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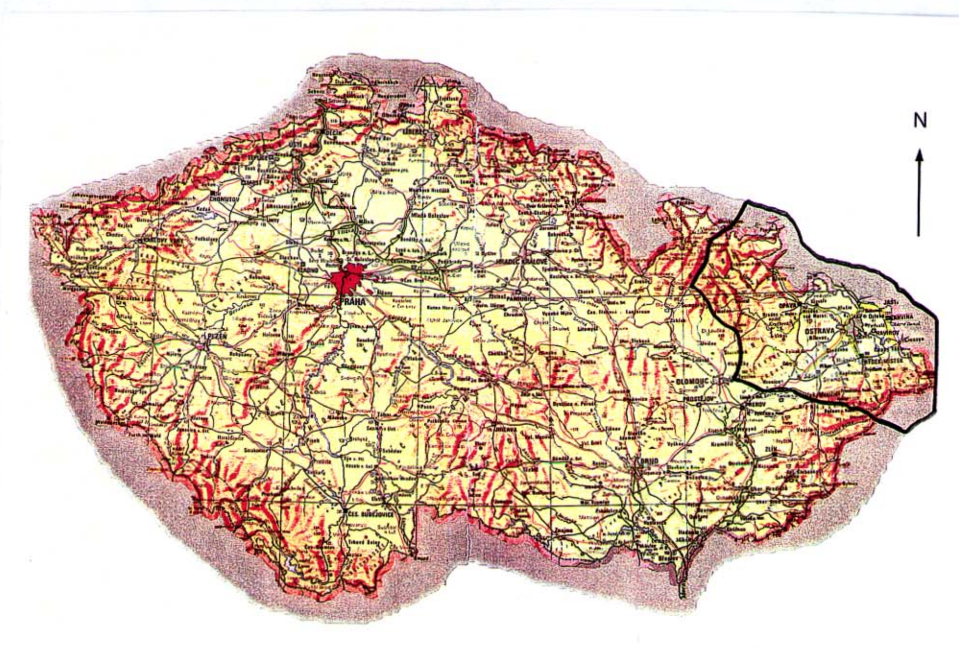
WATER POLLUTION ABATEMENT PROGRAMME - THE CZECH REPUBLIC

Pollution Abatement Analysis and Strengthening of Water Resources Management

Odra River Catchment - Phase II



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Abstract:

Odra river is extremely polluted by organic matter, nitrates, ammonia, phosphorus, bacteria, particles, heavy metals and other micro pollutants from municipalities, industries and agriculture. The poor water quality severely affects the ecology and represents a risk to human health. The water has a very limited value of use. This report presents an abatement programme with both technical and accompanying measures. In order to identify the major polluters several multi criteria analysis have been developed, discussed and evaluated. Technical measures for 23 "Hot spots " are proposed and ranked according to the cost/benefit ratio. Measures for agriculture have been based on previous work. The proposed abatement programme gives a significant reduction of the total pollution discharges in the region, and improves both local and regional water quality. The abatement programme will also contribute to the Czech Government's obligations to reduce the pollution to the Baltic Sea. Accompanying measures (policy, administrative including legal and economic measures) have been addressed in detail. The water and environmental management system has undergone tremendous changes since the "Velvet Revoution", and there is no longer time for major restructuring. The recommendations which are made in this report regarding accompanying measures are designed to make the environmental management function, and are at this stage mostly for studies and experimental projects. The report has been prepared jointly by Czech and Norwegian Scientists.

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For the administration

Jon Lasse Bratli

Jon Lasse Bratli

Preface

The Governments of the Czech Republic and Norway have signed a bilateral environmental protection agreement. As part of this agreement several collaborative projects have been carried out within "The water pollution abatement programme- The Czech republic".

The study reported here "Pollution abatement analysis and strengthening of water resources management, Odra River Catchment, Phase II" is a part of this programme, and has been a co-operation project between the Norwegian Institute for Water Research (NIVA), the Norwegian Institute for Urban and Regional Research (NIBR), the T.G. Masyrek Water Research Institute-branch Ostrava (WRI), the Mining University in Ostrava- Ecological Institute (EI) and the Water Management Authority Povodi Odry (PO). Phase I of the project was carried out in 1992.

The project is aimed at investigating local water quality problems in the Czech part of the Odra River catchment, and the prerequisites for a cost-efficient water management. An abatement programme, which outlines both technical and accompanying measures, has been prepared. As part of the project there has been 4 visits to the Ostrava region, and the Czech scientists have visited Norway in October 1994 to work jointly with a preliminary draft of this report. The study has been financed by the Norwegian State Pollution Authority (SFT), and co-financed by NIVA. NIVA has the overall responsibility for this report, but NIBR has prepared chapter 3 and 8. The report has been prepared by:

Research Scientist Kjersti Dagestad (NIVA):	*Project manager (March 1994-March 1995)*
Research Manager Hans Olav Ibrekk (NIVA/EBRD:	*Project manager (Sept. 1993-March 1994)*
Research Scientist Harsha Ratnaweera (NIVA):	*Mainly chapter 6-7*
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Research Fellow Jørn Holm-Hansen, (NIBR):	*Responsible for chapter 3 and 8*
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Water Manager Peter Brezina, (PO):	*Prof. assist., data- collection and calculations*

The project team would like to give credit to Technical Assistant Luis Benavides (NIVA) who has been a great help contributing to data processing and presentation, Research Manager Bjørn Faafeng (NIVA) for professional assistance in tasks involving eutrophication in reservoirs, Research Scientist Torleiv Bækken (NIVA) for professional assistance regarding water quality classification, Research Scientist, Eli Anne Lindstrøm (NIVA) for professional assistance regarding eutrophication in rivers, Research fellow Terje Kleven at (NIBR) for professional assistance regarding chapter 3 and 8, Eli Eldnes(NIVA) for graphic presentation and to Bjørg Storesund and Nina Markussen in SFT.

A special thank to the the Czech Authorities and enterprises in the Odra river catchment, who may have been exhausted by visits from foreign missions the last years, but still have taken of their time to assist the project team. Also thanks to the intepretors Honza Tylecek and Hannah Tridlicová making the language barrier smaller.

Finally special thanks to our Czech co-workers who have showed great enthusiasm, and assisted us with much valuable information, professional advice and put much personal efforts into providing the project team with the necessary data for this report. We hope that the study can contribute to identifying and solving some of the water quality and management problems in the region.

Oslo, March, 1995

Kjersti Dagestad

Table of Contents

Abstract

Pollution abatement analysis

Odra River with a total length of 854 km and a catchment area of 118900 km^2, flows to the Baltic Sea through the Czech Republic, Poland and Germany. The total length in the Czech part is 120 km, and the Czech catchment area constitutes 5% of the total catchment.

Odra River is extremely polluted, especially in the District of Ostrava and in the mouth of the tributaries, by organic matter, nitrates, ammonia, phosphorus, bacteria, particles, heavy metals and other micro pollutants. The poor water quality severely affects the ecology and represents a risk to human health. The water has a very limited value of use, and is at some location only suitable as a recipient for waste water.

The study reported here is a part of the bilateral environmental protection agreement between the Governments of Norway and the Czech Republic, and has aimed at solving local and regional water quality problems in the Czech part of the Odra River. An abatement programme has been prepared with both technical and accompanying measures.

The catchment area to Odra River is one of the most industrialised areas in the Czech Republic, and has 1.3 mill. inhabitants. Ostrava is the largest city with 330.000 inhabitants. The industry is dominated by coal and copper mines, coke ovens, steel work and pulp- and paper industry, agroofood and textile industry. Agriculture is also a main activity, and agriculture land is covering 50% of the total catchment.

The contribution of pollution from these man made sources is extremely high compared to the background sources (run-off from mountain area and forest). Background sources contribute only with 3% of the total loads. Untreated domestic waste water and overloaded waste water treatment plants are main sources to the high content of organic matter and nutrients. Agriculture is the dominant source to nitrogen, while the industry contribute with considerable amounts of heavy metals and other micro-pollutants.

The study has as mentioned, aimed at solving regional an local water quality problems. The water quality objectives (according to the Czech classifications system) and the estimated need for reduction of pollution for the water courses in the Odra river catchment, have therefor primarily been based on resulting water quality and the regional and local effects on ecology and human health. These effects have been related to the user interests in the area. The Baltic Sea Declaration of reducing the pollution with 50% and regulation 171/92 in the Czech environmental law, have also been reflected in addition to the resulting water quality (especially for phosphorus and nitrogen) when technical measures have been proposed.

There are 250 registered municipal and industrial sources in the region. A lot can be achieved by targeting the major polluters, but the selection of the sources with the highest cost/benefit potential will depends on the definition of requirements; discharge loads, resulting water quality, violation of discharge standards and so on. It is not possible to propose an absolute ranking method, so the ranking has been based on six multi-criteria analysis, which have been evaluated, discussed and proposed. The evaluation of the methods assisted with a qualified selection gave a very good result and identified 25 "Hot spots" which represent 67-100% (depending on the parameter) of the total pollution load from the 250 sources.

Technical measures have been proposed for 23 of the Hot Spots, 14 of the biggest waste water treatment plants and 9 big industries, and will give a significant reduction of the total emissions of

pollution (15% for Tot-N, over 20% for BOD, 33% for Tot-P and 50% for heavy metals), if these measures are implemented. The relative importance of these reductions in improving the water quality compared to other sources is considerable higher, while these outlets will have a direct effect on the water quality. The technical measures for municipal waste water are based on up-grading of the existing overloaded biological treatment plants. Nitrogen and phosphorus removal have been introduced at some of the plants. There has not been given any detail description of the technical measures for industrial "Hot-Spots", but the study has focused on how important it is to reduce the load of a specific parameter. Due to the widely variable industrial processes, the estimated costs must be considered as guideline values.

The 23 Hot-spots are ranked according to the cost/benefit ratio. The annual investment, operation and maintenance costs over a 20 years lifetime are stipulated to 29 mill US$ at municipal waste water treatment plants (60% of the total costs are because of nitrogen removal), and 23 mill US$ at industrial sources. This gives total annual costs of 52 mill. US$.

Reduction in % of total loads from anthropogenic sources									
BOD*	Tot-N	Tot-P	Fe	Zn	Hg	Cd	Pb	Cu	Ni
21	15	33	41	47	50	50	50	47	49
Total annual costs 52 mill US$									

*Total anthropogenic sources for BOD are referring to municipal and industrial pollution

The total loads from the remaining 227 sources and the remaining domestic pollution; smaller waste water treatment plants (15% of the inhabitants) and sewage from inhabitants who are not connected to public sewage(25%), will also give a significant contribution to the total pollution loads. This remaining pollution is, however, spread on a high number of polluters, and do not separately give a significant contribution to the total loads. The local problems caused by these sources can however be considerable, and the neccecity of measures to reduce these local effects should be addressed in detail.

Agriculture will also give a significant contribution to the total loads of pollution, but has only been touched briefly in this report. Measures for agriculture can have a high cost/benefit ratio, and based on very approximate estimations the measures for agriculture seem to give a significant contribution to the reduction of total nitrogen (9%), phosphorus (10%) and organic matter (not estimated) loads. Very rough calculations are showing that the total annual costs for agriculture can be in the order of 40 mill US$. The measures and costs need to be investigated further. The total achieved reduction, including measures at municipal/industrial sources and agriculture, may be in the order of 23% for phosphorus and 25% for nitrogen to a total annual costs of 90 mill US$.

The proposed abatement programme, for the 23 sources, in the Odra river catchment will improve the surface water quality significantly, and to some extent restore the ecological balance. The ground water quality will also be improved, especially in areas where the wells are shallow and influenced by the river quality. The objectives for water quality proposed in this report are achievable for organic matter, nitrogen (ammonia and nitrate), phosphorus, suspended solids, heavy metals and bacteria, especially in central parts of Odra, and in the mouth of the tributaries. The abatement programme reduces only to some extent the pollution in the upper parts of the catchment area, and other sources must be target (especially agriculture, outlets from smaller WWTP and sewage from inhabitants not connected to public sewage) to achieve improvements in local water quality in these areas.

Need for further reduction in all the above mentioned pollution parameters, should be investigated especially considering local effects, the effects on ground water and the effects on drinking water reservoirs. Separate abatement programme for the drinking water reservoirs should be prepared. The final goals for pollution reduction must be discussed in detail by water mangement authorities and politicians, especially the goals for phosphorus and nitrogen.

The level of the objectives for nitrogen set in this report may be reviced taking only the local effects of nitrogen into account (ammonia-fish kills and nitrate-ground water), but regardless of the local effects the measures will be necessary to meet the requirements in the environmental law (reg 171/92) and to contribute to achieve the obligations in the Baltic Sea declaration.

The level of phosphorus reduction according to the potential risk for eutrophication and blue green algae blooming, must also be investigated further. It is very important that necessary research is carried out to predict these effects both in the drinking reservoirs and in the rivers, in order to implement the necessary measures. The Water Management Authority should, however, judge if the proposed measures for phosphorus must be implemented regardless of the local effects, to meet the obligations in the Baltic Sea declaration and the requirements in the Environmental law (reg. 171/92).

Strengthening of Water Resource Management

The water management law (Act no. 130/1974 Sb.) § 1-7 establishes four core institutions in the Czech water management system. The Ministry of Environment is the superior "water management body" (vodohospodárský orgán), the other bodies being (a) the District Offices, (b) the Czech Environment Inspection and (c) the municipalities. Various types of decentralisation have been carried out with Czech public administration in order to secure a regional presence of sectorial ministries. The regional departments of the Ministry of Environment are examples of this.

Central government bodies at the District level - the District Offices - seek to bring about co-ordination and harmonisation against sectorial and localist challenges. The new level of government at a larger regional level envisaged in the new Constitution would strengthen the co-ordination of public policies. The District Office Environmental Division has a special responsibility for co-ordinating water management in the District. The District is responsible for setting the discharge limits for all sources of water pollution. The emission limits have to conform to the user limits of the river, and have to be approved by Povodí before it can be released as an officially valid discharge permit. The Inspection is composed of regional inspections, and checks whether the discharge permits are followed. The Inspection and the District are at the same level of power, and have some overlapping control competencies.

The municipalities have responsibilities in water management. They regulate and limit use of surface water, decide in cases of conflict over water use and charge those who damage public sewage or water supply. Privatisation and semi-privatisation of water management relevant institutions have taken place. Initially all the polluting enterprises themselves are under privatisation, a fact that requires special attention because the skills of environmental authorities that treat privatised and private businesses require different skill than needed previously. Economic, legal and administrative tools now will have to be used skilfully.

Also organisations that used to be a part of public administration now are becoming independent profit-making entities. The water supply and sewage companies are privatised and quite often split up into smaller companies covering more or less adequate areas as seen from a water management point of view. The watershed organisations (Povodí) are now shareholding companies owned by the state. The watershed organisation is the manager of water. It sells water and is responsible for the cleanliness of it. The watershed organisation gives obligatory expert opinions to the authorities.

Despite the fact that the procedures for environmental and water management in the Czech republic today opens up for public participation, e.g. through the system of Environmental Impact Assessment, public awareness and the environmental activism are very low.

All in all a viable structure for a well-functioning public administration is established in the Czech republic. It is no longer time for major restructuring. Now the task lies in making the structure work.

Only some smaller measures have therefore been proposed focusing on the main imperfections of the present water management, which are; 1)The weakness of the water use plan, 2)The weak co-ordination between land use and water use plans, 3) The non-existence of regionally or locally made water use plans and 4) The slow influx of specialists into environmental water management having formal background in economic, social, administrative and legal sciences

The following measures are proposed:

The potential of land use plans being used systematically, as a water management tool should be studied. The water management bodies and the Ministry of Environment ought to develop procedures for anchoring the Guideline Plan for Water Management in local preferences, for instance via the establishment of municipal water plans. The possibilities of co-ordinating it with the land use plan should be investigated. The need to bring all user interests into the planning process should be emphasised. Some financing of these pilot projects should be made from central funds.

An inter-municipal water council ought to be established on a voluntary basis between municipalities in the Odra river catchment area as an "experiment". The results of the co-operation should be evaluated professionally after two years and the reasons for making such co-operation e.g. on a catchment area level should be discussed.

The water managers in the Odra river catchment area should initiate a study on the regional effects of water management by introducing the second level of self-government. How should water management in the catchment area relate to this new level?. Especially the new possibilities of co-ordination and harmonisation of interests resulting from the new level of government should be investigated.

A strategy plan should be made as a joint project of relevant water management bodies in the area. The plan should include a description of the establishment of an efficient working relationship with industries in the catchment area using the mechanisms of economy, administration and education.

A comparative study ought to be made between the Odra river catchment area and one or more Western equivalents. The purpose of this study would be to describe how the water management institutions, involved in the study, cope with its tasks (tackling legal provisions, economic regulations, handling other administrative institutions and the public) and a description of their employees professional backgrounds. The aim of the study would be to come up with a list of professions the water management system of the Czech republic is lacking to meet modern requirements.

An informal environmental management forum for scientific and practical discussions should be established on the new knowledge on migrating pollutants (update on recent research) and how to adapt to, and use, this knowledge in everyday practical environmental management. A second theme for this forum would be production processes and *"cleaner technology"*.

A group consisting of specialists from each profession within air, soil and water pollution should be established with the task to check all fines in order to ensure whether they are given according to the present knowledge on migrating pollutants. The work made by this group should be summed up in a set of recommendation on how to apply the existing legal regulations in a way that comes as close as possible to 'integrated' environmental management.

One may also 1)set up project groups to solve specific environmental tasks, 2) introduce regular consultation processes (hearings) between the institutions involved and 3) introduce systems of rotation where people from the various institutions work in each other's institutions for a period.

Summary

1 Background

Surface waters as well as ground waters in the Odra river catchment in the Czech Republic are heavily polluted, especially in the Ostrava industrial region and its surrounding area. The high level of pollution cause considerable impacts on ecology and human health, and there is a definite need to develop sound abatement strategies to restore the ecological balance in the surface waters in the region.

The study reported here "Pollution abatement analysis and strengthening of the water resources management-Odra River Catchment, Phase II" is a part of the bilateral environmental protection agreement between the Governments of Norway and the Czech Republic. The study has aimed at solving local and regional water quality problems in the Czech part of the Odra river catchment, and to investigate the prerequisites for a cost-efficient water management of local and region problems. An abatement programme has been prepared with both technical and accompanying measures, which will contribute to restoring the ecological balance in the surface waters. The long term objectives of the study have been to develop planning and implementation tools for the elaboration of optimal strategies for cost-effective pollution abatement, the strengthening and improvement of the capacity and capability of Czech water resources authorities, and to exchange knowledge and analytical methods between Czech and Norwegian scientists. Phase I was carried out in 1993 (Ibrekk *et al.*, 1993). The project has been a co-operation between the Norwegian Institute for Water Research (NIVA), the Norwegian Institute for Urban and Regional Research (NIBR), the T.G. Masaryk Water Research Institute-branch Ostrava (WRI), the Mining University in Ostrava- Ecological Institute (EI) and the Water Management Authority Povodi Odry (PO).

Several other studies have addressed the environmental problems in the Ostrava region. Of particular relevance is the Baltic Sea Environmental Programme (BCEOM, 1992), the project Silesia (Industrial Economics and Sullivan Environmental Consulting,1992) and the National Odra project (WRI, 1993). The national Odra project will end in 1995.

The Baltic Sea Declaration was adopted by the Heads of the Governments of the Baltic Sea states, and included a target objective of the adoptions of measures to reduce the 1987 levels emissions by 50% by 1995. The Czech Republic is a contracting part to the declaration. The pre-feasibility study in the region which was executed in 1992 as a part of the Baltic Sea agreement, aimed primarily at reducing the pollution to the Baltic Sea not specifically to improve the local and regional water quality.

The World Bank project "Silesia" represents an external aid to the protection of the environment, and its objective is to stop the process of environmental deterioration. The study has performed a risk screening analysis for air pollution, occupational diseases, food contamination, waste disposal, drinking water contamination and surface water pollution. Phase two of the project is now being executed, but focuses on air pollution.

The T.G. Masaryk Water Research Institute in Ostrava (WRI) is currently executing a project in the Odra River funded by the Czech Ministry of Environment. The objective of this project is to obtain necessary data for the elaboration of an abatement strategy for the Odra River.

The other studies have served as a basis for this report, especially the National Project Odra. But as The National Project Odra will end in 1995, this study will hopefully contribute to the national project as well.

2 Study area

The Odra River starts in the Czech Republic and flows to the Baltic Sea. The catchment area is divided between Poland, Germany and the Czech republic. The Odra River Basin in the Czech Republic constitutes approximately 5% of the total catchment area. Odra river, in the Czech part, has a total length of 120 km, and the catchment area extends through the Northern Moravia and Silesia Regions. The main tributaries to the Odra River are Olse, Opava and Ostravice.

The climate in the catchment area is characterised by a mixture of ocean and continental climate, and in periods with drought the water demands in the region can-not be met. There has been dams constructed in the region to handle this, where the reservoirs Kruzberk, Sance and Moravka are used for drinking water supply.

Total population in the Czech part of Odra River is approximately 1.3 million where 1 million of these live in urban areas. Ostrava is the largest city with approximately 330.000 inhabitants. Large parts of the catchment area is agriculture land (ca. 50%). The main crop is potato, but there are also many pig and cattle breeding farms. Forested areas constitute 35% of the total area, and forestry is a major activity in the region and forms the basis of several industries.

The Ostrava region is heavily industrialised, and several polluting industries are located in the area. The industry in the region is in general extractive industry (coal and copper mines), coke ovens, metallurgy (steelworks and non ferrous foundries), power stations, pulp- and paper industry and chemical plants. Agrofood and textile industries are also present with several medium size factories. The activities in some of the heavy industries are presently decreasing.

3 Environmental administrative management; institutions, instruments and legislations

In any country, water management is a part of a larger resource, land use, nature and environmental management system. Chapter three presents the main features of the Czech water management in its transitional context. Emphasis is on the situation in the Odra river catchment area.

The water management law (Act no. 130/1974 Sb.) § 1-7 establishes four core institutions in the Czech water management system. The Ministry of Environment is the superior "water management body" (vodohospodárský orgán), the other bodies being (a) the District Offices, (b) the Czech Environment Inspection and (c) the municipalities.

For most parts of public administration the shift from state socialism to an open, pluralist system means that policy relevance has to be focused upon much more often than before, to the detriment of pure scientific considerations.

The water management system has to adapt to the general changes in the administrative system, which among others are:

1: Some administrative tasks are now performed by local self-government units
2: The public administration has to interact with independent economic entities that are to function along market lines
3: The public administration has to perform in an open society based on democratic policy-making
4: The public administrative system has to prepare for a new, second tier self-government level
5: State institutions are decentralised in order to create de-concentrated units of state power
6: Re-evaluation of the expertise profile
7: Handing over of several administrative tasks to semi-private or private institutions and firms

'Local self-government' versus 'state government' has become a familiar dichotomy that most Czech citizens consider to give a substantial explanation of where the conflict lines are stretched between political elites in the country today. The municipalities have responsibilities in water management. They regulate and limit use of surface water, decide in cases of conflict over water use and charge those who damage public sewage or water supply.

Local self-government, however, is not the only result of the decentralisation trend. Various types of decentralisation have been carried out with Czech public administration in order to secure a regional presence of sectorial ministries. The regional departments of the Ministry of Environment are examples of this.

Central government bodies at the District level - the District Offices - seek to bring about coordination and harmonisation against sectorial and localist challenges. The new level of government at a larger regional level envisaged in the new Constitution would strengthen the coordination of public policies.

The District Office Environmental Division has a special responsibility for coordinating water management in the District. The District is responsible for setting the discharge limits for all sources of water pollution. It also defines the individual time limits for compliance concerning water polluters. The emission limits are calculated by the architect (construction engineer), who has to ensure the emission limits conform to the use limits of the river. This calculation has to be approved by Povodí before it can be released as an officially valid discharge permit. The Inspection is composed of regional inspections, and checks whether the discharge permits are followed. The Inspection and the District are at the same level of power, and have some overlapping control competencies.

Privatisation and semi-privatisation of water management relevant institutions have taken place. Initially all the polluting enterprises themselves are under privatisation, a fact that requires special attention because the skills of environmental authorities that treat privatised and private businesses require different skill than needed previously. Economic, legal and administrative tools now will have to be used skilfully.

Also organisations that used to be a part of public administration now are becoming independent profit-making entities. The water supply and sewage companies are privatised and quite often split up into smaller companies covering more or less adequate areas as seen from a water management point of view. The watershed organisations (Povodí) are now shareholding companies owned by the state. The watershed organisation is the manager of water. It sells water and is responsible for the cleanliness of it. The watershed organisation gives obligatory expert opinions to the authorities.

Despite the fact that the procedures for environmental and water management in the Czech republic today opens up for public participation, e.g. through the system of Environmental Impact Assessment, public awareness and the level of environmental activism are very low.

All in all a viable structure for a well-functioning public administration is established in the Czech republic. It is no longer time for major restructuring. Now the task lies in making the structure work. Open discussions and ample possibilities for critical self-reflection among the practitioners - for instance in the water management sector - is indispensable in order to make this come about. Professional evaluations of how the system functions should form the basis of enlightened debates on how to improve the working of the public administration.

4 Water quality and effects

Czech classification of water quality and monitoring in the Odra river Basin

A comprehensive water quality monitoring programme is executed in the Czech part of the Odra River Basin. 34 of total 80 profiles have been used in this report to characterise the water quality in the catchment area.

The water quality is classified according to the Czech standard CSN 72 7221 in five classes based on the yearly calculated C_{90} value: Class I, Very pure water, class II, pure water, class II, polluted water, class IV,very polluted water and class V extremely polluted water. The water quality classes in the Czech system are indirectly related to user interests and the water's suitability for use. Different system for classification can not be compared directly, because the difference in natural water quality can be considerable. The Czech standard for phosphorus and heavy metals seems however to be very liberal, compared to USEPA, CCREM (Canadian criteria) and the Norwegian criteria.

Effects of pollution in the Odra river catchment

The water quality situation in the Odra river catchment, especially in the central parts of Odra river and in the mouths of the tributaries, must be characterised as very severe according to the effects on human health and the effects on ecology. The poor water quality affects the user interests in the catchment area (drinking water, recreation and industrial water supply), and the water has a very limited value of use. At some profiles the water is not suitable for any activity except being a recipient for waste water.

The river is very to extremely polluted (water quality class IV-V in the Czech classification system) for many of the pollution parameters; Organic matter, nitrates, ammonia, phosphorus, bacteria and particles. The heavy metal concentrations are also very high at many sites, even when bearing in mind that the Czech classification standard is very liberal for phosphorus and heavy metals compared with other standards.

The high nitrate content affects the drinking water quality both in reservoirs (especially in Kruzberk) and in ground waters. Bacteria contamination of drinking water has also been identified as a potential health risk. The heavy metal concentration and other micro pollutants also represent an acute and chronic risk to human health and the ecology. Blooming of toxic blue green algae contaminating the drinking water have not yet been reported as a problem, but there is a potential risk for this effect with the extremely high phosphorus values in the reservoirs. The extremely high content of phosphorus would normally also results in eutrophication of the rivers, but can be prevented due to other pollution (over loading of organic matter and high content of suspended solids, heavy metals etc.). The need and effects of phosphorus reduction should be investigated in detail.

The high ammonia concentrations can result in fish kills, and the bad oxygen conditions at some of the sites can also result in acute effects on the ecology. The high content of BOD, at places with large outlets of easily degradable organic matter, may change the biological diversity locally to more hetrothrophic species.

5 Need for pollution abatement

Setting water quality objectives for a recipient

To set objectives for a water course involve choices between consideration to human health, ecology and even to other important tasks a community are obligated to solve. The objectives for resulting water quality should therefore be related to/ or reflect the user interests in the recipient area. Each user interest will require a certain water quality with respect to human health, to ecology or to both.

The water quality objectives (according to the Czech classifications system) and the estimated need for reduction of pollution for the water courses in the Odra river catchment, have primarily been based on resulting water quality and the regional and local effects on ecology and human health. The effects have been related to the user interests in the area.

The water quality objectives have also reflected environmental legislation/standards and external factors like governmental obligations, EU's demands etc. The Baltic Sea Declaration of reducing the pollution with 50% and regulation 171/92 in the Czech environmental law, have therefore been considered in addition to the resulting water quality.

Finally there must be a comparison/evaluation of the objectives and the reality to reach these goals which depend on available technical solutions to reduce the pollution, the costs of the investments actions and the level of natural water quality.

Objectives for the water quality in Odra

To set some goals for the water quality in the Odra river catchment, WRI has suggested to give a certain area a recipient status. The user interests (today's user interests and potential user interests in the future) are not determined in detail, but the recipient status reflects the main user interests in the area. The Odra river catchment has been divided into three categories, and the following objectives for the different areas are set:

The water quality in the upper part (recipient area A) of Odra must correspond to water quality class I-II. This area has a high protection value, and the three main drinking water reservoirs are located in this area. The objectives for the middle part of Odra (recipient Area B) must correspond to water quality class II and III. There are no drinking water interests in this area, but this part of the catchment area has a high recreation value. The water quality must be suitable for fishing and bathing. Water quality class III for some of the parameters have been proposed in the lowest part (recipient area C) to change the condition from a waste water stream to a stream suitable for a limited use.

Based on the status in the recipient, the effects on ecology, human health and user interests, some special efforts must be put on reducing; organic matters (BOD), total nitrogen (tot-N), total phosphorus (tot-P), suspended solids (SS), zinc (Zn) in particular and heavy metals in general (see figure 4.2-4.15). The bacteria content must also be reduced.

Four alternative objectives have been evaluated according to the proposed recipient status and the effects on local- and regional water quality, but the objectives reflect the Baltic Sea obligation as well. Objective 1 is the most liberal objective proposed in this report, and objective 4 is the most conservative. Local effects, especially for phosphorus (possible eutrophication effects), but also for nitrogen compounds (ammonia-fish kills and nitrate-drinking water supply), should be investigated further before the final water quality objectives are accepted.

Even with the most conservative objective for phosphorus, one can expect euthrophication problems, especially when the other pollution, especially toxic pollution, are reduced. Need for further abatement can be required to obtain local effects. On the other hand the level of other pollution can still be too high to prevent this effect in the future.

Method to calculate the need for reduction

The difference between the water quality in the river today and the objectives set for water quality in the different parts of the catchment area, gives the need for pollution reduction. The water quality is classified according to the C_{90} value (90 percentile), and this maximum concentration occurs for some parameters at low flows, but other parameters follow the variations in water flow.

It has not been within the scope of this project to prepare a dose-response model. To find an appropriate method to calculate the need for reduction based on the critical values (C_{90}), data for water quality have been compared with the water flow in 7 profiles in Odra. Based on this the following formula has been proposed :

$$Mx, reduction = [C90, today - C90, objective] * fx * Q180$$

Where Q_{180} is the statistical median flow in the respective rivers and fx (table 01) is a factor for the relationship between median concentrations and C90 concentrations.

Table 01: Relationship between Cmedian and C_{90} for different pollution parameters

Parameter	Cmedian/C90
BOD_5	0.6
SS	0.4
Zn	0.4
$N\text{-}NH_4$	0.5
N-NO3	0.7
Tot.P	0.5

The formula and coefficients are not based on a comprehensive statistical analysis, and ought to be investigated further if this simplified method is going to be used for rough estimations.

Need for reduction in the river profiles

The need for reduction has been calculated for BOD, nitrogen, phosphorus, suspended solids and zinc (see table 02). The estimated need for reduction in different river profiles (table 02) must not be regarded as absolute (referring to the method used for calculation and the fact that the calculation is based on one year C_{90} values), but will give an idea of the need for total reduction if the objectives for water quality are going to be met. The current work with the dose-response model QUAL 2 at WRI, will give more exact data on the total need for pollution reduction.

Resulting water quality after pollution abatement-methodology

Discharge of pollution in one section of the river gives an effect on the water quality in downstream sections. If the self-purification in the rivers is not considered, the need for total investments will be over-estimated, and the wrong solutions to improve the water quality may be proposed. The dose-response should be based on comprehensive models and studies, but as an approach to be able to calculate the effects from different sources, only some qualified assumptions about the self purification capacity in the river for the different pollution parameters have been done in this study. The self-purification capacity has been calculated by simple equations and based on local knowledge.

Table 02: Need for reduction (tonnes/year) in some river profiles in Odra .

Nr	Profile	Objective 1					Objective 2		Objective 3		Objective 4	
		BOD	SS	Zn	Tot-N	Tot-P	Tot-N	Tot-P	Tot-N	Tot-P	Tot-N	Tot-P
1	Odra-Bohumin [9]	1861	10172	274						1299[1]	2098[4]	1299[1]
2	Odra Petrkovice [6]	91	11982							264	1262[4]	264
3	Odra Svinov	422	4451							45[8]	300	45[8]
4	Odra-Polanka	422	17845							103	157	103
5	Odra -Studenka		1361							84	312	84
6	Odra-nad Jicinkou		770							5	63	5
7	Odra-Jakubcovice									7	0	7
10	Bilovka Pod Sezinou	14	159							5)	89	5)
11	Jicinka-Kunin	68								21	67	21
12	Ostravice-Muglinov	398	3674	31						182	37[4]	182
13	Ostravice-Vratimov	2)								48	0	48
16 B	Lucina	25								28	119	28
18	Opava-Hostice	672	677							123	135[4]	123
20	Opava-pod Krnovem	13	213		52	46	52	46	52	59	52	59
22	Hvozdnice-usti	2	173							10	105	10
24B	Moravice.Sl. Harta	115			310	22	310	28	310	28	310	28
26	Zlata-Opavice	52			173	5	173	7	173	7	173	7
27	Olse-Vernovice	2)								221	0[4]	221
28	Olse-nad Stonavkou	2)								86	0[4]	86
29	Olse pod Tesinem	2)								83	108[4]	83

[1]The value for phosphorus seems to be high compared with values in Olse Vernovice and Odra Petrkovice. Need for reduction in this profile is based on a calculated C_{90} value

[2]There is no need for BOD reduction in these profile according to the water quality data. CODcr value is high and ought to be reduced.

[3] It is assumed that 10% of the total nitrogen is nitrogen connected to particles. The values in appendix 11.7 have been corrected according to this in the table above (personal information WRI, 1994).

4 The need for reduction of ammonia (N-NH4) is much higher

5) Phosphorus is not measured in the profile, but will according to the obejctives most likely have to be reduced

[6] The improved water quality for BOD compared with profile 3 is caused by the influence of Opava river

[7]The number seem to be very high compared with the other profiles and may be caused by one high peak

[8]The number seems to be very low compared with profile 4 and 2

[9]The need for reduction in pollution is caused by pollution from Ostrava region and the extremely polluted river Ostravice.

6 Pollution sources and identification of main polluters

<u>Estimated pollution budget</u>

The Odra River Basin belongs to the most exposed regions to pollution in the country, and the rough pollution budget prepared in this report indicate that anthropogenic sources in the catchment area constitute 97% of the total pollution. The poor water quality is caused by pollution from industrial activities and insufficient treated waste water from municipalities (included sewage from inhabitants which are not connected to public sewage). The contribution from point and non-point sources in the agriculture sector is also significant. Municipalities are the dominating source to phosphorus pollution, and agriculture is the dominating source to nitrogen pollution. Industries give a relatively small contribution to the total loads of BOD, Tot-N and Tot-P, but is responsible for heavy metal pollution and other micro pollutants.

Table 03: Rough pollution budget

	Municipalities				Industries	Agriculture		Background pollution		Total
	WWTP, SmVAK, OVAK*	Smaller WWTP	Rural areas**	Leachates solid waste		Run-off	Point, sources	Forest	Water	
BOD (ton/year)	5872	3114	7414	500	1 434	-	-	-	-	-
COD (ton/year)	20609		-	-	14 979	-	-	-	-	-
Tot-N (ton/year)	4643	726	1424	25	1 363	7390	1035	548	25	17179
Tot-P(ton/year)	930	181	356	5	36	71	128	44	2	1753
Zn (ton/year)					58					-
Fe (ton/year)	7			8	166					-
Pb (kg/year)					238					-
Cu (kg/year)					951					-
Ni (kg/year)					909					-
Hg (kg/year)					10					-
Cd (kg/year)					39					-
SS (ton/year)	6893	1779	7414	-	4915					-

* Bypassed sewage at the municipal waste water treatment plants is not included in the budget except for the largest WWTP plant - Privoz. The total numbers for bypass is not known, but the data from Privoz indicates that this can be considerable. The sewage system is based on combined sewers, and the storm water is assumed to be included in the outlet from the WWTP. Registered phosphorus values at the waste water treatment plant may also be underestimated, which might have resulted from unrealistically low P-discharge concentrations from simple biological WWTP.

** The selfpurification is assumed to be considerable before the pollution enters the water courses.

Table 04: Contribution from different anthropogenic sources [%]

Param.	Municipal					Industries	Agriculture
	WWTP, SmVAK,OVAK	Smaller WWTP**	Rural area	Leachates Solid waste	Total		
BOD*	32	17	40	3	92	8	-
Tot-N	28	4	9	0	41	8	51
Tot-P	54	11	21	0	86	2	12

*Compared only with pollution from municipalities and industries

**The total loads entering the water courses are much lower, due to selfpurification and some reduction in septic tanks etc.

<u>Identification of the main pollution sources- Multi criteria analysis for selecting the "Hot-spots "</u>

A lot can be achieved by targeting the major polluters in the catchment area, but the identification of the most important polluters will depend on the criteria of requirements; if one want to define the polluters according to discharge loads, resulting water quality, violation of discharge standards etc. It is not possible to propose an absolute ranking method, so the ranking has been based on several multicriteria analytical methods. Six multicriteria methods have been discussed, evaluated and proposed in this review. Two of these methods (PO-I, WRI-I) are based on the relation of pollution loads to the discharge limits for each source according to regulation 171-I. One method (PO-II) is based on pollution loads to the recipient and critical loads in the recipient according to the regulation 171-III. The next method (WRI-II) is based on the pollution loads, recipient status and the critical loads according to the regulation 171-III. A method (BCEOM) used in the Baltic sea report (BCEOM, 1992) based on differential weighting of pollution parameters in a multicriteria analysis are also analysed. Finally a method (NIVA) which partially combines some of the above methods are presented. This part of the study has been co-financed by NIVA.

The evaluation of the methods, assisted with a qualified selection, gave a very good result and identified 25 "Hot spots" which constitute 67-100% of the total pollution loads from the 250 major polluters in the catchment area.

The 250 major polluters mainly consist of the biggest WWTP in the area (60% of the inhabitants) and industrial sources. The total loads from the remaining pollution; smaller waste water treatment plants (15% of the inhabitants), sewage from inhabitants not connected to public sewage(25%) will also give a significant contribution to the total pollution loads. This remaining pollution is, however, spread on a high number of polluters, and do not separately give a significant contribution to the total loads. The local problems caused by these sources can however be considerable, and the neccecity of these measures to reduce these local effects should be addressed in detail.

Agriculture will also give a significant contribution to the total loads, but has only been touched briefly in this report. Measures for agriculture should be investigated further, while these can give a significant contribution to restore the ecological balance in the region.

7 Proposed environmental priority action programme-Technical measures

Abatement programme-cost/benefit

Measures for 23 of the 25 hot spots have been proposed based on the total loads from each "Hot spot" and/or if the local water quality require a better treatment. The discharge limits set in reg 171/92 have been reflected, but as the study mainly has focused on resulting water quality it has not been proposed measures if these are not solving local problems or give a significant contribution to the overall pollution in the catchment area.

The technical solutions for municipal waste water are based on upgrading of the existing overloaded biological WWTP. Nitrogen and phosphorus removal have also been introduced at some of the plants.

The presentation of a complete abatement programme for industries, is impossible within the frame of a study like this. The study has therefore concentrated especially on the criteria of "how important it is to reduce the load of a parameter from a specific industry to the river". This approach obviously has it's weaknesses, for example not giving priority to the nature of a specific industry. The status and potential of the existing industrial WWTP have not been addressed in detail, but should be considered prior to the selection of final measures. In this study, primarily the costs for external treatment are included, but one should also be aware of the possibilities for change in technology. It has also been proposed by the owners of some of the plants. Due to the widely variable industrial processes, the estimated costs must be considered strictly as guideline values.

Some general measures for agriculture have also been proposed, based on the Baltic Sea study.

Table 05 and 06 show the prioritised "Hot Spots", the reduction in tonnes/year for these sources after the measures, the estimated annual costs and the profiles which are affected by the reduction. The cost/benefit ranking is based on annual costs compared to removal of pollution in tonnes/year. The cost/benfit at municipal WWTP can not be compared with the benefits for industrial sources, while the investments at municipal waste water treatment plants mainly reduce organic waste, suspended solids and nurtient and measures at industrial sources mainly target heavy metals and other micro pollutants. The cost-benefit ranking is based on the multicriteria ranking only where two sources have the same cost benefit-ratio, but otherwise it does not fully take into account the fact that the local water quality problems for some sources may be larger than others. The ranking of industrial sources after the cost benefit ratio is even more difficult, since it is different parameters which are reduced. This means that the real cost-benefit ratio for both municipal and industrial sources may be better reflected in the ranking based on the multi criteria analysis, which in addition to total outlets also reflects local water quality problems.

Capitalized unit costs (20 years lifetime and 12% interest) and yearly operation and maintanance costs for the municipal "Hot spots" are estimated to 29 mill US$, where 2/3 of the total costs are due to nitrogen removal. The investments on industrial sources target primarily heavy metals and results in high annual costs (23 mill US$), giving total yearly costs for "Hot-spots" of 52 mill US$.

Table 05: Abatement programme for municipal "Hot spots"

No	Source	BOD	CODcr	SS	Tot-P	Tot-N	River profiles	Total profiles	Annual Costs 1000$US**
1	Ovak Ostrava-Ucov Privoz	536	1838	761	139	795	1	1	8523
2	SmVak 04-Novy Jicin	33	394	8	28	28	11,5,4,3,2,1	6	293
3	SmVak 03-cov Havirov	123	463	144	135	367	16B,12,1	3	5056
4	SmVAK 02-Cov Trinec	77	277	38	15	207	31,30,29,28,27	5	2239
5	SmVak Frydek Mistek	889	2051	567	46	97	13,12,1	3	1691
6	SmVak 06-Cov Opava	317	1808	339	22		18,17,2,1	4	315
7	SmVak 03-Cov Karvina	89	671	133	82	146	27	1	2307
8	Ovak Ostrava-Cov Trebovice	125	437	239	71	483	2,1	2	5577
9	Ovak Cov Zabreh	29	98	21	8	50	3,2,1	3	588
10	Vak Bruntal-Cov Bruntal*	52	217	26	10	8	24B,24A,17,2,1	5	111
11	Vak-Bruntal-Cov Krnov	142	120	46			21,20,19,18,17,2,1	7	113
12	Ovak Ostrava -Cerny Prikop	522	665	730		17	1	1	626
13	SmVak 03-Kanalizace Bohumin	567	714	533		12	1	1	680
14	SmVak 04-Kanalizace Bilovec	19	84	23		1	10,4,3,2,1	5	23
	Total	3519	9838	3620	555	2212			29121

* No effect of BOD in profile 1 and 2 ** Annual costs =Capitalized unit costs and yearly O&M costs

Some of the municipal waste water treatment plants managed by SmVAK and OVAK are not within the selected Hot spots, but will not manage to fulfil the requirements in reg 171/92 after year 2005. Action should also be considered for these sources.

In addition to technical measures accompanying measures for the "Hot-spots" must be considered. Accompanying measures have been addressed as an own part of this study, but at the WWTP some special problems have been identified; An analysis of the projected and the measured efficiencies (1993) of WWTP reveals considerable differences in several WWTP. This is suspected to be caused by non-optimal operation and/or by unexpected industrial discharges which are toxic to biological processes. The strengthening of the technological awareness among process personnel working in WWTP will play a key role in this aspect. It is suggested to actively utilise common forums to discuss such problems and promote technological competence. The Norwegian WWTP forum "NORVAR" is an excellent example regarding this. The quality assurance of measurements should be an important aspect in all monitoring procedures. It is also very important to register the by pass amounts in order to get the total picture of the discharge. Among other measures, lab- and pilot-scale on-site process optimisations are suggested, which are also addressed in the recommendations.

Table 06: Abatement programme for industrial "Hot-spots"

No	Source	Reduction [tonnes/year]						Reduction [kg/year]					River Profiles	Annual Costs*
		BOD	COD	SS	Tot-N	Fe	Zn	Hg	Cd	Pb	Cu	Ni	No	1000 US$
1	BochemieBohumin	41	224	10	9	8	7	5	12	48	18	81	1	1900
2	Hrusovska Chemica Spolecnost			210		16	13		3	40	18	30	1	1400
3	Massag Bilovec-NS										6	176	10,4,3,2,1	1900
4	Valcovny Plechu-Hlavni Op.									32	32	16	13,12,1	1500
5	Biocel Paskov	221	4199	176	29								12,1	3600
6	ZD Bohumin Zelezarny		1209	85		9	1						1	1400
7	Trinecke Zelezarny		642	321	71	21							30,29,28,27	7300
8	OKD Koks. Sverma Mar. Hory			789		11							1	1000
9	Nova Hut Ostrava-Cov Lucina				186	7	5						12,2,1	3100
	Total	262	6274	1592	295	78	29	5	15	119	74	303		23100

* Annual costs =Capitalised unit costs and yearly O&M costs

Table 07 shows the reduction in pollution load due to the measures at municipal and industrial sources. The reduction in loads of organic matter, nitrogen, phosphorus and heavy metals from municipal and industrial "Hot-spots", compared with the total loads from the 250 registered sources, will be halved with the proposed measures. The abatement programme also results in considerable reduction of pollution when the total loads from anthropogenic sources are taken into consideration (Tot-N, over 20% for BOD, 33% for Tot-P and 50% for heavy metals). The importance of the proposed measures to the improvements in water quality in Odra compared to the remaining municipal pollution, is considerable higher, while these sources will have a direct effect on the water quality. The selfpurification especially for sewage from rural areas is assumed to be large and reduce the pollution before it is entering Odra.

Table 07: Pollution reduction from municipal and industrial "Hot-spots" compared to total loads [%]

	BOD*	Tot-N	Tot-P	Fe	Zn	Hg	Cd	Pb	Cu	Ni
Municipal Hot-spots % of total loads from municipal sources within the 250 registered sources	60	48	60							
Municipal Hot-spots % of total loads from municipal sources	21	32	38							
Municipal Hot-spots % of total loads from anthropogenic sources	19	13	33	0	0	0	0	0	0	0
Industrial Hot-spots % of total loads from industrial sources within the 250 registered sources	18	22	0	43	47	50	50	50	47	49
Industrial Hot-spots % of total loads from anthropogenic sources	1	2	0	41	47	50	50	50	47	49
Municipal and Industrial Hot-spots % of total loads from the 250 registered sources	52	42	57	43	47	50	50	50	47	49
Municipal and Industrial Hot-spots % of total loads from municipal and industrial sources	21	31	37	43	47	50	50	50	47	49
Municipal and Industrial Hot-spots % of total loads from anthropogenic sources	21	15	33	41	47	50	50	50	47	49

*BOD total anthropogenic sources referring only to municipal and industrial pollution

Based on very approximate estimations the measures for agriculture seem to give a significant contribution to the reduction of total nitrogen (9%), phosphorus (10%) and organic matter (not estimated) loads. Rough calculations show that these reductions can be obtained with a total costs of 40 mill US$. The cost benefit for agriculture seems therefor to be a little bit higher but comparable with investments at municipal sources. This indicates that abatement in agriculture can be cost efficient. The effects of the measures and the costs in agriculture are however uncertain and should be investigated further.

Resulting water quality

The proposed abatement programme in the Odra river catchment will improve the surface water quality significantly, and to some extent restore the ecological balance. The ground water quality will also be improved, especially in areas where the wells are shallow and influenced by the river quality. The objectives for water quality proposed in this report are achieveable for organic matter, nitrogen (ammonia and nitrate), phosphorus, suspended solids, heavy metals and bacteria, especially in central parts of Odra, and in the mouth of the tributaries.

The abatement programme reduces only to some extent the pollution in the upper parts of the catchment area, and other sources must be investigated and target (especially agriculture, outlets from smaller WWTP and sewage from inhabitants not connected to public sewage) to achieve improvements in local water quality in these areas. The pollution reduction will result in:

- Improved oxygen conditions.
- Reduced episodes of fish kills and other acute ecological effects.
- Reduced chronic effects on the ecology.
- Reduction in the chronic and acute effects on human health by improving the drinking water quality.
- A more pleasant looking river with increased transparency
- Improved water quality according to the user interests in the area
- A significant reduction of the anthropogenic pollution to Poland and the Baltic Sea.
- Reduction in the risk of euthrophic water and blooming of toxic blue green algae
- Fewer violaters of the environmental law (regulation 171/92).

Need for further reduction in all the above mentioned pollution parameters, should be investigated especially considering local effects, and the effects on ground water and drinking water reservoirs. Separate abatement programme for the drinking water reservoirs should be prepared. The final goals must be discussed in detail by water mangement authorities and politicians, especially the goals for phosphorus and nitrogen.

The level of the objectives for nitrogen set in this report may be reviced taking only the local effects of nitrogen into account (ammonia-fish kills and nitrate-ground water), but regardless of the local effects the measures will be necessary to meet the requirements in the environmental law (reg 171/92) and to contribute to achieve the obligations in the Baltic Sea declaration.

The level of phosphorus reduction according to the potential risk for eutrophication and blue green algae blooming, must also be investigated further. It is very important that necessary research is carried out to predict these effects both in the drinking reservoirs and in the rivers, in order to implement the necessary measures. The Water Authority should, however, judge if the proposed abatement for phosphorus must be implemented regardless of the local effects, to meet the obligations in the Baltic Sea declaration and the requirements in the Environmental law (reg. 171/92).

Further studies and measures:

- Protection of drinking water quality

  A cost-efficient abatement programme to reduce the pollution from municipalities, industry and agriculture to the drinking water reservoirs; Kruzberk, Sance and Moravka including restoration measures in the reservoir should be prepared.

  In the preperation of the plans for the new big Slezska Harta drinking reservoir, registration of pollution sources, need for restriction on the activities and how to use land use planning and other legislation as an efficient tool should be addressed.

  Methods and models to calculate eutrophication effects in the Czech reservoirs should be investigated.

  Sub-surface water need to be protected, and there is need for studying the water quality situation, location of sub surface water used for drinking water supply and the need for pollution abatement

- Abatement strategies for agriculture

  The contribution to pollution from agriculture should be addressed including registration of pollution sources and other site specific data. Routines for the collection and the compilation of data should be established.

  Methods and models for calculating contribution from non-point pollution sources should be adapted to Czech conditions.

  There is also need to prepare a cost-effective abatement programme for agriculture including both technical and accompanying measures

- Eutrophication effects in polluted rivers-need for phosphorus removal

  The euthrophication effects in polluted rivers and the need for phosphorus reduction should be investigated, and the program should include the following steps:
  -Review of natural background levels of water quality in pristine areas (reference water)
  -Laboratory experiments to determine algae growth potential in pristine and unpolluted waters with a known P-concentration and in reference water which has been added phosphorus to the same levels as in polluted water.
  -Prediction of effects of phosphorus pollution when other pollution are reduced in the rivers.
  -Evaluation of the need for phosphorus removal to prevent local and regional effects.
  -Evaluation of the need for stricter water quality criteria
  -Evaluation of methods for measurement of phosphorus- quality assurance.

- Measures to reduce pollution from MWW-Exchange of knowledge and technology

  There is need for improved routines and measures to reduce the pollution from municipal sources, which may include;
  -Building up water supply and sewage companies capacity to have efficient O&M in WWTP
  -Establish common forum for exchange of ideas and measures
  -Demonstration projects for optimisation or upgrading of WWTP with nitrogen and phosphorus removal.

-Improved technical solutions and strategies for municipal waste water in area without WWTP or in area with small WWTP. This will include a inventory of pollution sources, effects on local water quality, review of alternative measures in rural areas and upgrading of existing WWTP.
-Accreditation (Quality assurance) of pollution loads measurements and their use

- Water quality data and monitoring

There is a lot of monitoring data in the area. It is recommended to do a statistical evaluation of water quality to find correlations between parameters in order to reduce the extent of the monitoring programme.

The water quality data should be systematised, in order to make the data more available, and to use them as an efficient planning tool for pollution abatement.

8 Policy, administrative and economic measures and tools

As an extension of chapter three chapter eight presents some basic problems related to the present water management system in the Czech republic. These problems form the background of the proposed measures.

Since the so-called *'Velvet revolution'* in 1989 the Czech public administration including water and environmental management has undergone a tremendous change in formal structures. The time has come for carefully making it work and improve it when considered necessary.

Therefore the suggestions given in chapter eight focus on small measures mostly within the framework of the present system of environmental management. That makes the proposed measures feasible within the Odra river catchment area. The suggestions are mostly for studies and experimental projects. These ideas are drawn from the Nordic experiences of reforming public administration by small steps. This kind of approach makes it possible to investigate the potentials of the administrative framework given before, and only changing it if necessary.

The main imperfections of Czech water management today is:

- The weakness of the water use plan
- The weak coordination between land use and water use plans
- The non-existence of regionally or locally made water use plans
- The slow influx of specialists into environmental water management having formal background in economic, social, administrative and legal sciences

The following measures are proposed:

- A study ought to be carried out on the potential of land use plans being used systematically as a water management tool.

- The water management bodies and the Ministry of Environment ought to carry out a pilot project on developing procedures for anchoring the Guideline Plan for Water Management in local preferences, for instance via the establishment of municipal water plans. The possibilities of coordinating it with the land use plan should be investigated. The need to bring all user interests into the planning process should be emphasised. Some financing of these pilot projects should be made from central funds.

- An informal environmental management forum for scientific and practical discussions should be established on the new knowledge on migrating pollutants (update on recent research) and how to adapt to, and use, this knowledge in everyday practical environmental management. A second theme for this forum would be production processes and *"cleaner technology"*.

- A group consisting of specialists from each medium should be established with the task to check all fines in order to ensure whether they are given according to the present knowledge on migrating pollutants. The work made by this group should be summed up in a set of recommendation on how to apply the existing legal regulations in a way that comes as close as possible to 'integrated' environmental management.

- A forum consisting of environmental managers and environmental officers from the enterprises should be established to investigate and discuss what *'prevention'* would mean in practice.

- A strategy plan should be made as a joint project of relevant water management bodies in the area. The plan should include a description of the establishment of an efficient working relationship with industries in the catchment area using the mechanisms of economy, administration and education.

- A comparative study ought to be made between the Odra river catchment area and one or more Western equivalents. The purpose of this study would be to describe how the water management institutions, involved in the study, cope with its tasks (tackling legal provisions, economic regulations, handling other administrative institutions and the public) and a description of their employees professional backgrounds. The aim of the study would be to come up with a list of professions the water management system of the Czech republic is lacking to meet modern requirements.

- The water managers in the Odra river catchment area should initiate a study on the regional effects of water management by introducing the second tier level self-government. How should water management in the catchment area relate to this new level? Especially the new possibilities of coordination and harmonisation of interests resulting from the new level of government should be investigated.

- One may set up project groups to solve specific tasks. Environmental tasks are well suited for such project groups.

- One may introduce regular consultation processes (hearings) between the institutions involved.

- One may even introduce systems of rotation where people from the various institutions work in each other's institutions for a period of time.

- An inter-municipal water council ought to be established on a voluntary basis between municipalities in the Odra river catchment area as an "experiment". The results of the co-operation should be evaluated professionally after two years and the reasons for making such cooperation e.g. on a catchment area level should be discussed.

1. Background

1.1 Need for pollution abatement

Surface waters as well as ground waters in the Odra River catchment are heavily polluted, especially in the Ostrava industrial region and its surroundings. In its catchment area there are several districts suffering from severe water pollution, caused by industrial effluents, overloaded treatment plants and discharges from agriculture.

The high level of pollution causes considerable impacts on human health and ecology. There is a definite need to develop sound abatement strategies to achieve long term objectives of reducing the deterioration of the environment in the region, and to restore the ecological balance in the surface waters in the region.

Several studies have addressed the environmental problems in the Ostrava region. Of particular relevance is the Baltic Sea Environmental Programme(BCEOM, 1992), The project Silesia (Industrial Economics and Sullivan Environmental Consulting, 1992) and the National Odra project (WRI, 1993).

1.2 Related Studies

1.2.1 The Baltic Sea Environmental Programme

On September 3, 1990 in Ronneby, Sweden the Baltic Sea Declaration on the Environment was adopted by the Heads of Government of the Baltic Sea States. The Czech Republic is an endorsing party to the Declaration. The Declaration expresses the firm determination of the parties to:

"Assure the ecological restoration of the Baltic Sea, ensuring the possibility of self-restoration of the marine environment and preservation of the ecological balance."

Further, the Declaration calls for the endorsing parties to:

"Urgently prepare a joint comprehensive programme for decisive reduction of emissions in order to restore the Baltic Sea to a sound ecological balance. The programme shall be based on concrete national plans provided by the countries concerned."

In order to achieve its objectives the Declaration called for the establishment of a High Level Ad Hoc Task Force under the auspices of the Helsinki Commission (HELCOM). The Task Force has developed a work plan which provided for the development of the Joint Comprehensive Programme. This plan called for preparation of a series of Pre-Feasibility Studies for Priority Areas. A Pre-Feasibility Study has been undertaken for the whole of the Odra River Basin (BCEOM, 1992).

The Odra River Basin study area included the entire drainage basin of the Odra River in the Czech Republic, Republic of Poland and the Federal Republic of Germany. The objective of the study was to prepare a priority action programme to pre-feasibility level to control and reduce the present pollution of the Baltic Sea from the Odra River Basin in line with the 1990 Baltic Sea Declaration. This includes a target objective of the adoption of measures by the countries in the region to reduce the 1987 emission levels by 50% by 1995.

The French consulting company BCEOM in co-operation with several local consulting firms in the region was contracted by the European Investment Bank (EIB) to undertake the pre-feasibility study. This study has identified several pollution "hot-spots" in the Ostrava region and proposed measures to reduce the emission levels from these. The priority action programme includes measures in the Ostrava region even though the discharges are located a long distance from the Baltic Sea.

The Baltic Sea study aimed at reducing the pollution load to the Baltic Sea and not specifically to improve the local water quality situation, therefore the priority action program emphasised measures with significant effect on the Baltic Sea and not on local effects. Measures that will reduce the input to the Baltic Sea will, however, also contribute to the improvement of local water quality in the area.

The necessity of local abatement in the catchment area is obvious, and the pre-feasibility study for the Odra River Basin will serve as a basis for the proposed project "Pollution abatement analysis of the Odra river catchment and strengthening of the water resource management."

1.2.2 The project "Silesia"

The Regional Environmental Programme in Northern Moravia

The project "Silesia" has been formed on the basis of the activities of the World Bank and represents an external aid to the protection of the environment in the Czech Republic. The project was executed by representatives of the Czech Republic, Poland, World Bank and US-EPA.

The objectives of the project "Silesia" are to stop the process of environmental deterioration in the model area; to reach a significant improvement of main ecological characteristics; and to create conditions for the realisation of a sustainable development strategy in the model area.

To reach these objectives an information, methodological and expert database will be formed and several sub-projects dealing with technological, economical and legal aspects will be integrated into a Master Plan for the region.

Currently Phase 1 of the project has been completed. Phase 1 involves gathering and assessment of available data, gathering of additional data and performing a comparative environmental risk screening analysis for air pollution, occupational Diseases, food contamination, waste disposal, drinking water contamination and surface water pollution (see below).

Phase 2 of the project focuses on air pollution problems due to the high health risk and a high level of exposure to the population. The project in phase 2 deals with different strategies to improve the technology mainly to reduce the air pollution from coke ovens.

In a meeting with representatives of the "Silesia" project it was clarified that the study reported here are complementary to the "Silesia" project.

Screening analysis of Surface Water Contamination and Drinking water contamination

The screening analysis for surface water (Industrial Economics Incorporated, 1992) provides very rough approximations of the human health and ecological risks posed by surface water contamination. In the analysis the surface water quality in the Odra, Ostravice, Olse, Opava and Moravice Rivers have been assessed by characterising current levels of risk to human health and aquatic life. The risk to human health has been characterised in terms of the potential individual risk of cancer and non-cancer health effects associated with exposure to pollutants through recreational use of surface water.

The ecological risk is characterised in terms of areal extent of pollutants stress, as measured by kilometres of river at risk of aquatic toxicity (to fish, invertebrates, and plants) and in terms of the severity of pollutant stress.

In addition, the analysis has identified the major sources of surface water contamination. For certain pollutants the results are based on a rudimentary release estimation and dilution approach that likely overstates the level of risk (Industrial Economics 1992). The main results of this analysis will be presented later in this report.

1.2.3 The national project Odra

The T.G. Masaryk Water Research Institute in Ostrava (WRI) is currently executing a project in the Odra River funded by the Czech Ministry of Environment. The objective of this project is to obtain necessary data for the elaboration of an abatement strategy for the Odra River.

The project is currently focusing on data collection and assessment of the status in the river, and not on a strategy for water pollution abatement. The project Odra does not propose technical measures for the "hot spots" in the region to improve the water quality in the river, but indicates the need for reduction based on the present water quality and the results from a sampling program executed at the worst pollution sources in the region.

The National Odra Project has resulted in a report (WRI, 1993) which characterise the pollution situation in Odra, and has so far pointed out 31 "Hot-spots". The "Hot spots" and the water quality in Odra have been further investigated in the Odra project in 1994.

The work programme of the study reported here reflects the important contribution from the national Odra Project. But as the project Odra will end in 1995, the pollution abatement analysis reported here will be a contribution to the national project as well.

There are eight different stages in the Odra Project:

<u>Programme Stage 01: Quality of water, deposits and sediments.</u>

Based on the result from some of Povody Odry's and the State Surveillance Program monitoring stations, the water quality has been evaluated. In addition, WRI has monitored some special pollutants which are not covered in the regular programs. Sediment sampling has also been undertaken to evaluate the environmental status in the water courses.

<u>Programme Stage 02: Biological Aspects and Biomonitoring</u>

Studies have been undertaken to determine the effects of pollutants on zoobentos, fish and fauna.

<u>Programme Stage 03: Point Pollution Sources</u>

31 key point pollution Sources have been surveyed including hydro toxicological evaluation of the sources.

Programme Stage 04: Area Pollution Sources

Heavy metals, chemical indices, nutrients and PCB have been monitored, especially nitrogen and phosphorus in rainfalls.

Programme Stage 05: Ecological Estimation of Pollution Sources

In this stage a method for setting pollution priorities from an ecological viewpoint was described and used for ranking of "Hot Spots"

Programme Stage 06: Water Management Evaluation

The water management, with special attention to determine the flow rate needed for dilution of organic pollution, has been evaluated.

Programme Stage 07: Hydrological Data and Characteristics

This stage focused on how hydrological elements influenced the water quality monitoring. Another main task was to give hydrological data and characteristics to other researchers of the Odra project.

Programme Stage 08: Water Quality Estimation and Forecasting

This stage involved modelling and prognosis of water quality including complex ecological assessment of the ecosystems. The modelling effort will be used to set water quality objectives in a later stage.

1.3 Objectives of the study

"Pollution abatement analysis and strenthening of the water resource management, Odra River Catchment" started in 1992 as part of the bilateral environmental protection agreement between the Governments of Norway and the Czech Republic. Phase I of this project was reported in January 1993 and outlined the work programme for phase II which is reported here. Phase II has been executed in the period from September 1993 to March 1995. This chapter outlines the objectives of the study and the main task in the working program. It focuses also on how pollution abatement analysis can be a contribution to other studies which are aimed at solving local and regional water quality problems in the region.

1.3.1 Long-term objectives

The long term objectives of the study are;

- to develop planning and implementation tools for the elaboration of an optimal strategy for cost-effective water pollution abatement in the Odra River catchment area.;
- to strengthen and improve the capacity and capability of Czech water resources management authorities; and
- to facilitate the transfer and exchange of knowledge and analytical methods between Czech and Norwegian scientists.

1.3.2 Short-term objectives

The short term objective of the study are;

- to develop a priority water pollution abatement program which includes investment actions as well as accompanying measures for the Ostrava region. The action program will focus on solving the most important local water pollution problems and contribute to a significant reduction of emissions in order to restore a sound ecological balance in the water courses.
- to assess the environmental situation in the study area and to identify the priority sources of water pollution.
- to determine abatement measures for each major source of pollution and to estimate the total costs of the action program .
- to assess the role of local self-government, non governmental organisation , industries and other interest groups in environmental decision making including assessing public awareness and public participation.
- to propose measures to strengthen and improve the capacity and capability of Czech water resources management authorities in view of the expected changes in the administrative system.
- to assess the use of economic instruments including user fees and charges to achieve the objectives of the water pollution abatement program.

1.3.3 Terms of reference

The study has involved the following tasks (see terms of reference in appendix 10.1):

Task 1; Environmental status in the study area
Task 2; Environmental administration and policy measures
Task 3; Sources of water pollution
Task 4; Water Quality - effect model - objectives
Task 5; Evaluation of proposed action
Task 6; Cost-effective abatement strategy
Task 7; Benefits from the proposed actions
Task 8; Reporting

1.3.4 The abatement analysis of Odra compared to related studies

As mentioned there have been and are, a lot of studies in the region focusing on the environmental problems. The national project Odra will in particular be important for authorities to solve local and regional problems, but the project has not so far elaborated a strategy for pollution abatement.

In this study for the Odra river catchment an action programme based on technical measures is proposed as well as accompanying measures. Costs and benefits of the technical measures in terms of reduction of pollutants and improved water quality has been estimated, and will be important and necessary for water management authorities and politicians when making the right priorities and decisions. The long term objective for the water quality in a recipient is a planning tool to achieve cost effective abatement strategies.

This study does not only outline a pollution priority programme, but can also serve as an example (as a method) on how a cost-effective action program can be developed. The study gives a review of the topics which should be covered in this type of study, and how important it is not only to consider the outlets of pollution with respect to the environmental law/standards, but also take into consideration the objectives for the water quality in the recipients. The pollution abatement analysis of the Odra river catchment is also important for transferring and exchanging knowledge and analytical methods between Norwegian and Czech Scientists.

In the next chapters a brief description of the study area, the environmental situation in the water courses and an evaluation of the water management in the region will be given. Based on the water quality status, the need for reduction of different pollution parameters are discussed and proposed. Chapter 6 gives information about different pollution sources and a crude pollution budget has been prepared. The pollution budget gives important information about the different sectors' contribution to the water quality problems, and indicate where special effort can be put to reduce the pollution. In order to identify the main polluters in the region ("Hot spots") several methods have been developed, discussed and evaluated (This part of the project has been co-financed by NIVA). Based on this ranking, technical measures for 23 point pollution sources have been proposed. Finally the costs, benefits and improvement in water quality as a result of the abatement programme have been addressed. Accompanying measures; policy, administrative including economial and legal measures are presented in chapter 8.

2. Description of the study area

2.1 Geographical key information

The Odra river flows to the Baltic Sea, and has a total length of 854 km. The catchment area, 118 900 km^2, is divided between Poland, Germany and the Czech Republic.

The Odra River Basin in the Czech republic constitutes about 5% (6250 km^2) of the total catchment area, and the length of Odra in the Czech republic is 120 km. In the Czech Republic the catchment area extends through the northern Moravia and Silesia region (the main part of it, the southern one, is centred in Ostrava city), and for a small part in the Bohemia region (near Liberec). The area is bordered by Poland to the north and east and with Slovakia to the South.

Figure 2.1 shows where the study area is located in the Czech Republic, and figure 2.2 gives more detailed information of towns, districts and main recipients in the catchment area.

The catchment area can be divided into two parts; 1) The north western part - the Jeseniky region culminating at 1492 m, and is formed of crystalline and igneous rocks and 2) The south-eastern part, the Beskydy region, part of the Carpatian mountains, culminating at 1324 m with rock strata of palozoicera. The Beskydy region is more subject to erosion, and the inclination of the river is double compared with the Jeseniky region. The average altitude in the catchment area is 200-300 m.

Total population of the Odra river Basin is around 15.3 million inhabitants. In the Czech part of the river basin the number of inhabitants is 1.3 million which gives a population density of 210/km^2. Approximately 1 million inhabitants live in urban areas. The largest cities in the region are shown in table 2.1.

Table 2.1. Main cities in the Czech part of the Odra River Basin (NIVA, 1993)

City	Inhabitants
Ostrava	331,000
Havirov	92,000
Karvina	70,000
Frydek-Mistek	66,000
Opava	63,000
Trinec	46,000
Orlova	38,000
Novy Jicin	33,000
Cesky Tesin	29,000
Krnov	26,000
Koprivnice	24,000
Bruntal	19,000
Jesenik	15,000

In the Czech part of the Odra River Basin approximately 51 % of the total area, 3,190 km^2, is agricultural land. The main crop is potato, but there are also many pig and cattle breeding farms. Forest constitutes 35% of the total area, and forestry is a major activity in the region and forms the basis of several industries.

The division between agriculture areas, forest and "other" areas is illustrated in table 2.2 for the different regions in the catchment area. The main part of "other area" is area of towns, roads and other built up areas.

Table 2.2: Division between agriculture, forest and "other" land in different districts

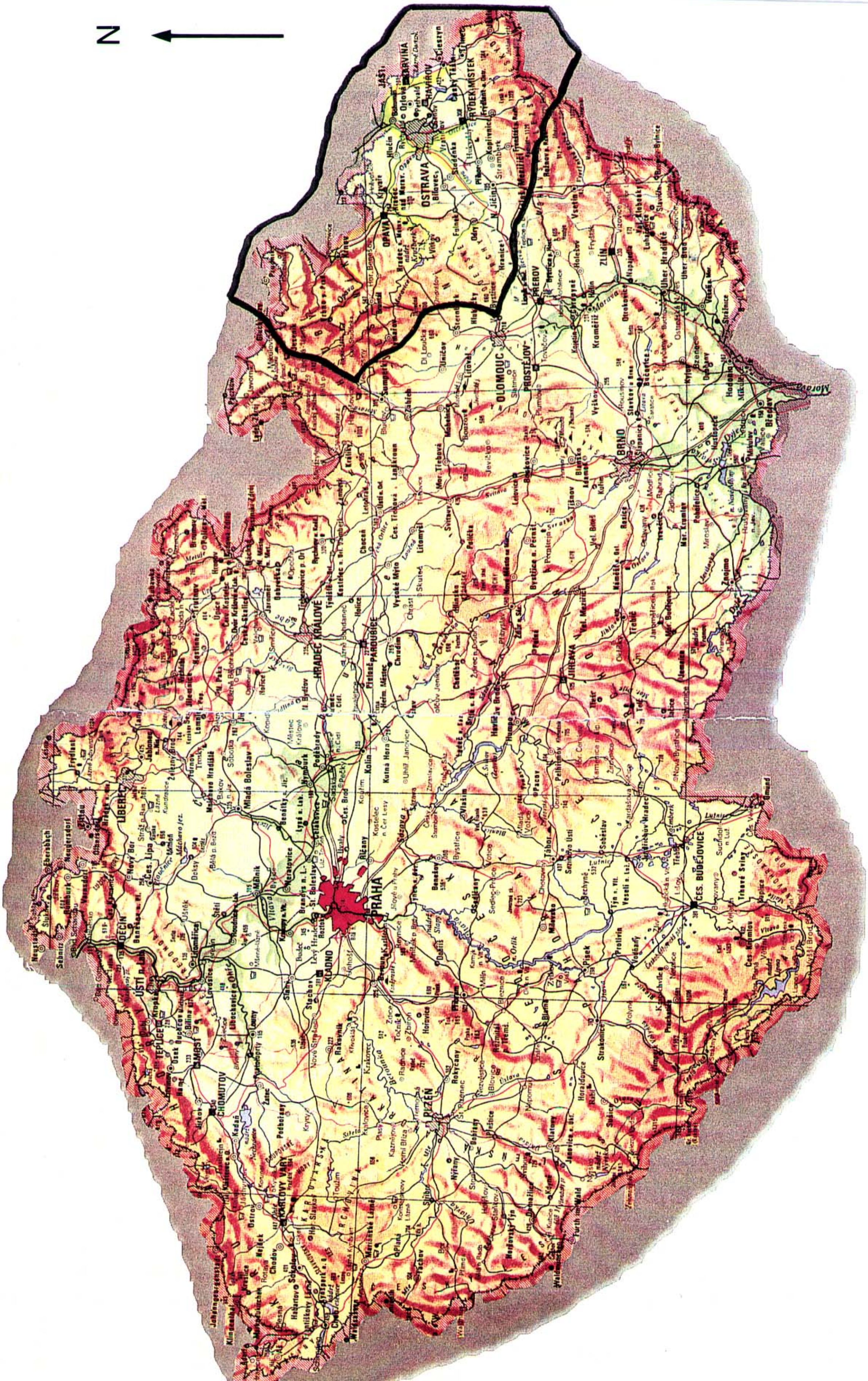
District	Agriculture [%]	Forest [%]	"other" [%]
Frydek Místek	40%	49%	11%
Karvina	51%	14%	35%
Opava	61%	28%	11%
Ostrava	41%	11%	49%
Novy Jicin	66%	23%	12%
Bruntal	46%	46%	8%
Olomouc	56%	27%	18%
Total area	51%	35%	14%

There are also small parts of the total catchment area belonging to the districts Sumperk and Prerov.

The industrial development in the Odra River Basin has been based on the exploration of coal mines both in Poland and in the Czech Republic, supporting the development of the power-, metallurgy- and heavy engineering industry. The chemical and pulp industry is also dominating.

The water demand in the region is very high and the requirements can not be met during periods of drought. Dams have been constructed in the river system to handle this demand. Inland fisheries are taking place in all reservoirs and in fish ponds, particularly confined to the reservoirs (Kruzberk, Moravka and Sance). There is no regular navigable route, but plans exist however, to construct a navigable fairway in the region.

Annually 370 million m^3 water is withdrawn from the river system (surface water). Industry is the most important water user, 60-65% of the total withdrawals. Water works withdraw 20-25%. The water consumption has shown a slight decline the last years. Further decline is expected. Withdrawals of underground water are estimated to 52 million m^3, approximately 14% of the surface water, per year during the last decades. The most significant consumers of underground water are industry and water works.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HRADEC KRÁLOVÉ
PARDUBICE
PRAHA
KLADNO
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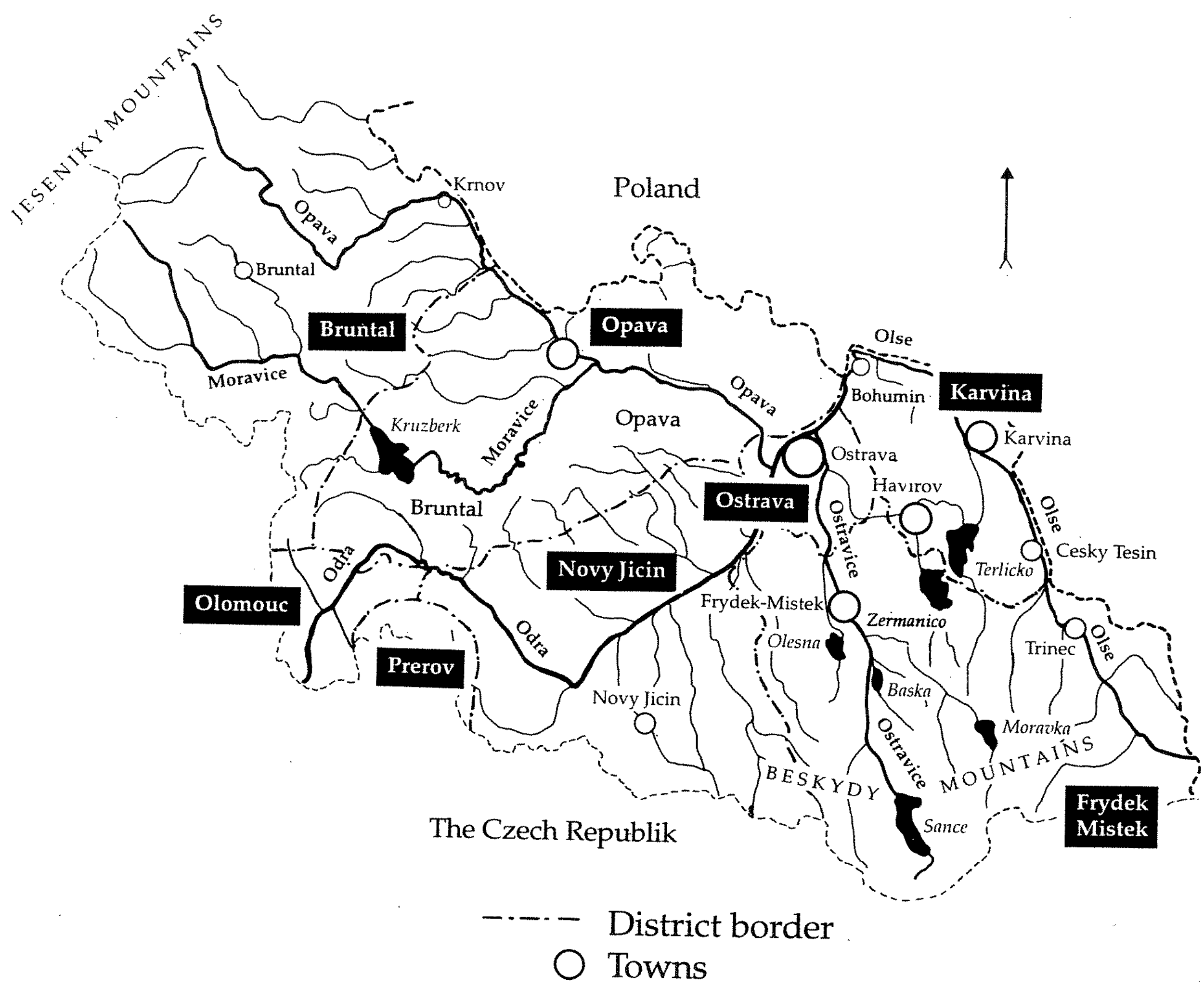


Figur 2.2: Odra catchment in the Czech Republic

2.2 Water courses -Climate

The climate in the catchment area is characterised by a mixture of ocean and continental climate. The average temperature in the higher parts of the region (Jeseniky region) varies from -9.5 °C in February to 16°C in July. In the lower parts (Ostrava), the temperature varies from -2°C in January to 18 °C in July.

