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WATER POLLUTION ABATEMENT PROGRAMME

THE CZECH REPUBLIC

PROJECT 3.3

The Quality of the Odra River According to International Classification of Water Quality

Project Report for Phase I and Programme of Work for Phase II

NIVA - REPORT

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Abstract:

The chemical and biological monitoring data of water from the rivers Ostravice, lower reaches of Odra and Olse have been used in comparing water quality systems of the Czech Republic, Norway, USA, Canada and the European Community. Only the Czech and the Norwegian systems have different classes of water quality. The classification of suitability of the surface water for specific uses is an important part of the Norwegian system which is not found in the other systems. The different systems give different results demonstrating that the systems are developed from different standpoints, and designed to meet national requirements. However, in some cases adjustments in the criteria/class values of certain parameters should be considered. Macroinvertebrates are used in the biological monitoring of rivers in the Czech Republic. The commonly used Saprobic Index are compared with the British BMWP index. Proposals on future work are presented.

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Project 3.3

THE QUALITY OF THE ODRA RIVER ACCORDING TO INTERNATIONAL CLASSIFICATION OF WATER QUALITY

Project Report for Phase I and Programme of Work for Phase II

Oslo, February 1993

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Preface

The Governments of Norway and the Czech and Slovak Federal Republic have signed a bilateral environmental protection agreement. As part of this agreement several collaborative projects have been identified. The permanent Norwegian - Czechoslovak working group for the protection of the environment has discussed these projects and decided to contract Norwegian Institute for Water Research (NIVA) in co-operation with the Water Research Institute Prague (WRY) and the Institute of Industrial Landscape Ecology (IILE), Strata to execute several projects under programme area "Abatement strategies in the River Odra catchment".

One of the projects is "The Water Quality of the Odra River According to International Classification of Water Quality". The project is executed jointly by Norwegian Institute for Water Research (NIVA), Povodi Odry (P.O.), T.G. Masaryk Water Research Institute - Ostrava branch (WRI-O) and Brno branch (WRI-B), and Institute of Industrial Landscape Ecology (IILE). Each institution has appointed key staff responsible for the execution of the project. The Czech team members are Ing. Petr Brezina (P.O.), Ing. Jiri Svrcula (WRI-O), Dr. Michael Fiala (WRI-B),and Dr. Alexandr Skacel (IILE). The Norwegian team members are Senior Researchers Karl Jan Aanes and Hans Holtan, and Researcher Torleif Bækken, all at NIVA. The Norwegian contact person is Torleif Bækken.

Oslo, February 1993

Torleif Bækken

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1. Objectives of the project

The main long term objective of the project is:

- to develop a tool for the assessment of environmental quality of rivers in the Odra catchment area, using physio-chemical and biological data.

Short term objectives:

- to organise a co-operating work team which include meetings, discussions and surveys in the Czech Republic and Norway.

- to compare water classification systems in the Czech Republic with common water quality criteria and classifications in Norway, EC, USA and Canada.

- to compare the environmental state of selected profiles (sites) of rivers within the Odra cathment area, using the methods developed in the Czech Republic, Norway, EC, USA and Canada on the Czech data sampled during 1991.

- to evaluate the quality of existing data and their precision to describe the environmental quality of the rivers, and if needed to specify additional parameters to fit a system for assessment of environmental quality of rivers.

2. Study area.

The Czech part of the Odra river basin covers an area of about 6250 km2. This is approximately 5 percent of the total catchment area of the Odra river. The river has a total length of 854 km of which 120 km is within the Czech Republic. The main river Odra is fed by numerous tributaries before it flows into Poland (Figure 1). The mean annual water flow at the Polish border is 43.3 m^3/s. Another 12.5 m^3/s comes from the river Olse. The Olse rises on the territory of Poland and it terminates in the territory of The Czech Republic. Its length in the Czech territory is about 87 km. including 25 km state border with Poland.

The number of inhabitants of the area are about 1.4 million and is expected to increase. About 1 million live in urban areas. The biggest city of the region is Ostrava having a population of 330.000.

3. Water quality.

45 profiles within the Odra catchment area are monitored regularly and a long list of water quality parameters are measured. In addition to physical and chemical parameters biological parameters are used as well.

Approximately 10.500 tons BOD5 and about 18.300 tons insoluble substances (TSS) are annually drained off into the water courses of the Odra River Basin.

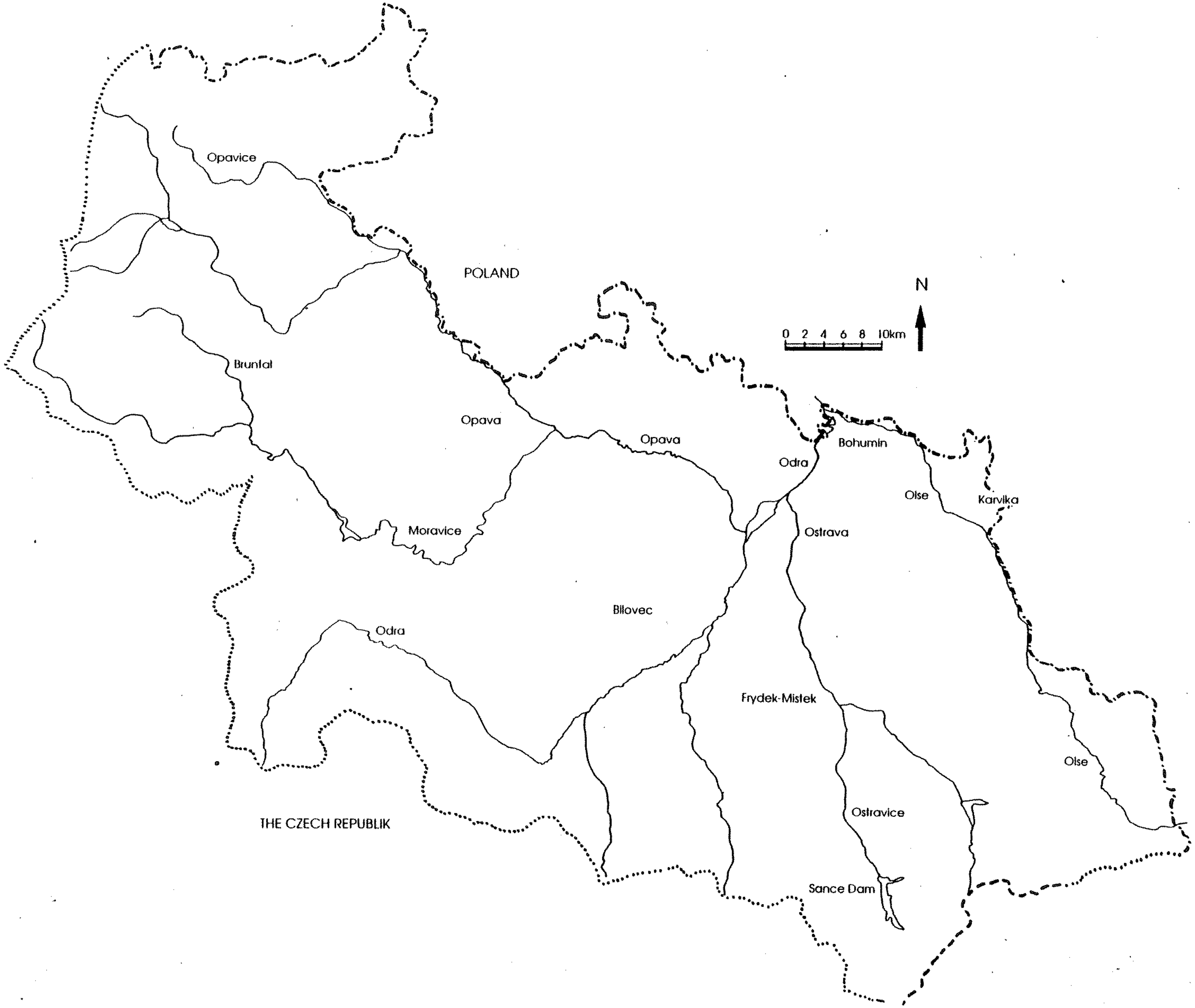
Upper parts of main tributaries of the Odra (the rivers Opava, Ostravice and Olse) incl. the Odra itself have positive oxygen proportions, water there is characterised as very clear or clear. The pollution with undissolved substances and bacteria under the influence of erosions and recreation is a negative fact, but the streams get balanced with it quite well.

