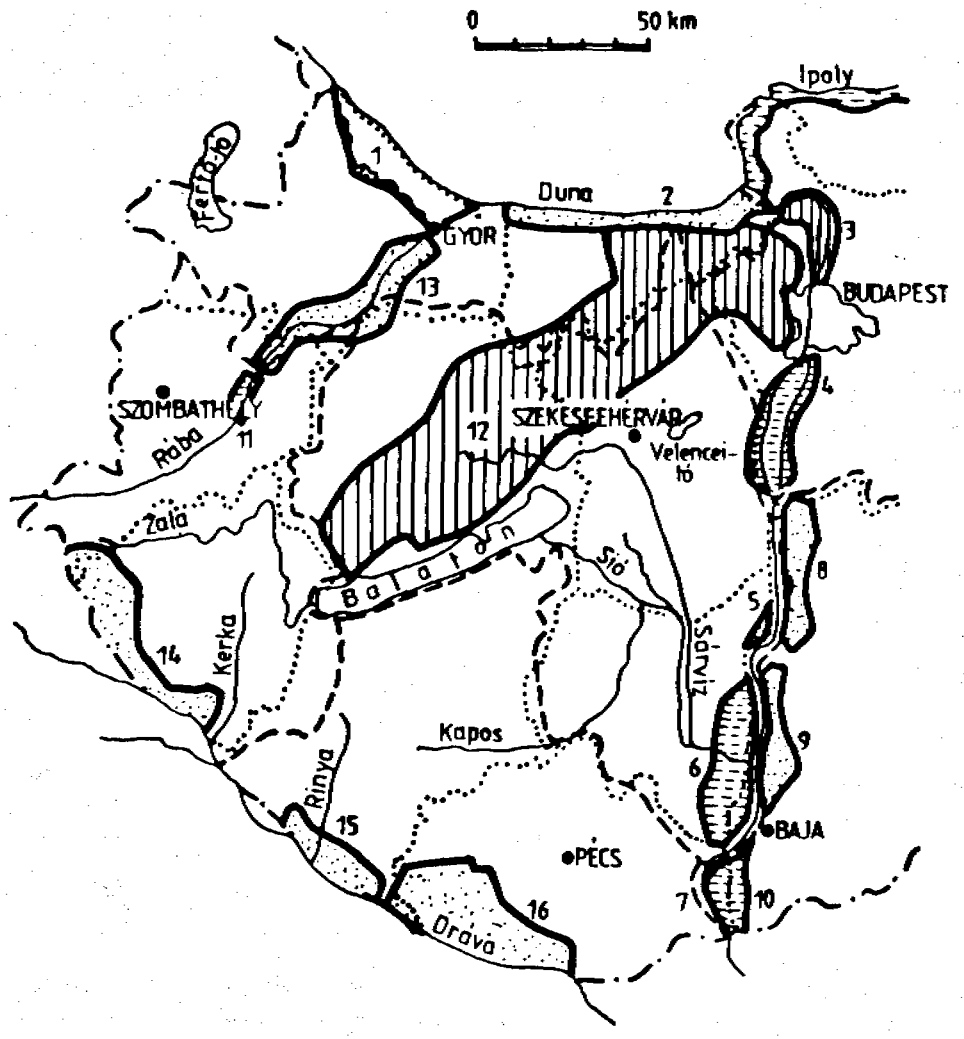


Fig. 4. The longitudinal section of the Hungarian part of the Tisza river with the present and planned barrages



Name of the indicated areas

1. Duna-Szigetköz
2. Duna, Komárom-Esztergom
3. Duna, Dunakanyar-Budapest North
4. Duna, Budapest-Rácalmás
5. Duna, Dunaföldvár-Paks
6. Duna, Paks-Báta
7. Duna, Mohács
8. Duna, Tass-Ordas
9. Duna, Kalocsa-Baja
10. Duna, Mohács island
11. Rába, Alsószölnök-Sárvár
12. Dunántuli Középhegység (Karstic)
13. Rába, Nick-Győr
14. Kerka- Mura, Lenti-Molnári
15. Dráva Felső
16. Dráva alsó

Fig.5. Water resource of bankfiltered character along the Danube and Drava (1-16) and that of the karstic zone (21)

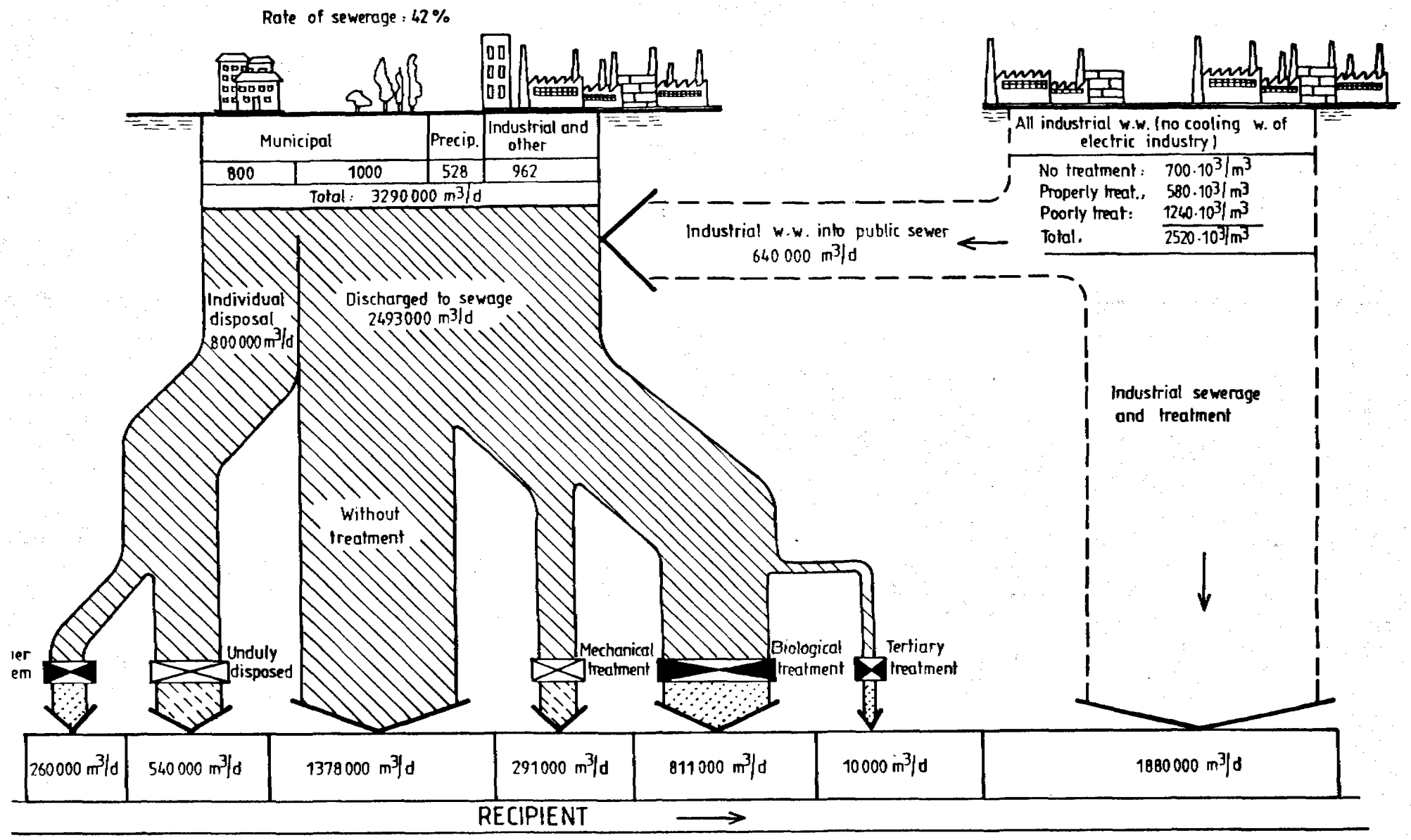


Fig. 6. Wastewater flow in 1991

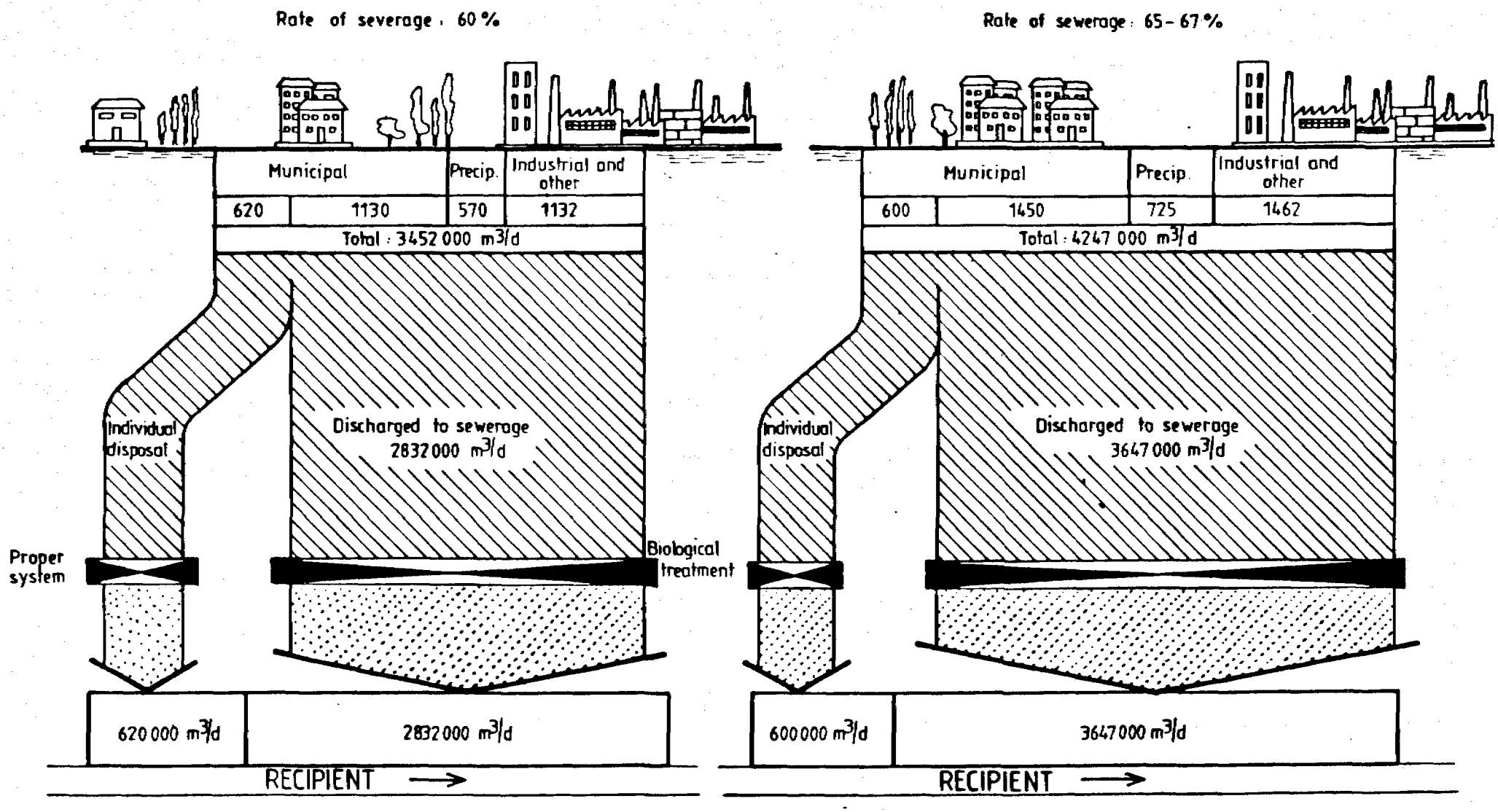


Fig. 7. Wastewater flow in 2000

Wastewater flow in 2010.

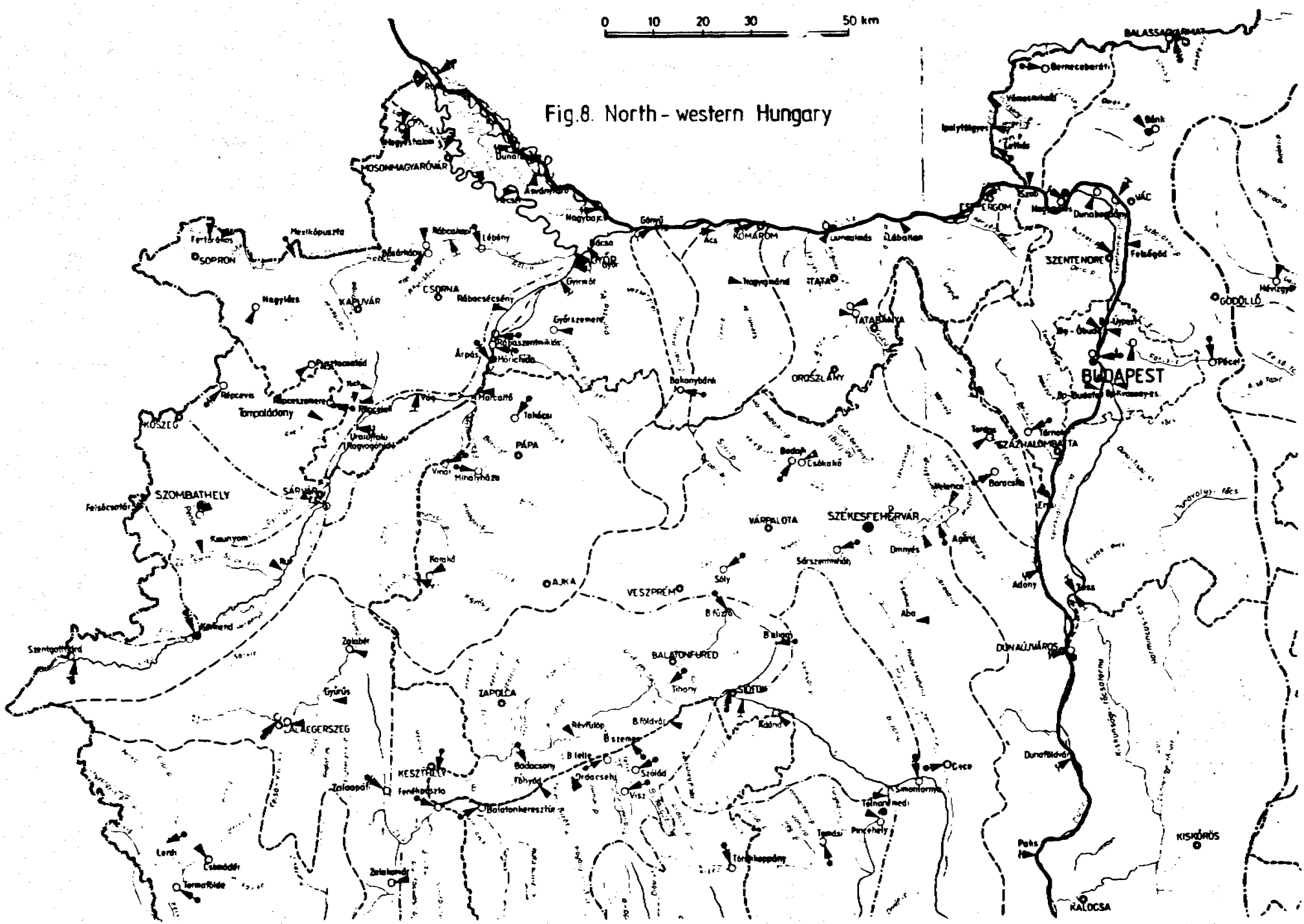


Fig.8. North - western Hungary

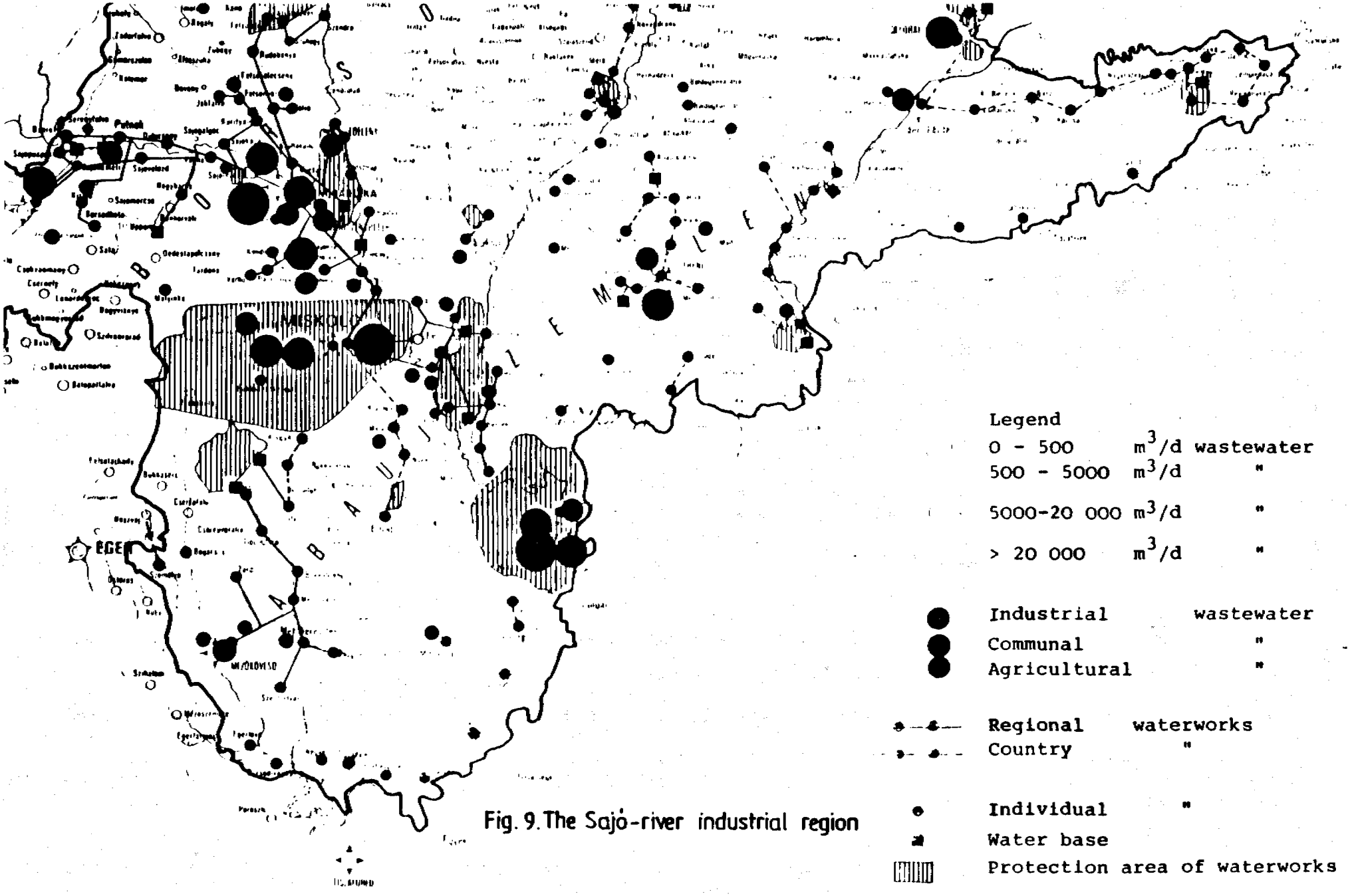


Fig. 9. The Sajó-river industrial region

Appendix A

The nitrate problem

In the past 15 years the increase of the nitrate was 27 % in the Danube while the same in the Tisza and in its tributaries was 62 %. Similar figures were observed in respect of NH_4^+ and organic nitrogen components.