The Beskydy mountains get the heaviest rainfalls (average 1500 mm/year). The Jeseniky mountains have an average rainfall of 1200 mm, and the driest part is the Opava region with only 600 mm/year. The rivers in the area have low flows with short extreme floods. The most significant differences in flood is in the Beskidy mountains. Although the Beskidy basin is smaller than the Jesenik basin the specific runoff is higher, and there are no difference, in inflow to Odra from the two regions. The flood in the Jeseniky region is during spring, but during the summer in the Beskydy region.

The main tributaries to the Odra River are Olse, Opava and Ostravice (see figure 2.3). Variation in water flow, length and catchment area of the tributaries and different profiles to Odra are shown in table 2.3 and 2.4.

Odra River has a length of 120 km, and the average yearly inflow to Poland from Odra River is approximately 70 m^3/s. The minimum flow is approximately 11 m^3/s (Q_{330}) and the maximum about 135 m3/s (Q_{30}).

As mentioned in the previous chapter, dams have been constructedin the region to meet the water supply demands. The dams main purposes are to obtain flood control and preserve water quality in the rivers (Brezina,1994). Because of many point sources of pollution the low flows can result in a poor water quality.

Sance, Kruzberk and Moravka are the main sources used for drinking water supply. In addition there are other reservoirs, mainly used for industrial water supply (Olesna, Zermanice and Terlicko). A new reservoir, Slezska Harta, is planned in Moravice river and will be the biggest dam and the main source for drinking water supply in the catchment area.

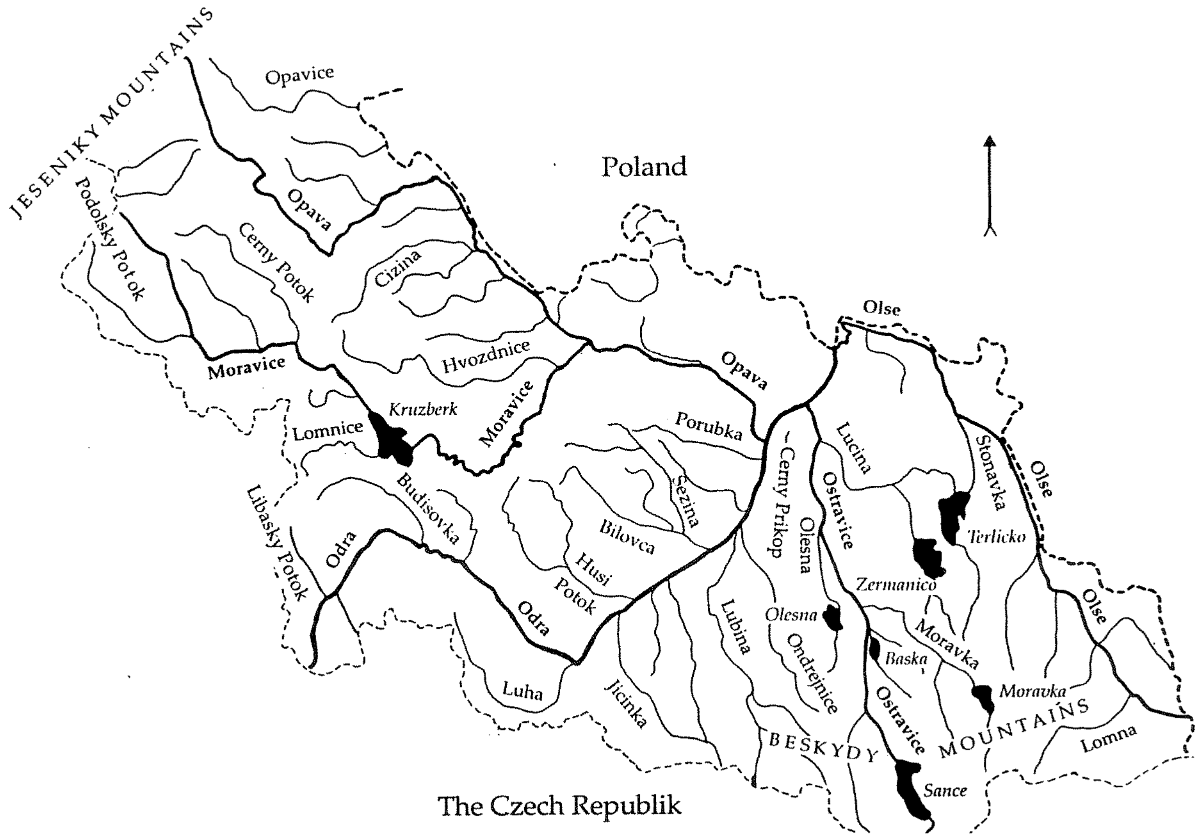


Figure 2.3: Rivers in the catchment area

Table 2.3 Odra river

Profiles	Catchment area	Average flow	Max.Flow (Q30)	Min.flow(Q330)	River km.
	[km^2]	[m^3/s]	[m^3/s]	[m^3/s]	[km]
Odra at the border to Poland	≈ 6250	≈ 70	≈ 135	≈ 11	0
Odra below Ostravice	4588	42	103	8	10.9
Odra below Opava	3705	27.7	67.9	5.1	17.5
Odra below Lubina	1384	11.1	31	1.3	31.5
Odra below Bilovka	1178	8.8	24.6	1.0	36.5
Odra below Jicinka	719	6.2	17.7	0.6	58.5
Odra nad Libavskym potokem	45	0.45	1.3	0.04	ca 118
Odra at the start	0	0	0	0	128

Table 2.4: Tributaries to Odra with catchment area > 50 km^2

Tributaries to Odra (Data in the mouth)			Area	Average flow	Max.Flow	Min. flow	Length
Primary	Secondary	Tertiary	[km^2]	[mr/s]	[mr/s]	[mr/s]	[km]
Olse (*)			**1120**	**12.5**	**27.2**	**2.6**	**71.5**
	Petruvka		153	1.3	2.9	0.4	-
	Stonavka (*)		131	1.5	3.2	0.3	-
	Lomna		71	1.5	3.7	0.2	-
Struzka			60	0.3	0.8	0	18.7
Ostravice (*)			**827**	**14.2**	**34.4**	**2.73**	**51.2**
	Lucina		197	2.4	5.0	0.5	37.2
	Olesna (*)		59	0.9	2.0	0.1	21.3
	Moravka		149	3.7	10.1	0.5	28.6
Cerny Prikop (*)			artif. channel	-	-	-	-
Opava			**2089**	**15.0**	**34.8**	**2.9**	**109.3**
	Moravice (*)		**901**	**7.7**	**21.5**	**1.4**	**105.3**
		Hvozdnice(*)	164	0.8	2.1	0.1	36.2
		Lomnice	50	0.4	0.4	0	2.3?
		Cerny Potok	109	1.0	2.7	0.1	24.5
		Podolsky Podok (*)	81	1.2	2.9	0.3	20.9
	Herlicka		50	0.20	0.5	0	-
	Cizina		103	0.5	1.1	0.1	-
	Opavice		195.4	1.3	3.3	0.3	35.5
Porubka			62	0.3	0.8	0	18.4
Ondrejnice			99	1.0	2.7	0.1	29.9
Lubina (*)			194	2.4	6.2	0.3	36.3
Bilovka (*)			142	0.7	1.9	0.1	23.7
	Sezina		74	0.4	1.1	0	-
Sedlnice			57	0.5	1.5	0	-
Husi Potok			143	0.8	2.3	0.1	-
Jicinka (*)			114	1.2	3.3	0.1	25
Luha			95	0.5	1.6	0	-
Budisovka			63	0.6	1.6	0	-
Libavsky Potok			59	0.6	1.7	0	-

* Rivers with water quality data presented in chapter 4.3

3 Environmental administrative management institutions, instruments and legislation

3.1 Analytical tools and framework

3.1.1 General

In any country water management is a part of a larger resource, land use, nature and environmental management system. The aim of chapter three is to give a brief presentation of the Czech water management system in its context.

Do the institutions at hand "match" the various types of environmental problems? This is the crucial question in an evaluation of a watershed management system anywhere in the world.

Management of water is a complex task involving a large variety of interests, groups and institutions. In order to make this presentation of the various part of Czech water management easier to read, some concepts and analytical tools will be presented.

A: Types of environmental problems (diffuse or concentrated)

B: Levels of decisionmaking (local or central)

C: Types of problem solving (coordinated or sectorial)

First of all, it is necessary to be aware of what kind of environmental problem one faces. Environmental problems can be classified as to *how they are generated* (from concentrated or from diffuse sources) and as to *the distribution of the environmental effects* (concentrated or diffuse) (Naustdalslid, 1992; Holm-Hansen & Naustdalslid 1993; Naustdalslid & Hovik, 1994).

3.1.2 Types of pollution

The following figure illustrates four possible combinations of sources and effects borrowed from (Nautstdalslid in:Naustdalslid & Hovik, 1994).

Box A contains typically *'local'* problems. Local sources produce local problems. The opposite of Box A is Box D. In this box environmental problems from diffuse sources to diffuse recipients are found. These are *'collective'*. Often such problems do not create serious problems alone, but may nevertheless add up to the effects of e.g. global warming of the atmosphere.

Box C environmental problems are often found in cases of water pollution from a point source into rivers. This is the problem of *'diffusion'*. The source is easily identifiable, but the effects are diffuse. Box B is opposite to Box C. The sources are diffuse, but the effects are concentrated. This is the problem of *'accumulation'*. This type of environmental problems, like those in Box C, often occurs in cases of water pollution. When many small sources contribute to a river or catchment area that flows into a lake or bay (in Norway: *fjord*) and accumulate there, one has the typical Box B type of pollution.

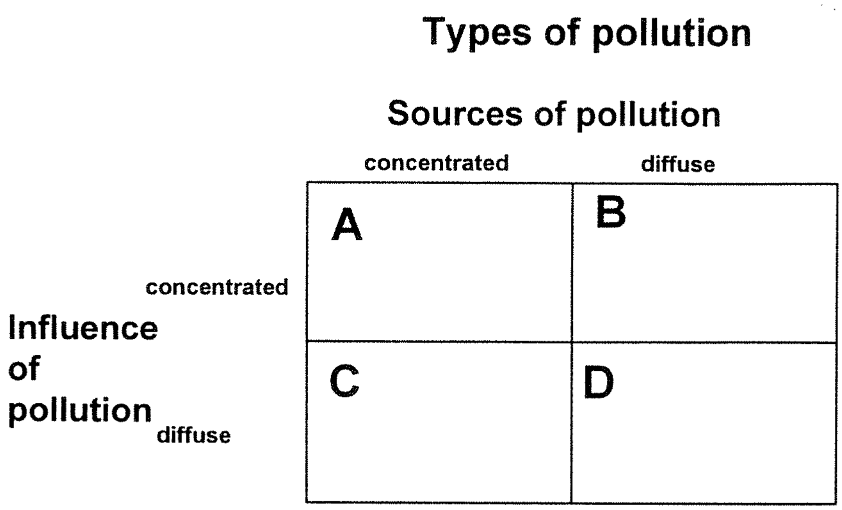


Figure 3.1 Type of pollution

3.1.3 Levels of decisionmaking

When one has reached an understanding of the characteristics of environmental sources and effects and their combinations, it is time to go through the institutional tools at hand. Are they able to cope with the main types of environmental problems? One aspect to this - that has been debated a lot in European countries in transition - is the distribution of competencies between central, regional and local level of government.

Box A: When local sources produce local problems one may expect local authorities to take a responsibility. Not only the environmental costs, but also the economic benefits from the polluting activity are local. Therefore the weighing of what is most important can be made by local self-government.

Box B: Like Box A type of environmental problems, Box B contains locally felt problems. But in this case the problems are generated from various sources outside the community where they are suffered. The management of *'accumulated'* environmental problems will not be easy as the "polluting" municipality usually is hesitant to pay for environmental improvements that are mainly enjoyed in another municipality. Therefore this kind of problem requires an authority above each local self-government that is willing to impose direct regulations.

Box C: When problems are *'diffuse'*, as in Box C cases, the eagerness to solve the problems may be less articulate in the receiving municipalities than in the case of *'accumulation'*. On the other hand in Box C cases the municipalities that receive pollution are in majority to those polluting. Nevertheless an authority above the municipalities is required as in Box B cases to coerce the polluting municipalities.

Box D: When problems are made and felt collectively, one comes close to the situation of *'common lands'*. If a sufficient amount of polluters take action to improve the environment, everybody will benefit. But each polluter can benefit without doing anything. If he does something to improve the environment and very few others do the same, he will suffer. If the decision whether to act or not is left to each actor, the most rational thing to do would be to refrain from acting. Therefore, an authority has to set standards and frameworks that everybody has to comply with.
Reorganisation of the central-local government relationship is a part of the modernisation of public administration in most countries. This is the case also in the Czech republic (see chapters 3.1.3, 3.2

and 3.3.3). It may be useful to distinguish between various forms of decentralisation (Holm-Hansen & Naustdalslid, 1993).

1: Administrative decentralisation means decentralising tasks and responsibilities from central government to *'field offices'* of central government. This is usually termed *'deconcentration'*. Deconcentration enables central government to operate at a local level with its own apparatus.

2: Political decentralisation denotes transferring responsibilities to elected bodies at a local level. This is the basis of local self-government. As compared to deconcentrated units elected bodies at a local level usually enjoys a high legitimacy among the local people.

3: Functional decentralisation is usually brought about by sector representatives in government that would like to see their sector more deeply implanted locally. This kind of decentralisation secures a common frame of reference and common expertise profile of a segment of public administration from bottom to the top.

4: Territorial decentralisation is about coordination between various sectors at a local level. The idea is that also at a local level an institution should be responsible for the totality.

3.1.4 Types of problem solving

For any policy area the dichotomy between *'sectorisation'* and *'coordination'* is relevant. For environmental matters, like water management, the choice between a sectorised and a coordinated organisation of the policy field is of great importance. In the case of water management being a very distinct sector may enhance the ability to keep a high scientific level professional identity which in its turn may be of great value in conflict with other sectors (economic development, infrastructure). On the other hand a water management sector that is loosely coordinated with other parts of public administration risks to be isolated and neglected. An answer to what is most appropriate - being a distinct sector or a well coordinated unit - can only be given when it is clear what the purpose of the institution is. If for instance water management is about *organising professional knowledge*, keeping a distinct sector would be most efficient. If, on the other hand, water management is perceived as *organisation and administration*, coordination would be the best solution (Nenseth, 1994). For most parts of public administration the shift from state socialism to an open, pluralist system entails that policy relevance has to be focused upon much more than before.

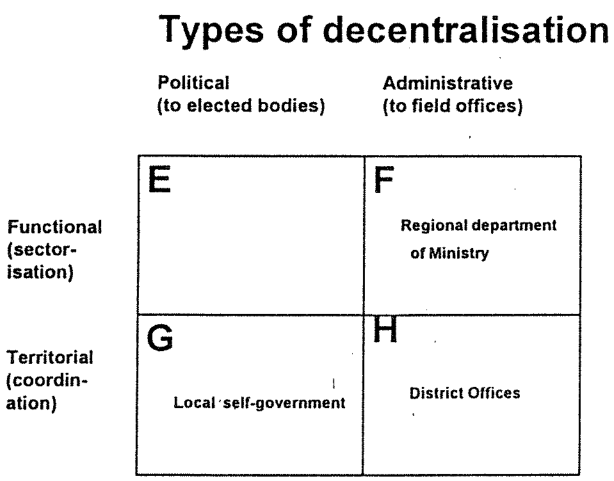


Figure 3.2 Types of decentralisation

3.2 General on transformation and public administration

3.2.1 Strategies for changing public administration

The transformation of Czechoslovakia and the Czech Republic from a one party rule to a pluralist parliamentary system, from centralism to decentralisation, from a politically guided economy to a market-based one, from state ownership of practically all means of production to private ownership necessarily implied a thorough revision of the public administrative system in the republic.

The new Czech government gave a policy statement on administrative reform in July 1992 (Vidlaková, 1993). According to this statement a more efficient public administration relies on:

- decentralisation
- improved administrative expertise
- enhanced technical capacities.

As a necessary precondition for a more efficient administration improved prestige for the administrative system itself was mentioned. In spite of the state-centredness of state socialism, civil servants did not enjoy much respect nor privileges. Neither did they possess much in terms of infrastructural means to work efficiently.

Since 1990 the public administrative system has been under reorganisation in the Czech Republic. Ministerial structures have been revised several times in order to find the most appropriate division of competencies (tasks and authority).

Self-government structures on a territorial basis were established shortly after the Czechoslovak *'Velvet revolution'* in November 1989. The number of municipalities has grown sharply and the municipalities try to establish themselves as a powerful factor. The endeavours of the municipal enthusiasts have, however, been curtailed by the small size of most Czech municipalities. Their size is not corresponding to the tasks they are assigned.

'Local self-government' versus *'state government'* has become a familiar dichotomy that most Czech citizens consider to give a substantial explanation of where the conflict lines are stretched between political elites in the country today.

However, decentralisation also applies to the institutions of the central state themselves. Ministries have established deconcentrated units or central field offices at a regional level (see chapter 3.1 and 3.2 above on functional decentralisation). These units cover the areas previously covered by the regions that were abolished in 1990. In this way functional decentralisation has contributed to giving some new life to the regions that were abolished in 1990. The central government is not only represented regionally by its ministries; at a District level central state has its own representative District Offices, that are to secure coordination and harmonisation against sectorial or localist split-up.

Ninety percent of the laws, amendments, by-laws and directives that have been adopted in Czechoslovakia since 1990 have been aimed at public administration. This fact may be taken as an expression of the importance that has been ascribed to public administration reform. On the other hand it may also be an illustration of the lack of systematic approach and integration of the reform attempts.

The public administrative system of the Czech Republic is being reformed to fit to the new political and economic situation in the country. Most parts of the decisions made are to originate from democratically elected bodies, from a local level and from the "market". The public administrative system has to adapt to a situation that is no longer *'dirigiste'*, but pluralistic and open. During the last few years, the introduction of a new administrative level with its own elected self-government council between the central state and the local (municipal) level has been one of the most vividly discussed themes in Czech politics.

3.2.2 General changes in public administration

The water management administrative system is situated in the middle of the process of finding a viable relation between:

- central and local authorities
- local governments and "field offices" of the central state
- horizontally and vertically organised state administration
- decisions made politically and decisions made by the market.

Several criteria could be conceived for the best balance between the factors mentioned above. Our purpose however, is to find out what would be possible in order to produce a more efficient set-up for the water management system. *'Efficiency'* in this context would mean *'conducive to clean water'*.

The water management system must adapt to the general changes in the administrative system:

1: Some administrative tasks are now performed by local self-government units
2: The public administration has to interact with independent economic subjects that are to function along market lines
3: The public administration has to perform in an open society based on democratic policy-making
4: The public administrative system has to prepare for a new, second tier self-government level
5: State institutions are decentralised in order to create de-concentrated units of state power
6: Re-evaluation of the expertise profile
7: Handing over of several administrative tasks to semi-private or private institutions and firms

<u>Some administrative tasks are now performed by local self-government units</u>

The main idea behind the introduction of local self-government to replace the local state administration is to enable local communities to decide on local matters. In water management the municipalities constitute one of the four institutions that are formally assigned the role of *"water management bodies" (vodohòspodárské orgány)*, the other ones being the District Offices (state agencies), the Czech Environment Inspection and the Ministry of Environment. The competencies of the municipalities are stated in the water management law (Act no. 138/1973 Sb.) § 3 (see: chapter 3.3.3.4 on the environmental division of towns and cities).

<u>The public administration has to interact with independent economic subjects that are to function along market lines</u>

From having been units in ministerial structures along branch lines, Czech enterprises are now to be independent profit-making units regardless of being privatised or not. For environmental and water use matters this means that the enterprises have to relate to public authorities in a new way. The mixture of administrative and economic measures applied in Czech environmental management requires that both enterprises and civil servants acquire skills that may have been weakly developed before (see chapter 3.6.1 on the environmental management in the enterprises).

The public administration has to perform in an open society based on democratic policy-making

In an open society, controversies over the use of water will come to the fore. Rivers, lakes and dams are managed by various institutions and will be used, or desired to be used, by various groups of individuals or enterprises. The expression of all the diverging interests may enter into conflict with the need to integrate the management of water resources. The procedures for water use and land use planning as well as for Environmental Impact Assessments of planned projects may serve as arenas for the various interests as well as a mechanism for preparing decisions (see the chapters 3.4 on planning tools).

The public administrative system has to prepare for a new, second tier self-government level

The implementation of the paragraph in the Czech Constitution that envisages a *regional self-government* level between the municipalities and the central state, has caused political controversy. The regional units will be far larger than the present Districts, that are institutions of cental state power. What should be the criteria for the establishment of these new regions. How big and how strong should the new second tier self-government units be? Should the new regional borders follow the old delineation between Moravia, Silesia and Bohemia? Under any circumstance, new regional structures when introduced would make some of the water management coordination easier. As shown in some of the chapters below several of the functional administrative institutions on a state level are still organised at a regional basis, also according to the otherwise abolished regional areas. This applies for the regional representation of the ministries, for the Environmental Inspection, Hygienic Institute and for the Hydrometeorological Institute (see chapters on these institutions).

Re-evaluation of the expertise profile

The expertise profile of state socialist countries was heavily shaped by the core characteristics of the original bolshevik modernisation strategies. Modernisation was to be brought about by technological progress. In order to safeguard this process, the society, with its supposedly backward mentality, was to be straightjacketed. Therefore state socialism, when over, left behind an underdeveloped civil society. As an effect of the underdevelopment of civil society, state socialism also left behind a weakly developed social science sector. In Western countries social science is actively made use of, and social science knowledge is to various degrees internalised by decisionmakers and the interested public in general (Naustdalslid & Reitan, 1994; Holm-Hansen, 1995 a). Due to the repressive character of Czechoslovak state socialist regimes until the end, the Czech public administration had to start from scratch. Critical inputs on administrative change from professionals in social science are still not very common in the Czech Republic. Still experts are engineers and problems are defined as technical. However, public administration as a subject for study and research is being introduced in the faculties of law as well as of economy.

Handing over of several administrative tasks to semi-private or private institutions and firms

In state socialist Czechoslovakia, in contrast to Poland and Hungary, almost all kinds of activities were run by the State. After the downfall of state socialism not only productive enterprises, but also public services, are to be privatised or made into state-owned commercial enterprises. In water management this applies for the water supply and sewage companies (see chapter 3.3.6) that are privatised. The watershed organisations - Povodí - have changed from institutions of public administration to state owned shareholding companies (see chapter 3.3.4).

3.2.3 The modified public administration

Czech public administration has already been structured and modified, decentralised and deconcentrated along various lines, to meet the new demands.

A certain political decentralisation has already been achieved through the establishment of local self-government (see Box G in the fourfold table in chapter 3.1.3). Self-government institutions at a local level secure an opportunity for local communities to run their own affairs, even though the small size of most municipalities makes implementation of decisions difficult.

Central field offices or regionally operating agencies of functional entities of the central state have proliferated sharply since the 1989 revolution. Deconcentration has produced strong segments that are vertically organised. The Ministry of Environment has its own department at the regional level, and so have other deconcentrated functionally specified state organs, such as military boards, police directorates, finance directorates, geodesic and cartographical boards and health offices. These belong to Box F in the four-fold table in chapter 3.1.3. This means that policy sectors with their own distinct profile and way of thinking manned by people with more or less similar educational background now are implanted at a regional level. An interesting feature is that several of these deconcentrated institutions operate on the basis of the now abolished regional delineations. In the case of the Odra river catchment area this means the region of Northern Moravia and Silesia.

The presence of regional agencies of specified state institutions make these institutions more efficient. When inter-sectoral co-ordination is required, however, the establishment of strong functional entities at the regional level may prove to hamper efficiency. This problem is made even bigger by the fact that several of the specialised offices at a regional level have over-lapping competencies.

But there are mechanisms to counteract the functional split-up. At the District level, that are far smaller than the previous regions, the central government has its own deconcentrated institutions, the District Office (Box H in chapter 3.1.3). Whereas the "field offices" mentioned above represent sectorial interests, the District Offices are to secure coordination and harmonisation to national goals. Local self-government also contribute to a harmonisation of interests.

Legal provisions make for a complex set of tools to be used by the new public administration. Economic, administrative and educational instruments are now at hand. The educational background and professional experience of civil servants, however, makes it difficult to fully utilise these new tools.

Services are already privatised or partly privatised. In the field of water management, the water supply and sewage companies are privatised, whereas the watershed organisations are made into state-owned shareholding companies.

All in all a viable structure for a well-functioning public administration is established in the Czech republic. It is no longer time for major restructuring. Now the task lies in making the structure work. Open discussions and ample possibilities for critical self-reflection among the practitioners - for instance in the water management sector - is indispensable in order to make this come about. Professional evaluations of how the system functions form the basis of enlightened debates on how to improve the working of the public administration.

3.3 Institutions

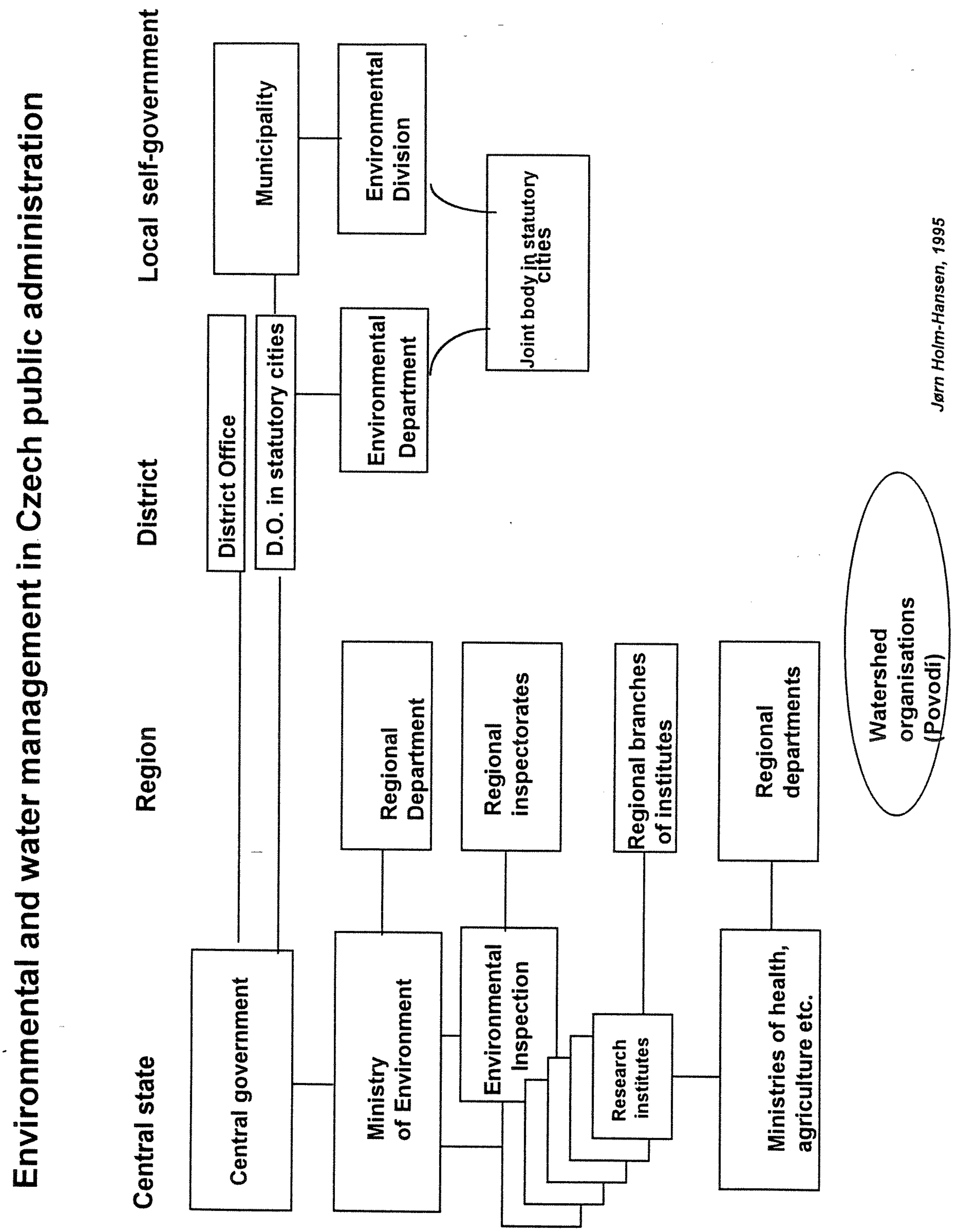


Figure 3.3: Environmental and water mangement i Czech public administration

3.3.1 The Ministry of Environment

3.3.1.1 Organisation and main responsibilities

The Ministry of Environment was established 1st January 1990. Since then it has been in a nearly permanent organisational change. Its main responsibilities, however, have remained the same.

The Ministry is responsible for setting the overall environmental policy goals and strategies. It is responsible for the coordination of other ministries and departments in environmental matters. It sets the overall environmental policy goals and strategies. The Ministry has five sections, each of them run by a deputy minister. Water management belongs under the Section of technical protection of the environment.

The Ministry of Environment is responsible for the administration of the National Environmental Fund, a major source for financing environmental projects in the Czech republic.

The Ministry of Environment is not responsible for land use planning, a policy area taken over by the Ministry of Economy.

The fields covered by the Ministry of Environment are listed in the act on the structure of state administration in the Czech Republic (§ 19 in act no. 21/1993 Sb.). In this law it is stated that the Ministry of Environment is the chief authority of state supervision of the environment.

It is the central authority for the following areas:

- water management
- forestry (except matters under the responsibility of the Ministry of Agriculture
- hunting, game-keeping and fishing in National Parks
- protection of air
- protection of nature and landscape
- protection of agricultural land
- State Geological Service
- protection of mineral wealth
- ecological supervision of mining
- waste management
- EIA, including EIAs on projects with transboundary effects
- national ecological policy.

3.3.1.2 History pre- and post-1989

Environmental policy as a field of political controversies came to the fore in Czechoslovakia in the eighties. Environmental groups, partly inside, partly outside the official system, made known the disastrous environmental situation in specific areas of the federal Republic. The environment was to a certain extent accepted by the regime as the field where aspects of the present political and economic system could be contested. As in many other state socialist countries the legitimacy of the system was challenged through its apparent disability to organise production in an environmental friendly way. The organisation of a more efficient administrative and legal apparatus for environmental protection therefore played a significant role in the immediate post-1989 period.

The Ministry of Environment has been through permanent reforms of its organisational chart internally. The question of which fields should belong to the Ministry of Environment and which fields should belong to other ministries, has also been posed consistently.

There have been constant discussions on where to place various fields of responsibilities both inside and possibly outside the Ministry of Environment. The organisational structure of the environmental sector in the Czech Republic has remained practically unchanged since 1990. The only major change took effect 31st October 1992 (act no. 474/1992 Sb.) when land use planning and building regulations were transferred from the Ministry of Environment to the Ministry of National Economy. The relevant unit in the Ministry of Economy is the sector for Urban Planning in the Department for Regional Policy.

The change of Ministry responsible for land use planning is significant because, broadly speaking, the two Ministries act as proponents of two distinct tendencies in water management - and environmental policies at large. The Ministry of Environment is prone to support regulations and state ownership of important water resources, whereas the Ministry of Economy takes a more classical liberal stand.

This conflict has shown itself clearly in the debate over the New Water Act.The new Water Act was awaited for 1994, but was not presented. The discussion on the law has mainly followed a pattern of water managers against economists. The law that is not presented is described as a compromise between these two main views, but it has nevertheless been kept in the Ministry of Environment (more on this in chapter 3.5.1.2).

The Ministry of Environment has been in frequent conflicts with the prime minister over the approach to environmental protection. The Minister of Environment would like to apply the catch words from the Brundtland report, the Rio conference and the European conference of environmental ministers in Luzerne. The Prime Minister prefers an approach focusing on concrete projects.

3.3.1.3 The role of the Ministry in water management

In water management the Ministry of Environment is the superior *"water management body" (vodohospodárský orgán)*, the other bodies being (a) the District Offices, (b) the Czech Environment Inspection and (c) the municipalities. The Czech water management law (Act no. 130/74 Sb.) § 5 assigns this task to the Ministry. The main water management tools given to the ministry by this act are among others:

- the Guideline Plan for Water Management (making sure water resources are not over-used)
- the management of the hydrological services/research as well as the applied water research
- the management of waterways
- the taking care of water accumulation, surface and ground water quality

Water quality standards are given centrally and become valid through government decision as state standard. The water quality standards of rivers are given in *"Regulation by the Government of the Czech republic no. 171 from 26 February 1992"*. This regulation establishes the parameters of the allowed water pollution rate.

The categorisation of the watercourses is made by the Ministry.

3.3.1.4 The Regional Departments of the Ministry

Since 1990 the Ministry is represented at a regional level in each of the following regions: Central Bohemia, Ceské Budejovice, Chomutov, Plzen, Liberec, Hradec Kralové, Brno, Olomouc and Ostrava. The establishment of these Departments belong to the administrative-functional decentralisation (see chapter 3.1.3).

In each of these nine regions the Ministry is represented by its own department (on Ostrava, see chapter 3.3.1.5). These departments cover several Districts. Their task is mostly to act as a body for those who make an appeal against decisions made by the District Offices. The departments also administer the EIA procedure. It also coordinates international projects in its geographical area. It is likewise responsible for water courses in border areas.

The Regional departments are responsible for the supervision and coordination of environmental activities within its geographical area in order to provide for a uniform state administration and application of the appropriate legal rules, but it can not force other administrative bodies to coordinate their activities. The Regional Department is to provide professional training of the employees of the District Offices. It is also to examine certain decisions made by the municipalities, i.e. decisions made on fields where competence has been delegated from the District Offices to a municipality (see chapter 3.3.3.1). The Regional department is also to provide professional assistance to the municipal authorities. The Regional Departments of the Ministry of Environment are the responsibility of one of the vice-ministers.

3.3.1.5 The Ministry of Environment in Odra river catchment area

* *The Ostrava Regional Department of the Ministry of Environment*

Geographical scope: The Ostrava Regional Department covers the physical confines of the Odra River catchment area. This area consists of seven Districts:

- Ostrava
- Karviná
- Frýdek-Místek
- Nový Jicín
- Opava
- Vsetín
- Bruntál.

Tasks: The most important activities of the Ostrava Regional Department are the following:

- Environmental audits
- EIA
- Environmental education and contact with Non-Governmental Organisations
- Treating damages from the Soviet Army activities (small)

The environmental audits have to be carried out as a part of the price setting before privatisation of an enterprise, from June 1992 to March 1994 310 environmental audits were made in the Ostrava Regional Department. To get privatised an enterprise would need the environmental audit plus a statement from the Regional Department of the Ministry of Environment as well as from the Environmental Inspection at a regional level. The Environmental Inspection is divided into the same nine regional departments as the Ministry of Environment.

The Regional Departments are to carry out state administration of border water courses. As the Odra river flow directly from the geographical area of the Ostrava Regional department into Poland, the Department has got responsibilities in this matter.

Personnel: The Regional Department in Ostrava has 18 employees. It is divided into three branches:

- Water management (3 people)
- Air, waste, geology (5 people)
- Protection of nature, forest management, agriculture (5 people)

Coordination: One of the main tasks of the Regional Department is to supervise and coordinate environmental activities in its geographical area.

3.3.2 The District Office

3.3.2.1 Organisation and main responsibilities

In Czech public administration the only regional body with a general competence is the District Office. This gives the office an important role in coordination and harmonisation (Box H in chapter 3.1.3).

There are 72 District Offices in the Czech Republic and three so-called statutory cities where the tasks of the District Office are carried out by the municipal authorities. The three statutory cities are Ostrava, Brno and Plzen.

The District Office is a deconcentrated (see chapter 3.1.3) state authority holding general functions at a District level. It is subordinated to the various ministries according to what issue it treats. This means that in matters concerning the environment the Ministry of Environment is responsible.

The District Office is headed by a District Chairman *(prednosta okresního úradu)* appointed by the Ministry of the Interior. Thus the District Office is a state organ at a regional level. That, however, is not totally true as the District Office is also influenced from local self-government through the representative District Assembly. The members of the District Assembly is elected by the municipalities in the District. The District Assembly mostly has a control function. According to Act 266/91 the District Assembly is to supervise the activities of the District Office by controlling the budget and the yearly reports. It is also to decide on the budget on the basis of a proposal by the head of the District Office. The District Assembly likewise check the state subventions to the local communities.

The present Czech system of District Offices functions very similarly to the Norwegian counties before they got their own elected councils in 1975.

There are functionally specified sub-divisions in the District Offices, like the Environmental or Ecological Division.

The District Offices are consulted by the State Environmental Fund (see chapter 3.5.2) on what environmental projects to give priority.

The District Offices constitute the primary state management organs not only in environmental matters. They are state management organs of first rank also in the following areas:

- land property matters, including land restitution
- traffic and road construction (not road maintenance)
- social welfare
- health (most hospitals and polyclinics)
- registration and control of industrial activities
- culture, sport and youth
- regional development (urban and regional planning, construction regulation)
- management of certain types of enterprises for the transitional period (enterprises that used to be owned by the Districts before 1990, e.g. housing companies
- civil defence and defence

Some of these subdivisions have their counterpart in the deconcentrated units of the ministries, e.g. the Ministry of Environment. The ministry also has a say in the working of the Environmental Division, e.g. through its advisory guidelines for the manning of the Divisions. The head of the District Office, however, decides finally on the staffing.

The District Offices apply the water quality standards that are given in the *"Regulation by the Government of the Czech republic no. 171 from 26 february 1992"*. This regulation establishes the parametres of the allowed water pollution rate, but the District Offices, by their environmental departments responsible for water, may set stricter standards.

3.3.2.2 History pre- and post-1989

Up until the end of 1990 the Czech republic was subdivided into seven regions, each of them with a 'national committee' *('národní výbor')*. (With the three Slovak regions Czechoslovakia had ten regions.) The national committees were shaped in the model of the USSR *'soviety'* , literally *'councils'*. The model implied that the councils function along the principles of unity, i.e. both political and administrative tasks were amalgamated, as were the representation of local and central state interests.

When the national committees were abolished after the 1989 *'Velvet Revolution'*, they were not replaced by an elected council. The regions however continued to exist as units of territorial state organisations. The administrative bodies of the previous national committees at a district level continued as District Offices.

The deconcentrated functionally specified state organs exist on a regional basis (such as Ministry of Environment, military boards, police directorates, finance directorates, geodesic and cartographical boards, health offices). These "central field offices" or "regionally operating agencies of functional entities of the central state" have proliferated sharply since the 1989 revolution.

At a district level, several specified deconcentrated state bodies have also been created over the last three years. These bodies are not tied to the District Offices, but to the relevant ministries.

3.3.2.3 The Environmental Division of the District Office

The District Office serves as one of the water management agencies *('vodohospodárský orgán')* in the Czech Republic according to the water management act (458/92). The District Office is obliged by the Directive Water Management Plan (smerný vodohospodárský plan) that is elaborated centrally in Prague.

Apart from water, the Environmental Divisions of the District Offices are responsible for:

- nature and landscape protection
- air quality
- waste management
- forest management
- EIA
- ecological education

Co-ordination: The District Office Environmental Division has a special responsibility for coordinating water management in the District. The law prescribes which activities belong to which agency. Nevertheless, when it comes to control of polluting sources, the District Office has to cope with overlapping control competence with the Environmental Inspection. There is a requirement that the bodies involved should inform each other. The Inspection and the District inform each other reciprocally about their decisions.

The District is responsible for setting the discharge limits for all sources of water pollution. It also defines the individual time limits for compliance concerning water polluters. The emission limits are calculated by the architect (construction engineer), who has to make sure the emission limits conform to the use limits of the river. This calculation has to be approved by Povodí before it can be released as an officially valid discharge permit.

The problem of overlapping competencies applies especially for water and waste. Control of air polluters is more clearly defined by the law. Usually it is the Inspection that goes to check the enterprise compliance with the rules. However both the District and the Inspection are entitled to give fines. Since early 1992 the Division can fine an enterprise on a par with the Czech Environmental Inspection. This is made on a first come first serve basis. The organ that discover the transgression will have the right to levy the fine. Fines levied by the District remain in the District budget and is to be used in the municipality where the fine was given. If the Inspection levies the fine, 50 percent of the money goes to the Environmental Fund. The other half goes to the municipality where the fine was given and is to be used on the environment. This dual situation has lasted since early 1992.

Among the other subdivisions of the District Office the Environmental Division mostly co-operates with the Chief Architect's Office (land use planning, urban planning, architecture) and the Division for Building.

The District Office also has an important role in making sure the regulations are enforced, but has overlapping competence with the Environmental Inspection on waste and water as both organisations can levy fines. In case of accidents resulting in exceeding the limits for waste and/or water, the polluter has to report to the District Office.The District Office alone can close down a dumping site on environmental grounds. The District Office is the review authority for decisions made by the municipality.

Generally the Regional representation of the Ministry is superior to the District, but in EIA matters the Ministry has no power to change the decisions of the District/magistrát. There is no organised co-ordination of water management in the sense that people tied to this sector meet regularly to discuss.

3.3.2.4 Environmental divisions of the District Offices in the Odra river catchment area

Nine District Offices entirely or partly lie within the physical confines of the Odra River catchment area. These are:

Bruntál
Opava
Ostrava
Frýdek-Místek
Karviná
Nový Jicín

Interviews have been made with the leaders of the Environmental Division of Karviná, the leaders of the Environmental as well as the Ecological Division of the Ostrava District Office (plus the officer responsible for EIA). The District Chairman of the Karviná District Office was likewise interviewed. The findings from the interview with the EIA are presented in the chapter on EIA. Because Ostrava is a statutory city, i.e. a city where District Office and municipality are merged, the results of the interviews of the Divisions for Ecology and Environment will be found in the chapter on municipalities.

Tasks: There was a general complaint among the environmental District Office officers interviewed that the number of cases that are to be treated is very high. This means that the District Offices are not able to act positively beforehand. The District Offices are therefore more re-active than active in environmental matters. Only tasks explicitly mentioned in the laws are carried out. *"It is therfore not possible tomake full use of the power formally assigned to the District Office"*, one leader of an Environmental Division at District level told.

Personnel: The personnel profile is heavily technical and natural science dominated. The most predominant backgrounds are: Machine engineering, biology, chemistry, foundry engineering. The employees have substantial theoretical background and training to tell adequately what water can accept.

The Environmental Division leaders tend to perceive themselves as stricter towards polluters and would-be polluters than the elected bodies at a municipal level, that are perceived to be more permissive to local wishes to exploit nature.

** The Environmental Division at the District Office of Karviná*

Karviná is the second most populous district of the Czech Republic and the second most densely populated as well. According to the Division leader Karviná has the most affected environment of all Czech districts. Most of the problems derive from sub-surface mining that causes a destruction of the landscape. The surface level of the landscape depresses, whole villages have to move out.

The Division of environment is one of ten offices in the District Office of Karviná. It mainly has administrative tasks.

The Division covers:

- water management, including aquatic constructions and serves as the Building office for aquatic investments, i.e. it releases permits for sewage, waste water treatment plants and pits

- air pollution

- protection of arable soil

- waste management

- EIA

The Division also takes care of the following areas, but with a weaker emphasis:

- nature and landscape protection
- protection and maintenance of forest areas
- hunting permissions
- veterinary care (supervise the implementation of the laws)
- protection of culture plant
- protection of geological items

17 people including the chief work in the Division. Anually the staff work on approximately 3.000 cases. Due to a heavy burden of work only the duties explicitly mentioned in the laws are treated. The work gets a quite re-active character and little time is left for going into the field. *" For this reason it is not possible to make full use of the power formally assigned to the Division"*, according to the leader of the Division.

The leader of the Environmental Division, sees two possible solutions to this problem, either one could increase the number of people in the Division or one could decentralise the responsibility to the municipalities.

Each producer of waste or polluter of water must submit all documents to the District Office. There are time limits to be observed, and there is no room for negotiations over that issue, according to the leader of the Division. Most enterprises now have to comply within the end of 1995 for water and waste and the end of 1998 for air pollution.

3.3.3 The local self-government (municipalities)

3.3.3.1 Organisation and main responsibilities of local self-government

All over East Central Europe localism was one immediate reaction in the months to follow the 1989 upheavals. This tendency was particularly strong in Czechoslovakia where state socialism had survived without anything but shallow reform attempts until 1989. The technocratic policies of the seventies and eighties applied for all spheres of politics and social life. For regional development the Czechoslovak state socialist technocracy implied establishment of regional centres, that were given most of the funds for development. The peripheries in each region were purposely understimulated. Impatient localism was a reaction to this.

The role and competence of the local government is defined in the Czech Constitution, chapter 7 on local self-government, in the Constitutional Act No 1/1993 and several acts from 1990 and forwards.

The municipalities constitute the basis of the local government. The municipalities are granted the right to self-government, i.e. to make decisions on local matters as well as to manage the municipal properties (Article 100, § 1 in the Constitution). A municipality is defined as a self- governing community of citizens. Municipalities manage their own property as legal entities. The municipalities have the right to issue by-laws. Several tasks have been delegated to the municipalities (see below). Municipalities decide themselves on the questions of boundaries, but have the right to enter cooperation across municipal borders to solve specific problems by inter-municipal cooperation.

Each local government is democratically founded in an elected council *(obecní zastupitelstvo)*. The local council has from seven to 70 members depending on the size of the population of the municipality. The council is responsible for the local budget, for the establishment of local taxes and fees, founding of enterprises as well as local by-laws.

Municipalities with a council consisting of at least 15 members may establish an executive body *(obecní rada)*. In all municipalities a mayor is elected by the local council. He is the supreme leader of the municipal administration and is the principal of the municipal civil servants.

The municipalities have exclusive as well as delegated responsibilities. Both types of tasks are the responsibility of the local council. The scope of basic activities are the same for all municipalities. The tasks delegated from the central state to the local government, however, vary greatly. Some municipalities only have got delegated the tasks concerning reporting to the state and administration of building and construction.

On the other extreme there are the 381 so-called *'designated municipal authorities'* with an enlarged scope of delegated state tasks. Such a designated municipality *('proverená obec')* will also cover the tasks of smaller neighbouring municipalities. Many municipalities simply do not have the administrative capacity required to administer delegated state tasks.

Among the tasks exclusively belonging to the local government are:

- Election of municipal organs
- The responsibility for the municipal economy and municipal property
- Decisions on the level of municipal taxation
- Decisions on participation in municipal associations
- Decisions on revisions of municipal borders
- Preparing development programmes of the municipalities
- Schools, culture, social care and health
- Public order (municipal police)

Most important among the delegated tasks are:

- Building and construction
- Environmental protection
- Public transport
- Enterprise licences
- Securing of social services

The District Office can delegate tasks to the municipal authorities on specific issues, but not without the agreement of the appropriate ministry (Act no. 410/1992 Sb.).

3.3.3.2 History pre- and post Revolution

Since 1960 local governments were regulated through a system of National Committees. These committees were to represent state power and administration at three sub-state levels: Municipal, district and regional levels. A Federal Act of 1967 defined the National Committees as state bodies of a self-governing nature, but they nevertheless remained representatives of central state power. In addition they were controlled by the Communist Party local branches.

As a result of the 1989 *'Velvet Revolution'* the system of local government was changed. After the local elections of November 24th 1990 new regulations came into force (Federal Constitutional Act No. 294/1990). The regulations were quite general leaving the precise amendments to be made by the parliaments in the two Republics.

There are several unclear regulations as to whether the local councils or the district authorities (non-elected administrative representatives of the central state) are to be finally responsible. To solve such situations agreements have been made between local governments and district authorities. In the fields of responsibility delegated from the central state, the municipalities are formally subordinated to the district authorities and the ministries. In the field of responsibility belonging solely to the municipalities only the laws and the parliament instruct them.

The municipalities are formally divided between urban and rural municipalities.

In the Czech Republic a very fast review of the current laws was made and new legislation was passed immediately. The main content of the new regulations was that the unified system of national committees at a local, district and regional level was abolished. Instead a two level system was introduced consisting of a local and a district level (more on the district level below). The regional level was abolished. The local government was regulated through Czech Act No. 367/1990 Sb. The district administration was regulated through Czech Act No. 425/1990 Sb.

The difficult question of transfer of state owned assets to the municipalities was regulated in Act No. 368/1990 Sb. A separate Act on municipal council elections and local referenda was made in Act No. 298/1992 Sb.

The localist enthusiasm and *'grand design'* reform strategies from 1990 has been replaced with a more down-to-earth approach. This approach is based on the idea of gradual adaptation and improvement (Hesse, 1993, p. 220).

The main legal framework of local government was established early in the Czech transformation process, and early legal shortcomings were discernible. Among these are the insufficient measures to delineate the competence of local versus central state level. This may open up for conflicts that otherwise would have been possible to avoid.

The right of the local communities to set their own boundaries led to a wide-spread splitting up of previous municipal entities. The new local governments now therefore cover small areas and modest amounts of people, often representing nothing more than a hamlet or two. Combined with several state tasks now delegated to the local level (i.e. tasks that were to be administered on a local level on behalf of the state) this has led to several practical problems.

The tendency to split up the municipalities into small units is derived from underlying trends in the post-communist Czech Republic that favour a certain localism. Experiences from state socialism had made people hesitant to accept urban, regional and physical planning. They were especially critical towards the so-called amalgamation of municipalities, that had not only led to viable regional centres, but also to impoverished "peripheries" inside each region. In 1950 there were 11.459 municipalities in the Czech part of Czechoslovakia. By 1989 this figure was down at 4.120 municipalities (Dostál, 1992). The process of splitting up led to an increase towards 6.098 by March 1993 (Council of Europe, 1993).

After 1989 the trend has been towards political, administrative and economic self-governing local communities. In the years to follow the 1989 upheaval the slogan seems to have been "the smaller the better", which is not necessarily congruous with the wish to establish viable local self-government institutions. Most municipalities simply became too small to carry the burden of providing municipal services and thereby a meaningful political arena for local participation.

As a consequence of the rather unclear distinctions between the competencies of the local self-government and those of the district authorities, the two authorities quite often make use of agreements to settle disputes.

As the fields of environment and building belong to those activities that are delegated to the local self-government, in these fields the local governments are subordinated to the District authorities and the Ministries. On the other hand local governments are to be refunded for costs due to delegated activities.

3.3.3.3 Role of municipalities in water management

The tasks of the municipalities in water management are indicated in Act 458/1992 on water management. The municipality:

- regulates and sets limits on use of surface water in certain cases (§ 3 a)
- regulates and limits use of drinking water in case of water shortage and decides in cases of strides over what use of water to give priority (§ 3 b)
- charges those who damage public sewage or water supply to carry out measures to mitigate the situation of undrinkable water (§ 4 c).

The municipality is the owner of some small streams that were "restituted" (i.e. given back to pre-1948 owners or their heirs) after the *'Velvet Revolution'*. Regulation of greater rivers and streams is a task that belongs to the competence of the District Office. If a problem occurs in a river owned by the Povodí Odry, the municipality will have to go via the District Office that in the next turn addresses the Povodí Odry.

The water quality standards and categorisation of recipients is *not* the responsibility of the municipalities (see chapter 3.3.1.3).

3.3.3.4 Environmental divisions of local self-government in the Odra river catchment area

* *The Division for Environment of Karviná city*

The Environmental Division was established in Karviná in 1993. Before that the tasks now performed by the Environmental Division was made by the Division for Land Use Planning. A separate division focusing solely on environment was considered necessary due to the influence of mining on natural conditions in the area.

The environmental officer interviewed, maintained that the responsibilities of the municipality in water management are quite limited because as he put it. " *-The main responsibility lies with the District Office".*

The municipality is the owner of small parts of small streams. Regulations for greater rivers and streams must go via the District Office. Owner of these streams is the Povodí Odry. If somebody plans to make use of a part of a river owned by the Povodí Odry for some activity, it has to be arranged with Povodí Odry, the District Office and the City.

Sometimes the fact that the municipality is not the owner of a stream or river may create problems. If there is a problem with a stream, the municipality will have to go via the District office that in the next turn will address the Povodí Odry.

The streams that are owned by the municipality, have been returned after the 1989 Revolution. Some streams and parts of them have been returned to municipalities and physical entities.

Local projects with financial help from the state have been carried out. These projects have focused mainly on dispersed land. The financing of this is provided through compensations from mining harms from the Ministry of Economy.

Through the *"Eco-milliard"* (Ministry of Finance) money is given to the construction of gas pipes that will make it possible to switch from local ovens to gas as a main source for heating.

'Ekoolza' is a project run by 'civic activists' most of them inhabitants of Karviná. The aim of Ekoolza is to reclaim the border river with Poland, Olza as well as other smaller streams. The project is tied to the Division for Environment of Karviná city.

<u>Personnel</u>: Only one person is responsible for water in the Environmental Division of the City of Karviná. This person has only secondary education. In the case a new water law with more responsibilities given to the local level, it will be necessary to employ somebody with a university degree, according to the director of the environmental department in Karviná city.

The main environmental problems in Karviná are caused by mining. Therefore the director of the environmental department spends 50 percent of his working time on mining questions. Apart from that, one person more works full-time on mining. There are altogether seven people in the Environmental Division of Karviná municipality. They are specialists on:

- air
- waste
- water
- agriculture
- dispersed vegetation

Co-ordination: According to the mayor of Karviná, strides over competence usually end with the District Office being pressed to more strict policies.

The relations to the mining industry is complex, according to the mayor. The mining companies are obliged to regulate and maintain the streams.

** The Environmental Division in the Ostrava magistrát*

Ostrava is in a special situation as it is both a municipality and a district.This is the case of the three so-called statutory cities in the Czech Republic, i.e. Brno, Plzen and Ostrava. The Environmental Department in Ostrava magistrát has the responsibilities it would have had in any other District, but it has tasks related to municipal competencies as well.

The Environmental Division in Ostrava is divided in two departments, for ecology and for water management and agriculture.

The responsibilities of the Environmental Division are:

- Nature and landscape protection
- Air quality
- Water management
- Waste management
- Forest management
- EIA
- Ecological education

An environmental judgement from the magistrát is required for all investments. Landscape planning documents will also have to be provided.

Coordination: The Division is not controlled by the elected body except in one case, the land use plan has to be approved by the elected body.

** The Department for Ecology of the Ostrava City Council (magistrát):*

The Department for Ecology is one of the two Departments of the Environmental Division in the Ostrava magistrát, the Department for Water Management and Agriculture being the other.

The Department has divided its tasks into two main work groups. The first group treats natural landscape protection, administrative/bureaucratic functioning of the state, municipal affairs, forests, ecological education. The second group takes care of waste management, air protection, EIA (two people) and Geographical (as well as *Town*) Information System.

The Division for Building as well as the Chief Architects Office (land use planning, urban planning and architecture) are also involved in environmental matters.

The administrative apparatus of the Ecological Department has to keep in touch with the elected bodies of Ostrava. The elected representatives in general are more permissive towards applicants for construction projects than the Department. Sometimes the Department has to present legal arguments to stop such pressure. Ostrava has one main municipality, but consists of 22 town quarter municipalities with their own mayors, town halls, staff and elected representatives.

The decision to keep the Environmental Division on the Magistrát level, and only to decentralise small tasks to the town quarter authorities, was made deliberately to hinder too much influence of local town quarter politicians likely to be very permissive to their applying neighbours.

Another problem connected to decentralisation to a municipal (or in cities town quarter) level is that the competence concentrated there may be very limited. Some municipalities in the countryside consists only of the mayor, the vice-mayor and perhaps the chairman of the Building Office, who then has to fill several other functions.

This plan is proposed by the Chief Architect. The Department for Ecology is in permanent contact, and is taking part for instance on providing information on the regional system of ecological stability.

Personnel: The Department for Ecology employs 20 people including technical and secretarial staff. All professional staff have a Masters Degree (in biology, machine engineering, chemistry, foundry engineering).

Coordination: The coordination of the institute to control what is given by law. There is a requirement that the bodies involved should inform each other. One example given by the director shows the distinction between the institutions in the field of air protection. The task of controlling big sources of pollution belongs to the Inspection. Middle sources belong to magistrát/District. Small sources should be in the magistrát/District, too, according to the director, but it has been delegated to the town quarter level.

The Inspection and the District (in Ostrava represented by the *magistrát*) inform each other reciprocally about their decisions.

* *Water Management and Agriculture Department of the Environmental Division in Ostrava magistrát:*

On the question of the role of the Department in categorisation of the rivers into various groups as to their application the director of the Department referred to the Government decree 171/92 (see chapter 3.4.2) This decree prescribes a division of the water into two groups with defined parameters for water quality. This division into two groups was made in 1978 and is still valid. Water quality standards are given centrally. The categorisation of the watercourses is made by the Ministry.

In the case of a dam being constructed, the Department would act in its capacity as a part of the District Office. The District Office can protect upstream rivers as if they were under group (i). It is, however, not in the authority of the Department (nor the District office as such) to define what quality should be met in specific rivers or parts of them. This is solely a central state task.

Personnel: Ten of the twelve employed in the department deal with water management. Among these ten, four deal with building problems connected to aquatic investments (dams, sewage, treatment plants). These part of the Department act as the District Building Office for all aquatic investments. The Department issues decisions on whether to build or not. It also checks the investments after they have been constructed.

The remaining six employees deal with matters concerning the protection of water (ground and surface).

Among the ten water managers all except the leader of the Department, who graduated from the Prague University of Chemical Technology, graduated from the Building Faculty of the Technical University in Prague.

3.3.4 The watershed organisation (Povodí)

3.3.4.1 Organisation and main tasks

The water management in the Czech Republic is organised according to the catchment areas. Five watershed organisations (Povodí) are responsible for the water management in the Czech catchment areas. These are:

- Labe (Elbe)
- Vltava (Moldau)
- Ohra
- Odra
- Morava.

The Povodí (watershed) organisations work according to the Act on Water (138/73). Unlike the German *Wasseramt*, for instance, the Czech watershed organisations are not official bodies. They have a dual function of water management enterprise (supply organisation) and advisory body for the water management authorities. This combination of administrative tasks and private business interests can prove to be difficult to handle. The Povodí is a shareholding company *('akciová spolecnost')* with one share owned by the State. The board of the enterprise consists of representatives from the Ministry of Environment, the Ministry of Agriculture, the Environmental State Fund as well as representatives of the employees.

In its administrative tasks the watershed organisation has two main functions. First it is to take care of water management, distribution and control of discharge. Secondly, it is to monitor water use and water quality.

The Povodí is the manager of the water. The institution sells water. It also has the responsibility for the cleanliness of the water. The reservoirs and the surface water belong to the responsibility of the Povodí. The Povodí institution acts as guarantor of *the Guideline Plans for Water Management (SVP)*, which means that they are obligatory expert consultation bodies for water management authorities.

The Povodí organisations must give expert opinion to all authorities. Local authorities, however, have only competence on water pipe-lines and sewage (owned by the municipalities and administered by the water supply and sewage companies). The local authorities have no say on water flow questions that are in the competence of the watershed organisations.

There are few lakes in the Czech republic. The Povodí organisations are responsible for the storage of water in reservoirs. However, the reservoirs do not only have storage functions, but are a part of the overall water system. This system has these purposes:

- water supply
- flood control
- preservation of minimum flows in rivers
- preservation of water quality in rivers
- recreation
- generation of water power

It is the task of Povodí organisation to ensure the harmonisation of purposes of the reservoirs.

3.3.4.2 The watershed organisation in the Odra river catchment area (Povodí Odry)

Geographical scope: Povodí Odry (literally Odra Watershed Area) covers the Czech part of the natural catchment area of Odra River. Administratively Povodí Odry is divided into two main areas, Opava and Frýdek-Místek.

Tasks: Povodí Odry supplies water to the industry and the municipalities. Previously this was made without contracts, but from 1994 contracts were introduced. There have been problems of payment from some of the enterprises.

Apart from the price mechanisms there is no control or requirement for economical use of water. The enterprises call and tell how much they order. Povodí Odry gets a certain part of the incomes, but most of it goes directly to the State, i.e. the Ministry of Finance and the Ministry of Environment.

The Ministry of Environment and the Ministry of Agriculture decide the prices according to the varying costs of maintenance and running of the water supply systems. For processed water used by households the price per m3 has increased fifteen times since 1989.

Management of the reservoirs is one of the main tasks of the Povodí Odry. There are plans for the construction of more reservoirs. In the Czech Republic about one hundred new reservoirs are planned, in the Odra watershed area eleven are on the list. The areas where the planned reservoirs will be located fall into three categories. In the first category of areas no buildings are permitted. Two of the eleven planned reservoirs in the Odra watershed area belong to this group. The second category allows reconstruction works and some smaller buildings. The third area category mainly is in registrated new buildings.

Consultation with Povodí Odry is required:

- in the case of construction of new factories or big farms
- in the case of construction of highways, railways, long distance pipelines and electricity lines
- in other cases if the construction will have adverse impact on the reservoir

The reservoirs, weirs and channels in the Odra river catchment area are concentrated in a relatively small area and interconnection between them is necessary.

For some of the planned reservoirs it might be necessary to move the village population in the future. In the village of Nove Herminový not far from Bruntál, the population staged protests, but the state and population have reached an agreement tied to the land use plan of the area.

Personnel: 460 people work in Povodí Odry. Among the qualified personnel civil engineers are predominant. They graduated from the Faculties of Construction in Prague and Brno. There are also some biologists, chemists, machine engineers, electricians, economists in the staff.

Co-ordination: Being the over-arching water management body in the catchment area of the Odra River the Povodí Odry keeps in contact with the other institutions, users and interest groups. It is obliged to provide all authorities with know-how.

Povodí Odry controls emissions from the enterprises, samples their waste waters, but hands it over to the Environmental Inspection for evaluation. This division of labour is due to the fact that the Inspection is less well equipped technically than the Povodí Odry. The Inspection is an office, the Povodí Odry an enterprise that is to earn money.

The Povodí Odry has a data base including all permits given to the enterprises in the catchment area. The District Offices has to send all permits to the Povodí Odry. This means that the Povodí Odry has a copy of all permits, whereas the permits including the related correspondence are kept in the files of the District Offices.

Information on the technology applied by the enterprises or their production processes is not kept in any base. The knowledge about the specific technologies is kept by the environmental experts.

Local authorities have the competence in water pipe-lines and sewage, but no competence in questions relating to water flows.

The District Office decides on the use of water, but consults with the Povodí Odry.

The City/District and the Hygienic Institute decide whether a river or stream is to be used for swimming or not as well as other hygienic questions.

3.3.5 The environmental inspection

3.3.5.1 Organisation and main responsibilities

The Environmental Inspection is one of the four institutions assigned a role as a *'water management body'* according to the water management law.

The Inspection is subordinated to the Ministry of Environment (Act no. 282/1991 Sb.). The institution is composed of regional Inspections, following the division lines of the abolished regions, with headquarters in the following cities: Prague, Ceské Budejovice, Plzen, Ústí nad Labem, Hradec Kralové, Havlíckuv Brod, Brno, Olomouc and Ostrava.

The Inspection checks whether enterprises follow the emission limits. The inspection gives fines to the enterprises. The Environmental Inspection deals with emissions, waste water, handling of equipment that can prove to be dangerous and it watches the payment for water use. The Inspection is given the right by law to require improvements or to fine. The Inspection is also authorised to order closure of enterprises. The Inspection plays the major role during and after environmental accidents. Fines given by the Inspection goes to the Environmental Fund. Companies can appeal to the District Office of the Ministry of Environment. The inspection and the district are at the same level of power. The one is not superior to the other. The water inspection, however, operates in a larger area (i.e in the Odra catchment area-districts of Ostrava, Opava, Frydek Mistek, Novy Jicin, Karviná, Bruntal and part of Sumperek district).

The Inspection has an advisory role in the process of Environmental Impact Assessment. The regional Branch of the Ministry asks the Inspection to evaluate each Environmental Impact Study. The Chief Director of the Inspection prepares one final statement after all departments have looked into the study. The Inspection in Ostrava gets this job in spite of the fact that the law does not give it this role. The law gives the District Office and the regional Branch this job. In the Ostrava Inspection this is seen as a sign of confidence.

3.3.5.2 The Environmental Inspection in the Odra river catchment area

* *The Ostrava Inspection of the Czech Environmental Inspection (Division for Water Protection):*

Geographical scope: The Inspection's Division for Water Protection in Ostrava covers the catchment area of Odra. Thus it constitutes the third level of water management in the Czech Republic, above the municipality *('obci a mest': village and town)* and the District *('okres')*, immediately subordinated to the Ministry of Environment.

Tasks: The Inspection in Ostrava has four divisions for air protection, waste management, nature protection and water protection. The divisions for forest protection is in Krnov town.

The Inspection is authorised to close down enterprises. This has happened 2-3 times a year since the law came into effect. It is the last resort after several levels of fining the enterprises. The practice of giving fines and closing the enterprises results in several serious complaints from enterprises, 80-100 per year. Practically all enterprises that are punished complain. 80 percent of the complaints lead to a new process, but are refuted.

The Division cooperates with the regional water management unit. The one is not subordinate to the other, but a certain division of labour mostly leaves problems concerning construction permits to the District level.

Personnel: The people employed in the Inspection have various backgrounds. Some are former professionals of scientific institutes, some former users. There are chemists, water managers (engineers), construction engineers, machine engineers and one biologist. There is no lawyer employed. As the Inspection got the authority to close enterprises in 1992 in addition to the right to fine, the Inspection is in need of lawyers to meet this situation, according to the director of the Division for Water Protection .

Coordination: The Inspection mostly cooperates with the Povodí Odry (chapter 3.3.4). The inspection uses the laboratories of the Povodí, as it has no laboratory on its own. The Inspection is the official decisionmaker, Povodí Odry the owner. The Environmental and Ecological Departments in the District Office (chapter 3.3.2.3) as well as the Water Research Institute (chapter 3.6.3) are frequent counterparts of the Inspection.

Not only for water issues, but also for the three remaining most important fields of the Inspection, i.e. air, waste and nature conservation, there is approximately one inspector per District. The number of workers assigned to each District depends upon the number of problems in the given area.

The Water Division meets in the District Office mostly with the building office to check decisions on building permits. The Inspection and the District exchange information about each others' fining practices.

Each officer of the Inspection has to keep in touch especially with one district office and to cooperate closely with this office. Regular meetings are held with the chairman of the district in the office of the Regional Department of the Ministry of the Environment in Ostrava. This involves only the chairmen. In addition a lot of unofficial contacts take place. When all employees meet each other it is for up date courses on new laws and regulations. Then staff from the District office, the Inspection and the regional Branch meet.

When it comes to the division of labour between the Inspection and the District Office, the latter institution mostly focus on construction whereas the first mainly is concerned about nature.

In exceptional cases the Inspection make some corrections to the decisions of the District. In such cases the basis for interference is in accordance with the law.

The Inspection has little to do with the municipalities as these mostly deal with wells and other small family based activities. The Inspection only interferes when somebody asks them to do so.

3.3.6 The water supply and sewage companies

3.3.6.1 Organisation and main responsibilities

The water and sewage companies are responsible for drinking water and pipelines, waste water pipelines and waste water treatment plants. The activity of the companies in water supply and sewage is carried out within the framework of the Guideline Plan for Water Management (SVP) that are given for ten years. These plans are only departed from in emergency situations.

The water supply and sewage companies belong to the public utilities that has been picked to be privatised in the Czech republic. Other such utilities are: Wastewater management facilities, municipal energy and central heating enterprises and gas distribution networks and others. Two clusters of problems have occurred linked to the privatisation of these utilities. First is the obvious problem of municipal finances that are insufficient to purchase and run the enterprises. The second problem is how much influence the democratically elected councils would have over the privatised public utilities (Andrews, Paroha, Vozab & Sauer, 1994).

The problem of who is responsible for the sewage, the company or the municipality, is formally solved according to the ownership of the sewage network. When the municipality is the owner, the municipality is responsible. The sewage company is responsible for the construction and operation of the treatment plants.

The investments for sewage systems are made according to certain criteria. These are firstly that the money invested are money paid for the pollution of surface water. Secondly, the plant should contribute to the treatment of the river from upstream to downstream parts. The third criteria is that the plant should be close to drinking water resources.

Drinking water supply is regulated by law so that it is defined how much water can be taken by each source. In emergency situations, for instance when there is too little rain, emergency plans are made by the water and sewage companies. These plans have to be approved by the district authorities. 1992 was dramatically dry. Some enterprises were hampered by reduced water supply in 1992. It is possible to reduce water supply to enterprises with 50 percent, but food industry is not restricted.

Water consumption has decreased significantly in the Czech Republic the last few years. This is mainly due to three factors. First, the transitional economic situation in the Czech Republic has lead to a decrease in water consumption following the decrease in industrial production. Secondly, price mechanisms has caused the same effect. Thirdly, the amount of consumers that may make use of a measurement system for their own water consumption has increased. Before the 1989 Revolution only 70 percent had this opportunity. By the end of 1993 almost every consumer had a measuring point.

3.3.6.2 Some water supply and sewage companies in the Odra river catchment area

There has been a tendency over the last few years to split water and sewage companies into smaller independent units, also in cases where water then will have to be brought in from areas outside that of the new water supply and sewage company. In Ostrava there is a separate water supply and sewage company, that buys 80 percent of its water from SmVaK. The magistrát of Ostrava decided to have their own firm. The French water supply and sewage company *Lyonnaise des Eaux Dumez* prepares a programme with the Ostrava company. Also Bruntál has seceded. The small town of Krnov(15-20 000 inhabitants) recently established its own water supply and sewage company.

** The share-holding company Northern Moravian Water Supply and Sewage (Severomoravské vodovody a kanalizace a.s.)*

The competence of SmVaK, the Northern Moravian Water Supply and Sewage Company, is derived from the Water Law of 1973 and following acts and announcements. Its activity is basically divided into two parts:

- Supply of tap water
- Sewage and cleaning of waste water

The company supplies and cleans drinking water for 700.000 people. It sells 130 million m³ of drinking water. The company has a network of pipelines that stretches itself 4000 kilometres. 80 percent of the water supply is from surface water, 20 percent from ground water. The ground water distribution in the area is widespread.

SMVaK runs 35 waste water treatment plants. Waste water from 500.000 people - 60 mill. m³/year - is collected. The different amount for drinking water and waste water is caused by the fact that the Ostrava Water Supply and Sewage Company (OVaK) treats water for SMVaK in the Ostrava region.

60 percent of the income of the company is obtained from sale of tap water. 35 percent is for treatment of waste water. The remaining five percent comes from laboratory services and other smaller jobs. The main bulk of the customers are households, but the SmVaK also treats water for enterprises, especially for food industry. The SmVaK has the responsibility for most of the biologically and mechanically treatable industrial waste water, but do not treat specially hazardous waste water.

The prices of 7,10 Kc for tap water and 6,10 Kc per m3 are the lowest in the Czech Republic (prices as of early 1995). The price hike is due to increases in the price of chemicals and equipment investments. Now it is necessary to make up for the negligence of the water supply and sewage equipment in the past. Now the discharge standards are set more realistically than before the 1989 Revolution, but the lack of money makes it difficult to set up waste water treatment plants. Many villages are without any plant. Formerly the investment was subsidised from the state budget, but in the future the municipalises will be responsible.

Investment is strongly needed, but the municipalities that own the company have very restricted budgets. The municipalities have had several offers from foreign banks, but they have been impossible to accept. The reason is that the loans offered are so expensive that in order to pay back prices on water would have to be set too high for the consumers to take.

A big waste water treatment plants is now under reconstruction in Frýdek-Místek (to be finished 1995) The big plants in Havirov and Trinec were both finished in 1994. There is a plan to widen the waste water treatment plant in Opava and to prepare the construction of one in Bohumín, the last town in the area of SmVaK without a plant for treatment of waste water. All the new plants will have nitrogen removal and will correspond to the new standards, except for phosphorus.

Ownership: SmVaK is a shareholding company *(akciová spolecnost)*. The shareholders are the municipalities that use the services of SmVaK, 182 towns and villages. Approximately ten percent of the shareholders are private persons that made use of the first wave of privatisation. Apart from the Northern Moravian Water supply and sewage company only the Company in Brno was privatised in the first round, but in Brno another model was chosen. There the so-called 'investment units', i.e. technical equipment) is owned by the municipality, whereas the 'process' is owned privately. The same model was chosen by the detached Ostrava company.

The municipal owners of SmVaK became shareholders in the company, and in order to pay their shares, they sold the pipelines, channels and reservoirs.

The second round of privatisation that started October 1st 1993 involved the remaining 40 Water and Sewage Companies. According to the director the experiences are positive first of all because a private company can decide about their own problems without recommendations from above. However, the process is time-consuming and there is a need for changes in laws and prescriptions.

As for the waste water treatment plants they are sometimes owned by the SmVaK, sometimes by the municipalities, but in the latter case, the municipality will rent the plant to the SmVak. In the Northern Moravian case, the districts of Bruntál and Ostrava have secluded.

Geographical scope: SmVaK covers four districts: Frýdek-Místek, Karviná, Nový Jicín and Opava.

Personnel: SmVaK employs approximately 1.550 people.The educational background of the staff is a mixture of chemists, engineers and experts on electronics. Only very special equipment is brought in from other companies, most is covered internally.

Coordination: As for the coordination with the Povodí Odry, the latter is the manager of the streams and the reservoirs from where SmVaK buys tap water. Water is owned by the state. If SmVaK managed the reservoirs, it would according to the director treat them *"as the first step in drinking water treatment"*. The manipulation of the flows by technical means would be devoted to making water drinkable. Meetings with other water management institutions are irregular and connected to immediate needs to meet.

The SmVaK is subordinated to the Ministry of Agriculture, whereas the Povodí Odry, the Water Research Institute (VÚV) and the Hydrometeorological Institute operate under the Ministry of Environment.

* *The share-holding company Ostrava Water Supply and Sewage (Ostrava vodovody a kanalizace a.s.)*

OVaK operates three waste water treatment plants in Ostrava (in the town quarters of Prívoz, Trebovice and Zábreh).

The OVaK is building a waste water treatment plant with a 2,6 milliard Kc (Czech crowns) budget (1,6 milliards to the waste water treatment plant and one milliard to the sewage system). The new system will treat the sewage from all the three existing sewage systems serving 550.000 people (personal equivalents) and 450.000 personal equivalents for the industry. The plant is planned to be finished in 1997.

The present price for water (tap and wastewater) from OVaK is 17 Kc/m3.

Ownership: 51 percent owned by the French company *Lyonnaise des Eaux Dumez*. The magistrát lends the technical equipment to the OVAK. OVAK and SmVaK are independent corporations. The only connection between them is that OVAK buys tap water from SmVak as Ostrava city is defficient in local sources of drinking water. This water is then sold to inhabitants and treated by OVAK treatment plants in Ostrava.

3.3.7 The Hygienic Institute

3.3.7.1 Organisation and main responsibilities

Previously called the Hygienic Station, the Hygienic Institute defines what is hygienic and urges the enterprises and the authorities to make healthy conditions.

Air, water, soil, living conditions and social services are the main branches. Hygiene of food as well as the hygiene of recreational water is perhaps the most specific field that comes under the responsibility of the Hygienic Institute.

The Hygienic Institute overlooks both surface and drinking water, tap water, swimming water as well as swimming pools from the hygienic point of view. The Institute is subordinated to the Ministry of Health. It was established as early as 1944, but the law concerning its activities is 30 years old (Act on health, hygiene and primary prevention). The Institute has cooperated with institutions and authorities with an environmental responsibility since the beginning.

Administratively the Hygienic Institute is headed by a General Hygienist in the Ministry of Health at a central state level. On a District level there is a District Hygienist tied to the state representation at District (okres) level. At an okres level some environmental responsibility is given to the Hygienist.

The Hygienic Institute can fine polluters.

The Hygienic Institute has been freed from some of its duties concerning the control of the observation of the standards set. Instead it has been given better possibilities of checking human exposure.