Mean parts of main tributaries of the Odra, incl. the Odra itself have considerably worse quality of water under the influence of greater industrial and urban centres (mainly the organic and bacterial pollution), that is caused by the insufficient capacity of water purification plants. The pollution caused by agriculture is conspicuously shown up there.

After the ingress of the Odra into Ostrava industrial conurbation, the quality of its water is considerably worsen, because there is a dense concentration of industry and built-up area there. The Odra River takes in its main affluents here.

The Odra River takes in the Ostravice from the south. This river is very polluted, with high inorganic and organic content as well as bacterial pollution.

A considerable tributary of the Odra cathment area is the Olse River which is extremely polluted, but it does not influence the quality of water in the Odra in the territory of The Czech Republic. It is significant as a border stream, because it brings the pollution into Poland. The river brings the pollution from Poland as well as from The Czech Republic. Important collectors lead into the Olse that bring the salty waters from coal mines and they influence the quality of water in the inorganic characteristics. The organic pollution also is considerable.



Figur 1. The Czech part of the catchment area of the Odra River.

4. Water quality criteria and classification.

The need for evaluation of the environmental quality with regard to surface water has made it necessary to make criteria, standards and classifications for pollutants in the aquatic environments. A criteria value gives a guideline for the concentration of a specific parameter that should not be exceeded. The principle of classification of water quality is based on the comparison of measured values of parameters with directives corresponding to an environmental evaluation.

A useful tool in the management of water resources is a system using accepted water quality criteria and classification standards for the degree of pollution in water. A good system should help in the assessment of environmental quality and degree of pollution, give guidelines for the suitability of waters for specific uses, give backgrounds for the requirements of remedial actions and be used when monitoring effects of reduced or increased pollution on a short and long time scale. Many of the rivers in The Czech Republic are heavily polluted and management of these water resources will be of great interest in the years to come.

There are two main methods for the assessment of water quality, the biological and the physico-chemical. The biological methods integrate ecological effects of pollution over some period of time, whereas chemical measurements give information of the quantity of different pollutants in the water at one particular moment. A combination of physico-chemical and biological techniques are the most preferable.

Although biological measurements are often used in the assessment of water quality, it is not a common system of biological techniques within the USA, Canada, EC or Norway. However, different systems using macro invertebrates of the benthic fauna are most commonly used. Only the British BMWP- index (Biological Monitoring Working Party) and the Saprobic Index (regularly used in The Czech Republic) will be considered here.

In general the different systems in use in The Czech Republic, in Norway, in the European Community, in USA (EPA), in Canada (CCREM) and other countries, are developed from different standpoints and are largely designed to meet national requirements. It is important to be aware of this fact when the different systems are compared. Mostly criteria for the protection of some kind of freshwater life is considered in this text. A general and brief description of some systems are given below.

4.1 EPA

The Environmental Protection Agency (EPA) has developed water quality criteria for USA. The EPA has not developed a system for the classification of the water quality. Only criteria for the protection of aquatic life will be considered here. There are two kind of criteria values: 1) the CCC- values (Criterion of Continuous Concentration) and 2) the CMC-values (Criterion of Maximum Concentration). CCC is the upper limit for a 4-days average concentration, and CMC is a maximum for 1-hour average, non of which shall be exceeded more than once every 3 years.

The criteria values are set to protect freshwater life and environments of aquatic organisms, and secure the use of commercial and recreational important species. The criteria do not intend to protect every single species all the time. The statistical methods used in the calculation of the values aim at protecting 95% of the species, including those potentially important from a commercial and angling point of view.

The CMC and CCC - criteria values are based on data from acute and chronic toxicity tests. In addition to the strict procedure of calculating the CMC and the CCC values, other important and relevant information may be taken into consideration before the final criteria values are determined.

As the toxicity of some heavy metals may vary with the content of calcium, different criteria values are calculated for each metal in relation to the $CaCO_3$ content. Examples with 50 and 100mg $CaCO_3$/l are given in the appendix.

4.2 CCREM

The criteria or guidelines for Canadian freshwater CWQG (Canadian Water Quality Guidelines) are based mainly on the work of EPA. However, the Canadian criteria intend to protect every single species all the time. There is just one criteria value for each parameter that should not at all be exceeded. The values are mostly set below EPA values for chronic criteria, and are often based on "no effect levels" tests on sensitive species. When such test are not available acute tests may be used together with a security factor of 0,01, which means that 0,01 times the acute test value is used as the criteria value.

In relation to some heavy metals the criteria vary with the calsium content mostly as for EPA (appendix).

4.3 EC

The EC has worked out water directives, water quality criteria (guidelines) for different use of surface waters. The Water Research Center of UK have made proposals for water quality criteria using different criteria values for the protection of salmonids, other kind of fish and freshwater life in general. These criteria and drinking water criteria are presented in the appendix.

In relation to some heavy metals, the protection of freshwater life and different kind of fishes, there exist different classes depending on the content of $CaCO_3$ (appendix).

There is no common water quality classification system of the EC, however many of the individual member states have such systems.

4.4 The Norwegian system for surface water classification.

Only the water quality classification will be considered here.

The Norwegian system is based on three principles:

1) the classification of the present situation, without deciding if the situation is natural or a polluted one.

2) The classification of the degree of pollution; this is the difference between a measured or assumed natural, background situation, and the present situation,

3) the classification of the suitability for applications; the suitability for the water quality as drinking water, water for irrigation, recreation, aqua culture, angling and so on.

Six kinds of pollution are considered, and each of these are characterised by one or more parameters:

A. Kind of pollution	B. Most common chemical and micro biological parameters
Eutrofication	tot.P, tot.N, Secchi
Organic matter	TOC, CODMn, Colour, Oxygen, Secchi
Acidification	Alkalinity, pH
Toxic effects	Heavy metals
Particles	Turbidity, Suspended matter
Microbiology	Thermotol. colif. bacteria

The water quality classes for a number of parameters are shown in table 1. For each parameter in the table of water quality classes there is superimposed a scheme with four classes of suitability classifying the suitability of the water quality for specific uses (appendix).

Although criteria values for some specific uses of the surface water exist in most systems as guidelines that should not be exceeded, the Norwegian kind of suitability evaluation is not considered in any of the other mentioned classification systems.

4.5 The Czech criteria and system for classification of surface water.

A criteria value gives a guideline for the concentration of a specific parameter that should not be exceeded. The Czech water quality criteria for potentially drinking water supply streams and other surface water have recently been revised. The water managing authorities are obliged to consider effects on biological parameters as benthic macro invertebrates, salmonid and cyprinid fish, self purification ability, biodiversity and productivity, as well as concentrations of chemical substances (appendix) when deciding on discharging waters. The obligation of these measures will be set down consecutively regarding on water protection interests and on local hydrological conditions. Parameters presented in appendix express the surface water contamination in 355 day flow rate or in the minimally guaranteed flow rate in the water course and after a mixing with waste waters or special waters.

The principle of classification of water quality is based on the comparison of measured values of parameters with directives corresponding to an environmental evaluation. The concentrations of certain parameters are divided into intervals. As a basis for a classification is some knowledge of the concentrations of some pollutant relative to background values and of the effects of toxicants to the environment. To day The Czech Republic has two classification systems; one national and one for the water pollution at the borders to foreign countries. The second one is developed as a COMECON system and will not be considered in further detail.