The projected figures for the year 2000 can be seen in Table 1 and 2. These represent the border sections of the Danube and Tisza (VITUKI-report: Development of nitrate removal methods). The attached figures might support the understanding of the problem.

The nitrate pollution is more severe in respect of the subsurface aquifers. Fig. A3-5 shows that in case of the Danube bank filtered wells the nitrate contamination surpasses that of the river, which is quite obvious if considered that these wells are supplied from the background subsurface water as well.

(All the figures and Tables from Hock, ENVIMARK Ltd. and VITUKI)

Table A -1

Rate of nitrification* in 3 periods

River at border sections	1971/75	1976/80	1981/85
Danube upstream	75	81	81
Danube downstream	78	80	80
Tisza upstream	56	73	75
Tisza downstream	66	74	76

* Rate of nitrification = $\frac{(NO_3\text{-}N)}{(NH_4\text{-}N) + (NO_2\text{-}N) + (NO_3\text{-}N)}$

Table A -2

Average NH_4^+- and NO_3^--values in three 5-years periods and forecasted to the year 2000

River	Component	Periods 1971/75	1976/80	1981/85	2000
Danube upstream	NO_3^-	6.4	8.6	9.5	11.6
border section	NH_4^+	0.61	0.56	0.48	0.53
Danube downstream	NO_3^-	6.9	8.7	8.8	11.5
border section	NH_4^+	0.58	0.61	0.62	0.43
Tisza upstream	NO_3^-	2.7	4.0	5.2	6.7
border section	NH_4^+	0.42	0.54	0.52	1.02
Tisza downstream	NO_3^-	6.2	8.1	12.1	18.6
border section	NH_4^+	0.58	0.67	1.06	1.89

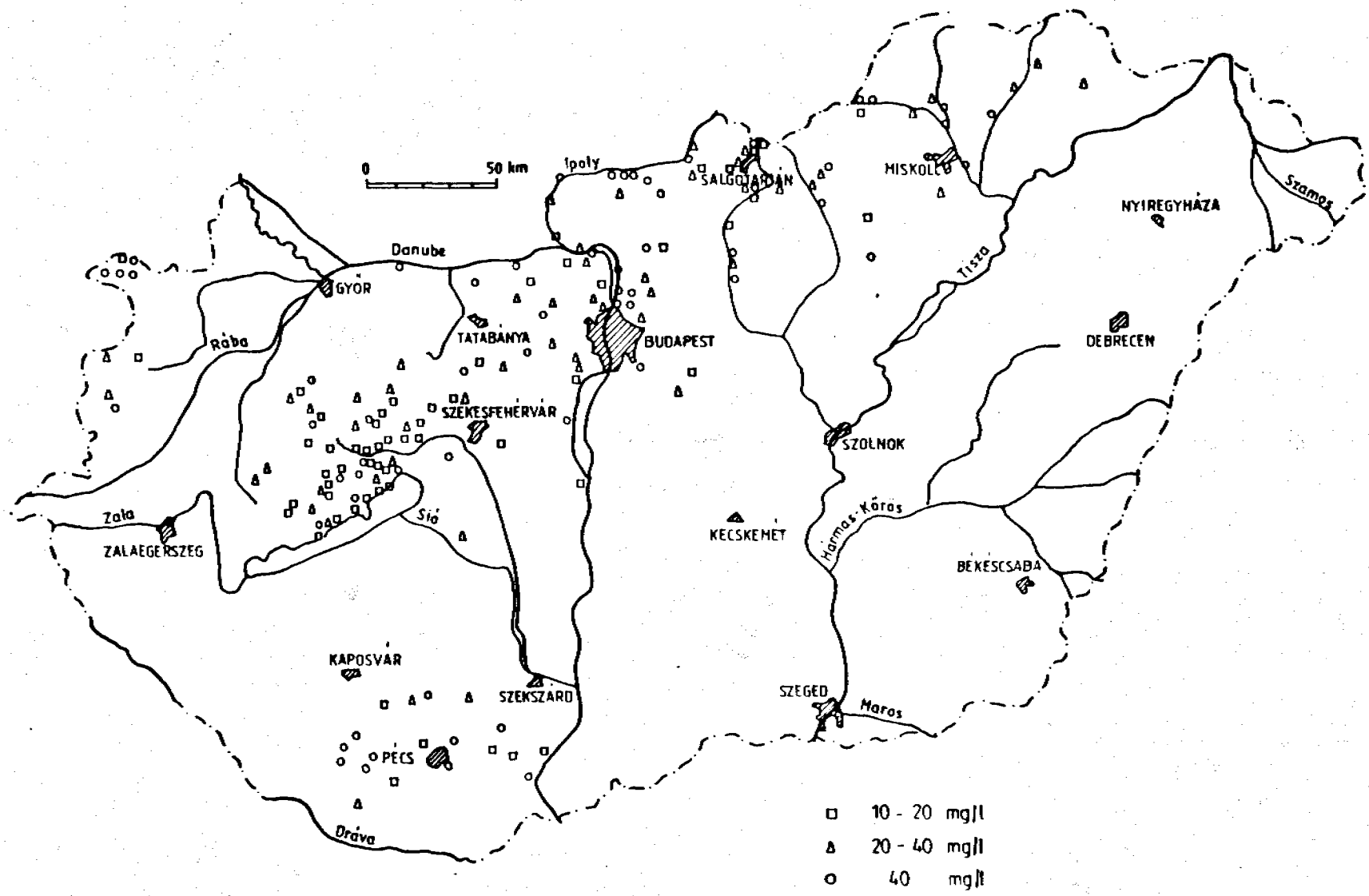


Fig . A -1. Nitrate contaminated waterworks in Hungary in 1986

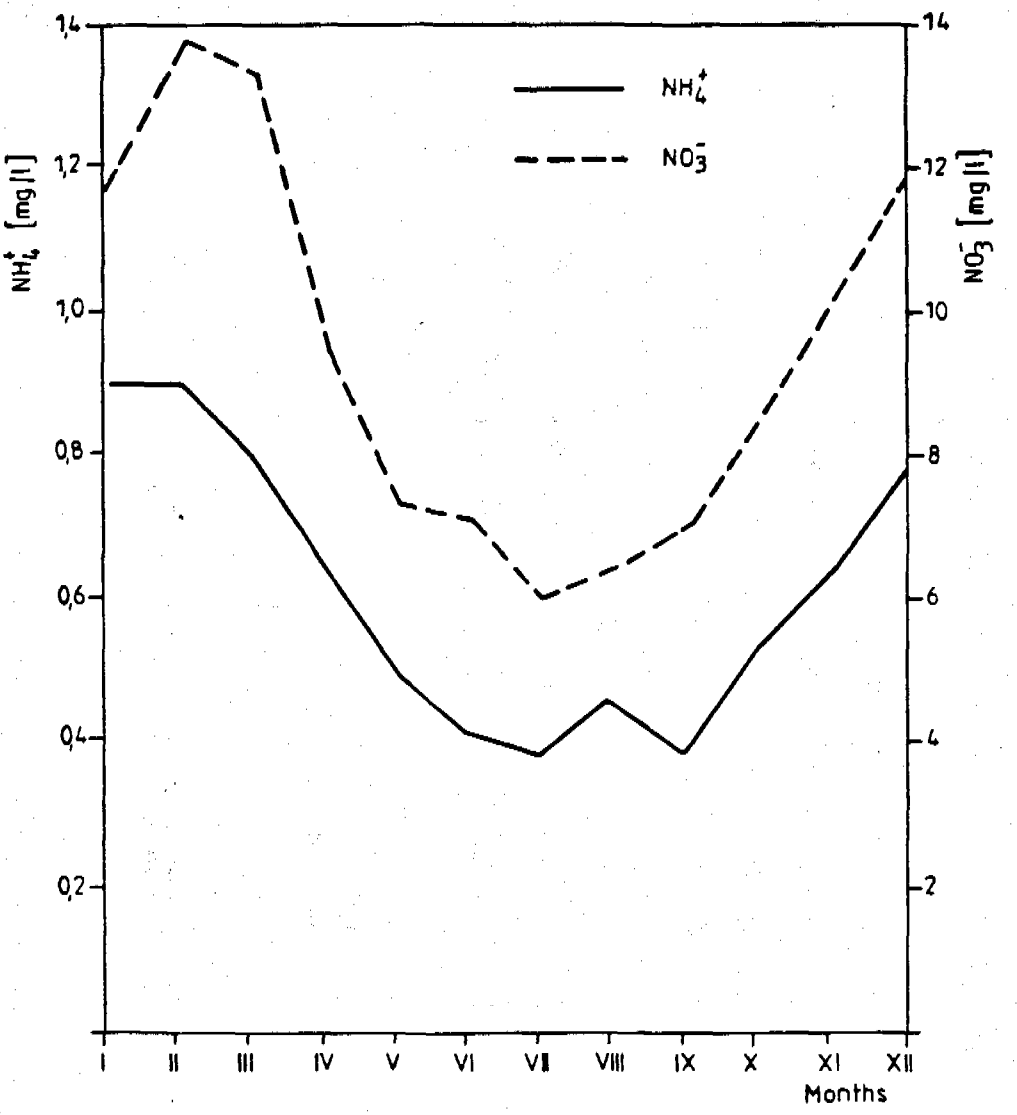


Fig. A - 2. Monthly variations of NH_4^+ and NO_3^- (averages) at the upstream border section of the Danube in 1981 - 85

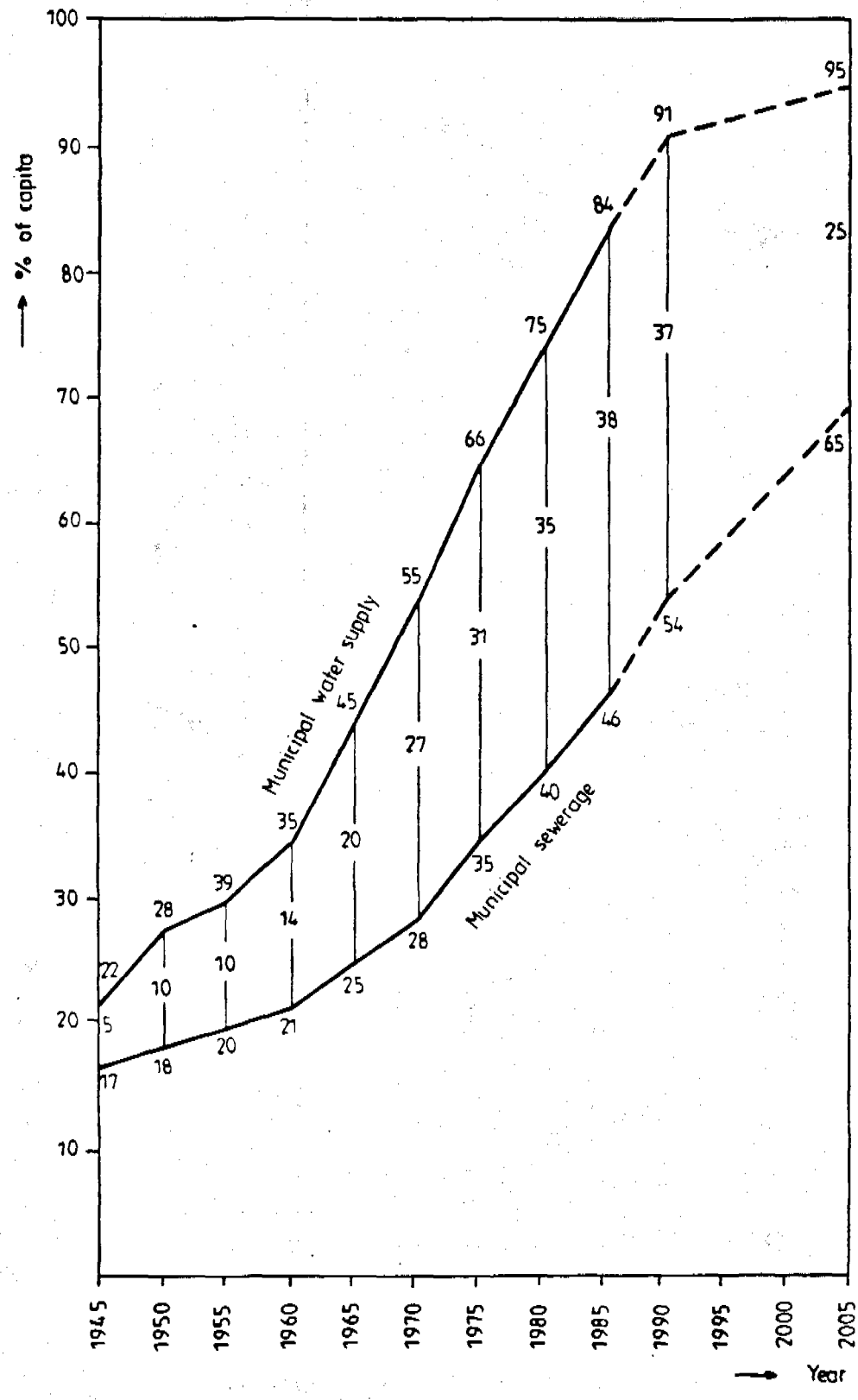


Fig. A -3. Development of water supply and sewerage in the period of 1945 - 2005

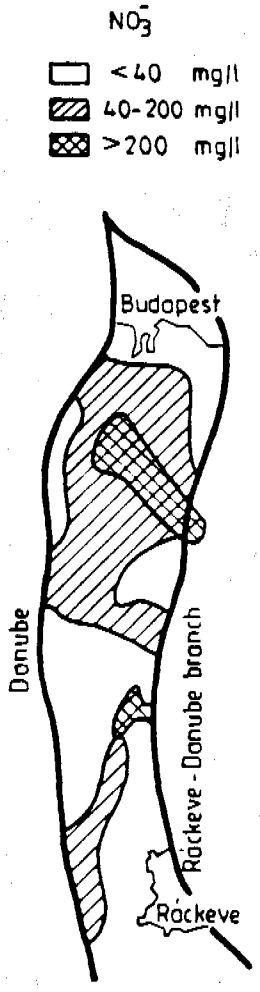


Fig. A - 4. NO_3^- contamination of groundwater in the Csepel - island (Downstream from Budapest)

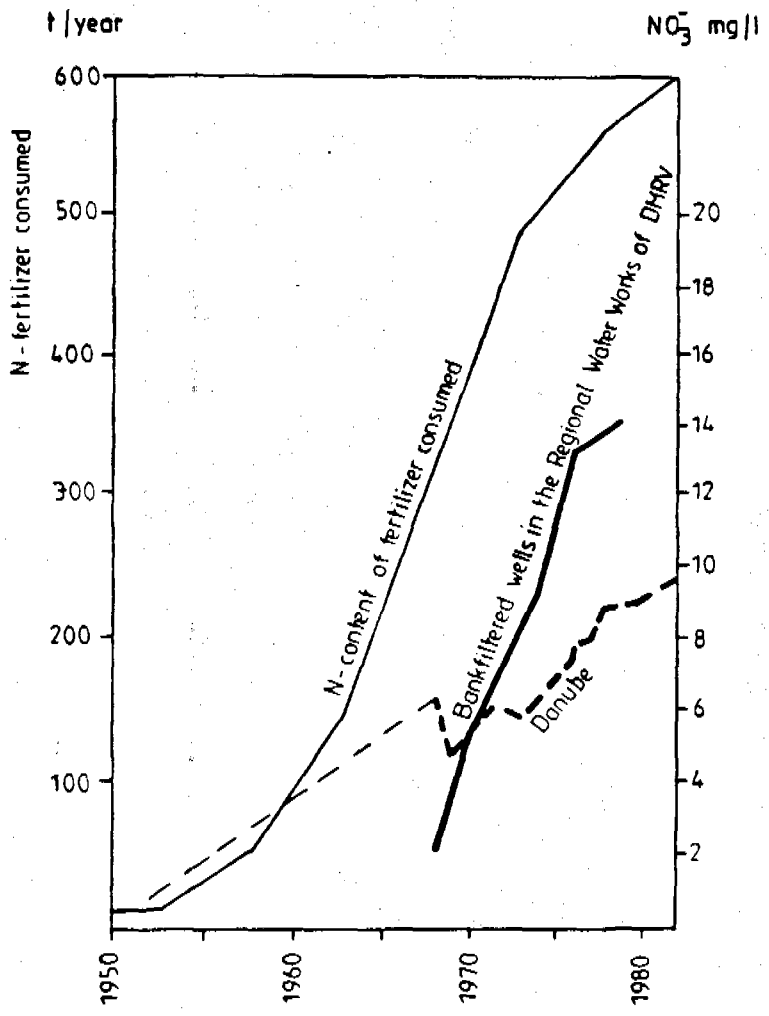


Fig. A - 5. Increase of NO_3^- content in the Danube and in bankfiltered wells along the river

Appendix B

Trends in the water quality of the Danube, Tisza, and Dráva rivers

(after Császár, OVF)

Figures 1a and 1b show the trends of the oxygen consumption (COD-bichromate, COD-permanganate) a-chlorophyll in concentrations and in mass-flux of the Danube at Baja, near the Yugoslavian border. Instead of deterioration, mostly some slight improvement can be seen between 1976-1990.

Figure 2a. and 2b. shows a rough longitudinal section in COD and O_2-saturation values for the period of 1976-1990. In the COD-values significant deterioration trends are observed in the upper Hungarian section partly because of the Slovakian--Hungarian polluters and especially that of Budapest. However, - once again - at Baja the improvement due to the assimilation can be seen.

While the Danube-discharges during the given 5-year periods were almost identical, this can not be said to the Tisza river.