Up till 1985 there was no law for the contamination of soil. After the initiative of Hygienic Institute an agricultural laboratory was established, that among other activities analyses waste land-fills.

For the Hygienic Institute the privatisation policy means increased paper work as everybody now can start an enterprise and everybody has to get a permit from the Hygienic Institute.

3.3.7.2 The Hygienic Institute in the Odra river catchment area

* *The Hygienic Institute (Hygienický Ústav), department of environmental health in Ostrava*

Geographical scope: Previously the institute in Ostrava served as a regional institute in Northern Moravia directing the district institutes. Now the branches are gathered as one institute, but still the Ostrava branch plays a special role because of its better equipment. When the regional level was abolished after the 1989 Revolution, the Hygienic Institutes were still organised according to the old regional divisions. Ostrava was the only exception to this. Here the Hygienic Institute was "decentralised" to a District level.

Tasks: The District Hygienic Institute has two departments, one epidemiological and one hygienic. The hygienic department is divided into three main fields, radiation hygiene, working conditions and environmental conditions. For municipal hygiene it divides its activities into a legal part, where it acts as a public authority and a more scientific one, where it scrutinises the state of health in the municipality.

In the field of drinking water the Hygienic Institute brings in human health as the main item, whereas the Hygienic inspection focuses primarily on the fixed limit values. Thus the Hygienic Institute is clearly the representative of an anthropocentric way of thinking inside the "environmental sector".

The enterprises are not checked regularly by the Ostrava Hygienic Institute. The enterprises should have their own offices and equipment, the director of the Institute said in the interview.

There are several effects of the transformation to be felt by the Hygienic Institute in Ostrava, according to its director. Now there are sometimes unclear ownership relations. State authorities and economic subjects are not yet clearly identifiable from each other. Formerly there was a centralised system of urban and regional planning, now it is sometimes rather chaotic, according to the director of the Institute's department of environmental health. The State Planning Institute does not exist any longer. It used to have its own experts on water, soil and roads. The role of the Guideline Plan for Water Management *(smerný vodohospodárský plán: SVP)* has changed from being a directive to being a recommendation (see chapters 3.4.2 and 8.2.3).

Personnel: The Hygienic Institute employs 400 people in Ostrava.

Coordination: The drinking water reservoirs are not only checked by the river catchment authority (Povodí Odry), but also by the Hygienic Institute. The Hygienic Institute makes sure the hygienic zone around the dams are respected. Here the role of initiator is on the side of the Hygienic Institute.

All constructors have to get a permit from the Hygienic Institute before it can start new activities. This permit is additional to the permit given by the Building Office at the 'okres' level. The building Office can not give its permit without the permit from the Hygienic Institute. Here the Hygienic Institute has two options. Either it states some specific conditions for giving a permit or it checks whether the existing equipment meets the demands. In the field of environment the District departments for water and ecology are the most frequent partners of the Hygienic Institute. This work is carried out in a special Commission for that purpose. The Commission is headed by an officer *('referent')* from the Building Office at District level. The second member of the Commission is the representative from the Hygienic Institute. Sometimes the applicant is invited.

Before the 1989 Revolution The Hygienic Institute regularly invited the directors of the Inspection and the District for meetings. Nowadays the responsibilities are more unclear, and meetings are fewer.

At a magistrát level there are special committees on specific issues such as traffic, building etc. As a part of his formal position the director of the Hygienic Institute in Ostrava is a permanent member of the magistrát environmental commission. One representative from the Hygienic Institute also takes part in the commission that judges the applications for development activities. There are also informal contacts between the workers in the Hygienic Institute and the member of the Environmental Committee.

3.3.8 The Hydrometeorological Institute

3.3.8.1 Organisation and main responsibilities

The institute guarantees the basic network of the hydrometeorological and climatological network in the Czech Republic. The Hydrometeorological Institute is organised region-wise following the old regions that were abolished after the 1989 Revolution. There are altogether seven regional branches. The institute has three functional divisions, for meteorology and climatology, for hydrology and for air pollution control. As for hydrology the institute has 112 water grading stations, 60 stations for measurement of water temperature.

3.3.8.2 The Hydrometeorological Institute in the Odra river catchment area

** Czech Hydrometeorological Institute, regional branch in Ostrava*

Geographical scope: The branch that has its offices in Ostrava-Poruba covers the region of Northern Moravia. The institute will probably not change its structure in order to adapt to the new regional borders that are under discussion. These borders will most probably not follow natural structure, as would be the most efficient way from a measurement point of view.

Tasks: 80-90 percent of the budget of the institute is derived from the state budget. It works under the auspices of the Ministry of Environment. The institute is a part of the environmental sector as a supplier of data that the other parts of the sector may make use of.

As a data base the Hydrometeorological Institute submits data for EIAs, but as the act on EIA was passed only in 1992, the institute has not been very much involved so far. Anyway the institute does not keep any record of EIA involvement as the firms that order the data do not have to state for what purpose the order is made.

Personnel: In the regional office there are 80 professionals, 20 percent of whom have a university degree.

Co-ordination: The Hydrological branch has its closest external contact with the Povodí Odry, especially on management and laboratory issues. There is a daily contact with the Povodí Odry based on exchange of information. This exchange goes both ways.

The Hydrometeorological Institute has running contact with the District Building Office concerning building permits. Investors have to buy the necessary data from the institute before the project can be submitted to the Building Office.

3.4 Planning tools

3.4.1 The system of land use planning

3.4.1.1 Organisation and main responsibilities

Land use planning and construction is under the jurisdiction of the Ministry of Economy since October 1992 (see chapter 3.3.1.2). The relevant unit in the Ministry of Economy in the Sector for Urban Planning in the Department for Regional Policy.

Since 1989 Czech land use planning has gone through a shift from being a technocratic tool in the hands of central and centralist government to being an instrument in the hands of local self-government.

As a result of the introduction of local self-government planners suddenly found themselves outside the walls of state bureaucracy. From now on planning was a tool of local self-government and planners had to be in close touch with local communities. In the beginning the municipalities tended to refuse physical planning altogether. Nevertheless approximately twenty percent of all municipalities carried out land use plans in 1991-93. Plans are most frequent in the economically most active areas such as Prague, Ostrava, Brno and Olomouc, and border areas to Austria and Germany. New actors have emerged that did not exist under state socialism - property owners, municipalities and developers. These actors need land use regulations (Hoffmann, 1994).

Czech physical planning is being repoliticised and heading towards the market at the same time. Physical planning is becoming a part of the so-called 'productive sector', a shift that is manifested by the fact that planning is now a part of the Ministry of Economy. The process of making planning more "political" has to do with the shift from a totally technocratic approach typical of state socialism to an open society with participatory ideals. *"Planners used to treat buildings and towns, now they must treat people as well"* (according to a statement made by one planner interviewed by: Hoffmann, 1994).

It is often claimed that Czech physical planning has suffered a crisis since 1989. Under state socialism planning was a pure technocratic task. Planners were insulated from popular sentiments, and were severely criticised from 1989 on because of their crucial role in the programmes aiming at amalgamation of municipalities and so-called *'managed urbanisation'*. Immediately after the fall of state socialism there was a tendency among physical planners to want their titles changed into *'policy makers'*.

3.4.1.2 The relation between land use planning and water use planning

There is no direct relationship between land use planning and the Guideline Plan for Water Management (see chapter 3.4.2 and 8.2.3) under the responsibility of the Ministry of Environment. During the preparation of land use plans, however, water management institutions have to be consulted. The guidelines from the SVP are to be observed by the land use plan.

3.4.1.3 Land use planning in the Odra river catchment area

* *Project Master Plan for Karviná and Trinec*

The office that will prepare a Master Plan for Karviná District and the industrialised parts of Frýdek-Místek District was established in February 1994. The office is based on a political agreement between the municipalities in the area covered.

This area is a functional region based on several common features:

- location at the riverside of River Olza
- industry
- landscape type
- border with Poland

The District of Frýdek-Místek is divided in two characteristic parts. The Eastern part is agricultural, rural and mountainous (except the industrial town of Trinec) whereas the Western part, near the town of Frýdek-Mistek, is heavily industrialised.

The Master (or Strategic) Plan for Karviná district will be finished by June 1995. Four people work in the office.

As a part of the EC Ouverture programme cooperation with districts in Spain and Wales was established. This programme made the need for a strategy for the region felt. Discussions with the municipalities led to the conclusion that the office should be established.

The establishment of the Master Plan Office is the first of its kind in the Czech Republic.

It was told in the interview that Project Master Plan for Karviná and Trinec is an effort to support the new regional administrative unit, above the districts that are mandated in the Constitution. The result of the plan will not be mandatory for the municipalities in the region, but the plan will be worked out in close cooperation with the municipalities in order to anchor as much as possible of the plan in local need and approaches. When a new second level tier elected body will be introduced in the Czech Republic is not clear, but it has been decided to take place. When this level is established regional planning and the elaboration of master Plans will be in the competence of this level.

Mines do not play an important role for land use plans as they do not need new ground due to the decline of that branch. There are altogether nine mines in Karviná. One will be closed in 1995. 3-4 will be closed within year 2000.

The Master Plan project cooperates mostly with three of the ten regional divisions. These are:

- Environmental Division
- Division for Soil
- Department for Regional Development

** Department of Regional Planning in the Chief Architect's Office, magistrát of Ostrava*

The Department of regional Planning is one of three divisions under the chief architect. The other two divisions are for (a) technical conceptions and (b) architectural concepts. 17 people are engaged in work with the town plan and in giving judgements of the land use plans. The plan for Ostrava agglomeration was accepted by Government in August 1994. It was made by the plan institute TERPLAN.

The plans are carried out in three stages. First research is being made, then the conception is developed and finally the decision is made.

The first phase *(research)* in gathering as much information as possible including opinions from the public on future activities. These opinions are analyzed in order to harmonise them into the final document.

This document is called *"Area and economic principles for the reconstruction of the area plan of Ostrava".*

Earlier one complex map was prepared, in which all conflicts were presented in the text. Now there were made four maps of conflicts. This was necessary as the situation is too complex to be shown in one map only. It is unusual in the Czech republic to have more than one map.

These four maps are:

1: map of negative influences to the environment
2: map of functional use of the area
3: map of traffic
4: map of technical infrastructure (water supply, heating etc).

The plan was discussed in the City council before it was finally stated.

The second stage *(development of the conception)* consists in inviting enterprises, administrative organs and the public to "the cabinet of the town plan", where the interested public can study the proposed amendments on transparent paper over the maps. The Department of Area Planning should accept proposals when possible, according to the leader of the Department for Regional Planning in Ostrava.

Most proposed amendments are in connection to the controversial highway D 67 through Ostrava. Several line courses have been proposed. The Directorate for Highways in the Czech Republic made 16 proposals for location. The Area Plan Office prosed three alternative locations. The chosen location is closer to the river than the other proposals. This roadway was found to be best as a result of the "analytical" phase of the EIA. The Department of Ecology in Ostrava magistrát was in favour of the other alternative farther from the river. The "choice" was between to evils - either to infringe harm upon a concentrated settlement of human inhabitants or to roadway the highway very close to the river.

For rivers the category of use is settled in the town plan, e.g. as recreational. Water quality, however, is regulated through the water management act. The water act is underpinned only by the Guideline Plan for water Management. A strategic approach in order to better the water quality in a certain part of a river is to regulate it as "recreational", thus creating a demand for cleaner water. In the interview in the Planning Unit it was said that this is an indirect way of doing it: As a result of the regulation into e.g. recreational areas a demand stricter rules for water quality in the area can be established.

3.4.2 The system of water planning

The Guideline Plan for Water Management *(smerný vodohospodárský plán: SVP)* is a general plan concerning water quality and water use issued by the Government. The SVP is the only water use plan in the Czech republic. Special parts of the SVP are for the specific catchment areas, but there are not made separate SVPs individually for the catchment areas. Neither are there water use plans for more detailed areas, such as Districts or municipalities..

The water management bodies are obliged by the Guideline Plan for Water Management. This plan is elaborated centrally in Prague. It has two parts:

- main outline of water management
- balance of water management

The outline is now valid until year 2005 (and is active since 1976). It gives a sketch of how water management will look in year 2005. Investments needed to reach the goals set are delineated for rivers, dams, sewage systems, waste water treatment plants, water pipes.

The balance of water management is made yearly for all the five River Basins in the Czech Republic. On one side the possibilities of water use are depicted. One the other side the needs of enterprises and households are described. The aim of the water balance plan is to secure that needs are not satisfied more than the capacity of water resources can take. The yearly balances are calculated by the *Tomás G. Masaryk Water Research Institute*. The Ministry of Environment orders the balances.

The balance of water management includes a chapter on the administrative structure of water management. In this chapter three types of enterprises are described:

- the watershed organisations
- the water management and sewage companies
- the state melioration (land reclamation) institution

The latest balance (of 1993) states that the ownership situation of the river basin authorities are not yet decided. The Ministry of Environment will decide which parts of the river basin authorities that will be privatised an which will belong to the state. Now they are shareholding companies with a 100 percent state ownership.

The water management and sewage companies are under privatisation or they are already privatised.

The State Melioration (land reclamation) Institution manages the small rivers. The rivers run by this institution often flow through agricultural areas or forests. The State Amelioration Institution belongs to the Ministry of Agriculture, but the placement of its rivers and streams is under consideration. Some of the smaller rivers flowing through forests or agricultural land are owned by the municipalities and forest companies.

The classification of the rivers into various groups as to their application is made in the Government decree 171/92. This decree prescribes a division of the water into two groups with defined parameters for water quality. The two categories are:

(i) - rivers/streams for potable water
(ii) - other important rivers

In addition a classification of water quality is made according to the Czech standard (CSN 757 221) into five classes.

3.4.3 Environmental impact assessment

3.4.3.1 The Czech EIA system

The Czech Republic has introduced procedures for Environmental Impact Assessment that basically correspond to the EIA systems that prevail internationally. The EIA regulations are given in act no. 244/92. The Czech word for EIA is *"hodnocení vlivu stavby na zivotní prostredí"*.

The EIA act provides screening rules that divide investments into three groups. The smallest investments projects will go directly to the Building Office of the District/magistrát without an EIA. Those investments that will have to undergo an EIA, are either treated by the District/magistrát Office or by the regional representation of the Ministry of Environment. The District/magistrát Office will carry out an EIA on smaller investments and investments with a local impact. Larger investments and investments that have impacts across district borders - such as most roads, petrol and gas tubes - belong to the competence of the representation of the Ministry of Environment.

There are approximately 150 EIAs at a national level a year. The District Offices usually carries out 2-15 EIAs a year. There are 75 District Offices in the Czech Republic. In each of the 75 districts one officer without staff is responsible for EIA. In the regional offices of the Ministry of Environment the deputy director is responsible for EIAs. In both cases the responsibility consists of conducting the EIA procedure, including making sure public participation is made.

When the EIA documentation is submitted to the District/magistrát Office, it is passed on to the municipality, the Environmental Inspection, the Hygienic Institute and other institutions to be consulted e.g. from the point of view of air pollution, nature conservation, waste management and traffic. As for water issues, the Water Division in the magistrát is involved for investments of a local character. EIA documentation on investments with larger impacts on out-flowing streams will be read by the Povodí Odry. In addition the responsible officer for EIAs in the District/magistrát will decide to show the documentation to other units.

A licensed EIA expert will be requested to make an evaluation of the EIA documentation and propose the EIA conclusion to the responsible district department.

The local population will be able to view the EIA documents after they have been received by the local authorities. A general discussion/open meeting is arranged locally where the investment is going to be located. This discussion is open for everybody. Also people that do not live in the community can take part. Objections to the investment plans do not necessarily have to be based on particular expertise. At his stage the complexity of the issue is to be focused upon.

There are special regulations on the rights of public associations and of the requirements for creating ad hoc public initiatives for taking part in the EIA process.

Only after this general discussion is held, the EIA officer in District/magistrát or Regional representation of the Ministry of Environment can allow the investment application to be submitted to the Building Office.

EIAs on Plans, Programmes and Policies is held to be premature in the Czech Republic. In the EIA act it is stated that assessments should be made on "concepts". To avoid fully-fledged EIAs the ministries tend to avoid the word "concept" about their policies.

Land use plans and master plans are mentioned in the EIA act as well, but tend to slip away from EIA. City authorities can make their projects evade from the screening procedure of the law simply by terming their master plan by a neutral label, not explicitly mentioned in the law.

From the experiences drawn from the practice of EIA several changes in the EIA law are under way. The scoping procedure is widely held not to have been satisfactory up till now. The first analytical part of a project is handed in with the notification (announcement that the project will be initiated). At this stage there is no scoping, and therefore analyses are often made on irrelevant issues, and time is lost. The Ministry of Environment seems to be aware of the flaws in the system, and is about to prepare rules that will ensure public participation (hearing) at the scoping phase in order to gather relevant inputs for the study programme for the Environmental Impact Study (the EIA "document").

There are also some uncertainties on which authorities should be present at the public meetings. In the future it will probably be possible for the public to take part in the scoping process (determining which questions to be investigated in the Environmental Assessment Study). It will also be possible to include projects for an EIA even if that specific kind project is not mentioned explicitly in a list.

In cities and in District Offices there is staff working specifically on EIA. They are methodically under supervision of and educated by the Ministry of Environment and has a close relationship to the regional representation of that Ministry.

The role of the division for environment in the city as to EIA is first of all tied to the role of the municipal authorities in the building preparation process. Besides that the city council organises the public discussion/hearing that is a part of the EIA process.

The Czech system of EIA includes licensing of EIA experts. This is the responsibility of the Czech Environmental Institute, but in the committee that actually issues the licences there are also members drawn from other institutions, such as the ministry of health. Approximately 30 percent of the candidates do not pass the exam at first stage. The exam requires a wide knowledge on legal and administrative-managerial aspects in addition to the environmental and ecological knowledge.

Czech EIA processes last for something between two months and one year. The EIA documentation must be displayed publicly for 30 days.

3.4.3.2 EIA in the Odra river catchment area

**The Regional Department of the Ministry of Environment*

The Regional department spends a considerable amount of time on EIA. It has carried out 22 EIAs.

Every second month there is a meeting between the District Office environmental departments and the Ostrava Regional Department, that covers the physical confines of the Odra River catchment area. The distribution of competence seems to be clear cut enough to avoid conflicts.

** Opava District, Environmental Department*

In Opava EIAs have been made on technological changes (three cases), new technologies (three cases) and new cases (two cases of land-fills). One staff is responsible for EIA in Opava district, but during the EIA process several other people from the District Office environmental department are involved.

The experiences of public involvement in EIA from Opava are of both kinds. Especially in cases of land-fills and incinerators it has been easy to get the local people involved. On the other hand, the arguments put forward by the local population are often not so much on environmental consequences as on the land-fill itself.

** Ostrava District*

Since the EIA act came into practice in 1992 seven EIAs have been finished and an additional three are under preparation in the magistrát of Ostrava. That is close to the average for Czech districts.

The investments were on installations for sewage, shopping centres, engineering and print shop. Only the sewage project was public (municipal), the others were private.

In order to sign an EIA study in the Czech Republic it is necessary to have passed a special exam. In Ostrava and surroundings 25 people have passed an exam of EIA, but these exams only cover parts of the field that has to be dealt with in an EIA. Ten firms in the Ostrava district take part in EIA activities. So far no firms in the Czech Republic operate solely as EIA firms.

Personnel: In the Ostrava District/magistrát eight professionals are working in the public administration with EIA matters. Most of them are graduates from the machine engineering faculty of Brno.

Co-ordination: Generally the Regional representation of the Ministry is superior to the District/magistrát, but in EIA matters the Ministry has no power to change the decisions of the District/magistrát.

** The Division for Environment of Karviná city*

In the near future a big public discussion will be organised between the Town Council and the mines in order to discuss a conflict over land use. The mines would like to extend the area used for extraction. The City accepts an extension only after an EIA. This lies within the competence assigned to the city according to the law.

** Environmental Division in the Karviná District Office*

In the Division one person has specialised on EIA. In addition the head of the Division involves himself partially. *("It is convenient for the head of Division to be involved in the EIA activities. The EIA approach is a broad one that makes it possible to get a good overview of the environmental problems in the District.")*

Five EIAs have been completed since the law was implemented in 1992. One is about to be finished and two are at the stage of statement. Among those EIAs completed, one got a negative conclusion. The case was that the investor wanted to make a land fill for waste stones from mining in a forest. The problem was not in the quality of the stones, but in the localisation of the land fill. Instead of changing the localisation, the investor complained to the Ministry. However, the law does not mention anything about complaints.

The four investments that passed an EIA were:

- Municipal waste land fill
- Decontamination centre for hazardous waste
- A transition of a cattle farm into pig farm
- Localisation of a new brewery

Public participation did take place only in the case with the Decontamination Centre Rychvald. The objections launched by the public had some political connotations and were not judged objective. Therefore they were not taken into consideration. People were afraid of toxic vapours from the chemical compounds. It was, however, specified very clearly in the documentation what sort of chemicals that could be treated in the contamination centre.

** Non-governmental organisations and EIA*

The semi-NGO network of voluntary nature protectors works closely with the Department for Ecology in the District Offices. This is also the case for the Ostrava magistrát (see 3.15). The nature protectors have a potential role in EIA as people to be consulted, but up till now this has not been the case. The reason for this is probably that the mostly biologically oriented nature protectors do not deal with the problems that have been subject for EIAs so far, which are mostly developments of technology (removal of old and installing of new).

The Czech Union of Nature Protectors *(Ceský svaz ochráncu prírody: CSOP)* is active in Havírov and other towns and cities in the Czech republic. The Havírov branch of the CSOP has been actively involved in an EIA procedure. In 1993 a shopping centre was planned in a wetland area by the stream Lucina. The town authorities would like to locate a shopping centre at this site because of its vicinity to the largest road in the town. The CSOP acted as a public body within the legal framework of EIA. In the end the shopping centre was located at a less environmentally harmful place in the town.

The Havírov branch of the CSOP has made use of the EIA act in two additional cases. In the first case some old trees were to be cut, but thanks to protests they were saved. The other case involved the *Act on protection of nature and the landscape (no. 114/1992 Sb.)* in addition to the EIA act. The place was the statue of Vladimir I. Lenin used to stand was saved from construction works.

3.5 Other policy tools

3.5.1 Economic instruments, administrative and regulatory measures

3.5.1.1 Policy and legislation

Officially of Czech environmental policies are to be pursued by emphasising so-called *indirect* instruments, among them economic incentives. The so-called *direct* instruments correspond to administrative measures. In each individual case, however, indirect and direct instruments will be combined. The principle that *"polluter pays"* is to be applied. This will decrease the need of government spending on environment, but the role of the government is understood as irreplaceable in some cases.

Concrete goals and measures are formulated for:

- The individual environmental media, such as air, water, geological environment, soil, nature, landscape and forests

- The economic sectors, such as the power industry, industrial production, transportation, agriculture,raw materials and waste

- The fields of society, such as health care, education, science and development of technologies

- Politics, such as the state administration, regional policies and international relations.

Implementation programmes are developed by the Ministry of Environment in cooperation with other relevant ministries (on programmes see chapter 3.5.3).

The legal provisions regulating water management in the Czech Republic are:

* Act no. 138/1973 Sb. The act on water management.

* Czech National Council Act no. 23/1992 Sb, amending act no. 130/1974 Sb, Act on the state administration of water management. The complete wording announced as Act no.458/1992 Sb.

* Decree of the Government of the Czech Republic no. 171/1992 Sb, decree on indices for admissible water pollution

* Decree of the Government of the Czechoslovak Socialist Republic no. 35/1979 Sb., on payment in water management. The complete wording in Government Decree no. 2/1989 Sb.)

* Czech National Council Act no. 281/1992 Sb., amending decree of the Government of the Czechoslovak Socialist Republic no. 35/1979 Sb., act amending the decree on payment in water management, in the wording of decree of the Government of the Czechoslovak Socialist Republic no. 91/1988 Sb.

* Decree of the Ministry of Environment of the Czech Republic no. 422/1992 Sb., amending decree of the Ministry of Forestry and Water Management of the Czech Socialist Republic no. 82/1976 Sb., decree on conditions for the use of surface waters for motor-driven shipping.

3.5.1.2 The New Water Act

A new act on water management is under elaboration. The debate over the new law has been politicised. Two main views, one liberal and one restrictive, have clashed. The views of economists and water managers (or *"liberals"* versus *"restrictive"*) differ mainly on the following subjects:

The economists are seeking economic efficiency. They state that there is little money for the protection of water. For the same economic reasons the economists say that some directives on water from the past should be abolished.

In order to increase economic efficiency economists also believe in privatisation. In the debate over the new Water Act economists have stated that also water should be owned by private. Now water is owned by the State unless it is explicitly transferred to another subject.

The water managers on their side have stated that water should be protected more strongly than before. The protection should not only be connected to some parameters of water quality, but to water as a part of the eco-system and a part of the landscape.

Water managers are in favour of a more strict rule, a rule that says that water is always possessed by the State.

Restitution of nationalised property to its owners or their descendants is a part of the Czech ownership reform. The liberals would like to extend the restitution process to apply also for the water. Before 1945 and 1948 ground water belonged to private persons and subjects. The liberals also want ground water below private land to be privatised. According to the proponents of a more restrictive law even fish ponds should belong to the state in order to make enforcement of regulations efficient. How to operate the pond, whether to accumulate water in a pond and how to feed the fish should be regulated.

The Ministry of Economy has acted as a proponent of the liberal view as it fears that stronger water protection could reduce the intensity of economic development in some regions and that as a result of this, the economic transformation would be delayed.

3.5.2 The State Environmental Fund

3.5.2.1 Organisation and main responsibilities

The State Environmental Fund was established in 1991 as a part of the modernisation of environmental management (act no. 388/1991 Sb.). The Fund plays a main role in the financing of environmental projects in the Czech Republic. It contributes to the policy of reducing spending from the National Budget.

The main idea behind the Fund is that fees drawn from polluters should be used for improving and protecting the environment. These fees are from discharge of waste water into surface waters, fees from withdrawal of underground water, fees for the discharge of pollutants into the air, fees from removal of agricultural land from the agricultural land resources fund and fees for depositing waste. Sources for the Fund can also be subsidies from the state budget and donations. The criteria for what kind of environmental programmes that are eligible for support from the Fund are given each year by the Ministry of Environment. These criteria are given for the environmental sector as a whole and for each environmental medium.

3.5.2.2 The State Environmental Fund in the Odra river catchment area

It is a general complaint in the Odra river catchment area that Northern Moravia is disfavoured in the competition over the Fund means. Too little of the fees drawn from Northern Moravia to the Environmental fund is ploughed back again. The law prescribes that 60 percent of the money given from a region should come back. Among the Czech regions Northern Bohemia enjoys a privileged position in this competition. This is due to three main factors. First, the problems are worse in Northern Bohemia that suffers from unfavourable wind conditions. The Moravian Gate helps air pollution spread itself with the winds. Secondly, Northern Bohemia has a stronger lobby in Prague. Thirdly, the environmental problems in Northern Bohemia are more easily measured.

It is the task of the District Office to supervise the procedure of who gets money from the State Environmental Fund. The Environmental Fund does not decide who will have money from the Fund without a written opinion from the District Office, but the District Office does not bear any responsibilities for the decision made. Discussions have been going on between the central government and local authorities on who should have the responsibilities. The result was that a regional office for Northern Moravia was established in order to supervise the flow in/out of the Environmental Fund. The office is run by the Environmental Fund. It is located in Havírov.

The District Offices have a ranking list of where to build waste water treatment plants. This list is internal and not available for the public. In Ostrava the central waste water treatment plant has the greatest priority as it is for large the most serious polluter. When this waste water treatment plant is built, it will also treat water from many enterprises as well.

3.5.3 Environmental programmes (international and national)

The Czech Ministry of Environment carries out several programmes, both national and international, to improve the environmental situation. Here only the programmes that are related to water quality in the Odra river catchment area are mentioned.

The Programme for the Revitalisation of River Systems

The decision to carry out this project was made by the Czech government in 1992 on a proposal by the Ministry of Environment. The aim of the programme is to increase the ability of the watershed systems to retain surface water. The programme also aims at remediating the harmful effects of the actual land use and of wide-area drainage systems. In the first year of the programme one third of agricultural land in the Republic was classified as excessively drained. The programme should also contribute to the renewal of the natural function of water courses. The Czech Republic has a total length of 89.600 kilometres of waters courses. 5.600 of these kilometres are in pipelines and 16.700 in artificial canals.

The Northern Moravia Master Plan Project ("Project Silesia")

This project is one of five projects carried out as a part of the Environmental Programme 1, which is a cooperation between the Czech environmental authorities, the World Bank and several European and overseas states. The Project Silesia includes the Czech and Polish environmental authorities and the US Environmental Protection Agency. The aim of the project is to draft an abatement programme that is economically viable. Its aim is to stop environmental destruction of the Districts of Ostrava, Karviná, Frýdek-Místek, Nový Jicín, Bruntál and Opava on the Czech side of the border. On Polish side the county *(województwo)* of Katowice and parts of the Opole, Bielsko-Biala and Czestochowa vojvodships are included.

The second phase of the project is to be finished in 1995. This phase consists in carrying out pilot projects, among them a project on reducing the risk of pollution of surface water. The main emphasis, however, is on reducing the environmental influence of coke ovens (see also chapter 1.2.2).

The Project for the Renewal of Lands Devastated by Mining Activities in Northern Bohemia and Northern Moravia

Like the Silesia Project this project is a part of the Environmental Programme 1. The Ostrava-Karviná coal mining area in the Odra river catchment area is a art of the project.

International Commission for the Protection of Odra Against Pollution

This is a project between the Czech Republic, Poland, Germany and the European Community to prepare for an international agreement on the protection of Odra to be signed.

Baltic Sea Programme

The Czech republic is an endorsing party to the Ronneby Declaration of 1990 on ecological restoration of the Baltic Sea. Odra river is the main conveyor of Czech contributions to the ecological state of the Baltic Sea (see 1.2.1.).

Project Odra

The T. G. Masaryk Water Research Institute in Ostrava carries out a research project aiming to obtain the data required for an abatement strategy for Odra. This is a national project financed by the Czech Ministry of Environment (see chapter 1.2.3).

3.6 Other factors

3.6.1 The environmental management in the enterprises

3.6.1.1 Organisation and main responsibilities

Initially environment was not mentioned in the Czech privatisation programme. In the so-called *'first wave'* of mass privatisation (through a sale of vouchers in a national auction) in 1991 environmental issues were not mentioned. The amendments of the Privatisation Act February 29 1992 required, however, environmental audits for all enterprises under privatisation.

The potential buyers of enterprises were given some advantages in the government Resolution of June 24 the same year. Only the environmental deficiencies inside the enterprise would be the responsibility of the purchaser. To clean it up the new owner would get assistance from the National Property Fund, that would keep 50 percent of the purchase sum of the enterprise as a reserve to be ploughed back as environmental investments in the enterprise.

Less than one year later, on March 17 1993, the a new Resolution (no. 455) replaced the old one (no. 123). This resolution states that all environmental liabilities of an enterprise is the responsibility of the purchaser. Investors will not have any reductions in the purchasing price for the cost of cleaning (Panayotou, Bluffstone & Balaban, 1994).

As of today, there are no legal regulations on the position, responsibilities and economy of the environmental departments in the enterprises.

3.6.1.2 Environmental management in enterprises located in the Odra river catchment area

Four important enterprises in the Odra river catchment area have been visited and interviews have been made with those responsible for environment in them.

* *The environmental department (Odbor TL zivotního prostredi)*
of the Trinec Steelplant (Trinecké Zelezárny)

<u>General:</u> The enterprise operates as an integrated unit including foundries, power stations and several engineering plants. The metallurgical production is the main basis of the enterprise, but coke and chemical production also play a significant role. Trinec Steelworks stretches itself out seven kilometres along the Olza river. As a steelwork the enterprise was established in 1839 thus being one of the oldest enterprises in its kind in the present Czech Republic. 15.000 people are employed, but they used to be 18.000. The unemployment in Trinec town is about three percent. The enterprise produces 2.3 million tonnes steel per year, but it used to be three million. 50 percent is exported. As a result of the first wave of privatisation 15 percent is privatised. The second wave leads to privatisation of another 40 percent. 80 percent of the raw materials is imported from Ukraine.

The enterprise gets it water partly from the Terlicko reservoir, partly from the river Olza, which is quite small. The river Olza also serves the great mining area of Karviná.

Trinec Steelworks belongs to the District of Frýdek-Místek which is predominantly agricultural, but the company borders the heavily industrialised district of Karviná.

Products: Steel, blooms, slabs, billets, sheet bars, iron and steel castings, steel forging and pressings, chains and chain products, rolls for metal shaping, metal support construction for building structures and technological equipment, natural stone and sand gravel, mortar-type cements, silicate and non-silicate refractory products, coke, pig iron and alloys, heat energy and electric power, processing of iron and manganese ores, manufacturing processes and production of machines and equipment, instruments for automatic control, robot equipment, microelectronics and system control.

The environmental department: The environmental department reports to the technical director. It presents a yearly environmental programme. This programme has to be approved by the General-Director. There is a check three times a year that the programme if observed. It was said that the programme is often made after a visit from the Inspection. This year there have been some postponements in the realisation of the programme. This is both due to lack of money and problems in finding the relevant firms to cooperate with.

For 1993 this plan included 22 smaller and two big projects. The smaller ones range from 300.000 Kc to six million Kc.

The total environmental expenditure of the enterprise was 225 million Kc in 1992 and was about 500 million in 1993. Most of this is for air protection.

Last year the Trinec steelworks gave 100 million Kc in fees to the Czech Environmental Fund, but got only 30 million back. These money are earmarked for the waste water treatment plant. That is 15-17 percent of the total investment, according to the director of the Environmental Department at the enterprise.

The environmental department was established five years ago on the basis of already existing smaller units. The department comprises 40 people in three divisions, for air, water and hygiene (including waste). It was held that all the employees in the department passed the exam that is arranged in order to make sure the personnel in the environmental department of the enterprises are qualified to make proper reports. 50 percent work in the laboratories. 50 percent are technical workers that treat the data and evaluates the decisions of the enterprise.

It was held that Northern Moravia is disfavoured in the competition over the Fund means. Among the Czech regions Northern Bohemia enjoys a privileged position in this competition. This is due to three main factors. First, the problems are worse in Northern Bohemia that suffers from unfavourable wind conditions. The Moravian Gate helps air pollution spread itself with the winds. Secondly, Northern Bohemia have a stronger lobby in Prague. Thirdly, the environmental problems in Northern Bohemia are more easily measured.

The steelworks usually get one visit from the Environmental Inspection every year and 1-2 from the District.

There are no regular contacts with the District or the municipality. The enterprise follows the state policy of voluntary decrease of the pollution. This has lead to the closure of one of the four original coke ovens in the enterprise. In the future another oven will be closed. This will more probably be a result of reduced production than a deliberate policy of closure. Trinec Steelworks is about to launch its first environmental audit. Such audits are made in all enterprise as a background for stipulating their value as an object for sale (privatisation). It will be less tempting to invest one's coupons in an enterprise that will have to spend a lot of money on environmental upgrading. The steelworks applied for an EC grant in order to be included in the group of enterprises that will undergo a total environmental evaluation.

Relation to town: The plant is overwhelmingly dominant in the town. The registered unemployment in Trinec is at three percent. The environmental director told on request that environmental activism in the town would help his department. Such activism, however, had to be "realistic" in order to be of any use. There is no tight contact between the enterprise and the city authorities. Trinec is like other similar Czech "company towns" in transition between being governed by the enterprise to establishing an authentic municipal authority. An interesting feature is the fact that the mayor *('starosta')* in Trinec is a member of the Green Party *(Strana Zelených)*. He used to work in the chemical plant of the Trinec Steelworks.

** The environmental department of Bochemie a.s.*

General: Bochemie a.s. is a medium size enterprise in Bohumín. It had a turnover of 450 in 1993 and is employing 450 people against 490 in 1991. The enterprise was established in 1904 as *Österreichisches Chemikalienwerk, R. Goldschmidt & Co. Kom. Gesellschaft in Oderberger Bahnhof.* The enterprise has changed its production assortment quite often. Bochemie was turned into a shareholding company with 100 percent private Czech ownership in 1993.

The city of Bohumín is without any waste water treatment plant.

Products: Bochemie produces

- disinfection means
- active accumulator masses for storage batteries
- fungicides
- herbicides
- pure and special inorganic chemicals
- pure and special gases and gas blends
- descaling products
- grinded sulphur

Bochemie is the only producer of some active components for microelectronics. The enterprise also exports technology or hybrid pickling to *Vacuum Schmeltze* and *Thyssen* in Germany as well as *Fagersta* in Sweden.

Fees and charges: The enterprise pays 2,5 mill. Kc yearly in charges for discharge. According to the technical director the Solid Waste Act has made it necessary for the enterprise to give priority to reducing waste as going on like before would be too costly.

Fines: There have been some penalties for accidents.

The Environmental Department: The enterprise has to have plans in case of accidents, drainage, waste, air pollution.

The enterprise spends 30 million Kc a year on environment.

The environmental department consists of four people, excluding the people in the enterprise laboratory doing jobs for the Department. The four people in the environmental department are mostly chemists that cover the fields of waste water, waste, industrial hygiene and air pollution. The law does not proscribe an environmental department in the enterprises, only that one person shall be responsible for water.

It was said that the environmental department needs its own laboratory for the checking of water quality and improvement of treatment technology.

Organic pollution, not metals, represents the most serious environmental problem caused by Bochemie.

The enterprise is evaluating the benefits of new technology as compared to an thkorough improvement of the old, but as so far not come to a conclusion.

The enterprise has two waste water treatment plants. They cost 25 mill. Kc per year. The enterprise has solved the problem of ammonium from the production of disinfection means. Now ammonium is recycled and used anew in the production process. The Czech Solid Waste Act. no 62/92 brings enterprises to reduce solid waste as much as possible because of prices.

According to the technical director, whom the environmental department is subordinated to, the financial pressure is now so high due to the economic mechanisms used by the authorities that enterprises starts to take care for the environment from the outset. The economic pressure has also lessened the division of opinion on environment at the enterprise top level, the technical director said.

After having been private for only half a year, it is to early to tell anything about the effects of privatisation, the technical director said. When Bochemie was about to be privatised, it was a quite large interest among companies. In order to buy Bochemie, however, the future owner had to promise strict environmental policies.

Bochemie prepares for increases in the fees, but do not know how much higher they will be.

It was held by the technical director that the relationship with the District Office and the Inspection was partly hampered by the fact that these institutions are manned with people with scarce experience from "practical life". Their approach is more "theoretical". Sometimes it is a problem to find a common language. The officials should focus less on fees and penalties and more on positive measures. They should not only have an interest in the fact *that* a problem is solved, but also on *how*.

<u>Relation to town</u>: Every three months the enterprise has a meeting with the Ecological Department of the city. The Ecological department is first of all interested in getting to know when and how problems are to be solved by the enterprises. The outcome of these meetings is concrete. The waste storage places are fixed. The city needs precise data on waste produced by the local enterprises because it has to know whether it is necessary to create a place to burn waste or not. Several enterprises together with the municipality and the Ministry for Economy and the Ministry for Environment have put money together in order to solve the waste problem. It is very difficult to get money back from the Environmental Fund, it was told. It was not clear how much money that goes from Bochemie to the Environmental Fund.

* *The environmental department of Bohumínské Zelezárny a Drátovny a.s (ZDB a.s.)*
Bohumín Iron and Wire Works

<u>General:</u> The Bohumín Iron and Wire Works is a state-owned share holding company, but is about to be privatised.

The turnover is 400 mill. Kc. The ZDB a.s. exports it products to Germany, India and Iraq.

The enterprise has 6.900 employees. It used to have 400 people more, but had to reduce it staff after it shut it steel producing unit.

The main environmental problem is connected to heavy metals. A pickling system that was bought from Germany has made it possible to recycle.

Products: It produces wire, radiators, heating, railway tracks. The enterprise used to produce its own energy, but nowadays it bought from outside. Iron is also bought from outside.

Fees and charges: The investments in environmental technology last year reduced pollution. If the price of the fees are constant, the fees paid will be 1 mill Kc yearly instead of 2 mill Kc

Fines: In 1994 the enterprise got a fine at 340.000 Kc. No fine was given in 1993.

Environmental Department: 30-40 people are engaged in the department *(oddelení zivotního prostredí)*. Most of the officers in the department are biologists and technical engineers.

250 mill Kc were spent on solving environmental protection only in wire production the last eight years. Of these 160 went to finance the German pickling technology. A regeneration and neutralisation plant (biological) was built for 86 mill Kc. A new storage plant or dumping site cost 80 mill Kc.

From the Environmental Fund the enterprise received 40 mill Kc for the pickling technology and 18 mill Kc to the regeneration plant.

The enterprise takes part in the quarterly meetings with the City Ecological department. If problems occur, contacts are made also by the phone.

Relation to the town: The ZDB is the largest enterprise in the city of Bohumín. ZDB helps financially by giving flats, culture and sports halls. The fire brigade inside the enterprise helps the City when needed. The enterprise has a contract that it would help the city also in case of accidents it did not cause itself. Bohumín is the last point before the Polish border to stop for instance oil spillage.

The enterprise has a large lobby with its own employees elected as representatives in the City Council. The chief water manager at the environmental department of ZDB is himself an expert member of the Environmental Council under the City Council.

* *Moravolen Bruntál a.s.*

General: Originally Moravolen spinning mill consisted of 17 plants. Now only three remain. One of them is Moravolen Bruntál a.s. The rest was sold. The plant in the Silesian town of Bruntál is a spinning mill. A majority of the shares belong to various owners, i.e. companies and banks. The rest of the shares was subject to coupon privatisation during the spring of 1994.

The enterprise has 400 employees, 38 of whom are experts (technical engineers). 85 percent of the employees are women. Two years ago the enterprise had one hundred less employed than now, but six years ago the number of people employed was 420.

The enterprise is 122 years old. It has been a spinning mill all the time. All machines are imported from abroad, France and Great Britain.

Moravolen Bruntál is one of the most important enterprises in town. There is also a Hydrometeorological Plant and an iron mining enterprise of importance in Bruntál.

Products: 1.200 tonne viscose is produced every year. The viscose is sent to weaving mills. Moravolen Bruntál produced socks and other items, but the raw materials for this production is bought in from outside.

The production is based on flax from the Jeseniki Mountains, that surround Bruntál.

Fees and charges: For outlet and abstraction the enterprise pays 800.000 Kc per year.

Fines: Moravolen Bruntál a.s. does not transgress the limits set.

The Environmental Department: Moravolen Bruntál a.s. had a separate environmental department, but it was closed on March 1st 1994 due to the dismembering of the large Moravolen enterprise. Now there is one person titled *'energetyk' (energeticist, power engineer)* who is in charge of the environmental field. He reports directly to the director of the enterprise.

The enterprise has a defined strategy for waste. Moravolen Bruntál has no dump of its own. Therefore it uses the municipal one. Water is a minor problem of the enterprise.

The water discharge of the enterprise is not big enough to require a water manager.

A project for a new waste water treatment plant for the enterprise is planned. This will be a closed cycle waste water treatment plant. Then it will be possible for Moravolen Bruntál to buy less water and discharge less.

Relation to town: The contact between the enterprise and the environmental authorities in the city passes via the director. The regular contacts are taken care of by the enterprise *'energetyk'*. Every month the municipal waste water treatment plant makes a test of the water quality. Twice a year the enterprise is checked by the Inspection. There are no regular meeting with the city environmental authorities. Such meetings are held only in specific cases. There is no contact between the relevant authorities and Moravolen Bruntál on the limits that are set.

All discharge water goes through the municipal waste water treatment plant. The enterprise does only the very basic pre-treatment, i.e. mechanic treatment and oil separation.

** Meat farm, Slechtitelský a Rozmnozovací Velkochov Prasat, Velké Albrechtice.*

General: Established in 1980 the breeding farm employed 67 people in 1994, ten less than the previous year. According to the director the staff will be further reduced. The enterprise consists of two farms.

As a part of the privatisation the enterprise is divided in six parts. The enterprise is a limited liability company (Czech abbreviation: s.r.o.).

The enterprise now sells the swine at a price lower than the cost of producing it. There has been a 140 percent increase in the cost of production.

Products: The total production of the enterprise amounts to 3.000 tons of swine meat a year. The enterprise produce the meat ready to slaughter, but does not slaughter it itself.

Fees and charges: The enterprise pays approximately 120.000 Kc a year. For drinking water the price is 8 Kc per m3.

Fines: The enterprise does not expect fines.

Environmental Department: The two people staffing the environmental group at the farm are both water experts (engineers).

The enterprise has no written environmental strategy.

The farm has its own waste water treatment plant, that has two parts, one mechanical and one biological. The plant has a capacity of 160 m^3 a day.

There is little use in recirculation of water as drinking water is required for the kind of production that is carried out by the breeding farm.

Co-ordination and relation to the town: Four times a year the Environmental Inspection makes a visit to the farm. Velké Albrechtice is a small community. The pig farm is a large polluter. Therefore the farm relates to the Environmental Division at District level, i.e. the District of Novy Jicín.

3.6.2 Non-governmental organisations

Public participation is explicitly a cornerstone of the present Czech land use planning system as well as EIA procedures.

Despite the fact that parts of the Odra river catchment area, especially the Ostrava agglomeration, is one of the most heavily polluted areas in the Czech Republic and in Central Europe at large, the level of civic environmental activism is low here. One indication of that is the fact that none of the 25 ecological/environmental periodicals registered in the republic by 30th November 1992 were issued in the Odra river catchment area, that includes the second most polluted and the most densely populated industrial area of the Czech republic (Environmental Year-Book of the Czech Republic 1992, p. 325-6).

* *Press cuttings*[1]

A systematic study of the main newspaper in the Odra river catchment area (Northern Moravia and Silesia) - the *Moravskoslezský den* - for the period of March 1993 to June 1994 shows that non-governmental groups play no significant role in the Odra river catchment area. There are frequent articles - mostly short notices - on water management, but these articles very seldom refer to conflicts and never to conflict involving non-governmental organisations or spontaneous action committees.

The articles can be grouped in four categories, all of them focusing on the technical-practical aspects:

- price hikes on water sold by the water supply and sewage companies
- results from investigations made by the hygienic stations, inspection or environmental departments
- waste water treatment plants that are projected
- spills and accidents.

[1] The collection of the press cuttings was made in cooperation with PhDr.Anna Paproková, a sociologist at the Mining University of Ostrava.

* *Magistrát of Ostrava (Department for ecology)*

The system of Voluntary Guardians of Nature finds itself between the sphere of self-organised society and the public administration. The 'guardians' report to the District Office, Department of Ecology. In Ostrava the deputy mayor is responsible for gathering the 'guardians' for meetings and consultation, but elsewhere it might be organised in other ways.

The system of Voluntary Guardians of Nature can hardly be described as a kind of civic activity. Before 1989 they were appointed by the Culture and School Department in the District Office. Now they are appointed by the Department for Ecology in the district. The guardians possess an official stamp. The also carry a "pin" with the state emblem. There is no national union of guardians of the nature.

Until 1992 the system of Voluntary Guardians of Nature (until 1992 the *'guardians'* were termed *'protectors')* drew its competencies from the Act on State Natural Protection (No. 40/1956). In 1992 the activities of the nature guardians were regulated through the new Act on the Protection of Nature and Landscape (No. 114/92).

Formally a nature protector had wide responsibilities. He could stop any construction if he found it to be in conflict with the acts of natural protection. After such a "veto", the District Office had to announce whether the protector was right, whether the project could continue after some amendments and whether the natural protection regulations were observed from the outset.

The inclusion of the natural protectors in the act 114/92 led to some changes in the framework of their activities. Previously the protectors were responsible only in protected areas. The 1992 law encompass all types of landscape in the Czech Republic. The protectors were given more lee-way in their activities as compared to the previous regulations that included a positive list of what to undertake.

The whole system of Nature Protectors underwent a crisis after the 1989 Revolution. The sudden freedom to activate oneself in environmental protection, politics and business made it difficult to attract volunteers to an established institution as this system was. It is also a problem that the increasing division of society works to the detriment of voluntarism. Those with much money are very busy and those without cannot afford being active as a volunteer.

Nevertheless in Ostrava most of the protectors remained. There are altogether eight of them, mostly people that hold a position as a natural scientists. Among the guardians are also previous civil servants turned into entrepreneurs. The system also consists of voluntary 'reporters' that give information to the 'guardians'.

It has turned out to cause some problems that the guardians no more are guided by explicit rules on what to do. Now they have to operate as individually responsible for their own area.

The guardians may disclose activities that will be punished with a maximum fine at 1 million Kc for juridical persons and up to 50.000 for physical bodies. The money collected in this manner is used by local environmental funds. In the case of Ostrava the fund is run by the deputy mayor. In the first half of 1994 O,5 million Kc was used from this fund. The money went to construction projects (gasification in some town quarters of Ostrava that used to be villages). Some money was also spent on educational purposes, e.g. the Earth Day.

In order to strengthen the relationship between the inhabitants and the guardians, the institution of town quarters in Ostrava has been made use of so that each guardian has their own area of the town to "supervise". They have presented themselves to the mayor as well as to the City Council of Ostrava.

The guardians - but not the reporters - were invited to take part in the discussions over land use in Ostrava. They were also invited to participate in the discussion on significance of various types of landscape.

A recent example from Ostrava is the establishment of the restricted area of Rezávka. Rezávka is a small stream. Near the stream there is a small pond with phragmites (aquatic weed). The shape of landscape will be protected and so will the occurrence of phragmites. Thus birds will prevail.

* *Czech Union of Nature Protectors (Ceský svaz ochráncu prírody), branch in Havírov*

The Union of Nature Protectors (CSOP) is a Non-Governmental Organisation established in 1980 as a "social organisation", formally independent from the state authorities. The Havírov branch of the CSOP has 80 members (in 1994). In Karviná District there are altogether three local branches left of the 13 previous ones. The other two are in Petrvald and Detmarovice. In Detmarovice the local branch receives 1000 Kc from the local heating power station yearly.

The organisation in Havírov has received 30.000 Kc from the CSOP centrally for three projects:

- protection of a meander in Lucina stream
- pruning of trees
- inventory of all amphibians in Karviná District.

The support is to cover only material costs. In 1994 the Havírov branch applied for 7.500 US dollar to revegetate parts of the district and to widen the wetland. The CSOP branch would like to buy cameras and computers.

Most of the people that take part in the local branch are manual workers. Some members have a university degree, but these people are often to0 busy to take part.

The CSOP branch has regular contacts with town and district authorities. Some of the professionals both at District and town level are members of the CSOP.

The chairman of the Havírov branch of the CSOP is a member of the Environmental Commission in Havírov, which is an advisory board for the city authorities. The commission has monthly meetings. The commission treats questions concerning the ecology of town, cleaning of the town and seeding of trees, according to Mr. Zahradník.

The commission consists of members of the City Council and specialists as well as engineers because technical knowledge is required to treat the building issues that often are on the agenda. Only Mr. Zahradník represents an NGO.

The Havírov branch of the CSOP has provided public participation to one important EIA (see chapter 3.4.3.2).

* *Vita - Association for Ecological Education (Sdruzení pro ekologickou výchovu)*

Vita is a non-profit, non-governmental and voluntary organisation. Geographically the activities of Vita are focused on Ostrava city. The association has two professional workers and 15 voluntary members. It was founded in 1991 by people who thought that ecological education was underestimated in schools.

Vita is financed by the Ministry of Education and the Ministry of Environment. Some funds is drawn from foundations, both Czech and foreign. Small amounts of money comes from the users (schools and participants at seminars).

Vita is a part of the network of the National Centre for Ecological Education, whose role is only coordinating.

Vita defines itself as educational and does not stage protests nor exert pressure upon the authorities. The activities of Vita are divided in two main groups:

- Nursery and primary schools (education)
- General public (ecological consultation)

The work directed towards nursery and primary schools is prepared in collaboration with the Chair of Pedagogy at the Ostrava University. Today ecological education does not exist as a subject in Czech schools, but is taught as a part of the biology curriculum. A practical ecological education, however, is established by the Ministry of Education. Vita helps teachers carry out this education. Vita's work towards the schools is divided in three main activities:

1: Various ecological programmes for schools are conceived mostly based on the idea that children learn about nature by practical experience in the nature (drama, painting included).
2: Seminars with the teachers are held.
3: Activities are prepared for Earth Day, e.g. on how to plant trees or ameliorate the environment of the school area.

In a year approximately 20 seminars for teachers are held. Programmes for children are made 3-4 times a week. One programme is 1-2 lessons of 45 minutes each.

For the school activities one worker is employed as a coordinator and secretary, most work is made by voluntary supporters of Vita.

The work directed towards the general public is similar to the activities that used to be termed *'small ecology'* in state socialist times. This is the ecology of household and living areas. The activities consist in giving advice on how to save energy, what kind of washing powder to use, how to protect the skin against UV radiation.

Vita has one part time worker for the activities towards the general public.

Vita arranges "open days" where lectures are given on the state of the environment in Ostrava as well as information on diets and hygiene.

* *Green Point*

Green Point was founded in 1990. It covers much of the same educational fields as Vita (see above), but includes more controversial environmental issues as well. People can call Green Point if a stack smells or trees are being cut. It serves as an information and citizen service to the inhabitants of Ostrava. It does not exist in other cities.

Green Point has two professional workers and ten volunteers.

Green Point has rented some rooms in the Musical Theatre at the Masaryk square in down town Ostrava. Here meeting are held with primary and secondary school pupils.

For Earth Day Green Point has adapted an idea from Norway to arrange a Childrens' Hearing with the environmental administration and Ministry.

** Duha (Rainbow)*

Duha was established in mid-1994 in Ostrava as an offshoot of Duha in Brno. Duha has made use of the infrastructure of Vita so far. Duha would like to be sharper in its critique than the other NGOs in the Odra river catchment area.

3.6.3 Research institutes

There are seven research institutes connected to the Ministry of Environment. These institutes are:

-The Czech Environmental Institute (CEÚ)
-The Hydrometeorological Institute (HMÚ)
-The Tomás G. Masaryk Water Research Institute (VÚV) in Prague, Brno and Ostrava
-The Board for Protection of Nature and Landscape of the Czech Republic (AOPKCR)
-The Research Institute for Gardening (VÚOS)
-The Czech Geological Survey (CGÚ)

The Ministry of Environment considers the possibility of a radical re-organisation of its own research sector. One alternative is to introduce an agency similar to the US Environmental Protection Agency. This would mean a merger of the existing institutes into the Agency, possibly with departments in the regions.

The present composition of scientific branches taking part in the environmental research sector does not include managerial, economic or social sciences.

In the Odra river catchment area the following research institutes are taking part in research relevant for environmental policies:

* Tomás G. Masaryk Water Research Institute, Ostrava Branch
* Ecological Institute of the Ostrava University
* Research Institute of Regional and Town Development, Ostrava branch (VÚROM)
* Mining University in Ostrava

4. Water quality and effects

4.1 Effects of pollution and main problems

4.1.1 General

To predict the resulting water quality caused by pollution (naturally and man made) is complex and depends on the type of pollution, physical-, biological-, and chemical factors and processes. The effects will also depend on the ecosystem. Pollution can have an effect both on human health and ecology. Several dose respons models have been developed to predict these effects, and to be able to set objectives for discharges of pollution to a recipient. Some of the models are complicated, but some are relatively simple and based on empirical data. In some cases, more general know-how has to be used to predict the effects. The local knowledge, will in every case, be important and necessary to decide the effect of an outlet.

It is especially due to the effects related to nutrients (eutrophication) and effects of organic matter that models and mathematical relations have been developed. The effects of bacteria and micro pollutants are not known very well, but there is some knowledge about dispersion, death rate and sedimentation. The effect of micro pollutants will vary depending on pollution parameter.

The water flow is a main factor regarding the effects of pollutants (dilution capacity) in a river, and the temperature is an important factor for the biological activity. In reservoirs the depth is an important parameter (boundary layer).

This chapter contains only a brief and general description of the effects from different types of pollution, but simplified dose-response equations for effect calculations in the recipient are discussed and proposed in chapter 5.2.3. These simplified equations have been used to determine the resulting water quality after investment actions in chapter 7.5.6.

The description is mainly based on literature from Bratli *et al.*(1994), Holtan and Åstebøl (1990) and Berge and Johansen (1994).

4.1.2 Organic matter

Organic matter (carbon is the main source) can be dissolved in the water or be present as solids. The organic matter is divided into easily degradable and to organic matter which is more difficult to decompose, soluble and not soluble. It originates from several sources; naturally (runoff from forest area, erosion, run off from marsh etc.), man made sources (industry, municipal waste water, point and non point pollution sources from agriculture etc.) and by internal production of organic matters by plants and algae in the recipient (eutrophication).

A high content of organic matters can be seen visually and discolour the water. Bacterias use use oxygen to degrade organic matter, and can cause absence of oxygen if the organic matters is high compared to the oxygen available. The combination with high temperature and low flows cause the worst situation. At high temperatures the rate of degradation is higher and the content of soluble oxygen available for degradation is less compared with the content at low temperatures. At high temperatures the amount of oxygen in water, is also less compared with low temperatures.

In fast flowing rivers the available oxygen from the atmosphere mix into the water, and will in most cases be enough for self purification. Absence of oxygen can also occur in shallow lakes and in deep lakes in the bottom layer. Organic matter is considered to be one of the most serious problems in Europe, because the load of organic matter is often higher than these rivers (often very large and slow flowing) can handle. The effects will be local if the outlets are reduced downstream in the river. Absence of oxygen can cause anaerobic conditions and gas production. The result of organic overloading changes the biological diversity. Fish can die and hetrotrophic species (fungi and bacteria) dominate.

Organic matter inhibits as well as stimulates the eutrophication process. Hetrotrophic species can dominate the primary producer, and thereby inhibit the eutrophication process. Organic matter might as well complex bind heavy metals, and thereby reduce the toxicity which in second turn will have a positive effect on the primary production.

4.1.3 Nitrogen and phosphorus

Discharge of nutrients (phosphorus and nitrogen) can lead to eutrophication (increased primary production). The eutrophication process in freshwater mainly depends on phosphorus, and nitrogen, other nutrients are less important. In coastal area though, it is mainly nitrogen which is a limiting factor for primary production, but phosphorus can also be important especially in coastal areas with a large influence of brackish water.

Phosphorus is naturally part of rocks and soil, and can be present in the water as a result of erosion and the amount will depend on the geological conditions. Phosphorus can also be present as a result of man made pollution; municipal waste water, industry and agriculture. Phosphorus is a non metallic element, and occur mainly as organic or inorganic compounds (PO_4, P_2O_7, PO_3), but very seldom as elementary phosphorus. Degradation processes and photosynthesis change the phosphorus condition constantly.

It is only part of the total phosphorus content which is available for plants and algae growth (mainly soluble reactive phosphorus and soluble non reactive phosphorus). Phosphorus connected to particles, can only under some special circumstances be released and become available for algae growth. Phosphorus from municipal waste water, some industries and phosphorus from heavily manured agriculture fields have a high biological availability, but phosphorus connected to particles, especially erosion products, has minimum effect on algae growth, see table 4.1.

The numbers in the table are only presented as guiding values for the relative importance of different sources compared to the total loads. The variations found in the study reported by Källqvist and Berge (1990) was very large and the number of samples relatively small.

In a lakes eutrophication can lead to increased production of plants, algae growing on surfaces and especially algae in suspension. The water can, as a result of eutrophication have a strong odour and the transparency can be reduced. The organic production can cause oxygen problems at a later stage when algae and plants sediment to the bottom of the lake and degrade. A low oxygen content in the water can cause a leakage of phosphorus from the sediments and an internal source of phosphorus will be the result and may accelerate the eutrophication process.

A disturbed balance in phosphorus will also influence the biological diversity (both zoobentos and fish) and blooming of blue green algae is a well known problem in eutrophic lakes.

The primary production in rivers are mainly algae growing on surfaces and moss. Algae in suspension and plants will be less important, but can be considerable in slow flowing rivers. In these cases rivers can be overgrown. Rivers respond directly to outlets of nutrients, and internal processes are of less importance compared to lakes. The organic production as a result of eutrophication can also cause absence of oxygen, and a change in biological diversity.

The eutrophication effect in European rivers is considered to be less important compared to the effects of organic matters. Eutrophication in these rivers can however play an important role in the future if the outlets of the remaining pollution are reduced.

Table 4.1 The available phosphorus content in % of total phosphorus from different sources (Berge and Källqvist, 1990)

Pollution Source	Laboratory experiments	Running water	Shallow oligotrophic lakes	Deep oligotrophic lakes	Shallow eutrophic lakes
Run-off from crop production (erosion)	37	24	13	6	20
Run-off from manure during autumn floods	63	63	63	63	63
Naturally erosion material	20	13	6	6	11
Effluent from manure storage	79	79	79	79	79
Leakage from green fodder's	59	59	59	59	59
Untreated WW	60	60	60	60	60
WW from sand filter trenches	95	95	95	95	95
Chemical treated WW	30	30	30	30	30
Detergents	76	76	76	76	76

The processes concerning phosphorus and the retention of phosphorus in rivers mainly depends on the amount of dissolved phosphorus compared to the amount of phosphorus connected to particles and the water flow. If the amount of phosphorus connected to particles is high and the river is slow-flowing, there is a certain retention caused by precipitation. Normally during an anual cycle the retention of phosphorus in rivers is small.

The general focus in Eastern Europe concerning nutrients has, as mentioned, not been the europhication effect, but primarily the effect of nitrates. Discharges of nitrate can cause health problems in cases where the outlet has influence on drinking water (especially in areas where ground water is used as drinking water). High ammonia and nitrate content can also be a problem for fish.

Nitrogen occurs as inorganic compounds (nitrate;NO_3, Nitrite; NO_2, ammonia;NH_4, N_2) and as organic nitrogen. Nitrate and ammonia is the most important in organic compounds. The atmosphere is generally the largest naturally source of nitrogen. Another main source is agriculture, mainly as a result of fertiliser consumption. The nitrate and especially the ammonia levels can also be high as a result of pollution from municipalities. High ammonia levels also indicates bad oxygen conditions.

The processes concerning nitrogen are complex (nitrification, de nitrification and nitrogen fiction). The de-nitrification can be considerable in slow flowing rivers, where the organic outlets are high and where absence of oxygen occur.

4.1.4 Particles

Particle transport can be a serious problem in some rivers, and originates from outlets from municipalities, industry and erosion from cultivated land and rocks. A high content of particles can also be a result of primary and secondary production in the river. Suspended solids can be categorised as organic and inorganic compounds. Depending on the quality of the particles, they can influence on the biological conditions both in rivers and reservoirs. Heavy metals and other micro pollutants can be connected to the particles, and the shape of the particles is significant to the health of fish, for example sharp particles have damaged the gills on fish (Berge and Johansen, 1994). Particles also create sludge, and therefore have influence indirectly on the living conditions for zoobentos and fish.

The problem with sedimentation and sludge is greatest in slow flowing rivers. In fast flowing rivers the problem occurs during floods. The retention of particles in a river during a year is normally low, and as the particle content varies considerably during the year and originates mainly from erosion it is very difficult to use particle content as an effective parameter in pollution abatement programmes This is discussed further in chapter 5.2.3

4.1.5 Micro-pollutants

Outlets of micro pollutants (organic micro pollutants, heavy metals and others like phenol, ammonia, chloride, fluoride etc.), can cause considerable damage to aquatic organisms and influence on human health. The micro pollutants can be acute toxic in very low concentrations, they are not easily degradable and accumulate in the organism.

Heavy metals can occur in many states which have different toxic effects on the organism. The toxic effects depend also on the remaining water chemistry and the pollution of other metals, organic matters etc. Micro pollutants can also accumulate in the sediments and cause severe ecological effects at a later stage. Accumulation of micro-pollutants in fish can represent a health risk if the fish is consumed.

Outlets of micro pollutants in a river will mainly effect the biology locally near the outlet. Depending on the dilution capacity, the effect will be reduced gradually downstream in the river.

The risk for acute toxic effects and the accumulation of micro pollution in sediments are generally largest in a slow flowing river.

4.1.6 Micro biological pollutants

The main concern regarding micro biological-pollutants are micro-organisms that cause diseases. There is special concern regarding coliform bacteria (originates from animals and human excrements). The effect depends on the concentration of bacteria, dilution capacity and the die-off rate. In fast flowing rivers the pollution can be transported far from the outlet, and therefore represents a risk in a greater area than slow flowing rivers. In slow flowing rivers though, the concentration can be extremely high near the outlet.

4.2 Classification

4.2.1 Monitoring

A comprehensive water quality monitoring programme is executed in the Czech part of the Odra River Basin. The water quality is monitored in 80 control points, once or twice every month. Normally 30 water quality parameters are analysed. In addition there are 5 automatic monitoring stations. Three of these are located in rivers which make the border with Poland (one at the border where Odra leaves the Czech Republic and enters Poland). Forty-two of the 80 profiles are a part of the national surveillance program, which is executed by Hydrometrological Institute, the rest of the 80 profiles are monitored by Povodi Odry.

In the Odra Project (WRI,1993) the water quality in 32 of the 80 profiles have been used to characterise the water quality in the catchment area. These profiles give a good covering- and overview of the waterquality in the river, and have formed the basis for the conclusions drawn in this report. In addition to the 32 profiles given in the national Odra project, two more profiles (profile 16B and 24B) have been added (see figure 4.1).

The analysis has been carried out by PO (1992). In addition WRI(1993) has analysed some parameters which PO do not cover in the normal program (total phosphorus and heavy metals). Data for phosphorus and heavy metals are not complete for all 34 profiles.

Water quality parameters and the water quality classification according to the C_{90} value are listed in appendix 10.2.

4.2.2 The Czech classification system

CSN 72-7221

The water quality is classified according to the standard CSN 72 7221 - Classification of surface water. This classification system was enacted in 1990.

The water quality is classified according to five classes;

Class I	Very pure water, This water is usually suitable for all applications; drinking water, food and other industries which need drinking water quality in the production process and for swimming pools. The recipient has good living condition for salmon and a very high conservation value.
Class II	Pure water, This water is suitable for the majority of applications The water has drinking water quality for some parameters, is suitable for recreation, is acceptable for breeding of fish and can be used as process water in industry.
Class III	Polluted water, This water is only suitable for industry supply. The water can be used as drinking water in the cases where there are no other sources, but it has to be treated and it is not recommended as drinking water. The water has a very low conservation value.
Class IV	Very polluted water, This water is suitable only for limited applications
Class V	Extremely polluted water, This water is unsuitable for any application

The 41 parameters which are classified can be divided into 6 groups:

1. Oxygen parameters (A)
2. Basic Chemical and physical parameters (B)
3. Additional chemical parameters (C)
4. Heavy metals (D)
5. Biological and micro biological parameters (E)
6. Radioactive parameters (F)

Critical loads are given for each class of the 41 parameters (radioactivity indicators are not included). The water is classified in a specific class according to the C_{90} value, and it is the worst parameter in each parameter group which is used for the classification. The C_{90} value express the maximum concentration (90 percentile) in the water during a year, and the probability of exceeding for one parameter is less than 10%. The C_{90} value is normally calculated on the basis of at least 24 samples.

Regulation 171/92 in water act 138/1973

The new regulation 171/92 in the water act 138/1973 regulate discharge of waste water and mine water to surface water (see appendix 10.3). The pollution authorities do not only set emission limits to the outlet (parameter I), but also consider effects, and have criteria, for the receiving water in accordance to parameter II and III. Parameter II consider effects on biological parameters; benthic macro invertebrates, salmon and cyprinid fish, the self purification ability, biological diversity and productivity. Parameter III gives limits for the concentration of chemical substances in the receiving water after mixing with waste water . The requirements are divided in two levels " water supply stream" and "other surface". The limits are referring to the Q_{355} flow or to the minimum guaranteed flow in the water course.

The limits in reg no 171/92 for "water supply streams" correspond to water quality class I-II in CSN 72 7221 for almost every parameter. The water quality for "other surface" correspond to water quality class III-IV depending on pollution parameter. The values in the regulation no. 171 will, in a long term perspective, be used to give discharge permits together with other guidelines in regulation no 171.

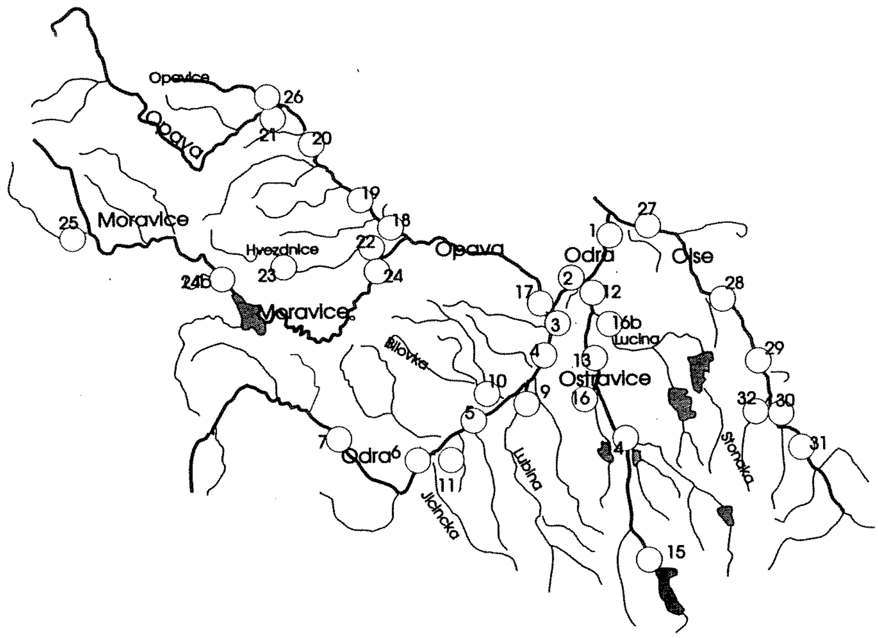
4.2.3 Classification of water quality in different systems

The Czech water quality classification criteria, described in previous chapter classify the water into five classes according to the C_{90} value, and are indirectly related to user interests. The Czech classification criteria according to the C_{90} value and the values in reg. 171/92 are shown in table 4.2 for some of the parameters.

The water quality is also classified into five classes in the Norwegian system (based on average/median or maximum concentration). The five classes in the Norwegian system are described as class 1; "good quality", Class II: "Reduced quality", Class III: "Fairly poor quality", Class IV: "poor quality" and class V: "very poor quality". In the Norwegian system the water quality can also be classified into 4 classes according to the suitability for use as for drinking water, irrigation, bathing and recreation, fish farming and fishing. The four classes are described as Class 1: "Good suitability", class 2: "suitable", class 3 " reduced suitability" and class 4 " not suitable" depending on the water quality. Table 4.3 shows the classification in different system according to the suitability for use.

Table 4.2: The Czech classification system for some parameters based on C_{90} values and reg. 171/92

	The Czech classification system for water quality CSN 75 7221					**Reg 171/92, Q355**	
	I	II	III	IV	V	"water supply stream"	"other surface"
BOD5 (mg/l)	<2	<5	<10	<15	>15	<4	<8
CODmn (mg/l)	<5	<10	<15	<25	>25	<8	<20
CODcr (mg/l)	<15	<25	<35	<55	>55	<20	<50
TOC (mg/l)	<5	<8	<11	<17	>17	-	-
Tot-P (mg/l)	<0.03	<0.15	<0.4	<1.0	>1.0	<0.15	<0.4
N-NH4 (mg/l)	<0.3	<0.5	<1.5	<5.0	>5.0	<0.5	<2.50
N-NO3 (mg/l)	<1.0	<3.4	<7.0	<11.0	>11.0	<3.4	<11.0
Σ(N-NH4+N-NO3) (mg/l)	<1.3	<3.9	<8.5	<16.0	>16.0	<3.9	<13.50
SS (mg/l)	<20	<40	<60	<100	>100	-	-
Fe (mg/l)	<0.5	<1.0	<2.0	<3.0	>3.0	<0.5	<2.0
Mn (mg/l)	<0.05	<0.1	<0.3	<0.8	>0.8	<0.20	<0.50
Cd (μg/l)	<3	<5	<10	<20	>20	<0.005	<0.015
Hg (μg/l)	<0.1	<0.2	<0.5	<1.0	>1.0	<0.005	<0.001
Zn (μg/l)	<20	<50	<100	<500	>500	-	-



NO.	PROFILE	Q355 [m3/s]	Q180 (m3/s)	River km. [km]	NO.	PROFILE	Q355 [m3/s]	Q180 (m3/s)	River km. [km]
1	Odra -Bohumin	5.91	25.20	3.30	17	Opava Trebovice	2.53	9.05	0.10
2	Odra-Petrkovice	3.78	16.10	12.70	18	Opava-Hostice	1.10	4.13	36.30
3	Odra-Svinov	0.90	6.19	19.10	19	Opava-Vavrovice	1.09	4.09	454.40
4	Odra-Polanka	0.87	5.87	25.40	20	Opava-pod Krnovem	0.90	3.41	61.20
5	Odra-Studenka	0.54	3.72	47.20	21	Opava-nad Krnovem	0.60	2.28	74.80
6	Odra-nad Jicinkou	0.22	2.18	60.00	22	Hvozdnice-usti	0.90	0.48	1.00
7	Odra-Jakubcovice	0.17	1.75	86.10	23	Hvozdnice-Mladecko	0.04	0.19	18.00
8	Cerny-Prikop	1.38 *		0.08	24A	Moravice-Branka	0.86	4.22	7.10
9	Lubina-Kosatka	0.17	1.30	1.90	24B	Moravice-Slezska Harta	0.67	3.38	55.10
10	Bilovka pod Sezinou	0.05	0.30	3.90	25	Podolsky potok	0.19	1.05	0.02
11	Jicinka-Kunin	0.06	0.56	1.30	26	Zlata Opavice	0.22	1.25	2.20
12	Ostravice-Muglinov	1.90	8.09	1.70	27	Olse-Vernovice	1.60	6.92	7.40
13	Ostravice-Vratimov	1.53	6.60	11.80	28	Olse nad Stonavkou	0.85	4.76	21.50
14	nad Moravkou	0.72	3.54	25.20	29	Olse pod Tesinem	0.72	4.07	32.80
15	Pod nadrzi	0.30	1.63	44.50	30	Olse nad Ropici	0.62	3.74	39.90
16A	Olesna -usti	0.07	0.48	0.50	31	Olse nad Trincem	0.52	3.19	50.60
16B	Lucina	0.26	1.30	0.20	32	Stonavka-usti	0.16	0.80	0.30

Figure 4.1 Location of monitoring profiles

Table 4.3: Quality Criteria according to the Norwegian system for user interests, the Reg 171/92 and EU

Parameter	**Drinking Water**				**Recreation**	**Fish farming**	**Fishing**
	N1)	C2)	EU3)	WHO	N1)	N1)	N1)
TOC(mg/l)	< 6.5	-	-		<6.5	<6.5	<6.5
BOD (mg/l)	-	<400	-		-	-	-
Tot-P (ug/l)	<20	<150	-		<20	<20	<20
N-NH4 (ug/l)	-	<500	3100 (m)	1500 4)	-	-	-
N-NO3 (ug/l)	-	<3400	11290(m)	10000	-	-	-
Tot-N (ug/l)	<550	-	-		<550	<550	<550
SS (mg/l)	<2	-	25(g)		<2	<5	<2
Zn (ug/l)	<60	-	3(m)	3 4)	<110	<60	<60

1)The Norwegian criteria according to Class II suitable and class III : Reduced suitability

2)Reg 171/92 limits for "water supply stream" in periods with low flow Q350

3)The EU values represent guidelines values (g) or maximum allowed concentration (m) in raw water (category A2) (EC, 1980)

4) No health based guideline value, but a guideline value to prevent complains from the consumers, specially regarding taste.

The Norwegian and Czech classification systems are not directly comparable; while the Norwegian criteria is mainly based on mean or average values, the Czech system use the C_{90} value. The comparison in table 4.4 has been based on the relationship between C_{90} and C_{median} for different parameters. This relationship has been based on calculations in chapter 5.2.1, and must be considered as rough estimates, but which give comparable numbers.

The critical load for several parameters in the Czech standard are set rather high, and the Norwegian Water Quality Criteria are conservative compared to the Czech standards. The difference in natural water quality can however be considerable, which is a another factor one must bear in mind when two different systems are compared.

Table 4.4: Comparison for some parameters in the Norwegian and Czech classification system, Cmedian (based on rough assumption between C_{90} and C_{median})

Parameter	I		II		III		IV		V	
	N	C***	N	C***	N	C***	N	C***	N	C***
TOC (mg/l)	<2.5	<3	2.5-3.5	3-4.8	3.5-6.5	4.8-6.6	6.5-15	6.6-10.2	>15	>10.2
Tot-P (ug/l)	<7	<15	7-11	15-75	11-20	75-200	20-50	200-500	>50	>500
N-NH4+N-NO3 (ug/l)	<250*	<850	250-400*	850-2630	400-550*	2630-5650	550-800*	5650-9700	>800*	>9700
SS (mg/l)	<1.5	<8	1.5-3	16	3-5	36	5-10	40	>10	>40
ZN (ug/l)**	<10	<20	10-30	20-50	30-60	50-100	60-110	100-500	>110	>500

*The Norwegian criteria are based on total nitrogen

** Criteria according to maximum values

*** Criteria based on assumptions about the relationship between median and maximum concentration.

In accordance with Norwegian conditions, one would expect algae blooming caused by phosphorus already in class II in the Czech system. Many factors can however influence this, which is briefly discussed in chapter 5.1.3. A revision of the values of Tot-P in the Czech system ought to be considered (Bækken, 1995 forthcoming).