The parameters for water quality used in the Czech Republic are divided into 6 groups:

1. Oxygen parameters
2. Basic chemical and physical parameters
3. Additional chemical parameters
4. Heavy metals
5. Biological and micro biological parameters
6. Radioactive parameters

The quality of water is divided into the following 5 classes accompanied with suitability for applications:

I class - very clear water, usually suitable for application;
II class - clear water, suitable for the majority of applications;
III class - polluted water, suitable for supply of industry only;
IV class - very polluted water, suitable only for limited applications;
V class- extremely polluted water, unsuitable for any application

Tables with parameters and class criteria are shown in the table 1 and the appendix. The classification of water quality according to each parameter into the particular group for water quality is performed by comparing the calculated 90 percentile value of at least 24 measurements for this parameter with the interval of values characteristic for each water quality class.

Table 1. Water quality classes in The Czech Republic and Norway.

	I		II		III		IV		V	
	N	C	N	C	N	C	N	C	N	C
Tot P µg/l	<7	<30	7-11	30-150	11-20	150-400	20-50	400-1000	>50	>1000
Tot N µg/l	<250		250-400		400-550		550-800		>800	
TOC mg/l	<2,5	<5	2,5-3,5	5-8	3,5-6,5	8-11	6,5-15	11-17	>15	>17
CODMn mg/l	<2,5	<5	2,5-3,5	5-10	3,5-6,5	10-15	6,5-15	15-25	>15	>25
O2 mg/l	>9	>7	6,4-9	6-7	4-6,4	5-6	2-4	3-5	<2	<3
%O2	>80		50-80		30-50		15-30		<15	
Alk mmol/l	>0,2		0,05-0,2		0,01-0,05		<0,01		0	
pH	>6,7		6,2-6,7		5,7-6,2		5,3-5,7		<5,3	
Cu µg/l	<2	<20	2-5	20-50	5-15	50-100	15-50	100-200	>50	>200
Zn µg/l	<10	<20	10-30	20-50	30-60	50-100	60-110	100-500	>110	>500
Cd µg/l	<0,04	<3	0,04-0,1	3-5	0,1-0,2	5-10	0,2-0,5	10-20	>0,5	>20
Pb µg/l	<1	<10	1-3	10-20	3-5	20-50	5-10	50-100	>10	>100
Ni µg/l	<3	<20	3-10	20-50	10-30	50-100	30-100	100-200	>100	>200
Cr µg/l	<1	<20	1-3	20-100	3-10	100-200	10-50	200-500	>50	>500
Hg µg/l	<0,01	<0,1	0,01-0,04	0,1-0,2	0,04-0,1	0,2-0,5	0,1-0,3	0,5-1,0	>0,3	>1,0
Al µg/l	<5		5-20		20-50		50-100		>100	
Fe mg/l	<50		50-100		100-300		300-600		>600	
Mn mg/l	<20		20-50		50-100		100-150		>150	
Turb FTU	<0,5		0,5-1		1-2		2-5		>5	
Susp mg/l	<1,5		1,5-3		3-5		5-10		>10	
Term coli/100 ml	<5	<20	5-10	20-200	50-500	200-2000	500-1000	2000-20000	>1000	>20000

5. Water quality of the river Ostravice, the River Olse and Odra downstream Ostrava.

5.1. Concentrations of heavy metals in relation to the criteria of EPA, CCREM and EC.

The heavy metals at some sites of the rivers were compared to the criteria of EPA, CCREM and EC. The sites are seen in figure 2. For EPA and CCREM the maximum value of 12 samples in 1992 is compared to the chronic criteria and two classes of $CaCO_3$. For the EC values for the protection of salmonid fishes have been chosen. For copper and zink 95 percentiles were used, whereas for the other metals annual average are used.

The values presented in table 2 show that the different methods/criteria give very different results. The EPA and CCREM criteria are exceeded many orders of magnitude for Cu, Zn, Cd, Pb and Hg at almost every site, whereas the EC and the Czech criteria are exceeded only at a few sites for some metals. In particular there are important differences for the mercury criteria. At the most the mercury values were 142 times the magnitude of the EPA criteria at Olse Ropice. At the same site the CCREM, EC and Czech showed 17, 0,6 and 1,7 times the criteria value, respectively. Certainly the EC and the Czech criteria is too low as it is more than 100 times higher than natural background values. As mercury is regarded a very toxic metal and accumulates in the food chain it is important to be aware of this fact. An accompanied value of the EC mercury criteria regarding accumulation in fish is however much more strict (0,3 mgHg/kg) and would correspond to a lower water criteria value.

The EC criteria seem to pay relatively more attention to the Cu and Zn- concentrations.

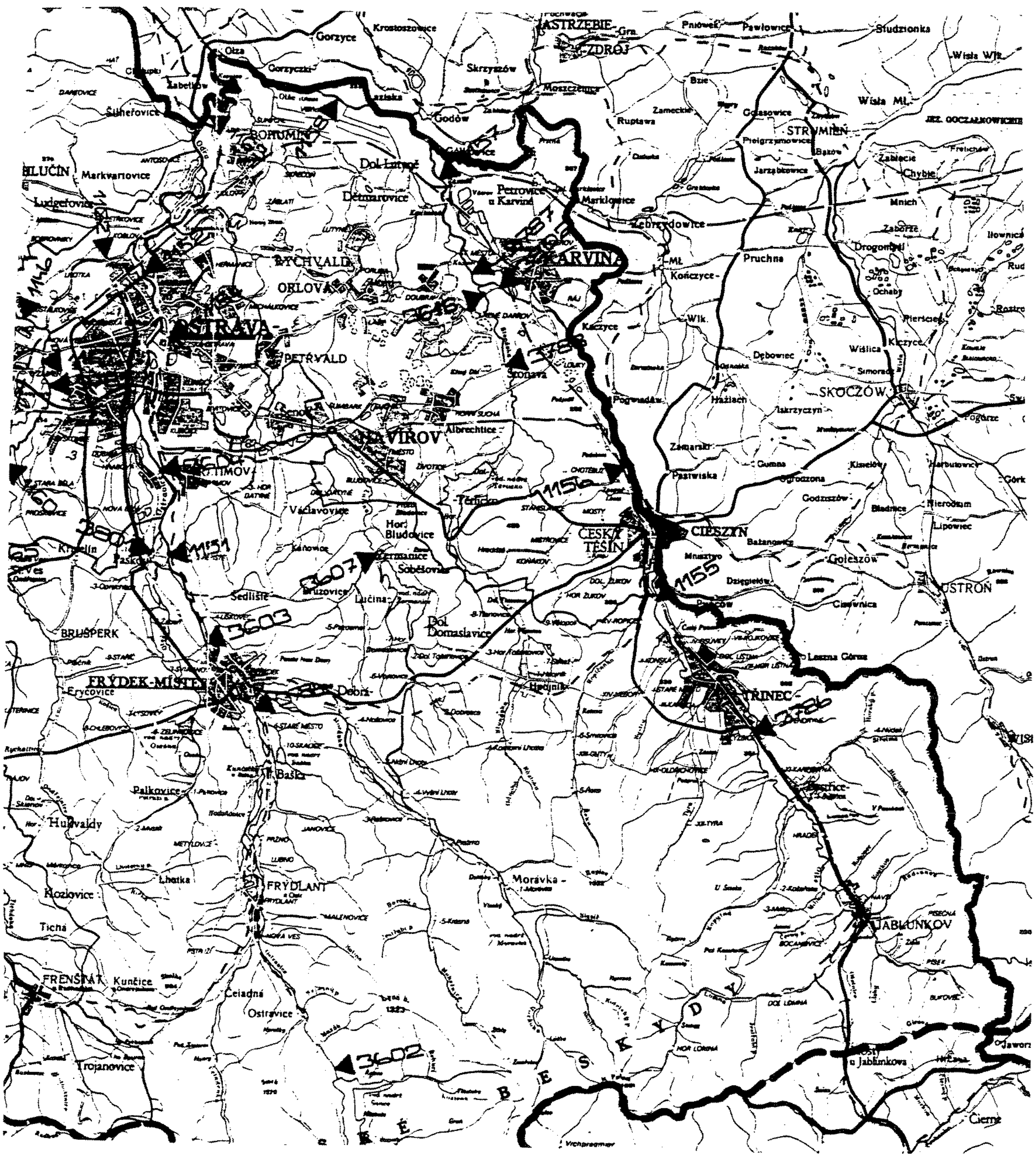


Figure 2. Map of the Ostrava region with sampling sites of the rivers Ostravice and Olse.