At Szolnok the characteristic discharges were as follows (in m^3/s):

	Medium flow	Min. flow	$Q_{80\ \%}$	$Q_{95\ \%}$	Max. flow
1976-80	798	109	1300	1988	5845
1981-85	523	80	906	1400	2070
1986-90	435	62	605	1243	4180

The COD-mass-flux and concentration values for the given periods can be seen upstream and dowsntream Szolnok on the Fig.3. The trends, however, are obscured by the above deviations in the discharges. The same is valid for the graph of Fig.4, however, the polluting effect of the Szamos between Tiszabecs and Záhony is markant.

According to Fig.5. the water quality of the Dráva-river is improving due mainly to the pollution control in the Austrian catchment area. It might be mentioned that the Hungarian pollution load of the Dráva is abt. 3 % of the total one produced in the country.

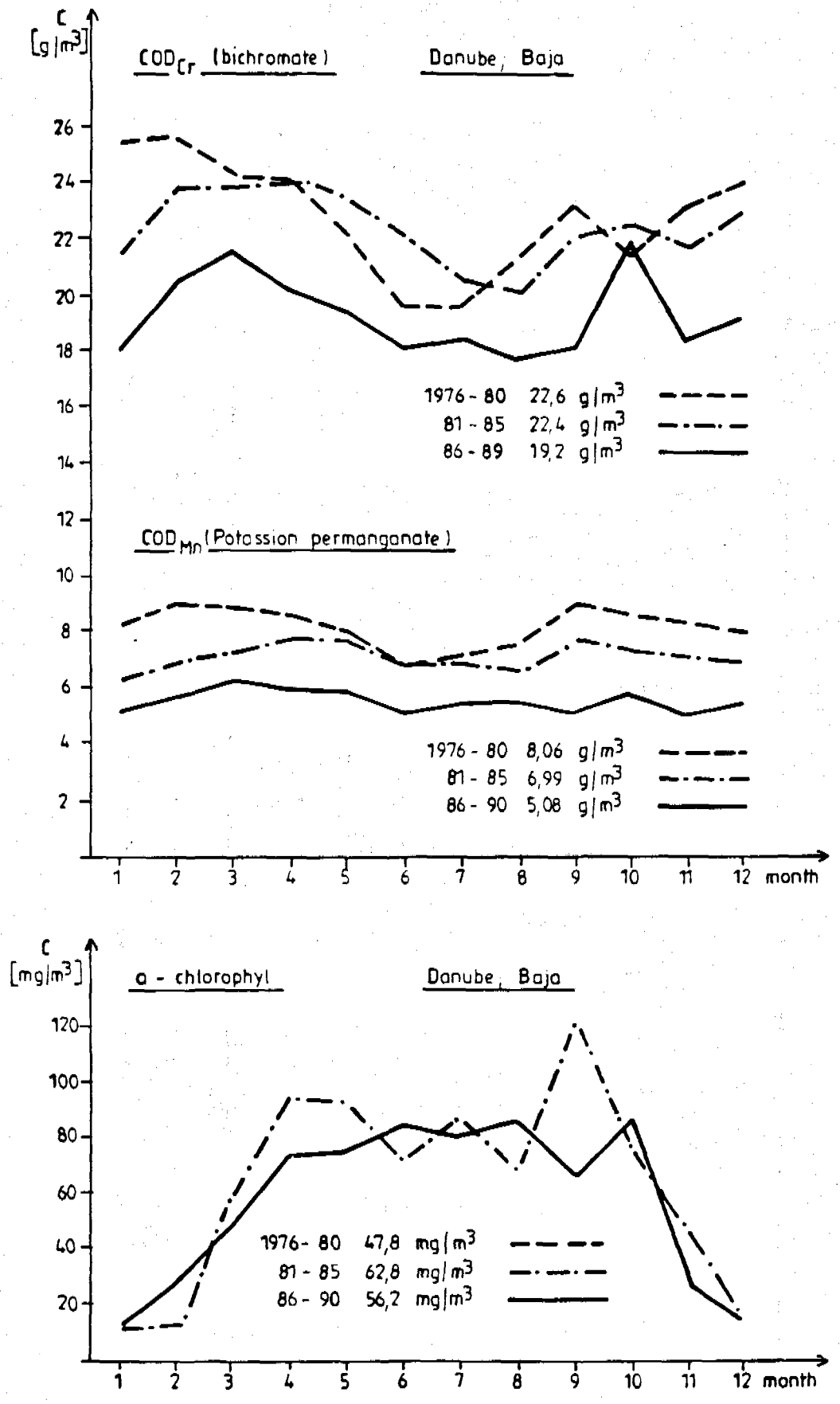


Fig. B - 1a. Trends of concentrations

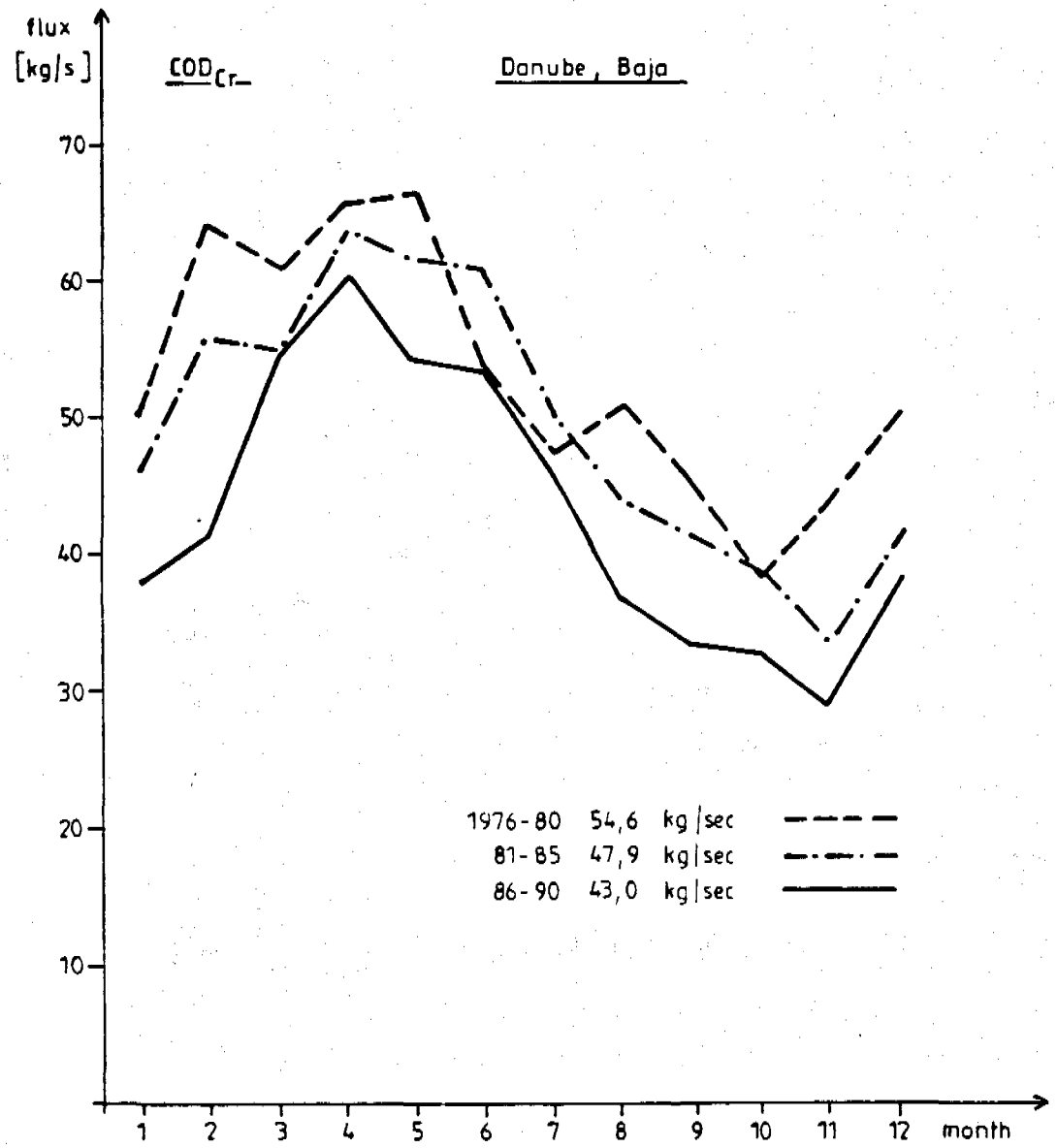


Fig. B -1b. Trends of mass- flux

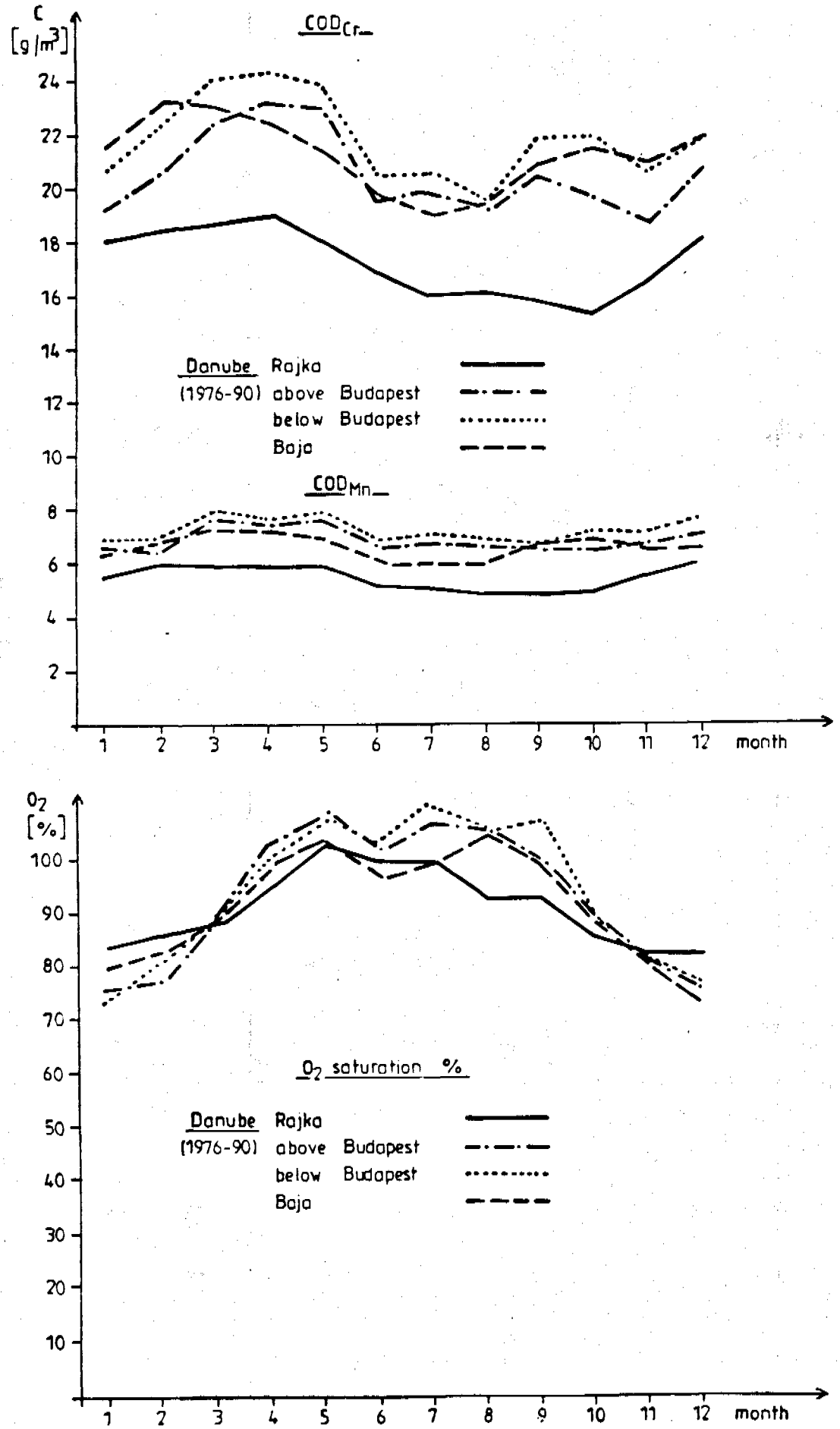


Fig. B - 2a. Trends in longitudinal direction

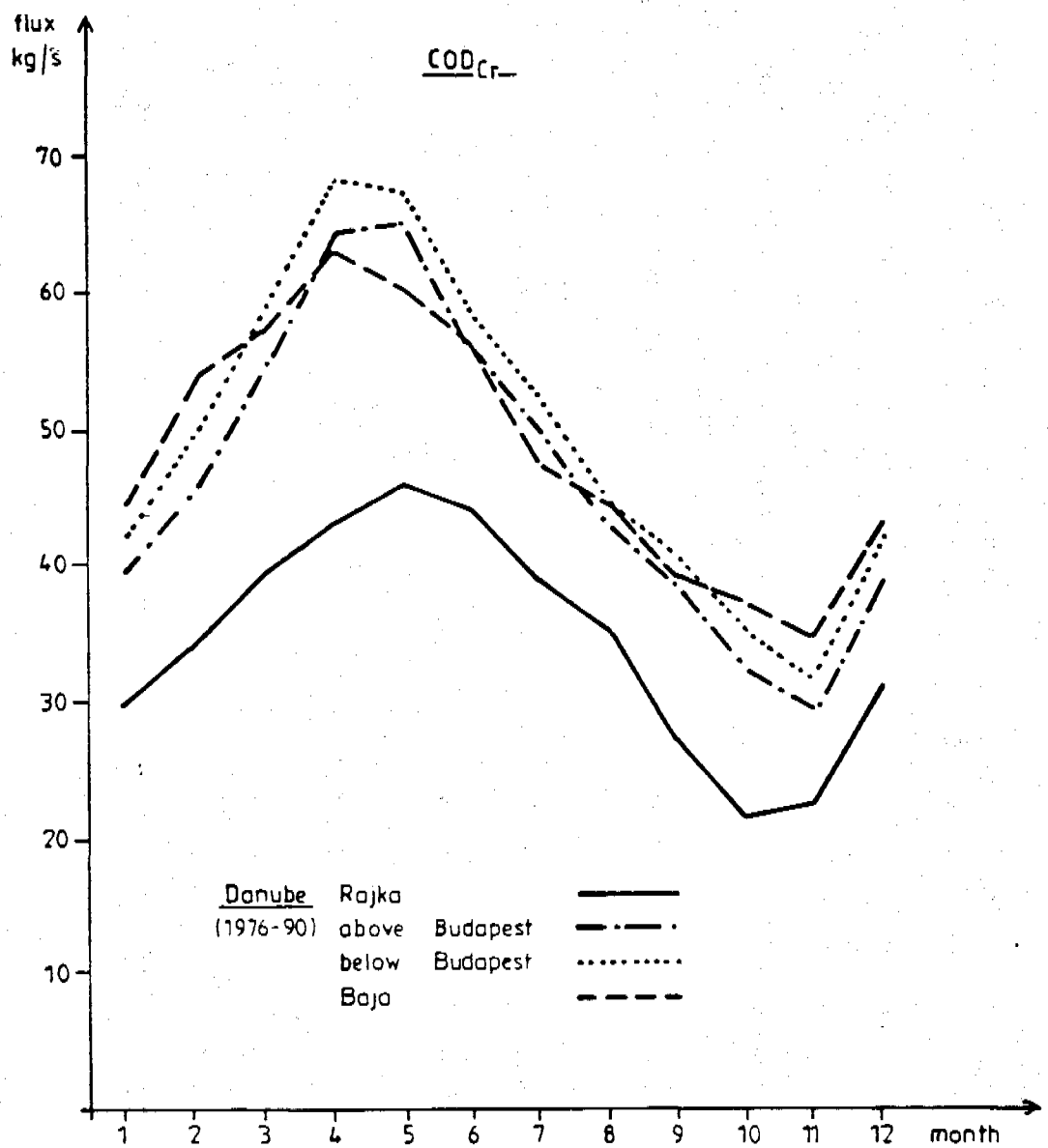


Fig. B -2b. Trends in mass-flux

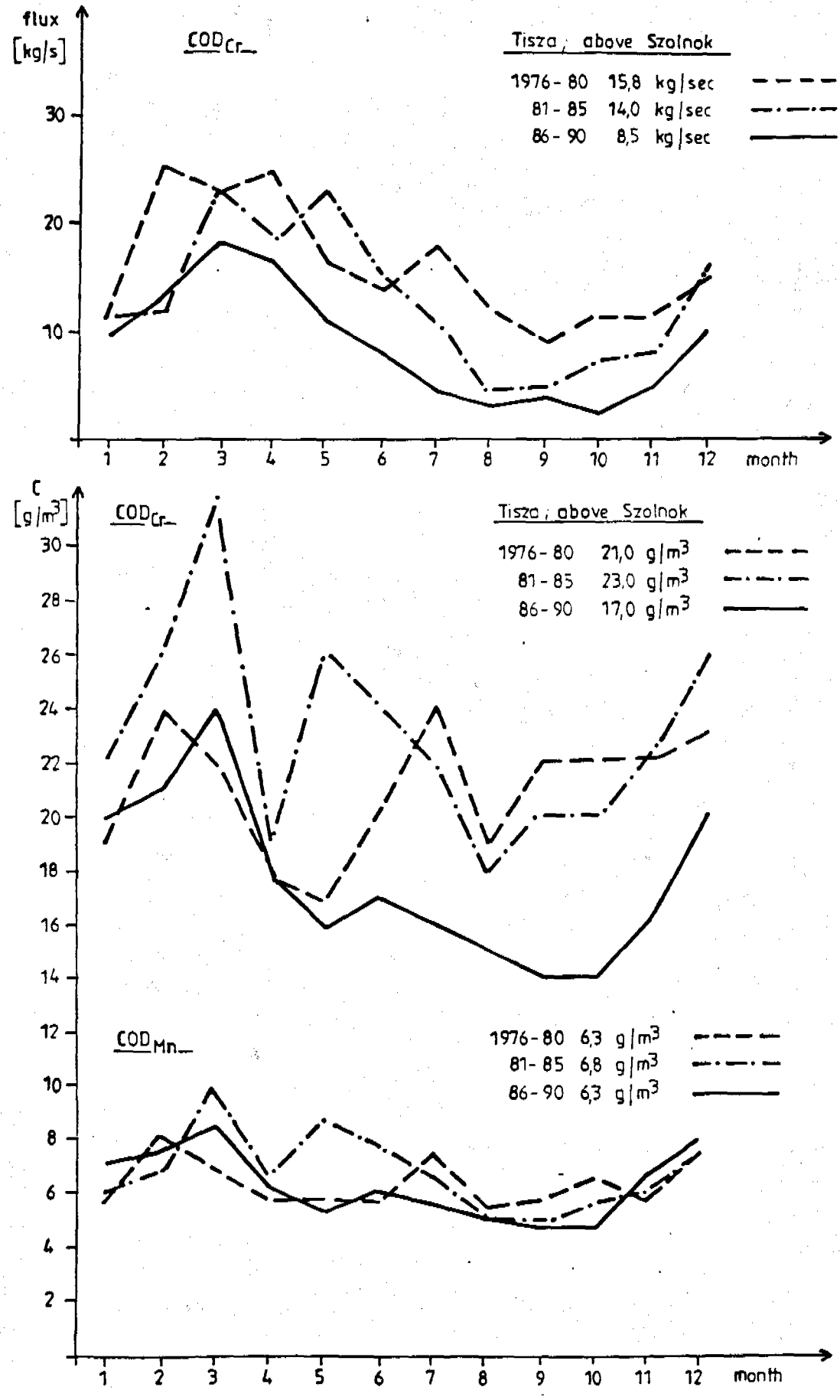
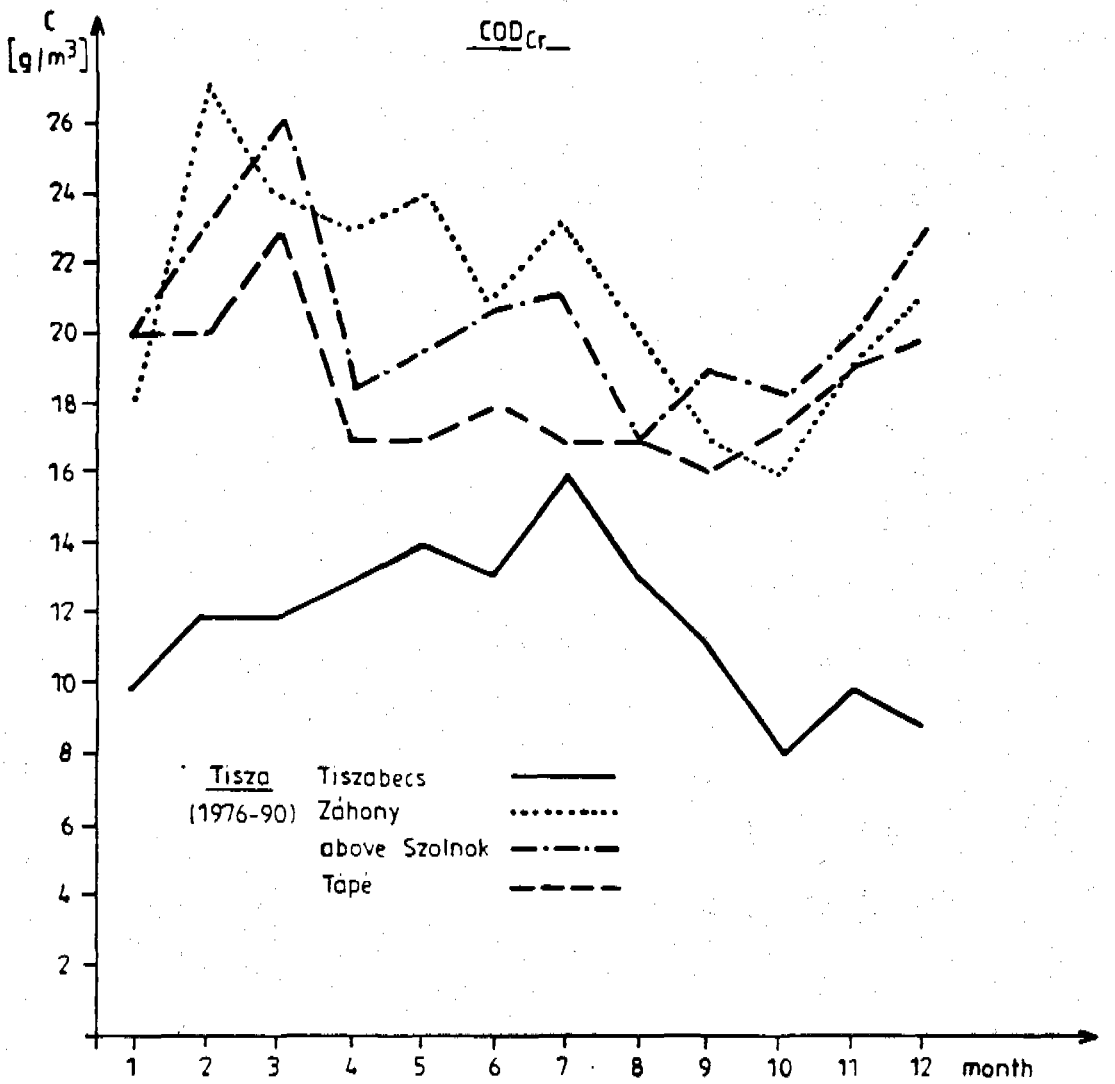


Fig. B - 3. Trends in the Tisza - river at Szolnok



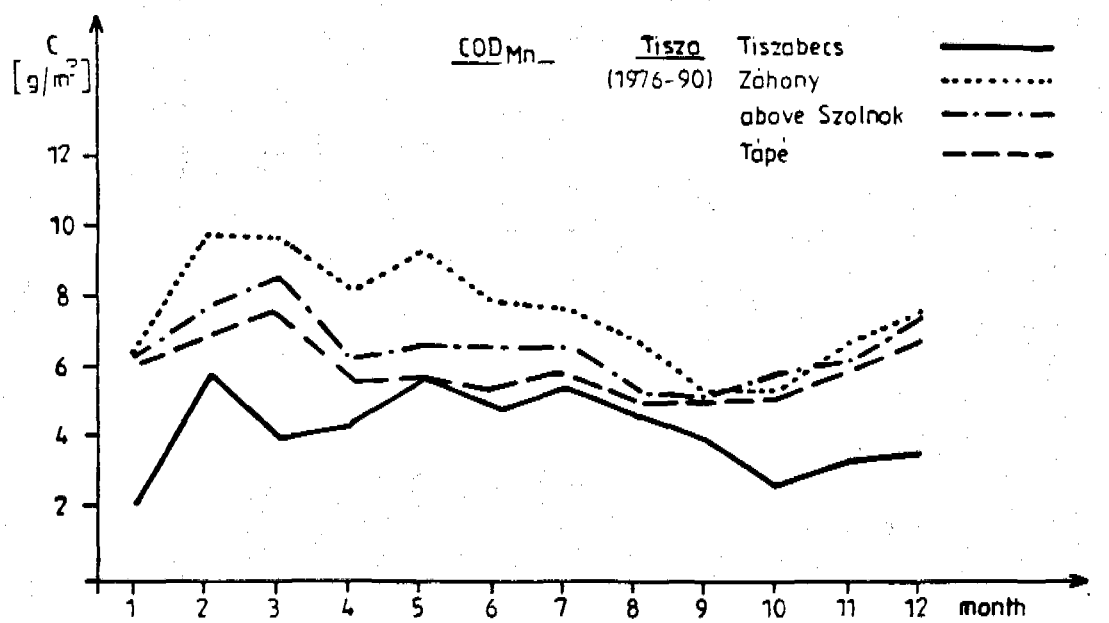


Fig. B - 4. Trends in the Tisza longitudinal section

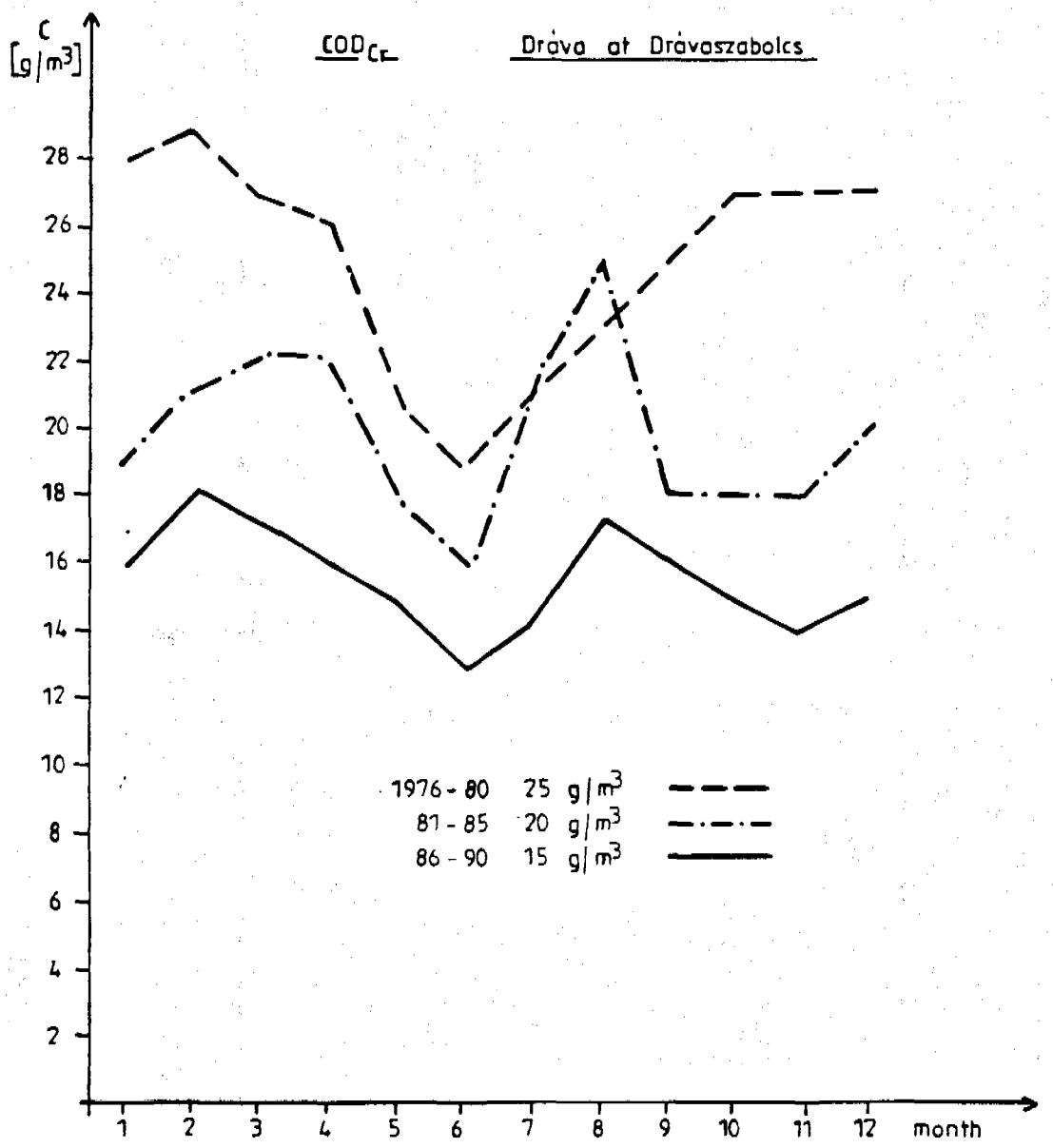


Fig. B - 5. Trends in the Dráva river

Appendix C

The wastewater problems of Budapest

(See Fig.1)

Budapest has a population strength of abt 2 million (20 % of the total population) and an area of 525 km^3. It is a typical industrial metropolis being the host for 40 % of all the industries of the country.

Pollution load of the Budapest Danube section

The sewerage system of the capital with a total length of 3700 km is in some parts of it more then 100 years old. As a consequence it is largely in obsolete condition badly needing reconstruction. Some districts are purely canalized and further development of the existing system is an urgent task. Out of the total system 1900 km is combined type draining both sewage, industrial wastewater and precipitation water. The daily dry weather flow of abt. 800 000 m^3, at present, might be increased by 10, or even more in case of rainy or snow melting period. In a yearly average the 18 pumping stations lift 200 million m^3 of sewage and precipitation water the rest is discharged by gravity into the Danube (see Fig.2). Out of the above figures of wastewater flow the greater part originates in the Pest side of the Danube in three catchment areas such as North Pest, Ferencváros and South Pest. The Buda-side of the capital is subdivided into 8 catchment areas (hilly topography). The sewerage system is fully outloaded and the maintenance is cumbersome.

The present treatment conditions are miserable. In the northern part of the capital there is a biological treatment plant of 140.000 m^3/d capacity (North Pest Treatment Plant) loaded with only 80-90.000 m^3/d, at present, and in the southern part, along the small Soroksár Danube branch an other one treats abt

75.000 m^3/d wastewater. The total load of the Budapest Danube section, expressed in BOD is roughly 200.000 kg/d at dry weather flow, and nobody knows the real load at stormy weather. In case of some previous trial measurements it was revealed that the heavy metal concentration of the wastewater increases with at least one order of magnitude in the latter case. On the territory of the capital abt 300 industrial establishments have so called pretreatment facilities. Most of these can not cope with the criteria prescribed by low. An other problem that the disposal of the refuse and sludge originating from these facilities is not solved at all.

Consequently it is quite obvious that both the sewerage system and the existing treatment plants are overloaded by industrial wastes, heavy metals and refractory organics. Finally it should be mentioned that the rest of the wastewater surpassing the above figures treated biologically is more or less screened before discharged to the Danube. The greater part of this arrives from the Pest (left) side of the river at the Ferencváros pumping station near the southern railroad bridge (Soroksári út).

The solids removed from the sewerage system, the sand traps, screens of the pumping stations and the sludge from the treatment plants are listed on a yearly basis as follows:

Sewer deposit	21.000	m^3
Sand	7.500	"
Screenings	6.000	"
Sludge North Pest	21.000	"
South Pest	16.000	"

The disposal possibilities of the sludge together with the screenings and the removed sewer deposits are in critical condition. All the tipping places are filled up at present. A thermal drying installation for sewage sludge in the North Pest Plant is in preparation. (Estimated cost 1/2 billion Forints).

Several concepts have been elaborated for updating of the sewerage and sewage treatment during the past decades. At present the review of these are under way and a short description of the plan is given below.

The projected dry weather flow on the long term is abt. 1.300.000 m^3/d and the average BOD is 220-240 mg/l, which means a new BOD load, if not treated, of abt 300.000 kg/d (other important contaminants, such as heavy metals see elsewhere). There are two major concepts of the future treatment, of the total wastewater. Besides of the present ones there will be either a centralized one, quite a large plant at the northern tip of Csepel island with 655.000 m^3/d capacity, or a decentralised system in which this plant would receive 60.000 m^3/d only, while another one, at the left river side on the area of the a.m.Ferencváros-pumping station in a covered and multistory design, would receive 430.000 m^3/d d.w.f. The remaining portions are forseen to be distributed in smaller plants mainly on the Buda side. In both concepts travelling of some sewage under the Danube bed and the transfer of a part of the sludge to the big plants is involved (see Fig.2).