Also for the heavy metals the differences are considerable, especially for cadmium being 40-75 times higher in the Czech system. The heavy metals have also been compared with the EPA, CCREM (The canaidian fresh water criteria) and the EU criteria (Bækken, 1995), and the evaluation showed that the different methods/criteria give very different results. The EPA and CCREM criteria were exceeded many orders of magnitude for Cu, Zn, Cd, Pb and Hg, whereas the EC and the Czech criteria were only exceeded at few sites and for only some of the parameters. The EC and the Czech criteria is too liberal while it is more than 100 times higher than natural background values. The Czech classification values of heavy metals in general and cadmium and mercury in particular should be addressed (Bækken, 1995 forthcoming). The differences in nitrogen compounds are also relatively large, but the Norwegian criteria are rather low compared to other systems.

Parameters for organic matter seem to correspond fairly well, but the Norwegian system does not use the CODcr method which gives different results depending of type of organic matter. The CODcr method measures a more complex oxidation of the organic matter, and is applicable at higher concentrations of chloride in the water (CODmn can not be used if the chloride concentration is higher than 300 mg/l), but when using permanganate (CODmn), the oxidation of organic matters varies between 20- 80% and is normally 40%, but when using dichromate (CODcr) the oxidation may be 90-100%. The differences in degree of oxidation of organic matter using the two methods have been adapted in the criteria. Large differences in classification can however occur, and can be explained by the content of less degradable matters which give a high degree of oxidation using di-chromate but low degree using permanganate.

The above mentioned factors should be taken into consideration when reading the next chapters.

4.3 Water quality and sediment sampling

4.3.1 Status

There are two main methods for the assessment of water quality. Biological parameters integrate ecological effects of pollution over some period of time, whereas the chemical parameters give information of the quantity of different pollutants in the water at one particular moment. The criteria for chemical parameters do however reflect the effects on human health and ecology and can be used to describe the environmental problems in the river.

This report focuses on the chemical parameters, and figures 4.2-4.15 present the water quality in the 34 profiles listed in appendix 10.2. The water quality has been described in detail for the largest rivers in the catchment area, and briefly for the smaller tributaries. The major polluters are also mentioned under each section to give an understanding of the poor water quality, as an introduction to chapter 6 where the pollution sources are addressed in detail.

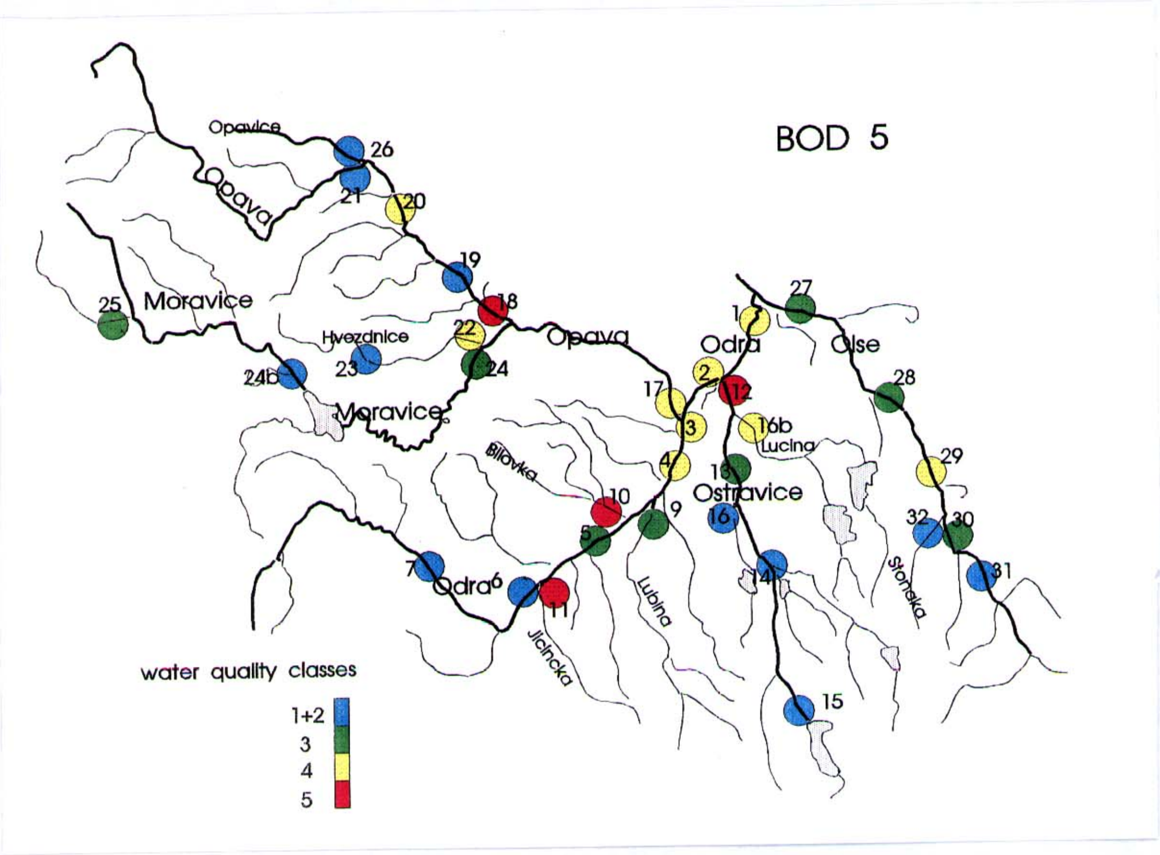


Figure 4.2: Classification of BOD in Odra according to the C_{90} value, 1992

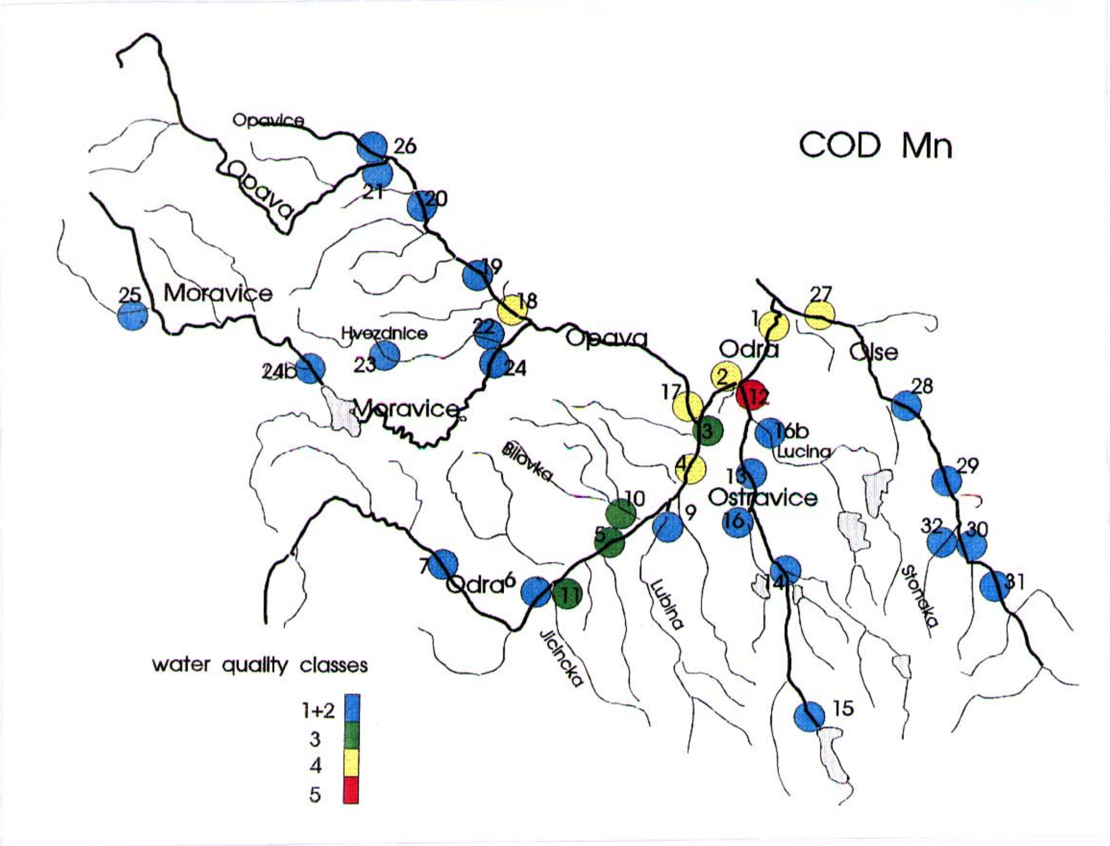


Figure 4.3: Classification of CODmn in Odra according to the C_{90} value, 1992

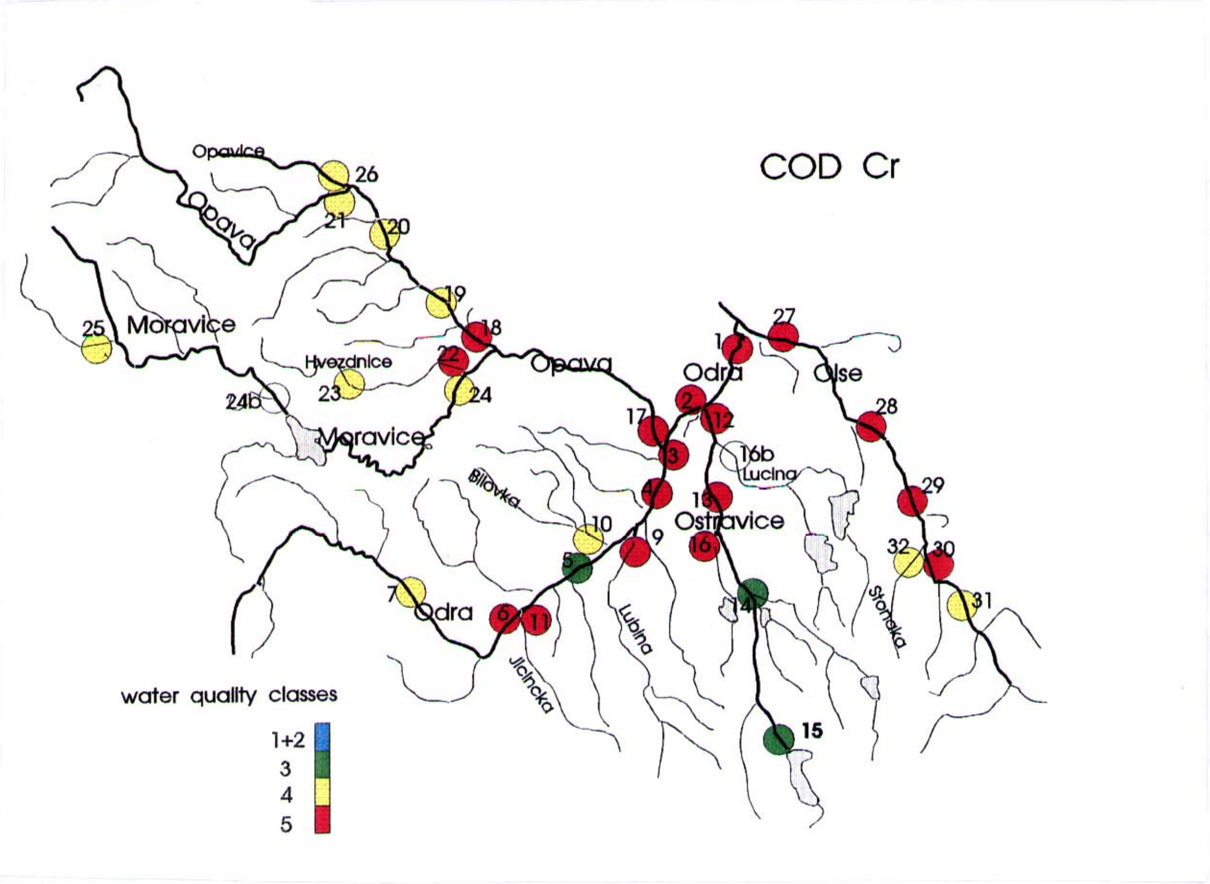


Figure 4.4: Classification of CODcr according to the C_{90} value, 1992

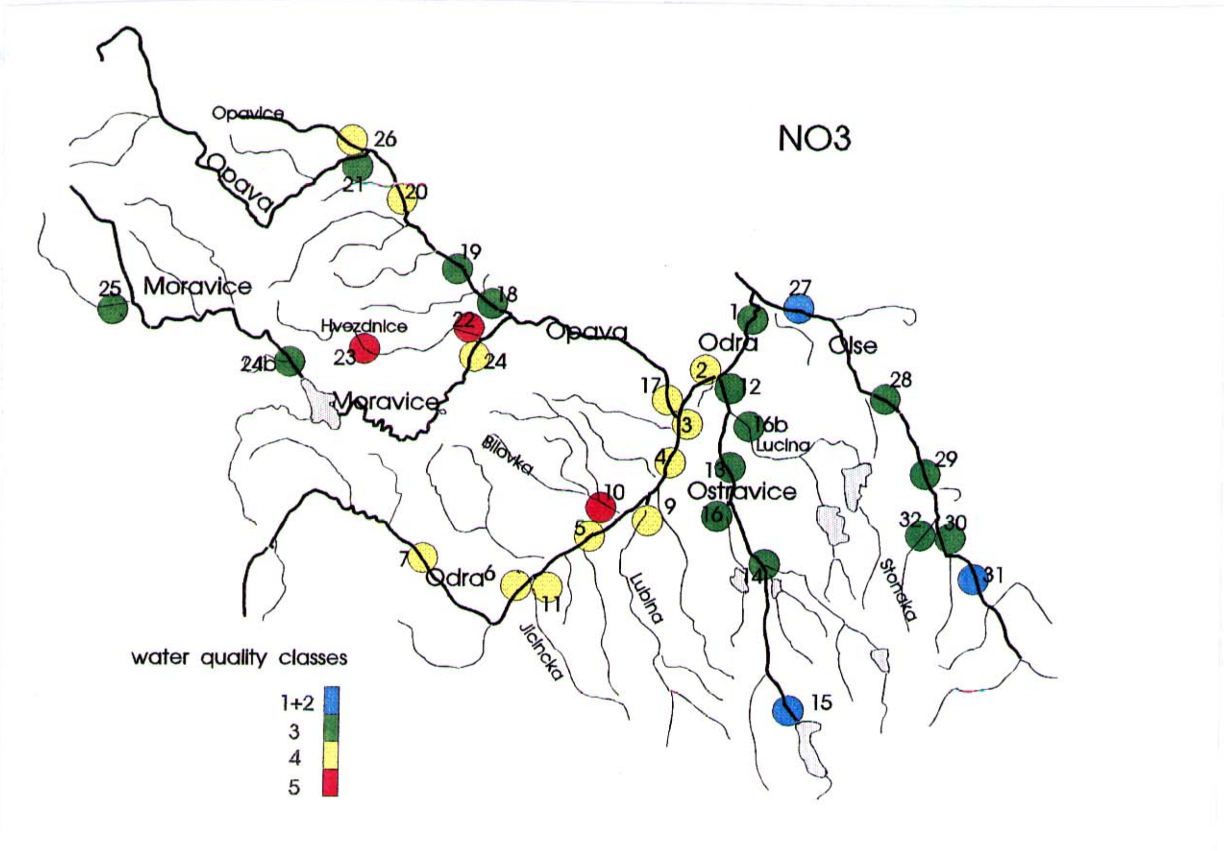


Figure 4.5: Classification of N-NO3 according to the C_{90} value, 1992

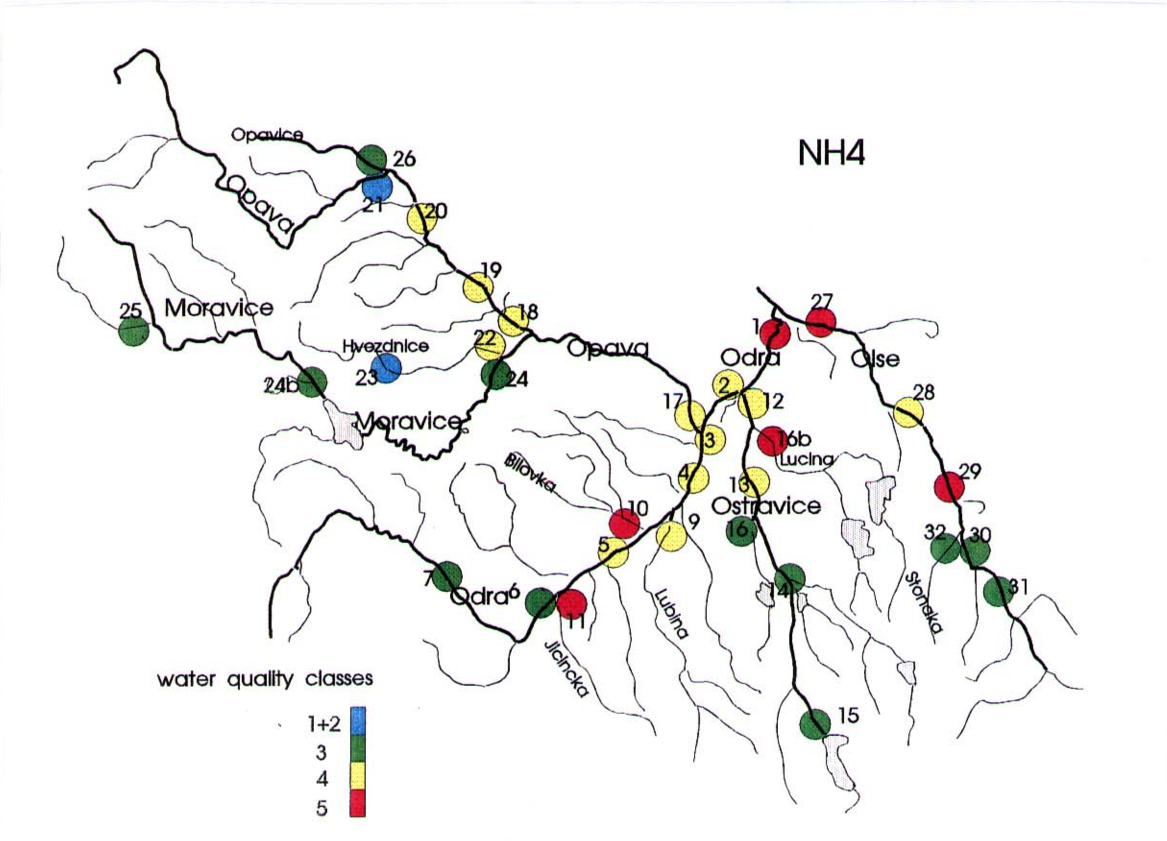


Figure 4.6; Classification of N-NH4 according to the C_{90} value, 1992

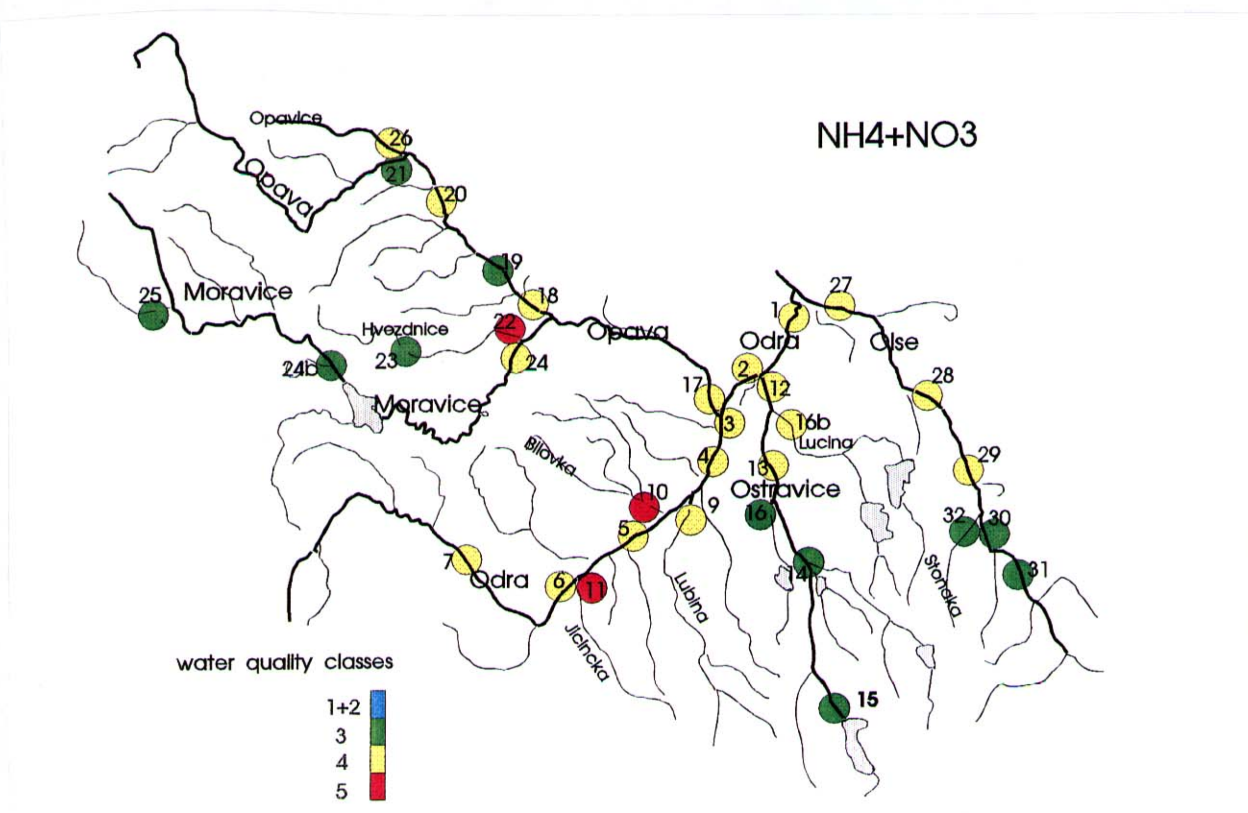


Figure 4.7: Classification of Σ(N-NH4+N-NO3) according to the C_{90} value, 1992

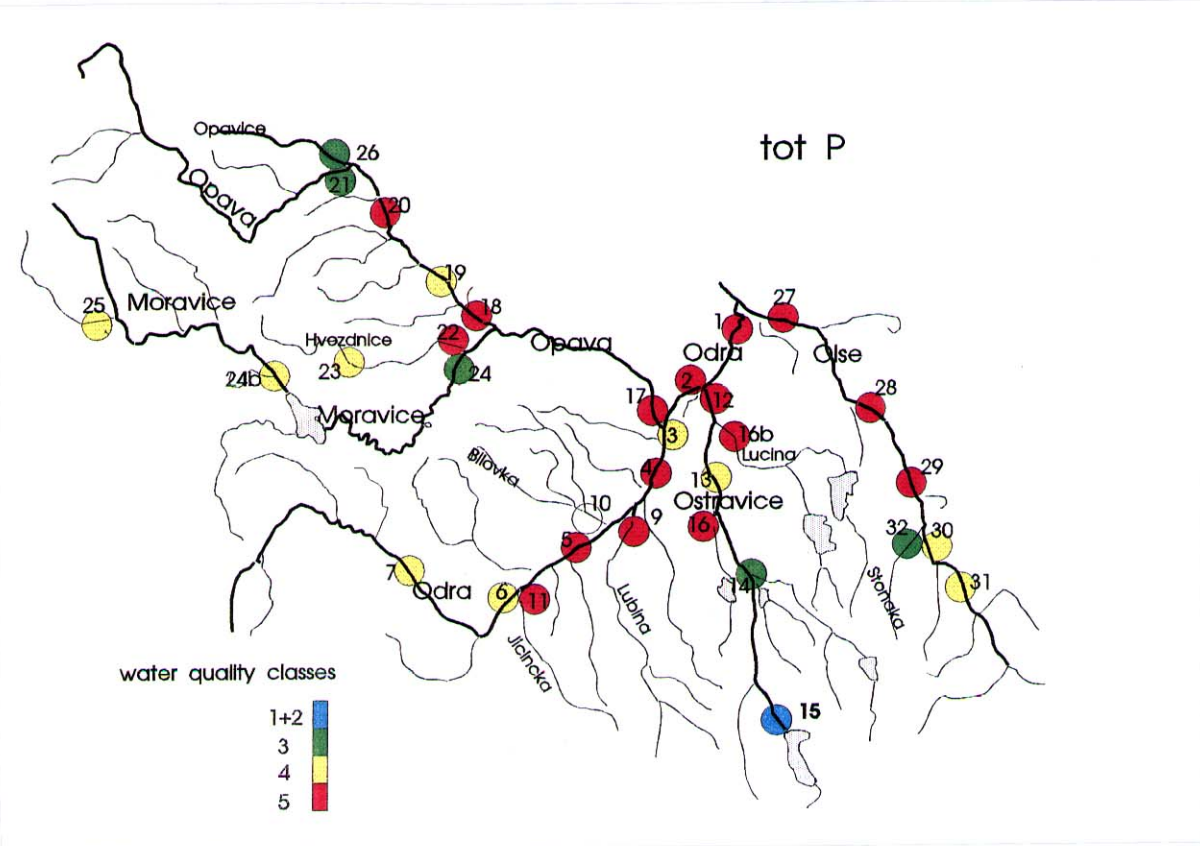


Figure 4.8: Classification of Tot-P according to the C_{90} value, 1993

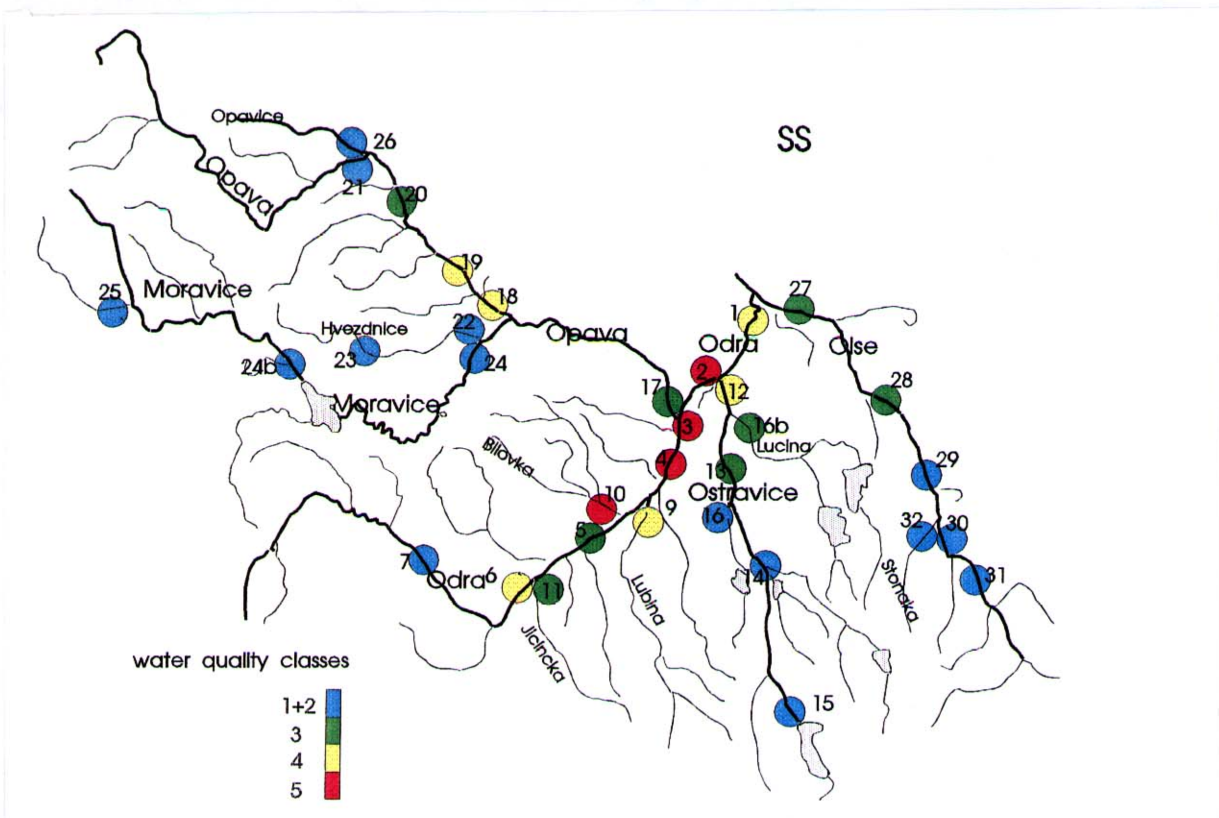


Figure 4.9: Classification of SS according to the C_{90} value, 1992

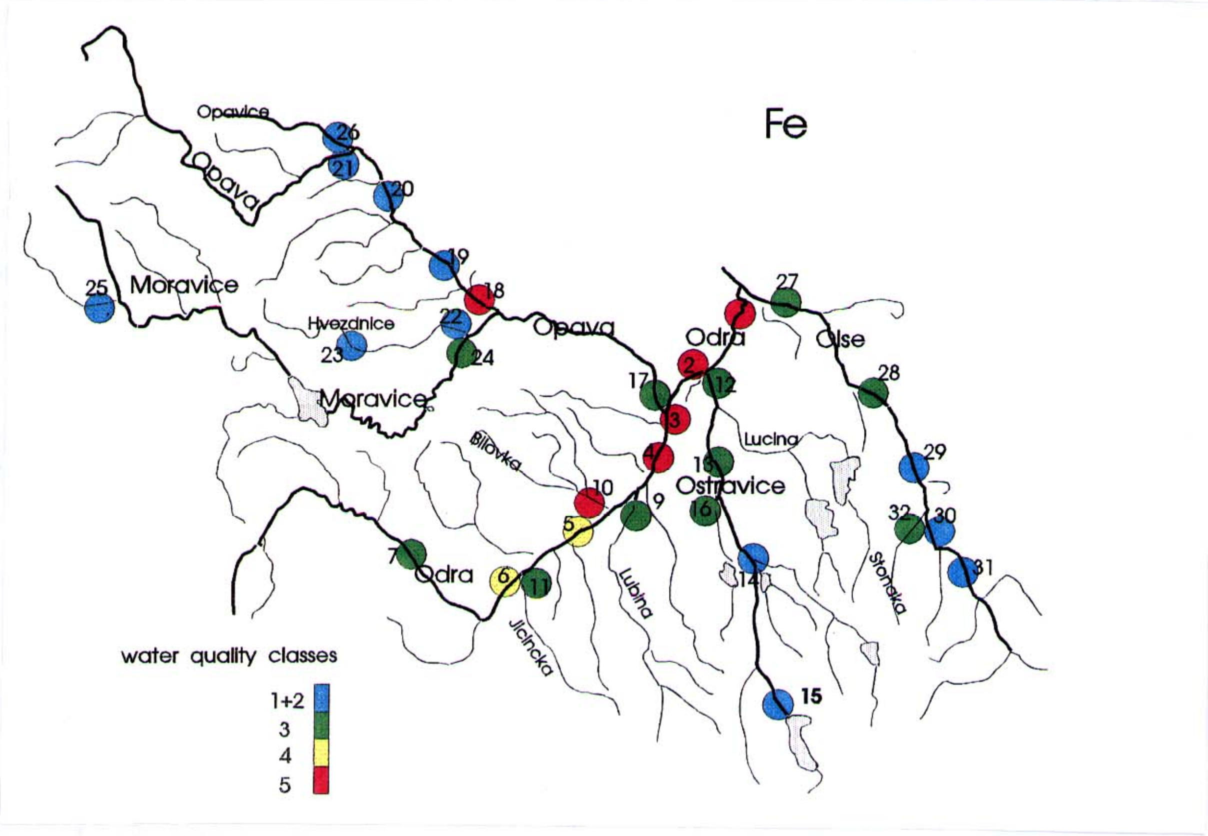


Figure 4.10: Classification of Fe according to the C_{90} value, 1992

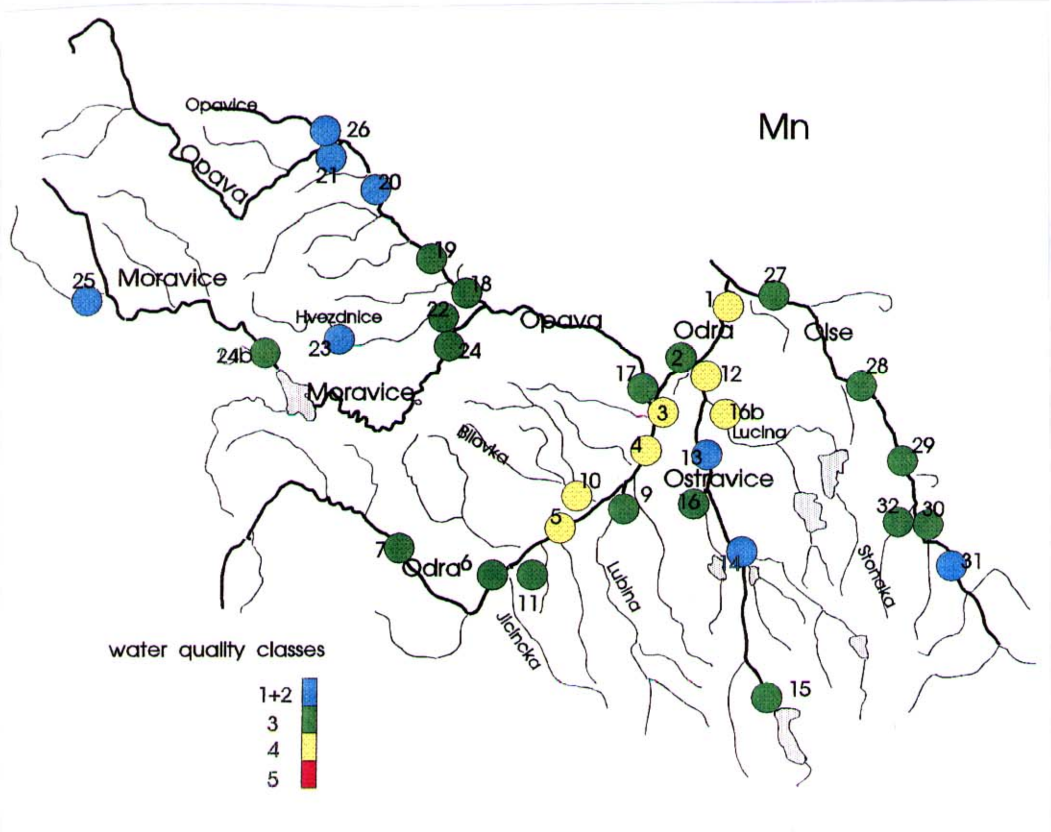


Figure 4.11: Classification of Mn according to the C_{90} value, 1992

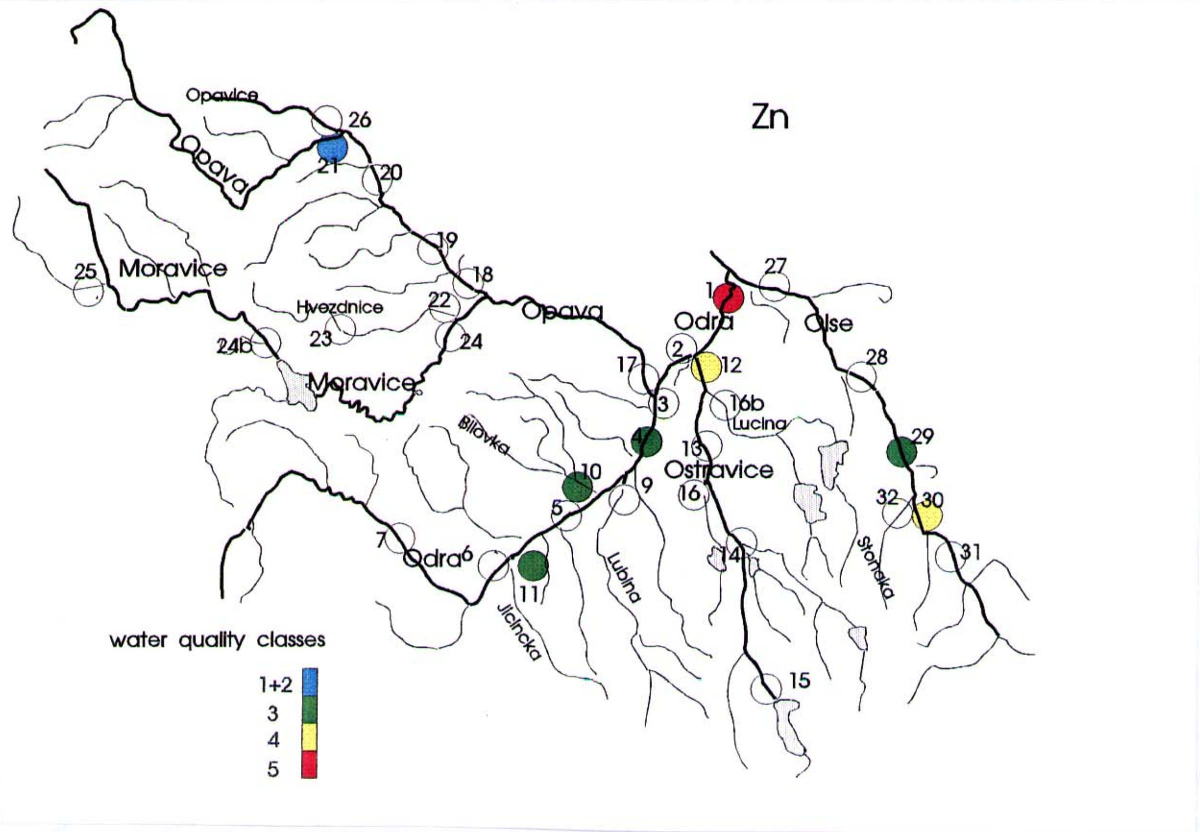


Figure 4.12: Classification of Zn according to the C_{90} value, 1993

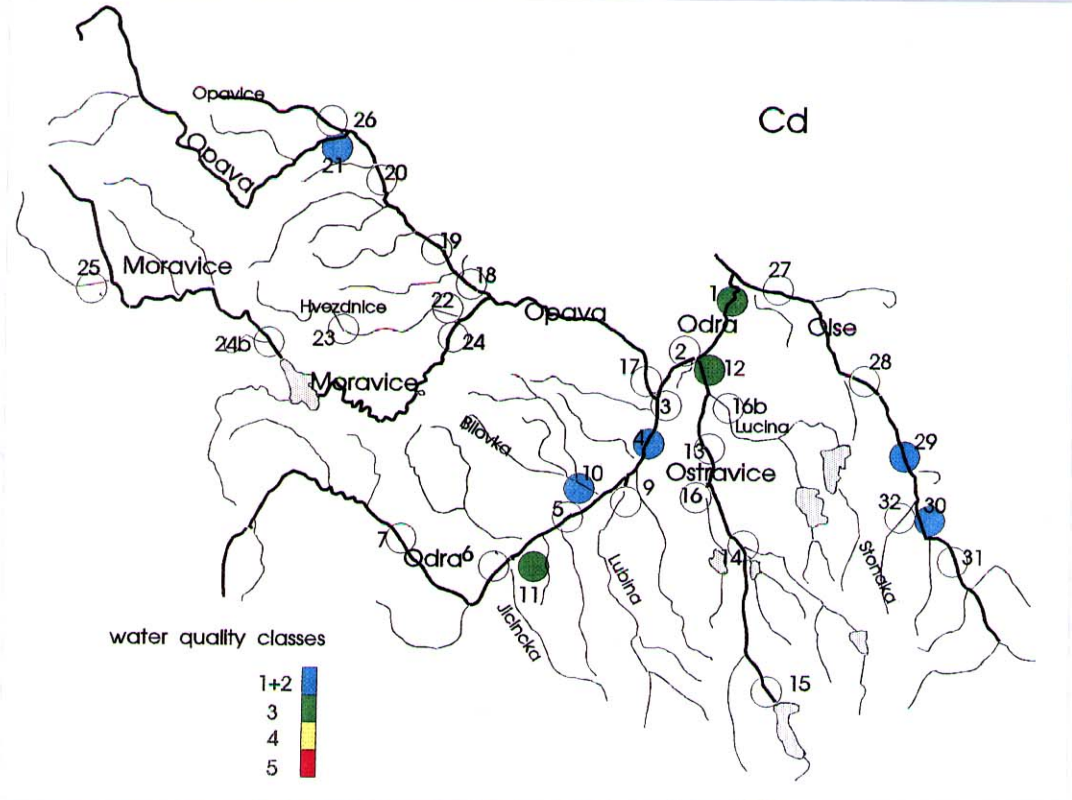


Figure 4.13: Classification of Cd according to the C_{90} value, 1993

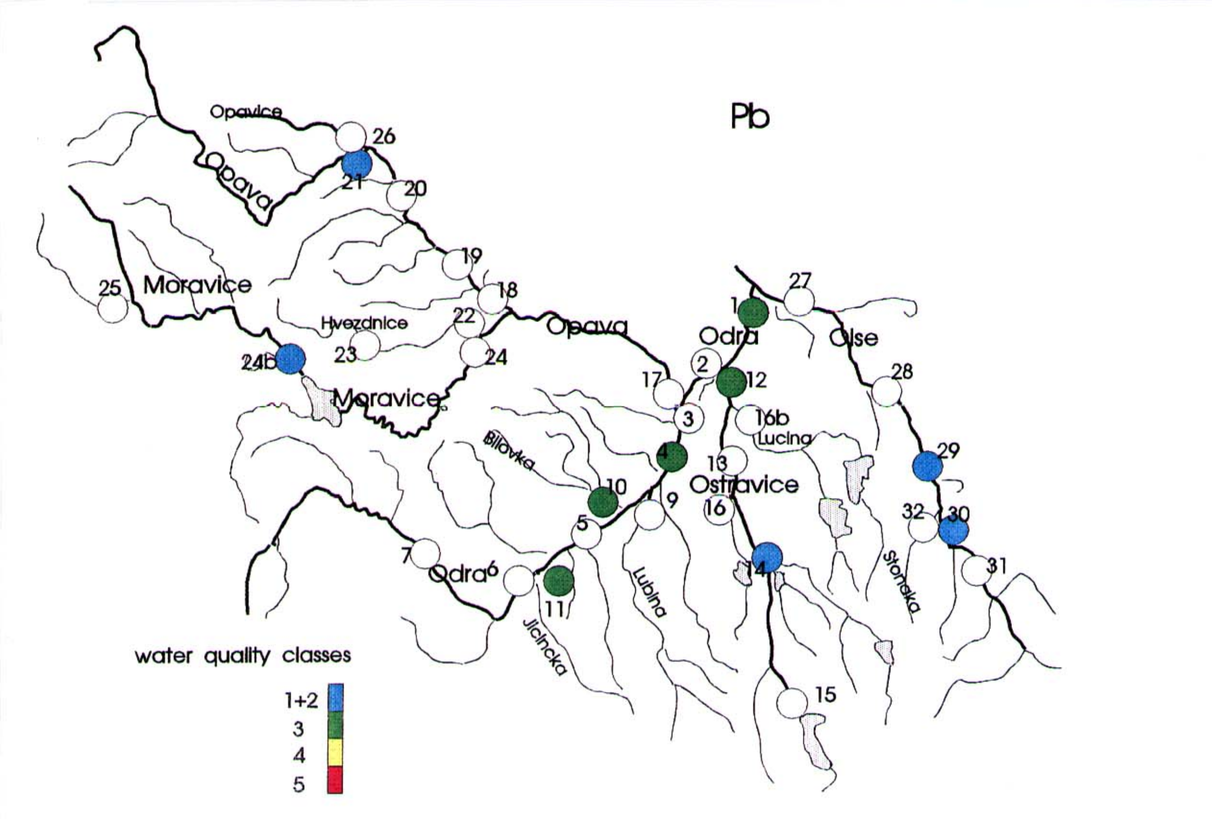


Figure 4.14: Classification of Pb according to the C_{90} value, 1993

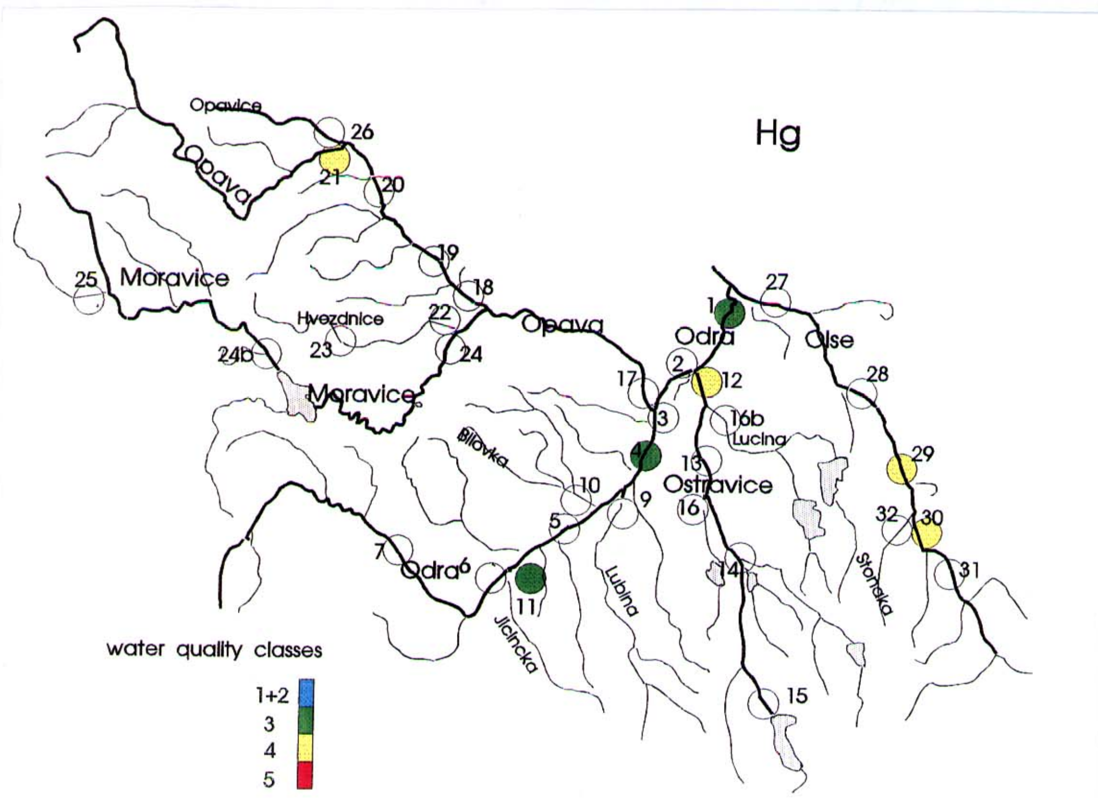


Figure 4.15: Classification of Hg according to the C_{90} value, 1993

4.3.2 Odra

The water quality in Odra has been monitored in 7 profiles (1 Odra Bohumin, 2 Odra-Petrkovice, 3 Odra Svinov, 4 Odra Polanka, 5 Odra Studenka, 6 Odra nad Jicinkou and 7 Odra Jakubcovice). The rest of the 34 profiles are located in the tributaries of Odra.

A Oxygen parameters (figure 4.2, 4.3, 4.4 and appendix 10.2):

In the first part Odra, before the Jicinkou profile, the oxygen conditions (BOD and CODmn) are classified as II. After the confluence with Jicinka, the water quality is affected and it drops down to class III. In the Polanka profile it is class IV, and there are no other changes to the Polish border. For the CODcr values the situation is more severe, and it is classified as class V in the whole Odra profile except in profile 7 where class IV occur. This indicates that a large part of the organic substances are not easily degradable. The situation for dissolved oxygen are however more favourable where class I is met in the whole profile except in profile Bohumin where it is classified as IV.

B Basic Chemical and physical parameters (Figure 4.5-4.11 , appendix 10.2)

The inorganic nitrogen (sum ammonia and nitrate) are classified as very polluted in the whole profile(class IV), and regarding ammonia it is extremely polluted (class V) in profile 1 (Bohumin). The nitrates are high (class IV) in the whole profile except in profile 1 where it is classified as III. The high content of nitrates upstream in Odra can be explained by a natural occurrence of nitrates in the water or by agriculture activities.

Odra from Studenka (profile 5) to Bohumin (profile 1) is also extremely polluted by phosphorus.

The content of SS (suspended solids) and iron (Fe) are also very high, and the water quality varies between very to extremely polluted (class IV and V) from profile 6 (nad Jicinkou) to Bohumin.

C Other Chemical Parameters (appendix 10.2)

The additional chemical indices are favourable, the criteria for class I and II are met, except in Bohumin where the water is extremely polluted (class V) by chloride.

D Heavy metals and organic pollutants (Figure 4.12- 4.15 and appendix 10.2)

The heavy metals are only monitored in a few profiles and the situation is severe especially in Bohumin, where the water is classified as extremely polluted according to Zn.

The organic pollutants, have a negative effect on the water quality downstream Polanka (Profile 4), and PCB has also increased in all inflows of Odra (WRI, 1993).

E Biological and micro biological parameters (appendix 10.2)

From the viewpoint of micro biological indices the whole river is extremely polluted. The bad water quality is mainly caused by a high content of coliform bacteria.

Trends in water quality over the past years

The water quality over the last three years (1990-1992) has been worse regarding BOD, CODmn and Fe. The water quality in Bohumin regarding BOD has, however, been improved with one water quality class (V-IV).

Conclusions

The water quality in Odra upstream Jicinka varies mainly between water quality class I-III. After the confluence with Jicinka (profile 6) the river is more affected, and considerable water quality deterioration occurs from profile 4 and down to Bohumin (class IV and V). The tributaries Lubina, Opava and Ostravice, specially the two last ones, cause the bad situation together with pollution sources located in the Ostrava region which discharge directly to Odra. In Bohumin the water quality is also affected by Olse river.

Odra river has a very limited value of use, except upstream in Odra before the river is affected by pollution sources. Organic compounds, nutrients and heavy metal are a problem.

Waste water from municipal and industry; Ostrava-Trebovice, waste water from Ostrava-Zabreh, Hrusovska Chemicka Spolecnost (Hrusov Chemical Work) and MCHZ (Moravian Chemical work) are some of the major point pollution sources.

The major point pollution sources are listed in table 4.5 (for more information see chapter 6).

4.3.3 Jicinka river - tributary to Odra

The water quality has been monitored in the mouth of the tributary Jicinka (profile 11-Jicinka Kunin). Jicinka is a small tributary, and is vulnerable to pollution.

The water in Jicinka is very- to extremely polluted according to organic matters, nutrients and bacteria (class IV-V). The rest of the parameters are mainly classified as polluted water (class III), but one should be aware of the high content of heavy metals. The water is suitable only for limited applications, and for some parameters not suitable for any application.

The water quality has been worse during the last three years (1990-1992) according to BOD, and there has been a slight increase in nitrates as well (WRI, 1993).

Major point pollution sources to this river profile are waste water of North Moravian Dairy Plants Kunin (Mlekrna Kunin) and Novy Jicin waste water treatment plant. Both sources contribute with easily degradable organic waste and nutrients. A large part of the catchment area (the Novy Jicin region) is also covered by agriculture fields, which will influence on the water quality (for more information see chapter 6).

Table 4.5: Major Point pollution sources with Odra as primary or secondary recipient

Profile	Recipient	Pollution source	Type of pollution	Loc. No
Odra-Bohumin	Cerny Prikop	Ovak Ostrava-Cerny Prikop	MWW	1
Odra-Bohumin	Cerny Prikop	OKD Koksovna Sverma Mar.Hory- hl.o.	Coke production	2
Odra-Bohumin	Bohuminska Struzka	Smvak 03-Kanalizace Bohumin	MWW	5
Odra-Bohumin	Cerny Prikop	Ovak Ostrava-Ucov Privoz	MWW	9
Odra-Bohumin	Bohuminska Struzka	Bochemie Bohumin-Hlavni Odpad	Chemical production	14
Odra-Bohumin	Struzka	Smvak 03-Cov Orlova-Poruba	MWW	18
Odra-Bohumin	Bohuminska Struzka	ZD Bohumin Zelezarny	Iron and steel work	21
Odra-Bohumin	Cerny Prikop	Ovak Ostrava-Vyust Cerveny Potok	MWW	23
Odra-Bohumin	Struzka	Smvak 03-Cov Rychvald	MWW	33
Odra-Bohumin	Michalkovicky Potok	Ovak Ostrava Kanalizace Michalkovice	MWW	39
Odra-Bohumin	Odra	Ovak Ostrava-Kanalizace Zabreh	MWW	42
Odra-Bohumin	Bajcuvka (Odra)	ZD Bohumin Dratovny	Iron and steel Work	43
Odra-Bohumin	Bajcuvka (Odra)	Smvak 03-Mrzirny Bohumin	MWW	44
Odra-Bohumin	Odra	Hrusovska Chemicka Spolecnost	Chemical production	51
Odra-Bohumin	Ostravice	Koksovna Svoboda- Fiebigh	Coke production	52
Odra-Bohumin	Bohuminska Struzka	Autopal Rychvald	Electronic equip. for cars	56
Odra-Petrkovice	Odra	Ovak Ostrava-Cov O-Trebovice	MWW	31
Odra-Petrkovice	Odra	MCHZ Hlavni Odpad	Chemical plant	54
Odra-Svinov	Odra	Ovak Cov Zabreh	MWW	53
Odra-Svinov	Porubka	Seliko zav.02 O-Svinov	MWW	55
Odra-Polanka	Polancice	Smvak 04-Kanalizace Klimkovice	MWW	25
Odra-Polanka	Husi Potok	Smvak o4-Cov Fulnek	MWW	32
Odra-Jacubcovice	Budisovka	Smvak 06-Cov Budisov	MWW	20

Loc.No See map, appendix 10.4
MWW-municipal waste water

Table 4.6: Major Point pollution sources with Jicinka as primary or Secondary Recipient

Recipient	Pollution source	Type of pollution	Loc.No
Jicinka	Smvak 04-Cov Novy Jicin	MWW	3
Jicinka	Mlekarna Kunin	Diary	45

Loc.No See map, appendix 10.4
MWW-municipal waste water

4.3.4 Bilovka - tributary to Odra

The water quality has been monitored in the mouth of the tributary Bilovka in profile 10 (Bilovka pod Sezinou). The river is small and is vulnerable to pollution.

Bilovka is one of the most polluted tributaries in the Odra river basin and is classified as very- to extremely polluted for organic matters, nutrients (both ammonia and nitrate, phosphorus is not measured), SS, Fe, Mn and biological parameters. Even the oxygen saturation is not acceptable, and there are also a high content of Zinc. The water is not suitable for any application.

During the last three years the water quality has been worse with regard to suspended solids and iron (WRI, 1993).

Both municipal and industrial sources discharge pollution to the river; insufficiently treated sewage from Bilovec town, insufficiently treated waste water from the pig farm Velke Albrechtice and waste water from Massag Bilovec are the main polluters. The agriculture pollution in the area is also significant compared to municipal and industrial sources (for more information see chapter 6).

Table 4.7: Major Point pollution sources with Bilovka as primary or secondary recipient

Recipient	Pollution source	Type of pollution	Loc.No
Bilovka	Smvak 04-Kanalizace Bilovec	MWW	12
Jamnik (Sezina)	Slechtitelska St. Velke Albrechtice	Pig farm	15
Bilovka	Massag Bilovec - NS	Metal products/galvano industry	16

Loc.No See map, appendix 10.4
MWW-municipal waste water

4.3.5 Lubina -tributary to Odra

The water quality has been monitored in the mouth of the tributary Lubina in profile 9 (Lubina-Kosatka). Lubina is a realtivly small tributary to Odra.

The main problem in the river is high content of inorganic nitrogen, phosphorus and coliform bacteria. The water has a very low application value.

The major point pollution sources are mainly municipal waste water from COV-Pribor, COV-Koprivnice, COV-Frenstat and Tatra Koprivnice, but the agriculture is also a main polluter specially regarding nitrogen (for more information see chapter 6).

Table 4.8: Major Point pollution sources with Lubina as primary or secondary recipient

Recipient	Pollution source	Type of pollution	Loc.No
Lubina	Svak-Cov Frenstat	MWW	10
Sykorecka (Koprivnicka)	Tatra Koprivnice	Car factory	28
Lubina	Smvak 04-Cov Pribor	MWW	29
Koprivnicka	Smvak 04-Cov Koprivnice	MWW	34

Loc.No See map, appendix 10.4
MWW-municipal waste water

4.3.6 Ostravice river- tributary to Odra

The water quality in Ostravice has been monitored in 4 profiles (12 Ostravice Muglinov,13 Ostravice Vratimov,14 nad Maravkou and 15 Pod nadrzi). In addition there is one water quality profile in the tributary Olesna (profile 16; Olesna-usti). Ostravice is one of the largest tributaries to Odra.

A Oxygen parameters (figure 4.2-4.4, appendix 10.2):

The oxygen saturation in Ostravice is good (class I) except in the mouth of the river (Muglinov), where it is characterised as very polluted (IV). BOD5 is classified as class II until Vratimov(profile nr 13) where it is classified as III. The situation are severe in Muglinov (profile 12) where the water quality according to BOD are extremely polluted. CODmn is in class II until Muglinov, where it also change to class V. CODcr is also classified into class V in Vratimov and Muglinov.

B Basic chemical and physical parameters (Figure 4.5-4.11, appendix 10.2)

Total phosphorus increase gradually from class II to class V at Muglinov. Ammonia is in class II until Vratimov (profile 13) where it drops down to class IV. The nitrate content is in class II at Pod nadrzi (15), and then drop down to class III in the rest of the river profile. The content of suspended solids are in class II, but drop to class III in profile 13(Vratimov). At Muglinov (profile 12) the water quality is in class IV according to SS. The iron content in the river profile is in class II in upper parts, but drop down to class III in profile 13. The Mn content is in class III in profile 15, but then the situation get better (class II) before it again drop down to class IV in profile Muglinov.

C Other Chemical Parameters (appendix 10.2)

Other chemical parameters are favourable except in profile 12 where the chloride and sulphate content are classified as III and V.

D Heavy metals and organic pollutants (Figure 4.12-4.15, appendix 10.2)

Heavy metals are measured in Muglinov, and the water is classified as very polluted (class IV) for Zn and Hg. According to Cd and Pb the water is classified as pure water (class II). Organic pollutants have been determined in Ostravice at Muglinov (WRI, 1993).

E Biological and micro biological parameters (appendix 10.2)

According to biological indices the water quality is in class II and III in profile 15 and 14, but drops down to class V in profile 13.

Trends in water quality over the past years

During the last three years (1990-1992) the water quality in Vratimov has been worse according to suspended solids and iron. The situation in Muglinov has been unchanged (WRI, 1993).

conclusions

The water quality in Ostravice is especially affected at Muglinov but also in some extent in Vratimov. The water is characterised as very to extremely polluted (class IV-V) for several parameters (oxygen conditions, phosphorus, ammonia, SS, Mn, Zn and Hg). In this part of the river the water has a very limited value of use.

The water quality situation indicates that municipal sources can not be the only point pollution source. The high content of organic pollutants and heavy metals indicates industrial sources as well. The high chloride and sulphate content are caused by coal or coke industry.

Before the Vratimov profile in the part downstream of the city Frydek, the river becomes very polluted by discharges from overloaded waste water treatment plant Frydek (at present under reconstruction) planned completed in 1994. Valcovny Plechu (main outlet) and Valcovny Plechu (secondary outlet) is a metal rolling mill located at Liscovec with two outlets, and do also causes pollution in the profile. Olesna a tributary to Ostravice (see chapter 4.3.8) also affects the water quality in this profile.

From Vratimov to Muglinov the river is influenced by several sources; Waste water from Biocel Paskov pulp mill, municipal waste water from Vratimov town (this outlet goes through a channel before the outlet to Ostravice, and self purification reduce the effect in Ostravice), Koksovna Svoboda (Coke plant) and Nova Hut (steel work).

Outlets of municipal waste water seems to play a major role, but agriculture will contribute. Lucina river (chapter 4.3.7) which flows into Ostravice also contributes to the environmental problems in Muglinov (for more information see chapter 6).

Table 4.9: Major Point pollution sources with Ostravice as primary or secondary recipient

Profile	Primary recipient	Pollution source	Type of pollution	Loc.No
Ostravice-Muglinov	Slezsky Nahon	Smvak 02-Kanalizace Vratimov	MWW	37
Ostravice-Muglinov	Ostravice	Nova Hut-Cov Ostravice	Steel work	58
Ostravice-Muglinov	Ostravice	Valcovny Plechu-Vedlejsi Odpad	Metall-rolling	59
Ostravice-Muglinov	Ostravice	Koksovna Svoboda	Coke-plant	52
Ostravice-Vratimov	Ostravice	Smvak 02-Cov Frydek-Mistek	MWW	11
Ostravice-Vratimov	Ostravice	Biocel Paskov	Pulp mill	19
Ostravice-Vratimov	Ostravice	Valcovny Plechu-Hlavni OdPad	Metall-rolling	48

Loc.No See map, appendix 10.4
MWW-municipal waste water

4.3.7 Lucina -tributary to Ostravice

Lucina is a relatively small tributary to Ostravice, where the water quality has been monitored in profile 16 B-Lucina

The water quality in the mouth of Lucina is evaluated as very polluted water, according to oxygen parameters, nutrients and coliform bacteria The river is anaerobic. The bad quality is mainly caused by discharges from Havirov waste water treatment plant. High ammonia content indicates influence of fresh sewage, and the low oxygen content prevent oxidation to NO_3. Agriculture can also contribute to pollution in this profile, but municipal waste water is probably the dominating source (for further information se chapter 6). The water in the river has a limited application value.

Table 4.10: Major Point pollution sources with Lucina as primary or secondary recipient

Recipient	Pollution source	Type of pollution	Loc.No
Lucina	Smvak 03-Cov Havirov	MWW	3
Lucina	Nova Hut Ostrava-Cov Lucina	Steel work	35
Susanka	Okd Dul Dukla Havirov	Coal mine	49

Loc.NO See map, appendix 10.4
MWW-municipal waste water

4.3.8 Olesna - tributary to Ostravice

The water quality is monitored in the mouth of Olesna. Olesna is a small tributary to Ostravice and flow into Ostravice upstream Vratimov.

The river is polluted specially regarding phosphorus, nitrate and ammonia, Fe and Mn.

Untreated waste water from Paskov (3000 inhabitants) is the main polluter. But there is also sewage from households upstream Paskov, which are not connected to the sewage system. Agriculture activities do also contribute to the pollution.

4.3.9 Opava river - tributary to Odra

Opava is the longest river in the Odra catchment area (110 km). The river forms the border with Poland between Krnov and Opava. The water quality has been monitored in 5 profiles(17 Opava Trebovice, 18 Opava-Hostice, 19 Opava-Vavrovice, 20 Opava-po Krnovem and 21 Opava nad Krnovem). The water quality has also been monitored in 5 profiles in the tributaries to Opava; 24A Moravice Branka, 24B Moravice Slezska Harta, 25 Podolsky potok, 26 Zlata Opavice and in two profile in Hvozdnice (profile 22 Hvozdnice-usti and 23 Hvozdnice-Mladecko).

A Oxygen parameters (figure 4.2-4.4 and appendix 10.2)

According to the oxygen saturation, the river is in class I except in Hostice (profile 18) where it is classified as pure water (class II). The BOD and CODcr value are also high in this profile (class V). In the rest of Opava BOD varies between class IV (profile 17 and 20) and class II (profile 19 and 21). The CODcr value is high also in other profiles; class IV in profile 19-21 and class V in profile 17. CODmn is in class II in profile 19-21, but in class IV in profile 17-18.

B Basic Chemical and physical parameters (Figure 4.5-4.11, appendix 10.2)

The phosphorus content in the mouth (profile 18 and 20) indicates that the river is extremely polluted. The water quality in profile 19 and 21 is classified into class IV and III. The inorganic nitrogen varies mainly between class II and IV in the profiles. The content of SS is high (class IV) in profile 18 and 19. The iron and mangan content varies mainly between II and III, but the iron content is also high in profile 18 (class V).

C Other Chemical Parameters (appendix 10.2)

The water is classified in class I for the rest of the chemical parameters.

D Heavy metals and organic pollutants (Figure 4.12-4.15, appendix 10.2)

The concentration of heavy metals is measured in profile 21(Profile before Krnov). The content of mercury is high (class V). The concentration of heavy metals have also been measured in some other profiles which are not presented on the maps, but showed that Zinc adversely affects the water quality in Opava and in all tributaries to Opava. Based on this it has been assumed that Zn is a natural component. Organic pollutants have also been recorded in the river (WRI, 1993).

E Biological and micro biological parameters (appendix 10.2)

From the micro biological point of view, the water quality is in class V, except above Krnov where it is in class IV.

Trends in water quality over the past years

The river quality has been worse the last three years according to nitrate and COD (WRI, 1993).

conclusions

The water quality varies in the river, and the worst water quality occurs in the mouth (profile 18-Hostice) and profile 17 (Trebovice), where the water quality is in class IV and V for several parameters (oxygen parameters, phosphorus, nitrates, ammonia, SS and Hg). The water downstream Krnov has a very limited application value.

The first part where the water quality is affected (BOD_5) is below Krnov after the influence by waste water from Krnov (the river is also affected with waste water from Vrbno above Krnov). The water in Hostice is influenced by insufficient treated waste water from Opava treatment plant. There are also some other sources in the tributaries, but many of these will have reduced effects in Opava, because of self purification.

Municipal waste water is an important source of pollution, but agriculture is a main contributor to nitrogen pollution and to some extent phosphorus pollution (for more information see chapter 6).

Table 4.11: Major Point pollution sources with Opava as primary or secondary recipient

Profile	Recipient	Pollution source	Type of pollution	Loc.No
Opava-Trebovice	Stepanka	Verejna Kanalizace Kravare	MWW (without treatm.)	27
Opava-Trebovice	Hrabynka	Rehabilitacni Ustav Hrabyne	Rehabilsat.center; MWW	30
Opava-Trebovice	Opusta	Verejna Kanalizace Bolatice	MWW (without treatm.)	36
Opava-Trebovice	Opava	Galena Opava	Pharmaceutical Industry	60
Opava-Hostice	Opava	Smvak 06-Cov Opava	MWW	4
Opava-Vavrovice	Cizina	Vak Bruntal Kanal. Horni Benesov	MWW	8
Opava-po Krnovem	Opava	Vak Bruntal-Cov Krnov	MWW	13
Opava-nad Krnovem	Opava	Vak Bruntal-Cov Vrbno P/PR	MWW	40

Loc.No See map, appendix 10.4
MWW-municipal waste water

4.3.10 Moravice-tributary to Opava

The water quality has been monitored in the mouth of Moravice Branka (profile 24A Moravice Branka) and upstream drinking water reservoir Kruzberk in Slezska Harta (profile 24B). Moravice starts upstream Kruzberk and flows into Opava downstream the town & Opava and after the confluence with the tributary Hvozdnice.

The water quality in the two profiles are approximately the same.

Special concern must however be paid to the water quality in Slezska Harta which constitutes approximately 80% of the catchment area to Kruzberk drinking reservoir. Both the phosphorus and bacteria content are alarming. The major point pollution sources in the catchment area to Kruzberk is waste water from municipalities Bruntal, Brdlicna, Dvorce and Rymarov. There are also many other smaller point pollution sources both within agriculture (smaller farms with husbandry) and industry. The run-off from agriculture is also considerable, and contributes to the phosphorus content. The water quality in Kruzberk is described in chapter 4.3.16.

Table 4.12: Major Point pollution sources with Moravice as primary or secondary recipient.

Profile	Recipient	Pollution source	Type of pollution	Loc.No
Moravice-Branka	Lobnik	Vak Bruntal-Cov Dvorce	MWW	41
Moravice-Slezska Harta	Cerny Potok (Moravice)	Vak Bruntal-Cov Bruntal	MWW	6
Moravice-Slezska Harta	Moravice	Vak Bruntal-Kanalizace Bridlicna	MWW	38
Moravice-Slezska Harta	Podolsky Potok	Vak Bruntal-Cov Rymarov	MWW	50

Loc.No See map, appendix 10.4
MWW-municipal waste water

4.3.11 Podolsky Potok - tributary to Moravice

The water quality has been monitored in Podolsky Potok in profile 25. Podolsky Potok is a small tributary to Moravice, and flows into Moravice, upstream of the drinking reservoir Kruzberk.

The river is polluted by organic matter, ammonia, nitrate, phosphorus and coliform bacteria. According to the classification system the water is suitable for industry supply only.

One main pollution source in the profile is municipal waste water from the town Rymarov.

The situation in the river according to micro biological parameters (probably coliform bacteria) can be alarming while it flows into Kruzberk. It depends however on the self purification.

4.3.12 Zlata Opavice - tributary to Opava

The water quality has been monitored in Zlata Opavice (profile 26). Opavice flows into Opava in Krnov city.

The water is polluted by nitrates, ammonia, phosphorus and coliform bacteria (III-IV) probably as a result of both municipal and agriculture pollution. The water has a limited value for different applications.

4.3.13 Olse river

Olse rises on the territory of Poland and enters the territory of The Czech Republic in Bukovec. Its length in the Czech territory is approximately 70 km. The water quality in Olse has been monitored in five profiles (27 Olse-Vernovice, 28 Olse nad Stonavkou, 29 Olse pod Tesinem, 30 Olse nad Ropici and 31 Olse nad Trincem). The water quality has also been monitored in a tributary Stonavkoua,- profile 32 (chapter 4.3.14).

A Oxygen parameters (figure 4.2-4.4, appendix 10.2)

According to oxygen indices, the water shows a sufficient oxygen saturation except in profile Vernovice, where it is class II. In the case of BOD_5 the water is gradually affected (from Trinec to Tesin) from pure water, II to very polluted water, IV. CODmn is mainly in class II, but the CODcr value varies between class V and IV. This indicate that Olse river is influenced by organic matter, but the amount of organic matter which does not decompose so easily, is larger here compared with other rivers in the catchment area.

B Basic Chemical and physical parameters (Figure 4.5-4.11, appendix 10.2)

The water quality according to manganese and nitrates are classified as polluted water (class III). The situation for ammonia is even worse and is classified as very-extremely polluted (class IV-V). The content of total phosphorus is high in the whole profile (class IV and V). According to iron and SS the water quality ranges between I and III.

C Other Chemical Parameters (appendix 10.2)

The chemical parameters in group C are satisfactory, except in profile Vernovice (profile 29) where the chloride content are in class V.

D Heavy metals and organic pollutants (Figure 4.12-4.15, appendix 10.2)

The river in profile 29 and 30 is very polluted by both zinc and mercury (class IV and III)
PCB has been found, and benzpyrene was recorded in Vernovice.

E Biological and micro biological parameters (appendix 10.2)

The water is also extremely polluted by bacteria.

conclusions

The water quality especially in profile 29 is very to extremely polluted according to several parameters; organic matters (hard degradable), nitrogen compounds (specially ammonia), phosphorus, heavy metals and coliform bacteria. The water in profile 27 and 28 shows a high content of organic matter (hard degradable) and nutrients (specially ammonia). The heavy metal contents and the concentration of total phosphorus and CODcr are also high in profile 30. The water varies from having a very limited application value to being unsuitable for any application. The water quality indicates pollution from municipal sources, but a high influence from industrial sources as well. The high chloride content in Vernovice is caused by mining water from Ostrava region. Agriculture is also assumed to give a significant contribution to pollution. The water quality in profile 30 is affected downstream Trinec by ammonia ions and phenols. This is mainly caused by influence of waste water treatment plant Trinec. Ammonia-phenol waste water from Trinec Iron and Steel Works (Trinecke Zelezarny) is treated at this WWTP. Before Tesinem (profile 29) the river is also affected by MWW from the town Cesky Tesin, and gets even more polluted by waste water from the town Karvina and CEZ elektrana Detmarovice before profile 27.

Table 4.13 Major Point pollution sources with Olse as primary or secondary recipient

Profile	**Recipient**	**Pollution source**	**Type of pollution**	**Loc.No**
Olse-Vernovice	Olsinsky Nahon (Olse)	Smvak 03-Cov Karvina	MWW	17
Olse-Vernovice	Mlynka (Detmarovice)	Cez Elektrarna Detmarovice-C.St.2	Power plant and MWW	57
Olse nad Stonavkou	Olse	Smvak 03-Cov Cesky Tesin	MWW	47
Olse nad Ropici	Olse	Smvak 02-Cov Trinecke	MWW	22
Olse nad Ropici	Olse	Trinecke Zelezarny	Steel work	26

Loc.No See map, appendix 10.4, MWW-municipal waste water

4.3.14 Stonavka -tributary to Olse

The water quality is monitored in the mouth of Stonavka a relatively small tributary to Olse.

The water quality varies mainly between II-III. The river profile is mainly polluted by nitrate, ammonia, phosphorus, manganese and iron. The micro biological content indicates that municipal waste water or agriculture can influence on the water quality. There are no major point pollution sources in this river profile.

4.3.15 Small but heavy polluted rivers in the Odra River Catchment

Hvozdnice - tributary to Opava

The water quality has been monitored in Hvozdnice a tributary to Opava in profile 22 Hvozdnice-usti and in profile 23 Hvozdnice-Mladecko. Hvozdnice flow to Moravice and to Opava downstream the city Opava.

The water quality in the river, especially in the mouth must be characterised as very polluted to extremely polluted according to organic matters and nutrients (phosphorus and nitrogen). There are anaerobic conditions, and the bacteria content is high.

The CODmn conditions in the river have been improved during the last three years (1990-1992), but the water quality has been worse according to nitrates (WRI, 1993).

The bad situation is mainly caused by sewage from smaller villages and pig farms. The sources are not within the main polluters in the region.

Porubka
Extremely polluted tributary to Odra which is polluted by sewage water from Ostrava (Svinov) and industrial waste water from Seliko Svinov

Bohuminska struzka
Very polluted tributary to Odra by waste water from Freezing store Bohumin, Bochemie-chemical plant, Bohumin Iron and Wire Works and municipal waste water from the WWTP in Bohumin.

Husi potok
Husi Potok is a polluted tributary to Odra. The river is polluted by waste water from Masospol and Brezova (pig farm).

Cerny Potok
This river profile (no. 8) has not been evaluated according to the classification criteria. Some values indicate however that the river is extremely polluted. The river functions as an artificial channel for waste water. The river profile is polluted by WW from Ostrava town (Privoz) and from Koksovna Sverma.

4.3.16 Drinking water reservoirs, Sance, Kruzberk and Moravka

The public water supply in the region is mainly based on surface water, and 65% of the water supply comes from the three reservoirs Sance, Kruzberk and Moravka. The remaining 123 public sources (35% of the water supply) are smaller sources, and mainly sub surface water from a high number of public wells in the region. In addition, there are some private wells.

The ground water often has very high content of both Mn and Fe, and in some cases there has been registered a high content of nitrate. This study has primarily addressed the surface water quality in the region.

Some eutrophication problems in Kruzberk has also been reported. This area is influenced by pollution from agriculture, municipal and industrial sources.

Povodi Odry has provided NIVA with some water quality data, from the three reservoirs (PO, 1995, appendix 10.5).

Nutrient concentrations, especially inorganic nitrogen compounds (ammonium, nitrate and nitrite), have been measured in the three reservoirs over a number of years. Phosphorus concentrations (total-P) have been analysed during the last 4 years.

Phosphorus and chlorophyll-a

Phosphorus values in figure 4.16 are based on yearly values. These values seem to be too low for Kruzberk compared with the values in figure 4.18, and indicate that the mean values might be three times higher (approximately 170 mg/l). This assumption is also strengthened by the C_{90} value in Slezska Harta (profile 24 B in the inflowing river to Kruzberk-Moravice). This river profile constitutes approximately 80% of the catchment area to Kruzberk, and the C_{90} value for Tot-P in this profile is 560 mg/m^3. This gives an estimated mean value of 280 mg/l in the inlet to the reservoir (according to the method used in chapter 5.2.1). The estimated retention of phosphorus in Kruzberk is approximately 30%, giving a mean value in the outlet in the order of 180 mg/l.

Also a few series of chlorophyll-a measurements taken at the same time as Tot-P are available from the last years (figure 4.18 and appendix 5.2). Some of these data are obviously erroneous and have been omitted from the figures and the interpretations (e.g. Kruzberk 1/21/91 total-P=0.007 mg/m^3 and 1/27/92 total-P=0.002 mgP/m^3, while most other values are > 150 mgP/m^3). It is not only the low phosphorus values which indicate an error in the values, but the large variations as well. Anyhow the number of measurements per year in the summer months are rather limited, and this means that the single year's values and the year-to-year variations of Tot-P and chlorphyll -a may be misleading.