Table.2. The concentration of heavy metals relative to the criteria in two classes of calcium content of waters. Location of sites are shown in figure 2 .(continues next page)

Ostravice, Liskovec, 3603

Parameter	EPA (CCC)		CCREM		EC (Salmonids)		C
$mgCaCO_3/l$	50	100	0-60	60-120	0-50	50-100	
Cu	2,6	1,4	8,5	8,5	<2,8	0,6	0,2
Zn	0,9	0,5	1,9	1,9	1,3	0,2	0,6
Cd	4,5	2,7	15	3,8	0,45	0,45	0,2
Pb	-	-	-	-	-	-	
Ni	0,15	0,06	0,5	0,2	<0,2	<0,1	
Hg	50	50	6	6	0,26	0,26	0,6
Fe	0,1	0,1	-	-	-	-.	
Mn	0,025	0,025	-	-	-	-	

Ostravice, Muglinov, 1152

Parameter	EPA (CCC)		CCREM		EC (Salmonids)		C
$mgCaCO_3/l$	50	100	0-60	60-120	0-50	50-100	
Cu	2,9	1,6	9,5	9,5	3,2	0,7	0,2
Zn	4,4	2,3	8,6	8,6	8,1	1,2	2,6
Cd	12	7,3	40	10	1	1	0,5
Pb	23	9,4	30	15	5,3	2,1	0,3
Ni	0,39	0,2	1,4	0,5	0,4	0,2	
Hg	42	42	5	5	0,28	0,28	0,5
Fe	0,164	0,164	-	-	-	-	
Mn	0,450	0,450	-	-	-	-	

Olse, Ropice, 1155

Parameter	EPA (CCC)		CCREM		EC (Salmonids)		C
$mgCaCO_3/l$	50	100	0-60	60-120	0-50	50-100	
Cu	2,6	1,4	8,5	8,5	3,2	0,7	0,2
Zn	2,2	1,2	4,3	4,3	3,4	0,5	1,3
Cd	7,5	4,5	25	6,3	0,7	0,7	0,3
Pb	15	6,3	20	10	-	-	0,2
Ni	0,17	0,1	0,6	0,2	0,25	0,12	
Hg	142	142	17	17	0,6	0,6	1,7
Fe	0,67	0,67	-	-	-	-	
Mn	0,14	0,14	-	-	-	-	

Table 2 continued.

Olse, 1156

Parameter	EPA (CCC)		CCREM		EC (Salmonids)		C
$mgCaCO_3/l$	50	100	0-60	60-120	0-50	50-100	
Cu	2,3	1,3	7,5	7,5	3,0	0,7	0,15
Zn	1,6	0,8	3,1	3,1	2,5	0,4	0,9
Cd	7,6	4,5	25	6,3	0,7	0,7	0,3
Pb	15	6,3	20	10	-	-	0,2
Ni	0,2	0,1	0,7	0,3	0,26	0,13	
Hg	67	67	8	8	0,37	0,37	0,8
Fe	0,74	0,74	-	-	-	-	
Mn	0,15	0,15	-	-	-	-	

Olse, Vernovice, 1158

Parameter	EPA (CCC)		CCREM		EC (Salmonids)		C
$mgCaCO_3/l$	50	100	0-60	60-120	0-50	50-100	
Cu	3,5	1,9	11,5	11,5	4,4	1	0,2
Zn	2,7	1,5	5,3	5,3	3,6	0,5	1,6
Cd	32	19	105	26	3	3	1,4
Pb	31	13	40	20	7	2,8	0,4
Ni	0,7	0,4	2,6	0,9	0,8	0,4	
Hg	133	133	16	16	0,38	0,38	1,6
Fe	0,68	0,68	-	-	-	-	
Mn	0,30	0,30	-	-	-	-	

Odra, Bohumin, 1163

Parameter	EPA (CCC)		CCREM		EC (Salmonids)		C
$mgCaCO_3/l$	50	100	0-60	60-120	0-50	50-100	
Cu	5,1	2,8	16,5	16,5	4,2	0,9	0,3
Zn	22	12	44	44	39	5,6	13
Cd	10,6	6,4	35	9	1,1	1,1	0,5
Pb	38	16	50	25	5,8	2,3	0,5
Ni	0,4	0,2	1,5	0,5	0,4	0,2	
Hg	42	42	5	5	0,28	0,28	0,5
Fe	0,03	0,03	-	-	-	-	
Mn	0,94	0,94	-	-	-	-	

5.2 Classification using the Norwegian and the Czech system.

The present state of the eutrofication parameters, P and N, the organic matter as measured by COD_{Mn} and the bacterial situation were in the IV (bad) or V class (very bad) at all sites of the Ostravice, Olse and Odra Bohumin seen from the Norwegian point of view. Also the Czech classification gave a high class of water quality for these parameters at most sites. However most often one lower class than proposed by the Norwegian system. When looking at the heavy metals, the same pattern appears, but with greater differences between the Norwegian and the Czech classes.

The Norwegian system has not told about the pollution because the pollution is defined as the difference between the observed values and the natural, background values. Surely the background values in this area are higher than in Norwegian surface waters.

Also the suitability classes of the Norwegian system give high numbers. At almost every site the concentrations of P, N and COD_{Mn} is so high that the water is regarded as unsuitable for all the mentioned applications. This would also to some degree apply to the Czech system that also give application guidelines to the water quality classes.

For the heavy metals the situation is almost the same. At least some of the metals have so high concentrations that the water is regarded as unsuitable for most applications.

Table 3. Values, water quality classes for the present state (I-V) and the suitability classes for different uses (1-4) for the Norwegian system compared with the present state classes as seen by the Czech system. Results based on selected parameters from measurements during 1992. Location of sites are shown in figure 2 .
(continues on next pages)

Ostravice down reservoir source, 3602

Norwegian system

	P	N	COD	O2	O2 %	ALK	pH	Cu	Zn	Cd	Pb	Ni	Cr	Hg	Fe	Mn	SS	COLI
Values	35	3580	6,8	8,8	90	0,5	7								400	290		130
Present state	IV	V	IV	II	I	I	I								IV	V		III
Water supply	4	4	4	2	1	1	1								3	4		3
Irrigation	3	3	2	1	1	1	1								3	4		2
Bathing	4	4	3	1	1	1	1								2	3		2
Fish farming	4	4	4	1	1	1	1								4	4		3
Fishing	3	4	3	1	1	1	1								3	4		3

Czech system

	P	N	COD	O2	O2 %	ALK	pH	Cu	Zn	Cd	Pb	Ni	Cr	Hg	Fe	Mn	SS	COLI
Values	73	6200	4,7	9,3		7,1-7,8									310	180	42	0,83
Present state	II		I	I		I									I	III	III	II

Ostravice up Moravka river, 3784

Norwegian system

	P	N	COD	O2	O2 %	ALK	pH	Cu	Zn	Cd	Pb	Ni	Cr	Hg	Fe	Mn	SS	COLI
Values	240	4000	6,7	8,6	60	0,7	7,2								2210	75		15000
Present state	v	v	iv	ii	ii	i	i								v	iii		v
Water supply	4	4	4	2	2	1	1								4	2		4
Irrigation	4	4	2	1	1	1	1								4	2		4
Bathing	4	4	3	1	1	1	1								4	1		4
Fish farming	4	4	4	2	2	1	1								4	3		4
Fishing	4	4	3	1	1	1	1								4	2		4

Czech system

	P	N	COD	O2	O2 %	ALK	pH	Cu	Zn	Cd	Pb	Ni	Cr	Hg	Fe	Mn	SS	COLI
Values	172		5,3	9,3			7,4-9,4								990	45	51	110
Present state	iii		ii	i			v								ii	i	iii	iv