As far as the effluent criteriae of the treated wastewater is concerned it is, at present, prescribed in the followings: BOD = 20 mg/l, COD = 75 mg/l, NH_4^+ = 5 mg/l, total P = 2 mg/l, NO_3^- = 50 mg/l. This means an at least 90 p.c. reduction of the BOD - load and - according to the experiences on the existing treatment plants - similar efficiency of heavy metal removal. Sludge handling and disposal is forseen mainly by drying and by coincineration with the communal refuse in the garbage-incineration plants of the capital.

However, there remains a major problem with the precipitation-water "diluting" the wastewater at the rainy period. The first pollution shock of a storm flushing the sewerage system should be - by all means - retained at the treatment plants.

There is an open question still what dilution should be allowed before the overflows.

The investment cost of both of the a.m. concepts of wastewater and sludge treatment is forseen - on 1991 price estimation - about 40 billion Forints. The yearly operation cost is around 15 billion Forints. However, the construction of the extended sewerage and the necessary mains run up to an other similar sum, most probably.

Appendix D

1. The Danube bend as a recreational area

The Danube Bend north from Budapest with an approximative, length of 60 km (see Fig.1 and 8) abounds in historical monuments. Tourists from the nearby capital with its 2 million inhabitants, crowds seeking recreation are more and more attraction of historical monuments, beautiful landscapes, mountain forests and the quiet river.

The fairly pure water of the Danube with its pleasant temperature (the mean temperature is 19,3 °C (66,7 °F) in July and 19,4 °C in August, with occasional maxima of 25 °C = 77 °F) favours the growing popularity or water sports.

Life in the Danube Bend has undergone many changes over the ages. In prehistoric times, there was fishery and hunting. Later on, the limes, or frontier of the Roman Empire was defended here. The luxury of royal courts was witnessed by Esztergom from the eleventh to thirteenth centuries and by Visegrád in the fourteenth and fifteenth centuries. A rapid cultural and economic decline took place during the 140 years of Turkish rule, followed by a slow recovery from the eighteenth century onwards. The life of the river band has now taken on a completely new texture create by the recreational demands of our age. The large-scale demand for relaxation is exerting its beneficial influence on the architectural, economic, commercial and traffic development of Danube settlements. At present, 85 % of the houses are inhabited during the summer only, and only a few families maintain year-round residence along the river. Holiday-makers are predominant in Leányfalu, established scarcely 80 years ago, as well as in certain parts of two other townships on the right bank of the Danube,ancient Szentendre, and Visegrád, and the same can be said of Horány and Surány rapidly developing resort centres on Szentendre Island.

In order to achieve a uniform development of the whole recreational area, a regional plan was prepared. In accordance

with this plan, various facilities serving tourism and excursions (restaurants, hotels, campings, resthouses for tourists, spring intakes, marked tourist paths), are rapidly increasing, the protection of historical monuments is being energetically pursued and transport facilities are improving. The construction of regional waterworks to serve the recreational area has been established.

2. The Kisköre reservoir as a recreational paradise

The construction of the impoundment of the Tisza river at Kisköre was started in 1967 and finished in 1973.The impounded section is 40 km in length and the greatest width is 6 km. The planned area of the water surface is 127 km^2 (12.700 hectar) with an average water depth of 2.5 m. However, at present, the surface area is only 90 km^2 and in 40 % of the impounded river section the water depth does not reach 1 m. Within the impoundment many small islands and marshy areas results in an attractive environs. In general the water quality is acceptable and the silting of unorganic character is not yet significant.

A major problem of utilizing the reservoir for water sports arises from the root-timbers (stumps) left in the inundated land. At present the fishing (both professional and hobby) is the major atrraction for holydaymakers, however, this is often antogonized by the water level variations due to other water uses (among the others irrigation or groundwater table control).

There are some sections of the reservoir (mainly in the vicinity of larger villages) where the infrastructure for summer holyday is favourable and the touristic development is accelerated in the last decade. Many tourists enjoy besides the water sports the land-bound sports (such as golf,tennis, hunting) as well. Privatization of land helps enormeously the rapid extension of housing,however,there is a need in government (local government) supported infrastructure development together with a better considered water management oriented towards the profitable uses of the impounded river section.