According to international criteria for phosphorus and nitrogen classification the reservoirs are eutrophic (even if the yearly mean values for phosphorus in figure 4.16 are used). This means that algal blooms are possible under normal circumstances, especially in Kruzberk, but also in the two other reservoirs.

Nitrogen

The median seasonal sum concentrations of inorganic nitrogen compounds (DIN) are also high (figure 4.17). Again Kruzberk has the highest values with annual averages 3-6 mg N/l. The DIN values are probably never low enough to give N-limitation to phytoplankton in any of the reservoirs.

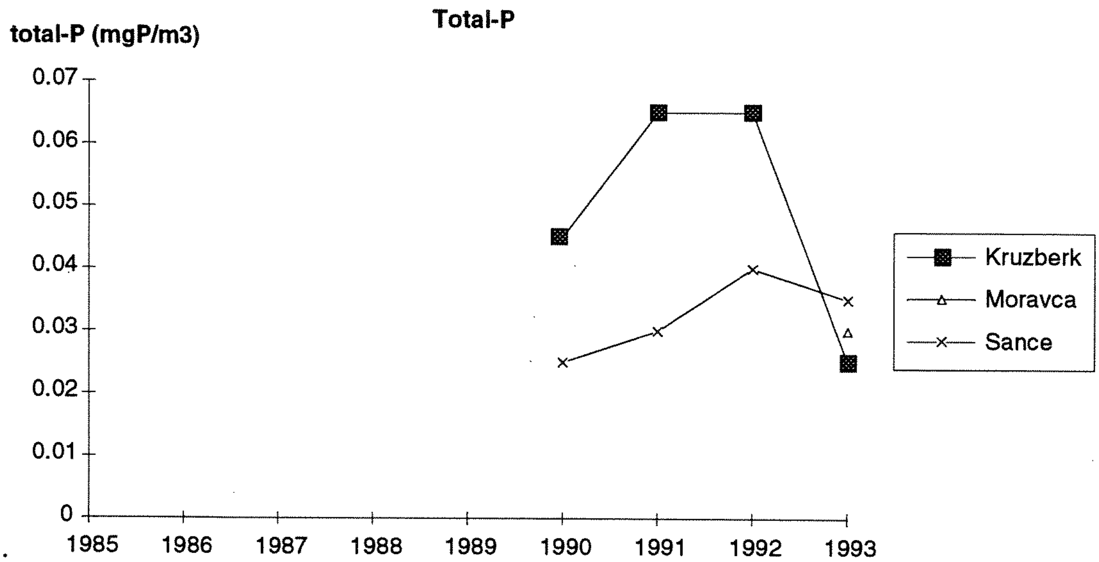


Figure 4.16 Median yearly concentrations of total-P in the three reservoirs as given by PO (1995). These P-values are probably underestimated, see comments in text.

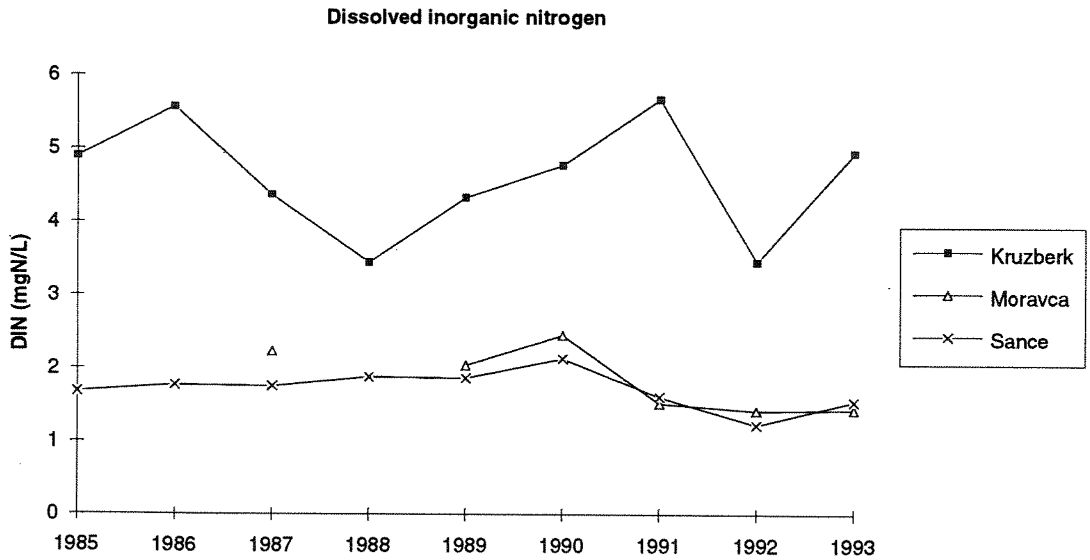


Figure 4.17 Average seasonal concentrations of dissolved inorganic N (DIN) in the three reservoirs

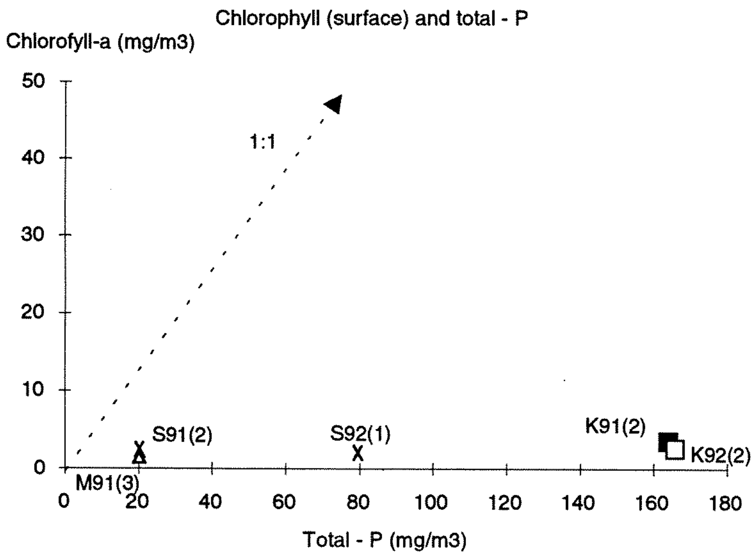
Conclusions

The available data indicate that light is probably the most growth limiting factor for phytoplankton due to deep mixing, but phosphorus may be limiting in periods. Despite the rather high levels of P and N, the chlorophyll-a concentrations are low. By far most values are below 5 mg/m^3, which is remarkable when compared to the concentration of nutrients in the water. In most lakes, the seasonal average ratio between Chl-a and P varies between 1.0 and 0.1. Whereas the ratio in Moravka and Sance are at the lower end of this scale, this ratio in Kruzberk is almost an order of magnitude smaller: in the order of 0.02.

This extremely low chlorophyll yield, especially in Kruzberk, may have three possible explanations:

1. The high flushing rate in the reservoirs gives insufficient time for optimal reproduction of the phytoplankton, and also promotes deep mixing and hence severe light limitation.
2. Due to few measurements per season (2-4) larger peaks of phytoplankton are probably omitted.
3. The chlorophyll concentrations may be incorrect (too low) which is also supported by the possible errors in the phosphorus values and the reported eutrophication problems.

We do not have enough information to interpret which of these factor (-s) is the most important.



Figur 4.18 Total-P vs. chlorophyll-a relationships from the three reservoirs. The 1:1 line is given for comparison. The numbers are based on values from summer months, in addition the lowest phosphorus values for Kruzberk is omitted. The numbers of measurements are limited (the number in parentheses indicates how many values the calculations are based on).

If the values are correct it seems unnecessary with nitrogen removal (according to EC values) or phosphorus removal, but there appears to be some discrepancy in the data. Bacteria content can also be a problem in the reservoirs, and it is not known how micro pollutants may affect the water quality in the reservoir. The eutrophication effect in the drinking reservoirs, and the need for pollution abatement for these reservoirs ought to be studied in more detail (see recommendations in appendix 10.16).

4.3.17 Sediment sampling

WRI-O has executed a sediment sampling programme and the results have been discussed as part of the project "The environmental quality of river Odra according to international criteria" (Bækken *et al*, 1995 forthcoming)

The quality in Odra according to the sediment samples shows a very polluted situation. Comparing the values with the Canadian classification system, there is a potential risk of effects on the ecology (rather high for some of the parameters). The situation is however only representative at locations where the river is slow flowing and where sedimentation can occur.

4.4 Effects of pollution in the Odra River Catchment

4.4.1 Human Health

Drinking water

As mentioned in the previous chapter Kruzberk, Moravka and Sance reservoirs contribute approximately 65% of the drinking water supply. The other 123 public sources of drinking water in the region are either mixed with water from one or more of these three reservoirs, or are used directly by inhabitants living near the sources. The risk to human health in the area has been determined within project Silesia (Industrial Economic and Sullivan Environmental consulting, 1992).

The sources of drinking water which represent the greatest risk to cancer are the sources located in the Ostrava district. The Sance reservoir may present the greatest single risk of bacteria contamination. Most of the other sources effected by bacterial contamination are small ground water sources (Industrial Economic and Sullivan Environmental consulting, 1992). One should also be aware of the potential bacteria contamination of Kruzberk reservoir due to activities in the catchment area.

Blooming of toxic blue green algae has not yet been reported as a problem, but there is a potential risk concerning the extremely high phosphorus values in the reservoirs.

The high content of Mn and Fe in ground water sources can be a practical problem for consumers (taste), but manganese may also represent potential risk for human health (neurotoxic). Bacteria content, can as mentioned, contaminate some of the sources. High nitrate level levels (personal information, Kynsl, 1994) have also been observed, and there is some concern about increased risk of cancer connected to the nitrate content. The guiding value for nitrate in WHO's Guidelines for drinking water quality is however established solely to prevent methaemoglobinaemia (WHO, 1993).

Recreation, swimming and fishing

The recreational risks to human health have also been determined for swimming in project Silesia. As part of the analysis five official recreational swimming sites were identified in the region. Measured total coliform concentrations indicated the potential for exceedance of U.S. EPA recreational water quality guidelines by a factor of between 1.06 and 63. This finding suggested that swimmers at these sites may be at risk of contracting the gastrointestinal illnesses associated with bacteria.

The potential average lifetime cancer risks at two recreational swimming sites based on estimated concentrations of 12 carcinogens, were found to be $2x10^{-6}$ and $7x10^{-6}$. The risk was mainly attributable to high estimated arsenic concentrations.

Cancer risk from ingestion of recreationally caught fish was identified as potentially higher. Olse River angler data indicated that average lifetime cancer risks could be as high as $3x10^{-4}$. Annual cancer cases associated with eating these fish were estimated to be less than 1 per year. Other recreational risks to human health were found to be low(Industrial economics, 1992).

4.4.2 Ecology

General

The water quality situation in Odra river catchment must be characterised as very severe according to ecology and regarding the suitability for use.

The river is very to extremely polluted (water quality class IV-V in the Czech classification system) at many sites and for the majority of pollution parameters. Especially in the central parts of Odra (from profile 1-4), and in the mouth of the tributaries. The bad water quality affects the user interests, and the water according to the Czech classification system varies from having a very limited application value to not suitable for any activity except being a recipient for waste water.

In the upper parts of the catchment the water quality is better and in most cases in class II, but very seldom in class I. In this area the water is suitable for the majority of applications for drinking water (if treated for some parameters), recreation, and has good living condition for fish etc.

Biological and micro biological indices

According to the micro-biological indices the water quality is classified as V almost in all profiles. This is mainly caused by bacteria contamination, which indicates that municipal sources are a primary source of pollution, but also that agriculture (husbandry) can contribute.

The saprobie index are not yet available, but the effects of the bad water quality have been observed on benthic macro invertebrates (Bækken *et al.*, 1995 forthcoming).

Oxygen Parameters

Even if the BOD values are very high in many profiles, the oxygen saturation is mainly satisfactory. This can be caused by several factors e.g. turbulence. The oxygen conditions in Bilovka, Ostravice (in the mouth), Lucina and in Hvozdnice are however alarming.

The river is also extremely affected by CODcr (class V). The situation is better regarding CODmn, but this parameter is also at many sites classified as very polluted (class IV). The difference between CODmn and CODcr can be explained by the differences in easily degradable organic matter and organic matter which do not decompose so easily, and indicates that industry contribute to the severe situation as well as municipalities.

It is assumed that the biological diversity is changed to more hetrotrophic species at sites with large outlets of easily degradable organic matter.

Nitrate, ammonia and phosphorus

Nitrates and ammonia, especially the ammonia content is very high in many profiles (class IV and V), in Odra river, in the mouth of the tributaries and in Opava. The phosphorus values are also extremely high in the majority of profiles (class V), despite the fact that the Czech limits for phosphorus is very liberal.

The extremely high phosphorus content registered in Odra would normally represent a high risk for producing toxic-blue green algae or at least result in some eutrophication problems. It has however not been reported about these problems, which may be explained by several factors (see chapter 5.1.3).

The eutrophic situation for the reservoirs (chapter 4.3.16), also indicate that one could expected large eutrophication problems.

The high ammonia content can be toxic to fish, and result in high nitrates content when these compounds are oxidised. The nitrogen levels will not have any other ecological effect, because it is not a limiting factor for primary production in freshwater. Nitrate can however cause local problems, in drinking water, especially if ground water is affected.

Nitrate, ammonia and phosphate indicate the influence of insufficient treated waste water. The high ammonia content is also a result of industrial pollution, and the nitrate and ammonia levels will also be influenced by agricultural activities.

Suspended solids

The water quality is also poor regarding SS, especially in the mouth of the tributaries and in Odra. The high particle content is caused by anthropogenic sources, but the main contribution is naturally from erosion.

Heavy metals and other micro pollutants

Results from Bækken (1995 forthcoming) shows that excess of Cu, Zn, Cd, Pb and Hg can give chronic effects on the ecology at almost every sites where these components are measured. As far as the organic pollutants are concerned, the increased values of PCB were recorded in all inflows of the Odra river (WRI, 1993).

The high content of these micro-pollutants are mainly caused by the different industrial activities in the region, but mercury may also have connection with pesticides use in the agriculture. It is also assumed that the parameters Mn, Fe and in some extent Zn have a high naturally background level.

Results from project Silesia

The project Silesia also executed a risk assessment study to determine the effects on ecology in the study area. The areal extent and severity of surface water contamination for each of the five major rivers in the study area was determined by using monitored concentrations of dissolved oxygen, ammonia and iron at 70 sites, eight metals at nine sites, and five organic at six sites. The number of pollutants exceeding criteria and the severity of exceeding was calculated for all pollutants (EPA,1992).

The results showed that chronic ecological surface water criteria could be exceeded in between 26 and 82 percent of the individual rivers examined, or approximately 57 percent of all river kilometres examined, see table 4.14.

Table 4.14 Summary of areal extent and severity of surface water contamination in the study area. The analysis is based on monitored concentrations and U.S. EPA aquatic toxicity criteria (Industrial Economics 1992)

River	Total river km's examined	River km's with exceeding	Number of pollutants exceeding criteria	Number of pollutants exceeding 10 times criteria
Ostravice	54.0	16.5 (31%)	8	1
Olse	50.6	39.9 (79%)	7	1
Moravice	82.4	21.6 (26%)	1	0
Opava	74.8	61.2 (82%)	6	0
Odra	86.1	59.8 (69%)	9	1
Total	347.9	199.0 (57%)	11	1

4.4.3 Conclusion

Regarding human health with respect to drinking water, recreation-swimming and fishing the highest risk is connected to the content of micro pollutants, bacteria and nitrate. The phosphorus content also represents a potential for toxic blue green algae blooming.

Regarding ecology, ammonia, phosphorus, organic matter and the level of micro pollutants represent a large potential risk for chronic and acute effects on aquatic life. The high content of suspended solids also reduces the conditions for aquatic organism.

The severe situation is, for many parameters and profiles, caused by insufficient treated waste water (NH_4 and coliform bacteria follow the same pattern), but industry affects the water quality adversely especially with regard to heavy metals, organic pollutants and ammonia. The high chloride content in some profiles indicates the influence of mining water. The water quality is also affected by agriculture activities in the area especially regarding bacteria, phosphorus and nitrogen (nitrates from run-off and ammonia from manure). Micro pollutants from pesticides used in the agriculture sector can also be a problem.

The bad water quality effects the user interests in the whole area (industry supply, drinking water and recreation) and the water has a very limited value of use.

5. Need for pollution abatement

This chapter focuses on the need to reduce pollution loads (in tonnes pr. year) to the rivers in the catchment area in order to achieve an acceptable water quality with regard to ecology, human health and for the user interest in the catchment area.

5.1 Objectives

5.1.1 Setting water quality objectives to a recipient

Water quality objectives for a recipient must be based on the effect both on human health and ecology. Since environmental objectives involve choices (according to human health, ecology and even to other important issues a community is obligated to solve) the objectives for water quality should be related to, or reflect, the user interests in the recipient area. Each user interest will require a certain water quality with respect to human health, to ecology or to both.

The water quality objectives must also be in accordance with environmental legislation and standards, and external factors such as; governmental obligations, EU demands, common environmental plans, international conventions. etc.

Finally, there must be a balance between the objectives and the reality to reach these goals which depends on technical opportunities to reduce the pollution, the costs for the investment plans and the level of natural water quality.

5.1.2 Czech Water Quality Criteria

To set some goals for the water quality in the Odra river catchment, WRI has suggested that a certain area should be given a recipient status. The user interests (today's user interests and potential user interests in the future) are not determined in detail, but the recipient status reflects main user interests in the area. The proposed recipient status for Odra corresponds to category A in the upper part of the catchment area, status B in the middle part of the catchment area and status C in the lower part of the catchment area (see figure 5.1).

Category A, B, C and D are described as followed (WRI, 1994):

A) Natural water stream - water stream with extraordinary protection

The total conditions of this water stream (and/or its certain section) approach "original" natural conditions, and/or is relatively insignificantly affected by anthropogenic effects. The environmental value of this stream is high and the extraordinary attention is paid to its protection. The water quality is suitable for various uses, including water supply and fishing (salmon fish). The special category of A streams form "water supply streams" (reg.171/92), but with additional requirements directed towards the protection. The characteristics correspond to a very pure to pure water in compliance with CSN 75 7221 (class I and II). The biological and technical conditions are very favourable and the stream creates a suitable bio-corridor.

B) Water stream for recreation - water stream with increased protection

The conditions of the water are good or very good, and despite certain anthropogenic effects the environmental functions of the stream have been preserved. Attention is paid to its protection. The water quality in this stream is suitable for recreation purposes - swimming and water sports, fishing (not very demanding fish species), agriculture (irrigation) and water supply to industries. The water quality according to the Czech classification system CSN 75722 corresponds to pure to polluted water (class II-III). The biological and technical conditions are good, and the stream creates a bio-corridor, or at least a "zone" corridor.

C) Special water stream - water stream with partial protection

The conditions of the water is characterised as acceptable. It is influenced by anthropogeneous pollution and its environmental functions have been partially preserved. The water stream is near the maximum bearable load. In this sense, the water stream is partially protected and its main task is to function as a recipient for non-harmful waste. The water quality in this water stream is usually suitable for limited use (industries which require less water quality), but there are no hygienic problems. The water quality corresponds to polluted or very polluted water according to CSN 75 7221 (class III or IV), and/or it fulfils the requirements for parameters II and III in reg.171/92 (" other surface waters"). The water contains organisms which do not demand the best water quality. The biological and technical conditions are defined as acceptable. There is a minimum vegetation zone to no vegetation zone. The landscape value is small.

D Waste "waste stream" - with a minimum protection.

The stream is characterised as waste water. The water quality according to CSN 75 7221 corresponds to extremely polluted water (class V). The water is not in compliance with Environmental Law, and the stream exceeds a bearable load. Even the moderate parameters II and III (reg. no 171/92) are not met.

5.1.3 Objectives for Odra - acceptable loading

Main problems

Based on the recipient status for Odra the following objectives according to CSN 75 7221 are proposed;

The water quality in the upper part of Odra must correspond to water quality class I-II. This area has a high protection value, and the three main drinking water reservoirs are located in this area. The objectives for the middle part of Odra must correspond to water quality class II and III. There are no drinking water interests in this area, but this part of the catchment area has a high recreation value. The water quality must be suitable for fishing and bathing. Water quality class III has also been proposed for some of the parameters in the lowest part (recipient area C) to change the condition from a waste water stream to a stream suitable for a limited use.

By studying the existing water quality situation in Odra (chapter 4), there are several parameters causing the main water quality problems in the river according to the above mentioned objectives. Based on the status in the recipient, the effects on ecology, human health and the user interests, some special efforts must be put on reducing; organic matters (BOD), total nitrogen (Tot-N), total phosphorus (Tot-P), suspended solids (SS), Zinc (Zn) in particular and heavy metals in general. The bacteria content must also be reduced. The need for reduction has been calculated for BOD, nitrogen, phosphorus, suspended solids and Zinc.

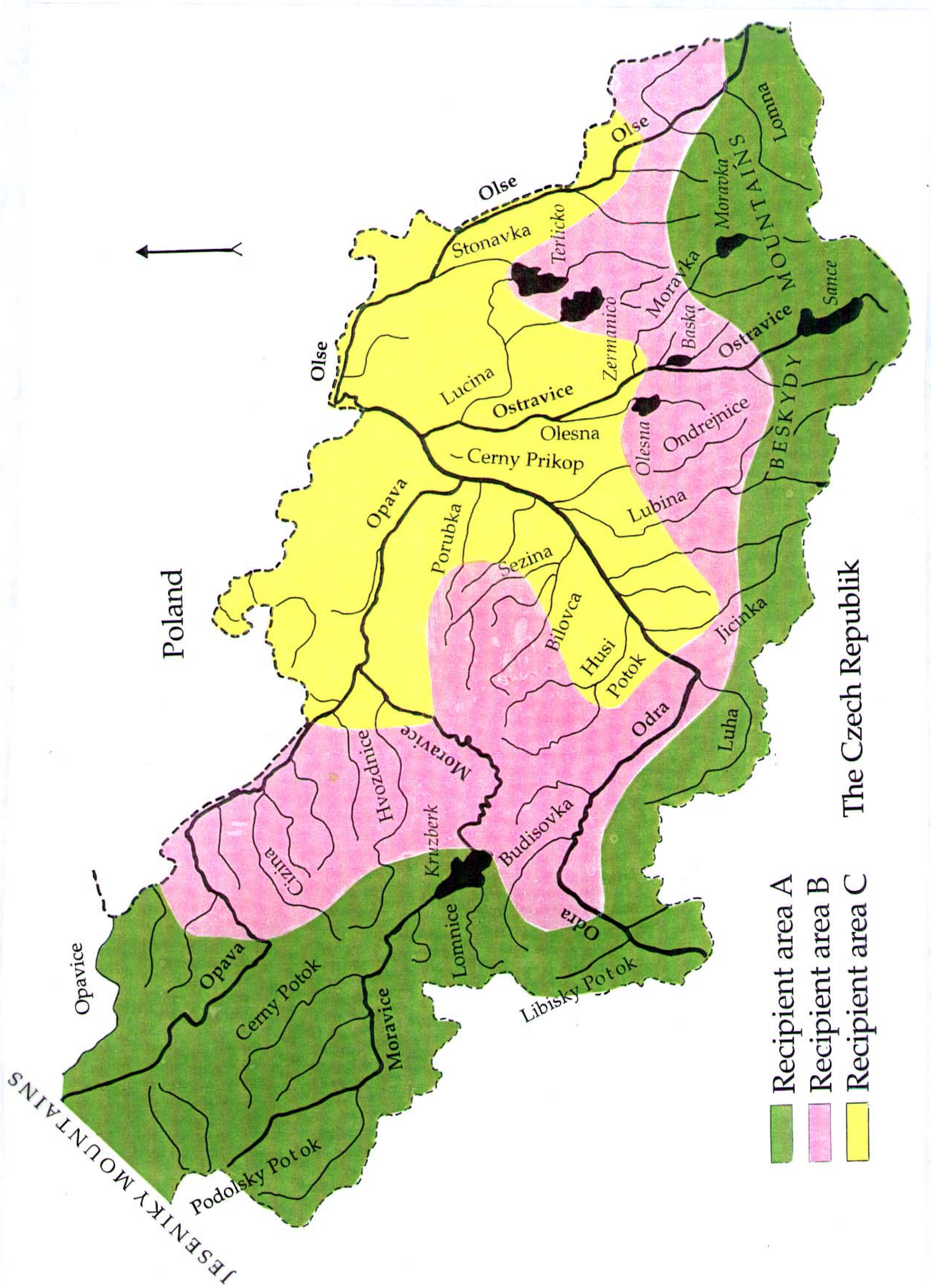


Figure 5.1: Recipient status in Odra

Organic matter, suspended solids and Zinc

Organic matter is one of the most serious problems in Odra, and by reducing organic load there will be additional effects on other parameters (particles and pollution connected to particles). BOD should be reduced in the whole catchment area, and water quality class I in recipient area A, class II in recipient area B and class III in recipient area C for this parameter has been suggested. The same criteria are proposed for SS and Zn.

Suspended solids varies through the year, and from year to year, and erosion is the main source. It is also assumed that the zinc content to some extent is natural. Technical measures for anthropogenic sources may therefore not be enough to reduce the content of these two parameters, and the objectives for SS and Zn are therefore unrealistic. Some calculations have however been done to show the need for reduction if the objectives for these parameters are going to be the same as organic matter.

The classification criteria for oxygen parameters are approximately the same in the Norwegian and Czech water quality classification system, but the values for suspended solids and Zinc are more conservative in the Norwegian system. This can be explained to some extent by the differences in natural water quality in the two countries.

Heavy metals

The level of other heavy metals is also very high and should be reduced as much as possible. The need for reduction in tonnes pr. year have however not been calculated. The worst point pollution sources within this category has however been evaluated as a result of the ranking procedure presented in chapter 6.7. The point pollution sources with high toxicological effects, and that were identified as a result of toxicological testing in the project "Toxicity screening of industrial waste water in the Odra river basin" (Kallqvist, 1994) have also been addressed. In addition to these main polluters, there are also smaller toxic sources which can result in severe local problems, and must be specially addressed.

Bacteria

The reduction in bacteria load will be achieved by reduction of the other parameters, especially at municipal sources in cases where advanced biological/chemical treatment are proposed.

Nutrients, Phosphorus and Nitrogen

The need for reduction in nutrients loads (phosphorus and nitrogen) are however discussed, and based on 4 alternative sets of objectives in accordance to the discussions below (see table 5.1-5.4).

The project team stresses however that the final goals must be discussed in detail by water management authorities and politicians. A more detailed analyse of the local water quality is required where also the main problems are addressed regarding local user interests, especially regarding nitrate pollution and ground water, but also the effects of phosphorus pollution.

Recipient area A (class I-II)

Reduction of nutrients can be important in the upper parts of the catchment area, where the water is used as drinking water.

Phosphorus can cause eutrophication, and subsequent problems, and high nitrate content in drinking water can cause health problems. High ammonia content may lead to complaints from the consumers.

To comply with the Czech water quality standard (reg. 171/92) "water quality stream" and the recipient status given in the previous chapter, the water quality class must be at least class II at minimum flows Q_{355} (both regarding ammonia and nitrate).

Alternative 1 (table 5.1) is based on the same class for phosphorus as for nitrogen (water quality class II). It must be mentioned though that the values for nitrate and ammonia in Kruzberk is even today within the EC and WHOs guidelines value for drinking water, despite the fact that the water quality in the inflow river is in class III. The effects on ground water have, however, not been studied and it might be important to improve the water quality for nitrogen to class II in the area. The local effects should be studied more in detail before special action to reduce nitrogen in this area are implemented.

The criteria for phosphorus in recipient area A, regarding eutrophication effects, can however seem to be very liberal compared to the Norwegian criteria. Alternative 2 (table 5.2) is therefore proposed, and based on class I for phosphorus in recipient area A. Data for Kruzberk however shows no special eutrophication effect, but as mentioned in chapter 4.3.16 the measured values for phytoplankton production seem to be too low compared to the high content of phosphorus. Class I represents median values up to 15µg/l, and it may be necessary to reduce the level even more than proposed.

Recipient area B (class II-III):

Reduction of nitrogen can be important in the middle part of the catchment area as well, because of the living conditions for fish (this area is going to be used for recreation), or if there are local ground water sources that may be affected.

Class III for ammonia and nitrate must be met according to the recipient status and reg 171/92 (reg 171/92 do only require class IV for nitrate), but a detailed study of local effects on ammonia and nitrate should be carried out before reduction in nitrogen is recommended. Even if the objectives proposed in this study are not met, which in this part of the catchment area especially may be the case for nitrate, it may not be necessary to reduce the pollution if there are no local problems which call for action.

The need for stricter limits for phosphorus in this part of the catchment than proposed in alternative 1 and 2 (table 5.1), can be discussed. It is assumed that the eutrophication effect is not that important with regard to the present situation (the over-load of organic matters, suspended solids and heavy metals may reduce the living condition for algae). The phosphorus values are however extremely high compared to the Norwegian guidelines, and indicate a potential risk for eutrophication if the other pollution sources are reduced. Alternative 3 and 4 (table 5.3 and 5.4) reflect this situation, and objectives 3 and 4 will also contribute to the goals set in the Baltic Sea programme (reduction of 50% of the pollution to the Baltic Sea). The need for phosphorus reduction is discussed in detail in the section below.

Recipient area C (class III-IV):

Nitrogen reduction in the lowest part of the catchment area is not necessary to meet the objectives for recipient status C. Except in some profiles where the ammonia concentration is high. The nitrate level can however cause local effects on ground water. Phosphorus reduction is necessary even to meet class IV.

To contribute to the national goal for the Baltic sea, the total load of both nitrogen and phosphorus should be reduced to meet class III (The largest nitrogen and phosphorus sources are within recipient area C) and objective 4 for nitrogen (table 5.4) reflects the Baltic Sea goals more than local water quality objectives. The local effects of phosphorus are discussed below.

Special concern to reduce phosphorus in Odra?

The Norwegian and Czech standards for phosphorus can not be compared directly because of the differences in natural water quality . The phosphorus content in bedrock and soils may be higher in the Czech republic compared to Norwegian conditions, and this can be an explanation for the relative small eutrophication problems caused so far. The most probable explanation though, as explained below, is that eutrophication may be prevented due to other types of pollution (over load of organic matter, high content of toxic micropollutants and particles....).

The water quality in Norway is generally good with a low content of organic matters, particles and heavy metals. The content of calcium and other electrolytes are also very low. The typical "Norwegian water"; softwater rivers with low content of electrolytes, organic matter and nutrients salts respond to very low concentrations of phosphorus (Lindstrøm, 1994). Eutrophication effects with substantial increases in production and accumulation of algal biomass can occur in rivers with concentrations of total phosphorus in the range of 5-20 ug/l. Eutrophication has until recently been a major pollution problem in Norway.

Factors which may reduce the eutrophication effect of phosphorus in the Czech rivers are the high content of particles, calcium and other electrolytes, pH, over load of organic matter (both humic matter and various types of organic pollutants), heavy metals (and other toxic pollutants), but also physical conditions in the rivers such as flow conditions, water velocity, transport of particles, movements in the river bed etc.

The content of heavy metals and other toxic pollutants will be essential for the living conditions in the recipient, and can suppress (cover) the eutrophication effects of phosphorus pollution.

Particles normally reduce the biological availability of the phosphorus. The phosphorus which is connected to particles will normally not be available for algae growth (ref. chapter 4.1.3). Particles can also reduce the eutrophication effect by preventing the sun light from penetrating to the algae, also stimulate the eutrophication process by binding heavy metals and other toxic pollutants.

High content of electrolytes in the water can effect the biological availability of phosphorus by reducing the solubility of most phosphorus salts. The effect of pH on the bio-availability of P is somewhat uncertain. On one hand the solubility of several P-salts increase with decreasing pH. On the other hand low pH liberate low soluble aluminium complexes.

The influence of organic matter on the primary production is hard to predict. The primary production (building of organic matter) and the degradation process are in the same cycle, and it can not be discussed separately from each other. A high content of organic matter can however disturb the normal balance, and heterotrophic species may compete with the primary producers. A large amount of the organic matter can also be present as particles and thereby have the same effects as described above.

Water quality class III is the strictest value proposed for recipient area C, and represents a median concentration on 200 ug/l. It is asumed that eutrophication can be a problem even with this concentration, especially when organic matters and heavy metals are reduced, and the need for further reduction may be required to obtain any improvements in the water quality. On the other hand the particle content can still be too high, and prevent the eutrophication effects even when organic matter and heavy metals are reduced.

There is the need for more research to predict the effects of phosphorus in this type of recipients when other types of pollution, especially heavy metals and other toxic pollution, is reduced. The Norwegian experience regarding eutrophication effects caused by phosphorus and technical measures/technology to reduce the pollution, will be very important to transfer to Eastern Europe where the concern so far has been on reducing organic matter, but where the extremely high phosphorus content may cause problems in the future. The need for abatement of different pollution parameters must therefore be studied in an interactive study and not separately (see recommendations in appendix 10.16).

Alternative objectives for water quality

Table 5.1: Alternative 1 for water quality objectives in the Orda river catchment

	Upper Part : A	Middle Part: B	Lower part: C
BOD	I	II	III
NH4+NO3	II	III	-
Tot-P	II	III	-
SS	I	II	III
Zn	I	II	III

Table 5.2: Alternative 2 for water quality objectives in the Odra river catchment

	Upper Part : A	Middle Part: B	Lower part: C
BOD	I	II	III
NH4+NO3	II	III	-
Tot-P	I	III	-
SS	I	II	III
Zn	I	II	III

Stricter limits for phosphorus in recipient area A compared to alternative 1.

Table 5.3: Alternative 3 for water quality objectives in the Odra river catchment

	Upper Part : A	Middle Part: B	Lower part: C
BOD	I	II	III
NH4+NO3	II	III	-
Tot-P	I	II	III
SS	I	II	III
Zn	I	II	III

Stricter limits for phosphorus in the whole catchment compared to alternative 1.

Table 5.4: Alternative 4 for water quality objectives in the Odra river catchment

	Upper Part : A	Middle Part: B	Lower part: C
BOD	I	II	III
NH4+NO3	II	III	III
Tot-P	I	II	III
SS	I	II	III
Zn	I	II	III

Stricter limits for both phosphorus and nitrogen compared to alternative 1.

5.1.4 Regulation 171/92

The need for reduction of pollution discussed in this report has so far been based on the effects on water quality. The requirements for different types of sources must however also comply with the emission limits, parameter I, in reg 171/92.

Limits are given for municipal waste water treatment plants and different categories of industry and must be met within year 2005.

This call for actions independent of the water quality discussed in the previous chapter (see chapter 7)

5.2 Need for reduction and pollution abatement

5.2.1 Method for calculating reduction

The difference between the water quality in the river today and the objectives set for water quality in the different parts of the catchment area, gives the need for pollution reduction.

The water quality is classified according to the C_{90} value. The worst water quality occurs for some parameters with low flows, but other parameters follow the variations in water flow.

To find an appropriate method to calculate the need for reduction of different pollution parameters based on the critical values (C_{90}), data for water quality in 1991 has been compared with the water flow. The data are presented for 7 profiles in appendix 10.6.

It seems that organic matter (BOD_5), nitrates(NO_3) and suspended solids (SS) follow the variations in the water flow while the maximum concentrations of phosphate (PO_4) and ammonia (NH_4) occurs in periods with low flows. Suspended solids has extreme variations. This is a typical variation pattern, and indicate that pollution connected to particles or pollution that is a result of erosion (for instance nitrates from agriculture, BOD and SS) is highest during floods. While ammonia and phosphates mainly origin from point pollution sources, and will result in maximum concentrations during low flows.

The statistical C_{90} value for the data in 1991 (appendix 10.6) is calculated and compared with the average and median concentrations of the 12 samples (see the formula used for average concentrations). Average and median water flow are also compared with Q_{180} (Hydrological data, Povodi Odry). There is a good relationship between the water flow and Q_{180} for the data in 1991, which indicate that the samples are taken at representative water flows.

$$Caverage = \frac{\sum_{i=1}^{12} ci * qi}{\sum_{i=1}^{12} qi}$$

Based on the results in appendix 10.6, there seems to be a good relationship between both $C_{average}$ and C_{90} (except for SS) and C_{median} and C_{90}. The median values for $C_{average}/C_{90}$ and C_{median}/C_{90} in the 7 profiles are shown in table 5.5.

Table 5.5; Relationship between Caverage/C90 and Cmedian/C90 based on 7 profiles in Odra (1991)

Parameter	Caverage/C90	Cmedian/C90
BOD_5	0.7	0.6
SS	0.8	0.4
$N\text{-}NH_4$	0.5	0.5
$N\text{-}NO_3$	0.8	0.7
Sum NH_4+NO_3	0.8	0.7
PO4	0.6	0.6

Based on this table and the fact that a large part of the total phosphorus and zinc is connected to particles, the relationship in table 5.6 has been used to calculate mass transport and need for reduction in the different profiles based on the formula below.

$$Mx,reduction = \left[C90,today - C90,objective\right] * fx * Q180$$

Table 5.6: Factors, fx, used for calculating mass transport and need for reduction

Parameter	Cmedian/C90
BOD_5	0.6
SS	0.4
Zn	0.4
$N\text{-}NH_4$	0.5
N-NO3	0.7
Tot-P	0.5

5.2.2 Need for reduction in recipient profiles

Table 5.7 presents the need for reduction in tonnes/year for the different river profiles and objective alternatives discussed in the previous chapter. There is only the need for reduction in the main profile that is shown (see also appendix 10.7).

The need for reduction must not be seen as absolute (referring to the method used for calculation and the fact that the calculation is based on one year C_{90} values), but will give an idea of the need for total reduction if the objectives for water quality are going to be met. The current work with the dose respons model QUAL 2 at WRI, will give more exact data on the total need for pollution reduction. The reduction of SS and Zn are, as mentioned previously unrealistic because of the natural content compared to the total outlets from anthropogenic sources.

The need for reduction of nutrients must as mentioned be investigated in detail regarding the local water quality. A study addressing the need for the reduction of pollution to the drinking water reservoirs is recommended.

Table 5.7: Need for reduction (tonnes/year) for different water quality parameters in different river profiles.

Nr	Profile	Objective 1					Objective 2		Objective 3		Objective 4	
		BOD	SS	Zn	Tot-N	Tot-P	Tot-N	Tot-P	Tot-N	Tot-P	Tot-N	Tot-P
1	Odra-Bohumin [9]	1861	10172	274						1299[1]	2098[4]	1299[1]
2	Odra Petrkovice [6]	91	11982							264	1262[4]	264
3	Odra Svinov	422	4451							45[8]	300	45[8]
4	Odra-polanka	422	17845							103	157	103
5	Odra -Studenka		1361							84	312	84
6	Odra-nad Jicinkou		770							5	63	5
7	Odra-Jakubcovice									7	0	7
10	Bilovka Pod Sezinou	14	159							5)	89	5)
11	Jicinka-Kunin	68								21	67	21
12	Ostravice-Muglinov	398	3674	31						182	37[4]	182
13	Ostarvice-Vratimov	2)								48	0	48
16 B	Lucina	25								28	119	28
18	Opava-Hostice	672	677							123	135[4]	123
20	Opava-po Krnovem	13	213		52	46	52	46	52	59	52	59
22	Hvozdnice-usti	2	173							10	105	10
24B	Moravice.Sl. Harta	115			310	22	310	28	310	28	310	28
26	Zlata-Opavice	52			173	5	173	7	173	7	173	7
27	Olse-Vernovice	2)								221	0[4]	221
28	Olse-nad Stonavkou	2)								86	0[4]	86
29	Olse pod Tesinem	2)								83	108[4]	83

[1]The value for phosphorus seem to be high compared with values in Olse Vernovice and Odra Petrokovice Need for reduction in this profile is based on a calculated C_{90} value

[2]There is no need for BOD reduction in these profile according to the water quality data. CODcr value is high and ought to be reduced.

[3] It is assumed that 10% of the total nitrogen is nitrogen connected to particles the values in appendix 10.7 have been corrected according to this in the table above (personal information WRI, 1994).

4 The need for reduction of ammonia (N-NH4) are much higher

5) Phosphorus is not measured in the profile, but will according to the obejctives most likely have to be reduced

[6] The improved water quality for BOD compared with profile 3 is caused by the influence of Opava river

[7]The number seem to be very high compared with the other profiles and may be caused by one high peak

[8]The number seems to be very low compared with profile 4 and 2

[9]The need for reduction in pollution is caused by pollution from Ostrava region and the extremely polluted river Ostravice.

5.2.3 Resulting water quality after pollution abatement-methodology

Discharge of pollution in one section of the river gives an effect on the water quality in downstream sections. If the rivers' self purification are not considered the need for total investments will be over estimated and the proposed startegies to improve the water quality may be incorrect.

As discussed in chapter 4.1 the resulting water quality in rivers due to pollution (naturally and man made) is a complex system and depends on many physical, biological and chemical factors and processes. To determine these effects there will be need for advanced dose-respons models; epecially to determine biological response (algae, heterotrophic growth etc.), but also to determine the reduction and different states of the chemical parameters (Tot-P, Tot, N, BOD, SS, Zn etc.)

It has not been within the scope of this project to adopt advanced dose-respons models for the river and reservoirs. WRI has however, started to work with QUAL 2 which is an advanced dose respons model for rivers. There is no data available from this model that can be used in this report to determine the effects of outlets.

To calculate the effects from different sources, qualified assumptions can however be used for the river self purification capacity. The self purification capacity or retention coefficients for different parameters (based on the total yearly outlets) are illustrated by simple equations (see figure 5.2-5.6).

The figures illustrate the effect of a pollution source at a given distance from the outlet. The equations have been determined by WRI, PO and NIVA and must be seen as very rough estimations, and should not be used independent of this study. The fact that the equal amount of BOD, nutrients etc. from municipal sources can have different effects on the water quality compared to other sources is also neglected when the effects of pollution abatement are estimated in chapter 7. This due to lack of knowledge, and little information regarding biological availability coefficients for different sources as described in chapter 4.1.

Organic matter, BOD

BOD is a measure of the biological oxygen demand to degrade organic matter, and the reduction coefficient in figure 5.2 depends on the amount of soluble organic matter, the organic matter connected to particles, easily degradable and organic matter which is not so easily degradable. Silage effluent from agriculture, outlet of municipal waste water, outlets form some types of industries, will for instance decompose, very fast, and other such as natural organic matter (NOM) will decompose relatively slowly.

Figure 5.2 is proposed by WRI and PO as a rough assumption, and based on local knowledge.
The retention of BOD in Kruzberk is assumed to be 70%.

The retention coefficients for different profiles are calculated in appendix 10.8.

Nitrogen- Tot-N

The processes involved in the nitrogen cycles are very hard to predict. The nitrogen is mainly soluble in water, but the organic nitrogen that is connected to particles or is incorporated in organic matter can precipitate. Approximately 10% of the total nitrogen load in Odra is organic nitrogen (personal information WRI, 1994).

As mentioned in chapter 4.1 the de-nitrification process can be considerable.

In the Baltic Sea Environmental programme (Berge *et al*, 1992) a qualified assumption was made regarding nitrogen and phosphorus reduction from the outlet-points to the Baltic Sea. It was assumed that nitrogen was reduced by 60% in primary recipients and 50 % in secondary recipients giving an overall retention of 80% for nitrogen. For phosphorus it was assumed a retention of 40% both in the primary and secondary recipients was predicted, giving an overall retention of 65% for phosphorus (The primary recipient is channels, brooks , streams, lakes, rivers and wetlands. The large rivers were counted as secondary recipients).

Figure 5.3 is proposed by PO and WRI as a rough estimation and based on local knowledge.

Retention in Kruzberk reservoir is assumed to be 25%, based on the formula given by Holtan and Åstebøl (1990)

$$R=\frac{0.2}{1+\sqrt{\frac{1}{Tw}}}+0.1$$

Tw is theoretical retention time which is based on the volume of Kruzberk, the catchment area and specific run of coefficients (Tw≈0.23 year). The calculated retention coefficients for the different water quality profiles in Odra are presented in appendix 10.8.

Phosphorus-Tot-P

There is continuous exchange of phosphorus between the water, the organism and the sediments in rivers. Several physical (specially water flow-sedimentation), chemical and biological factors will influence this exchange, for instance the mineral water equilibrium, sorption processes, redox potential and different types of organism (Holtan and Åstebøl, 1990).

The phosphorus content that is retained in a watershed over a period of time is relatively small.
In a study done for Glomma, a river in Norway, a retention coefficient on 0.1% pr river km was found (Holtan and Åstebøl, 1990). The average water flow in this river is higher than Odra (approximately two times higher in the upper parts).

A coefficient for Odra is difficult to predict, but as a very rough estimation 0.2 % pr river km is proposed. Based on the assumption done in the Baltic Sea programme the phosphorus values in figure 5.4 are conservative. The retention coefficients for phosphorus in different water quality profiles are shown appendix 10.8. The retention of phosphorus in Kruzberk reservoir is assumed to be 35% based on the formula given by Larsen and Mercier (1975-1976):

$$R=\frac{1}{1+\sqrt{\frac{1}{Tw}}}$$

Suspended solid

During a year a very little part of the total amount of the suspended solids are retained in rivers. Figure 5.5 has been proposed as a very rough estimate. It has also been assumed that the retention in Kruzberk is 100%.

Zinc, Zn

The retention of different metals will vary depending on many factors; the amount connected to particles, pH, stream conditions (flocculation), vegetation etc. A very "rough" estimate is proposed in figure 5.6. Despite the fact that a large amount of Zinc is connected to particles it is assumed less retention than for particles. Zn is a mobile metal, and there will probably be very little retention during the year (the picture would have been different for Fe, and assumed to be more like SS). A 10% retention in Kruzberk has also been proposed. The retention coefficients for zinc in different water quality profiles are presented in appendix 10.8.

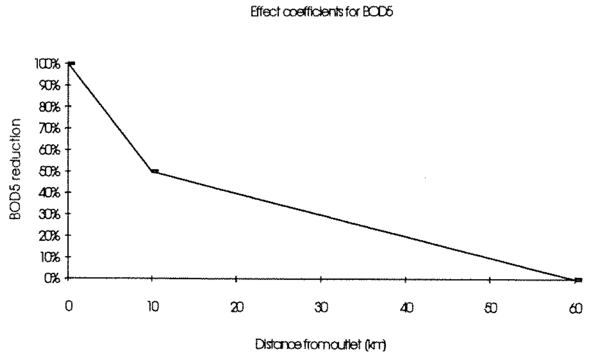


Figure 5.2: Effect coefficients for BOD

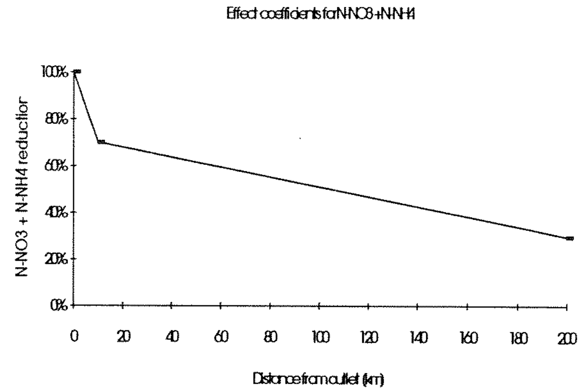


Figure 5.3: Effect coefficients for inorganic nitrogen

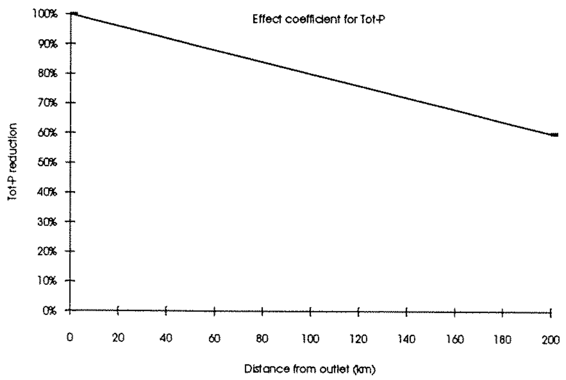


Figure 5.4: Effect coefficients for Tot-P

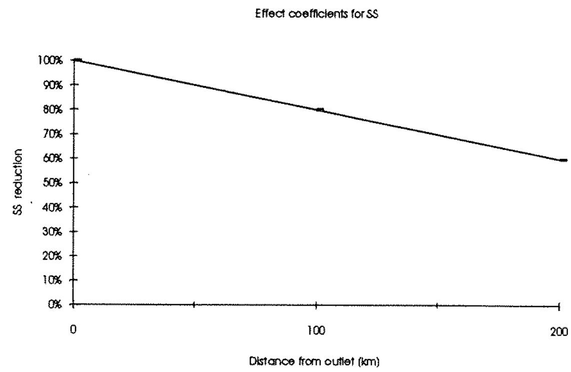


Figure 5.5: Effect coefficients for SS

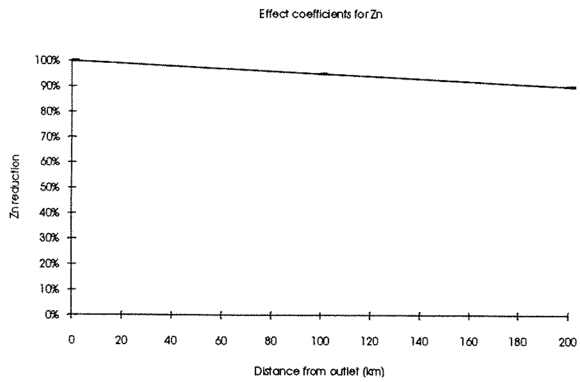


Figure 5.6: Effect coefficients for Zn.

6 Pollution Sources

6.1 Point and non point sources

The pollution sources are divided in two groups based on their nature of existence as point- and non point sources. The point sources are distinctly identified concentrated streams of pollutants, while the non point sources are diffuse pollutant streams discharging to a wide areas of a recipient. Discharge from municipalities (treatment plants in rural and densely built up area and runoff from waste disposals), industries and some activities in agricultural industries (livestock) are defined as point sources of pollution. Runoffs from agriculture, forest, built up areas, mountains and atmospheric deposition are characterised as non point pollution sources.

Although the non point sources have low loads of pollution, their total pollution loads are considerable. Estimates for the rivers draining into Baltic Sea put the share of non-point sources at minimum of 50% (Environment for Europe, 1993).

The current study primarily addresses the important point pollution sources, which give a significantly contribution to the total loads, such as the biggest municipal waste treatment plants and industrial sources. Considering technical solutions, the non-point sources are addressed only in general on the basis on the estimated pollution loads for these sources.

Ideally, a detailed abatement strategy for other sources, especially from agriculture, should also have been carried out. The pollution from smaller municipal WWTPs and pollution from inhabitants which are not connected to the public sewage system usually one by one contribute insignificantly to the total loads but can cause local pollution problems. However, a detailed consideration of these two issues are not presented here, as they are beyond the scope of this study. It is recommended that further studies address these issues.

Data from pollution sources reported in this study have been obtained by different methods:

- Brief visits to industries
- Brief visits to municipal WWTPs and from interviews with OVAK and SmVAK
- Using official records for waste water discharges and water demand provided by Povodi Odry
- Using data from other studies, Project Odra, Project Silesia and Baltic Sea Environment Programme.
- Calculations based on other background information and coefficients.

6.2 Municipalities

6.2.1 Municipal Waste water

<u>General about WWTP in eastern Europe</u>

Human activities in an urban area are the major source of incoming pollutants to a municipal WWTP, and represent organic wastes (BOD), nutrients (nitrogen and phosphorus compounds), and suspended solids. Urban centres are often associated with industries, and their non- or partially-treated waste water may also be a source to a municipal WWTP. The lack of WWTP to a satisfactory coverage is identified as a common situation in the eastern Europe by a previous study (Environment of Europe, 1993). And the available WWTPs are reported to be overloaded, improperly maintained and managed, and identified to have considerable bypasses, in many areas of the eastern Europe.

Concentration of nutrients in the municipal waste water varies considerably with the sewer system used in the city. In general, the cities with good separate sewers have a daily waste water production of 250 l/PE (person equivalent), while this is increased to 400 l/PE in cities with combine sewers. The majority of sewer systems in the Odra catchment are combined sewers. Thus the water production per PE is higher, and the nutrient concentrations in waste water are lower compared with separate sewer networks. Table 6.1 gives the average pollution production per PE and the average nutrient concentration in municipal sewage (Henze and Ødegaard, 1994).

Table 6.1 Average waste water production and pollution load

Parameter	**Specific load**	**Waste water composition, g/m^3**		
	g/PE.d	Typical range* g/m^3	250 l/pe.d (separate s.)	400 l/pe.d (combine s.)
BOD5	62.5	150-300	250	150
SS	62.5	100-200	250	150
Tot P	3.0	4-8	12	7.5
Tot N	12.0	20-60	48	30

**The lower value represents combine sewers, and the upper value represents separate sewer systems*

WWTP in the Odra catchment

Domestic waste water from approximately 1 million inhabitants (75%) are reported to be connected to municipal WWTPs in the Odra catchment area. The water management companies OVAK manages 3 and SmVAK manages 10 municipal WWTPs with annual flow over 1 million m^3. Table 6.2 presents key information for these WWTPs, which receive pollution from approximately 780 000 inhabitants (60%). The rest of the inhabitants connected to public sewage system (approximately 195.000, 15%) are served by smaller treatment plants which are spread out in the catchment area (PO, 1995).

Table 6.2. Selected municipal sewage treatment plants (with flow over 1 million m3/y) in the Ostrava region. Source: OVAK and SmVAK, 1994.

WWTP		**Capacity, PE**		**Load, m^3/y ('000)**		**Bypass, m3/y ('000)**
		Projected	**in 1993**	**Projected**	**in 1993**	**in 1993**
1	Ostrava-Privoz		249 200	32 500	32 103	2 346
2	Ostrava-Trebovice		151 833	12 500	10 394	?
3	Havirov		89 607	16 235	10 285	?
4	Frydek-Mistek (Sviadnov)	123 000	103 922	8 924	9 768	20-30%
5	Opava	159 000	135 338	7 410	7 380	?
6	Karvina	75 000	60 648	8 212	7 379	?
7	Novy Jicin	38 000	24 722	3 175	4 108	?
8	Koprivnice	20 000	10 808	2 179	2 778	?
9	Frenstat	25 600	7 150	1 861	2 704	?
10	Orlova-Poruba	58 300	27 069	6 030	2 453	?
11	Cesky Tesin	43 537	18 927	3 374	2 349	?
12	Ostrava-Zabreh		15 767	1 900	1 789	?
13-33	Others		≈38 000		≈6 000	
1-33	Total	-	≈933 000	-	≈100 000	-

Information in the table 6.2 reveals an average waste water production of about 400 l/day.PE. In 1993, only 4 large WWTP were overloaded with respect to the waste water flow according to the reported values. 3 WWTPs had unused capacities with a total of 12 million m^3/y.

Most of the municipal WWTP in the Odra catchment area do have a secondary treatment. A mechanical treatment and a biological treatment with an activated sludge system for organic matter removal is common. No processes for phosphate removal are present today, although for some plants future plans do exist to introduce biological P-removal. Few treatments plants have started with the biological nitrogen removal, while a number of plants intend to do so. A summary of processes and the reported treatment efficiencies in 1993 are given in table 6.3.

Table 6.3. Type of selected WWTP and their efficiencies in 1993 (source: OVAK and SmVAK, 1994).

	WWTP	**Type***	**Treatment efficiency (%), in 1993**			
			BOD5	**Susp. solids**	**Phosphates**	**Nitrogen**
1	Ostrava-Privoz	M-S-AS-S	91	85	58	36
2	Ostrava-Trebovice	M-S-AS-S	93	91	33	27
3	Havirov	M-S-AS-S	89	86	10	?
4	Frydek-Mistek (Sviadnov)	M-AS-S	57	57	45	26
5	Opava	M-S-AS-S	87	81	4	40
6	Karvina	M-S-BF-S	88	80	33	12
7	Novy Jicin	M-S-AS-S	86	85	51	2
8	Koprivnice	M-S-BF-S	80	79	7	?
9	Frenstat	M-AS-S	89	86	45	?
10	Orlova-Poruba	M-S-AS-S	94	90	64	7
11	Cesky Tesin	M-S-AS-S	91	87	31	18
12	Ostrava-Zabreh	M-S-BF-S	89	87	40	?

** M-Mechanical, S- Sedimentation, AS- Activated sludge, BF- Biofilter*

According to the table, all municipal WWTPs have 70-94% removal efficiencies for BOD5 and for suspended solids, except for Frydek-Mistek WWTP. This was probably due to the overload. However, the nutrient removal seems to be very poor in general, mainly due to the lack of N- and P- removal processes. The situation in 1994 will be better for certain WWTPs, concerning the ongoing construction on nitrogen removal.

The total contribution of pollutants to the Odra catchment is important to analyse in order to understand the importance of municipal sources. Based on the data provided by OVAK and SmVAK the total load from the major part of the municipal sources has been calculated. These values should be considered carefully, due to the uncertainties in the data such as whether or not by pass is included, or the phosphates values represent a combination of total- and ortho-phosphate values, etc. The total load from smaller waste water treatment plants has also been estimated, and based on general values given in table 6.1 and an estimated treatment efficiency of 30% for BOD, 60% for SS and 15 % for phosphorus and nitrogen. Thus, the total pollution load from inhabitants connected to sewage systems could be presented as in table 6.4.

Table 6.4 Total load of pollutants from municipal sources in 1993. (OVAK and SmVAK, 1994; NIVA, 1995).

	SmVAK and OVAK*		**Smaller treatment plants****		**Total load from WWTP**	
Parameter	Load to WWTP, t/y	Load to recipient, t/y	Load to WWTP, t/y	Load to recipient, t/y	Load to WWTP, t/y	Load to recipient, t/y
BOD5	23 000	5872	4448	3114	27448	8986
SS	29 000	20609	4448	1779	33448	22388
Phosphates (as P)	1 100	930	214	181	1314	1111
Nitrogen	4 550	4643	854	726	5404	5399

* Values calculated on the basis of data provided by SmVAK and OVAK and qualified assumptions from NIVA based on data obtained from PO.

** Estimated values based on average treatment efficiency of 30% for BOD, 60% for SS and 15% for Tot-N and Tot-P

6.2.2 Municipal waste water from rural area

The remaining inhabitants (25%, or approximately 325.000 people) are without public sewage systems. The pollution production from this population is given in table 6.5 and based on specific numbers given in table 6.1.

Table 6.5: Pollution loads (estimated) from inhabitants without public sewage system

BOD5 (tonnes/year)	**Tot-N (tonnes/year)**	**Tot-P (tonnes/year)**	**SS (tonnes/year)**
7414	1424	356	7414

Compared with the load from the municipal WWTP, the total load from this source is considerable.

This project has, however, focused only on large point pollution sources. This is primarily due to the lack of detailed information about waste water in rural areas; technical solutions, exact location of the outlets and local water quality. Inhabitants who are not connected to public sewage system are of course largest in rural areas, see table 6.6. It is assumed that a large part of the pollution is discharged directly to the soil or to smaller brooks, but some may have technical solutions like septic tanks. There is some reduction of BOD, Tot-N and Tot-P in these septic tanks. The self purification before entering Odra is assumed to be considerable, but there can be local problems (especially concerning ground water sources). Some of the outlets in rural areas will also contribute to the pollution in Odra.

Table 6.6: Percentage of inhabitants without public sewage systems (PO, 1995)

District	[%]
Ostrava	3
Karvina	10
Opava	45
Bruntal	42
Frydek Mistek	50
Novi Jicin	40

Water quality problems and technical solutions to reduce local and regional problems should be investigated in detail also for these type of sources. Norway is also a sparsely populated country and Norwegian and Czech knowledge on this issue could be combined and used to solve possible problems in the area (see recommendations in appendix 10.16).

6.2.3 Leachates from solid waste dumping

No detailed information about leachates from solid waste disposal sites were available. The municipal dumping sites were until 1992 spread out in the region, and there was no collection or treatment of leachates. In addition there were a few dumping sites for industry. The abandoned sites are now re-cultivated.

Five new sites have been built, where the collection of leachates was included. The collected leachates are transferred back again to the dumping sites to reduce the dust. There has not yet been reported any pollution discharges from the newer sites (personal communication, WRI, 1994).

The pollution loads from the re cultivated old sites are not known in detail. However an approximate estimate of the BOD pollution numbers from the Baltic Sea study (BCEOM, 1992) have been used here; 0.33 kg BOD_5/person/year (based on 0.15 m^2 of dumping site pr. inhabitant and a specific run of coefficient 2000 m^3/ha/year).

With 1.3 mill. inhabitants this gives a pollution load of about 450 tonnes BOD5/year.

The number can be even higher while the average run off coefficient for Odra is approximately 2800 m^3/ha/year and not 2000 m^3/ha/year.

Based on the BOD number and the numbers given by Holtan and Åstebøl (1990), an approximate estimation of the pollution in leaches from dumping sites is given in table 6.7.

Table 6.7: A rough estimation of pollution in leaches from dumping sites

BOD [tonnes BOD/year]	Nitrogen [tonnes Tot-N/year]	Phosphorus [tonnes Tot-P/year]	Iron [tonnes Fe/year]
500	25	5	8

The numbers in the literature varies considerably. The total load of pollution from dumping sites is however neglect-able compared to the total pollution loads to Odra. It can though, have considerable local effects regarding organic matters, nutrients and micro pollutants.

6.2.4 Storm water

The pollution in storm water from built-up areas in cities, residential areas, roads, etc. varies with the population density, the size of the rainfall, the type of drainage system etc.

Holtan and Åstebøl (1990) have given some guidelines for coefficients on "city area" and "villa area".

It is assumed that the area specified as "other" areas in table 2.2, chapter 2.1, mainly consists of city or villa area (including roads). Based on this assumption the coefficients for the river profiles for this type of area are given in table appendix 10.9. The total area of "other" areas varies between 8-50% depending on location. Built up area represents 14% of the total catchment area in Odra.

The total loads are calculated in appendix 10.9, and the pollution for this type of areas is considerable for BOD compared to the total loads. The storm water may also have a high content of micro pollutants. The sewage system in the Odra catchment area mainly consists of combined sewers, and in areas where this pollution is produced there are also assumed to be a good coverage of sewage system. The total loads from storm water in table 6.8 will therefore be included in the total loads from municipal waste water treatment plants in the area.

Table 6.8: Total loads of pollution from storm water.

Area	**Nitrogen**		**Phosphorus**		**Organic matters**	
[km^2]	[kg Tot-N/km^2 yr]	[tonnes Tot-N/yr]	[kg Tot-P/km^2 yr]	[tonnes Tot-P/yr]	[kg BOD/km^2 yr]	[tonnes BOD/yr]
875	500	422	80	68	3000	2535

6.2.5 Conclusion - Effects of pollution from municipalities

The effect of pollution from municipalities depends on whether it is municipal waste water, leachates from solid waste or storm water run off, as described above. The storm water is assumed to be included in the reported discharges from the waste water treatment plants. Leachates from solid waste dumping sites gives only a small contribution to the total loads, but can have considerable local effects if the pollution enters to ground water or to the watershed.

Municipal waste water gives a large contribution to the total pollution situation in Odra. The effects can not be addressed generally, but depend on the local recipient conditions, the size of the outlet, technical solutions, influence of industry and so on.

The discharges from the major WWTP which serve 60% of the inhabitants will not only give a significantly contribution to the total loads, but also give severe local problems and a significantly contribution to the water quality problems in Odra described in chapter 4.4, with respect to organic waste, nutrients, suspended solids, bacteria and even to organic micro pollutants and to heavy metals if the pre treatment of industrial effluent has been insufficient.

The pollution from inhabitants without sewage systems (25%) or discharges from smaller treatment plants (15%) can give severe local pollution problems. The total loads from these sources give a significant contribution to the total pollution budget, and do also indicate that these may contribute to the pollution situation in Odra despite that the self purification for these sources are assumed to be considerable. The sources should be investigated in detail, especially concerning local problems.

The most significant reductions in phosphorus can be achieved in the municipal sector which represents the largest source of phosphorus pollution, and where the content of available phosphorus for algae growth is very high. The organic matter from these sources are also very easily degradable, and the reduction of BOD will give a considerable improvement of the water quality in Odra. The reduction in BOD will also improve the local water quality, for example, outlets of sewage can often be visual due to the hetrotropic growth. A sufficient treatment and reduction in bypass from the WWTP will also considerably reduce the pollution loads and improve the hygienic conditions.

6.3 Industries

6.3.1 Industrial pollution in Odra

The Ostrava Region is a heavily industrialised area. Several highly polluting industries are located in the region.

The industries in the Ostrava catchment area are in general; extractive industry (coal and copper mines), coke ovens, metallurgy (Steelworks, non ferrous foundries), power stations, paper mills and chemical plants. Agro food and textile industries are also present with several medium size factories, generating mainly organic pollution. Activities in some heavy industries are presently decreasing.

These industries produce waste water with a high organic content, heavy metals, other inorganic and organic toxic wastes, and may also be corrosive. A general introduction to some of the industries processes and the kind of pollutants originating from these are given below.

The quality of industrial waste water depends on the nature of industry. Some industrial waste waters are possible to discharge directly into the sewer system without affecting the general municipal waste water quality, while other waste water may be very toxic and may cause considerable changes in the waste water quality. Therefore, it is important to have pre-treatment facilities both when discharging to the common sewer system and directly to a recipient.

It is difficult to estimate the total load from industrial waste water treatment plants in the Odra catchment area due to the complexity. However the total discharge from the 25 largest industries in the area to recipients after various pre-treatment procedures have been calculated. The results are presented in table 6.9. The results include the waste water discharges registered for industries, where in very few cases the domestic waste water from employees are also included. The table does also indicate the pollution from other industries that are not discharging to municipal waste water treatment plants. The industries from which the waste water is discharged to the municipal sewage network are not included here and considered under municipal WWTPs.

Table 6.9. Discharge from 25 most important industrial WWTP to recipients in 1993 (Povodi Odry, 1994), and outlets from other industries not discharging to municipal waste water treatment plants.

Parameter	Major load from Industry [tonnes/year]	"Other Industry" [tonnes/year]	Total loads [tonnes/year]
BOD	1263	172	1435
COD	13205	1774	14979
N	1173	190	1363
PO4	31	5	36
SS	3831	1084	4915
Fe	158	9	167
Zn	56	2	58
Hg	0.01	0	0.01
Cd	0.03	0	0.03
Pb	0.24	0	0.24
Cu	0.16	0	0.16
Ni	0.61	0	0.61

6.3.2 Industry processes and pollution

Iron and steel industries

Among the four groups of activities in this process, cooking and pickling produces effluents with a very high content of dissolved pollutants, and are thus not feasible for recycling after a treatment. The gas scrubbing process and the rolling process result in waste water with a high content of suspended pollution; oxides, suspended matter and insoluble hydrocarbons, etc., and are almost entirely recyclable.

Cooking generates ammonia liquors which originate from the coal moisture and from formation water. These are weak ammonia liquors (2.5-10 g/l) with high content of phenols (1-4 g/l). The pickling process produces wash water with high iron contents (up to 300 mg/l). The wastewater also contains either sulphuric or hydrochloric acids, depending on the process. The hydrochloric acid (HCL) can be thermally regenerated reducing a large part of dissolved iron and HCL in the effluent. The lubrication procedures produces a high oil content in the waste water (0.1-0.6 g/l).

The gas scrubbing is used in balling, agglomeration, blast furnaces, direct reduction and steel works. The waste water usually contains high levels of suspended solids (0.2-1 g/l) and ammonia up to 0.5 g/l. The waste water also contains sulphur, cyanide, silica and some other oxides. In this process, most of the waste water is treated and recycled within the process.

Finally, during the rolling process, the waste water is produced during descaling, granulation and spraying with water. This waste water may also contain some hydrocarbons from lubrications, in addition to the oxides.

Coal mines and coal gassification

Washing plants in coal mines produce waste water with a very high content of suspended solids, in the range of 10-100 g/l. During the coal gassification two types of waste water are produced; formation water and gas scrubbing effluent. These effluents contain phenols, ammonia, cyanide, acids and tars. The waste water is also some times associated with heavy metals.

Pulp and paper industries

These industries consist of two types of manufacturing. The pulp production and paper production.

The waste water from the pulp and paper production process depends on the raw materials (wood, straw, bagass) and the manufacturing process (mechanical, bisulphate, Kraft and CTMP-Chemical thermo-mechanical pulp). The water consumption for each type of process varies widely in the range of 10-100 m^3 per ton of pulp. The waste water is usually black and white liquors and results from bleaching, washing/emptying and from evaporation condenses. The effluents contain BOD_5 between 100 to 1000 mg/l and COD between 300 to 4000 mg/l, and with colours prominent and resistant to biological processes. The absorbable organic halogens (AOX) are also produced during bleaching with chlorine products and are toxic and very difficult to biodegrade.

Paper is made from new pulp, wastepaper from which the ink has not been removed, or rags. Depending on the required quality of paper, various additives and coatings may be introduced as, mineral fillers (kaolin, talc, etc.), organic fillers (starch, latex), dyes, aluminium sulphates and retention agents. The de-inking is achieved by backwashing with a high flow or with mechanical flotation with various chemicals, discharging waste water with high suspended solids contents. The typical water quality parameters of the waste water are 0.1-3 g/l of suspended solids and 100-1300 mg/l of BOD_5.

Textile industries

These industries have various stages; scouring and combing of wool, preliminary treatments before textile finishing and textile finishing, producing waste water with different characteristics. During the first stage, suspended matter of 250-600 kg per ton wool is discharged to the waste water. About 25-30% of this is grease, 10-15% are soil and sand, and the remaining is organic salts. The preliminary treatment before textile finishing produces waste water with 0.3-30 g/l of BOD_5. The waste water from the final finishing stage usually have pH 4 to 12, COD 250-1500mg/l, suspended solids 30-400 mg/l and colour 500-2000 mg-Pt/l. Chromium levels can be as high as 4 mg/l and sulphides can be up to 50 mg/l.

Chemical industries

The waste water produced in these industries may be very different from one to the other. Very high COD levels, suspended matter and heavy metals are common in many chemical producing plants. The industries producing organic products do often result in waste water contain oil and other organic wastes.

Agrofood industries

The very high content of organic and biodegradable pollutants are characteristic for these industries (diaries, slaughter houses, piggeries etc). These wastes trend to rapid acidification and fermentation. The waste water is commonly treated with biological methods, but often experiences the insufficiency of medium with nitrogen or phosphorous. The waste water from piggeries could be considered as a typical example, and the amount of waste water and the degree of pollution often vary with the methods of stock breeding, the method of cleaning the sites, the time spent in the sites and the type of the feed used. In general, 17-25 l of waste water is produced per pig in hydraulically cleaned sites, with concentration of 0.6-0.8 g/l of BOD5, 17-20 g/l of COD and 1-1.4 mg/l of TKN (total Kjeldal Nitrogen). Slaughter houses produce wastewater with different concentrations in different amounts.

Effects in recipient

The effects in the recipient from the above mentioned pollution sources vary considerable, and can-not be addressed generally.

The different industries contribute to the severe water quality situation in the recipients in the Odra catchment area with organic waste, nutrients, suspended solids and specially micro pollutants. The toxicological effect from many of these are considerable, and affect the ecology as well being a threat to human health.

6.4 Agriculture

6.4.1 Methodology

The main pollution from agriculture is nutrients (phosphorus and nitrogen), organic waste and pesticides. There are methods developed for quantifying nutrient loads from different types of agricultural activities, but it is very difficult to estimate the load to open waters from organic waste and pesticides.

In addition to pollution from area runoff, the pollution from agriculture also originate from different point sources:

- Silage effluents from ensilage of green fodder.
- Manure storage's.
- Waste water from milking parlours and washing rooms.

To calculate the pollution from agriculture in detail alot of data is required on agricultural activities and empirical coefficients.

The pollution from area run-off depends on the size of agriculture area, applied amount of mineral fertiliser and manure and coefficients for nutrients run-off. The coefficients for nutrients run-off are empirical and based on soil type, type of crop, slope of fields, land use practice, ploughing and soil handling, climatic conditions and the application of manure and commercial fertilisers.

Pollution from point sources mainly depends on type of animal, number of animals and storage/disposal conditions for silage and manure.

It has not been possible to obtain exact data on pollution from agriculture in the region. The agricultural sector has undergone big changes over the last years. Large state co-operations have been split up in smaller units, and the use of mineral fertiliser has decreased.

The pollution from agriculture is however considerable in the region, and has to be taken into consideration to propose a cost effective pollution abatement programme. With the data available though, it is only possible to propose cost-effective solutions for municipal and industrial sources.. General measures for agriculture are however listed in chapter 7.4.

The project team proposes a study to get an overview of the agricultural sector in the region. To be able to calculate the pollution load from agriculture and to propose cost-effective solutions it can be valuable to adapt Norwegian methods to Czech conditions (see recommendations in appendix 10.16).

6.4.2 Pollution from agriculture

As mentioned earlier, the lack of specific data has made it necessary to base the conclusions in this report on previous work done by NIVA (Berge *et al*, 1992) in the Baltic Sea Environmental Programme (Topical Area Study for agricultural run-off).

The Baltic Sea study covered all main tributaries to the Baltic sea, and addressed the Odra River Basin in general. It should be noted that the total loads to the Odra river basin can not be transferred directly to the Czech part, and thus there is an uncertainty connected to the calculations below. Additionally, the above study was conducted in a period with great changes in the society in Eastern Europe, which also questions the applicability of conclusions to present situations.

Area run-off

The total fertilisation intensity (mineral and manure) was estimated to 110 kg N/ha and 27 kg P/ha, and the nutrient run-off coefficients to 23 kg N/ha year and 0.22 kg P/ ha year (Berge *et al*, 1992).

Appendix 10.9 shows the calculated agriculture area for the different recipient profiles in Odra. Agriculture constitutes approximately 50% of the total area in the region, but varies between 60 and 40%. Based on this land use the contribution from the agricultural sector has been calculated (appendix 10.9). Possible loss from heavily manured fields are not included in the numbers.

Point pollution sources

The total load from point pollution sources in the Czech part of Odra, has also been based on estimates from the Baltic Sea Environmental Programme. Leakage from sources like manure storage, fertiliser storage and green fodder from Poland to Odra is estimated to 20700 tonnes nitrogen pr. year and 2550 tonnes phosphorus pr. year (Berge *et al*, 1992). It is assumed that the numbers in the Czech Republic is approximately 5% of the numbers in Poland based on the area of farmland in The Czech Republic compared to the area of farmland in the Polish catchment area. This is of course a rough estimation, but gives a general picture on the size of the problem.

Waste from large piggeries is not included in the numbers, and has been characterised as an industrial source.

Total pollution load from the agriculture sector

Based on the assumptions above, this gives a total contribution from agriculture as presented in table 6.10. The point pollution sources constitute of 12% of the nitrogen load, and 64% of the phosphorus load. The most important sources for phosphorus are leakages from manure storages. The values are probably overestimated since the calculation is based on the average conditions in the whole Odra River Basin.

The organic pollution from agriculture is difficult to estimate, and no conclusions can be drawn on the basis of previously work.
There is no information about the applied amount of pesticides either, but the total consumption has decreased during the last years. The concentration in the soil from former use can however be considerable and leak into the watersheds.

Table 6.10: Pollution load from agriculture (Source: Berge *et al*, 1992, combined with assumption NIVA, 1995)

	Area run-off		**Point pollution**		**Total load**
	[tonnes/year]	[%]	[tonnes/year]	[%]	[tonnes/year]
Nitrogen	7390	88	1035	12	8425
Phosphorus	71	36	128	64	199

6.4.3 Effects of agricultural pollution on the local environment

The effects of pollution are discussed in general in chapter 4.1. Only a brief description on the main problems related to agriculture pollution is given in this chapter.

In the local water bodies the point sources have more dramatic effects than the diffuse sources. With regard to the agriculture, this applies most severely to the manure handling and storage. Direct effects, such as fish kills, resulting from discharge of organic, oxygen consuming compounds like manure and silage effluents are common.

Manure leakage contains high levels of ammonia. This is converted to free ammonia when it leaks into waters with high pH. Free ammonia is highly toxic to fish and can be responsible for fish kills.

The storage of manure and heavily manured fields do not only result in leakage to surface waters, but also to ground waters by increasing the nitrate content to above acceptable levels for drinking water. The ammonia oxidation as well as nitrate leaching, results in acidification of the soil and the ground waters. This process mobilises aluminium into the ground water which also reduce its suitability for possible consumption.

As discussed in chapter 4.1.3 the amount of phosphorus which is available for algae growth depends on the pollution source. Manure (both leakage from storage and from heavily manured fields during floods) and silage effluents have a relatively high content, but diffuse run off (erosion) from crop production has a very low content of available phosphorus for eutrophication (se table 4.1, chapter 4.1.3). Approximately 2/3 of the total phosphorus load from agriculture (load from the point pollution sources) will therefore have a relatively high content of phosphorus available for algae growth. The agriculture in Odra give a very large contribution to the total nitrogen loads in the catchment area.

Acute toxic effects from pesticides can appear in local water bodies, and can enter surface and ground water. Several of these compounds impose stress on the ecosystems, but the overall ecosystems consequences are not known. Having first entered the hydrological cycle, the residence time of the pesticides is long since it is difficult to degrade (Berge *et al*, 1992).