Table 3 continued

Ostravice Liskovec, 3603

Norwegian system

	P	N	COD	O2	O2 %	ALK	pH	Cu	Zn	Cd	Pb	Ni	Cr	Hg	Fe	Mn	SS	COLI
Values	311	5030	8,9	10	96	0,7	7,6	17	56	3	<20	18	16,0	0,6	1120	25		8030
Present state	v	v	iv	i	i	i	i	iv	iii	v		iii	iv	v	v	ii		v
Water supply	4	4	4	1	1	1	1	3	2	4		2	3,0	4	4	1		4
Irrigation	4	4	2	1	1	1	1	3	2	4		2	3,0	4	4	1		4
Bathing	4	4	3	1	1	1	1	2	1	4		1	2,0	4	4	1		4
Fish farming	4	4	4	1	1	1	1	4	3	4		3	4,0	4	4	2		4
Fishing	4	4	3	1	1	1	1	3	2	4		2	3,0	4	4	1		4

Czech system

	P	N	COD	O2	O2 %	ALK	pH	Cu	Zn	Cd	Pb	Ni	Cr	Hg	Fe	Mn	SS	COLI
Values	780		5,8	10,6			7,7-8,4	14	39	3	<20	13	9,0	0,43	630	20	84	379
Present state	iv		ii	i			i	i	ii	ii	<ii	i	i	iii	ii	i	iv	v

Ostravice Paokov, 1151

Norwegian system

	P	N	COD	O2	O2 %	ALK	pH	Cu	Zn	Cd	Pb	Ni	Cr	Hg	Fe	Mn	SS	COLI
Values	370	5990	9,9	8	71	0,7	7,5								1760	55		12500
Present state	v	v	iv	ii	ii	i	i								v	iii		v
Water supply	4	4	4	2	2	1	1								4	2		4
Irrigation	4	4	2	1	1	1	1								4	2		4
Bathing	4	4	3	1	1	1	1								4	1		4
Fish farming	4	4	4	2	2	1	1								4	3		4
Fishing	4	4	3	1	1	1	1								4	2		4

Czech system

	P	N	COD	O2	O2 %	ALK	pH	Cu	Zn	Cd	Pb	Ni	Cr	Hg	Fe	Mn	SS	COLI
Values	620		8,6	8,6			7,6-8,0								960	52	93	1083
Present state	iv		ii	i			i								ii	ii	v	v

Table 3 continued

Ostravice Vratimov, 3604

Norwegian system

	P	N	COD	O2	O2 %	ALK	pH	Cu	Zn	Cd	Pb	Ni	Cr	Hg	Fe	Mn	SS	COLI
Values	402	5650	8,4	7,7	70	0,8	7,5								1350	90		42000
Present state	v	v	iv	ii	ii	i	i								v	iii		v
Water supply	4	4	4	2	2	1	1								4	2		4
Irrigation	4	4	2	1	1	1	1								4	2		4
Bathing	4	4	3	1	1	1	1								4	1		4
Fish farming	4	4	4	2	2	1	1								4	3		4
Fishing	4	4	3	1	1	1	1								4	2		4

Czech system

	P	N	COD	O2	O2 %	ALK	pH	Cu	Zn	Cd	Pb	Ni	Cr	Hg	Fe	Mn	SS	COLI
Values	840		6,9	8			7,5-8,1								780	88	97	400
Present state	iv		ii	i			i								ii	ii	iv	v

Ostravice Muglinov, 1152

Norwegian system

	P	N	COD	O2	O2 %	ALK	pH	Cu	Zn	Cd	Pb	Ni	Cr	Hg	Fe	Mn	SS	COLI
Values	-	-	35,2	4,5	47	1	7,4	19	260	8	30	34	17,0	0,5	1640	450		157000
Present state	-	-	v	iii	iii	i	i	iv	v	v	v	iv	iv	v	v	v		v
Water supply	-	-	4	3	3	1	1	3	4	4	4	3	3,0	4	4	4		4
Irrigation	-	-	3	1	1	1	1	3	4	4	4	3	3,0	4	4	4		4
Bathing	-	-	4	2	2	1	1	2	4	4	4	2	2,0	4	4	4		4
Fish farming	-	-	4	3	3	1	1	4	4	4	4	4	4,0	4	4	4		4
Fishing	-	-	4	2	2	1	1	3	4	4	4	3	3,0	4	4	4		4

Czech system

	P	N	COD	O2	O2 %	ALK	pH	Cu	Zn	Cd	Pb	Ni	Cr	Hg	Fe	Mn	SS	COLI
Values	-	-	31,2	5,6			7,5-7,9	16	243	7	25	31	13,0	0,43	1250	330	115	1073
Present state	-	-	v	iii			i	i	iv	iii	iii	ii	i	iii	iii	iv	v	v

Table 3 continued

Olse Ropice, 1155

Norwegian system	P	N	COD	O2	O2 %	ALK	pH	Cu	Zn	Cd	Pb	Ni	Cr	Hg	Fe	Mn	SS	COLI
Values	264	8200	7,2	8,3	83	1,1	7,5	17	130	5	20	15	<10	1,7	670	140		102000
Present state	v	v	iv	ii	i	i	i	iv	v	v	v	iii	<iii	v	v	iv		v
Water supply	4	4	4	2	1	1	1	3	4	4	4	2	<2	4	4	3		4
Irrigation	4	4	2	1	1	1	1	3	4	4	4	2	<2	4	4	3		4
Bathing	4	4	3	1	1	1	1	2	4	4	4	1	1,0	4	4	2		4
Fish farming	4	4	4	2	1	1	1	4	4	4	4	3	<3	4	4	4		4
Fishing	4	4	3	1	1	1	1	3	4	4	4	2	1,0	4	4	3		4

Czech system	P	N	COD	O2	O2 %	ALK	pH	Cu	Zn	Cd	Pb	Ni	Cr	Hg	Fe	Mn	SS	COLI
Values	420		6,3	8,7			7,5-8	16	101	5	20	15	<10	1,5	620	97	38	870
Present state	iv		ii	i			i	i	iv	iii	iii	i	<ii	v	ii	ii	ii	v

Olse pod Ceskym Teoinem, 1156

Norwegian system	P	N	COD	O2	O2 %	ALK	pH	Cu	Zn	Cd	Pb	Ni	Cr	Hg	Fe	Mn	SS	COLI
Values	450	7100	7,2	8	87	1,5	7,4	15	93	5	20	18	<10	0,8	740	150		100000
Present state	v	v	iv	ii	i	i	i	iii-iv	iv	v	v	iii	<iii	v	v	iv-v		v
Water supply	4	4	4	2	1	1	1	2-3	3	4	4	2	<2	4	4	3-4		4
Irrigation	4	4	2	1	1	1	1	1-3	3	4	4	2	<2	4	4	3-4		4
Bathing	4	4	3	1	1	1	1	1-2	2	4	4	1	1,0	4	4	2-4		4
Fish farming	4	4	4	2	1	1	1	3-4	4	4	4	3	<3	4	4	4		4
Fishing	4	4	3	1	1	1	1	2-3	3	4	4	2	1,0	4	4	3-4		4

Czech system

	P	N	COD	O2	O2 %	ALK	pH	Cu	Zn	Cd	Pb	Ni	Cr	Hg	Fe	Mn	SS	COLI
Values	910		6,7	8,8		7,4-8,2	15	75	4	20	17	<10	0,7	650	105	35	833	870
Present state	iv		ii	i		i	i	iii	ii	iii	i	<ii	iv	ii	iii	ii	v	v