ROMANIA

TECHNICAL REPORT

CAMP DRESSER & Mc KEE INTERNATIONAL INC.
environmental engineers, scientists,
planners & management consultants

WATER AND SANITATION FOR HEALTH (WASH) PROJECT
TASK No 271

DANUBE EMISSIONS MANAGEMENT DECISION SUPPORT PROJECT (DEMDESP) SECTOR ROMANIA

1 9 9 2

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R O M A N I A

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ACKNOWLEDGMENT

The hereinattached report was prepared in accordance with the subcontract signed on the 17th of February, 1992, between Camp Dresser & Mc Kee International Inc. and Inginerie Urbana S.A.

The informations regarding river flows, population, domestic and industrial wastewaters as well as the treatment facilities are based on the following sources:

1. "Romanian Statistic Yearbook of 1990" published by The National Statistics Commission in 1991.

2. "Water Register of Romania" vol. III, published by The Institute of Meteorology and Hydrology of Bucharest in 1972.

3. "Statistics of the Existing Facilities in Public Works 1986 - 1988" of the former State Council for Local Authorities Problems.

4. Existing informations collected from the local authorities and local water enterprises of the main cities investigated.

5. Data provided by The Institute of Research and Environmental Engineering of Bucharest.

Concerning the trends expected in urban and industrial development and pollution load the problem was quite difficult to solve because the lack of information's sources due to the transition period from a centralised system to a free-market economy in full progress in Romania nowadays. The industrial restructuration based on total different principles, the cancella-

tion of all the restrictions regarding the population right of accomodation in big cities, the agriculture reform not yet completely achieved are generating an important degree of doubt for all the informations obtained.

The above mentioned estimations are mainly based on our engineers experience and the observed economical tendencies and should be taken into consideration as 50% - 60% degree of accuracy.

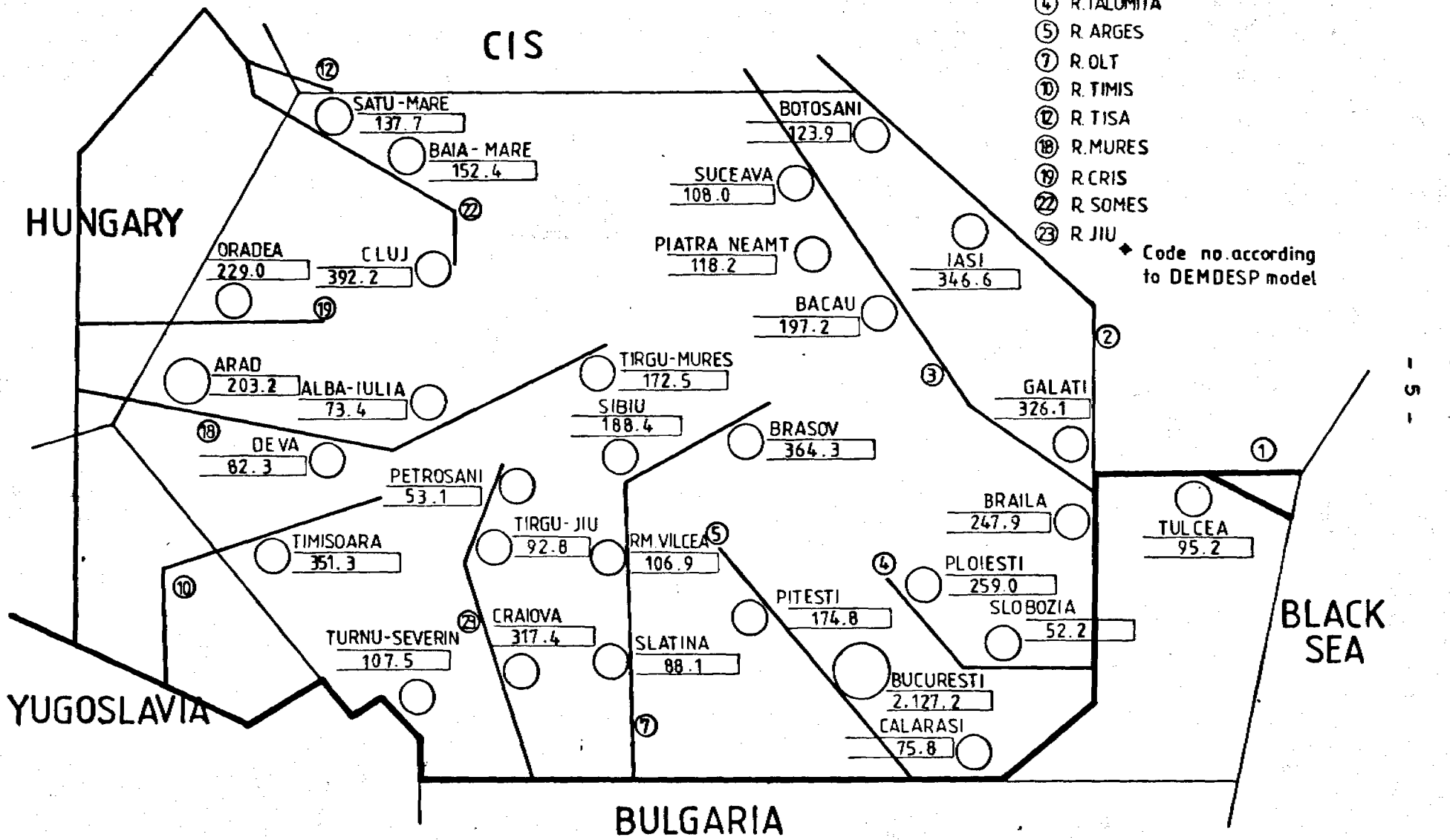
The rivers from the western side of the country namely Mureş (code no 18), Criş (code no 19) and Someş (code no 22) are tributaries to Tisza river (code no 12) main tributary joining the Danube are treated in a complete manner in "Danube River Study for the Hungarian Water Catchment Area" prepared by Innosystem Ltd. Budapest in 1991, thus that the cumulative flows and polluters are presented in that study.

Comparing to the DEMDESP model it was introduced as a supplement to the initial concept the river Jiu (code no 23), considered as being of importance.

Finally, as a general observation, one mentions that all the data and figures presented in this study are limited at the territory of Rumania.

DANUBE EMISSION MANAGEMENT DECISION SUPPORT PROJECT - ROMANIAN DANUBE RIVER BASIN

MAIN URBAN CENTERS LOCATED IN RIVER BASINS
(Population in thousands)



1. ASSESSMENT OF WATER POLLUTION IN THE ROMANIAN PART OF THE DANUBE RIVER BASIN

1.1. Description of the River and its Tributaries

The Danube is the second largest river of Europe with an average flow of about 12,000 m^3/s and a total length of 2857 km, has its final water course in length of 1075 km located on the territory of Romania.

The starting point of the Romanian sector of the Danube is the little community Baziaş (on the left side). From this point up to the discharge of the Timok river (tributary on the right side) the Danube is a natural border between Romania and Yugoslavia.

Downstream of the Timok discharge point up to the city of Călăraşi (on the left side) the Danube forms the natural border between Romania and Bulgaria and from this point up to the discharge in the Black Sea tne Danube flows entirely on tne Romanian territory with the only exception of tne Northern arm of the Danube Delta called Kilia which is also a natural border between Romania and C.I.S.

In other words should be mentioned that on this part of tne Danube river as well as Romania, Yugoslavia, Bulgaria and C.I.S. have their own contributions in tne water pollution.

Another mention concerns the rivers from the Western part of the Romanian territory. The major rivers namely Someş (22^x), Crişul (19^x) and Mureş (18^x) are all tributaries to Tisza river and their final water courses are located as well as Tisza on the territory of Hungary. Simmilary the Timiş (10^x) river has its final water course located on the Yugoslavian territory. Consequently all the data regarding these rivers are limited at the territory of Romania.

---

x) Code numbers according to the DEMOESP model.

Table no 1

ROMANIAN PART OF THE DANUBE RIVER BASIN
Tributaries lengths and catchment areas
(limited at the Romanian territory)

Tributary	Code no	Length (km)		Catchment area (Sq. km)
		Main river only	Main river with all tributaries	
SOMES	22	349	5,51o	15,o15
CRIS[x)]	19	49o	4,887	14,46o
MURES	18	716	9,64o	27,83o
TIMIS	1o	231	1,751	5,795
JIU	23	331	3,176	1o,o7o
OLT	7	67o	8,465	24,o1o
ARGES	5	327	3,665	12,59o
IALOMITA	4	4oo	2,589	1o,43o
SIRET	3	576	13,965	42,83o
PRUT[xx)]	2	716	4,183	1o,99o
DANUBE (entry)	1	-	-	-
DANUBE (discharge)	1	1,o75	2,431[xxx)]	32,25o[xxx)]

x) Addition of Quick Cris, Black Cris and White Cris

xx) Only for the right side (left side belongs to C.I.S.)

xxx) Danube only (left side, without the indicated tributaries)

Table no 2

Tributaries characteristic flows

Tributary	Code no	Minimum flow 95% cu.m/s	Dilution flow cu.m/s	Maximum flow 1% cu.m/s
SOMES (at border)	22	6.1	1o.o	3,4oo
QUICK CRIS (ditto)	19	1.58	1.85	1,o8o
BLACK CRIS (ditto)	19	1.11	1.49	73o
WHITE CRIS (ditto)	19	.51	.76	7oo
MURES (ditto)	18	15.oo	23.o	2,35o
TIMIS (ditto)	1o	2.7	4.6	1,5oo
JIU	23	6.9	8.5	1,97o
OLT	7	16.o	28.5	3,375
ARGES	5	4.97	1o.4	2,23o
IALOMITA	4	4.o	7.34	89o
SIRET	3	23.6	3o.8	5,4oo
PRUT	2	9.o5	13.1	3,5oo
DANUBE (entry)	1	136o.o	1632.o	16,45o
DANUBE (discharge)	1	155o.o	2o3o.o	15,7oo

NOTE:

1) Minimum flow 95% = minimum average flow realized in 5 years in a century

2) Maximum flow 1% = maximum average flow realized in one year in a century

3) Dilution flow admitted by domestic regulations

Entering in the Romanian sector the Danube river becomes very narrow in the so called "Iron Gates" area and the velocity increases. In this ares exists an Water Power Plant built-up in co-operation by Romania and Yugoslavia using the water energy source, but downstream of this point the river is characterized by a reduced slope of less than .01‰. Even in these conditions the river is still suitable for navigation under pilot control. The most difficult problems appear for the snip channel in the Danube Delta which needs a permanent dredge.

Another point of interest is the fact that the Danube river flow diminishes from the entry area up to the discharge despite the tributaries contribution. This flow diminution seems to be caused by the aquifer supply in the area.

In the Table no 1 are shown the tributaries lengths and catchment areas and in the Table no 2 the characteristic flows.

1.2. Water Quality of the Danube River

The quality of the Danube River was subject of a systematic national surveillance program since 1979 and more recently of an international program after the "Declaration of Bucharest" from 1988.

The control sections include three major sectors of the Danube as follows;

- the first sector from Bazias to Gruia corresponding to the hydroenergy and navigation corrected course;

- the second sector from Gruia to Chiciu corresponding to the discharges of the most important tributaries from the Southern Carpathians and Balkans;

- the third sector from Chiciu to the Black Sea corresponding to the discharges of the tributaries from the Eastern Carpathians and Moldavia. This sector includes the two Danube pools and the Danube Delta.

Table no.3

AVERAGE WATER QUALITY OF THE DANUBE RIVER
SECTION GRUIA (Km 851)

Years	Values	Flow[x] Cu.m/s	S.S. (minerals) mg/l	Dissolved oxygen mg/l	Dissolved oxygen %	BOD_5 mg/l	COD-Mn mg/l	P-total mg/l $.10^{-3}$	N-total mg/l $.10^{-3}$	TDS mg/l	Alkalinity $CaCO_3$ mg/l	pH
1979-81	min	6050	8	6.3	65.3	2.6	4.5	200	80	259	145	7.2
	max	6465	16	7.5	73.0	3.6	6.0	320	810	278	155	7.4
	ave	6780	13	6.9	72.1	3.1	5.1	250	340	268	150	7.3
1984-86	min	4925	21	4.6	52.9	2.0	3.7	210	48	264	135	7.3
	max	7350	41	6.6	67.9	2.8	4.5	240	520	280	145	7.7
	ave	5856	25	5.7	59.9	2.3	4.1	220	440	271	142	7.5
1988-90	min	3755	21	6.8	63.8	2.2	4.2	360	1780	289	150	7.4
	max	5386	23	8.4	76.9	2.7	5.5	540	2480	331	155	7.4
	ave	4651	22	7.6	70.4	2.4	4.6	430	2157	306	153	7.4

Specific polluants -mg/l $x10^{-3}$[xx]

Years	Values	Phenols	Oil	DDT	Lindan	Cd	Cr	Cu	Pb	Zn	Hg
1979-81	min	1	-	.05	.08	3	4	5	21	90	.17
	max	8	-	.19	.23	5	9	26	30	359	.29
	ave	5	-	.12	.21	4	6	14	24	190	.23

Table no.3

AVERAGE WATER QUALITY OF THE DANUBE RIVER
SECTION GRUIA (Km 851)-continuation-

Years	Values	Phenols	Oil	DDT	Lindan	Cd	Cr	Cu	Pb	Zn	Hg
1984-86	min	6	200	.78	.01	2	2	3	14	42	.18
	max	13	600	1.22	.01	3	6	7	24	206	.49
	ave	9	400	.91	.91	2	3	5	18	98	.35
1988-90	min	2	40	.22	.05	1	5	12	2	22	.00
	max	3	260	.80	.10	3	13	21	12	35	.06
	ave	2	123	.67	.08	2	9	16	7	37	.03

x) average flow measured at the samples collection time

xx) values obtained for the water natural hardness= 2.2-2.6 meV$CaCO_3$

Table no.4

AVERAGE WATER QUALITY OF THE DANUBE RIVER
SECTION CHICIU (Km.375)

Years	Values	Flow[x] cu.m/s	S.S. (minerals) mg/l	Dissolved oxygen mg/l	Dissolved oxygen %	BOD_5 mg/l	COD-Mn mg/l	P-total mg/l $.10^{-3}$	N-total mg/l $.10^{-3}$	TDS mg/l	Alkalinity $CaCO_3$ mg/l	pH
1979-81	min	6050	27	6.5	69.7	3.1	4.0	170	130	284	145	7.3
	max	8225	76	7.8	86.4	3.9	4.8	300	290	292	155	7.4
	ave	6928	69	7.2	78.2	3.5	4.5	240	200	289	150	7.3
1984-86	min	4883	22	7.5	83.3	3.3	3.5	270	480	265	145	7.3
	max	7015	86	7.7	86.1	4.5	4.4	300	680	307	145	7.7
	ave	6023	52	7.6	84.7	4.5	4.0	290	600	291	145	7.6
1988-90	min	4104	37	7.7	70.5	2.2	4.2	270	1950	310	150	7.4
	max	6087	64	8.5	78.5	3.3	4.8	410	2140	315	155	7.7
	ave	5125	55	8.0	74.0	2.9	4.4	340	2050	312	153	7.6

Specific pollutants-mg/l $.10^{-3}$[xx]

Years	Values	Phenols	Oil	DDT	Lindan	Cd	Cr	Cu	Pb	Zn	Hg
1979-81	min	5	- .06	.15	2	7	13	16	110	.18	
	max	13	- .23	.30	4	15	24	25	310	.37	
	ave	7	- .13	.17	3	10	18	20	180	.27	

Table no.4

AVERAGE WATER QUALITY OF THE DANUBE RIVER
SECTION CHICIU (Km 375)-continuation-

Years	Values	Phenols	Oil	DDT	Lindan	Cd	Cr	Cu	Pb	Zn	Hg
1984-86	min	4	100	.34	.03	3	3	7	3	90	.18
	max	14	300	.82	.10	4	8	10	19	136	.47
	ave	11	260	.57	.06	3	5	8	13	109	.32
1988-90	min	4	140	.10	.07	1	7	17	12	28	.26
	max	13	290	.37	.32	3	13	21	20	90	.33
	ave	7	217	.62	.20	2	10	10	16	60	.29

x) average flow measured at the samples collection time

xx) values obtained for the water natural hardness= 2.2-2.6 meV$CaCO_3$

Table no.5

AVERAGE WATER QUALITY OF THE DANUBE RIVER
SECTION VILCOV (Km.18)

Years	Values	Flow[x] cu.m/s	S.S. (minerals) mg/l	Dissolved oxygen mg/l	Dissolved oxygen %	BOD_5 mg/l	COD-Mn mg/l	P-total mg/l $.10^{-3}$	N-total mg/l $.10^{-3}$	TDS mg/l	Alkalinity $CaCO_3$ mg/l	pH
1979-81	min	5580	50	6.8	72.8	3.8	4.4	120	130	285	145	7.2
	max	7800	100	8.8	78.9	3.9	7.0	240	340	320	150	7.6
	ave	7085	90	7.6	76.7	3.8	5.4	200	233	297	147	7.4
1984-86	min	5050	55	6.1	66.0	3.0	3.9	190	410	294	150	7.6
	max	6400	203	7.5	80.7	4.5	4.8	250	500	331	155	7.9
	ave	5917	70	6.7	73.0	3.6	4.3	220	460	315	152	7.7
1988-90	min	4888	27	7.7	74.6	2.6	4.7	290	2140	310	145	7.6
	max	6200	72	8.1	74.8	3.1	5.0	400	2400	339	160	7.8
	ave	4972	49	7.9	74.7	2.8	4.9	330	2257	329	152	7.7

Specific pollutants - mg/l . 10^{-3}[xx]

Years	Values	Phenols	Oil	DDT	Lindan	Cd	Cr	Cu	Pb	Zn	Hg
1979-81	min	2	-	.02	.00	2	2	8	5	120	.20
	max	19	-	.65	.41	6	15	21	41	220	.64
	ave	6	-	.27	.14	3	8	16	19	154	.35

Table no.5

AVERAGE WATER QUALITY OF THE DANUBE RIVER
SECTION VILCOV (Km 18)-continuation-

Years	Values	Phenols	Oil	DDT	Lindan	Cd	Cr	Cu	Pb	Zn	Hg
1984-86	min	4	150	.10	.05	2	2	2	13	50	.21
	max	22	400	.61	.19	5	4	30	18	122	.83
	ave	10	240	.34	.12	3	3	17	16	90	.46
1988-90	min	5	120	.07	.05	2	5	4	12	33	.31
	max	12	1450	.53	.10	4	6	20	27	105	.37
	ave	7	603	.21	.08	3	6	14	20	63	.34