6.5 Background pollution and atmospheric deposition

The atmosphere, rocks and forest contribute to the water quality in a watershed, in terms of the content of organic matter and nutrients.

6.5.1 Atmospheric deposition on surface water

Nutrients precipitating from the atmosphere on the water surface give a direct contribution to pollution in the area.

Precipitation data from 1992 in the region (WRI, 1994), are given in table 6.11. Based on these numbers an average nitrogen coefficient of 800 kg Nitrogen/ km^2 year is used. The precipitation and the nitrogen concentration will vary from year to year, but the number seems to be comparable with coefficients used in Norway (Holtan and Åstebøl, 1990).

The phosphorus content in the precipitation is given as $P\text{-}PO_4$, and gives a coefficient of 40 kg $P\text{-}PO_4/km^2$ year. In addition to this contribution the phosphorus can be attached to particles, which is assumed to be as much as 50% (Holtan and Åstebøl, 1990). This suggests that the coefficient for the Odra catchment area can be in the order of 80 kg Tot-P/km^2 year. This number seems to be high compared to the Norwegian criteria and international literature (Holtan, Kamp-Nielsen, Stuanes, 1988). The numbers given in the literature vary between 6-102 kg/Km^2 year with a mean value on 43 kg Tot-P/km^2 year. Thus 60 kg Tot-P/km^2 year is used to calculate the total load from this source in the Odra catchment area.

Table 6.11: Atmospheric deposition in the Odra catchment area (WRI, 1994)

Location	N-NO3 [kg/km2 year]	N-NO2 [kg/km2 year]	N-NH4 [kg/km2 year]	Sum-N [kg/km2 year]	P-PO4 [kg/km2 year]
Bohumin	169	39	542	750	8
Cesky Tesin	253	9	363	626	7
Frydek Mistek	318	2	295	614	6
Poruba	255	5	284	544	9
Kuncicky	338	40	465	843	59
Lysa Hora	694	4	1030	1728	52
Markvartovice	297	6	527	830	35
Moravka	531	7	829	1368	54
Ropicie	273	5	420	699	128
Stare Hamry	474	5	758	1237	50
Staremesto	432	4	550	987	19
Tyra	342	2	601	945	118
Zermanice	223	6	543	772	35
Average	354	11	554	919	45
Median	318	5	542	830	35

Based on the surface area of lakes and reservoirs in the catchment area and the concentration of pollution in the precipitation, the contribution from atmospheric deposition is calculated in appendix 10.9 and showed in table 6.12.

The total load is approximately 2 tonnes of phosphorus and 25 tonnes of nitrogen pr. year, which is neglectable compared to the total pollution loads.

Table 6.12: Total load from atmospheric deposition on surface water

Area of surface water	Nitrogen		Phosphorus	
[ha]	[kg Tot-N/km^2 year]	[tonnes Tot-N/year]	[kg Tot-P/km^2 year]	[tonnes Tot-P/year]
3094	800	25	60	2

6.5.2 Run off from forests and mountains

Background concentrations of pollution from forest and mountains are influenced by many factors:

- Climate; precipitation, intensity and variation in rainfall
- Geology, soil
- Slope of fields
- vegetation

Large variations in these coefficients can occur depending on location, and the coefficients are, therefore, uncertain. The coefficients used in the current study are based on Norwegian guidelines (Holtan and Åstebøl, 1990) from an area which seems to be comparable to Odra; 250 kg Tot-N/km^2 year and 20 kg Tot-P/km^2 year. (An area with the same values for atmospheric precipitation).

Forest constitutes approximately 35% of the total catchment area, but varies between ca. 20-50%. The coefficients for land use for the different recipient profiles are given in table 10.9.1, appendix 10.9, and the total loads are calculated in table 10.9.2, appendix 10.9.

44 tonnes phosphorus pr. year and 548 tonnes nitrogen pr. year, give a relatively small contribution to the total pollution load.

Table 6.13: Total loads from forest and rocks

Area	Nitrogen		Phosphorus	
[km^2]	[kg Tot-N/km^2 year]	[tonnes Tot-N/year]	[kg Tot-P/km^2 year]	[tonnes Tot-P/year]
2188	250	548	20	44

6.6 Water pollution budget

6.6.1 Pollution from sources

Based on the previous chapters, the total loads from different pollution sources in the Odra river catchment area are presented below.

Table 6.14: Pollution from different sectors and sources

	Municipalities				**Industries**	**Agriculture**		**Background pollution**		**Total**
	WWTP, SmVAK, OVAK*	Smaller WWTP	Rural areas**	Leachates solid waste		Run-off	Point, sources	Forest	Water	
BOD (ton/year)	5872	3114	7414	500	1 434	-	-	-	-	-
COD (ton/year)	20609		-	-	14 979	-	-	-	-	-
Tot-N (ton/year)	4643	726	1424	25	1 363	7390	1035	548	25	17179
Tot-P(ton/year)	930	181	356	5	36	71	128	44	2	1753
Zn (ton/year)					58					-
Fe (ton/year)	7			8	166					-
Pb (kg/year)					238					-
Cu (kg/year)					951					-
Ni (kg/year)					909					-
Hg (kg/year)					10					-
Cd (kg/year)					39					-
SS (ton/year)	6893	1779	7414	-	4915					-

* Bypassed sewage at the municipal waste water treatment plants is not included in the budget except for the largest WWTP plant - Privoz. The total numbers for bypass is not known, but the data from Privoz indicates that this can be considerable. The sewage system is based on combined sewers, and the storm water is assumed to be included in the outlet from the WWTP. Registered phosphorus values at the waste water treatment plant may also be underestimated, which might have resulted from unrealistically low P-discharge concentrations from simple biological WWTP.

** The selfpurification is assumed to be considerable before the pollution enters the water courses.

Table 6.15 illustrates the extreme influence of the anthropogenic pollution in the region. Waste water from municipalities, agriculture industry is responsible for 97% of the total pollution in the region. The contribution from background sources is neglectable.

Table 6.15: Contribution from Anthropogenic sources compared with background sources [%]

Parameter	**Anthropogenic Sources**	**Background**
Tot-N	97	3
Tot-P	97	3

Table 6.16: Contribution from different anthropogenic sources [%]

Param.	Municipal					Industries	Agriculture
	WWTP, SmVAK,OVAK	Smaller WWTP	Rural area**	Leachates Solid waste	Total		
BOD*	32	17	40	3	92	8	-
Tot-N	28	4	9	0	41	8	51
Tot-P	54	11	21	0	86	2	12

*Compared only with pollution from municipalities and industries

**The total loads entering the water courses are much lower, due to selfpurification and some reduction in septic tanks etc.

Municipal Waste water is the dominating source to phosphorus pollution, but agriculture gives a significant contribution to the total nitrogen loads. Since the existing WWTPs usually already have the biological treatment, the total contribution from this source compared to the total load (municipal and industrial sources) is only 32%. Still the municipal WWTPs will be a source with a high cost-benefit ratio (upgrading of existing plants). The BOD contribution from agriculture has not been estimated, but can be large.

Industry gives a relatively small contribution to the total loads of BOD, Tot-N and Tot-P, but may, as mentioned earlier, give a considerable effect on local water quality, especially regarding to micro pollutants.

6.6.2 Pollution transport in rivers

The transport of pollution in the rivers Opava, Ostravice, Olse entering the Odra River in 1993 is presented in table 6.17 In profile Bohumin the river is affected by pollution from the Ostrava region, Opava and Ostravice. The pollution transport to Poland will approximately be the sum of pollution transport in Odra-Bohumin and in Olse-Vernovice.

Table 6.17. Pollution load from the rivers Opava, Ostravice and Olse to the River Odra in 1993. Selected parameters.(Source: Povodi Odry, 1993)

	Odra *Bohumin* [tonnes/year]	**Odra** *Polanka* [tonnes/year]	**Opava** *Dehylov* [tonnes/year]	**Ostravice** *Muglinov* [tonnes/year]	**Olse** *Vernovice* [tonnes/year]	**Load to Poland*** [tonnes/year]
BOD-5	6593	1382	944	1163	1414	≈8007
COD-mn	10720	2661	1291	3069	2552	≈13272
N-NH4	2451	243	260	475	876	≈3327
N-NO3	5930	2039	917	700	508	≈6438
N-NO2	153	30	16	40	90	≈243
PO4-P	207	30	56	60	88	≈295
total Fe	2408	1049	99	210	349	≈2757
Zn	393	16.9	9.68	32.7	16	≈409
Cu	9,95	2.98	1.19	1.82	3.58	≈3.58
Ni	17.1	6.02	2.15	3.34	11.6	≈28.7
Cr	13	5.35	2.06	2.51	3.42	≈16.42
Cd	2.48	0.56	0.42	0.72	1.72	≈4.2
Pb	20.4	5.49	4.09	5.02	7.17	≈27.57
Hg	0.2	0.03	0.03	0.05	0.12	≈0.32

*Estimated loads based on the pollution transport in Odra Bohumin and Olse Vernovice

Table 6.18 presents the estimated mass transport calculated by NIVA based on C_{90} values (mainly from 1992), and are compared with the data from PO(1993). There seems to be good agreement between the calculated values and the values given by PO on mass transport. The method used by NIVA thus seems to give relatively good estimates compared to the "real" mass transport.

The nitrate values given by NIVA seem however to be underestimated, but on the other hand, the year 1993 was reported to have relatively high floods. The differences in Bohumin between Tot-P and PO_4 seem also to be very high compared to the differences between P-PO_4 and Tot-P in other profiles. The calculation done by NIVA in this profile was based on an estimated C_{90} value for Tot-P and may be overestimated.

Table 6.18: Calculated mass transport compared with "real" mass transport

	Odra *Bohumin* [tonnes/year]		**Olse** *Vernovice* [tonnes/year]		**Poland** [tonnes/year]	
	NIVA*	PO[1993]	NIVA*	PO[1993]	NIVA*	PO[1993]
BOD-5	6628	6593	1192	1414	7820	8007
N-NH4	2615	2451	721	876	3336	3327
N-NO3	3783	5930	474	508	4257	6438
PO4-P**	1458	207	225	88	1683	295

*Calculated values based on C90 values for 1992, phosphorus 1993

**Tot-P (NIVA) and P-PO4 (PO)

To give an estimate of the self purification-retention in the river for phosphorus and nitrogen, the total loads of pollution in the catchment area have been compared with the pollution transport in the rivers.

Table 6.19 also show the mass transport for some heavy metals, which seems very high compared to the total outlets from the main source which is industry.

Table 6.19: Mass transport in rivers compared with outlets from different pollution sources.

	Pollution to Poland [tonnes/year]	**Pollution from sources** [tonnes/year]	**Self purification-retention** [%]
BOD-5	7820**	18334 2)	
Tot-N*	8350**	17179 1)	51
Tot-P	1683**	1821 1)	4
total Fe	2757	167 3)	
Zn	409	58 3)	
Cu	3.58	0.16 3)	
Ni	28.7	0.61 3)	
Cd	4.2	0.03 3)	
Pb	27.57	0.24 3)	
Hg	0.32	0.01 3)	

* tot-N is assumed to be: ~ 1.1 * sum inorganic

** Calculated by NIVA

(1) all sources (2) All sources except agriculture and background pollution (3) Industry

The average effect coefficients for the whole Odra catchment for nitrogen seem to be slightly higher (35%→50%) than assumed in chapter 5.2.3 (table 10.8.2, appendix 10.8), considering the values given in table 6.19. Comparing the average self purification coefficient in Odra Bohumin and Olse Vernovice in table 10.8.3 in appendix 10.8 with table 6.19, the effect coefficients for phosphorus seem to be slightly lower (8%→4%). On the other hand the relative uncertainty in calculations of pollution loads to Poland and to sources may be considerable, and therefore the assumption in chapter 5.2.3 may be more reliable (for example, the P-pollution to Poland may be overestimated as mentioned above, but on the other hand the phosphorus values from WWTP may be underestimated. The bypassed amount from the WWTP is also uncertain, and so is the nutrient loads from agriculture).

The effect coefficients given in chapter 5.2.3 will therefore be used to calculate resulting water quality after the abatement program (see chapter 7.5.6)

6.7 Identification of main pollution sources

6.7.1 Introduction

As it is seen from the preceeding chapter, the environmental pollution created in the Odra river basin is a result of various sources. Some sources have satisfactory waste water treatment plants while others have problems to cope with the discharge limits given in the environmental regulation. On the other hand, some recipients are much more vulnerable to pollutants or need more reduction in the total loads, than others due to their environmental conditions today, and must be considered in addition to the discharge limits predicted by the law. The need for the reduction of environmental pollution is therefore bound to many factors as above, in addition to the social and economical factors for each industry. In order to achieve the water quality goals set by the authorities, each and every polluter should actively be engaged in reducing their discharge levels. However, there are some sources, in which improvement of discharge will result in considerable improvements in the recipient quality, compared to the others. For such polluters, the cost-benefit value for the environment may be considerably high. This study intend to identify such polluters and to analyse the possibilities to achieve the water quality goals with a reasonable cost-benefit ratio.

The identification of the most important polluters depends on the definition of requirements. If one wants to identify the polluter with highest violations of discharge limits, for example to increase penalties, probably an analysis of discharge limits and real discharge loads may be sufficient. On the other hand, if one wants to achieve the improvement of a recipient quality disregarding other factors, an analysis of recipient quality, goals and the discharge loads will be sufficient. Thus the "main polluter" will vary in different ranking procedures.

We have analysed several ranking procedures in this study, and suggest to using a method that considers as many of these aspects as possible.

6.7.2 An analysis of methods used for source ranking

Six multicriteria analytical methods are analysed in this review. Two of these methods (PO-I, WRI-I) are based on the relation of pollution loads to the discharge limits for each source according to regulation 171-I. One method (PO-II) is based on pollution loads to the recipient and critical loads in the recipient according to the regulation 171-III. The next method (WRI-II) is based on the pollution loads, recipient status and the critical loads according to the regulation 171-III. A method (BCEOM) used in the Baltic sea report (BCEOM, 1992), based on differential weighting of pollution parameters in a multicriteria analysis, is also analysed. Finally a method (NIVA) which partially combines some of the above methods will be presented. Only the simplified versions of their methods are presented below.

Abbreviations:
C^I - source discharge limit according to regulation 171-I (parameter I), mg/l
C^{III} - recipient critical load according to regulation 171-III (parameter III), mg/l
C^S - source discharge concentration, mg/l
C^r - concentration in recipient, mg/l
Q^S - source discharge flow, m^3/s
Q^{355} - recipient flow (355-day flow), m^3/s
index "i" - pollution parameters 1 to n
index "j" - pollution sources 1 to p
index "k" - recipient profile
L - length of deteriorated recipient, km

6.7.2.1 Method PO-1

This method was adopted by PO from Mr Nesmerak of WRI, Prague and was presented at a seminar on the Labe river project, in January 1993. The method is based on the proportion of pollution loads to the regulation limits (171-I).

$$C_{PO-I} = \sum_{i=1}^{n} \left(\frac{C_i^s}{C_i^I} * Q_s\right)$$

This method enables the source discharge load to be evaluated in relation to the discharge limits(parameter I-reg 171) for each source. The method requires equal amounts of pollution parameters (i) for comparison among sources.

The method does not consider the recipient status (C^r) or the critical loads to recipients (C^{III}).

6.7.2.2 Method WRI-I

This method is used by the WRI for the ranking of pollution sources in the Odra project (WRI,1993).

$$C_{WRI-I} = \sum_{i=1}^{n} \left(\frac{(C_i^s - C_i^I)}{C_i^I} * Q_s\right)$$

The method is similar to the above PO-I, but uses the deviation of source discharge (C^S-C^I) from the regulations (C^I) instead of the absolute value of discharge (C^S) in PO-1.

This method does not consider the recipient status (C^r) or the critical loads to recipients (C^{III}). Additionally, the term (C^S-C^I) may create problems resulting in negative and positive values affecting the sum of coefficients. The WRI has only used parameters which were common for all pollutants.

6.7.2.3 Method PO-II

This method is also adopted from Mr Nesmerak at WRI, Prague and was amended and presented by PO.

$$C_{PO-II} = \sum_{i=1}^{n} \left(\frac{C_i^s * Q^s * L}{C_i^{III} * (Q^{355} + Q^s)} \right)$$

The method could also be presented as:

$$C_{PO-II} = \sum_{i=1}^{n} \left(\frac{\text{source pollution load} * \text{length of recipient}}{\text{critical load of pollution in recipient at } Q^{355} + Q^s)} \right)$$

The incorporation of the critical load for a recipient into the criteria is an advantage compared to the above two methods. However, there are two major disadvantages in this method. Neither the current status of the recipient (C^r) or the source discharge limit (C^I) are considered in the evaluation.

6.7.2.4 Method WRI-II

This is a method proposed by WRI representing a combination of the ranking of both the source and the recipient.

$$C_{WRI-II} = SiP * PiR$$

SiP = ranking of source within a profile

$$= \frac{\text{individual overload from source "j"}}{\text{overload in recipient profile "k"}} = \frac{(C_j^s - C_k^{III}) * Q_j^s}{(C_k^r - C_k^{III}) * Q_k^{355}}$$

PiR = ranking of profile within a recipient

$$= \frac{\text{Total pollution load in recipient profile "k"}}{\text{critical load of pollution in recipient}} = \frac{C_k^r * Q_k^{355}}{C^{III} * Q^{355}}$$

$$C_{WRI-II} = \frac{(C_j^s - C_k^{III}) * Q_j^s}{(C_k^r - C_k^{III}) * Q_k^{355}} * \frac{C_k^r * Q_k^{355}}{C^{III} * Q^{355}}$$

When considering the sum of several parameters, terms $(C_j^s - C_k^{III})$ and $(C_k^r - C_k^{III})$ may result in negative values, when the water quality is better than the critical load or when the concentration in the outlet is less than the critical load in the recipient. This may lead to the problems, affecting the sum of coefficients, as it was discussed earlier.

This is, however, an interesting method which evaluates sources according to their local recipients and status. In addition to the ranking of discharge level, it also considers the ranking of recipient profile's status within a recipient. However, the method does not consider the source discharge limits (171-I).

6.7.2.5 Method BECOM

This method was used in the Baltic Sea report (BCEOM,1992). The method categorises all major pollution parameters into four groups (BOD/Nutrients/Heavy metals/Cl^- & SO_4^{2-}). All sources are prioritised within each of these four groups.

Each source in every group is given a weight up to 100. In the groups of nutrients (N & P) and Cl^- & SO_4^{2-}, each ion is given a maximum weight of 50, so the total within one group is 100. For heavy metals, all concentrations are first converted into ZTE - Zinc Toxicity Equivalents (1[Cu]=5ZTE; 1[Pb]=10 ZTE; 1[Cd]=50 ZTE etc). The total concentration, which is expressed in ZTE, is then ranged giving 100 units to the source with maximum ZTE.

The original method is based on pollution loads:

$$C_{BECOM} = Q_s * \sum_{i*=1}^{4} C_{i*}^{s} * Z_{i*}$$ where "i*" is one of the four group of parameters.

This method assumes that each of four parameter groups (BOD, nutrients...) are equally critical to the recipient. This, however, seems urreasonable. More meaningful weights of Z_i coefficients tackling this problem are possible, but are complicated and will always be disputable. However, this method has its advantages such as the possibility to rank the pollution loads for each parameter among sources, which is logically required in practice.

6.7.2.6 Method NIVA

This is a method which partially combines the above methods.

$$C_{NIVA} = \sum_{i=1}^{n} X_1 * X_2 * X_3$$

where, X_1 - represents the recipient status relative to critical loads (171-III) or objectives in the recipient profile.

X_2 - represents the effect of dilution or combined with X_3 and X_2 the source load relatively to the critical loads (or objectives for the recipient)

X_3 - represents the source load relative to discharge limits (171-I)

$$X_1 = \sum_{i=1}^{n} \frac{C_i^r}{C_i^{III}} ; \qquad X_2 = \sum_{i=1}^{n} \frac{Q^s}{(Q^{355} + Q^s)} ; \qquad X_3 = \sum_{i=1}^{n} \frac{C_i^s}{C_i^I}$$

$$C_{NIVA} = \sum_{i=1}^{n} \frac{C_i^r}{C_i^{III}} * \frac{Q^s}{(Q^{355} + Q^s)} * \frac{C_i^s}{C_i^I}$$

This method practically covers all the important factors; the current status of the recipient in relation to critical loads or the water quality objectives for a recipient, the pollution load from each source in relation to the given discharge limits and the specific source contribution compared to the maximum accepted load in the recipient to obtain a certain water quality. The formula does not result in mixed sign (±) values.

One important feature in this formula is the factor X_2, which decreases the ranking weight with the increasing of dilution possibility. And, if an industry is discharging according to the norms and additionally if the recipient is in good condition and can bear a high load, the ranking weight is considerably decreased. On the other hand, when a small source exceed the discharge permit and is discharging to a sensitive recipient, this will give a higher ranking.
One can also introduce weights to coefficients X_1, X_2 and X_3, if required. The formula needs to have similar amounts of parameters for each source, as explained under PO-I.

6.7.3 Ranking procedure

Ranking of pollution sources in a river basin is a complicated procedure. One has to consider the effect of discharge not only in relation to the primary recipient, but should also related to the secondary and final recipients. In practice, the concentrations of many parameters entering to final recipients will vary from their values at the point of discharge to the primary recipient due to degradation or precipitation etc. during the transport. A simplified procedure for calculation of such effects is described in chapter 5.2.3. This will be used only for the effect evaluation after the improvement proposals.

The final ranking should have considered:

1. Local effects (primary recipient level)
2. Regional effects (secondary recipient level)
3. Effect on the Odra (final recipient level).

To consider all these three stages is however too complicated, and at this stage the above mentioned methods has been used to rank the sources primarily according to the local water quality. Qualitative ranking has however been done at the end of this chapter to also consider regional effects or the effects on pollution reduction to Poland, by choosing large outlets.

When considering the practical side, it seems that one can select a few very critical parameters that pose the main problems in the recipient both for ranking and for cost/benefit analysis. BOD, nutrients, SS and Zn could be such a minimum since they also represent other parameters relatively good for the given case.

As a concluding remark we should state that it is not possible to suggest any absolute ranking procedure, since it depends on the way one wants to set the priorities among recipients, accordance with discharge permits, water quality objectives, etc. Analysis of above proposed methods indicate specific advantages of each method, and in the final ranking presented in the next chapter 6.7.4 consideration of several of the methods have been used to point out the hot spots in the region.

6.7.4 Results of the ranking procedure

There are over 250 point-pollution sources registered at the Povodi Odri's database. The 250 point pollution sources only include the biggest WWTP and industry sources. The outlets from smaller treatment plants and pollution from rural districts are not included in the database. This means that the 250 registered point pollution sources represent between 40-73 % (BOD, Tot-P and Tot-N)of the total load from municipal and industrial sources (see table 6.20). The outlets from smaller treatment plants and outlets from rural areas are however spread out in the region on a high number of polluters, and are neglectable when the main task is to identify Hot- spots which not only contribute to local pollution problem but also give a significant contribution to regional pollution problems and to the total loads.

Table 6.20: Pollution from 250 registered sources compared with total loads from municipal and industrial sources.

Parameter	250 registered sources [%]	Other municipal and industrial sources [%]
BOD	40	60
Tot.N	73	27
Tot-P	64	36

The WRI and PO have ranked pollution sources according to their methods. From these lists we have selected the 58 most important sources, which included the first 40 sources according to each method, and an analysis of the total outlets from the remaining sources confirm that they can be neglected in the procedure of identifying "hot-spots". Table 6.21 presents the data for total loads from the 58 hot-spots compared to the 250 registered point pollution sources.

Table 6.21. Summary of pollution loads data

	BOD t/y	COD-Cr t/y	Tot-N t/y	Tot-P t/y	SS t/y	Fe t/y	Zn t/y	Hg kg/y	Cd kg/y	Pb kg/y	Cu kg/y	Ni kg/y
58 important spots	6430	31373	5169	829	9145	165	56	10	30	238	156	613
192 less important spots	876	4215	837	137	2589	9	2	0	0	0	0	0
250 registered spots	7306	35588	6006	966	11734	174	58	10	30	238	156	613
Ratio 58 /250	88%	88%	86%	86%	78%	95%	97%	100%	100%	100%	100%	100%

The results indicate that 20% (58) of all registered sources in the catchment (250) discharges 78-100% of the pollutants. This validate our selection of the 58 sources as "important spots" for further ranking.

Table 6.22 and 6.23 presents pollution concentrations and loads from these sources.

The pollution sources are ranked according to the "NIVA mix" (average ranking, see below) ranking from 4 of the 6 methods using all available water quality parameters (BOD, COD-Cr, sum of nitrates and ammonia, total-P, suspended solids, Fe, Zn, Hg, Cd, Pb, Cu and Ni) from 1993. However, the recipient water quality was available only in major recipients (see table 6.24). PO-II method was used to demonstrate the effect of both the primary recipient and of the major recipient (only the water flow (Q_{355}) is different) on ranking, and given under methods "PO-II (primary)" and "PO-II (major)". The NIVA method requires the knowledge of recipient water quality, and therefore only the effect on major recipients was considered. The interesting method proposed by WRI (WRI-II) was not possible to consider due to the lack of necessary data at this time. The method BECOM was not used either.

The ranking procedures were also conducted considering only BOD values, and the results are given for the different methods in the right-most columns in Table 6.24. A comparison of the ranking of BOD with the rankings based on all available water quality parameters does not indicate a difference when dividing the pollution sources in to two groups as "hot-spots" and "non hot-spots".

Table 6.22. Pollution concentrations of 58 hot-spots.

Rank	PO-new	Point source	Primary recepient	Major recepient	Qs, m3/y ('000)	BOD	COD- Cr	Tot-N	Tot-P	SS	Fe	Zn	Hg	Cd	Pb	Cu	Ni
						mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
1	1	OVAK OSTRAVA-CERNY PRIKOP	CERNY PRIKOP	Odra -Bohumin	4346	140	293	24.8	3.3	183							
2	9	OVAK OSTRAVA-UCOV PRIVOZ	CERNY PRIKOP	Odra -Bohumin	32103	15	86	32.8	4.6	18							
2.1		BYPASS : OVAK OSTRAVA-UCOV PRIVOZ			2346	170	341	37	10.9	225							
3	3	SMVAK 04-COV NOVY JICIN	JICINKA	Jicinka-Kunin	4150	18	145	26.8	7.31	17							
4	5	SMVAK 03-KANALIZACE BOHUMIN	BOHUMINSKA STRUZKA	Odra -Bohumin	2100	290	480	26.7	0.4	269							
5	7	SMVAK 03-COV HAVIROV	LUCINA	Lucina	10285	22	95	45.7	14.1	24							
6	22	SMVAK 02-COV TRINEC	OLSE	Olse nad Ropic	4260	28	115	58.6	4.42	19							
7	2	OKD KOKSOVNA SVERMA MAR.HORY-hl.o.	CERNY PRIKOP	Odra -Bohumin	3830	17	167	24.5	0.4	236	4.8						
8	11	SMVAK 02-COV FRYDEK-MISTEK	OSTRAVICE	Vratimo	9768	101	260	19.9	5.68	68							
9	12	SMVAK 04-KANALIZACE BILOVEC	BILOVKA	Bilovka pod Sez	352	75	380	25.2	5.5	80							
10	4	SMVAK 06-COV OPAVA	OPAVA	Opava-Hostice	7380	53	295	18.5	3.484	61							
11	17	SMVAK 03-COV KARVINA	OLSINSKY NAHON (OLSE)	Olse-Vernovice	7379	22	141	29.8	12.1	28							
12	26	TRINECKE ZELEZARNY	OLSE	Olse nad Ropic	32124	3.2	40	4.2	0.1	20	1.3						
14	21	ZD BOHUMIN ZELEZARNY	BOHUMINSKA STRUZKA	Odra -Bohumin	5676	10.4	263	6.4	0	30	3	0.5					
16	14	BOCHEMIE BOHUMIN-HLAVNI ODPAD	BOHUMINSKA STRUZKA	Odra -Bohumin	300	270	1490	81.6	0.3	69	50	48	0.03	0.08	0.32	0.12	0.54
18	19	BIOCEL PASKOV	OSTRAVICE	Ostravice-Muglin	8605	45.7	588	13.4	0.7	41							
19	51	HRUSOVSKA CHEMICKA SPOLECNOST	ODRA	Odra -Bohumin	609	75	503	18.2	1.8	495	53	42	0.001	0.01	0.13	0.06	0.1
20	31	OVAK OSTRAVA-COV O-TREBOVICE	ODRA	Odra-Petrkovice	10393	22	92	56.5	7.8	33							
22	13	VAK BRUNTAL-COV KRNOV	OPAVA	Opava-po Krnovem	4288	53	168	24.4	3.5	43							
23	16	MASSAG BILOVEC - NS	BILOVKA	Bilovka pod Sez	110	37	180	27.3	0.1	52	1	3		0.003		0.1111	3.2
26	52	KOKSOVNA SVOBODA - FIEBIGH	OSTARVICE	Odra -Bohumin	4800	12	112	12.5	0.5	43	1.43						
29	58	NOVA HUT - COV OSTRAVICE	OSTRAVICE	Ostravice-Muglin	900	13	145	10.2	0.2	98	1	0.77					
31	35	NOVA HUT OSTRAVA-COV LUCINA	LUCINA	Lucina	13500	3.2	84	27.5	0.2	12	1	0.77					
41	48	VALCOVNY PLECHU - HLAVNI ODPAD	OSTRAVICE	Vratimo	3161	7.6	50	6.7	0.1	83	0.8	0.3			0.02	0.02	0.01
43	53	OVAK COV ZABREH	ODRA	Odra -Bohumin	1789	22	83	61	6.2	35							
13	42	OVAK OSTRAVA-KANALIZACE ZABREH	ODRA	Odra -Bohumin	2788	15	180	22	1.6	14							
15	34	SMVAK 04-COV KOPRIVNICE	KOPRIVNICKA	Lubina-Kosatka	2778	18	108	36.7	17.3	15							
17	18	SMVAK 03-COV ORLOVA-PORUBA	STRUZKA	Odra -Bohumin	2452	15	93	38.4	7.55	21							
21	10	SM VAK-COV FRENSTAT	LUBINA	Lubina-Kosatka	2704	18	50	17.9	7.1	16							
24	15	SLECHTITELSKA ST. VELKE ALBRECHTICE	JAMNIK (SEZINA)	Bilovka pod Sez	35	100	420	33.5	17.7	225							
25	45	MLEKARNA KUNIN	JICINKA	Jicinka-Kunin	98	205	560	3.7	6.9	174							
27	6	VAK BRUNTAL-COV BRUNTAL	CERNY POTOK (MORAVICE)	Moravice-Branka	4334	22	80	13.9	2.5	14							
28	37	SMVAK 02-KANALIZACE VRATIMOV	SLEZSKY NAHON	Ostravice-Muglin	340	135	460	25.2	5.5	80							
30	43	ZD BOHUMIN DRATOVNY	BAJCUVKA (ODRA)	Odra -Bohumin	1200	9.3	170	6.7	0.1	55	6.7	0.2					
32	44	SMVAK 03-MRAZIRNY BOHUMIN	BAJCUVKA (ODRA)	Odra -Bohumin	27	3175	4210	84.7	9.1	231							
33	23	OVAK OSTRAVA-VYUST CERVENY POTOK	CERNY PRIKOP	Odra -Bohumin	1378	10	60	8	2.8	56	5						
34	40	VAK BRUNTAL-COV VRBNO P/PR	OPAVA	Opava-nad Krnovem	943	5	50	26.8	4.4	11							
35	47	SMVAK 03-COV CESKY TESIN	OLSE	Hvozdnice-Mladec	2348	17	78	25.4	5.41	20							
36	28	TATRA KOPRIVNICE	SYKORECKA (KOPRIVNICKA)	Lubina-Kosatka	3773	6	38	5.4	0.1	13	0.22	0.05					
37	39	OVAK OSTRAVA KANALIZ. MICHALKOVICE	MICHALKOVICKY POTOK	Odra -Bohumin	510	50	104	20.2	5.5	65							
38	25	SMVAK 04-KANALIZACE KLIMKOVICE	POLANCICE	Odra-Polanka	78	100	300	20.2	5.5	80							
39	29	SMVAK 04-COV PRIBOR	LUBINA	Lubina-Kosatka	940	11	117	16.7	3	15							
40	33	SMVAK 03-COV RYCHVALD	STRUZKA	Odra -Bohumin	220	94	168	33.3	5.4	71							
42	20	SMVAK 06-COV BUDISOV	BUDISOVKA	Odra-Jakubcovice	65	85	400	25.2	5.5	80							
43	54	MCHZ HLAVNI ODPAD	ODRA	Odra-Petrkovice	7759	15	44	28.6	0.3	36							
44	32	SMVAK 04 COV FULNEK	HUSI POTOK	Odra-Polanka	263	16	67	30.6	5.9	17							
45	55	SELIKO zav.02 O-SVINOV	PORUBKA	Odra-Svinov	693	175	266	13.4	0.2	30							
46	38	VAK BRUNTAL-KANALIZACE BRIDLICNA	MORAVICE	Moravice-Sleska Harta	130	60	210	20.2	5.5	150							
47	8	VAK BRUNTAL KANAL. HORNI BENESOV	CIZINA	Opava-Vavrovice	98	50	260	10.9	1.3	50							
48	59	VALCOVNY PLECHU - VEDLEJSI ODPAD	OSTRAVICE	Ostravice-Muglin	2147	3	20	4.6	0.3	11	0.5						
50	50	VAK BRUNTAL-COV RYMAROV	PODOLSKY POTOK	Moravice-Sleska Harta	1800	16	73	9.6	1.5	12							
51	27	VEREJNA KANALIZACE KRAVARE	STEPANKA	Opava Trebovice	168	50	250	20.2	5.5	80							
52	57	CEZ ELEKTRARNA DETMAROVICE-C.ST 2	MLYNKA (DETMAROVICE)	Olse-Vernovice	5902	6	130	3.3	0.9	42							
53	36	VEREJNA KANALIZACE BOLATICE	OPUSTA	Opava Trebovice	75	80	180	25.2	5.5	80							
54	41	VAK BRUNTAL-COV DVORCE	LOBNIK	Moravice-Branka	422	4.5	27	11.6	1.3	12							
55	49	OKD DUL DUKLA HAVIROV	SUSANKA	Lucina	2500	4.5	150	6.2	0.5	15							
56	30	REHABILITACNI USTAV HRABYNE	HRABYNKA	Opava Trebovice	70	18	88	16.2	3.8	28							
57	60	GALENA OPAVA	OPAVA	Opava Trebovice	696	16	103	1.3	0.1	12							
58	56	AUTOPAL RYCHVALD	BOHUMINSKA STRUZKA	Odra -Bohumin	40	5.3	87	10.9	0.1	14	0.75	0.3				0.2	0.15

Table 6.23. Pollution loads from 58 hot-spots.

Rank	PO-new	Point source	Primary recepient	Major recepient	Qs, m3/y ('000)	BOD	COD-Cr	Tot-N	Tot-P	SS	Fe	Zn	Hg	Cd	Pb	Cu	Ni
						t/y	t/y	t/y	t/y	t/y	t/y	t/y	kg/y	kg/y	kg/y	kg/y	kg/y
1	1	OVAK OSTRAVA-CERNY PRIKOP	CERNY PRIKOP	Odra -Bohumin	4346	608	1273	108	14	795		0	0	0	0	0	0
2	9	OVAK OSTRAVA-UCOV PRIVOZ	CERNY PRIKOP	Odra -Bohumin	32103	482	2761	1053	148	578	0	0	0	0	0	0	0
2.1		BYPASS : OVAK OSTRAVA-UCOV PRIVOZ			**2346**	**399**	**800**	**87**	**26**	**628**							
3	3	SMVAK 04-COV NOVY JICIN	JICINKA	Jicinka--Kunin	4150	75	602	111	30	71	0	0	0	0	0	0	0
4	5	SMVAK 03-KANALIZACE BOHUMIN	BOHUMINSKA STRUZKA	Odra -Bohumin	2100	609	1008	58	1	565	0	0	0	0	0	0	0
5	7	SMVAK 03-COV HAVIROV	LUCINA	Lucina	10285	228	977	470	145	247	0	0	0	0	0	0	0
6	22	SMVAK 02-COV TRINEC	OLSE	Olse nad Ropic	4260	119	490	250	19	81	0	0	0	0	0	0	0
7	2	OKD KOKSOVNA SVERMA MAR.HORY-hl.o.	CERNY PRIKOP	Odra -Bohumin	3830	65	640	94	2	904	18	0	0	0	0	0	0
8	11	SMVAK 02-COV FRYDEK-MISTEK	OSTRAVICE	Vratimo	9768	987	2540	194	55	664	0	0	0	0	0	0	0
9	12	SMVAK 04-KANALIZACE BILOVEC	BILOVKA	Bilovka pod Sez	352	26	· 134	9	2	28	0	0	0	0	0	0	0
10	4	SMVAK 06-COV OPAVA	OPAVA	Opava-Hostice	7380	391	2177	137	26	450	0	0	0	0	0	0	0
11	17	SMVAK 03-COV KARVINA	OLSINSKY NAHON (OLSE)	Olse-Vernovice	7379	162	1040	220	89	207	0	0	0	0	0	0	0
12	26	TRINECKE ZELEZARNY	OLSE	Olse nad Ropic	32124	103	1285	135	3	642	42	0	0	0	0	0	0
14	21	ZD BOHUMIN ZELEZARNY	BOHUMINSKA STRUZKA	Odra -Bohumin	5676	59	1493	36	0	170	17	3	0	0	0	0	0
16	14	BOCHEMIE BOHUMIN-HLAVNI ODPAD	BOHUMINSKA STRUZKA	Odra -Bohumin	300	81	447	18	0	21	15	14	9	24	96	36	162
18	19	BIOCEL PASKOV	OSTRAVICE	Ostravice-Muglin	8605	393	5060	115	6	353	0	0	0	0	0	0	0
19	51	HRUSOVSKA CHEMICKA SPOLECNOST	ODRA	Odra -Bohumin	609	46	306	11	1	301	32	26	1	6	79	37	61
20	31	OVAK OSTRAVA-COV O-TREBOVICE	ODRA	Odra-Petrkovice	10393	229	956	587	81	343	0	0	0	0	0	0	0
22	13	VAK BRUNTAL-COV KRNOV	OPAVA	Opava-po Krnovem	4288	227	720	105	15	184	0	0	0	0	0	0	0
23	16	MASSAG BILOVEC - NS	BILOVKA	Bilovka pod Sez	110	4	20	3	0	6	0	0	0	0	0	12	352
26	52	KOKSOVNA SVOBODA - FIEBIGH	OSTARVICE	Odra -Bohumin	4800	58	538	60	2	206	7	0	0	0	0	0	0
29	58	NOVA HUT - COV OSTRAVICE	OSTRAVICE	Ostravice-Muglin	900	12	131	9	0	86	1	1	0	0	0	0	0
31	35	NOVA HUT OSTRAVA-COV LUCINA	LUCINA	Lucina	13500	43	864	371	3	162	14	10	0	0	0	0	0
41	48	VALCOVNY PLECHU - HLAVNI ODPAD	OSTRAVICE	Vratimo	3161	24	158	21	0	199	3	1	0	0	63	63	32
43	53	OVAK COV ZABREH	ODRA	Odra -Bohumin	1789	47	188	68	10	39	0	0	0	0	0	0	0
13	42	OVAK OSTRAVA-KANALIZACE ZABREH	ODRA	Odra -Bohumin	2788	42	446	61	4	39	0	0	0	0	0	0	0
15	34	SMVAK 04-COV KOPRIVNICE	KOPRIVNICKA	Lubina-Kosatka	2778	50	300	102	48	42	0	0	0	0	0	0	0
17	18	SMVAK 03-COV ORLOVA-PORUBA	STRUZKA	Odra -Bohumin	2452	37	228	94	19	51	0	0	0	0	0	0	0
21	10	SM VAK-COV FRENSTAT	LUBINA	Lubina-Kosatka	2704	49	135	48	19	43	0	0	0	0	0	0	0
24	15	SLECHTITELSKA ST. VELKE ALBRECHTICE	JAMNIK (SEZINA)	Bilovka pod Sez	35	4	15	1	1	8	0	0	0	0	0	0	0
25	45	MLEKARNA KUNIN	JICINKA	Jicinka--Kunin	98	20	55	0	1	17	0	0	0	0	0	0	0
27	6	VAK BRUNTAL-COV BRUNTAL	CERNY POTOK (MORAVICE)	Moravice-Branka	4334	95	347	60	11	61	0	0	0	0	0	0	0
28	37	SMVAK 02-KANALIZACE VRATIMOV	SLEZSKY NAHON	Ostravice-Muglin	340	46	156	9	2	27	0	0	0	0	0	0	0
30	43	ZD BOHUMIN DRATOVNY	BAJCUVKA (ODRA)	Odra -Bohumin	1200	11	204	8	0	66	8	0	0	0	0	0	0
32	44	SMVAK 03-MRAZIRNY BOHUMIN	BAJCUVKA (ODRA)	Odra -Bohumin	27	86	114	2	0	6	0	0	0	0	0	0	0
33	23	OVAK OSTRAVA-VYUST CERVENY POTOK	CERNY PRIKOP	Odra -Bohumin	1378	14	83	11	4	77	7	0	0	0	0	0	0
34	40	VAK BRUNTAL-COV VRBNO P/PR	OPAVA	Opava-nad Krnovem	943	5	47	25	4	10	0	0	0	0	0	0	0
35	47	SMVAK 03-COV CESKY TESIN	OLSE	Hvozdnice-Mladec	2348	40	183	60	13	47	0	0	0	0	0	0	0
36	28	TATRA KOPRIVNICE	SYKORECKA (KOPRIVNICKA)	Lubina-Kosatka	3773	23	143	20	0	49	1	0	0	0	0	0	0
37	39	OVAK OSTRAVA KANALIZ. MICHALKOVICE	MICHALKOVICKY POTOK	Odra -Bohumin	510	26	53	10	3	33	0	0	0	0	0	0	0
38	25	SMVAK 04-KANALIZACE KLIMKOVICE	POLANCICE	Odra-Polanka	78	8	23	2	0	6	0	0	0	0	0	0	0
39	29	SMVAK 04-COV PRIBOR	LUBINA	Lubina-Kosatka	940	10	110	16	3	14	0	0	0	0	0	0	0
40	33	SMVAK 03-COV RYCHVALD	STRUZKA	Odra -Bohumin	220	21	37	7	1	16	0	0	0	0	0	0	0
42	20	SMVAK 06-COV BUDISOV	BUDISOVKA	Odra-Jakubcovice	65	6	26	2	0	5	0	0	0	0	0	0	0
43	54	MCHZ HLAVNI ODPAD	ODRA	Odra-Petrkovice	7759	116	341	206	2	279	0	0	0	0	0	0	0
44	32	SMVAK 04 COV FULNEK	HUSI POTOK	Odra-Polanka	263	4	18	8	2	4	0	0	0	0	0	0	0
45	55	SELIKO zav.02 O-SVINOV	PORUBKA	Odra-Svinov	893	121	184	9	0	21	0	0	0	0	0	0	0
46	39	VAK BRUNTAL-KANALIZACE BRIDLICNA	MORAVICE	Moravice-Sleska Harta	130	8	27	3	1	20	0	0	0	0	0	0	0
47	8	VAK BRUNTAL KANAL. HORNI BENESOV	CIZINA	Opava-Vavrovice	98	5	25	1	0	5	0	0	0	0	0	0	0
48	59	VALCOVNY PLECHU - VEDLEJSI ODPAD	OSTRAVICE	Ostravice-Muglin	2147	6	43	10	1	24	1	0	0	0	0	0	0
50	50	VAK BRUNTAL-COV RYMAROV	PODOLSKY POTOK	Moravice-Sleska Harta	1800	29	131	17	3	22	0	0	0	0	0	0	0
51	27	VEREJNA KANALIZACE KRAVARE	STEPANKA	Opava Trebovice	168	8	42	3	1	13	0	0	0	0	0	0	0
52	57	CEZ ELEKTRARNA DETMAROVICE-C ST 2	MLYNKA (DETMAROVICE)	Olse-Vernovice	5902	35	767	19	5	248	0	0	0	0	0	0	0
53	36	VEREJNA KANALIZACE BOLATICE	OPUSTA	Opava Trebovice	75	6	14	2	0	6	0	0	0	0	0	0	0
54	41	VAK BRUNTAL-COV DVORCE	LOBNIK	Moravice-Branka	- 422	2	11	5	1	5	0	0	0	0	0	0	0
55	49	OKD DUL DUKLA HAVIROV	SUSANKA	Lucina	2500	11	375	16	1	38	0	0	0	0	0	0	0
56	30	REHABILITACNI USTAV HRABYNE	HRABYNKA	Opava Trebovice	70	1	6	1	0	2	0	0	0	0	0	0	0
57	60	GALENA OPAVA	OPAVA	Opava Trebovice	696	11	72	1	0	8	0	0	0	0	0	0	0
58	56	AUTOPAL RYCHVALD	BOHUMINSKA STRUZKA	Odra -Bohumin	40	0	3	0	0	1	0	0	0	0	0	8	6

Table 6.24. Results of the ranking procedure

NIVAmix	Map reference	Pollution source	Q355	PO:Q355, m3/y	PO-II (prim.)	PO-II (major)	PO-I	WRI-I	NIVA		PO-II (prim.)	PO-II (major)	PO-I	WRI-I	NIVA
											BOD	BOD	BOD	BOD	BOD
1	1	OVAK OSTRAVA-CERNY PRIKOP	5.91	0.02	1	24	7	3	5		1	14	4	5	17
2	9	OVAK OSTRAVA-UCOV PRIVOZ	5.91	0.02	6	15	1	20	2		11	17	5	41	18
3	3	SMVAK 04-COV NOVY JICIN	0.06	0.06	3	1	16	29	1		7	3	22	38	1
4	5	SMVAK 03-KANALIZACE BOHUMIN	5.91	0.04	5	34	10	2	7		2	20	3	2	16
5	7	SMVAK 03-COV HAVIROV	0.26	0.16	2	2	2	6	27		12	5	9	29	6
6	22	SMVAK 02-COV TRINEC	0.62	0.62	20	8	12	19	4		18	9	15	25	12
7	2	OKD KOKSOVNA SVERMA MAR.HORY-hl.o	5.91	0.02	4	29	13	14	10		9	32	7	9	24
8	11	SMVAK 02-COV FRYDEK-MISTEK	1.53	1.31	11	4	3	5	33		3	2	1	6	4
9	12	SMVAK 04-KANALIZACE BILOVEC	0.05	0.02	14	10	37	17	6		10	7	38	13	3
10	17	SMVAK 03-COV KARVINA	1.6	1.04	10	6	6	9	31		22	11	12	30	20
11	4	SMVAK 06-COV OPAVA	1.1	1.1	9	3	8	13	30		6	1	27	54	21
12	26	TRINECKE ZELEZARNY	0.62	0.62	27	13	9	47	3		34	13	2	32	2
13	42	OVAK OSTRAVA-KANALIZACE ZABREH	5.91	0.89	25	27	17	15	12		33	31	23	34	37
14	21	ZD BOHUMIN ZELEZARNY	5.91	0.04	23	38	11	23	9		29	40	13	31	32
15	34	SMVAK 04-COV KOPRIVNICE	0.17	0.02	19	16	18	16	25		38	23	24	39	7
16	14	BOCHEMIE BOHUMIN-HLAVNI ODPAD	5.91	0.2	17	36	26	8	17		26	36	26	3	38
17	18	SMVAK 03-COV ORLOVA-PORUBA	5.91	0.09	12	35	20	25	15		25	39	31	45	42
18	19	BIOCEL PASKOV	1.9	1.53	21	11	5	10	38		15	8	6	15	11
19	51	HRUSOVSKA CHEMICKA SPOLECNOST	5.91	5.83	49	26	19	4	13		53	37	34	17	44
20	31	OVAK OSTRAVA-COV O-TREBOVICE	3.78	3.76	31	14	4	7	35		37	16	8	28	22
21	10	SM VAK-COV FRENSTAT	0.17	0.06	8	5	24	36	28		13	10	25	40	8
22	13	VAK BRUNTAL-COV KRNOV	0.9	0.84	15	7	15	21	39		8	4	10	16	19
23	16	MASSAG BILOVEC - NS	0.05	0.02	16	12	47	39	14		28	18	54	27	23
24	45	MLEKARNA KUNIN	0.06	0.06	44	22	45	11	11		31	12	42	8	9
25	15	SLECHTITELSKA ST. VELKE ALBRECHTIC	0.05	0.006	18	23	55	12	18		16	22	55	19	29
26	52	KOKSOVNA SVOBODA - FIEBIGH	1.9	1.9	50	28	23	42	8		49	26	11	20	14
27	6	VAK BRUNTAL-COV BRUNTAL	0.67	0.124	7	9	22	40	41		4	6	18	33	13
28	37	SMVAK 02-KANALIZACE VRATIMOV	1.9	0.07	37	40	38	18	20		21	35	33	7	35
29	58	NOVA HUT - COV OSTRAVICE	1.9	1.53	56	43	31	24	16		56	50	28	18	34
30	43	ZD BOHUMIN DRATOVNY	5.91	0.06	42	48	29	30	19		45	54	36	35	45
31	35	NOVA HUT OSTRAVA-COV LUCINA	0.26	0.26	35	17	14	49	37		46	24	17	53	15
32	44	SMVAK 03-MRAZIRNY BOHUMIN	5.91	0.06	43	52	43	1	26		19	44	30	1	40
33	23	OVAK OSTRAVA-VYUST CERVENY POTOK	5.91	0.02	24	45	35	43	23		35	51	41	52	49
34	40	VAK BRUNTAL-COV VRBNO P/PR	0.6	0.4	40	21	42	48	21		52	34	51	56	50
35	47	SMVAK 03-COV CESKY TESIN	0.85	0.72	39	19	25	31	42		41	21	29	43	33
36	28	TATRA KOPRIVNICE	0.17	0.02	29	20	32	54	36		23	15	21	36	5
37	39	OVAK OSTRAVA KANALIZ. MICHALKOVICE	5.91	0.02	38	53	39	32	24		30	53	39	22	47
38	29	SMVAK 04-COV PRIBOR	0.17	0.11	30	18	40	45	40		36	19	44	51	28
39	25	SMVAK 04-KANALIZACE KLIMKOVICE	0.87	0.01	26	44	51	28	32		17	41	48	10	41
40	33	SMVAK 03-COV RYCHVALD	5.91	0.04	34	51	44	33	29		20	46	40	11	48
41	20	SMVAK 06-COV BUDISOV	0.17	0.01	22	33	52	26	50		14	27	50	12	43
42	48	VALCOVNY PLECHU - HLAVNI ODPAD	1.53	1.28	45	25	27	41	48		47	30	19	26	31
43	53	OVAK COV ZABREH	0.89	0.89	51	30	30	38	43		51	29	32	37	25
44	54	MCHZ HLAVNI ODPAD	3.78	3.77	52	32	21	46	46		48	25	14	42	30
45	32	SMVAK 04 COV FULNEK	0.87	0.04	33	39	56	55	34		39	42	53	49	46
46	55	SELIKO zav.02 O-SVINOV	0.9	0.018	53	54	33	22	45		43	45	16	4	10
47	38	VAK BRUNTAL-KANALIZACE BRIDLICNA	0.67	0.32	46	31	48	27	51		42	28	47	21	39
48	8	VAK BRUNTAL KANAL. HORNI BENESOV	1.09	0.004	13	41	53	37	55		5	38	52	24	53
49	59	VALCOVNY PLECHU - VEDLEJSI ODPAD	1.9	1.28	57	55	41	58	22		58	57	37	50	36
50	50	VAK BRUNTAL-COV RYMAROV	0.67	0.12	48	37	34	44	49		40	33	35	44	26
51	27	VEREJNA KANALIZACE KRAVARE	2.53	0.02	28	47	49	35	54		27	47	46	23	52
52	57	CEZ ELEKTRARNA DETMAROVICE-C.ST.2	1.6	0.24	55	46	28	53	44		55	52	20	46	27
53	36	VEREJNA KANALIZACE BOLATICE	2.53	0.02	36	49	54	34	57		24	48	49	14	54
54	41	VAK BRUNTAL-COV DVORCE	0.86	0.02	41	42	50	56	53		44	49	56	58	55
55	49	OKD DUL DUKLA HAVIROV	5.91	0.07	47	50	36	52	56		50	55	43	57	56
56	30	REHABILITACNI USTAV HRABYNE	2.53	0.002	32	56	57	50	58		32	58	57	47	57
57	60	GALENA OPAVA	2.53	2.12	58	57	46	51	52		57	56	45	48	51
58	56	AUTOPAL RYCHVALD	5.91	0.04	54	58	58	57	47		54	59	58	55	58

Ranking method: A: NIVA (major recipient), B: PO-II(primary recip.), C: PO-II (major recip.), D: PO-I (primary recip.), E:WRI-I (primary recipient)

As the various methods represent different important factors, we have attempted to define an "average" ranking system. The method was called as "NIVA mix". We divide all methods in to three groups (1) methods concerning specific discharge (WRI-I, PO-I); (2) methods concerning recipient (PO-II primary & major); and (3) method concerning several factors (NIVA). We have weighted each group equally and calculate the average ranking based on this:

$$R_{NIVA\ mix} = 1/3(R_{WRI-I} + R_{PO-I}) + 1/3(R_{PO-II(prim.)}) + R_{PO-II(maj.)}) + 1/3(R_{NIVA})$$

The first twelve sources according to NIVA mix are identified as the first group of hot-spots in this study.

Table 6.24 presents the results of ranking of pollution sources with respective priority numbers for each method.

As mentioned earlier the presented ranking has been evaluated according to local problems. In order to also include regional effects and the total reduction of pollution for Odra river catchment, a qualified selection of additional "hot spots" were selected. This has mainly been done considering the sources specific load compared to the total pollution load from the 250 sources. In addition some pollution sources has been included in the "hot spots" based on toxicological testing (Källquist and Soldan, 1994), and due to special considerations like extremely small and polluted primary recipients (small canals). Finally one municipal WWTP was added due to its possible effect of Kruzberk drinking water reservoir, and Zabreh treatment plant was also included because of existing plans to transfer the sewage to Ostrava-Privoz waste water treatment plant.

Table 6.25. Summary of additional hot-spots and additional selection criteria

No	NIVA mix	Source	Additional selection criteria
13	14	Zd Bohumin Zelezarny	High Fe (11%), Zn (5%) and COD (6%)loads
14	16	Bochemie Bohumin-Hlavni Odpad	High heavy metal loads (up to 94%)
15	18	Biocel Paskov	High COD (19%) loads
16	19	Hrusovska Chemicka Spolecnost	High heavy metal loads (up to 46%)
17	20	Ovak Ostrava-Cov O-Trebovice	High N (13%) and P (12%) loads
18	22	Vak Bruntal-Cov Krnov	High loads and deteriorated recipient
19	23	Massag Bilovec - Ns	High heavy metal loads (up to 58%)
20	26	Koksovna Svoboda - Fiebigh	High Fe (5%) loads
21	27	Vak Bruntal-Cov Bruntal	Pollution to Kruzberk drinking water reservoir
22	29	Nova Hut - Cov Ostravice	Deteriorated recipient, and due to next source (23)
23	31	Nova Hut Ostrava-Cov Lucina	High Zn (19%) and Fe (9%) loads
24	41	Valcovny Plechu - Hlavni Odpad	High heavy metal loads (up to 43%)
25	49	Ovak Cov Zabreh	Will be transferred to UCOV Privoz

In addition to the above list, we have also considered the discharge from the pig farm - Schlechtitelska St. velke Albrecht, due to its high BOD loads. However the loads are very insignificant in relation to total loads. The local impact is, on the other hand, considerable due to very narrow and polluted recipient. At this stage we have decided to avoid this industry in the hot-spots list.

This study, therefore, identifies 25 point-pollution sources as "hot-spots", where technical measures will considerably improve the water quality in the Odra catchment area. Some of these technical improvements have already taken place, which thus improved the discharge quality in 1994, compared to the commonly available data (1993) used in the ranking. These issues will be discussed in Chapter 7, where abatement plans for 23 of these 25 hot-spots are proposed.

6.7.5 Conclusions

As it is seen from table 6.26, the selection of "58 most important sources" for the ranking procedure is quite reasonable, as these sources represents 78-100% of total measured discharges from industry and municipalities in to the catchment.

The selection of 25 hot-spots for consideration of abatement programmes is also well documented, as these sources represents 67-100% of the total registered 250 sources, and 83-100% of the loads of the 58 important sources. Since the recipient quality is also included in the ranking, these 25 sources will also reduce the most important local problems.

Even if the 25 sources represent 30-53%(BOD, Tot-N and Tot.-P) of the total loads from municipal and industrial sources the importance of these sources to the improvements in water quality is considerably higher, while the self purification from the outlets from smaller WWTP and especially from rural areas will be large.

Table 6.26. Summary of loads from hot-spots

	BOD t/y	COD-Cr t/y	Tot-N t/y	Tot-P t/y	SS t/y	Fe t/y	Zn t/y	Hg kg/y	Cd kg/y	Pb kg/y	Cu kg/y	Ni kg/y
sum 25 hot-spots	5570	26953	4388	689	7892	148	56	10	30	238	148	607
sum 33 non-hot spots	860	4420	781	139	1252	17	0	0	0	0	8	6
sum 58 important spots	6430	31373	5169	829	9145	165	56	10	30	238	156	613
All 250 registered spots	7306	35588	6006	966	11734	174	58	10	30	238	156	613
Ratio 58 spots/250 registered	88%	88%	86%	86%	78%	95%	97%	100%	100%	100%	100%	100%
Ratio 25 hot-spots / 58 spots	87%	86%	85%	83%	86%	90%	100%	100%	100%	100%	95%	99%
Ratio 25 hot-spots/250 registered	76%	76%	73%	71%	67%	85%	97%	100%	100%	100%	95%	99%
Ratio 25 hot-spots/total Mun & Ind	30%	-	53%	45%	-	85%	97%	100%	100%	100%	95%	99%

7 Pollution abatement- Technical Measures

7.1 Introduction

This study has addressed the hot-spots within municipal WWTP and industry presented in chapter 6.7 The intention of this chapter is to evaluate the possibilities to meet the water quality goals presented in chapter 5.2.2 by proposing treatment improvements for the important sources. The technical measures are also analysed with respect to economy in order to evaluate cost-benefit effect for each measure.

Pollution abatement from smaller waste water treatment plants, rural area and agriculture is not addressed in detail within this study, but one should however be aware that technical solutions for these sources also can be cost-effective especially in relation to local problems. Measures within agriculture can also be cost-effective compared to the Hot-spots, and give a significant contribution to the total improvement of water quality in the region. General measures within agriculture has thus been addressed in chapter 7.4, and are compared with measures for municipal and industrial sources in chapter 7.5. Further studies ought to address pollution from agriculture, smaller municipal waste water treatment plants and pollution from rural area (see recommendations in appendix 10.16).

7.2 Pollution abatement-municipal sources

7.2.1 Importance of municipal sources

Table 7.1 summarises the importance of the municipal WWTP discharges in to the recipients in the Odra catchment area. 60% of the population are connected to these, and the table does not include smaller waste water treatment plants or municipal waste water from rural area. The data are given in relation to all 250 registered point-sources.

Table 7.1 : Contribution from WWTP

	BOD	COD-Cr	Tot-N	Tot-P	SS
Total load from the 250 registered point-sources, t/y	7306	35588	6006	966	11734
Load from the biggest WWTP, t/y	5872	20609	4643	930	6819
% of the load from 250 registered sources	80%	58%	77%	96%	58%
Load from municipal hot-spots, t/y	4683	16013	3514	672	4841
% of the load from 250 registered sources	64%	45%	59%	69%	42%

The municipal WWTP are a major source of BOD, P and N to the recipients in the Odra catchment. Approximately 42-69% of each of these components are coming from the 14 municipal WWTP selected as "hot-spots" in this study. The possibilities to reduce these contributions, based on the information received during the site visits, OVAK and SmVAK offices and from the PO-database for 1993 are investigated in this chapter. The technical data for upgrading of WWTP and the economic analysis are mainly based on the information presented in chapter 7.2.2.

It should be noted that the bypass data from the WWTP are not registered in the database, except for UCOV Privoz. Considering this by pass load from Privoz, the by-pass from other WWTP may also be considerable. On the other hand it has not been reported (SmVAK and OVAK) any by-pass amounts from the other WWTP, and therefore this study addresses the selected hot-spots including only the bypass from Privoz.

Several municipal WWTP in the Odra catchment area are under reconstruction or planning at present to upgrade their processes. The nitrogen removal is of major concern in this respect.

The phosphate removal seems however not to be given the required priority at present. The importance of phosphate discharge control was addressed earlier (chapter 5.1.3), and an introduction of phosphate removal at the municipal waste water treatment plants will give a significant contribution in this respect. Another aspect of the phosphate removal is the requirements in the regulation 171/92. However the requirements for phosphate removal is liberal, even with the new limits in reg 171/92 which are going to be met by the year 2005 (1.5 and 3.0 mg/l total-P, respectively for WWTP > or < 100000 PE). To reach even these liberal limits, many WWTP will have to introduce advanced phosphate removal processes by 2005. In this study the chemical phosphate removal, which is very effectively achieved by upgrading of existing biological treatment plant, has been proposed. Considering the approximation, the indicated costs for this upgrading will be in the same order as for a biological phosphorous removal process.

7.2.2 Technical measures and efficiency

The removal of organic matter (BOD), particles (SS) phosphates and nitrogen is the most important for municipal waste water. All medium and large size municipal waste water treatment plants can be divided into nine groups based on the unit-processes, as shown in table 7.2.

Table 7.2 Major municipal WWTP types

	Name	Description	Details
1	M	Mechanical	Traditional, screening & settling
2	C-hi	Chemical, high load	CEMT, for particle removal
3	C-lo	Chemical, low load	Primary precip., for P & particle removal
4	B-hi	Biological, high load	0.5 kg BOD_5/kg SS*d, Act.Sludge/Biofilm, no presettling
5	B-lo	Biological, low load	0.2 kg BOD_5/kg SS*d, Act.Sludge/Biofilm, w/ presettling
6	B&C-hi	Biol./Chem. simul. precip.	combination of Biol. and Chem.
7	B&C-lo	Biol./Chem separate	combination of Biol. and Chem.
8	B&C+NAS	Biol./Chem. + N-removal with Activated sludge process	Pre-denitrif./simult. precipi. in Act. Sludge
9	B&C+NBF	Biol./Chem. + N-removal with Biofilm proces	Pre-precip., biofilm post-denitrif. + external C-source

The treated waste water quality from these WWTP varies significantly. The average treatment efficiencies are given in table 7.3.

Table 7.3. Expected effluent quality for WWTP > 10 000 PE, for a city with combined sewers (Source: Henze and Ødegaard, 1994).

Type of WWTP	BOD		SS		Total-N		Total-P	
	g/m^3	%	g/m^3	%	g/m^3	%	g/m^3	%
Raw water	150	0	150	0	30	0	7.5	0
M	105	30	60	60	25	15	6.5	15
C-hi	75	50	30	80	23	25	2.5	70
C-lo	45	70	15	90	21	30	0.8	90
B-hi	20	70	30	80	23	25	5.3	30
B-lo	20	90	15	90	21	30	5.3	30
B&C-hi	20	90	20	90	20	35	1.0	90
B&C-lo	10	95	15	95	20	35	0.5	95
B&C+NAS	10	95	10	97	10	70	1.0	90
B&C+NBF	5	97	10	97	5	85	0.5	95

In the following chapters the municipal WWTP in Odra catchment according to the tables 7.6-7.36 are described. The reported removal efficiencies are also evaluated with the "normal" efficiencies given in table 7.3. The evaluation of cost-benefit for investments are based on operation and maintenance (O&M) costs and capital costs (20 years life time, 12% interest) given in the table 7.4.

Table 7.4 Annual costs for WWTP (100 000 PE), (capitalised costs and O&M costs, US$/$m^3$, Qspec.=400 l/PE*d)

	Type	**Capital**	**O&M**	**Total**
1	M	0.110	0.050	0.160
2	C-hi	0.117	0.075	0.192
3	C-lo	0.133	0.083	0.217
4	B-hi	0.150	0.083	0.233
5	B-lo	0.180	0.083	0.263
6	B&C-hi	0.185	0.108	0.293
7	B&C-lo	0.167	0.100	0.267
8	B&C+NAS	0.283	0.158	0.441
9	B&C+NBF	0.225	0.175	0.440

(Source: Henze and Ødegaard, 1994).

When it is suggested to upgrade a municipal WWTP, the unit costs presented in table 7.5 are used.

Table 7.5. Unit costs (capitalised costs and O&M costs) in US$/kg pollutant to be removed by upgrading of municipal WWTP.

	Upgrading step	**BOD**	**Total-P**	**Total-N**
1	No ⇒ M	4	-	-
2	No ⇒ B-hi	2	-	-
3	No ⇒ C-hi	1.3	19	-
4	No ⇒ C-lo	1.0	15	-
5	M ⇒ C-hi	0.4	4	-
6	M ⇒ B-hi	1	-	-
7	B ⇒ B&C	0.3	10	-
8	B&C ⇒ B/C+N (AS or BF)	-	-	10

7.2.3 Ovak Ostrava, Cerny Prikop treatment plant

This WWTP has a calculated capacity of 90 000 PE, and discharges waste water with a high pollution load. The treatment plant consists of a mechanical treatment unit, and the high suspended solids loads in the discharge, question the performance of this process. The phosphorus concentrations seem to be slightly lower than expected from "normal" sewage. The WWTP does not comply with the discharge standard , reg. 171-I (see appendix 10.11).

Table 7.6 : OVAK Ostrava, Cerny Prikop treatment plant

		BOD	COD- Cr	Tot-N	Tot-P	SS
Discharge in 1993	Flow: 4 346 000 m3/y					
	concentration, mg/l	140	293	24.8	3.3	183
	load, t/y	608	1273	108	14	795
	% of total load*	8%	4%	2%	1%	7%
After abatement	concentration, mg/l	20	140	21	3.3	15
	load, t/y	87	608	91	14	65
Pollution Reduction	amount, t/y	522	665	17	0	730
	Abatement effect	86%	52%	15%	0%	92%
	% of total load	7%	2%	0%	0%	6%

* % of total referring to the total load from the 250 registered sources

The waste water from this WWTP is discharged into the Cerny Prikop (artificial canal), which has a very low water flow (Q_{355}=0.02 m^3/sec) and is heavily polluted. Most of the ranking methods were based on the quality of the major recipient which has a much higher flow, and a much better water quality. The fact that this WWTP was ranked as no. 1 even in relation to the major recipient (Odra-Bohumin, Q_{355}=5.91 m^3/sec) indicates the importance of abatement.

It has therefore been suggested to upgrade this WWTP to a high-loaded biological WWTP. The biological treatment will reduce the content of BOD to 20 mg/l and consequently also the COD. This will also reduce the SS concentrations to acceptable levels. The total nitrogen concentrations are, however, not specially high, and the load represents only 2% of the total registered (250) point-source load in the catchment. For this reason nitrogen removal for this plant has not been considered. However, if the later analysis indicate higher total-N values, N-removal will be recommended.

With the proposed improvements the WWTP will meet the requirements in the discharge standard also after year 2005.

The estimated investment for the proposed abatement plan is presented below.

Table 7.7: Cost-benefit for cerny prikop treatment plant

	BOD	Total-N	Total-P	Sum
Investment, US$ ('000)	626			626
Cost-benefit, kg removed/US$	0.83			
Other indirect benefits	reduction of COD and N.			

7.2.4 Ovak Ostrava-Ucov Privoz

Privoz WWTP is the largest municipal WWTP in the Odra catchment, and has a capacity of 250 000 PE. The WWTP has a mechanical treatment including a primary settler and activated sludge process as the unit process. The treated water is discharged to Cerny Prikop (Q_{355}=0.02 m^3/sec) and further in to Odra Bohumin (Q_{355}=5.91 m^3/sec).

In addition to the domestic waste water, this plant receives waste water from metallurgical industries, chemical factories, breweries and meat processing factories. The existing BOD and SS removal efficiencies are acceptable, but the plant does not comply with the discharge standards for ammonia, Tot-P and SS (see appendix 10.11). The waste water treatment plant was ranked as no. 2. When also considering the specific contribution to the total loads from this WWTP, it is recommended to introduce N and P removal by upgrading this plant to a chemical/biological treatment plant with N-removal using the activated sludge process. A further improvement in BOD and SS removal will also be achieved with this upgrading, and will give a contribution in total reduction for these parameters. With the proposed abatements the WWTP will also meet the requirements in the new discharge limits from year 2005.

Table 7.8: OVAK Ostrava-Ucov Privoz

		BOD	COD- Cr	Tot-N	Tot-P	SS
Discharge in 1993	Flow: 32 103 000 m3/y					
	concentration, mg/l	15	86	33	5	18
	load, t/y	482	2761	1053	148	578
	% of total load*	7%	8%	18%	15%	5%
After abatement	concentration, mg/l	10	50	10	1	10
	load, t/y	321	1605	321	32	321
Pollution Reduction	amount, t/y	161	1156	732	116	257
	Abatement effect	33%	42%	70%	78%	44%
	% of total load	2%	3%	12%	12%	2%

* % of total referring to the total load from the 250 registered sources

The treatment plant has a considerable bypass in 1993, Q=2 346 000 m3/y. The table below indicates the calculated pollution load from this bypass, based on average concentrations.

Table 7.9: Bypass before and after investment actions and extra load from the WWTP

	BOD	COD- Cr	Tot-N	Tot-P	SS
	t/y	t/y	t/y	t/y	t/y
Bypass before abatement	399	800	87	26	528
Bypass after abatement (10% untreated bypass)	40	80	9	3	53
Extra load from WWTP after including 90% of bypassed amount	21	106	21	2	21
Load from bypass and extra load from WWTP after abatement	61	186	30	5	74

The current bypass loads are considerable. It is therefore strictly recommended to upgrade the WWTP at least to treat 90% of the bypass. The above table summarises the total discharge after treating 90% of the bypass in the new WWTP.

The UCOV Privoz is the biggest of the three major WWTP administrated by OVAK. They are now in the process of upgrading the treatment of all three (Privoz, Zabreh and Trebovice) WWTPs. The design capacity is 1 mln PE and 500 mln KCs (US$ 15 mln) are estimated for this upgrading, and the waste water from Zabreh and Trebovice will be transferred to Privoz WWTP after upgrading. In this study, however, we have considered these WWTP as individual units and proposed abatement plants, which will approximately result in a similar improvement with a similar investment, compared with the proposed combined WWTP. We have considered a similar treatment efficiency for wastewater in all 3 plants. In reality the discharge will be done only through the Privoz's discharge canals. However, the plan is not full financed yet and it is not clear whether partial pre-treatment and discharges may takes place at Zabreh and Trebovice. Additionally, one has to consider the transport expenses and sewer line constructions if the discharge is to be unified. For this reason, we have considered the continuation of the discharge of treated wastewater to the current recipients.

The discharge loads from the new combined WWTP will be as following:

Table 7.10: Outlet from new Privoz (Q= 47 630 m3/y ('000))

	BOD	COD- Cr	Tot-N	Tot-P	SS
	t/y	t/y	t/y	t/y	t/y
UCOV Privoz	321	1605	321	32	321
UCOV Privoz, current bypass	61	186	30	5	74
COV Zabreh†	36	188	38	9	27
COV Trebovice†	104	520	104	10	104
Total discharge after abatement	522	2499	493	56	526

† see chapters 7.2.5 & 7.2.6 for details.

Summary of the estimate for the investment requirement is given below:

Table7.11: Investment for abatement at Privoz, Zabreh and Trebovice

	Investment, US$ ('000) pr ton removed			
	BOD	Total-N	Total-P	Sum
UCOV-Privoz, upgrading	48	7319	1156	8523
UCOV-Privoz, bypass	113	633	232	978
COV-Zabreh†	3	497	82	588
COV-Trebovice†	37	4833	707	5577
Sum	201	13282	2177	15666
Cost-benefit	3.33	0.1	0.1	

† see chapter 7.2.5 & 7.2.6 for details.

7.2.5 Ovak Cov Zabreh

The mechanical-biological treatment plant in Zabreh treats a part of the domestic waste water from Ostrava city (ca. 16 000 PE) and primarily discharges to a profile of Odra with a low flow (Q_{355}=0.89 m^3/sec).

The total-N values are high, probably due to industrial waste water. However, the specific contribution from this WWTP to the catchment is 1% of the registered (250) point sources, for all important parameters. This treatment plant was not within the identified Hot spots either (ranked as no 43), but as mentioned in the previous chapter, this WWTP will be closed and the waste water will be transferred to UCOV Privoz after reconstruction. Therefore, we have considered an upgrading to a biological/ chemical treatment with nitrogen removal by activated sludge system, similar to the proposed UCOV Privoz.

The WWTP at present does not comply with the discharge limits in reg. 171 for ammonia, but may receive other limits because of influence from industrial sources (see appendix 10.11).

With the proposed investment the treatment plant will comply with the discharge limits also after year 2005.

Table 7.12: Ovak Cov-Zabreh

		BOD	COD- Cr	Tot-N	Tot-P	SS
Discharge in 1993	Flow: 1 789 000 m3/y					
	concentration, mg/l	26	105	37.8	5.6	22
	load, t/y	47	188	68	10	39
	% of total load*	1%	1%	1%	1%	0%
After abatement	concentration, mg/l	10	50	10	1	10
	load, t/y	18	89	18	2	18
Pollution Reduction	amount, t/y	29	98	50	8	21
	Abatement effect	62%	52%	74%	82%	55%
	% of total load	0%	0%	1%	1%	0%

* % of total referring to the total load from the 250 registered sources

The estimated investment for the proposed abatement plan is presented below:

Table 7.13: Cost-benefit for Zabreh treatment plant

	BOD	Total-N	Total-P	Sum
Investment, US$ ('000)	9	497	82	588
Cost-benefit, kg removed/US$	3.3	0.1	0.1	
Other indirect benefits	reduction of SS.			

7.2.6 Ovak Ostrava-Cov Trebovice

The WWTP at Trebovice is mechanical-biological, and has a capacity of 152 000 PE. At present Trebovice WWTP is responsible for 10% N and 8% of P discharges. The plant has satisfactory BOD removal(?), but the high concentration of Tot-N and Tot-P indicate the influence. The WWTP does not comply with the discharge limits regarding Tot-P in reg 171/92 (appendix 10.11). The treated water is discharged to Odra-Petrkovice (Q_{355}=3.78 m^3/sec). The treatment plant was ranked as no 20.

The plant should be upgraded to an advanced treatment plant with combined chemical and biological processes including N-removal because a relatively significant contribution to nitrogen, and to meet the requirements in the discharge standard also after year 2005.

The present plans to OVAK indicate the transfer of all waste water tops to the Privoz WWTP for full treatment after Privoz has been upgraded. The treatment efficiencies and the investment costs for that will be comparable to the upgrading of the plant, as considered here.

Table 7.14: Ovak Ostrava-Cov Trebovice

		BOD	COD- Cr	Tot-N	Tot-P	SS
Discharge in 1993	Flow: 10 393 000 m3/y					
	concentration, mg/l	22	92	57	7.8	33
	load, t/y	229	956	587	81	343
	% of total load*	3%	3%	10%	8%	3%
After abatement	concentration, mg/l	10	50	10	1	10
	load, t/y	104	520	104	10	104
Pollution Reduction	amount, t/y	125	437	483	71	239
	Abatement effect	55%	46%	82%	87%	70%
	% of total load	2%	1%	8%	7%	2%

* % of total referring to the total load from the 250 registered sources

With the proposed investment the treatment plant will comply with the discharge limits after year 2005.

The estimated investment for the proposed abatement plan is presented below:

Table 7.15: Cost-benefit for Trebovice treatment plant

	BOD	Total-N	Total-P	Sum
Investment, US$ ('000)	37	4833	707	5577
Cost-benefit, kg removed/US$	3.3	0.1	0.1	
Other indirect benefits	reduction of SS and COD.			

7.2.7 Smvak 04-Cov Novy Jicin

Novy Jicin treatment plant was built with mechanical biological treatment in 1976 and modernised in 1982. This WWTP has a projected capacity of 38 000 PE and a Qdim = 3 174 000 m^3/y.

At present the plant operates with an overload of 30%. The pollution loads from this plant are not very high (~2% of total measurable point sources) to the catchment area. However, the primary and the major recipient - Jicinka-Kunin has a very low flow (Q_{355}=0.06 m^3/sec) and a deteriorated water quality which requires a better treatment at the WWTP. The treatment plant was ranked as no 3, and does not comply with reg 171 for COD, ammonia and phosphorus (see appendix 10.11).

For this reason, an advanced waste water treatment is suggested for this plant, including a low loaded activated sludge treatment combined with chemical treatment. The treatment plant will also comply with the new discharge standard after 2005, except for N. The N-removal is not considered at this time since the specific load is less than 2% of the total.