Table 3. continued

Olse Vernovice, 1158

Norwegian system

	P	N	COD	O2	O2 %	ALK	pH	Cu	Zn	Cd	Pb	Ni	Cr	Hg	Fe	Mn	SS	COLI
Values	-	-	11,5	6,6	72	1,9	7,2	23	160	21	40	64	<10	1,6	680	300		80000
Class for nature state	-	-	iv	ii	ii	i	i	iv	v	v	v	iv	<iv	v	v	v		v
Water supply	-	-	4	2	2	1	1	3	4	4	4	3	<3	4	4	4		4
Irrigation	-	-	2	1	1	1	1	3	4	4	4	3	<3	4	4	4		4
Bathing	-	-	3	1	1	1	1	2	4	4	4	2	1,0	4	4	4		4
Fish farming	-	-	4	2	2	1	1	4	4	4	4	4	<4	4	4	4		4
Fishing	-	-	3	1	1	1	1	3	4	4	4	3	<3	4	4	4		4

Czech system

	P	N	COD	O2	O2 %	ALK	pH	Cu	Zn	Cd	Pb	Ni	Cr	Hg	Fe	Mn	SS	COLI
Values	-	-	11,3	7,7			7,3- 7,9	22	107	21	33	63	<10	0,83	670	250	45	640
Class for nature state	-	-	iii	i			i	ii	iv	v	iii	iii	<ii	iv	ii	iii	iii	v

Odra Bohumin, 1163

Norwegian system

	P	N	COD	O2	O2 %	ALK	pH	Cu	Zn	Cd	Pb	Ni	Cr	Hg	Fe	Mn	SS	COLI
Values	-	-	37,6	6,1	47	1,5	7,1	33	132 0	7	50	38	64,0	0,5	31,1	940		12700 0
Present state	-	-	v	iii	iii	i	i	iv	v	v	v	iv	v	v	v	v		v
Water supply	-	-	4	3	3	1	1	3	4	4	4	3	4,0	4	4	4		4
Irrigation	-	-	3	1	1	1	1	3	4	4	4	3	4,0	4	4	4		4
Bathing	-	-	4	2	2	1	1	2	4	4	4	2	4,0	4	4	4		4
Fish farming	-	-	4	3	3	1	1	4	4	4	4	4	4,0	4	4	4		4
Fishing	-	-	4	3	3	1	1	3	4	4	4	3	4,0	4	4	4		4

Czech system

	P	N	COD	O2	O2 %	ALK	pH	Cu	Zn	Cd	Pb	Ni	Cr	Hg	Fe	Mn	SS	COLI
Values	-	-	22,4	6,2			7,2- 7,6	21	113 0	6	27	28	28,0	0,4	11,8	540	376	963
Present state	-	-	iv	ii			i	ii	v	iii	iii	ii	ii	iii	v	iv	v	v

5.3. The Biological Indices.

The two biological indices demonstrated, the Saprobic Index and the BMWP- index (Biological Monitoring Working Party)(see ch.4) both indicate how the water quality affects biological communities. The S.I. values range between 0 and 8, 0 beeing the least polluted situation. The BMWT values ranges between 1 and 10, 1 being the most polluted situation. The values the indices therefor are inversly related as shown in figurs 3 and 4. Both indices are developed for use in organic pollution, however they may also respond to mixed pollution.

As demonstrated by both the indices, the benthic communities were in general less affected in the upper reaches of the rivers than downstream. In most cases this may be explained with an increased organic/general pollution downstream. High metal contents in the river water as well as in sediments may affect the communities at some sites, as for example at Olse Vernovice. Toxic effects on the communities are however not ment to be included in the indices.

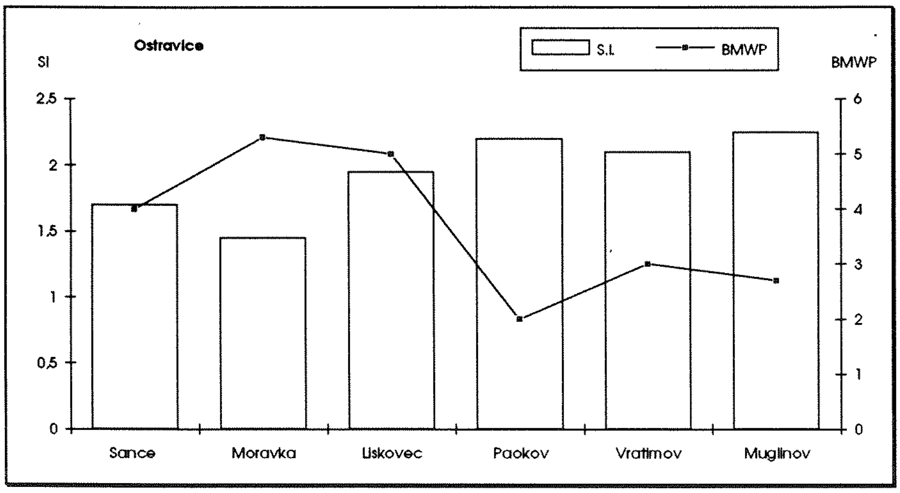


Figure 3. The Saprobic Index and the BMWP index at different sites in the Ostravice River.

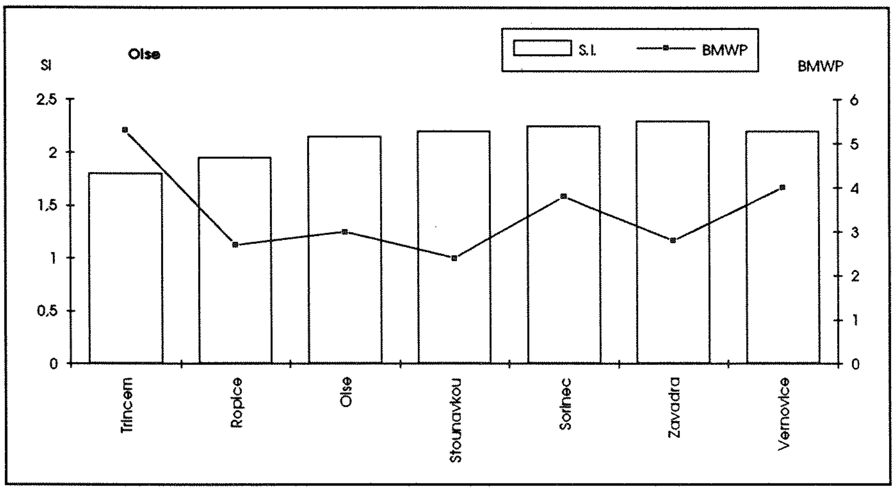


Figure 4. The Saprobic Index and the BMWP index at different sites in the Olse River.

Table 4. Indices used on benthic macro invertebrate assemblages in Ostravize and Olse rivers. The Saprobic index (SI) and the BMWP index together with the nubmer of species and the water quality class as determined by the SI. Location of the sites are shown in figure 2.

station	Ostravice, Sance	Ostravice, Moravka	Ostravice, Liskovec	Ostravice, Paokov	Ostravice, Vratimov	Ostravice, Muglinov
st.number	3602	3784	3603	1151	3604	1152
S.I.	1,7	1,45	1,95	2,2	2,1	2,25
BMWP	4	5,3	5	2	3	2,7
Number of species	8	7	5	2	4	3
Water quality class (S.I)	II	II	II	III	II	III
Limits(SI)	<2,2	<2,2		<3,2		

station	Olse, Trinec	Olse, Ropice	Olse	Olse, Stonavkou	Olse, Sorinec	Olse, Zavadra	Olse, Vernovice
st. number	3786	1155	1156	3802	3787	1157	1158
S.I.	1,8	1,95	2,15	2,2	2,25	2,3	2,2
BMWP	5,3	2,7	3	2,4	3,8	2,8	4,0
Number of species	3	3	4	5	5	5	6,0
Water quality class (S.I)	II	II	II	III	III	III	III
Limits(SI)		<2,2					

6. Proposed work programme

Water quality parameters.

In general, up to now, a long list of parameters have been measured in the monitoring program of the water quality of the Odra river. Potentially toxic materials as heavy metals and some organic micro pollutants are measured less frequently. For these parameters profiles downstream cities and in drinking reservoirs have been given priority. Besides, the material so far have shown that the detection limits for some heavy metals are high relative to both EC and Norwegian standards, and for that reason could hide possible variations between sites.