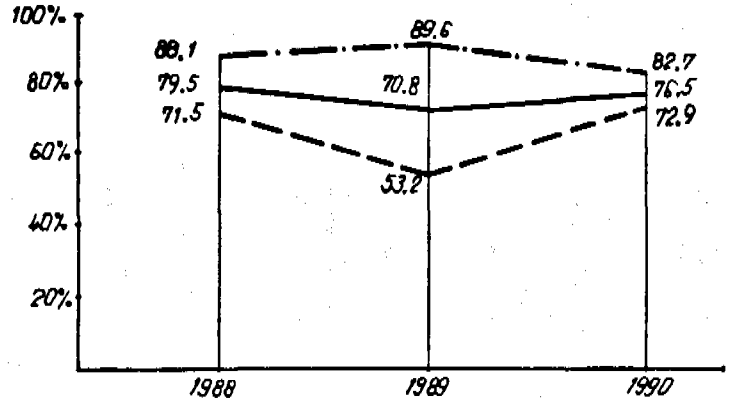
x) average Flow measured at the samples collection time

xx)values obtained for the water natural hardness=2.2-2.6 meV$CaCO_3$

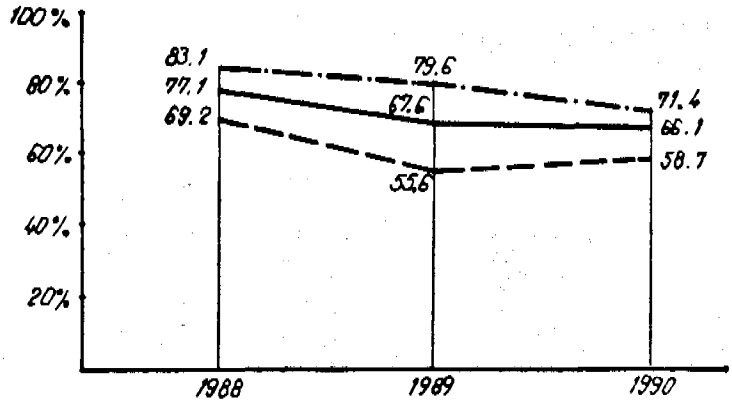
FLUCTUATIONS OF THE DISSOLVED OXYGEN CONCENTRATION% OF THE DANUBE LAKES IRON GATES I & IRON GATES II IN THE PAST 3 YEARS (1988 - 1990)

(100 % = O_2 CONCENTRATION AT SATURATION)

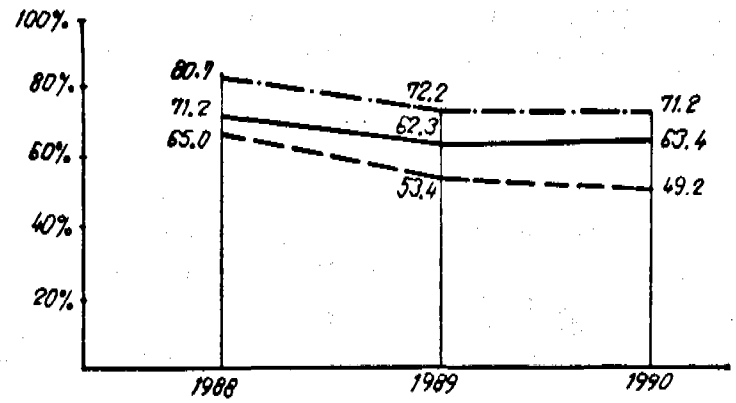
Dissolved O_2



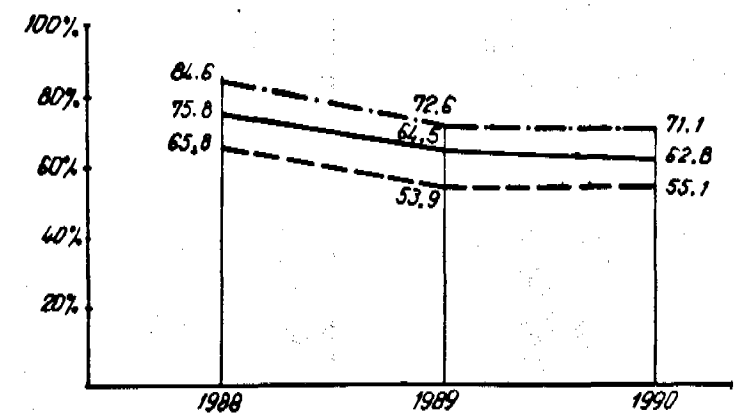
SECTION BAZIAS (Km 1071)



SECTION MILANOVAC (Km 996)



SECTION KLADOVO (Km 934)



SECTION RADUIJEVAC (Km 851)

LEGEND

- maximum
- average
- minimum

In the Tables no 3, 4 and 5 are indicated the average concentrations of pollutants determined for the Danube river in the sections Gruia (km 851), Chiciu (km 375) and Vîlcov (km 18).

By examining these concentrations it results some concentrations for dissolved oxygen, ammonia, nitrites, oil, phenols, pesticides, heavy metals over the limits as well as a general tendency of pollution growth since 1979.

One may notice important changes concerning the nutrients. During the 11 years the Nitrogen increased tremendously so that the actual Nitrogen/Phosphorus ratio is close to 1o very significant as a beginning of an important eutrophization period.

Meantime an important decrease of the dissolved oxygen in the lakes Iron Gates I and Iron Gates II was observed as it is shown on the attached diagrams.

Although the up-to-date state of the Danube river quality seems to be yet quite satisfactory, the dissolved oxygen levels, the accumulation of nutrients and the saprobic bio-indicators clearly indicates an unfavorable evolution in a short time.

1.3. Water Quality of the Tributaries

Generally the tributaries of Danube present higher concentrations of pollutants. If their average contribution to Danube in terms of flow is about 1o%, the contribution in terms of BOD_5 is about 1/3.

In the Table no 6 are indicated the average pollutants concentrations for the tributaries with the only exception of Prut river for which detailed informations weren't available.

The samples were taken in the final sections of the rivers at a distance of about 5oo m. upstream from the junction with Danube. The tributaries quality is included in the same control program as for the Danube and the analysed period is the same 1988-199o.

Table no.6

AVERAGE WATER QUALITY OF THE TRIBUTARIES 1988 - 1990

Tributary	Values	Flow[x] m^3/s	S.S. (mineral) mg/l	Dissolved oxygen %	BOD_5 mg/l	TDS mg/l	$N\text{-}NH_3$ mg/l	$N\text{-}NO_3$ mg/l	$P\text{-}DO_4$ mg/l
JIU	min.	36	61	58	6	315	3	3	.3
(Km 293)	max.	132	536	79	13	636	33	13	.5
	ave.	87	225	67	10	452	16	7	.4
OLT	min.	68	57	82	3	473	.3	2.0	.10
(Km 604)	max.	232	408	100	6	835	3.0	3.0	.13
	ave.	129	176	93	5	705	1.5	1.7	.20
ARGES	min.	40	64	18	23	437	5	.2	. 4
(Km 432)	max.	81	339	48	53	600	7	.7	4.0
	ave.	55	177	29	47	502	6	.5	1.6
IALOMITA	min.	10	69	9	39	1566	17	.2	1.0
(km 243)	max.	13	899	29	45	1700	74	2.0	1.3
	ave.	11	584	17	41	1651	47	1.1	1.1
SIRET	min	90	48	68	6	592	.9	1.6	. 5
(km 155)	max.	142	500	71	7	871	2.5	2.2	1.1
	ave.	120	303	70	6	690	1.5	2.0	. 7

x) measured flows at the samplles collection time

Table no.6

AVERGE WATER QUALITY OF THE TRIBUTARIES 1988 -1990 (Continuation)

Tributary	Values	Specific pollutants mg/l.10^{-3}									
		Oil	Phenols	Lindan	DDT	Cd	Cr	Cu	Pb	Zn	Hg
	min.	xx)	9	. 05	. 38	3	13	17	10	70	. 20
JIU	max.	xx)	12	. 09	. 40	6	21	34	34	104	. 80
	ave.	300	10	. 07	. 42	4	16	17	21	85	. 50
	min.	xx)	9	. 08	. 39	2	2	6	11	60	. 12
OLT	max.	xx)	10	. 13	. 74	6	14	8	40	149	. 22
	ave.	xx)	12	. 10	. 56	4	9	7	28	73	. 16
	min	200	12	. 04	. 66	1	7	15	11	150	. 19
ARGES	max.	600	18	. 45	. 77	5	18	40	25	412	. 47
	ave.	400	15	. 24	. 71	3	12	25	17	217	. 22
	min.	500	9	. 13	. 39	4	5	4	32	38	. 48
IALOMITA	max.	1000	25	. 39	. 49	7	16	13	42	130	. 64
	ave.	700	16	. 26	. 44	5	9	10	36	94	. 37
	min.	250	14	. 02	xx)	2	2	4	12	50	. 36
SIRET	max.	400	27	. 20	xx)	5	13	9	26	372	. 69
	ave.	300	22	. 04	. 26	4	7	7	20	173	. 53

xx) unrecorded

The total production of pollutants was established taking into consideration the multi-year average flow from the National Hydrographic Records and the measured average concentrations shown in the tables 3 - 7. The global figures are indicated in the Table no 7.

Table no 7

TRIBUTARIES POLLUTANTS PRODUCTION

ITEM	Unit	Danube x)	Jiu	Olt	Argeş	Ialomiţa	Siret	Total DANUBE
Flow	cu.m/s	5464	9o	16o	65	4o	21o	6o29
	%	91%	1.5%	2.5%	1%	.6%	3.4%	loo%
BOD_5	t/day	1227	78	69	264	142	1o9	1889
	%	64.9%	4.1%	3.7%	14%	7.5%	5.8%	loo%
S.S.	t/day	13218	175o	2433	994	2o18	5498	25911
	%	51%	6.8%	9.4%	3.8%	7.8%	21.2%	loo%
N total	t/day	983	179	44	37	166	64	1437
	%	66.7%	12.2%	3%	2.5%	11.3%	4.3%	loo%
P total	t/day	128	3	3	9	4	12	159
	%	8o.5%	1.9%	1.9%	5.7%	2.5%	7.5%	loo%
TDS	t/day	135o17	3515	9746	3959	57o6	12519	17o462
	%	79.2%	2.1%	5.7%	2.3%	3.4%	7.3%	loo%

The total has not included the figures for Prut river. In its case the availability of data is limited only at the right side of the river. The available figures for Prut river are:

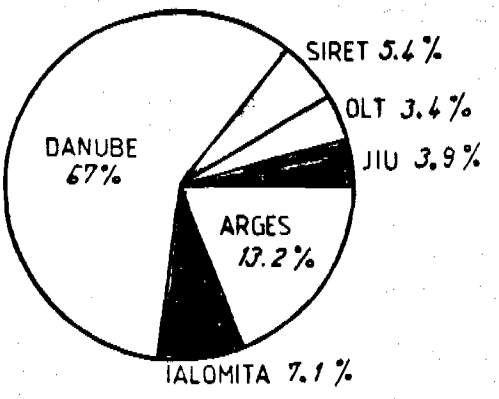
Average flow = 8o cu.m/s
S.S. = 1o2.2 t/day
COD (Cr.) = 81.4 t/day
BOD_5 = 34.9 t/day

x) Dischargers direct to Danube

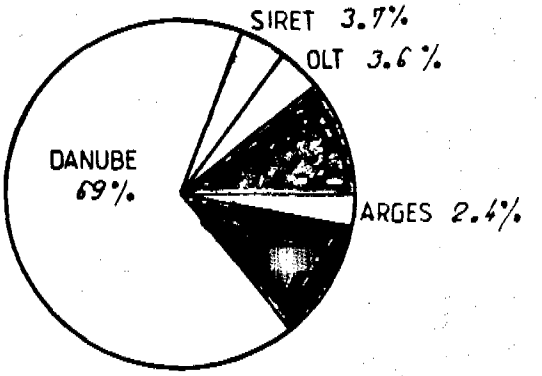
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AVERAGE CONTRIBUTION OF THE MAIN TRIBUTARIES IN THE TOTAL DANUBE POLLUTION

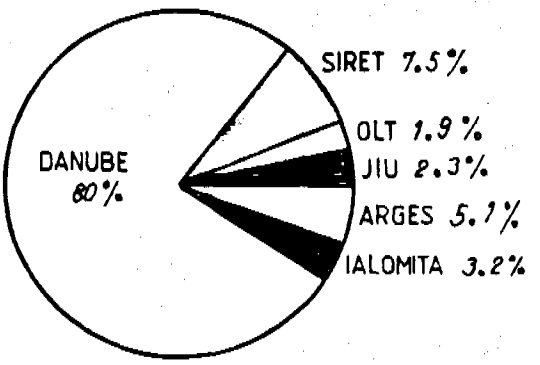
BOD_5 - total
2012 tons/day



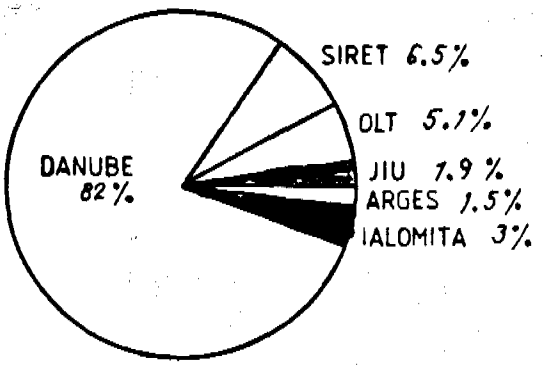
N - total
1567 tons/day



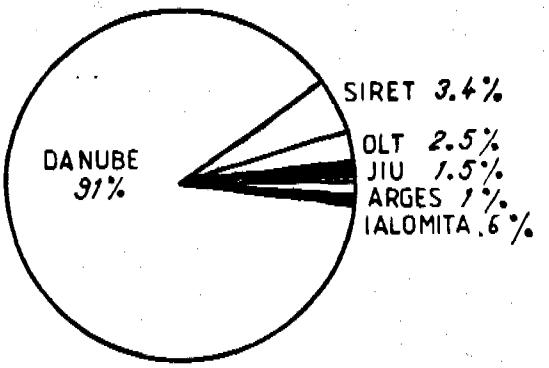
P - total
215 tons/day



T. D.S.
189.608 tons/day



TOTAL FLOW
6029 cu.m/s



Also the contributions of Iskar and Yantra rivers (from Bulgaria) should be added in order to obtain the total Danube pollution.

1.4. Ground Water

As will be further discussed almost every urban community has not yet a complete sewerage system. At national level the ratio km of water pipes versus km of streets is about 2/3 but only 45% of streets are provided with sewers. It is obvious under these circonstances that septic tanks are still in use and an important amount of wastewater penetrates into the ground. More over the sewers themselves are not enough watertight especially at the joints.

Consequently the aquifer is biologically polluted in the urban areas.

However in the rural areas (about 40% of the population) wells of small depth are frequently used as water sources.

In the last years one identified important concentrations of pollutants as nutrients, oil and phenols in some areas as the region between cities Piatra Neamţ and Bacău (Trotuş river valley) and in the neighbourhood of the Ploieşti city.

The absence of informations on individual water sources does not allow an ampler discussion, but is no doubt that unavoidable improvments in agricultural techniques as an intensive use of fertilizers and pesticides will seriously and quickly affect the ground water on much larger areas.

1.5. Impacts of Water Quality on Uses

1.5.1. Urban Use

About 13.3 million from a total population of 23.2

million are supplied from centralised water systems. About 1o.2 million of these consumers are located in urban areas.

The common practice is to supply from the city public network the habitations as well as the public buildings and industries located in the same area. However in several cases greater industrial plants have their own systems.

The existing capacity of urban water systems comes to a total of about 1o6 cu.m/s; about 4o cu.m/s from ground water sources and 66 cu.m/s from surface sources. Only 64% of the existing streets are provided with water pipes.

The yearly drinking water distributed is about 2,451 million cu.m as follows:

- for habitations 1,o67 million cu.m (43%)
- for public buildings 486 million cu.m (2o%)
- for industries 898 million cu.m (37%)

The daily average drinking water consumption of about .56o cu.m/capita indicates important water loses.

The typical concept for the surface water treatment plants consists of grit chambers, floculation, sedimentation, sand filters and chlorine disinfection and only chlorine disinfection for the underground waters.

In some cases, according to the raw water quality, additional iron removal facilities by aeration are provided.

More sophisticated technologies as ozonation and activated carbon filters are not yet used on large scale.

In the last years for energy and flow-regulation purposes artificial lakes become wide-spread on the national territory. Corroborating with a larger use of chemical fertilizers both have generated the apparition of the surface water eutrophization, mainly during the spring and summer seasons. Under these new conditions the existing technologies gradually appear as limited and needing adequate improvments.

The characteristics of the main urban systems are indicated in the Table no 8.

TABLE No.8

MAIN URBAN WATER USERS

River basin	Code no	CITY	Population thousands	Average daily water distributed 1000 cu.m/day	Sources		TREATMENT F=floculation & sedimentation SF=sand filtration A=aeration Cl=chlorine disinfection	Raw water special problems
					Ground-water %	Surface %		
1	2	3	4	5	6	7	8	9
SOMES	22	CLUJ	392.2	192.0	26%	74 %	F[x)]+SF[x)]+Cl	
		DEJ	41.4	28.0	100%	-	Cl	
		BAIA-MARE	152.4	135.0	-	100 %	F+SF+Cl	
		SATU-MARE	137.7	71.6	100%	-	A+F+SF+Cl	Fe=2.3 mg/l
CRIS	19	ORADEA	229.0	190.0				
MURES	18	TIRGU-MURES	172.5	104.0	45%	55 %	F+SF+Cl	
		ALBA-IULIA	73.4+54.5	117.5	15%	85 %	F+SF+Cl	
		DEVA	82.3	51.6	10%	90 %	F+SF+Cl	Organics=25 mg/l
		ARAD	203.2	180.9	100%	-	F+SF+Cl	
TIMIS	10	TIMISOARA	351.3	226.5	5%	95 %	A+F+SF+Cl	Fe=14 mg/l NO_3=3.1 mg/l

TABLE no.8

MAIN URBAN WATER USERS(Continuation)

1	2	3	4	5	6	7	8	9
JIU	23	PETROSANI	53.1	23.o	15 %	85 %	$F^{x)}+SF^{x)}+Cl$	
		TIRGU JIU	92.8	44.o	100 %	-	Cl	
		CRAIOVA	317.4	221.0	60 %	40 %	$A^{x)}+F^{x)}+SF^{x)}+Cl$	F=25 mg/l Org.=30 mg/l
OLT	7	BRASOV	364.3	220.0	35 %	65 %	F+SF+Cl	
		SIBIU	188.4	97.9	5 %	95 %	F+SF+Cl	
		RIMNICU VILCEA	106.9	62.3	4 %	96 %	F+SF+Cl	Org.=40 mg/l
		SLATINA	88.1	53.5	100 %	-	Cl	
ARGES	5	PITESTI	174.8	190.0	15 %	85 %	$F^{x)}+SF^{x)}+Cl$	SO_4=120 mg/l
		BUCURESTI	2,127.2	1.788.1	8 %	92 %	$F^{x)}+SF^{x)}+Cl$	NO_3=10 mg/l Org.=20 mg/l
IALOMITA	4	PLOIESTI	259.0	70.5	100 %	-	Cl	
		CLOBOZIA	52.2	24.0	17 %	83 %	$A^{xx)}+F+SF+Cl$	H_2S=9.5 mg/l$^{xx)}$
SIRET	3	SUCEAVA	108.0	147.0	55 %	45 %	$F^{x)}+SF^{x)}+Cl$	
		PIATRA NEAMT	118.2	73.o	100 %	-	Cl	
		BACAU	197.2	92.0	100 %	-	Cl	Org.=30 mg/l
		GALATI	326.1	259.0	55 %	45 %	$F^{x)}+SF^{x)}+Cl$	$NO_3^{x)}$=13 mg/l Org.$^{x)}$=44 mg/l

Table no.8

MAIN URBAN WATER USERS (Continuation)

1	2	3	4	5	6	7	8	9
PRUT	2	BOTOSANI	123.9	77.4	-	100 %	F+SF+Cl	
		IASI	346.6	394.5	30 %	70 %	$F^{x)}$+$SF^{x)}$+Cl	$SO_4^{x)}$=215 mg/l Org.=20 mg/l
DANUBE	1	TURNU SEVERIN	107.5	100.0	-	100 %	F+SF+Cl	NO_3=29 mg/l
		CALARASI	75.8	45.0	-	100 %	F+SF+Cl	Org.=20 mg/l
		BRAILA	247.9	52.0	-	100 %	F+SF+Cl	Org.=30 mg/l
		TULCEA	95.2	149.0	13 %	87 %	F+SF+Cl	Org.$^{x)}$=20 mg/l

x) Surface water only

xx) Groundwater only

1.5.2. Ecosystems and Fisheries

Due to the past Government policy the most important Danube pools as Fîntînele, Zimnicea, Balta Ialomiţei and Balta Brăilei were drained off and transformed in agricultural lands thus that the most important fisheries of the Romanian territory were suppressed.