Table 7.16: Smvak 04-Cov Novy Jicin

		BOD	COD- Cr	Tot-N	Tot-P	SS
Discharge in 1993	Flow: 4 150 000 m3/y					
	concentration, mg/l	18	145	27	7.3	17
	load, t/y	75	602	111	30	71
	% of total load*	1%	2%	2%	3%	1%
After abatement	concentration, mg/l	10	50	20	0.5	15
	load, t/y	42	208	83	2	62
Pollution Reduction	amount, t/y	33	394	28	28	8
	Abatement effect	44%	66%	25%	93%	12%
	% of total load	0%	1%	0%	3%	0%

* % of total referring to the total load from the 250 registered sources

The estimated investment for the proposed abatement plan is presented below.

Table 7.17: Cost-benefit for Novy Jicin treatment plant

	BOD	Total-N	Total-P	Sum
Investment, US$ ('000)	10		283	293
Cost-benefit, kg removed/US$	3.3		0.1	
Other indirect benefits	reduction of COD and SS.			

7.2.8 Smvak 03-Kanalizace Bohumin

The WWTP in Bohumin is small consisting of a mechanical treatment. The WWTP receives industrial waste water, which is indicated by the high BOD and SS values. The WWTP discharges to Bohuminska struzka which has a low water flow (Q_{355}=0.04 m^3/sec) and the major recipient (Odra-Bohumin, Q_{355}=5.91 m^3/sec) has a highly deteriorated water quality.

The treatment efficiency from the waste water treatment plant is insignificant, and the contribution to the total loads are relatively high for BOD. The possibilities to improve the WWTP are therefore considerable. Average concentrations and the annual loads of N and P, however, seems to be low. The reported phosphorus concentration seems however to be very low, compared to expected concentrations in sewage. The waste water treatment plant does not comply with the discharge limits in reg 171/92 (see appendix 10.11). The WWTP was ranked as no 4.

We have suggested to improve the biological treatment to remove BOD and to remove SS more efficiently, using a high load biological treatment. The treatment plant will also comply with the new discharge standard after 2005, except for N. N-removal is not considered at this time, since the specific load is less than 1% of the total. Nitrogen removal is only recommended if there are special local problems connected to nitrogen.

The WWTP will comply with the discharge limits after year 2005.

Table 7.18: Smvak 03-Kanalazace Bohumin

		BOD	COD- Cr	Tot-N	Tot-P	SS
Discharge in 1993	Flow: 2 100 000 m3/y					
	concentration, mg/l	290	480	27	0.4	269
	load, t/y	609	1008	56	1	565
	% of total load*	8%	3%	1%	0%	5%
After abatement	concentration, mg/l	20	140	21	0.4	15
	load, t/y	42	294	44	1	32
Pollution Reduction	amount, t/y	567	714	12	0	533
	Abatement effect	93%	71%	21%	0%	94%
	% of total load	8%	2%	0%	0%	7%

* % of total referring to the total load from the 250 registered sources

The estimated investment for the proposed abatement plan is presented below:

Table 7.19: Cost-benefit for Kanalizace Bohumin

	BOD	Total-N	Total-P	Sum
Investment, US$ ('000)	567			567
Cost-benefit, kg removed/US$	3.3			
Other indirect benefits	reduction of COD, N and SS.			

7.2.9 Smvak 03-Cov Havirov

Havirov WWTP was build in 1960 with a mechanical and biological (activated sludge) process and a projected capacity of Qdim=16 235 000 m3/y.

The primary recipient is Lucina with a low water flow (Q_{355}=0.16 m^3/sec) and flows further to a profile of Lucina with Q_{355}=0.26 m^3/sec). Waste water from industries result in high ammonia-N concentrations, contributing to 8% of the total measurable point sources in the catchment. The phosphate concentrations are also considerably high, and give a significant contribution to the total loads. The WWTP do not comply with the reg 171-I for these parameters either (see appendix 10.11). Havirov was ranked as "Hot spot" no 5.

An upgrading to a biological/chemical treatment with nitrogen removal is recommended.

The plant is under reconstruction at present. However, the current upgrading plans do not include phosphate removal, thus will not comply with the regulation.

The WWTP will after the proposed abatement also comply with the new discharge standard after year 2005.

Table 7.20: Smvak 03- Cov Havirov

		BOD	COD- Cr	Tot-N	Tot-P	SS
Discharge in 1993	Flow: 10 285 000 m3/y					
	concentration, mg/l	22	95	46	14.1	24
	load, t/y	226	977	470	145	247
	% of total load*	3%	3%	8%	15%	2%
After abatement	concentration, mg/l	10	50	10	1	10
	load, t/y	103	514	103	10	103
Pollution Reduction	amount, t/y	123	463	367	135	144
	Abatement effect	55%	47%	78%	93%	58%
	% of total load	2%	1%	6%	14%	1%

* % of total referring to the total load from the 250 registered sources

The estimated investment for the proposed abatement plan is presented below.

Table 7.21: Cost-benefit for Havirov treatment plant

	BOD	Total-N	Total-P	Sum
Investment, US$ ('000)	37	3672	1347	5056
Cost-benefit, kg removed/US$	3.3	0.1	0.1	
Other indirect benefits	reduction of COD and SS.			

7.2.10 Smvak 02-Cov Trinec

This plant was build in 1966 and has a projected capacity of 3 100 000 m3/y and has a capacity of 25-30 000 PE. Mechanical treatment, primary sedimentation and activated sludge treatment are included in the process. At present there is an overload of 37%. A very high total-N concentrations are observed, where most of the nitrogen presents in the ammonia-form. This is probably due to the industrial discharges (a large amount of the waste water from steel work Trinecke Zelzarny are discharged here). The WWTP does not comply with the discharge standard in reg 171(see appendix 10.11). The WWTP contribute from 1-4% of the total loads from the point pollution sources, and is ranked as "Hot spot" no 6.

The treated water flows in to the primary and major recipient Olse nad Ropic with a Q_{355}=0.04 m^3/sec. A good nitrogen removal process should be introduced. This will require an upgrading to a chemical/biological treatment with activated sludge process and N-removal. The WWTP will after abatement comply with the requirements in reg. 171 also after year 2005.

The WWTP is already under reconstruction (1994), but the planned process does not include chemical treatment as recommended in this study. The ongoing reconstruction estimates 100 000 PE including receiving 55% of the load from Trinecke Zelenarny. These constructions are estimated to be about US$ 10 mln, including sewage lines.

Table 7.22: Smvak 02- Cov Trinec

		BOD	COD- Cr	Tot-N	Tot-P	SS
Discharge in 1993	Flow: 4 260 000 m3/y					
	concentration, mg/l	28	115	59	4.4	19
	load, t/y	119	490	250	19	81
	% of total load*	2%	1%	4%	2%	1%
After abatement	concentration, mg/l	10	50	10	1	10
	load, t/y	43	213	43	4	43
Pollution Reduction	amount, t/y	77	277	207	15	38
	Abatement effect	64%	57%	83%	77%	47%
	% of total load	1%	1%	3%	2%	0%

* % of total referring to the total load from the 250 registered sources

The estimated investment for the proposed abatement plan is presented below.

Table 7.23: Cost-benefit for Trinec treatment plant

	BOD	Total-N	Total-P	Sum
Investment, US$ ('000)	23	2070	146	2239
Cost-benefit, kg removed/US$	3.3	0.1	0.1	
Other indirect benefits	reduction of COD and SS.			

7.2.11 Smvak 02-cov Frydek-Mistek

Frydek Mistek WWTP was build in 1967 with a projected capacity of 123 000 PE and a capacity of 8 900 000 m3/y. The plant consists with mechanical and biological treatment processes. The sewerage system is a combined system and industrial waste waters from textile, food-stuffs, and brewery industry are also discharged into the sewer system.

Currently the plant is over-loaded and a considerable portion of the sewerage is by-passed and discharged into the primary recipient Vratimov (Q_{355}=1.31 m^3/sec) and to the major recipient Ostravice River (Q_{355}=1.53 m^3/sec) without treatment (The information about by pass has been obtained during a site visit, but has not been officially reported and is therefore not included in the pollution budget). The contribution to total loads, and the abatement effect will therefore be much higher than reported below. Even without bypass the WWTP was ranked as "Hot-spot" no 8, and gave a significant contribution to the total pollution load. The WWTP do not comply with the discharge standard in reg 171 (see appendix 10.11). At present the Frydek-Mistek WWTP pays Ckr 25 mln/year as discharge fees.

Poor BOD removals suggests process problems caused by industrial waste water or/and by technical problems. An advanced treatment is recommended. The nitrogen loads are low but over 3% of the total load. Additionally, the current NH_4-N concentration is 17.8 mg/l which is beyond the allowable limit by regulation (15 mg/l until 2005). The possible N-load from the by pass should also be counted.

Therefore we suggest to introduce an advanced chemical and biological treatment including N-removal. It may be necessary to reduce industrial pollution in order to cope with the NH_4-N limits after 2005.

SMVAK is already engaged in the modernisation of this WWTP, and the new design capacity of the plant is 200.000 P.E.. The construction started in 1993 and about one-fourth of the plant is completed. The treatment process is biological with nitrogen removal (pre-de nitrification). SMVAK has no plans on phosphorus removal and the concentrations do not comply with the regulation by or after 2005. Referring to our general comments about effect on the water quality in the recipient, we recommend the phosphorus removal to be incorporated, and the WWTP should reduce the phosphorus values even further than the liberal limits set in the reg 171 (to 1 mg/l instead of 1,5 mg/l). The extension of the waste water treatment plant will also eliminate the by pass amount and give a significantly contribution to improved water quality not only as a result of improved treatment efficiency.

Table 7.24: Smvak 02- Cov Frydek-Mistek

		BOD	COD- Cr	Tot-N	Tot-P	SS
Discharge in 1993	Flow: 9 768 000 m3/y					
	concentration, mg/l	101	260	20	5.7	68
	load, t/y	987	2540	194	55	664
	% of total load*	14%	7%	3%	6%	6%
After abatement	concentration, mg/l	10	50	10	1	10
	load, t/y	98	488	98	10	98
Pollution Reduction	amount, t/y	889	2051	97	46	567
	Abatement effect	90%	81%	50%	82%	85%
	% of total load	12%	6%	2%	5%	5%

* % of total referring to the total load from the 250 registered sources

The estimated investment for the proposed abatement plan is presented below:

Table 7.25: Cost-benefit for Frydek Mistek treatment plant

	BOD	Total-N	Total-P	Sum
Investment, US$ ('000)	267	967	457	1691
Cost-benefit, kg removed/US$	3.3	0.1	0.1	
Other indirect benefits	reduction of COD and SS.			

7.2.12 Smvak 04-Kanalizace Bilovec

Bilovec WWTP with capacity has mechanical-biological treatment and discharges to Bilovka (Q_{355}=0.02 m^3/sec) and further to Bilovec pod Sezinou (Q_{355}=0.05 m^3/sec). Both the BOD and SS discharge concentrations are considerably high, and indicate a poorly operated and/or influence from Industry. The WWTP do not comply with the discharge standard in reg 171 (see appendix, 10.11), and the WWTP was ranked as no 9.

Bilovka is a very polluted tributary and even if the total contribution to the catchment seem to be quite insignificant (~0%), it is recommended to upgrade the waste water treatment plant. BOD, COD and SS limits in the regulation does not allow this discharge at present.

Considering the deteriorated and small recipient we will recommend to introduce a low loaded biological treatment plant. This will enable to keep the discharge within the allowable limits even after 2005.

Table 7.26: Smvak 04- Kanalizace Bilovec

		BOD	COD- Cr	Tot-N	Tot-P	SS
Discharge in 1993	Flow: 352 000 m3/y					
	concentration, mg/l	75	380	25	5.5	80
	load, t/y	26	134	9	2	28
	% of total load*	0%	0%	0%	0%	0%
After abatement	concentration, mg/l	20	140	21	5.3	15
	load, t/y	7	49	7	2	5
Pollution Reduction	amount, t/y	19	84	1	0	23
	Abatement effect	73%	63%	17%	4%	81%
	% of total load	0%	0%	0%	0%	0%

* % of total referring to the total load from the 250 registered sources

Table 7.27: Cost-benefit for Smvak 04- Kanalizace Bilovec treatment plant

	BOD	Total-N	Total-P	Sum
Investment, US$ ('000)	23			23
Cost-benefit, kg removed/US$	3.3			
Other indirect benefits	reduction of COD and SS.			

7.2.13 Smvak 06-Cov Opava

Opava WWTP was build in 1967 with a projected capacity of 159 000 PE and a Qdim = 7400 000 m^3/y. The WWTP consists with a mechanical and biological treatment processes. This WWTP discharges to Opava-Hostice (Q_{355}=1.1 m^3/sec).

The discharged water quality indicates low treatment efficiencies compared to the normal levels for BOD and SS, indicating process problems either caused by industrial waste water or/and by technical problems. The specific loads are also considerable compared to the total discharge to the catchment. The waste water treatment plant do not comply with the discharge standard (see appendix 10.11). The WWTP was ranked as "hot spot" no 11.

Phosphorus removal is however necessary, and it is suggested to upgrade the waste water treatment plant to an efficient low loaded biological/chemical treatment plant. Nitrogen removal is not suggested at this time. The current NH_4-N discharge is 16.9 mg/l which is over the 15 mg/l limit until 2004. With the suggested treatment plant here a portion of NH_4-N will be removed and therefore, it is assumed that the NH_4-N levels will be within the limit until 2004. However, the plant should be upgraded to N-removal plant or take severe actions to limit industrial discharges to meet the limits after 2005.

Table 7.28: Smvak 06- Cov Opava

		BOD	**COD- Cr**	**Tot-N**	**Tot-P**	**SS**
Discharge in 1993	Flow: 7 380 000 m3/y					
	concentration, mg/l	53	295	19	3.5	61
	load, t/y	391	2177	137	26	450
	% of total load*	5%	6%	2%	3%	4%
After abatement	concentration, mg/l	10	50	19	1	15
	load, t/y	74	369	137	4	111
Pollution Reduction	amount, t/y	317	1808	0	22	339
	Abatement effect	81%	83%	0%	86%	75%
	% of total load	4%	5%	0%	2%	3%

* % of total referring to the total load from the 250 registered sources

The estimated investment for the proposed abatement plan is presented below.

Table 7.29: Cost-benefit for Opava treatment plant

	BOD	Total-N	Total-P	Sum
Investment, US$ ('000)	95		220	315
Cost-benefit, kg removed/US$	3.33		0.1	
Other indirect benefits	reduction of COD and SS.			

7.2.14 Smvak 03-Cov Karvina

Karvina WWTP was build in 1961 with a projected capacity of 75 000 PE and Qdim = 8200 000 m3/y. The plant has mechanical-biological treatment, consisting with 6 biological filters. This WWTP discharges to Olse-Vernovice (Q_{355}=1.04 m^3/sec) and further to Olsinsky Nahon (Q_{355}=1.6 m^3/sec).

The plant has fairly good BOD and SS removal today, but does not comply with the discharge standard in reg 171 for several other parameters (see appendix 10.11). The plant was ranked as "Hot spot" no 10.

The plant should be improved especially regarding to phosphates, and nitrogen removal is also recommended. It is suggested an upgrading to a combined biological/chemical treatment plant with N-removal.

The plant will after abatement comply with the discharge standard in reg 171/92.

Table 7.30: Smvak 06- Cov Karvina

		BOD	**COD- Cr**	**Tot-N**	**Tot-P**	**SS**
Discharge in 1993	Flow: 7 379 000 m3/y					
	concentration, mg/l	22	141	30	12.1	28
	load, t/y	162	1040	220	89	207
	% of total load*	2%	3%	4%	9%	2%
After abatement	concentration, mg/l	10	50	10	1	10
	load, t/y	74	369	74	7	74
Pollution Reduction	amount, t/y	89	671	146	82	133
	Abatement effect	55%	65%	66%	92%	64%
	% of total load	1%	2%	2%	8%	1%

* % of total referring to the total load from the 250 registered sources

The estimated investment for the proposed abatement plan is presented below:

Table 7.31: Cost-benefit for Karvina treatment plant

	BOD	Total-N	Total-P	Sum
Investment, US$ ('000)	27	1461	707	2307
Cost-benefit, kg removed/US$	3.3	0.1	0.1	
Other indirect benefits	reduction of COD and SS.			

7.2.15 Vak Bruntal-Cov Krnov

Krnov is a small mechanical-biological WWTP. This WWTP discharges to Opava (Q_{355}=0.84 m^3/sec) and further to Opava pod Kronovern (Q_{355}=0.9 m^3/sec). The pollution loads from this plant are not very high (~2% of total measurable point sources) to the catchment area. However, the discharge is significant considering the size of the plant. There is an insufficient treatment of BOD, and the plant does not comply with the discharge standard in reg 171 (see appendix 10.11). The plant was ranked as "Hot spot" no 22.

It is suggest to improve the biological treatment to a high loaded plant, which will also indirectly improve the discharge quality in relation to other parameters.

Table 7.32: Smvak 06- Cov Krnov

		BOD	COD- Cr	Tot-N	Tot-P	SS
Discharge in 1993	Flow: 4 288 000 m3/y					
	concentration, mg/l	53	168	24	3.5	43
	load, t/y	227	720	105	15	184
	% of total load*	3%	2%	2%	2%	2%
After abatement	concentration, mg/l	20	140	24	3.5	30
	load, t/y	86	600	105	15	129
Pollution Reduction	amount, t/y	142	120	0	0	56
	Abatement effect	62%	17%	0%	0%	30%
	% of total load					

* % of total referring to the total load from the 250 registered sources

The estimated investment for the proposed abatement plan is presented below:

Table 7.33: Cost-benefit for Krnov treatment plant

	BOD	Total-N	Total-P	Sum
Investment, US$ ('000)	113			113
Cost-benefit, kg removed/US$	1.25			
Other indirect benefits	reduction of COD, N and SS.			

7.2.16 Vak Bruntal - Cov Bruntal

Kruzberk reservoir is used for drinking water supply in the area. There are about 250 different small discharges (mainly with agricultural origin) in the catchment area which could affect the water quality in the reservoir. Among these discharges, 4 municipal WWTP are identified to be among the highest 58 pollutants in the Odra catchment. The discharge load from these 4 WWTP are given below:

Table 7.34: Loads from municipal waste water treatment plant in the catchment are to Kruzberk reservoir

		BOD	COD- Cr	Tot-N	Tot-P	SS
Vak Bruntal-COV Bruntal	conc., mg/l	22	80	13.9	2.5	14
Q = 4 334 000 m^3/y	load, t/y	95	347	60	11	61
Vak Bruntal-COV Rymarov	conc., mg/l	16	73	9.6	1.5	12
Q = 1 800 000 m^3/y	load, t/y	29	131	17	2.7	22
Vak Bruntal-COV Dvorce	conc., mg/l	4.5	27	11.6	1.3	12
Q = 422 000 m^3/y	load, t/y	1.9	11.4	4.9	0.5	5.1
Vak Bruntal-COV Kanl. Brdlicna	conc., mg/l	60	210	20.2	5.5	150
Q = 130 000 m^3/y	load, t/y	7.8	27.3	2.6	0.7	19.5

Only Vak Bruntal - COV Bruntal seem to give any "significant" load to the recipient. However, it is not considered whether any of these loads may represent any acute danger to the drinking water quality. The primary concern in that aspect should be disinfecting, which is not generally considered under this abatement program, but is strictly advisable for all four WWTP. It is however recommended to perform an own abatement programme for the drinking reservoirs in the region where all sources must be evaluated (see recommendations in appendix 10.16).

Within this study it is only suggested to include Vak Bruntal - COV Bruntal in the abatement plan. VAK-Bruntal is today a mechanical treatment plant, and discharges waste water to Cerny Potok (Q355=0.124 m^3/sec) and further to the Moravice-Slezska Harta (Q355= 0.67 m^3/sec). The treatment plant was ranked as "Hot spot" no 27, but is considered due to the above mentioned affects on the drinking reservoir.

It is suggested to upgrade the treatment to a full chemical / biological treatment. The specific loads before and after abatement are given below. We also suggest to include a good sludge separation system in order to achieve the extra high treatment efficiencies indicated below.

Table 7.35: Smvak 06- Cov Bruntal

		BOD	COD- Cr	Tot-N	Tot-P	SS
Discharge in 1993	Flow: 4 288 000 m3/y					
	concentration, mg/l	22	80	13.9	2.5	14
	load, t/y	95	347	60	11	61
	% of total load*	1.3%	1%	1%	1.1%	0.5%
After abatement	concentration, mg/l	10	30	12	0.3	8
	load, t/y	43	130	52	1	35
Pollution Reduction	amount, t/y	52	217	8	10	53
	Abatement effect	55%	63%	13%	88%	43%
	% of total load	1%	1%	0%	1%	0%

* % of total referring to the total load from the 250 registered sources

The estimated investment for the proposed abatement plan is presented below:

Table 7.36: Cost-benefit for Bruntal treatment plant

	BOD	Total-N	Total-P	Sum
Investment, US$ ('000)	16		95	111
Cost-benefit, kg removed/US$	3.3		0.1	
Other indirect benefits	reduction of COD, N and SS.			

7.2.17 Other municipal WWTP

Table 7.37 gives an overview of municipal waste water treatment plants managed by SmVAK and OVAK which are not within the selected Hot spots, but which will not manage to fulfil the requirements in reg 171/92 (appendix 10.3). Action should be considered for these sources, but is not evaluated within the current study (see reccomendations in appendix 10.16).

Table 7.37: Municipal waste water treatment plants which do not comply with reg 171/92

Pollution Source	Regulation 171 before 1995					Regulation 171 after 1995				
	BOD	COD-Cr	N-NH4	Tot-P	SS	BOD	COD-Cr	N-NH4	Tot-P	SS
SmVAK 02-Kanalizace Vratimov	x	x			x	x	x	x		x
OVAK Ostrava Vyust Cerveny Potok					x					x
SmVAK 03-COV Cesky Tesin			x	x	x			x	x	x
OVAK Ostrava Kanaliz. Michalkovice	x				x	x		x	x	x
SmVAK 04-Kanalizace Klimkovice	x	x			x	x	x			x
SmVAK 03-COV Rychvald	x				x	x	x	x		x
SmVAK 06-COV Budisov		x			x	x	x	x		x
SmVAK 04 COV Fulnek								x		
VAK-Bruntal Kanalizace Bridlicna	x	x			x	x	x			x
VAK Bruntal Kanal Horni Benesov		x			x	x	x			x

7.2.18 Accompanying measures for WWTP

An analysis of the projected and the measured efficiencies (1993) of WWTP reveals considerable differences in several WWTP. This is caused by non-optimal operation and/or by unexpected industrial discharges which are toxic to biological processes. The strengthening of the technological awareness among process personnel working in WWTP will play a key role in this aspect. It is suggested to actively utilise common forums to discuss such problems and promote technological competence. The Norwegian WWTP forum "NORVAR" is an excellent example for this.

The quality assurance of measurements should be an important aspect in all monitoring procedures. It is suggested to avoid the use of grab samples in sampling. All analysis should be conducted on composite samples (hourly/weekly/monthly based). It is also very important to register the by-pass amounts in order to get the total picture of the discharge. Among other measures, lab- and pilot-scale on-site process optimisations are suggested (appendix 10.16).

7.3 Pollution abatement- industrial sources

7.3.1 Importance of industrial sources

Many industries are situated in the Odra river catchment area. Most of these produce waste water flows which contain considerable amounts of heavy metals and other pollution, even after industrial pre-treatment facilities. In contrast to the last decade or earlier, today as firms are split up and privatised, the costs of industrial pre-treatment are felt to be high, and there is a risk that increasing amounts of industrial discharges will flow directly into municipal sewers which are not equipped to handle such waste. An another common issue for many industries in the Eastern Europe is the out-dated instruments and technologies together with bad house-keeping practice. The major issues for industrial pollution prevention are therefore:

- Internal measures like modernisation, waste minimisation, etc.,
- to find innovative, cost-effective waste water treatment measures depending on site-specific features,
- to optimise pre-treatment facilities and municipal WWTP according to the incoming waste water and to the expected treatment efficiencies.

Table 7.38 summarises the pollution from the industrial sources to the recipients in the Odra catchment area. The data are given in relation to the all 250 measurable point-source discharges in the catchment.

Table 7.38: Contribution from industrial "Hot-Spots".

		BOD	COD-Cr	Tot-N	Tot-P	SS	Fe	Zn	Hg	Cd	Pb	Cu	Ni
		t/y (or %)							kg/y (or %)				
Total load*		7306	35588	6006	966	11734	174	58	10	30	238	156	613
Industrial sources	load	1435	14979	1363	36	4915	167	58	10	30	238	156	613
	%*	20	42	23	4	42	96	100	100	100	100	100	100
Industrial hot-spots	load	887	10940	875	18	3051	148	55	10	30	238	148	607
	%*	12	31	15	2	26	85	94	100	100	100	95	99

**refers to the total loads from the 250 registered point-pollution sources.*

The industrial sources are the major contributors of heavy metals to the recipients in the Odra catchment. Approximately 85-100% of each of these components are coming from the 11 industrial sources which were selected as "hot-spots" in this study.

In this report the possibilities to reduce these contributions are investigated, and based on the information received during the site visits and from the PO-database for 1993. Abatement plans for the most acute industrial pollution sources are selected considering their specific pollution load, concentrations and recipient status. This study proposes abatement plans for 9 of these 11 sources.

The presentation of a complete abatement programme for industries with different backgrounds, is impossible within the frame of a study like this. The study has therefore concentrated on the criteria of "how important it is to reduce the load of a parameter from a specific industry to the total catchment". This approach obviously has it's weaknesses, for example by not giving priority to the nature of a specific industry. We do not go into details on the status and potential of the existing WWTP either, which should be considered prior to the selection of final abatement method.

Due to the widely variable industrial processes, the estimated costs must be considered strictly as guideline values. The calculations are based on the waste water volume and the complexity of removal of a given amount of a heavy metal compared to total-N or total-P in a municipal WWTP. As a very approximate method, we have used the rates for an advanced chemical treatment plant based on volume as the basic cost added with specific cost components to remove heavy metals. The latter is calculated assuming unit removal cost for 1 ton of Fe or Zn or 1 kg of other heavy metal removal is equal to the costs for removing 1 ton of P or N. When it is required to remove several non-heavy metal parameters, the rate for advanced chemical / biological WWTP was used. Only the total cost should be noted, since the removal of any specific parameter is not possible to identify in this procedure. In this study, primarily the costs for external treatments are included, but one should also be aware of the possibilities for change in technology. This is also already proposed by the owners for some of the industry plants.

7.3.2 OKD Koksovna Sverma

Koksovna Sverma is a coke plant, and discharges waste water to the primary recipient Cerny Prikop (Q= 0.02 m^3/sec) and further to the major recipient Odra-Bohumin (Q= 5.91 m^3/sec).

Table 7.39: OKD Koksovna Sverma

		BOD	COD-Cr	Tot-N	Tot-P	SS	Fe	Zn	Hg	Cd	Pb	Cu	Ni
Discharge 1993	Flow: 3 830 000 m3/y	t/y (or %)							kg/y (or %)				
	conc., mg/l	17	167	25	0.4	236	4.8						
	t/y or kg/y	65	640	94	1.5	904	18.2	0	0	0	0	0	0
	% of total	1%	2%	2%	0%	8%	11%	0%	0%	0%	0%	0%	0%
After abatement	conc., mg/l	17	167	25	0.4	30	2						
	t/y or kg/y	65	640	94	1.5	115	7.6	0	0	0	0	0	0
Reduction	t/y or kg/y	0	0	0	0	789	10.6	0	0	0	0	0	0
	% of total	0%	0%	0%	0%	7%	6%	0%	0%	0%	0%	0%	0%

*% of total referring to the total load from 250 registered sources

The waste water contents considerable amounts of suspended solids and Fe, which represents respectively 8% and 11% of the total measurable load in the catchment. Koksovna Sverma was ranked as "Hot spot" no 7. The table below summarises the pollution loads from the plant.

It is difficult to suggest any detailed abatement plan for industrial WWTP, due to the sparsely available data on the technological process. However, the loads from the plant to the recipients has been taken into the consideration, and based on only this, it is recommended to reduce suspended solids and Fe to acceptable levels. In many cases suspended solids levels can be reduced to 30 mg/l either by chemical or mechanical means. It is also expected that a considerable removal of Fe will be accompanied with this, since Fe assumed to be associated with particles or in the particle form. Based on volume calculations, the estimated expenses for this abatement procedure will be approx. 1 mln US$.

7.3.3 Trinecke Zelezarny

Trinecke Zelezarny steelworks was founded in 1839 and is today a relatively modern integrated metallurgical plant. The plant produces a wide range of metallurgical products, and has 15 000 employee. The total steel production amounts to 2.3 million t/y of which 50% is exported. Due to lower demand for steel the production capacity of 3.0 million tonnes has not been utilised since 1989.

The plant is situated along the Olse River and it covers an area which is about 7 km long. Each production department has their own integrated treatment plant. The company has 15 major outlets to the Olse River to a profile with a minimum flow Q355=0.62 m^3/sec.

Table 7.40: Trinecke Zelezarny

		BOD	COD-Cr	Tot-N	Tot-P	SS	Fe	Zn	Hg	Cd	Pb	Cu	Ni
Discharge 1993	Flow: 32 124 000 m3/y	t/y (or %)						kg/y (or %)					
	conc., mg/l	3.2	40	4.2	0.1	20	1.3						
	t/y or kg/y	103	1285	135	3	642	42	0	0	0	0	0	0
	% of total	1%	4%	2%	0%	5%	24%	0%	0%	0%	0%	0%	0%
After abatement	conc., mg/l	3.2	20	2.0	0.1	10	0.7						
	t/y or kg/y	103	642	64	3	321	21	0	0	0	0	0	0
Reduction	t/y or kg/y	0	642	71	0	321	21	0	0	0	0	0	0
	% of total	0%	2%	1%	0%	3%	12%	0%	0%	0%	0%	0%	0%

*% of total referring to the total load from 250 registered sources

The summary of discharge data indicate that 24% of all measured Fe-discharges is coming from this sources. Both the suspended solids values and COD values are also considerable. Trinecke Zelezarny was ranked as "Hot spot" no 12.

The plant has several abatement plans to improve the discharge quality. In 1993, the company completed the construction of the water recirculation plant at the rolling mill at a cost of US$ 4.3 mln. This has reduced the amount of waste water discharge by 1000 l/s, and the load of pollutants by 160 tonnes of BOD_5, 712 tonnes of SS, and 137 tonnes of oil. The completion of the Trinec municipal sewage treatment plant which will treat waste water from the coke production plant, will reduce the discharges of phenols and ammonia to the Olse River significantly. The company is planning to construct a central waste water treatment plant on the premises of the plant. This plant will treat all the waste water generated at the plant. A feasibility study has been undertaken and the study concluded that the plant should be built.

Considering the discharge loads, it is suggested that the plant should reduce suspended solids, COD, total-N and Fe content in the discharge by 50%. Some of these parameters are interrelated, therefore an abatement program for few parameters will achieve the total goals. The estimated expenses are set to US$ 7.3 mln.

7.3.4 Zd Bohumin Zelezarny

Bohumin Zelezarny produces wire, radiator-heaters, railway cars etc. The company is owned by the state, but will be privatised. There are 6900 employees. The environmental problems are related to the high content of iron and other heavy metals and the discharge of inorganic acids used in the pickling process.

The waste water is discharged to the primary recipient Bohuminska struzka which has a very low flow (Q=0.04 m^3/sec) and further to Odra-Bohumin with a low flow of Q=5.91 m^3/sec. There are four WWTPs: 1) Mechanical /chemical WWTP (oxidation and sedimentation) for iron production, cooling, rain water and sewage; 2) Neutralisation unit which receive acid water from the pickling process; 3) Biological treatment plant for sewage and 4)a rescirculation (closed cycle) plant for pickling acid.

Table 7.41: ZD Bohumin Zelezarny

		BOD	COD-Cr	Tot-N	Tot-P	SS	Fe	Zn	Hg	Cd	Pb	Cu	Ni
Discharge 1993	Flow: 5 676 000 m3/y	t/y (or %)							kg/y (or %)				
	conc., mg/l	10.4	263.0	6.4	0.0	30.0	3.0	0.5					
	t/y or kg/y	59	1493	36	0	170	17	3	0	0	0	0	0
	% of total	1%	4%	1%	0%	1%	10%	5%	0%	0%	0%	0%	0%
After abatement	conc., mg/l	10.4	50.0	6.4	0.0	15.0	1.5	0.3					
	t/y or kg/y	59	284	36	0	85	9	1	0	0	0	0	0
Reduction	t/y or kg/y	0	1209	0	0	85	9	1	0	0	0	0	0
	% of total	0%	3%	0%	0%	1%	5%	2%	0%	0%	0%	0%	0%

*% of total referring to the total load from 250 registered sources

The factory discharges 10% of Fe and 5% of Zn of the total measurable loads in the catchment area. ZD Bohumin Zelezarny is ranked as "Hot-spot" no 14. The factory it self has proposed several abatement measures. It is suggested that the factory should reduce it's COD concentrations to 50 mg/l and also to reduce suspend solids, Fe- and Zn- load by 50%. It is expected that the cost of these abatement will be about US$ 1.4 mln.

7.3.5 Bochemie Bohumin-Hlavni Odpad

This is a partially-privatised factory for chemical products, with 450 employees. Bochemie has 4 main groups of products: 40 % of the production is disinfecting products on the basis of chlorine, and are used in the agro industry, in hospitals, for cleaning and in household. 40% of the production are used as chemicals in batteries Ni, Cd, Zn and Cl. There is also a whole range of inorganic products (15%) which also produce waste water with a whole range of heavy metals Cd, Zn, Mg, Na, S. The last 5% are special gasses for calibration and for microelectronics industry.

The environmental problems from this industry are mainly related to the disinfecting products and batteries. The waste water has a high content of Zn and other heavy metals, organic waste, chloramine, ammonium and suspended solids. Bochemie Boumin is ranked as "Hot-spot" no 16. The waste water is discharged to the primary recipient Bohuminska struzka which has a very low flow (Q=0.04 m^3/sec) and further to Odra-Bohumin which has a flow of Q=5.91 m^3/sec.

The outlet was found to be toxic (Kallqvist and Soldan, 1994) and Cu and Zn could be the major toxic compounds. It is also noted that the specific organic compounds may also contribute to the toxicity here.

The table below summarises the discharge situation in 1993. Certain internal improvement measures has taken place during 1994. A considerable improvement is expected by switching to semi-finished products instead of raw materials in technical processes. Considering the recipient situation, it is suggested that this industry should reduce their discharge by 50 % in all parameters except for phosphates. A very approximate calculation indicates that an investment of US$ 1.9 mln will be a reasonable estimate.

Table 7.42: Bochemie Bohumin-Hlavni Opdad

		BOD	COD-Cr	Tot-N	Tot-P	SS	Fe	Zn	Hg	Cd	Pb	Cu	Ni
Discharge 1993	Flow: 300 000 m3/y	t/y (or %)							kg/y (or %)				
	conc., mg/l	270	1490	61.6	0.3	69	50	48	0.03	0.08	0.32	0.12	0.54
	t/y or kg/y	81	447	18	0	21	15	14	9	24	96	36	162
	% of total	1%	1%	0%	0%	0%	9%	25%	94%	79%	40%	23%	26%
After abatement	conc., mg/l	135	745	31	0.3	34.5	25	24	0.02	0.04	0.16	0.06	0.27
	t/y or kg/y	41	224	9	0	10	8	7	5	12	48	18	81
Reduction	t/y or kg/y	41	224	9	0	10	8	7	5	12	48	18	81
	% of total	1%	1%	0%	0%	0%	4%	12%	47%	39%	20%	12%	13%

*% of total referring to the total load from 250 registered sources

7.3.6 Biocel Paskov

Biocel Paskov is a privatised pulp and paper mill which produces 200 000 t/y of pulp, cellulose, and is utilising magnesium-bisulphate as lignin dissolving agent. The plant uses only soft wood-spruce, which is obtained primarily from the region. Currently 75% of the production is exported. As a by-product the plant is producing yeast, which is used in animal husbandry.

The plant has been in operation since 1983 and has 1500 employees. About 50 % of the pulp is chlorine bleached while the other half is chlorine free (permanganate). The waste water from the washing process is evaporated together with waste water from the cooking process. The condense water from the evaporation is heavily polluted, and is lead to a mechanical / biological WWTP with post precipitation. The treated waste water is then discharged to Ostravice river to a profile with a flow of Q=1.53 m^3/sec, and further to Muglinov, with flow Q=1.9 m^3/sec.

Biocel Paskov is the largest source of pollution in the Ostravice River, and was ranked as "Hot spot" no 18 in chapter 6.7. The water quality in the river is influenced by this discharge, especially with the discharge of slowly biodegradable lignite, which gives the river a brown colour. Table 7.43 indicates that the waste water from this industry accounts for 14% of the total measurable COD load to the recipients. COD is one of the major problems in waste water from pulp & paper mils. However, there are technologies to cope with this problem, and considering the high specific load from this hot-spot, it is suggested to reduce COD at least by 50%. Both the suspended solids and BOD are expected to reduce considerably during this COD abatement. The cost is estimated to be about 3.6 mln US$.

Biocel Paskov is already planning to convert from chlorine bleaching to ozone bleaching, which will considerably reduce the COD load and eliminate the AOX discharge. The AOX causes poor efficiencies in biological treatment plants, and is hazardous. This process involves considerable investment, which is today estimated to be about US$ 35 mln.

Table 7.43: Biocel Paskov

		BOD	COD-Cr	Tot-N	Tot-P	SS	Fe	Zn	Hg	Cd	Pb	Cu	Ni
Discharge 1993	Flow: 8 605 000 m3/y	t/y (or %)							kg/y (or %)				
	conc., mg/l	46	588	13	0.7	41							
	t/y or kg/y	393	5060	115	6	353	0	0	0	0	0	0	0
	% of total	5%	14%	2%	1%	3%	0%	0%	0%	0%	0%	0%	0%
After abatement	conc., mg/l	20	294	10	0.7	21							
	t/y or kg/y	172	2030	86	6	176	0	0	0	0	0	0	0
Reduction	t/y or kg/y	221	2030	29	0	176	0	0	0	0	0	0	0
	% of total	3%	7%	0%	0%	2%	0%	0%	0%	0%	0%	0%	0%

*% of total referring to the total load from 250 registered sources

7.3.7 Hrusovska Chemicka Spolecnost

The Hrusov Chemical Works is a part of the Moravian Chemical Works Company (MCHZ Hrusov). The chemical company has operated several different production lines. The main production is inorganic chemical compounds. Currently the company is operating two main production lines, products based on barium chemistry and hydro-sulphites. The key raw materials are zinc powder, formal-aldehyd, NaOH, ethylalcohol, hydro-sulphite, and barium. The products are mostly used within the textile and chemical industry.

The technology of the plant is out-dated and the plant is run-down. The plant has severe environmental problems. Spills and deposition of used chemicals have created major waste problems. Although the volume of discharged waste water is low, their concentration is high which results in considerable heavy metal loads to the recipient Odra (Q=5.91 m^3/sec). The outlet was found to be very toxic (Källqvist and Soldan, 1994), even after the plant modifications made during 1992 and 1993. Zn is suspected to be the major toxic compound, but should be confirmed by further analysis. In the ranking of "Hot spot" within this study, it was ranked as no 19.

Table 7.44: Hrusovska Chemicka Spolecnost

		BOD	COD-Cr	Tot-N	Tot-P	SS	Fe	Zn	Hg	Cd	Pb	Cu	Ni
Discharge 1993	Flow: 609 000 m3/y	t/y (or %)							kg/y (or %)				
	conc., mg/l	75	503	18	1.8	495	53	42	0.00	0.01	0.13	0.06	0.10
	t/y or kg/y	46	306	11	1	301	32	26	1	6	79	37	61
	% of total	1%	1%	0%	0%	3%	19%	44%	6%	20%	33%	23%	10%
After abatement	conc., mg/l	75	503	18	1.8	150	27	21	0.00	0.01	0.07	0.03	0.05
	t/y or kg/y	46	306	11	1	91	16	13	0	3	40	18	30
Reduction	t/y or kg/y	0	0	0	0	210	16	13	0	3	40	18	30
	% of total	0%	0%	0%	0%	2%	9%	22%	3%	10%	17%	12%	5%

*% of total referring to the total load from 250 registered sources

Process modernisation and efficient in-plant waste minimisation (cleaner production) should be the most cost effective investment for this factory instead of a end-of-pipe treatment. Since cost estimates for such abatement is not possible to give in this study, we will estimate the abatement cost associated with an external WWTP, which is approximately US$ 1.4 mln.

7.3.8 Koksovna Svoboda - Fiebigh

This is a coke plant producing low concentrated waste water which flows to Ostravice (Q= 1.9 m3/sec). However the Fe-concentrations are considerable, and reaches over 4% of the total load. For this reason this sources was selected for abatement evaluation. Considering the other Fe-sources and their possibilities to reduce the loads, this source is not recommended to propose for abatements.

Table 7.45: Koksovna Svoboda - Fiebigh

		BOD	COD-Cr	Tot-N	Tot-P	SS	Fe	Zn	Hg	Cd	Pb	Cu	Ni
Discharge 1993	Flow: 4 800 000 m3/y	t/y (or %)							kg/y (or %)				
	conc., mg/l	12	112	12.5	0.5	43	1						
	t/y or kg/y	58	538	60	2	206	7	0	0	0	0	0	0
	% of total	1%	2%	1%	0%	2%	4%	0%	0%	0%	0%	0%	0%
After abatement	conc., mg/l	12	112	12.5	0.5	43	1						
	t/y or kg/y	58	538	60	2	206	7	0	0	0	0	0	0
Reduction	t/y or kg/y	0	0	0	0	0	0	0	0	0	0	0	0
	% of total	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

*% of total referring to the total load from 250 registered sources

7.3.9 Nova Hut Ostrava-Cov Lucina

Nova Hut was founded in 1953 and has 17700 employees. The company produces coke and steel and results in many different types of waste water consisting rainwater, waste water from cooling, sewage and waste from the coke plant (phenols, NH_3).

Waste water is primarily discharged to Lucina (Q=0.26 m3/sec). The remaining portion is discharged to Ostravice, and will be discussed under the next hot-spot. The waste water quality is in accordance to the discharge permit. The outlet was ranked as no 31 in the Hot spot evaluation. The discharge represents high Zn and Fe loads and also other studies indicate the toxic possibilities (Kallqvist and Soldan, 1994).

Table 7.46: Nova Hut Ostrava-Cov Lucina

		BOD	COD-Cr	Tot-N	Tot-P	SS	Fe	Zn	Hg	Cd	Pb	Cu	Ni
Discharge 1993	Flow: 13 500 000 m3/y	t/y (or %)							kg/y (or %)				
	conc., mg/l	3.2	64	28	0.2	12	1	0.77					
	t/y or kg/y	43	864	371	3	162	14	10	0	0	0	0	0
	% of total	1%	2%	6%	0%	1%	8%	18%	0%	0%	0%	0%	0%
After abatement	conc., mg/l	3.2	64	14	0.2	12	1	0.39					
	t/y or kg/y	43	864	186	3	162	7	5	0	0	0	0	0
Reduction	t/y or kg/y	0	0	186	0	0	7	5	0	0	0	0	0
	% of total	0%	0%	3%	0%	0%	4%	9%	0%	0%	0%	0%	0%

*% of total referring to the total load from 250 registered sources

However, due to the high volume of waste water, even the small concentrations result in high specific loads to the catchment. This has resulted in high toxic ranking (TEF-value), according to Kallquist and Soldan (1994). This is obvious from the above table. For this reason, we will suggests to reduce total-N, Fe and Zn by 50%. The estimated costs for this abatement is US$ 3.1 mln.

7.3.10 Nova Hut - Cov Ostravice

This is the second discharge of the NOVA Hut plant. The waste water is discharged to the Ostravice-Muglinov profile.

Neither the specific loads nor concentrations are seem to be important to enough to consider any abatement at this stage. However, this is a discharge form the same industry as last one, and therefore selected to consider here.

Considering the total discharge load from this plant we will not suggest any abatements at his time.

Table 7.47: Nova Hut -Cov Ostravice

		BOD	COD-Cr	Tot-N	Tot-P	SS	Fe	Zn	Hg	Cd	Pb	Cu	Ni
Discharge 1993	Flow: 900 000 m3/y	t/y (or %)							kg/y (or %)				
	conc., mg/l	13	145	10	0.2	96	1	0.77					
	t/y or kg/y	12	131	9	0	86	1	1	0	0	0	0	0
	% of total	0%	0%	0%	0%	1%	1%	1%	0%	0%	0%	0%	0%
After abatement	conc., mg/l	13	145	10	0.2	96	1	0.77					
	t/y or kg/y	12	131	9	0	86	1	1	0	0	0	0	0
Reduction	t/y or kg/y	0	0	0	0	0	0	0	0	0	0	0	0
	% of total	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

*% of total referring to the total load from 250 registered sources

7.3.11 Massag Bilovec

Massag chemical works was founded in 1828 and produce today 1400 different products (small metal products and products for cars) which is exported to 64 countries. The company has 720 employees and is privatised. The galvanic process is old and causes many problems, specially heavy metals (Zn) and high pH. The company has three WWTP, mechanical/ chemical, cyanide removal and one for sand/calcium removal.

The waste water is discharged to Bilovka river (Q= 0.02 m3/sec) and further to Bilovka-pod Sezinou (Q=0.05 m3/sec) both of which have very low flows. This discharge causes very high pollution of Cu and Ni in the recipient, in addition to other heavy metals. Massag Biolvec was ranked as no 23 in the evaluation of Hot spots, but has very high Cu and Ni discharges to the recipients.

Table 7.48: Massag Bilovec

		BOD	COD-Cr	Tot-N	Tot-P	SS	Fe	Zn	Hg	Cd	Pb	Cu	Ni
Discharge 1993	Flow: 110 000 m3/y	t/y (or %)							kg/y (or %)				
	conc., mg/l	37	180	27	0	52	1	3	0	0.003	0	0.11	3.2
	t/y or kg/y	4	20	3	0	6	0	0	0	0	0	12	352
	% of total	0%	0%	0%	0%	0%	0%	1%	0%	1%	0%	8%	57%
After abatement	conc., mg/l	37	180	27.3	0.1	52	1	3		0		0.06	1.6
	t/y or kg/y	4	20	3	0	6	0	0	0	0	0	6	176
Reduction	t/y or kg/y	0	0	0	0	0	0	0	0	0	0	6	176
	% of total	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	4%	24%

*% of total referring to the total load from 250 registered sources

The company has planned to install a new treatment (Reverse Osmoses) and to use new technology in the galvanic production. It is suggest that this industry should reduce their Cu and Ni discharges at least by 50%, which is estimated to cost about US$ 1.9 mln.

7.3.12 Valcovny Plechu - Hlavni Odpad

Valcovny Plechu is a chemical production plant with waste water discharging to Ostravice Muglinov which has a minimum flow Q=1.28 m^3/sec. The waste water is highly polluted with several heavy metals, and the specific loads reaching up to 41% of the total measurable load to the catchment. The plant was ranked as no 42 in the Hot spot evaluation, but has been investigated here because considerable Cd and Pb in the catchment is resulting from this plant.

Table 7.49: Valcovny Plechu- Hlavni Odpad

		BOD	COD-Cr	Tot-N	Tot-P	SS	Fe	Zn	Hg	Cd	Pb	Cu	Ni
Discharge 1993	Flow: 3 161 000 m3/y	t/y (or %)							kg/y (or %)				
	conc., mg/l	8	50	7	0.1	63	0.8	0.3			0.02	0.02	0.01
	t/y or kg/y	24	158	21	0	199	3	1	0	0	63	63	32
	% of total	0%	0%	0%	0%	2%	1%	2%	0%	0%	27%	41%	5%
After abatement	conc., mg/l	8	50	7	0.1	63	0.8	0.3			0.01	0.01	.005
	t/y or kg/y	24	158	21	0	199	3	1	0	0	32	32	16
Reduction	t/y or kg/y	0	0	0	0	0	0	0	0	0	32	32	16
	% of total	0%	0%	0%	0%	0%	0%	0%	0%	0%	13%	20%	3%

*% of total referring to the total load from 250 registered sources

Most probably the internal process optimisation and the modernisation is the key to waste minimisation. Considering the available information, however, the external treatment costs to remove Pb, CU and Ni is estimated to be approximately 1.5 mln US$.

7.4 Agriculture

7.4.1 Importance of agriculture pollution

Based on rough estimates for total pollution loads from the agriculture sector, presented in chapter 6.4, the pollution from this sector is considerable compared to the total loads from municipal and industrial sources. Agriculture contributes with approximately 50% of the anthropogenic nitrogen loads and 12% of the anthropogenic phosphorus pollution.

To achieve a cost/effective abatement program in the Odra river catchment this calls for actions in the agriculture sector as well as in the municipal and industrial sector, especially concerning the removal of nitrogen. This is necearry due to the international agreement to reduce the total loads to the Baltic Sea with 50%, even if this is not needed to improve the local water quality.

As mentioned in chapter 6.4 the project team encourages a study focusing on agriculture pollution, effects and solutions (see recommendations in appendix 10.16).

The abatement programme to reduce the pollution from the agriculture sector will not only be of technical character, but there will also be a lot to achieve by accompanying measures.

With the available data it is impossible to propose cost effective solutions in this study, it can only be proposed some general actions/recommendations based on the Baltic Sea study (Berge et al, 1992).

7.4.2 Technical measures

As a result of the high prices on mineral fertiliser, the pollution from run-off due to fertiliser consumption seems to be less important than run-off from manured fields. Manure pollution is also large as a point pollution source, while the storage conditions and storage capacity for manure are poor. This result in leakage of manure into ground water and watersheds, and spreading of manure on the field outside the growing season. These conditions have also been reported for the Czech part of the Odra river Basin (personal information Berge, 1995), but it is not known in detail if this has been changed during the last years. The general technical actions for agriculture, based on the above mentioned assumptions are listed below:

Animal Husbandry

- Increase the storage capacity of manure to approximately 8 months, which is necessary to avoid spreading of manure outside the growing season.
- Ensure sufficient technical standard of the manure storage facilities. They should be roofed over and with no leakage's both to ground- and surface waters.
- Stop the direct discharge of liquidated manure/farm waste.
- Stop dumping of manure on small areas.
- Avoid outdoor storage of manure, particularly the lagoon solution.
- Ensuring sufficient capacity and standard of silage storage.
- Ensure safe storage for mineral fertilisers and other agrochemicals.
- Reduce the volume of water in piggeries to what is necessary to make the manure pump able.
- Change from high spreading equipment to low spreading equipment in manure application (reduce ammonia volatilisation)
- Incorporate manure into soil without delay after application by ploughing or harrowing (reduce ammonia volatilisation)

Run off from agricultural fields

- Reduce autumn tillage as much as possible, especially on erosion exposed fields.
- Increase the use of catch crop

7.4.3 Accompanying measures

Accompanying measures mentioned in the Baltic Sea Programme (Berge, *et al.*, 1992):

- Bring environmental aspects into agricultural policy
- Institutional strengthening
- Develop advisory service, e.g. to help farmers setting up fertilising plans etc.
- Increase both the capacity and quality of agricultural education regarding environmental issues
- Develop and adopt environmental legislation and standards in the agriculture sector
- Develop effective pollution control services and/authorities, including use of fines also for the agriculture sector.
- Active use of subsidies to achieve less intensive agriculture where it is needed.
- Use of taxation to achieve sound use of agrochemical/better utilisation of manure.

7.5 Prioritised technical measures and improved water quality

7.5.1 Background for measures

The objective of this study has been to propose an abatement program which gives a significant contribution to restore the ecological balance in surface waters in the region. The proposed measures in the previous chapters have been based on the goals for total reduction of pollution in the different recipient profiles in accordance to the criteria listed below:

When a specific load of BOD, N and/or P from a municipal waste water treatment plant is larger than 3% of the total load in the catchment, we have proposed abatement for the respective parameter. Additionally, when a recipient requires a better treatment, or if other specific important reasons have been the case we have also proposed abatement plans regardless of the significance compared to the total load. These reasons are specified under each hot-spot.

Measures at the industrial waste water treatment plants are proposed when the load of a specific parameter is higher than 3%. Other important reasons, like local water quality problems (especially toxicological effects), are specified in detail in the previous chapters.

The discharge limits set in reg 171/92 have been reflected, but as the study mainly focuse on resulting water quality, it has not been proposed investments for "Hot-spots" not complying with the discharge limits if these are not solving local problems or give a significant contribution to the over all pollution in the catchment.

This chapter summarise the measures presented in the previous chapters and outline a prioritised list where the measures have been ranked according to the cost/benefit ratio.

The chapter do also give an overview of the improved water quality if the proposed measures are implemented, and the need for further measures/ studies.

7.5.2 Cost/benefit for industrial and municipal sources-prioritised measures

The cost/ benefit at municipal WWTP can not be compared with the cost/benefit for industrial sources, while investments at municipal WWTP mainly reduce organic waste, suspended solids and nutrient and investments at industrial sources mainly target heavy metals and other micro pollutants.

Municipal WWTP

The cost-benefit ratio for the technical measures in chapter 7.3 is given in appendix 10.2, and are used to rank the measures within the municipal sector (see table 7.50).

The cost-benefit ranking is based on annual costs compared to removal of pollution in tonnes/year (see table 7.51).

Privoz, Trebovice, Zabreh, Novy Jicin, Havirov, Trinec, Frydek Mistek, Opava, Karvina and Bruntal WWTP have a high cost/ benefit ratio.

Comparing the cost/benefit ratio for the different municipal sources, some of the largest WWTP have a high cost/benefit ratio of BOD, 3.33 kg BOD/US$. The cost/benefit ratio for BOD varies between 0.83 and 3.33, and are highest for those WWTP which already have biological treatment, and which only need to improve the process.

The costs of reducing nitrogen and phosphorus are much higher, and require the same amount of investments pr kg removal of phosphorus and nitrogen, 0.10 kg Tot-N /US$ and 0.10 kg Tot-P /US$. Two third of the total investments costs at the municipal waste water treatment plants is due to nitrogen removal. Additional benefits are achieved for SS and CODcr. There are also additional benefits for nitrogen removal for some of the WWTP where only removal of organic matter are proposed.

The cost-benefit ranking does not take into account the fact that the local water quality problems for some sources may be larger than others. So the real cost/benefit ratio might be better reflected in the multi criteria ranking (NIVA, mix), which in addition to total outlets also reflects local water quality problems. The cost-benefit ranking is based on the multicriteria ranking only when two sources have the same cost benefit ratio.

Some of the municipal waste water treatment plants managed by SmVAK and OVAK are not within the selected Hot spots, but will not managed to fulfil the requirements in reg 171/92 after year 2005. Actions should be considered for these sources, but are not proposed within the current study.

An analysis of the projected and the measured efficiencies (1993) of WWTP reveals considerable differences in several WWTP. This is suspected to result from non-optimal operation and/or by unexpected industrial discharges which are toxic to biological processes. The strengthening of the technological awareness among process personnel working in WWTP will play a key role in this aspect. It is suggested to actively utilise common forums to discuss such problems and promote technological competence. The Norwegian WWTP forum "NORVAR" is an excellent example for this. The quality assurance of measurements should be an important aspect in all monitoring procedures. It is also very important to register the by pass amounts in order to get the total picture of the discharges. Among other measures, lab- and pilot-scale on-site process optimisations are suggested, which is also addressed in the recommendations.

Table 7.50: Prioritised municipal "Hot Spots"

Source	Cost/benefit ranking	Original ranking, NIVA mix*	River profiles which are affected**	Total number of river profiles
Ovak Ostrava-Ucov Privoz	1	2	1	1
SmVak 04-Novy Jicin	2	3	11,5,4,3,2,1	6
SmVak 03-cov Havirov	3	5	16B,12,1	3
SmVAK 02-Cov Trinec	4	6	31,30,29,28,27	5
SmVak Frydek Mistek	5	7	13,12,1	3
SmVak 06-Cov Opava	6	9	18,17,2,1	4
SmVak 03-Cov Karvina	7	10	27	1
Ovak Ostrava-Cov Trebovice	8	11	2,1	2
Ovak Cov Zabreh	9	13	3,2,1	3
Vak Bruntal-Cov Bruntal	10	14	24B,24A,17,2,1	5
Vak-Bruntal-Cov Krnov	11	12	21,20,19,18,17,2,1	7
Ovak Ostrava -Cerny Prikop	12	1	1	1
SmVak 03-Kanalizace Bohumin	13	4	1	1
SmVak 04-Kanalizace Bilovec	14	8	10,4,3,2,1	5

*NIVA, mix ranking for municipal sources

** See appendix 10.13

Table 7.51: Prioritised abatement programme for municipal "Hot spot" (ton/year)

No	Source	BOD	CODcr	SS	Tot-P	Tot-N	Annual Costs 1000$US**
1	Ovak Ostrava-Ucov Privoz	536	1838	761	139	795	8523
2	SmVak 04-Novy Jicin	33	394	8	28	28	293
3	SmVak 03-cov Havirov	123	463	144	135	367	5056
4	SmVAK 02-Cov Trinec	77	277	38	15	207	2239
5	SmVak Frydek Mistek	889	2051	567	46	97	1691
6	SmVak 06-Cov Opava	317	1808	339	22		315
7	SmVak 03-Cov Karvina	89	671	133	82	146	2307
8	Ovak Ostrava-Cov Trebovice	125	437	239	71	483	5577
9	Ovak Cov Zabreh	29	98	21	8	50	588
10	Vak Bruntal-Cov Bruntal*	52	217	26	10	8	111
11	Vak-Bruntal-Cov Krnov	142	120	46			113
12	Ovak Ostrava -Cerny Prikop	522	665	730		17	626
13	SmVak 03-Kanalizace Bohumin	567	714	533		12	680
14	SmVak 04-Kanalizace Bilovec	19	84	23		1	23
	Total	3519	9838	3620	555	2212	29121

* No effect of BOD in profile 1 and 2

** Annual costs =Capitalized unit costs and yearly O&M costs

Industrial sources

It is even more difficult to prioritise the industrial sources according to the cost benefit ratio, since it is different parameters which are reduced at the sources. We have however tried to do a qualified ranking according to the cost/benefit ratio, but as for the municipal sources the real cost/benefit might be better reflected in the multi-criteria ranking procedure which also consider local effects.

Table 7.52: Prioritised industrial "Hot-spots"

Source	Cost/benefit ranking	Original ranking, NIVA mix*	River profiles which is affected**	Total number of profiles
Bochemie Bohumin-Hlavni Opdad	1	4	1	1
Hrusovska Chemica Spolecnost	2	6	1	1
Massag Bilovec-NS	3	7	10,4,3,2,1	5
Valcovny Plechu-Hlavni Opdad	4	9	13,12,1	3
Biocel Paskov	5	5	12,1	2
ZD Bohumin Zelezarny	6	3	1	1
Trinecke Zelezarny	7	2	30,29,28,27	4
OKD Koksovna Sverma Mar. Hory	8	1	1	1
Nova Hut Ostrava-Cov Lucina	9	8	12,2,1	3

NIVA, mix ranking for industrial sources

** See appendix 10.13

Table 7.53: Prioritised abatement programme for industrial "Hot-spots" (ton/year)

No	Source	Reduction [tonnes/year]						Reduction [kg/year]					Affected River Profiles	Annual Costs*
		BOD	COD	SS	Tot-N	Fe	Zn	Hg	Cd	Pb	Cu	Ni	No	1000 US$
1	BochemieBohumin	41	224	10	9	8	7	5	12	48	18	81	1	1900
2	Hrusovska Chemica Spolecnost			210		16	13		3	40	18	30	1	1400
3	Massag Bilovec-NS										6	176	10,4,3,2,1	1900
4	Valcovny Plechu-Hlavni Op.									32	32	16	13,12,1	1500
5	Biocel Paskov	221	4199	176	29								12,1	3600
6	ZD Bohumin Zelezarny		1209	85		9	1						1	1400
7	Trinecke Zelezarny		642	321	71	21							30,29,28,27	7300
8	OKD Koks. Sverma Mar. H.			789		11							1	1000
9	Nova Hut Ostrava-Cov Lucina				186	7	5						12,2,1	3100
	Total	262	6274	1592	295	78	29	5	15	119	74	303		23100

* Annual costs =Capitalized unit costs and yearly O&M costs

7.5.3 Summary of investment for "Hot-spots"

<u>Reduction in load</u>

The table below presents the pollution loads to the catchment before and after the proposed abatement programme.

The abatement programme for the "Hot-spots" in the region has resulted in considerable improvements and reduction in total loads from these sources.

The reduction from municipal "Hot-spot" sources for organic matter, nutrients and suspended solids range from 63%-83%. The reduction for these parameters are also very well achieved for the industrial "Hot spots", especially the reduction for less degradable organic matter (CODcr), but also for nitrogen and BOD. The discharges of heavy metals have been halved (see table 7.54.d).

If the reductions are compared with the total loads from the 250 point pollution sources which is registered by PO in the catchment area, the abatement programme has approximately halved the total outlets of organic matter, nitrogen, phosphorus, suspended solids and heavy metals. As mentioned earlier (chapter 6), the 250 registered sources do not represent the total contribution from anthropogenic sources. In addition to the contribution from the 250 registered sources, pollution come from smaller waste water treatment plants (≈15% of the inhabitants), waste water from inhabitants who are not connected to public sewage (≈25%) and pollution from non point and point sources within agriculture.

Table 7.54.e presents the reduction from the abatement programme for municipal and industrial sources compared to the total loads from these sources. The reduction in pollution for these two sectors are also compared with the total anthropogenic loads in the catchment area.

This table indicates that the abatement program results in considerable reduction of pollution when the total loads from anthropogenic sources are taken into consideration (15% for Tot-N, over 20% for BOD, 33% for Tot-P and 50% for heavy metals), the relative importance of these measures in improving the water quality is considerable higher, while the outlets from the "Hot-Spots" will have a direct effect on the water quality. Sewage especially from rural areas, but also smaller WWTP represent a high pollution load, but the selfpurification will be considerable before entering Odra and its tributaries. It is however important to evaluate measures also for smaller WWTP, rural areas and for agriculture in order to achieve a cost-efficient action program.

Table 7.54 Summary of measures at "Hot-spots"

Table 7. 54a: Before Abatement:

	BOD	COD-Cr	Tot-N	Tot-P	SS	Fe	Zn	Hg	Cd	Pb	Cu	Ni
	t/y							kg/y				
Municipal hot-spots	4683	16013	3514	672	4841							
Industrial hot-spots	887	10940	875	18	3051	148	55	10	30	238	148	607
Sum - hot-spots	5570	26953	4388	690	7892	148	55	10	30	238	148	607
Total load*	7306	35588	6006	966	11734	174	58	10	30	238	156	613

* Referring to the total load from 250 registered sources

Table 7. 54b: After Abatement:

	BOD	COD-Cr	Tot-N	Tot-P	SS	Fe	Zn	Hg	Cd	Pb	Cu	Ni
	t/y							kg/y				
Municipal hot-spots	1164	6175	1302	117	1221	0	0	0	0	0	0	0
Industrial hot-spots	626	4666	580	18	1459	78	29	5	15	119	74	303
Sum - hot-spots	1789	10841	1882	135	2681	78	29	5	15	119	74	303
Total load*	3525	19476	3500	411	6523	104	32	5	15	119	82	309

* Referring to the total load from 250 registered sources

Table 7. 54c: Removal by Abatement:

	BOD	COD-Cr	Tot-N	Tot-P	SS	Fe	Zn	Hg	Cd	Pb	Cu	Ni
	t/y							kg/y				
Municipal hot-spots	3519	9838	2212	555	3620	0	0	0	0	0	0	0
Industrial hot-spots	262	6274	295	0	1592	71	27	5	15	119	74	303
Sum - hot-spots	3781	16112	2507	555	5212	71	27	5	15	119	74	303

Table 7. 54d: Reduction

	BOD	COD-Cr	Tot-N	Tot-P	SS	Fe	Zn	Hg	Cd	Pb	Cu	Ni
Municipal hot-spots	75%	61%	63%	83%	75%	0%	0%	0%	0%	0%	0%	0%
Industrial hot-spots	30%	57%	34%	0%	52%	48%	49%	50%	50%	50%	50%	50%
Sum abatement, % hot-spots	68%	60%	57%	80%	66%	48%	49%	50%	50%	50%	50%	50%
Sum abatement, % 250 sources	52%	45%	42%	57%	44%	41%	47%	50%	50%	50%	47%	49%

Table 7.54 e: Reduction in pollution from the abatement programme compared with total loads [%]

	BOD*	Tot-N	Tot-P	Fe	Zn	Hg	Cd	Pb	Cu	Ni
Municipal Hot-spots % of total loads from municipal sources within the 250 registered sources	60	48	60							
Municipal Hot-spots % of total loads from municipal sources	21	32	38							
Municipal Hot-spots % of total loads from anthropogenic sources	19	13	33	0	0	0	0	0	0	0
Industrial Hot-spots % of total loads from industrial sources within the 250 registered sources	18	22	0	43	47	50	50	50	47	49
Industrial Hot-spots % of total loads from anthropogenic sources	1	2	0	41	47	50	50	50	47	49
Municipal and Industrial Hot-spots % of total loads from the 250 registered sources (table 7.50 d)	52	42	57	43	47	50	50	50	47	49
Municipal and Industrial Hot-spots % of total loads from municipal and industrial sources	21	31	37	43	47	50	50	50	47	49
Municipal and Industrial Hot-spots % of total loads from anthropogenic sources	21	15	33	41	47	50	50	50	47	49

*BOD total anthropogenic sources referring only to municipal and industrial pollution

<u>Total costs</u>

Table 7.55 summarises the estimated annual costs of the abatement programme.

Table 7.55. Approximate annual costs (capitalised and O&M costs) for the proposed measures, in US$ 1000.

	BOD	Tot-N	Tot-P	HM etc.	Sum
Municipal hot-spots	2123	21453	5544		29121
Industrial hot-spots				23100	23100
Sum: hot-spots (rounded)	52221				

7.5.4 Cost/Benefit in the agriculture sector

Since the agriculture sector represents 51% of the total anthropogenic nitorgen load, and since nitrogen removal in rural districts may not be considered as cost effective if there are no ground wells for drinking water which can be affected, the largest potential to achieve cost-effective solutions for nitrogen will in addition to the big waste water treatment plants be in the agriculture sector.

The total contribution from agriculture to phosphorus pollution is smaller, but still approximately 12% of the total anthropogenic loads.

For the agriculture sector it is obvious that the main goal must be to reduce nitrogen, especially in area with groundwater and where discharges results in fish kills, but phosphorus removal and BOD removal can be important as well considering the local effects and international agreements.

The total reduction of nitrogen and phosphorus pollution from agriculture in the Odra river Basin based on the measures in chapter 7.4 were calculated to 30070 tonnes Tot-N/year and 3405 tonnes Tot-P/ year (Berge *et al.*, 1992). This gives a total reduction of 1500 tonnes Tot-N/year and 170 tonnes Tot-P/ year in the Czech part (i.e. the Czech pollution load is considered to be 5% of the total production in the Odra river Basin).

Since the proposed measures in chapter 7.4.2 are very general, the total costs given in the Baltic Sea programme can not be transferred directly to the Czech part of the Odra river basin. The costs estimates in the Baltic Sea report were made in a period with big changes in the agriculture sector (big state co-operatives were split up into smaller units).

The total investment costs for the Odra River Basin were stipulated to 10.000 mill US$. The costs were based on building costs for farm buildings in Norway. The capital costs operating and maintenance costs were not included in the budget. The operating costs on these investments are however very low while they mainly include simple buildings and/or traditional farm machinery's (Berge *et al*, 1992).

These stipulated costs for the whole Odra River basin will very roughly result in an investment cost of 500 mill US $ (Norwegian price level) for the agriculture sector in the Czech part of the catchment. It is assumed that the Czech price level is approximately 60% of the Norwegian price level giving total costs of 300 mill US $. Using the same interest and lifetime as for municipal waste water treatment plants(20 year and 12%) this give capitalised costs of approximately 40 mill US$.

Table 7.56: Estimated reduction of pollution in agriculture and investments (The numbers are based on rough estimates and should not be used separately from this study)

	Tot-N	**Tot-P**
Reduction (tonnes/year)	1500	170
Reduction (%)	18	85
Costs US$ 1000*	40 000	

*The costs do not include O&M costs, but these are very low

7.5.5 Total investments and benefits

The cost/benefit between for the different sectors are compared in table 7.57.

Table 7.57: Reduction in load and annual costs for different sectors

	Municipal WWTP			Industry**			Agriculture***		Total***		
	BOD*	Tot-N	Tot-P	BOD*	Tot-N	Tot-P	Tot-N	Tot-P	BOD*	Tot-N	Tot-P
Reduction (tonnes/year)	3519	2212	555	262	295	0	1500	170	3781	4007	725
Contribution % total antrophog. loads	32	28	54	8	8	2	51	12		100	100
Reduction %total anthropogenic loads	19	13	32	1	2	0	9	10	20	24	42
Costs US$ 1000	2123	21453	5544				40000		2123	61453	5544
US$ 1000/ton reduction	0.6	9.7	10.0				26,7		0.6	15.3	7.6

* Total load from anthropogenic sources do only include municipal and industrial sources

** The investments in the Industry sector are not identified for each parameter, total annual costs including heavy metals are 23 mill US$

*** The costs for nitrogen removal in the agriculture sector do also include phosphorus and will give a significant contribution to BOD reduction. The costs and reductions must be considered as very approximately. The annual cost are not directly comparable with costs at municipal WWTP while O&M costs are not included (O&M costs are however low).

The investments in the agriculture sector give a significant contribution to the total loads. The cost benefit for the agriculture sector seems to be a little bit higher but comparable with investments at municipal sources. This indicate that abatements in the agriculture may be cost efficient. The measures and costs in the agriculture sector are however uncertain and ought to be investigated further.

The proposed investments with annual costs (capitalised costs and O&M costs) of 92 mill.US$, results in a total reduction of the total loads from anthropogenic sources with 24% for nitrogen, 42% for phosphorus and over 20% for BOD. The reduction for heavy metals will be 50%.

7.5.6 Improved water quality

The reduction of pollution will result in improved water quality in the Odra river catchment The effects from the pollution reduction for each "Hot spot" in the different section of the catchment area are calculated in appendix 10.13.

Table 7.58-7.60 summarise the reduction in pollution from the "Hot-Spots" in each of the river profiles and compare the result with the goals for water quality in each profile. The proposed abatement will give a significant improvement in the water quality.

7.5.6.1 Odra

<u>General</u>

The improvements in water quality for organic matter, suspended solids, nutrients, heavy metals and bacteria are considerable in the whole river, especially in down stream profiles.

The abatement programme for "Hot spots" do not solve the problems in the upper parts, and additional measures especially within the agriculture sector, for smaller waste water treatments plant and measures in rural districts must be considered in this part of the river.

BOD

The best results are achieved for BOD when comparing the reduction with the objectives, but there are need for further reduction upstream Opava river in the profiles Odra Svinov and Odra Petrokovice.

The reduction in BOD will improve the oxygen conditions, increase the transparency of the water, make the river more pleasant looking and change the conditions in the lowest part from being classified as very polluted water with a limited application value to become class III (polluted water) suitable for industry supply.

Table 7.58: Reduction in organic matter, suspended solids and zinc compared with the water quality objectives.

No	Profile	BOD ton/year			SS ton/year			Zn ton/year		
		Goal	Reduction	%	Goal	Reduction	%	Goal	Reduction	%
1	Odra -Bohumin	1861	2296	123	10172	4628	45	274	27	10
2	Odra-Petrkovice	91	215	236	11982	669	6			
3	Odra-Svinov	422	43	10	4451	50	1			
4	Odra-Polanka	422	17	4	17845	30	0			
5	Odra-Studenka		16		1361	8	1			
6	Odra-nad Jicinkou		0		770	0	0			
7	Odra-Jakubcovice		0		0	0				
10	Bilovka pod Sezinou	14	19	136	159	23	14			
11	Jicinka--Kunin	68	33	49	0	8				
12	Ostravice-Muglinov	398	713	179	3674	870	24	31	5	16
13	Ostravice-Vratimov		889		0	567				
16B	Lucina	25	123	492	0	144		0	5	
18	Opava-Hostice	672	367	55	677	392	58			
20	Opava-pod Krnovem	13	142	1092	0	56				
22	Hvozdnice-usti	2	0	0	0	0				
24B	Moravice-Slezska Harta	115	52	45	213	26	12			
26	Zlata Opavice	52	0	0	173	0	0			
27	Olse-Vernovice		110		0	470				
28	Olse nad Stonavkou		32		0	347				
29	Olse pod Tesinem		50		0	355				
Sum	- Odra at the Border	1861	2406	129	10172	5098	50	274	27	10

Table 7.59: Reduction in phosphorus pollution compared with the water quality objectives

No	Profile	Obj. 1, ton/year			Obj. 2. ton/year			Obj.3(4),ton/year		
		Goal	Reduction	%	Goal	Reduction	%	Goal	Reduction	%
1	Odra -Bohumin		440			440		1299	440	34
2	Odra-Petrkovice		133			133		264	133	50
3	Odra-Svinov		34			34		45	34	76
4	Odra-Polanka		26			26		103	26	25
5	Odra-Studenka		27			27		84	27	32
6	Odra-nad Jicinkou		0			0		5	0	0
7	Odra-Jakubcovice		0			0		7	0	0
10	Bilovka pod Sezinou		0			0		(-)	0	
11	Jicinka--Kunin		28			28		21	28	133
12	Ostravice-Muglinov		175			175		182	175	96
13	Ostravice-Vratimov		46			46		48	46	96
16B	Lucina		135			135		28	135	482
18	Opava-Hostice		22			22		123	22	18
20	Opava-pod Krnovem	46	0	0	46	0	0	59	0	0
22	Hvozdnice-usti		0			0		10	0	0
24B	Moravice-Slezska Harta	22	10	45	28	10	36	28	10	36
26	Zlata Opavice	5	0	0	7	0	0	7	0	0
27	Olse-Vernovice		96			96		2211	96	43
28	Olse nad Stonavkou		14			14		86	14	16
29	Olse pod Tesinem		15			15		83	15	18
Sum	= Odra at the border							1520	536	35

SS and Zn

Even if the objective for SS is unrealistic (due to the natural background values for this pollution), there seem to be significant improvements for this parameter as well, and ca. 50% of the objective is met. The zinc content is still too high (10% of the goal is achieved), but it is doubtfully that the parameter can be reduced to more than 20% of the objective (The total contribution from anthropogenic loads constitute only a small part of the total loads, table 7.50 e).

The reduction in suspended solid will increase the transparency, and make the river more pleasent looking.

Tot-P

The reduction in phosphorous pollution is considerable, and varies from 25-76% of the objectives depending on the profile. The reduction in Odra Bohumin compared to the goals is 34%, but the reduction in the upper parts are poor.

There are some doubts about the improvements in local water quality by reducing this parameter (referring to the discussions in chapter 5.1.3). When the other pollution are reduced, there will probably still be a potential risk that eutrophication can become a problem, including mass development of algae.

Further reduction of phosphorus can therefore be necessary in order to improve the local water quality. In this case other pollution sources must be targeted specially in the upper parts of the river (agriculture, smaller WWTP and pollution from inhabitants who are not connected to public sewage).

The need for phosphorus reduction according to local water quality problems ought to be investigated (see recommendations in appendix 10.16).

The pollution reduction from the proposed abatement program will however, as mentioned earlier, contribute to a reduction in the total loads to Poland and the Baltic Sea.

Table 7.60: Reduction in nitrogen pollution compared with the water quality objectives 1)

No	Profile	Obj 1(2,3),ton/year			Obj. 4. ton/year		
		Goal	Reduction	%	Goal	Reduction	%
1	Odra -Bohumin		1688		2098	1688	80
2	Odra-Petrkovice		546		1262	546	43
3	Odra-Svinov		68		300	68	23
4	Odra-Polanka		19		157	19	12
5	Odra-Studenka		19		312	19	6
6	Odra-nad Jicinkou		0		63	0	0
7	Odra-Jakubcovice	21	0	0	0	0	
10	Bilovka pod Sezinou		1		89	1	1
11	Jicinka--Kunin		28		67	28	42
12	Ostravice-Muglinov		473		37	473	1265
13	Ostravice -Vratimov		97		0	97	
16B	Lucina		553		119	553	465
18	Opava-Hostice		0		135	0	0
20	Opava-pod Krnovem	52	0	0	52	0	0
22	Hvozdnice-usti		0		105	0	0
24B	Moravice-Slezska Harta	310	8	3	310	8	3
26	Zlata Opavice	173	0	0	173	0	0
27	Olse-Vernovice		327		0	327	
28	Olse nad Stonavkou		190		0	190	
29	Olse pod Tesinem		219		108	219	203
Sum	= Odra at the border				2098	2015	96

1)Further reduction in nitrogen might be necessary in prof; 1,2,12,18,27,28,29 to reduce the ammonia concentrations

Tot-N

The water quality according to nitrogen compounds will be improved, especially regarding ammonia pollution and fish kills, but also regarding nitrate and the potential health risk for drinking water. The objectives must as mentioned earlier be revised according to these to possible effects. With the preliminary goals proposed in this report, the objectives will be met in a range from 6-80%.