In addition to describe the general picture of the level of pollution in the Odra river system, investigations on the kind of pollution are initiated, and assumed parameters responsible for the deterioration of water quality and biological communities are focused on in the selected profiles.This is an efficient way to demonstrate how different methods would give different answers to the pollution problems of the rivers, and to form a basis for a discussion on the applicability of the systems. This work should proceed in phase II to have a more close look at the number of physical and chemical parameters actually needed to describe the water quality, the criteria values of the parameters, and the class values in the classification system to make it a cost effective system in the management of the Odra river systems.

Environmental quality; water, sediments and biota.

The modern approach to pollution problems is to assess the *environmental quality*, and focusing not only on the water phase in a stretch of a river, but also on the accumulation of potentially toxic materials in the sediments and the accumulation and biomagnification of toxicants in organisms, particularly in eatable organisms as fish. This approach is very important because a majority of common toxic substances, as for example mercury (which seem to be a considerable problem), other heavy metals, PCB and PAH, are adsorbed to organic and inorganic particles which settle to the sediments. These sediments therefor may act as reservoirs and potential sources of pollution for a very long time. When toxic materials are present in high concentrations in the sediments, the biological communities disappear and the capability of self purification of organic matter in the rivers is seriously reduced. The sediment approach of the criteria and classification of the environmental quality therefor will be put into focus in phase II of this project. A Czech program on stream sediment analysis has started in the region and several rivers have been sampled and analysed for metals.

A lot of toxic substances also accumulate in organisms, including fish. For some toxic substances as mercury, lead and PCB biomagnification also occur. This means that the concentrations of the toxic elements increase from the lowest to the highest level in the ecological food chain. Both the extent of bioaccumulation and biomagnification of toxic elements are of utmost importance when assessing the environmental quality of a river. In addition the contents of toxic compounds in fish are important from a public health point of view. The accumulation of toxicants in fish therefor should be a part in the phase II of this project. A project dealing with this issue has already started at some sites in the Odra catchment area.

The biological effects of the pollutants is a crucial point in the assessment of environmental quality of rivers. The biological classification systems commonly used considers so far mostly the effects of organic pollution. The system used in The Czech Republic, the Saprobic index, is particularly designed for this kind of pollution. However, frequently the rivers within the Odra catchment are polluted by toxic materials. A biological classification system which includes this aspect should be developed. Based on the great amount of chemical and biological data available, the Odra region would seem the right place to initiate this kind of work.

All this work will be done in co-operation between the Czech and the Norwegian scientists, leading to an important exchange of knowledge and methods.

7. References

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8. APPENDIX

Parameters	C		EC*				EPA*				CCREM*	
	Non DW max	Pot. DW max	DW 90%	DW max	F.W.L. AA <50mg**	Salm. AA <50mg**	CCC,50mg $CaCO_3$	CCC,100 mg$CaCO_3$	CMC,50mg $CaCO_3$	CMC,100 mg $CaCO_3$	Max 0-60 mg$CaCO_3$	Max 60-120
BOD5	8	4	3			3						
COD-Mn	20	8										
COD-Cr	50	20										
Dissolved solids	1000	500						1000				
Cl	400	200	200					500				
SO4	300	200	150									
Ca	300	200										
Mg	200	100										
NH4	2,5	0,5	0,038			0,31		1,8				
NO3	11	3,5	5,65					90				
Fe	2	0,5						1				
Mn	0,5	0,2						1				
As	0,1	0,05	0,01	0,05	0,13	0,05	0,19	0,048	0,36	0,85	0,05	
Cd	0,015	0,005	0,001	0,05	0,005	0,005	0,00066	0,0011	0,0018	0,0039	0,0002	0,0008
Cr-total	0,3	0,1										
Cr-III							0,12	0,21	0,98	1,7		
Cr-IV			0,05	0,05	0,005	0,005						
Cr-VI	0,05	0,02						0,011		0,0039		
Cu	0,1	0,05	0,02		0,001	0,005	0,0065	0,012	0,0092	0,018	0,002	0,002
CN	0,2 uld							0,0052		0,022		
Pb	0,1	0,05	0,05	0,05	0,005	0,004	0,0013	0,0032		0,082	0,001	0,002
Hg	0,001	0,005	0,0005	0,001	0,001	0,001	0,000012	0,000012	0,0024	0,0024	0,0001	
Ni		0,05		0,05	0,008	0,05	0,088	0,16	0,79	1,4	0,025	0,065
Se	0,1	0,05						0,035		0,26		
Ag	0,05	0,01		0,01				0,00012	0,0012	0,0041	0,0001	
Ur	0,1	0,05										
V	0,05	0,005										
Zn	0,1	0,05	0,5		0,1	0,03	0,059	0,11	0,065	0,12	0,03	
Phenols	0,1	0,02	1	0,0005				2,56		10,2		
Ph	6,0-9,0	6,0-8,5								6,5-9,0		
Tot colif	600	80	50 <1					2				

*The toxicity of some metals vary with the calcium content of the water, CMC-Criterion of Maximum Concentration , CCC-Criterion of Continuous Concentration.

**FWL - freshwater life, salm.-salmonides, AA- Annual Average, <50 - < 50 mg Ca CO_3/l

Classes of water quality and their limits.

A. Indicators of oxygen regime:

Indicator	Unit	Class				
		I	II	III	IV	V
1. DO	mg/l	>7	>6	>5	>3	<3
2. BOD-5	mg/l	<2	<5	<10	<15	>15
3. COD-Mn	mg/l	<5	<10	<15	<25	>25
4. COD-Cr	mg/l	<15	<25	<35	<55	>55
5. TOC	mg/l	<5	<8	<11	<17	>17
6. Sulfane and sulfides	mg/l	+	+	+	<0,02	>0,02

+) below detection limit

B. Chemical indicators - basic

Indicator	Unit	Class				
		I	II	III	IV	V
1.pH		6,0-8,5	6,0-8,5	6,0-8,5	5,5-9,0	<5,5;>9,0
2. Water temperature	°C	<22	<23	<24	<26	>26
3. TDS	mg/l	<300	<500	<800	<1200	>1200
4. Conductivity	mS/m	<40	<70	<110	<160	>160
5. TSS	mg/l	<20	<40	<60	<100	>100
6. Total Fe	mg/l	<0,5	<1,0	<2,0	<3,0	>3,0
7. Total Mn	mg/l	<0,05	<0,1	<0,3	<0,8	>0,8
8. Ammonia nitrogen	mg/l	<0,3	<0,5	<1,5	<5,0	>5,0
9. Nitrite nitrogen	mg/l	<0,002	<0,005	<0,02	<0,05	>0,05
10. Nitrate nitrogen	mg/l	<1,0	<3,4	<7,0	<11,0	>11,0
11. N-org	mg/l	<0,5	<1,0	<2,5	<3,5	>3,5
12. Total P	mg/l	<0,03	<0,15	<0,4	<1,0	>1,0

C. Chemical indicators - complementary

Indicator	Unit	Class				
		I	II	III	IV	V
1. Chlorides	mg/l	<50	<200	<300	<400	>400
2. Sulfates	mg/l	<80	<150	<250	<300	>300
3. Calcium	mg/l	<75	<150	<200	<300	>300
4. Magnesium	mg/l	<25	<50	<100	<200	>200
5. Absorbance (254nm, 1cm)*		<0,15	<0,25	<0,35	<0,55	>0,55
6. Fluorides	mg/l	<0,2	<0,5	<1,0	<1,5	>1,5
7. Phenols I	mg/l	<0,002	<0,01	<0,02	<0,5	>0,5
8. Anionic tensides	mg/l	+	<0,5	<1,0	<2,0	>2,0
9. Non polar extractable substances	mg/l	+	<0,05	<0,1	<0,3	>0,3
10. Total cyanides	mg/l	+	+	<0,2	<0,5	>0,5
11. Active chlorine	mg/l	+	+	+	<0,05	>0,05
12. Extractable	µg/l	<5	<10	<20	<30	>30
organic bounded chlorine	µg/l	<5	<10	<20	<30	>30