Actually the majority of fisheries are located on the rivers from the mountains area or in natural ponds or pools supplied from underground water sources, used more for sports than for an industrial fishing. These areas can be considered quite clean from the pollution point of view.

However some eutrophisation was installed even in the mountain lakes and consequently phytophague species were selected in order to populate the lakes. Until now this type of ecosystems seems to work well.

Finally must be mentioned that exist some cases of pools or lakes used as recepteurs of treated urban or industrial effluents, one of the best known being Buftea from the lakes of Bucharest which receives treated water from the city of Buftea and Film Studios. In simmilar cases there happen often accidents caused by the wastewater treatment plant faillures but such cases are not characteristic.

1.5.3. Other Uses

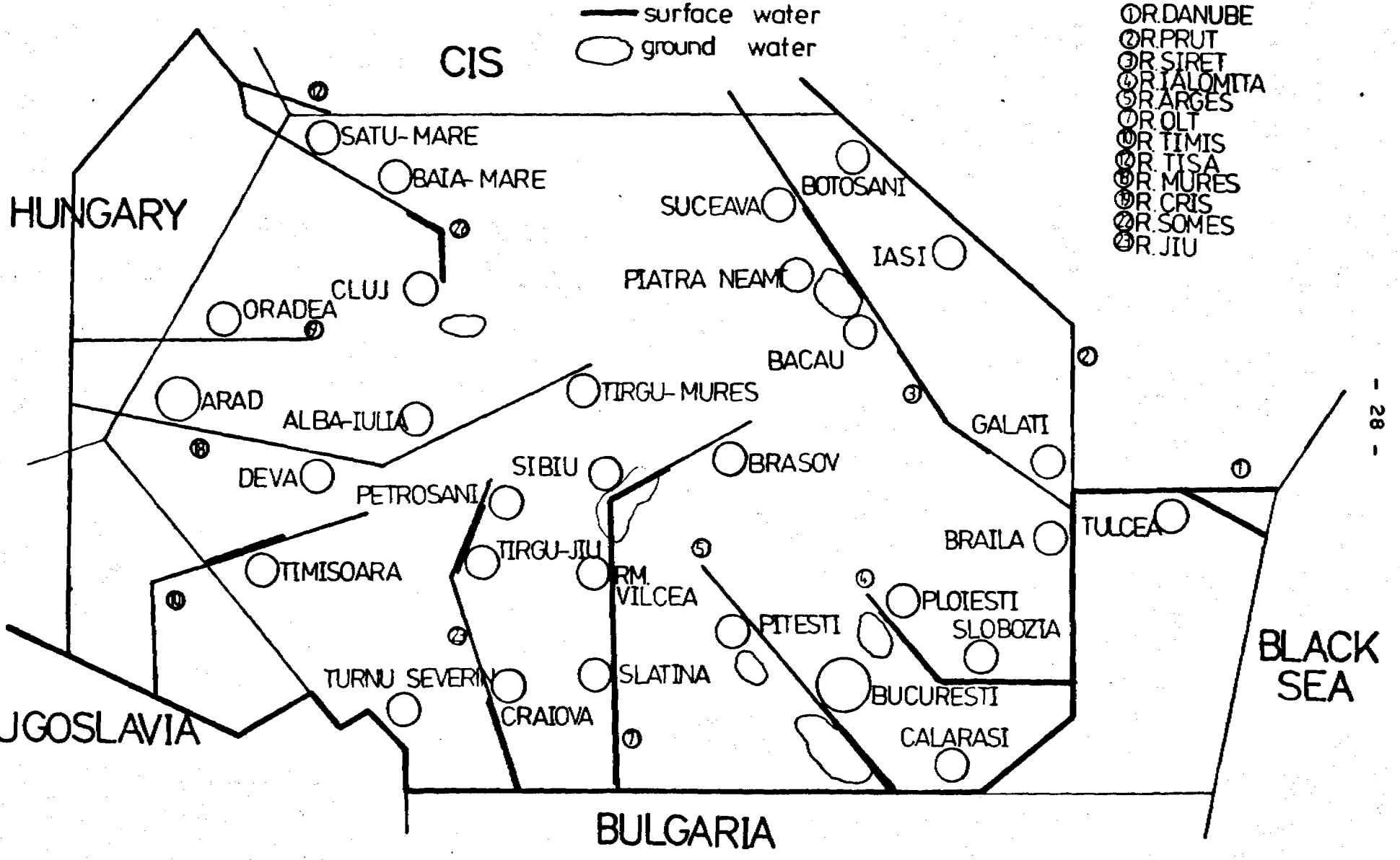
Another major use of water consists in land irrigation. The main irrigated surfaces are located along the inferior river courses as well as along the Danube.

The water pollution problems are similary to the surface sources of urban use.

Because of high concentrations of oil, phenol, chemicals and BOD there are some sectors of the rivers unsuitable for this purpose.

DANUBE EMISSION MANAGEMENT DECISION SUPPORT PROJECT-ROMANIAN DANUBE RIVER BASIN

LOCATION OF MAIN WATER POLLUTION PROBLEMS AREAS



The most polluted courses are Jiu (downstream from Craiova), Argeş (downstream from Bucharest), Olt, Ialomiţa and partially Siret.

2. EMISSIONS AND DISCHARGERS

2.1. Overview

The Danube river is the main wastewaters receiver of Romania. The emissions are received through the tributaries as well as directly from the riversiders. As it was discussed previously the average daily Danube pollution is of about 25,900 tons of suspended solids and 1,890 tons of BOD_5. Almost half of the suspended solids and 1/3 of the BOD_5 represent the contributions of the Romanian tributaries to the Danube pollution.

If the figures concerning the final figures of pollutants for the Danube and tributaries presented in the chapter no 1 are based on scheduled analyses and can be considered as reliable, the adequacy of the data presented for municipal and industrial emissions should be examined with certain degree of aproximation.

The available figures are extracted from the reports of the local sewerage enterprises and the accuracy depends on the purpose and the moment when these reports were prepared. Even a certain relation between the water supplied and the wastewater produced is not compulsory, because some cities as Oradea, Ploieşti, Suceava, Bacău, Botoşani a.o. receive in the public sewerage wastewater from industries which are not supplied through public water network and on the other hand some cities as Dej use the industrial waste treatment plants for their wastewater treatment too.

Is difficult to separate the industrial wastewaters from the urban ones because in most of cases both effluents are collected in the same sewerage.

Under these conditions any records regarding urban or industrial wastewaters can easily include as well wastewaters from the other category.

Moreover, during the dictatorship period, the control of the environmental authorities over the industries was seriously limited and several times the real figures of the industrial pollution rested unknown.

However a certain discussion based on the existing figures is possible and some aspects can be emphasized.

The Danube river water quality is strongly influenced by the polluters brought from the urban, industrial and agricultural water users.

Although exist more than 3,7oo treatment plants, only 6o% of the wastewater is subject of treatment and only 31% is satisfactory treated.

In the last 5 years were observed the following trends:

- a non -significant increase of flow (2-3%);
- a dminishing of the BOD_5 in the urban wastewater;
- a diminishing of the BOD_5/COD ratio which means water less responsive to biological treatment.

Concerning the treatment technologies applied, mechanical and biological treatments are used at nation wide scale.

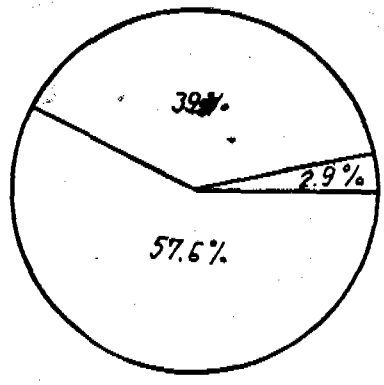
The mechanical treatment consists in screening, grit removal, oil and grease separation and settling. Commonly flocculants are not used for settling, but in some industrial plants chemical treatments can be observed.

The biological treatment consists in more than 95% of cases in aeration basins with activated sludge. The aeration is produced both by pneumatic and mechanical means but aerators are more frequent.

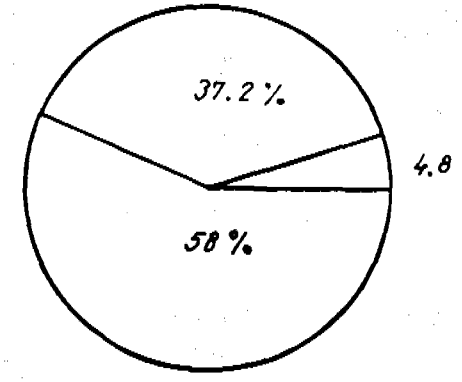
With very few exceptions (color removal at the pulp and paper mill of Adjud, sand filters at Buftea), tertiary treatments are not used.

PERCENTAGE OF THE DIFFERENT CATEGORIES OF SOURCES TO THE GLOBALE POLUTION

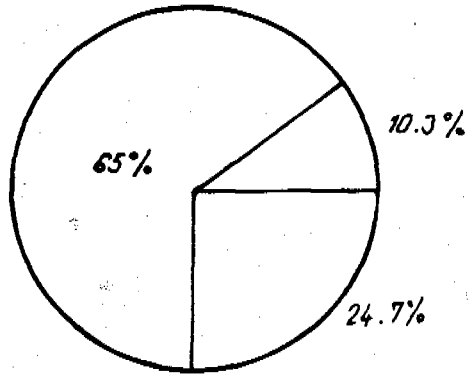
REFERENCE FLOW



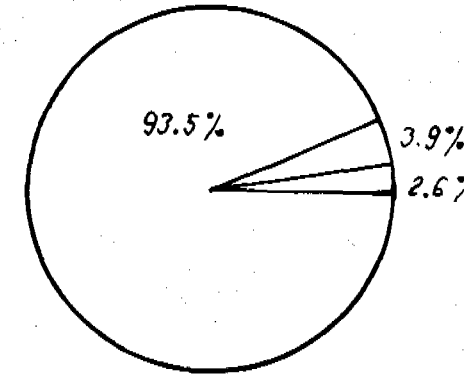
COD - Mn.



BOD_5



SS



LEGEND :

URBAN WASTEWATERS

INDUSTRIAL WASTEWATERS

AGRICULTURAL WASTEWATERS

Advanced technologies as treatments with oxygen, activated carbon filters a.s.o. were never used.

The sludge is treated in 80% of cases by anaerobical digestion, but some plants have aerobic treatment installations. For dewatering, drying beds are of common use but exist also mechanical dewatering systems especially for the paper mills.

Compact units as Imhoffs are still used for smaller communities.

The above described technologies are provided for urban treatment plants as well as for industrial or agricultural plants.

Analysing the sources, the major BOD_5 producers are the municipalities and animal husbandries but the industries are mainly responsable for the suspended solids and dissolved solids production.

According to the surface water quality control records the most critical industrial categories are the chemical industry, the oil and petrochemical industry and the pulp and paper industry.

From the records appear as frequently passing the admissible limits the chemical plants from Rîmnicu Vîlcea (r.Olt), Bacău (r. Siret), the petrochemical plants from Borzeşti, Roznov and Săvineşti (r. Siret), the paper mills from Piatra Neamţ (r. Siret) and Dej (r. Someş) and the fertilizer industries from Tîrgu Mureş (r. Mureş) and Slobozia (r. Ialomiţa).

2.2. Municipal Dischargers

In the Table no 9 are summerized the main municipal dischargers. One mentions that for the ratio km of streets versus km of sewers were considered as sewers the streets provided with sewers and not the total length of the sewerages.

The average efficiency reported by the local enterprises should be considered with precautions.

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Table no.9

MAIN URBAN SEWERAGES

River Basin	Code no.	CITY	Population (thousands)	SEWERAGE		WASTE WATER			EXISTING TREATMENT PLANT			
				Network C=combined S=separative	Km of streets / Km of sewers	Flow cu.m/day x10³	SS kg/day x10³	BOD_5 Kg/day x10³	Nominal capacity -l/s-	Technology M=mechanical B=biological	Average efficiency S.S. reduction	Average efficiency BOD_5 reduction
1	2	3	4	5	6	7	8	9	10	11	12	13
SOMES	22	CLUJ	329.2	C	342/205	130.o	26.0	20.8	1200	M + B	72 %	75 %
		DEJ	41.4	C	121/ 58	21.o	3.2	3.9	230	M	50 %	65 %
		BAIA-MARE	152.4	C	170/ 97	69.2	10.9	7.0	1000	M + B	82 %	83 %
		SATU MARE	137.7	C	135/116	44.9	12.1	9.2	800	M + B	66 %	74 %
CRIS	19	ORADEA	229.0	C	264/247	240.0	86.4	59.3	2070	M + B	84 %	82.5 %
MURES	18	TIRGU MURES	172.5	C	170/132	110.0	34.3	15.5	1200	M + B	50 %	46 %
		ALBA IULIA	73.4	C	182/ 96	31.9	3.8	1.1	225	M	x)	x)
		DEVA	82.3	S	172/ 80	37.0	7.4	3.0	x)	M	x)	x)
		ARAD	203.2	S	385/139	94.0	13.2	8.5	1300	M + B	90 %	90 %
TIMIS	10	TIMISOARA	351.3	C	505/331	186.0	42.8	27.0	x)	M + B	90 %	64 %
JIU	23	PETROSANI	53.1	C	98/ 54	17.8	2.4	0.9	x)	M	65 %	25 %
		TIRGU JIU	92.8	S	81/41	26.0	2.1	2.o	-	-	-	-
		CRAIOVA	317.4	C	284/122	156.o	22.3	14.9	-	-	-	-
OLT	7	BRASOV	364.3	C	322/322	197.0	15.3	12.4	1600	M + B	41 %	25 %
		SIBIU	188.4	C	260/225	44.6	6.3	10.7	1200	M + B	93 %	80 %

Table no.9

MAIN URBAN SEWERAGES (Continuation)

1	2	3	4	5	6	7	8	9	10	11	12	13
		RIMNICU VILCEA	106.9	C	251/134	50.0	2.5	3.0	575	M + B	61 %	70 %
		SLATINA	88.1	C	107/ 53	45.5	3.0	1.6	500	M + B	90 %	90 %
ARGES	5	PITESTI	174.8	S	255/183	165.o	5.8	4.7	1750	M + B	82 %	81 %
		BUCURESTI	2127.2	C	1864/1544	1710.0	331.0	260.0	-	-	-	-
IALOMITA	4	PLOIESTI	259.0	C	426/252	190.0	57.0	15.6	1700	M	50 %	50 %
		SLOBOZIA	52.2	S	160/x)	20.0	4.0	1.6	310	M + B	40 %	50 %
SIRET	3	SUCEAVA	108.0	C	127/110	134.0	30.8	22.8	1760	M + B	86 %	64 %
		PIATRA NEAMT	118.2	C	141/ 91	56.7	22.7	15.8	650	M + B	86 %	90 %
		BACAU	197.2	C	240/146	110.0	42.9	38.3	x)	M + B	64 %	61 %
		GALATI	326.1	C	299/175	185.0	71.0	44.4	-	-	-	-
PRUT	2	BOTOSANI	123.9	C	155/122	115.0	18.8	6.6	1200	M + B	50 %	60 %
		IASI	346.6	C	505/295	350.0	190.0	133.0	3600	M + B	83 %	75 %
DANUBE	1	TURNU SEVERIN	107.5	C	162/ 96	100.0	20.7	15.4	-	-	-	-
		CALARASI	75.8	S	138/ 62	31.0	5.4	5.0	500	M[xx)]	85 %	55 %
		BRAILA	247.9	C	267/170	51.0	5.3	3.7	-	-	-	-
		TULCEA	95.2	C	127/ 80	21.2	5.7	6.1	-	-	-	-

x) data non available

xx) using floculants for sedimentation

Concerning the trends for the municipal dischargers, almost all the professionals agreed that important leakages of water are discharged in sewers and produce the dillution of the waste. It can be foreseen that for water economy reasons the leakage reduction will be one of the most important problems in the future and consequently higher concentrations of pollutants in the municipal wastewater are to be expected.

2.3. Industrial Dischargers

The Table no 1o presents the main industrial dischargers organized and summarized on tributaries basins. The figures include both discharges in urban sewerages as well as industrial discharges in own sewers, so that these data must be considered only as a general information about the industrial pollutants structure.

The figures can neither be added, nor substracted from the urban dischargers figures because they interfere.

Table no 1o

MAIN INDUSTRIAL DISCHARGERS (year 1989)

Tributary basin	Main polluters S.S. t/day	COD-Mn t/day	BOD_5 t/day	Specific polluters t/day
JIU	3957.o	126.2	64.6	
OLT	274.2	218.1	39.8	Cl^- = 863.2
ARGES	331.o	31o.3	95.2	
IALOMITA	1o12.o	262.4	83.6	
SIRET	144.2	522.o	126.4	NH_4^+ = 36.3
PRUT	1o2.2	81.4	34.9	
DANUBE (direct)	1919.o	419.7	148.4	
T o t a l	7739.6	194o.1	592.9	

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Detailing the industrial discharges the situation of each basin results as follows:

2.3.1. River Jiu Basin

The total industrial wastewater flow is of about 800,000 cu.m/day produced by:

- thermal power plants 61.1%
- chemical industry 29.1%
- mining industry 4.9%
- building materials industries 4.9%

A very important flow is used for cooling at the power plants nor being polluted.

2.3.2. River Olt Basin

The total industrial wastewater flow of about 550,000 cu.m/day is produced by:

- chemical industry 77.3%
- pulp and paper 15.1%
- metallurgy 7.6%

The most important polluters are the chlorides (863 t/day) and suspended solids (274 t/day) from the chemical industry.

2.3.3. River Arges Basin

From the total industrial wastewater flow of about 2,000,000 cu.m/day about 1/3 is produced by the various industries of Bucharest which itself represents about 20% of the national industrial potential.

The remaining 2/3 come from:

- oil & petrochemical industry 67.3%
- chemical industry 23.6%
- others 9.1%

BOD_5/COD ratio is about 0.3.

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2.3.4. River Ialomiţa Basin

The industrial flow of about 1,1oo,ooo cu.m/day is produced by:

- oil & petrochemical industry 55%
- chemical industry (fertilizers) 25%
- paper industry 16.5%
- food industry 3.5%

2.3.5. River Siret Basin

The industrial wastewater flow of about 1,7oo,ooo cu.m/day comes from:

- chemical industry 48.7%
- oil & petrochemical 26.6%
- pulp & paper industry 24.3%
- steel plant o.4%

Siret is the most important receiver of organic matters (COD = 52o t/day) of a reduced biodegradability (BOD_5/COD = o.24).

2.3.6. River Prut Basin

River Prut receives about 41o,oo cu.m/day from the various industries of Botoşani and Iaşi cities.

2.3.7. Danube River Direct Dischargers

The Danube river receives directly about 775,ooo cu.m/day industrial wastewater and about 4o,ooo cu.m/day from animal farms.

The industrial flows come from:

- chemical industry 54.7%
- pulp & paper 2o.5%
- mining industry 13.2%
- food 5.8%
- steel 3.3%
- others 2.5%

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2.4. Agricultural and Animal Husbandry Emissions

It is obvious that the use of fertilizers and pesticides for agricultural purposes has a polluting effect but no records are available in this field.

We mention only that important animal husbandries (pigs farms over 5o - 7o,ooo capita) are located near Timişoara (Timiş), Cluj and Baia Mare (Someş), Oradea (Criş), Craiova (Jiu), Slatina (Olt), Slobozia (Ialomiţa), Bacău and Galaţi (Siret), Iaşi (Prut), Călăraşi (Danube). Although equiped with wastewater treatment plants these farms are generating very often pollution problems, because of training failures.

Although the up-to-date tendencies are to avoid such enormous animal concentrations the problem of pollution will remain because smaller farms will be even worse operated from the point of view of wastewater treatment.

3. CONCLUSIONS AND RECOMMENDATIONS

3.1. Summary Conclusions on Conditions and Trends

The social, economic and demographic development of the Danubian riverside countries in the last 25 years as well as the hydroelectric works achieved have determined unfavorable effects on the water quality.

The increase of the nutrients concentration values and of the N/P ratio have determined an important plankton production development which registred in the past 2o - 25 years a growth of about loo times.

The dissolved oxygen has reduced of 25' - 3o% and under these circonstances the capacity of the river as receiver of wastewater becomes limited.

Meantime the values of N/P ratio tend to lo, which indicates the beginning of an important eutrophication and consequently a more severe dissolved oxygen reduction.

The situation is even worse for the tributaries, which present higher levels of pollution.

3.1.2. Water Quality and Emissions Monitoring and Control

The actual wastewater treatment plants can't achieve a proper monitoring and control of the polluting emissions for several reasons as:

- the insufficiency of the existing treatment facilities;
- the overloading of the existing capacities;
- the failure in operating the existing plants;
- the absence of a modern informational system at the national level;
- the absence of a suitable budget able to support important improvements.

3.1.3. Emission and Dischargers

As it was related in the chapter no 2, still exist important urban centers and industries without wastewater treatment plants as Bucharest, Craiova, Galaţi and many others which have insufficient capacities. Only 31% of the emissions are properly treated.

Meantime the diminishing of the BOD_5/COD ratio values indicates more difficulties in biological treatment.

3.1.4. Key Difficulties

As key difficulties one considers the lack of wastewater treatment capacities and the financial support for serious improvements in this field of activity.

3.2. Recommendations

3.2.1. Pollution Management Actions Needed

The practice has demonstrated that even states with a powerful economy and an intensive care for environment needed time and a good financial support in order to control the waste emissions.

It is also obvious that the pollution in the Danube river basin reached alarming levels and quick decisions should be taken.

In our oppinion correct decisions can be obtained only by the international co-operation of all the riverside countries and other interested partners in environment protection.

Meanwhile it is absolutely sure that under the actual circonstances of the economy the Government of Romania is not able to achieve from the budget an investment programme able to bring a serious improvement in wastewater treatment, thus the only viable solution is an external financial support as foreign aids or/and foreign loans for this purpose.

From the Romanian side one may count on private studies and consulting groups as INGINERIE URBANA, but also on some state studies and research institutes experienced in this field as:

- The Institute of Research and Environmental Engineering Bucharest, Splaiul Independenţei nr. 294, sector 2, tel. 90-373060;
- PROED S.A. - Projects and Studies Institute for Public Works Bucharest, str. Tudor Arghezi nr. 21, sector 2, tel. 90-118444, fax 90-121801.

3.2.2. High Priority Pollution Reduction Improvements Needed

In the actual conditions one may appreciate that any measure able to reduce the Danube pollution is opportune. It

should be mentioned that the project for the Bucharest wastewater treatment plant was completed and the construction works on site were started and interrupted because of lack of founds.The wastewater treatment plant of Craiova is in a similar situation.

The continuation and the completion of these two treatment plants should bring by themselves a reduction of more than 2o% of the total contribution of all the Romanian tributaries to Danube pollution and meantime is the quickest action can be done.

For this reason the completion of works at these two treatment plants can be considered as a high priority in Danube pollution reduction.

On long term the trends in industrial pollution are almost unpredictable because the major future changes in the economic structure of the country. Under these circonstances a general study with the participation of the ministries of Environment, Economy and Industries, Trade and Tourism, Transports and Public Works in order to settle properly this matter is also a high priority problem.

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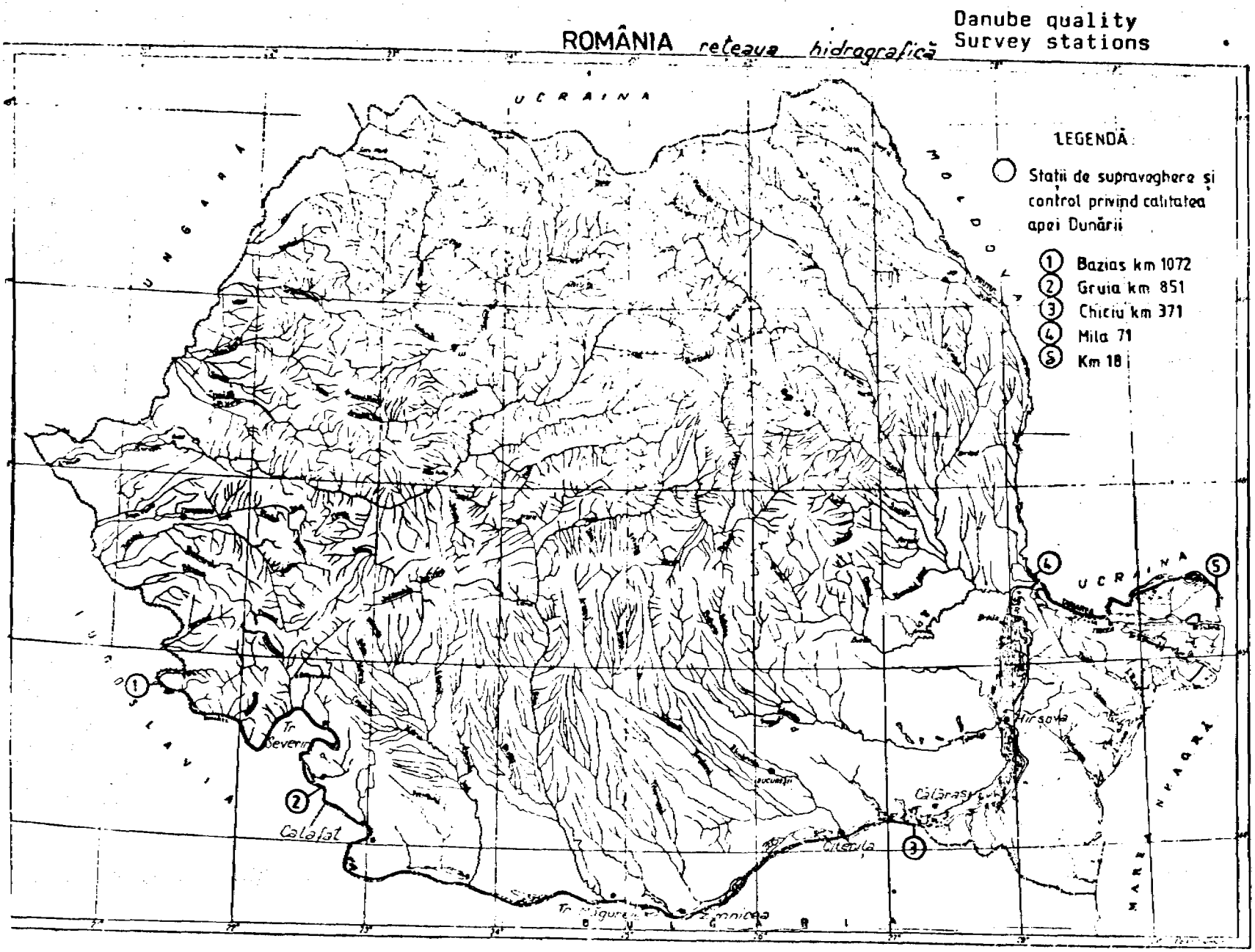
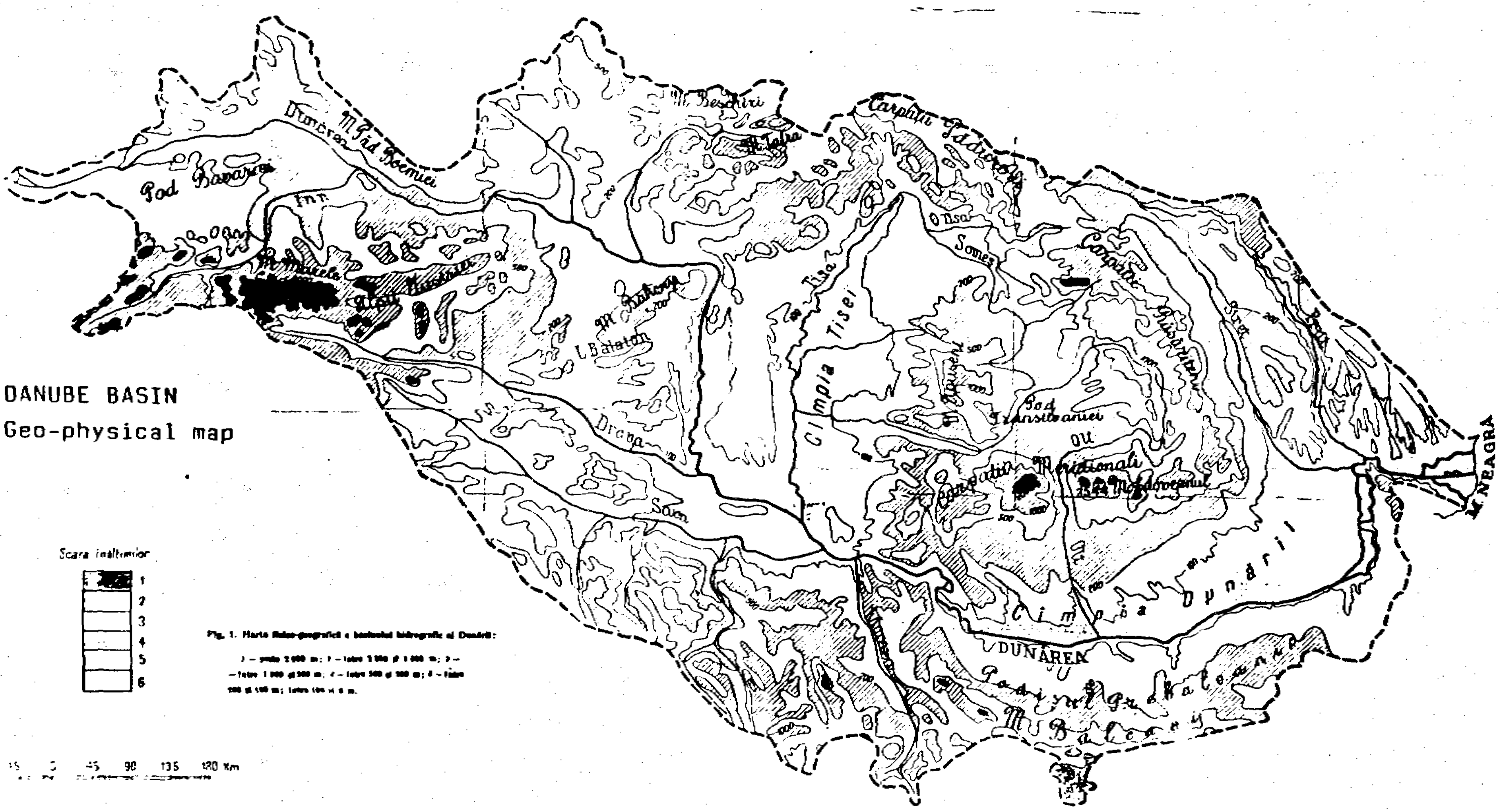

ROMÂNIA rețeaua hidrografică
Danube quality
Survey stations
UCRAINA
LEGENDĂ
Stații de supraveghere și control privind calitatea apei Dunării
1 Bazias km 1072
2 Gruia km 851
3 Chiciu km 371
4 Mila 71
5 Km 18
Tr. Severin
Calafat
Călărași
Hîrșova
MAREA NEAGRĂ

Fig nr 2.

DANUBE BASIN
Geo-physical map



Scara înălțimilor
1
2
3
4
5
6

Fig. 1. Harta [illegible]

15 0 45 90 135 180 Km

Desenat L. Sănduie

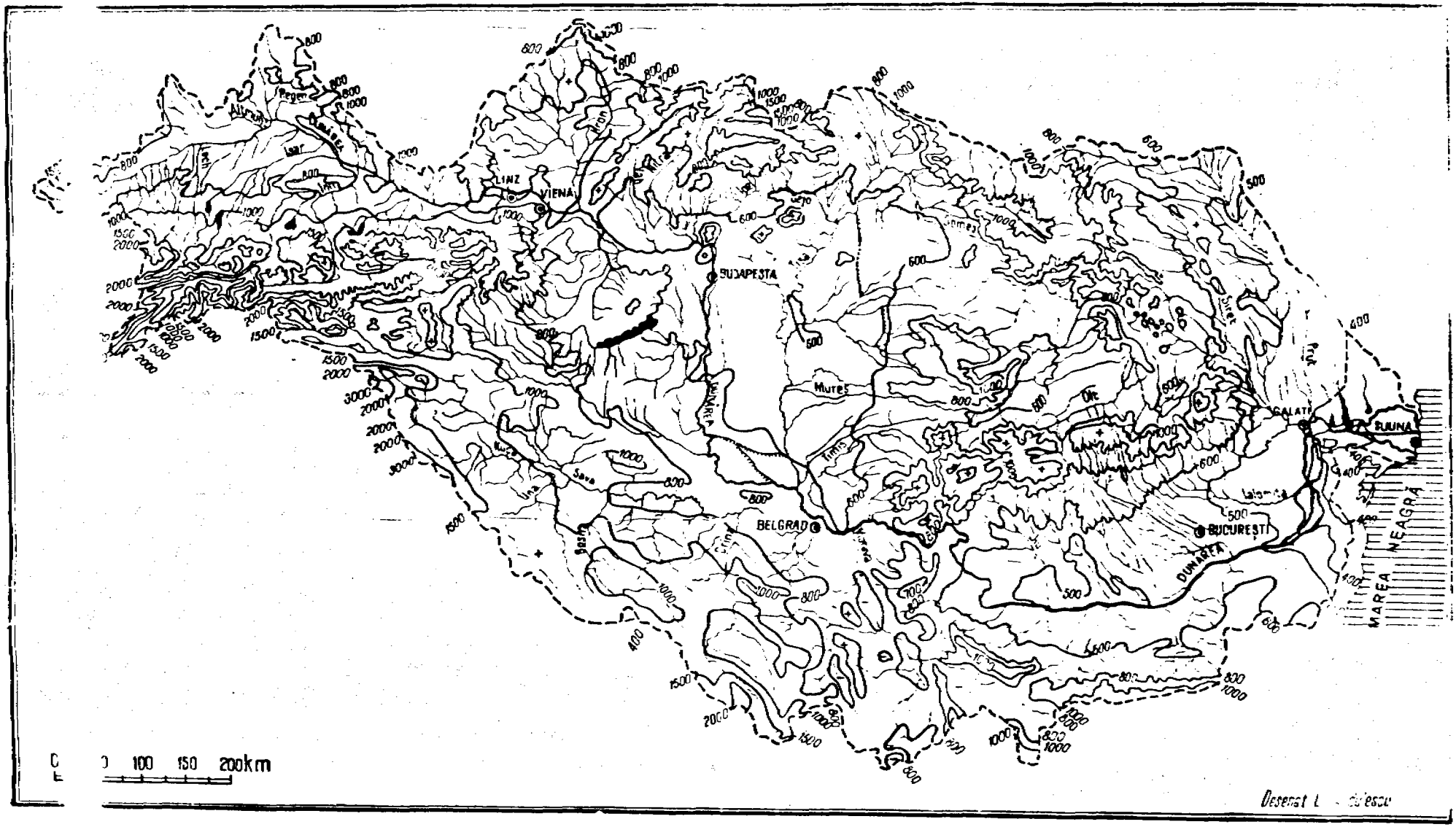


Fig. 3. Harta repartiției teritoriale a precipitațiilor medii multianuale.

DANUBE BASIN
Average multi-year
Rainfalls distribution