µg/l is microgrammes per liter

+) below detection limit

*) ultra violet

D. Heavy metals

Indicator	Unit	Class				
		I	II	III	IV	V
1. Hg	µg/l	<0,1	<0,2	<0,5	<1,0	>1,0
2. Cd	µg/l	<3	<5	<10	<20	>20
3. Pb	µg/l	<10	<20	<50	<100	>100
4. As	µg/l	<10	<20	<50	<100	>100
5. Cu	µg/l	<20	<50	<100	<200	>200
6. Total Cr	µg/l	<20	<100	<200	<500	>500
7. Cr	µg/l	+	<10	<20	<50	>50
8. Co	µg/l	<10	<20	<50	<100	>100
9. Ni	µg/l	<20	<50	<100	<200	>200
10. Zn	µg/l	<20	<50	<100	<500	>500
11. V	µg/l	<10	<20	<50	<100	>100
12. Ag	µg/l	+	10	20	50	50

+) below detection limit

E. Biological and microbiological indicators

Indicator	Unit++)	Class				
		I	II	III	IV	V
1. Saprobic Index PB (Pantle-Buck)		<1,2	<2,2	<3,2	<3,7	>3,7
2. Psychlophilic microorganismus	KTJ/1ml	<500	<1000	<5000	<10000	>10000
3. Coliform bacteria	KTJ/1ml	<1	<10	<100	<1000	>1000
4. Thermotolerant coliform bacteria	KTJ/1ml	<0,2	<2	<20	<200	>200
5. Enterococci	KTJ/1ml	<0,1	<1	<10	<100	>100

KTJ is abbr. for colonies making the unit.

++) Determination of bacteria number is carried out by cultivation on cultivation mediums (solids), all the number of grown up colonies. The colony can arise from one separate cell or agglomerates (microcolonies), that is why results are presented as numbers of units making colonies (numbers of colonies) from 1 ml of sample.

F. Radioactivity indicators

Indicator	Unit	Class				
		I	II	III	IV	V
1. Gross Alpha radioactivity	mBq/l	<50	<100	<500	<2500	>2500
2. Gross Beta radioactivity	mBq/l	<200	<500	<1000	<2500	>2500
3. Radium 226	mBq/l	<20	<50	<120	<500	>500
4. Uran	µg/l	<5	<20	<50	<100	>100
5. Tritium	Bq/l	<10	<100	<1000	<5000	>5000

Classification of Present Situation

	Parameters	Present situation I	II	III	IV	V
Eutrofication	Total fosfor, µg/l	<7	7 - 11	11 - 20	20 - 50	>50
	Total nitrogen, µg/l	<250	250 - 400	400 - 550	550 - 800	>800
	Klorofyll a, µg/l	<2	2 - 3,7	3,7 - 7,5	7,5 - 20	>20
	Prim.prod.,gC/m2år	<25	25 - 50	50 - 90	90 - 150	>150
Organic matter	TOC,mg/l	<2,5	2,5 - 3,5	3,5 - 6,5	6,5 - 15	>15
	KOF(Mn),mgO/l	<2,5	2,5 - 3,5	3,5 - 6,5	6,5 - 15	>15
	Fargetall	<15	15 - 25	25 - 40	40 - 80	>80
	Siktedyp,m	>7	4 - 7	2 - 4	1 - 2	<1
	Oksygen,mg O2/l	>9	6,4 - 9	4 - 6,4	2 - 4	<2
	Oksygenmetn. %	>80	50 - 80	30 - 50	15 - 30	<15
Acidification	Alkalitet, mmol/l	>0,2	0,05 - 0,2	0,01 - 0,05	<0,01	0
	pH	>6,7	6,2 - 6,7	5,7 - 6,2	5,3 - 5,7	<5,3
Toxic effect	Kobber, µg Cu/l	<2	2 - 5	5 - 15	15 - 50	>50
	Sink, µg Zn/l	<10	10 - 30	30 - 60	60 - 110	>110
	Kadmium, µg Cd/l	<0,04	0,04 - 0,1	0,1 - 0,2	0,2 - 0,5	>0,5
	Bly, µg Pb/l	<1	1 - 3	3 - 5	5 - 10	>10
	Nikkel, µg Ni/l	<3	3 - 10	10 - 30	30 - 100	>100
	Krom, µg Cr/l	<1	1 - 3	3 - 10	10 - 50	>50
	Kvikksølv, µg Hg/l	<0,01	0,01 - 0,04	0,04 - 0,1	0,1 - 0,3	>0,3
	Aluminium, µg Al/l	<5	5 - 20	20 - 50	50 - 100	>100
	Jern, µg Fe/l	<50	50 - 100	100 - 300	300 - 600	>600
	Mangan, µg Mn/l	<20	20 - 50	50 - 100	100 - 150	>150
Particles	Turbiditet, FTU	<0,5	0,5 - 1	1 - 2	2 - 5	>5
	Susp. stoff, mg/l	<1,5	1,5 - 3	3 - 5	5 - 10	>10
Microbiol.	Termotolerante koliforme bakt. antall/100ml	<5	5 - 50	50 - 500	500 - 1000	>1000

Drinking Water

	Parameters	Present situation I	II	III	IV	V
Eutrofication	Total fosfor, µg/l	<7	7 - 11	11 - 20	20 - 50	>50
	Total nitrogen, µg/l	<250	250 - 400	400 - 550	550 - 800	>800
	Klorofyll a, µg/l	<2	2 - 3,7	3,7 - 7,5	7,5 - 20	>20
	Prim.prod.,gC/m2å	<25	25 - 50	50 - 90	90 - 150	>150
Organic matter	TOC,mg/l	<2,5	2,5 - 3,5	3,5 - 6,5	6,5 - 15	>15
	KOF(Mn),mgO/l	<2,5	2,5 - 3,5	3,5 - 6,5	6,5 - 15	>15
	Fargetall	<15	15 - 25	25 - 40	40 - 80	>80
	Siktedyp,m	>7	4 - 7	2 - 4	1 - 2	<1
	Oksygen,mg O2/l	>9	6,4 - 9	4 - 6,4	2 - 4	<2
	Oksygenmetn. %	>80	50 - 80	30 - 50	15 - 30	<15
Acidification	Alkalitet, mmol/l	>0,2	0,05 - 0,2	0,01 - 0,05	<0,01	0
	pH	>6,7	6,2 - 6,7	5,7 - 6,2	5,3 - 5,7	<5,3
Toxic effects	Kobber, µg Cu/l	<2	2 - 5	5 - 15	15 - 50	>50
	Sink, µg Zn/l	<10	10 - 30	30 - 60	60 - 110	>110
	Kadmium, µg Cd/l	<0,04	0,04 - 0,1	0,1 - 0,2	0,2 - 0,5	>0,5
	Bly, µg Pb/l	<1	1 - 3	3 - 5	5 - 10	>10
	Nikkel, µg Ni/l	<3	3 - 10	10 - 30	30 - 100	>100
	Krom, µg Cr/l	<1	1 - 3	3 - 10	10 - 50	>50
	Kvikksølv, µg Hg/l	<0,01	0,01 - 0,04	0,04 - 0,1	0,1 - 0,3	>0,3
	Aluminium, µg Al/l	<5	5 - 20	20 - 50	50 - 100	>100
	Jern, µg Fe/l	<50	50 - 100	100 - 300	300 - 600	>600
	Mangan, µg Mn/l	<20	20 - 50	50 - 100	100 - 150	>150
Particles	Turbiditet, FTU	<0,5	0,5 - 1	1 - 2	2 - 5	>5
	Susp. stoff, mg/l	<1,5	1,5 - 3	3 - 5	5 - 10	>10
Microbiol.	Termotolerante koliforme bakt. antall/100ml	<5	5 - 50	50 - 500	500 - 1000	>1000

(white)	Klasse 1:
(dotted)	Klasse 2:
(grey)	Klasse 3:
(black)	Klasse 4:

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