If further reduction is wanted according to local water quality (especially for ammonia in the lowest part) and the Baltic Sea obligations, it is obviously that other sectors, especially agriculture in the upper parts, must be target to achieve the remaining reduction.

Heavy metals

The water quality will be improved significantly for heavy metals, and the abatement programme will results in 50% reduction in the whole Odra river catchment. Table 7.5.2 shows the river profiles which will achieve an improved water quality (For Odra river there will be some improvements in profile no. 1,2,3 and 4). The improved water quality will reduce episodes with fish kills, and the chronic ecological effects. The acute and chronic health risk connected to the consume of fish and contaminated drinking water will also be reduced.

Bacteria

The hygienic conditions in the river will be improved considerably due to more efficient municipal waste water treatment. This will reduce the health risk connected to swimming, and the contamination of ground water and surface water used for drinking water supply.

7.5.6.2 Opava

The water quality in Opava is only improved to some extent, but fairly well in the upper parts (profile Krnov). The best results are achieved for BOD and SS. Other actions than proposed should be conducted to reduce the phosphorus and nitrogen loads. The effects on the local water quality are however recommended to be studied more in detail, and may result in a revising of the goals set in this report. According to the present water quality it seems at least to be need for further reduction of nitrogen to reduce the ammonia concentration.

The abatement programme will improve the oxygen conditions, the transparency of the water, make the river better looking and improve the hygienic conditions.

7.5.6.3 Moravice

The abatement programme will result in considerable water quality improvements for BOD, but also a reduction of phosphorus is achieved. The reduction in nitrogen is poor.

The reduction of pollution to Kruzberk reservoir is the main concern in this river, and a comprehensive study which target the pollution from all sources in the catchment area and the resulting water quality ought to be carried out. Agriculture contribute in a large extent to the pollution especially regarding nitrogen and bacteria, but also with phosphorus pollution (see recommendations in appendix 10.16).

The phosphorus reduction is not assumed to be enough to prevent blooming of toxic blue green algae. Further improvements to reduce the nitrate content in the reservoir can also be necessary.
The achieved reduction in BOD will improve the water quality locally and make the river more pleasant looking. The reduction of bacteria will also improve the hygienic conditions, but with the remaining activities in the catchment area Kruzberk reservoir is vulnerable to bacteria contamination.

7.5.6.4 Ostravice

Ostravice is very polluted with organic matter, nutrients, heavy metals and bacteria.

The abatement programme will improve the water quality both regarding easily degradable organic matter and organic matter which is not so easily degradable, and the measures at Biocel pulp mill will also improve the colour in the river. The water quality objectives for BOD are met, and the reduction of organic matter will result in much better oxygen conditions, which today are very severe.

The content of several heavy metals Pb, Cu, Ni, Fe and Zn will be reduced.

The water quality goals for both phosphorus and nitrogen are also met. The achieved reduction in nitrogen are probably needed to improve the local water quality since the ammonia concentrations are very high, but the need for reduction in phosphorus according to local problems may be investigated further before the measures for phosphorus are implemented.

The improvements in oxygen conditions, heavy metal concentration and the ammonia concentration, will result in fewer episodes of fish kills and reduce the acute and chronic effects on ecology and human health. The water quality will change from being extremely polluted and only suitable to be a recipient for waste water to become class III (polluted) and suitable for industry supply.The river will also be more pleasant looking and the transparency as well as the hygienic conditions, will be improved.

7.5.6.5 Olse

The abatement programme will improve the water quality in Olse especially for ammonia, CODcr and heavy metals, and will result in fewer fish kills and chronic effects on the ecology. There are also considerable phosphorus reductions, but the need for these improvements should be study more in detail in accordance to local water quality, the effects on Poland and on the Baltic Sea.

7.5.6.6 Smaller Tributaries

Bilovka

The environmental conditions in this tributary are today severe according to organic matters and oxygen conditions, ammonia, nitrate, bacteria and heavy metals. The phosphorus concentrations are not measured, but assumed to be very high.

The proposed abatement programme targets two important sources in this river; Bilovec waste water treatment plant and Massag chemical plant. The investment actions will improve the oxygen conditions (the objectives for BOD are met) and reduce the heavy metal concentration considerably. The hygienic conditions will also be improved to some extent.

Both the ammonia and nitrate concentrations in the river are very high, and there are no improvements for these parameters. Need for pollution abatement for these parameters, as well as for phosphorus, should be studied in detail. The measures proposed in this study are not enough to solve the problems in the river, and the big pig farm Schlectitelska St.velke Albrecht must also reduce their outlets to the recipient.

Jicinka

Jicinka is also a very polluted tributary, and the abatement programme results in considerable improvements for the water quality for organic matter and nutrients. The abatement programme will improve the oxygen conditions locally, increase the transparency and make the river more pleasant looking, but further measures are necessary to restore the ecological balance. The effects for agriculture pollution and measures in this sector, should be considered.

Lucina

The bad situation for BOD, the severe oxygen conditions, phosphorus, nitrogen (especially ammonia) and bacteria in Lucina are in a large extent caused by Havirov waste water treatment plant. The proposed measures for this WWTP will improve the water quality, and the stream will meet the objectives set in this report class (III).

Hvozdnice, Zlata Opavice and Olesna

The pollution abatement programme do not reduce the pollution in these tributaries. Agriculture, outlets from smaller WWTP and sewage from rural area must be target to improve the local water quality.

7.5.6.7 Conclusions

The proposed abatement programme will improve the surface water quality significantly, and to some extent restore the ecological balance. The ground water quality will also be improved, especially in areas where the wells are shallow and influenced by the river quality.

The objectives for water quality set in this report are very well achieved for organic matter, nitrogen (ammonia and nitrate), phosphorus, suspended solids, heavy metals and bacteria. Especially in downstream profiles in Odra and in the mouth of the tributaries. The abatement programme does only to some extent reduce the pollution in the upper parts of the catchment area, and other sources must be investigated and target (especially agriculture, outlets from smaller WWTP and sewage from inhabitants who are not connected to public sewage) to achieve improvements in local water quality in these areas. The reduction of organic matter (both easily and less degradable), the reduction of nitrogen (both nitrate and ammonia), suspended solids, bacteria, heavy metals and phosphorus will result in:

- Improved oxygen conditions.
- Reduced episodes of fish kills and other acute ecological effects.
- Reduced chronic effects on the ecology.
- Reduction in the chronic and acute effects on human health by improving the drinking water quality.
- A more pleasant looking river with increased transparency
- Improved water quality according to the user interests in the area
- A significant reduction of the anthropogenic pollution to Poland and the Baltic Sea.
- Reduction in the risk of euthrophic water and blooming of toxic blue green algae
- Fewer violaters of the environmental law (regulation 171/92).

Need for further reduction in all the above mentioned pollution parameters, should be investigated especially considering local effects, and the effects on ground water and drinking water reservoirs. Separate abatement programme for the drinking water reservoirs should be prepared. The final goals must be discussed in detail by water management authorities and politician, especially the goals for phosphorus and nitrogen.

The level of the objectives for nitrogen set in this report may be revised taking the local effects of nitrogen into account (ammonia-fish kills and nitrate-ground water), but regardless of the local effects the measures will be necessary to meet the requirements in the environmental law (reg 171/92) and to contribute to the obligations in the Baltic Sea declaration.

The level of phosphorus reduction according to the potential risk for eutrophication and blue green algae blooming, must also be investigated further. It is very important that necessary research is carried out to predict these effects both in the drinking reservoirs and in the rivers, in order to implement the necessary measures. The Water Authority should, however, judge if the proposed abatement for phosphorus must be implemented regardless of the local effects, to meet the obligations in the Baltic Sea declaration and the requirements in the Environmental law (reg. 171/92).

7.5.7 Need for further studies

There are need for further studies and measures in the region.

- Protection of drinking water quality

  A cost-efficient abatement programme to reduce the pollution from municipalities, industry and agriculture to the drinking water reservoirs; Kruzberk, Sance and Moravka including restoration measures in the reservoir should be prepared.

  In the preperation of the plans for the new big Slezska Harta drinking reservoir, registration of pollution sources, need for restriction on the activities and how to use land use planning and other legislation as an efficient tool should be addressed.

  Methods and models to calculate eutrophication effects in the Czech reservoirs should be investigated.

  Sub-surface water need to be protected, and there is need for studying the water quality situation, location of sub surface water used for drinking water supply and the need for pollution abatement

- Abatement strategies for agriculture

  The contribution to pollution from agriculture should be addressed including registration of pollution sources and other site specific data. Routines for the collection and the compilation of data should be established.

  Methods and models for calculating contribution from non-point pollution sources should be adapted to Czech conditions.

  There is also need to prepare a cost-effective abatement programme for agriculture including both technical and accompanying measures

- Eutrophication effects in polluted rivers-need for phosphorus removal

  The euthrophication effects in polluted rivers and the need for phosphorus reduction should be investigated, and the program should include the following steps:
  -Review of natural background levels of water quality in pristine areas (reference water)
  -Laboratory experiments to determine algae growth potential in pristine and unpolluted waters with a known P-concentration and in reference water which has been added phosphorus to the same levels as in polluted water.
  -Prediction of effects of phosphorus pollution when other pollution are reduced in the rivers.
  -Evaluation of the need for phosphorus removal to prevent local and regional effects.
  -Evaluation of the need for stricter water quality criteria
  -Evaluation of methods for measurement of phosphorus- quality assurance.

- Measures to reduce pollution from MWW-Exchange of knowledge and technology

  There is need for improved routines and measures to reduce the pollution from municipal sources, which may include;
  -Building up water supply and sewage companies capacity to have efficient O&M in WWTP
  -Establish common forum for exchange of ideas and measures
  -Demonstration projects for optimisation or upgrading of WWTP with nitrogen and phosphorus removal.
  -Improved technical solutions and strategies for municipal waste water in area without WWTP or in area with small WWTP. This will include a inventory of pollution sources, effects on local water quality, review of alternative measures in rural areas and upgrading of existing WWTP.
  -Accreditation (Quality assurance) of pollution loads measurements and their use

- Water quality data and monitoring

  There is a lot of monitoring data in the area. It is recommended to do a statistical evaluation of water quality to find correlations between parameters in order to reduce the extent of the monitoring programme.

  The water quality data should be systematised, in order to make the data more available, and to use them as an efficient planning tool for pollution abatement.

8 Policy, administrative and economic measures and tools

8.1 General

8.1.1 The effectiveness of a policy sector

Basically the effectiveness of a policy sector, like water management of a watershed, is dependent upon abilities on four areas, the ability to:

- set goals
- create institutions
- develop tools
- implement policies
- evaluate and change strategies.

The effectiveness is dependent upon a correspondence between tasks and tools. In order to increase the understanding of what makes a policy sector more efficient, it is necessary to know about and reflect upon how tasks are being defined and set as well as how the tools are being produced and the necessary institutions created. The ability to investigate the existing system of each policy sector, to evaluate it and if necessary change it, is of paramount importance. This is to study the preconditions for the implementation of policies. Are the existing institutions able to "match" the problems they are to solve or mitigate? Is the financing of the institutions organised in such a way that tasks given priority will get its share?

It is thus possible to sequence the study of a policy area in:

- a study of the situation (e.g. the environmental situation)
- a study of how this situation is perceived (what is defined as problematic)
- a study of policies and plans to mitigate the problems
- a study of the implementation of the policies, plans and decisions (financing, legal framework, institutions)
- a study of the actual effects of the plans

8.1.2 Objectives of the study

The objective of our study is to investigate the prerequisites for a cost-efficient water management of *local and regional* problems. This implies a somewhat different approach than the ones that might have been most appropriate for a study of water pollution in a larger geographical setting.

Are local environmental problems important? This is a question that probably will get different answers in different countries and regions. In countries with a strong environmental consciousness - or relatively few other serious problems (like housing, employment, needs for deep economic restructuring) - local problems environmental will be relatively important.

In countries with a low level of environmental consciousness - or relatively low priority given to environmental protection - the incentives to act environmentally is mostly given from outside. International agreements, conditions for obtaining loans and credits from international banks and a general need to be on good terms with richer and more green neighbours constitute main stimuli for the environmental policies pursued.

This fact will influence how the initial situation is understood, what is perceived as problematic. Transboundary effects of pollution will have a relatively high priority compared to local ones simply because environmental policies are not generated locally. The pressure from international sources on the national environmental authorities is stronger than the pressure from domestic sources.

The Odra river catchment area is a region where most industrial activities will have an immediate transboundary effect as it is situated along the Polish border. The so-called *Project Silesia* and the *Baltic Sea Programme* (see chapters 1.2.1, 1.2.2 and 3.5.3) focus on transboundary effects.

Despite the fact that the environmental situation in the Odra river catchment area is one of the poorest in Europe, local environmentalism is poorly developed (see chapter 3.6.2). These facts are important to bear in mind when one makes a study of how environmental and water management goals are set and administrative structures adapted in this area.

This chapter will present some questions and perspectives and relate them to recent debates in Western administrative, organisational and social science.

The chapter will include a set of proposals and recommendations. A massive reorganisation of public administration is the one proposal that certainly is *not* appropriate in the Czech republic today. The basic elements of local self government and deconcentrated state institutions at district level are already in full swing (see chapter 3). The regional level that would cover larger geographical areas than the districts - and contribute to the integration of water management among other policy fields - is on its way despite tough discussions on its actual shape. The basic tools have also been introduced: Legal provisions, economic mechanisms and an environmental sector to man it.

What is needed now to make water management more efficient, is careful and systematic work within the framework given. In order to bring about improvements more experience is needed on how the present public administrative set-up and assortment of policy tools function. In order to make this experience more valuable systematic and professional evaluations and studies ought to be made. The practitioners within Czech water management, environmental management and land use planning should play a central role in such an undertaking of critical self-reflection.

The suggestions below will be within the limits of what is reasonably feasible within the Odra river catchment area.

8.2 Tools

8.2.2 Land use planning

8.2.2.1 Land use planning and water management

The management of water is the result of pressure from various user interests. These may be the interests of hydroelectric power, agriculture, recreation, transport, aquaculture, cultural heritage, fishing, drinking water or nature protection. Each interest has its own ambition and its own resources.

In order to cope with the problem of sector interests supported by their own sectorial or special laws land use planning may prove to an indispensable tool also for water resource management. Land use planning may have important indirect effects on water use by defining the status of a given area that influences on water. The sectorial laws usually take the interests of one specific purpose very well into consideration, but fail to pay sufficient attention to the totality, the total results, e.g. in water resources management.

8.2.2.2 Norwegian experiences

Investigations made in Norway of the potential use of the general Planning and Building Act in water resource management at a local level has shown that making use of a general law may secure a result that is better in sum than an uncoordinated use of the special laws (Falleth & Røe).

By making use of the Planning and Building Act (or similar legal regulations), anticipation may be achieved e.g. by concentrating the erection of dwelling houses and even forbidding construction that leads to a scattered settlement pattern, which has proved to be environmentally detrimental.

The Planning and Building Act can ensure a concentration of industry and agriculture to areas where these activities bring about as little environmental harm as possible.

The Planning and Building Act can secure public access to swimming and boating places. It can forbid building and construction near the shores.

In the Norwegian system the Planning and Building Act opens up for the possibility of a municipal action plan for emissions and sewage as a part of the municipal plan.

All these possibilities given in the Planning and Building Act may contribute to a more integrated water management system in each municipality. One important advantage of the integration of water planning in the physical planning system is that the decisions this way are formalised and made compelling.

8.2.2.3 Land use planning and water management in the Odra river catchment area

In the Czech Republic the responsibility for land use planning rests with the District level. As shown elsewhere (chapters 3.4.1.3 and 8.2.2) a Master Plan for Karviná District and the industrialised parts of Frýdek-Místek District will be elaborated as a cooperation between the municipalities in the area covered. This project is a Czech-European Union cooperation that may lead to results of general interest for other Districts as well.

8.2.2.4 What to do?

- A study ought to be carried out on the potentials of using land use plans systematically as a water management tool.

8.2.3 Water use planning

8.2.3.1 Profile of Czech water use planning

In the Czech republic the water use plan is a result of the scarcity of clean water. The purpose of the plan is to restrict the use of water so that over-exploitation is avoided (chapter 3.4.2). The plan regulates water quality and water use.

Another aspect of water use planning is to weigh the differing user interests connected to water use and water protection. Whereas the restriction of water use in quantitative and qualitative terms is a scientific matter, the weighing is a political matter.

The water plan is termed *'smerný' ('guiding'or 'trend')*, which means that it has not the same force as a land use plan. The elaboration of the plan is the responsibility of the Ministry of Environment, whereas land use planning is under the Ministry of Economy (see chapter 3.3.1.2).

The role of the Districts and local self-government institutions in elaborating the parts of the plan that are relevant for their geographical area is still unclear. A general weakness of guideline plans that are not binding, is their lack of robustness in conflict. A measure to increase the strength of the guidelines in the water management plan would be to fasten it in local and regional preferences.

In order to make water use plans strong they need to be "carried" by vital institutions of public administration.

8.2.3.2 Norwegian experiences

Various measures have been taken by central state authorities in Norway to make water use planning a part of land use planning (according to the Planning and Building Act).

The Ministry of Environment cooperated closely with the county self-government institutions as well as the environmental departments of the county governor (similar to the environmental departments of Czech District Offices).

The elaboration and follow-up of water use plans is organised in various ways in each Norwegian county. Water use plans may be large, including several municipalities in a catchment area, or it may be smaller, including a smaller number of municipalities. The common feature, however, is that the environmental department of the county governor is the main organiser. The county level self-government counterpart of the county governor is the elected county council. This county may set up a water use committee. There are also variations between the Norwegian counties on the role of municipalities in water use planning (Gundersen & Mydske, 1993).

In 1989 the Ministry of Environment and the county self-government institutions as well as the environmental departments of the county governor elaborated a proposal for new national guidelines for the use of the water in Glomma catchment area (Miljøverndepartementet, 1992).

Six priority tasks were chosen: Water quality, water regulations and hydroenergy, cultural heritage, fish resources, outdoor life/ tourism and land use in areas close to water. The Ministry of Environment cooperated closely with the county self-government institutions in this project as well as the environmental departments of the county governor (similar to the environmental departments of Czech District Offices). The chairman and secretary of the county council water use committee were members.

In 1991-93 the Norwegian Directorate for Nature Management carried out a project on local water use plans. The Directorate supported financially the elaboration of local water use plans in several Norwegian municipalities. In Norwegian terms *"water use planning"* is to be understood as *"planning of watercourses and land along them"*. The planning is to encompass the resources in the watercourse and in the watercourse nature as well as interests and activities tied to the watercourse. On central state level it is stated that the municipalities are to play a central role in water use planning. As watercourses cross municipal borders the county council is to harmonise interests. The county governor (the environmental department at county level) is to have guiding responsibilities (Reitan, 1993).

The Norwegian system of water use planning consists of various solutions more or less adapted to local and regional circumstances. The effects of the different solutions that are chosen are evaluated and used as basis for new solutions.

8.2.3.3 What to do?

The water management bodies and the Ministry of Environment ought to carry out a pilot project on developing procedures for anchoring the SVP in local preferences, for instance via the establishment of municipal water plans. The possibilities of coordinating it with the land use plan should be investigated. The need to bring all user interests into the planning process should be emphasised. Some financing of these pilot projects should be made from central funds.

8.2.4 Control and monitoring system

8.2.4.1 Integration of water management in an overall environmental management system

When studying the water management system of one country one may either evaluate its success within water management issues isolated or one may see water management as one important component of an overall environmental management system.

The latter option is the one that is prevailing recommended internationally. According to the prevailing view environmental management should be *'integrated'* or *'multi-media'*, i.e. oriented towards all the media (water, waste, soil, air). The emphasis on integration of the sectors within environmental management is explained by what we know about pollution and environmental degradation: Serious environmental harm may be infringed upon one medium as a result of slack control in another medium. Decisions made specifically for one medium - e.g. on reduction of sewage sludge and other toxic residues dumped into water - may lead to a replacing of a problem - e.g. to land fills or incineration - rather that its solving (Weale et.al., 1991, pp. 1-38).

When environmental cost-efficiency is the goal, medium-specific management may prove to be counterproductive. Water management cost efficiency does not have to imply an over-all environmental cost-efficiency:

"When a control is imposed in one medium without considering the implications for other disposal routes, there may be not only an all-round deterioration, in environmental quality, but costs may also be incurred unnecessarily. For example, if an air pollution problem is solved by creating a sludge that is disposed of in water, the river quality may deteriorate to the economic disadvantage of manufacturers downstream who require relatively pure water for their production processes. The sum of costs thus imposed may be greater than the costs of more comprehensive pollution abatement imposed on the original polluter (Weale et al. p 9).

Czech pollution control does not meet the prevailing requirement internationally of being *'integrated'*, i.e. *'multi-media'* oriented. Czech environmental management is still functionally divided into separate institutions and departments for waste, water and air with their own legal rules to follow. The reason why this set up is not recommended is that it may hinder a rational use of the resources put into environmental protection. Curbing discharges into one of the media may lead to an environmental harm in another medium with the result of increasing the total environmental harm. An integrated approach that sees pollution of all the media together would help avoiding this pitfall. This implies that money levied from pollution of one medium should be possible to transfer to the abatement of pollution in another medium. This transfer should be accomplished through the environmental funds or similar institutions.

All this is underscored and cemented by the fact that most people involved in environmental protection in the Czech republic are professionals within their separate field (e.g. with the title of *'vodohospodár'*, water manager).

The single-media environmental management does exist institutionally by separate bodies taking care of one medium. Therefore it also exists in the minds and behaviour of the enterprises and municipalities that pollute. When fines and charges are given according to the pollution of the environmental media separately, the polluter adapts to this rather than to the over-all effects of its pollution.

Separate from, but still close to, the problem of medium-oriented environmental management, is the problem of *'reactive'* environmental management. Instead of reacting when the environmental harm is already done, an anticipatory approach would be more cost-efficient (prevention in the first hand is usually cheaper than cleaning-up afterwards). As a parallel to what is needed to achieve an integrated environmental management, anticipation requires substantial knowledge and research. It also requires a knowledge that is less focused on the state of the recipient than the production process of the polluter. One thing that is already known, is that routine production procedures may, when the pollution from it is accumulated in the eco-system, generate more harm to the environment than several of the more "accidental" emissions that are reacted towards as soon as they have been disclosed.

It has been held that prevention is more cost-efficient than repair. As a parallel to what is needed to achieve an integrated environmental management, anticipation requires much knowledge and research. It also requires a knowledge among environmental and water managers that is less focused on the state of the recipient than the production process of the polluter.

The mismatch between the problems (pollutants migrating between the environmental media) and the organisational structure of the environmental management system in most countries (that is divided according to the environmental media) makes it obvious that "something has to be done" to create interaction between the organisational parts of the environmental management sector.

At first sight the obvious need to integrate would entail a thorough reorganisation of the over-all environmental management structure in order to bring the 'guardians' of all environmental media into one institution. The option of reorganising massively does not, however, have to be the only solution and certainly not the first step to be made. In order to achieve an over-all perspective of the actors in environmental management, the legal regulations should be rewritten in order to secure the integrated approach among the actors, both controllers and controlled. With a set of measures to make the various intra-environmental management sectors meet, this may be sufficient to reach the wished level of integration.

Changes in the education of environmental managers is another measure to promote the over-all, integrated approach. This, however, may prove to be a tall order without substantial research coverage. The present knowledge on the migration of pollutants across the physical, chemical and biological processes is still very fragmentary.

It is very important that the rethinking of environmental managements and control that follows from the knowledge on migrating pollutants does not lead to insecurity in the enterprises on how to relate to the environmental rules. The introduction of an integrated approach in environmental management should be clearly announced in advance, it should be transparent and understandable and it should not lead to an abrupt augmentation of the fines and charges. Rather it should lead to a restructuring of the reasons for the fines and charges to be paid by the enterprise.

8.2.4.2 What to do?

In order to cope with the problems described above in this chapter, there is a set of measures that could be taken on a short term perspective in the Odra river catchment area.

- An informal environmental management forum for scientific and practical discussions should be established on the new knowledge on migrating pollutants (update on recent research) and how to adapt to, and use, this knowledge in everyday practical environmental management. A second theme for this forum would be production processes and *"cleaner technology"*.

- A group consisting of specialists from each medium should be established with the task to go through all fines in order to check whether they are given according to the present knowledge on migrating pollutants. The work made by this group should be summed up in a set of recommendation on how to apply the existing legal regulations in a way that comes as close as possible to 'integrated' environmental management.
- A forum consisting of environmental managers and environmental officers from the enterprises should be established to investigate and discuss what *'prevention'* would mean in practice.

8.2.5 Mix of administrative, economic and educational measures

8.2.5.1 General

The key to an efficient environmental strategy for an area like the Odra river catchment area heavily polluted by industry is to take the economic interests of the enterprise as the point of departure. Big Czech enterprises have well-established environmental departments (chapter 3.11) to make the enterprises meet the demands in this field. In some cases enterprises have an environmental strategy. Studies of the behaviour and strategies of environmental departments in industrial enterprises in the West have resulted in some general knowledge on how these strategies are made (Aasen & Onsager, 1991).

These experiences show that it is as a reaction to the combination of administrative and economic pressure that the enterprises develop their environmental strategies. The basic incitement to develop an environmental strategy in an enterprise is given by the authorities by means of issuing of permits and establishment of limits as well as permits to use natural resources. This, however, may prove to be a mere reactive approach that fails to result in a long-term cost-efficiency. The active, or *'pro-active'*, approach entails a thorough revision of the technologies and organisational methods made use of in order to develop a *production process* that makes the enterprise avoid the regulatory punishments. This approach help the enterprise manoeuvring itself ahead of the development of environmental regulations.

It has been established that enterprises with a clear strategy for competition develop environmental strategies more easily as well. The ability to plan strategically also makes a potential place for environment (Aasen & Onsager, p.10-11).

The authorities hold three main types of measures to promote environmentally friendly policies:

- administrative
- economic
- educational.

Administrative measures: The Czech Republic possesses the traditional set of institutions and legal measures to coordinate and control within water management (see chapter 3). As seen from the point of view of commercial enterprises these regulations are *costs*, that have to be compensated for.

Economic measures: Charges for pollution of water in Czechoslovakia was introduced in 1966. The rules for this were severe, but little came out of it as there were granted exemptions. In reality most of the charges did not exceed the costs of installing and operating water treatment installations. (Benes, 1992, p. 315). After the downfall of state socialism in 1989, economic mechanisms make more sense since enterprises gradually have become commercial and therefore interested in avoiding taxes and charges.

Environmental taxes may be on emission, which requires monitoring and induce the enterprise to produce in a less polluting way. Taxes may also be on the product itself, a strategy that aims at reducing the demand for polluting products because their prices will rise, but that does not induce the enterprise to produce more environmentally friendly.

The income from the charges for water pollution goes into the State Environmental Fund. It is an official policy to reduce the share of the money spent on environmental protection that comes from the National Budget. Instead the State Environmental Fund will be the main contributor (see chapter 3.5.2). The Fund will be dependent upon high pollution charges.
The criteria for what kind of environmental programmes that are eligible for support from the Fund are given each year by the Ministry of Environment. These criteria are given for the environmental sector as a whole and for each environmental medium.

Educational measures: In the recent years the "soft" methods of manipulating society from above in environmental matters have gained ground in Western Europe. A typical example of these soft methods are the campaigns run by the State Information Agencies in Western countries to make people behave and consume more environmentally friendly. In some countries NGOs are sponsored substantially to carry out such educational campaigns in the population at large or in specific target groups. In the Czech Republic NGOs play an important role, even if they are few and small, in disseminating knowledge on environmental concerns (see chapter 3.6.2).

8.2.5.2 Administrative, economic and educational measures in the Odra river catchment area

The Odra river catchment area is densely populated and heavily industrialised (coal mining, metallurgy and chemical production). Most of the large enterprises belong to the old-fashioned industry inherited from the pre-World War I-period and reshaped by the development of state socialist heavy industry, the so-called *"Iron Option"*. The Silesian hard coal area of Ostrava-Karviná played a central role in state socialist image-building. Ostrava was called the *"Iron Heart"* of Czechoslovakia. These enterprises are not supposed to be economically viable when the reorganisation of Czech industries really starts. Economic mechanisms in environmental management may prove to be difficult to achieve in a situation of massive industrial collapse. Educational methods may play a role in the meantime during reorganisation of the industries. Thorough knowledge on the economic regulations of pollution should be conveyed to those responsible for the restructuring of each enterprise in order to ensure environmentally acceptable technological solutions. This is perhaps more cost-efficient than giving penalties to activities that will shut down in a short time.

The adaptation to environmental demands in the market (among consumers), that has played an important role in certain industrial branches in the West, is not likely to be an important factor for the environmental strategies of the most polluting enterprises in the Odra river catchment area. The reason for this is that these industries mostly produce items that are not vulnerable to the kind of changes in the preferences among consumers that manifest themselves when shopping.

In order to make use of economic measures it is necessary to get rid of the state socialist pattern of "industrial paternalism". In this system local and regional authorities were dependent upon the dominating industries in the area (Illner, 1992). The Ostrava-Karviná hard coal area showed a typical examples of industrial paternalism. Still industries play an important role in the deliberations of local and regional decisionmakers as everyone lives from industries in the area. In order to achieve results from making use of economic measures it is necessary to apply them "draconically". This makes decentralisation and regionalisation of decisionmaking in these matters dubious. Such experiences are also drawn in Western European countries like the Netherlands (Bouwer, 1994).

8.2.5.3 What to do?

A strategy plan should be made as a joint project of relevant water management bodies in the area. The plan should include a description of how to establish an efficient working relationship with the future industries in the catchment area using the mechanisms of economy, administration and education.

8.2.6 Professional profile of water and environmental managers

8.2.6.1 Natural, social and administrative knowledge

Water management has a solid bureaucratic presence in the Czech republic. The presence of specific water management institutions and specific positions within other institutions for water managers help making water management an important issue. The educational background of those involved in water management is rather uniform. Prevalent backgrounds are engineering and biology.

There is little doubt that the professional level of Czech water management is high when it comes to its basic foundation: The knowledge of water. An efficient water management system, however, is not only dependent upon the scientific ability of its employees, but on their skills in focusing on policy relevant issues, as well.

What would strike Western observers of the Czech water management system is the absence of an institutionalised and systematised applied administrative and social science as a part of water management. Easy to explain by the state socialist past, this situation is nevertheless worth discussing. To meet the modern requirements of a market-based democratic system (tackling legal provisions, economic regulations, handling other administrative institutions and the public) knowledge within administrative, organisational and social sciences is required.

It is customary to state that nature and society has to be seen together in order to find the most reasonable ways to achieve efficiency in environmental matters. It is necessary to know about economic mechanisms to establish a viable system of economic methods of forcing enterprises and consumers to act environmentally. In order to make environmentally viable physical planning it is necessary to know about the people who (will) live in the areas planned for. When planning the water use in a district it is necessary to know about the wishes of the local population and the probable wishes in the future.

In sum this means that two types of knowledge are required: Natural and social. The only problem is that these two kinds of knowledge are not symmetrical. Natural science can tell how nature *is* and science can predict its development. Social sciences, on its hand, can *not* tell how society *is* or *will be*.

This is due to the fact that the acting individuals in society have a will, whereas the various parts of nature don't. The actors in society can act in order to avoid unwished results or to achieve desired results. As a consequence social scientists cannot perform with the same accuracy when talking about society as natural scientists can when they talk about nature, simply because social scientists cannot know how the minds of social actors may change. In addition analysing society in order to discuss it, is not a task confined to the social scientists. On the opposite it is an ideal in democracy that everybody take part in that kind of discussion.

Water management and environmental management in general have to live with this. An immediate reaction in the existing management system may be to fight this "watering out" of the scientific foundation of what one does. This is understandable and commonplace everywhere. Nevertheless, environmental and water management is not science, but public administration and politics.

There is a very strong propensity in the transitional countries in Europe to attack any problem technically. Complex problems are easily reduced to a technical or natural science question. This refuge - sometimes into technicalities, sometimes into science - can be termed the *"unnoticed remnant of state socialism"*. Risking to carry the idea too far one could say that the state socialist past manifests itself as natural science and technical knowledge being too strong.

Richard Pomahac, who teaches public administration at the Charles University in Prague, says:
"... very vocal and self-confident technocrats stress the superiority of technical knowledge, fail to understand the systemic explanation of social events and believe in social engineering and rationalistic constructivism. As a result of technocrat faith in the inevitable power of progress, many bureaucrats seem to be surprised when this progress is not actually happening in their own country."(Pomahac, 1993, p. 61)

The heritage of state socialism favours technocratic approaches. The very idea of the state socialist project was to modernise a seriously backward society by forcing technological development, while straight-jacketing society.

Engineers, not manual workers, constituted the social backbone of state socialism. The prevalence of technically trained personnel on a high educational level is one of the most characteristic remnants of state socialism.[2] Political development, understood as creating legitimate institutions, bringing people in as citizens, encouraging public debate was all downplayed. All the institutions that usually are grouped together as *'civil society'*[3] did not develop strongly.

Due to the attitude of state socialism treating an unruly civil society as anathema, also social sciences were underdeveloped in state socialism. Political science, for instance, was mostly located in pedagogical institutes, it being a method of political education in authorised marxist-leninist dogma. Practical applied social science had to be hampered in a system in which political and administrative issues were subject to dogmatic discussions, since only one solution could be right at the time.

To say the least, state socialism did not offer a fertile ground neither for social nor for human science. The core of social and human science, *critical self-reflection*, could hardly develop far. Several truly outstanding scholars in these sciences were able to contribute significantly to the international scientific society, but their work could not be received in their home countries. In addition to the suppression of scholarly work, also applied social research was quelled.

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[2] The term 'engineer' in the Czech republic denotes all graduates from technical universities, agronomists, coal mining geologists and architects included.

[3] *'Civil society'* can be defined as the organisms in society that create social and political consciousness, like churches, schools, political parties, trade unions, associations.

8.2.6.2 Professional profile of water and environmental managers in the Odra river catchment area

The background of most people involved in water management in the Odra watershed does not represent any exception to the general pattern. Almost everyone has a technical or natural scientific background.

In several of the interviews it was stated that it would be useful to include lawyers and economists to the staff. However, people with these professions are difficult to employ for the salaries that are offered in public administration. Specialists in administrative and organisational science are not numerous in the Czech republic and particularly not in the Odra river catchment area, a region that is considered not to be privileged when it comes to educational facilities.

Within the modern environmental and water management system that the Czech Republic is now building up, the communication with each enterprise is important. Not only control of the emissions, but also a control of the production process is required. This means that engineers that specialise in production processes will be more needed than they have been hitherto.

8.2.6.3 What to do?

A comparative study ought to be made between the Odra river catchment area and one or more Western equivalents. The purpose of this study would be to describe how the water management institutions involved in the study cope with its tasks (tackling legal provisions, economic regulations, handling other administrative institutions and the public) and what kind of professional backgrounds their employees have. The aim of the study would be to come up with a list of what professions the water management system of the Czech republic is in short of to meet modern requirements.

8.3 Institutions

8.3.1 Division of responsibilities between the levels of government

8.3.1.1 Models of autonomy, integration and network

The strife over competencies between the various levels of government has been prevalent in most previously state socialist countries since 1989-90. The Czech Republic is no exception.

In Western political science debate over these questions several models compete, but most researchers agree that the tendency is for the central state to give local self-government authorities more leeway, i.e. more indirect steering and more freedom within a settled framework (Holm-Hansen, 1993, pp. 18-21).

Among the models used in Western research on the relationship between central and local authorities, the so-called *'autonomy model'* comes closest to the way of thinking about these affairs that prevails in post-socialist countries. This model emphasises the autonomy of the municipal entities towards the central state level. The units of public administration are considered from their rank in the hierarchy of government. The relationship between central state and local level may be viewed as a continuum where *'full decentralisation'* and *'full centralisation'* constitute the extremes.

An alternative model would be the so-called *'model of integration'*. This model takes as its point of departure specific policy areas and looks at how central state and local level perform, not up against each other, but together. This approach is mainly used in the cases where the central state has clear political goals and makes use of the local level as territorial implementers and adaptors of this policy. In this perspective what matters is first of all decisions with *local consequences*. For the local self-government what matters is whether they are able to influence on centrally made decisions with local repercussions. In this model the units in public administration are viewed as partners and are not ranked hierarchically.

A third model would be the *'network model'*. This model does not distinguish between public and private, local and central actors. In this model - which is inspired by sociology - the units are not defined as formal institutions, but rather as entities in relation to each other as defined by the members themselves. Above these networks there are some "brokers", whose task is to establish consensus about decionmaking and implementation processes. Another term that is often used for this kind of network is *'pillar'*, the agricultural sector in Western European countries serving as the archetype. Here all intra-sectorial actors from the bottom to the top agree on the basic issues, and are willing to fight against other *"pillars"*.

The existence of more approaches in the study of local-central relationships than the hierarchy oriented model is a result of the development in Western countries. More and more responsibilities have been given to local self-government institutions. The percentage of GNP now spent by local governments is increasing. In addition the tendency of deregulating the economy, implies an increased responsibility of each local and regional self-government to take care of its own development.

For Western municipalities it is less and less interesting to get autonomy. Now it is more important to take part in the settling of the framework with the central state level. Taking over responsibilities at the local and regional level is usually appreciated by central state authorities.

It is reason to believe that the 'network' way of working will be more and more useful also in countries in transition. The massive industrial reorganisation during the transition period leads to impacts that primarily are of a local character. Attempts are being made, for instance in the Czech Republic, to establish tri-partite cooperation at a regional or inter-municipal level on unemployment issues. The enterprises, that are becoming more and more regionalised as privatisation proceeds, meet with regional branches of the trade unions and (inter-)municipal and deconcentrated state bodies (Dostál, Petr in: Dostál, Illner, Kára, & Barlow, 1992).

8.3.1.2 Central and local level of government in the Odra river catchment area

When it comes to water issues the strife of competence between central and local level does not seem to be particularly harsh. The act on water management (Act no. 458/1992 Sb.), clearly states what tasks that are assigned to each water management body.

The interviews that forms the basis of chapter three in this report were made in the significant, populous and industrial municipalities. They were all well equipped with a staff to take care of water issues even if complaints were heard about long working hours. An indirect effect of the post-socialist localism that influenced the creation of a large sum of small Czech municipalities is that the new municipalities simply became too small to manage the task of providing the necessary services to its inhabitants. The Czech municipal system has remedies against this situation in the institution of *'designated municipality' ('proverená obec')*. These municipalities help adjacent, smaller ones in carrying out tasks and providing services that they would not be able to carry out otherwise (chapters 3.3.3.1 and 8.3.3).

The local and state level meet each other at the District level. The District Offices (chapter 3.3.2) serve as general representatives of central state power at a District level. It has its own staff, e.g. in environmental matters.

It has been recognised, and even stated in the new Constitution, that the Czech republic needs a second tier self government institution, but controversies over the practical implications of this has left this reform in a standstill for the last few years. The local-central state debate would become different after the introduction of such a level. *Local* self-governments would get a reduced say, but *self-government* as such would increase its influence. The reason for this is that the regional scope, irrespective of which of the debated solutions that is finally chosen, is big enough to carry a meaningful self-government structure that is able to carry out bigger tasks.

From a functional point of view the introduction of an intermediate level of government will make it possible to achieve a more efficient water management tied to a democratically elected body that commands a large enough area with probably sufficient resources to be able to achieve something significant in water management.

8.3.1.3 What to do?

The water managers in the Odra river catchment area should initiate a study on the regional effects for water management of introducing the second tier level self-government. How should water management in the catchment area relate to this new level? Especially the new possibilities of coordination and harmonisation of interests resulting from the new level of government should be investigated.

8.3.2 Co-ordination between water management organisations

8.3.2.1 General

Coordination between institutions and actors within one field of activities has been "in fashion" within applied social science in Western Europe and Northern America the last few years. Most recommendations from researchers and advisers contain one or more references to *'coordination'*. Coordination usually consists at least of the following two elements: Exchange of information and adaptation of at least two parties.

Obvious flaws in the management of various fields have been related to lack of coordination. Insufficient coordination leads to:

- overlapping (*result:* double work)

- "grey zones" (*result:* uncovered tasks because it is believed that "someone else" is responsible for these tasks)

- too small entities to make use of economics of scale

- the victory of partial interests over common interests (Jacobsen, 1993).

Coordination is achieved through the establishment of various kinds of meeting places where views can be exchanged and adaptation can be arrived at. These meeting places can be: Meetings (formal and informal), committees and project groups. In Western studies on coordination physical location is often emphasised. Thorough studies of the rather obvious assumption that vicinity or co-location leads to closer *cooperation* have been made with the aim of finding out more about how to arrange it to achieve *coordination.*

However, coordination is not always a physical question. It may also be cultural. Deficient coordination can quite often be tracked back to differences in cultural - e.g. educational or professional - backgrounds of those involved (see also chapter 8.2.6). In these cases the lack of coordination may occur within the same organisation and within the same physical confines.

The eagerness to coordinate may yield unexpected side effects. Conflict is one of them. It is hardly possible to achieve coordination without conflict in one way or another. The communication and adaptation that are the indispensable stages of coordination has to entail conflict. The question, of course, is how the conflicts are managed. Another side effect of coordination that may be unexpected is that its price sometimes may be high. It takes time to let various institutions, organisations and individuals meet to discuss and adapt. The time spent on this could be used more directly on problem solving (Jacobsen, 1993).

8.3.2.2 Coordination in the water management of Odra river catchment area

In chapter three of this report all institutions related to water management in the Odra river catchment area are treated, also with respect to their practices in coordination. There is a certain difference in the opinion of those interviewed on how clear the legal provisions really are on who will do what in Czech water management.

The institutions and organisations involved in water management all have their own profile and interests. One common interest that is stated by all actors involved is improvement of the environmental situation of the water in the Odra river catchment area. Then the challenge lies in coordinating the efforts on bringing about cleaner water. In obtaining this aim all organisations involved are dependent upon each other.

There is some uncertainty as to the new roles of the institutions due to the massive reorganisation of Czech public administration since 1990, but no reason to believe that more in water management than in other sectors. There is a certain overlap in the competence to give penalties to polluters between the Inspection and the District Office.

The only significant sign of potential problems of cultural coordination was found in the relation between the Hygienic Institute and the other institutions involved. The approach of the Hygienic Institute is clearly anthropocentric and based on the attitudes that dominate in the health sector. Against this approach based on a concern for human health, are the approaches of the natural scientists (for whom nature protection is most important) and the engineers (for whom reducing emissions is most important). There are few meeting places and few practical common procedures that make the Hygienic Institute meet with the other institutions with a share in water management of the Odra river catchment area. There are some formal procedures in the building permit and Environmental Impact Assessment procedures that involve both the Hygienic Institute and the water management organs, but these procedures do not bring the institutions together. Mostly they give their opinion separately.

An interesting feature in the Odra river catchment area is the existence of the Water Management House (Dum vodohospodáru) with several water management institutions gathered in two multi-storeyed buildings on the Varenská street in Ostrava. This may encourage coordination as meeting and informal contacts are made much more easy when institutions are placed in the same building.

There are three institutions that may take the lead in bringing about coordination between the institutions and organisations involved in water management: The Regional Department of the Ministry of Environment, the District Offices and the Povodí Odry.

The Regional department has the responsibility of coordinating all environmental activities in its area. This means that it brings about coordination in a wider environmental sense than just water management. The District Office has an even wider responsibility, that does not only embrace the environmental matters, but social, educational and industrial activities as well. This means that the District Office could bring about coordination with other sectors than just the environmental one. Each District Office, however, does only cover a part of the catchment area. The watershed organisation Povodí Odry covers exactly the catchment area. It is well equipped and has enough resources to take a lead. This is especially true for the scientific part of water management as the Povodí Odry has laboratories that are also used by other institutions within water management in the area. On the other hand the Povodí Odry will encounter problems as a general water management coordinator because it is a commercial, though state-owned, company.

8.3.2.3 What to do?

If lack of coordination is considered a problem, and it might well be that it should not, there are several ways of establishing the meeting places and procedures that would boost exchange of views and adaptation between the institutions relevant for water management in the Odra river catchment area.

- One may set up project groups to solve specific tasks. Environmental tasks are well suited for such project groups.

- One may introduce regular consultation processes (hearings) between the institutions involved.

- One may even introduce systems of rotation where people from the various institutions work in each other's institutions for a period of time.

However, it is necessary to be careful not to invest more in coordinating activities than these activities will yield.

8.3.3 Cooperation between municipalities

8.3.3.1 Intermunicipal cooperation

The District Office has among its competencies the coordination and solution of problems concerning more than one municipality. The regional development , urban and regional planning is the responsibility of the District Office.

However, the District Office is a representative of central government, and may risk to come in conflict with the idea of local self-government. *Inter-municipal* cooperation represents an alternative, or supplement, to the coordination of municipalities made by the District Offices. Inter-municipal cooperation implies an infringement on strict localism because it entails decision-making in larger units. On the other hand inter-municipal cooperation strengthens *self-government,* because it makes it possible for self-government institutions that cooperate to solve problems that otherwise would have to be solved "from above" by central government institutions. Inter-municipal cooperation enhances the effectiveness of local self-government in making and implementing decisions.

There are several examples of inter-municipal cooperation in the Czech republic. As mentioned above (chapter 3.3.3.1) the Czech municipal system incorporates the institution of *'designated municipality';* municipalities help adjacent, smaller municipalities in carrying out tasks and providing services that they would not be able to carry out otherwise.

According to the law the municipalities can associate in Municipal Unions, that have the status of legal persons. The municipalities can transfer property and financial means to these unions. The unions are to be established only for a set of specified end:

- Education, local culture and social care
- Management of welfare installation owned by the municipalities, such as the supply of drinking water, sewage, sanitation and waste treatment.

Inter-municipal cooperation can be made in several varying as to how much the cooperation is binding the participants (Weigård, 1991). How much autonomy is the member municipality to retain? How much power is the inter-municipal organisation to obtain? Should the decisions made in the inter-municipal boards be made by consensus (keeping power in the hands of individual municipalities) or rather on a majoritarian basis (easing the process of gaining binding decisions)?

Water management is one of the fields where inter-municipal coordination is needed the most. Upstream polluters in one municipality may pollute inhabitants in a downstream municipality (see chapter 3.1.2). There are ample reasons for conflict, and the District Office, as a representative of the central government, has a coordinating responsibility. If local self-governments would like to have a direct say on what coordination should consist in, inter-municipal harmonisation made by themselves is the most appropriate strategy.

The fact that the municipalities are small and that most water problems involve more than one municipality has lead to the need of discussing inter-municipal cooperation in this field. In water management the indisputable need to influence on upstream sources of pollution is an incentive for inter-municipal cooperation in water questions.

8.3.3.2 Inter-municipal cooperation relevant for water management in the Odra river catchment area

The water supply and sewage companies in the watershed area have split up (chapter 3.3.6), which means that cooperation on this field has diminished.

In the Districts of Karviná and Trinec, however, a significant step towards cooperation between municipalities on physical planning has evolved (chapter 3.4.1.3 and 8.2.2). The office that will prepare a Master Plan for Karviná District and the industrialised parts of Frýdek-Místek District was established in February 1994. The office is based on a political agreement between the municipalities in the area covered.

8.3.3.3 What to do?

An inter-municipal water council ought to be established on a voluntary basis between municipalities in the Odra river catchment area as an "experiment". The results of the cooperation should be evaluated professionally after two years and the idea of making such cooperation e.g. on a catchment area level should be discussed.

8.4 Accompanying measures-Conclusions

Czech water management faces most of the general challenges of public administration of the so-called countries in transition. Among these are:

- making self-government work
- basing the activities on openness and democracy
- implementing policies in a coordinated and harmonised way
- bringing social, administrative, legal and economic knowledge into the expertise profile
- adapting to a situation were most enterprises are private

Czech public administration has been through the major part of its post-1989 restructuring. Its basic structures now fit to the new political and economic situation in the country. The time for dramatic upheaval is over. Now it is time to make the new structures work. Open discussions and ample possibilities for critical self-reflection among the practitioners are indispensable elements in this respect.

Democratic and open procedures are introduced. To make the procedures function, a wider scope of backgrounds for civil servants is required. This is also needed if public administration is to work efficiently with private enterprises. Self-government is implanted, although with a varying degree of effective autonomy due to the small size of most municipalities. Decentralisation, however, is not solely a matter of local self-government. Also state institutions have been deconcentrated and are now represented at the regional and district level. Decentralisation of specified state functions, like e.g. environmental protection, may have negative impact on coordination of policies and harmonisation of interests.

An efficient water management system demands much from coordination of user interests, and from working relations with enterprises, branches and municipalities. An efficient water management system requires that municipalities and districts cooperate and that they themselves - or superior state organs - are able to make binding decisions. This has to do with the fact that polluters and polluted may be situated in different municipalities or districts.

All in all the Czech water management sector has found its place in the new public administration. Nevertheless, there are three major weaknesses in the present Czech water management system:

1: Water use plans are to weak and/or too little tied to land use plans
2: Mechanisms for coordination and harmonisation between municipalities and between districts are weakly developed
3: The expertise profile in water management is still too one-sidedly technical

The basic tools of an efficient water management system has been introduced in the Czech republic: Legal provisions, economic mechanisms and an environmental sector to man it. What is needed now to improve water management, is careful and systematic work within the framework given. An enhanced capability of reflecting on how the present public administrative set-up and assortment of policy tools function is indispensable. In order to make these experiences more valuable, systematic and professional evaluations ought to be made.

The suggestions given in chapter eight is kept within the limits of what is reasonably feasible within the Odra river catchment area. The suggestions are mostly for studies and experimental projects to be evaluated later on. These ideas are drawn from the Nordic experiences of reforming public administration by small steps. This kind of approach makes it possible to investigate the potentials of the administrative framework given, before, and only if necessary, changing it.

The potentials of an efficient land use planning system for water use management are probably huge. In the Czech republic water use and land use planning are very loosely integrated. In addition land use plans are binding whereas water use plans are only "guiding". Finding out more on what could be made within the existing framework to utilise land use planning in water management would be useful, and feasible within one catchment area, e.g. Odra. The same applied for the suggestion on "experimenting" with municipal water plans. Today the so-called Guideline water plans of the Czech republic are made on a national level only.

The establishments of various fora for environmental officers belonging to the management of each environmental medium should be established to counteract disintegration. One of these fora might concentrate on the wisdom of each fine given locally. Is the fine given according to the present knowledge on migrating pollutants?

The difficult task of making full use of the diversity of economic, administrative and educational mechanisms should be subject of a strategy plan developed on the basis of the Odra river catchment area.

In order to prepare for the introduction of the new regional level of government envisaged in the Constitution a study should be made on the effects for water management. Especially the new possibilities of coordination and harmonisation of interests resulting from the new level of government should be investigated.

At the inter-municipal level a self-government based "water council" should be established to bring about coordination between municipalities.

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10. Appendix

10.1 Terms of reference

The study "Pollution abatement analysis of the Odra river catchment and strengthening of the water resources mangement" has involved following tasks:

Task 1: **Environmental status and trends in the study area**

Sub-task 1.1 <u>Review of existing monitoring data.</u>

The monitoring data will be reviewed to assess the water quality situation in the major watercourses in the river basin. This review will be based on the description of the water quality situation in the Odra basin prepared as part of the Odra Project. This is based on water quality data obtained by PO and WRI-O.

Responsible: **WRI-O**, and PO.

Sub-task 1.2 <u>Sediment sampling.</u>

Selected sediment sampling will be undertaken in the area (maximum 6 stations) as part of project 3.3 (water quality classification). Samples will be analysed both in Norway and locally. Sediment sampling is included in the Odra Project and results will be submitted by WRI-O as part of task 1.1.

Responsible: **NIVA**, PO, and WRI-O.

Sub-task 1.3 <u>Assessment of effects on ecology and human health.</u>

The effects of the present water quality on the ecology and the human health will be assessed. This will partly be based on U.S. EPA's risk screening analysis.

The assessment will be based on Czech and international water quality criteria. Results from project 3.3 "Classification of water quality" will be used in this phase. Most of the work will be done under project 3.3. NIVA is responsible for the assessment. WRI-O will provide material prepared as part of the Odra Project (water quality - ecology) and EI material related to Project Silesia (human health).

Responsible: **NIVA**, WRI-O, PO, and EI (Project Silesia).

Task 2: **Environmental administration and policy measures**

Sub-task 2.1 <u>Local and regional environmental administration</u>

The environmental administration system at local and regional level will be assessed in view of the expected changes in division of responsibility and the organisational structure of the Czech Republic. Focus will be on the role of municipalities with consideration of increased delegation of power. The interaction on water management issues between local self-government bodies, local and district representatives of the state authorities, economic actors in industry and agriculture will be treated. NGO's and ad hoc initiatives taken by the local population will be studied. Reforms of the local-district-regional-state relationship are under way. Their relevance for creating a more efficient water management system will be treated in the study. The most important sources of pollution will be identified (task 3.3), and responsible leaders of industrial and agricultural polluters will be interviewed. In cases of specific conflicts the actors will be interviewed. Special attention will be given to the practical possibilities of a more locally based and integrated, cross-sectional management system.

Responsible: **NIBR and EI**

Sub-task 2.2 Legal, economic and planning instrument

The legal basis for environmental protection will be assessed as well as the economic instruments used. The use of economic instruments to achieve the desired environmental objectives will be evaluated and how to use fees and charges will be discussed. In addition the system for water resources planning will be studied.

Construction projects for which procedures of Environmental Impact Assessment (244/92) have been applied, will be studied with a focus on their implications for an efficient water management system.

Responsible: **NIBR**, NIVA and **EI**

Task 3: Sources of water pollution

Sub-task 3.1 Inventory of sources of water pollution

The key point and non-point sources of water pollution in the region will be identified. As part of the Odra Project WRI-O has undertaken an screening analysis and selected the 31 key point polluters in the region (hot-spots). The selection of key polluters has mainly been based on the total discharge of BOD (biological oxygen demand).

For each source the annual loading will be determined. Atmospheric deposition of pollutants will be included in the program as a non-point source of pollution.

Since the Ostrava region is heavily industrialised and discharges of heavy metals and micro-pollutants are significant, the ranking of hot-spots will be evaluated.

However, due to lack of water quality data (metals and micro-pollutants) the key criteria for ranking will be discharges of BOD.

Responsible: **WRI-O**. The information will be verified by PO.

Agricultural non-point sources will be assessed by NIVA. The method used as part of the Baltic Sea environment program will be used. NIVA will submit relevant background documentation.

Responsible: **NIVA**

Sub-task 3.2 Preparation of a water pollution budget/total loading

For the most important water quality parameters the annual loading to the major water courses will be calculated. This will serve as the basis for establishing a crude water pollution budget for the region.

Results from project 5.2 Water toxicity testing will be used.

Responsible: **WRI-O** and NIVA

Sub-task 3.3 Selection of the most important water pollution sources / Ecological assessment of pollution sources.

Based on the monitoring and an assessment of the pollution sources, the most important point and non-point water pollution sources in the region will be determined and subsequently ranked. The abatement strategy will be targeted to reduce the most significant water pollution problem.

This assessment will be based on selected defined indicators and methods. This will require substantial input from all co-operating parties. Relevant methods used in the elaboration of the Environmental Action Program for Central and Eastern Europe. In addition extensive consultations/discussions between the co-operating institutions are planned.

Responsible: **WRI-O**, PO, EI and **NIVA**.

Task 4: Water quality - effect model

Sub-task 4.1 Modelling

As part of WRI-O's Odra project several modelling efforts are under way. The results from these efforts will be utilised where appropriate.

Responsible: **WRI-O**

Sub-task 4.2 Development of water quality objectives

Based on scientific judgement and participation of decision makers and the public, feasible water quality objectives will be proposed for the major water courses. The water quality objectives will be based on Czech and international water quality criteria. Results from project 3.3 will be used in this phase.

Responsible: **NIVA** (approach), WRI-O (execution), EI (Project Silesia), and NIBR.

Sub-task 4.3 Need for pollution abatement

Based on the proposed water quality objectives and the pollution situation today, the need for water pollution abatement will be defined. The need will be expressed as reduction in tonnes per year for each major water quality parameter.

Responsible: **NIVA** and WRI-O

Task 5: Evaluation of proposed actions

Sub-task 5.1 Proposed actions

For each major source (10-15 main hot-spots) of water pollution; i.e. municipal, industrial and agricultural; actions will be proposed to reduce the loading of pollutants. For each proposed action solutions will be reviewed and the corresponding reduction in loading will be estimated.

Project "Silesia" will also propose environmental actions and prepare an environmental action program. Results from this activity will be used in this program.

As part of the Baltic Sea Environmental Action Programme a questionnaire has been sent to 11 key polluters in the region. The results will be translated by WRI-O and submitted to NIVA.

The Czech institutes will provide logistical support and take part in visits to the selected hot-spots to discuss abatement actions.

Responsible: **NIVA**, WRI-O, PO, and EI.

Sub-task 5.2 Costs of actions

Investment and O&M costs for each action will be calculated. The costing will be based on European price level. Results from project "Silesia" will be used.

Responsible: **NIVA**

Task 6: Cost-effective abatement strategy

Sub-task 6.1 Development of abatement strategy

The next step will be to clarify the costs of each measure and the expected benefits, i.e. reduced discharges of different elements/substances. Based on a comparison of costs and reduction in discharges the cost-effectiveness of each measure can be calculated. This will form the basis for the final abatement strategy.

Responsible: **NIVA.**

Sub-task 6.2 Accompanying measures

The strategy will also include proposals for revising the legal, economic and planning framework for environmental protection in the region.

Responsible: **NIBR**, NIVA and EI.

Sub-task 6.3 Proposed environmental priority action program

The priority action program will focus on solving the most immediate pollution problems. The action program will consist of short-term and long-term actions. The program will include capital and recurrent cost for implementation of actions.

Responsible: **NIVA** and NIBR.

Task 7: Benefits from the proposed action program

Sub-task 7.1 Reduction in pollution load

The resulting reduction in pollution load of each proposed action will be estimated. The reduction in the annual pollution load will also be assessed.

Sub-task 7.2 Local and regional benefits

The local and regional environmental benefits and corresponding improvement in human health will be assessed.

Sub-task 7.3 Benefits on the pollution situation in the Odra River (Poland)

The benefits of the action program in the water quality in the Odra River at the border with Poland will be assessed.

Responsible: **NIVA** and WRI-O.

Task 8: Reporting

Sub-task 8.1 The study team will prepare a joint report presenting the findings of the above mentioned tasks and conclusions. The report will be written in English. A key element in the report will be translated material prepared by WRI-O as part of the Odra Project. The project team plan to translate the report into Chech as well.

Responsible: **NIVA** with contributions from all institutions.

10.2 Water quality and classification in Odra and tributaries

Table 10.2.1 Water quality classification based on C_{90} consentrations, 1992 (WRI, 1993)

NB.	PROFILE	Q355	River km.	OXYGEN PARAMETER			BASIC CHEMICAL PARAMETER								ADDITIONAL CHEMICAL				Biol.&Mic.Biol
		[m3/s]	[km]	O2 Sat.	BOD5	COD - Mn	pH	Temp.	DS	SS	Fe	Mn	N - NH4	N - NO3	Cl	SO4	Ca+2	Mg+2	Parameters
1	Odra -Bohumin	5,91	3,30	IV	IV	IV	III	III	IV	IV	V	IV	V	III	IV	III	II	I	V
2	Odra-Petrkovice	3,78	12,70	I	IV	IV	I	I	II	V	V	III	IV	IV	I	II	I	I	V
3	Odra-Svinov	0,90	19,10	I	IV	III	II	II	II	V	V	IV	IV	IV	I	II	I	I	V
4	Odra-Polanka	0,87	25,40	I	IV	IV	III	III	II	V	V	IV	IV	IV	I	II	I	I	V
5	Odra-Studenka	0,54	47,20	I	III	III	III	III	II	IV	IV	IV	IV	IV	I	II	II	I	V
6	Odra-nad Jicinkou	0,22	60,00	I	II	II	I	I	II	IV	IV	III	III	IV	I	II	I	I	V
7	Odra-Jakubcovice	0,17	86,10	I	II	II	I	I	II	II	III	III	III	IV	I	I	I	I	IV
8	Cerny-Prikop	1.38 *	0,08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	Lubina-Kosatka	0,17	1,90	I	III	II	I	II	II	IV	III	III	IV	IV	II	II	I	II	V
10	Bilovka pod Sezinou	0,05	3,90	III	V	III	I	I	II	V	V	IV	V	V	II	II	I	I	V
11	Jicinka--Kunin	0,06	1,30	I	V	III	I	I	II	III	III	III	V	IV	I	II	II	I	V
12	Ostravice-Muglinov	1,90	1,70	IV	V	V	I	I	IV	IV	III	IV	IV	III	III	V	II	II	V
13	Ostravice-Vratimov	1,53	11,80	I	III	II	I	I	II	III	III	II	IV	III	I	II	I	I	V
14	nad Maravkou	0,72	25,20	I	II	II	V	I	I	II	I	II	III	III	I	I	I	I	IV
15	Pod nadrzi	0,30	44,50	I	II	I	I	I	I	II	I	III	III	II	I	I	I	I	II
16A	Olesna -usti	0,07	0,50	I	II	II	I	I	II	II	III	III	III	III	I	II	I	I	V
16B	Lucina	0,26	0,20	IV	IV	II	I	I	IV	III	III	IV	V	III	IV	III	II	I	V
17	Opava Trebovice	2,53	0,10	I	III	III	I	II	II	III	III	III	IV	IV	I	I	I	I	V
18	Opava-Hostice	1,10	36,30	II	V	IV	I	I	II	IV	V	III	IV	III	I	I	I	I	V
19	Opava-Vavrovice	1,09	454,40	I	II	II	I	I	I	IV	II	III	III	III	I	I	I	I	V
20	Opava-pod Krnovem	0,90	61,20	I	III	II	I	I	I	III	II	II	III	IV	I	I	I	I	V
21	Opava-nad Krnovem	0,60	74,80	I	II	I	I	I	I	II	I	I	II	III	I	I	I	I	IV
22	Hvozdnice-usti	0,90	1,00	IV	IV	II	I	I	II	II	I	III	IV	V	II	III	II	I	V
23	Hvozdnice-Mladecko	0,04	18,00	I	II	II	I	I	II	II	I	II	II	V	I	III	II	I	IV
24A	Moravice-Branka	0,86	7,10	I	III	II	I	II	I	II	III	III	III	IV	I	I	I	I	V
24B	Moravice-Slezska Harta	0,67	55,10	I	II	IV	I	I	I	II	III	III	III	III	I	I	I	I	IV
25	Podolsky potok	0,19	0,02	I	III	II	I	I	I	II	II	II	III	III	I	I	I	I	V
26	Zlata Opavice	0,22	2,20	I	II	II	I	I	I	II	II	I	III	IV	I	I	I	I	IV
27	Olse-Vernovice	1,60	7,40	II	III	IV	I	I	V	III	III	III	V	II	V	III	III	III	V
28	Olse nad Stonavkou	0,85	21,50	I	III	II	I	II	II	III	III	III	IV	III	II	II	I	I	V
29	Olse pod Tesinem	0,72	32,80	I	IV	II	I	II	II	II	II	III	V	III	II	II	I	I	V
30	Olse nad Ropici	0,62	39,90	I	III	II	I	I	I	II	II	III	III	III	II	II	I	I	V
31	Olse nad Trincem	0,52	50,60	I	II	II	I	I	I	II	I	I	III	II	I	I	I	I	IV
32	Stonavka-usti	0,16	0,30	I	II	II	I	I	II	II	III	III	III	III	II	II	II	I	V

Table 10.2.2 C90 consentrations, 1992 (WRI, 1993)

NB.	Profile	Q355	River km.	OXYGEN PARAMETER					BASIC CHEMICAL PARAMETER					ADDITIONAL CHEMICAL					Biol.&Mic.Biol.
				O2 Sat.	BOD5	COD-Mn	pH	Temp.	DS	SS	Fe	Mn	N-NH4	N-NO3	Cl	SO4	Ca+2	Mg+2	Parameters
		[m3/s]	[km]	[%]	[mg/l]	[mg/l]		[C]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	
1	Odra -Bohumin	5,91	3,30	4,2	13,9	19,8	7.3-7.8	23,2	1069	92	3,55	0,361	6,58	6,8	303	243	79	24,0	1136
2	Odra-Petrkovice	3,78	12,70	8,3	10,3	10,9	7.3-7.7	21,8	389	119	3,70	0,266	4,76	7,9	48	95	62	14,7	2256
3	Odra-Svinov	0,90	19,10	7,8	13,6	10,3	7.4-7.9	22,0	391	117	3,39	0,323	2,34	8,4	45	99	71	13,9	3760
4	Odra-Polanka	0,87	25,40	8,2	13,8	16,2	7.5-8.4	23,3	420	301	8,66	0,409	1,93	7,8	47	91	69	12,8	406
5	Odra-Studenka	0,54	47,20	7,4	9,5	13,3	7.5-8.1	23,3	388	89	2,87	0,348	2,43	9,8	38	86	77	13,1	771
6	Odra-nad Jicinkou	0,22	60,00	8,5	6,6	9,7	7.3-8.1	20,0	299	88	2,96	0,194	1,07	8,5	32	82	56	12,4	236
7	Odra-Jakubcovice	0,17	86,10	9,5	3,4	7,5	7.2-8.9	21,6	240	35	1,00	0,112	0,68	7,5	20	79	38	10,8	79
8	Cerny-Prikop	1.38 *	0,08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	Lubina-Kosatka	0,17	1,90	8,8	8,9	9,9	7.7-8.3	22,4	419	82	1,93	0,136	2,38	7,1	77	91	67	9,2	491
10	Bilovka pod Sezinou	0,05	3,90	5,9	12,4	13,6	7.4-7.9	18,8	456	102	3,28	0,316	9,06	13,8	50	119	68	20,6	1166
11	Jicinka--Kunin	0,06	1,30	8,5	16,4	13,2	7.6-8.3	21,8	453	48	1,60	0,113	7,60	7,6	48	95	91	12,1	5860
12	Ostravice-Muglinov	1,90	1,70	5,0	12,6	35,3	7.6-7.9	20,4	1084	96	1,81	0,347	4,71	4,9	290	318	100	36,3	760
13	Ostravice-Vratimov	1,53	11,80	7,1	6,6	8,6	7.5-8.0	17,3	335	41	1,27	0,095	2,85	4,8	31	85	66	7,6	440
14	nad Maravkou	0,72	25,20	8,9	3,0	5,0	7.3-9.3	18,8	193	29	0,36	0,053	0,64	3,8	11	47	39	5,0	90
15	Pod nadrzi	0,30	44,50	8,7	2,3	3,7	7.0-7.8	18,6	104	27	0,30	0,171	0,63	1,8	5	31	19	4,0	1,4
16A	Olesna -usti	0,07	0,50	9,6	3,4	7,9	7.6-8.4	17,2	387	37	1,07	0,18	1,09	6,9	33	115	72	10,3	351
16B	Lucina	0,26	0,20	4,9	11,0	9,8	7.3-7.8	21,8	948	43	1,19	0,301	7,63	6,4	325	213	96	18,3	1308
17	Opava Trebovice	2,53	0,10	8,4	7,2	10,7	7.2-7.7	22,7	319	53	1,43	0,189	2,70	8,1	38	79	51	12,1	1067
18	Opava-Hostice	1,10	36,30	6,8	18,6	20,6	7.1-7.7	21,3	318	73	3,55	0,169	3,95	6,6	34	74	50	10,4	5500
19	Opava-Vavrovice	1,09	454,40	8,5	4,3	8,3	7.2-7.8	18,6	245	67	0,91	0,123	0,95	5,9	24	63	44	9,9	533
20	Opava-pod Krnovem	0,90	61,20	7,6	5,2	8,2	7.1-7.6	18,4	229	40	0,66	0,089	1,39	7,7	24	61	38	7,8	746
21	Opava-nad Krnovem	0,60	74,80	9,5	3,7	4,9	7.1-7.7	17,1	171	29	0,44	0,045	0,39	5,5	15	46	30	8,8	55
22	Hvozdnice-usti	0,90	1,00	4,3	10,2	9,5	7.4-7.8	17,5	468	29	0,48	0,218	4,93	13,5	57	154	85	21,9	1234
23	Hvozdnice-Mladecko	0,04	18,00	9,4	2,9	6,5	7.5-8.3	18,7	494	22	0,49	0,063	0,34	11,9	45	233	101	20,4	48
24A	Moravice-Branka	0,86	7,10	9,1	5,7	8,4	7.4-8.5	22,5	239	31	1,47	0,163	0,70	8,1	22	70	43	10,0	324
24B	Moravice-Slezska Ha	0,67	55,10	8,6	3,8	6,4	7.1-7.9	19,2	211	25	1,07	0,116	0,90	6,9	19	52	52	9,6	115
25	Podolsky potok	0,19	0,02	8,7	5,2	6,8	6.8-7.4	13,3	146	22	0,76	0,07	1,40	5,3	16	33	24	4,8	521
26	Zlata Opavice	0,22	2,20	9,5	4,2	5,2	7.4-8.4	18,4	253	31	0,50	0,033	0,61	9,0	20	71	44	10,5	73
27	Olse-Vernovice	1,60	7,40	6,5	9,1	15,1	7.3-7.9	21,3	4295	53	1,01	0,27	6,61	3,1	2096	201	152	53,0	800
28	Olse nad Stonavkou	0,85	21,50	8,4	6,7	8,2	7.6-8.1	22,3	463	57	1,07	0,175	3,66	4,1	72	117	72	12,8	731
29	Olse pod Tesinem	0,72	32,80	8,0	10,0	8,4	7.4-8.1	22,2	423	37	0,87	0,164	7,51	3,8	61	88	68	12,3	1538
30	Olse nad Ropici	0,62	39,90	7,8	8,2	8,7	7.5-8.0	22,6	470	39	0,94	0,154	10,16	3,4	77	107	68	14,9	1968
31	Olse nad Trincem	0,52	50,60	9,3	3,6	5,0	7.2-8.5	17,6	203	33	0,40	0,03	0,64	2,9	13	41	44	9,1	60
32	Stonavka-usti	0,16	0,30	7,2	3,4	6,2	7.6-7.9	16,9	483	30	1,03	0,18	0,67	3,9	58	119	75	11,7	368

Table 10.2.3 C90 concentrations and classification for Tot-P and hevy metals, 1993 (WRI, 1994)

NB.	PROFILE	Q355	River km.	D1	D2	D3	D5	D6	D9	D10	TOTAL	*C90 Calculate/
				Hg	Cd	Pb	Cu	Cr	Ni	Zn		C90 Analytical
		[m3/s]	[km]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]		Tot-P[mg/l]
1	Odra -Bohumin	5.91	3.30	0.48/III	5.0/III	20/III	17/I	19/I	28/II	961/V	V	*3.67/V
2	Odra-Petrkovice	3.78	12.70									*1.44/V
3	Odra-Svinov	0.90	19.10									0.862/IV
4	Odra-Polanka	0.87	25.40	0.43/III	4.3/II	26/III	22/II	39/II	32/II	94/III	III	1.51/V
5	Odra-Studenka	0.54	47.20									*1.83/V
6	Odra-nad Jicinkou	0.22	60.00									0.541/IV
7	Odra-Jakubcovice	0.17	86.10									0.4037/IV
8	Cerny-Prikop	1.38 *	0.08									-
9	Lubina-Kosatka	0.17	1.90									2.856/V
10	Bilovka pod Sezinou	0.05	3.90	-	4.0/II	20/III	21/II	16/I	57/III	86/III	III	-
11	Jicinka--Kunin	0.06	1.30	0.40/III	5.0/III	20/III	21/II	16/I	23/II	90/III	III	2.756/V
12	Ostravice-Muglinov	1.90	1.70	0.55/IV	6.5/III	30/III	17/I	14/I	28/II	403/IV	IV	*1.83/V
13	Ostravice-Vratimov	1.53	11.80									0.859/IV
14	nad Maravkou	0.72	*25.2	0.33/III	2.0/I	<20/II	11/I	<10/I	10/I	43/II	III	0.193/III
15	Pod nadrzi	0.30	44.50									0.090/II
16A	Olesna -usti	0.07	0.50									0.538/IV
16B	Lucina	0.26	0.20									1.76/V
17	Opava Trebovice	2.53	0.10									*1.28/V
18	Opava-Hostice	1.10	36.30									2.282/V
19	Opava-Vavrovice	1.09	454.40									0.865/IV
20	Opava-pod Krnovem	0.90	61.20									1.248/V
21	Opava-nad Krnovem	0.60	74.80	0.69/IV	2.0/I	<20/II	10/I	<10/I	10/I	46/II	IV	0.308/III
22	Hvozdnice-usti	0.90	1.00									1.657/V
23	Hvozdnice-Mladecko	0.04	18.00									0.503/IV
24A	Moravice-Branka	0.86	7.10									0.319/III
24B	Moravice-Slezska Harta	0.67	55.10	0.85/IV	2.3/I	<20/II	12/I	<10/I	11/I	39/II	IV	0.56/IV
25	Podolsky potok	0.19	0.02									0.393/III
26	Zlata Opavice	0.22	2.20									0.386/III
27	Olse-Vernovice	1.60	7.40									*2.06/V
28	Olse nad Stonavkou	0.85	21.50									1.551/V
29	Olse pod Tesinem	0.72	32.80	0.73/IV	4.0/II	20/III	12/I	<10/I	21/II	88/III	IV	1.692/V
30	Olse nad Ropici	0.62	39.90	0.53/IV	3.0/II	20/III	14/I	10/I	18/I	180/IV	IV	0.869/IV
31	Olse nad Trincem	0.52	50.60									0.428/IV
32	Stonavka-usti	0.16	0.30									0.341/III

10.3 Regulation no 171/1992 of the Government of the Czech republic

171

REGULATION OF THE GOVERNMENT OF THE CZECH REPUBLIC, FROM THE 26TH FEBRUARY 1992, WHICH LAYS DOWN THE PARAMETERS OF THE ALLOWABLE WATER POLLUTION RATE

The Government of the Czech Republic charges after the paragraph 23 section 2 of the Act RN. 138/1973 On waters (Water Act)

Par. 1

When giving licences for discharging of waste waters and special waters into surface waters or when laying down conditions for discharging of mine waters into surface waters, the water managing authority takes measures after the parameters of the allowable water pollution rate I, II, III (further only "parameters") cited in the amendment of this regulation, in such away to contaminate surface waters as minimally as possible.

(2) If water managing authority gives an exceptional licence, regarding to the important social interest, for discharging of waste waters or of special waters into ground waters, the discharged waters have to be purificated or treated in such manner neither to deteriorate nor to endanger the ground water quality.

Par. 2

(1) Parameters I are obligatory for a water managing authority when giving licences for discharging of waste or special waters into surface waters or when laying down conditions for discharging of mine waters into surface waters (further only "decision on waters discharging")**Error! Reference source not found.**.

(2) Parameters I lay down the highest allowable rate of pollution within discharged waters. A water managing authority can se down more rigorous measures with regards to local hydrological conditions and water protection interests.
They are obliged to have regards for appropriate influence of cooling waters and other waters.

(3) Water managing authorities can license water discharging beyond the parameter I limits during a necessary time only, in case of the introduction of a waste water treatment plant into operation, in case of a plant break down, in case of a necessary reconstruction or in other exceptional cases. They decide of the licence on the basis of technically substantiated application of that, who discharges waters into surface waters (further only "contaminator").

(4) Water managing authorities can license water discharging beyond the limits of parameter I even in such cases, when the waste or special waters will be discharged into surface waters in a controlled manner, with a simultaneously laying down of the other conditions.

(5) Water managing authorities can require in the individual production waste water their separate treatment from the other waters.

Par. 3

Water managing authorities are obliged to consider even to the Parameters II and III when deciding on discharging waters. The obligation of these will be set down consecutively regarding on water protection interests and on local hydrological conditions. Parameters III express the surface water contamination in 355 day flow rate or in the minimally guarantied flow rate in the water course and after a mixing with waste waters or special waters.

Par. 4

(1) Contaminator is obliged to monitor the amount of waste and special waters and their pollution according to the relevant technical standards 1), if water managing authorities do not determine another methods.

1) CSN 75 7241 - Waste and special water control (Technical standard)

CSN 83 0540 - Chemical and physical waste water analyses. (Technical standard)

(2) As if no technical standard has been issued for the determination of a parameter, water managing authorities lay in down after discussing it with the central water managing authority of the Czech Republic.

Par. 5

(1) Values of the parameters, which have been laid down during the decision on discharging waters according with the par. 2 and 3, are kept, as far as the higher values are not found within the discharged waters composite sample which has been gained by pouring together of the same volumes of the discharged water samples. The samples ought to be collected in one hour intervals or they can be collected with an automatic sampling device too. The time intervals of the control monitoring will be determinated by the water managing authority regarding to the regime of discharging waters from the pollution source.

(2) In case of an emergency water discharging from the pollution source, water managing authority lays down the conditions for the control of the parameter values keeping. It will be done individually according to the local conditions.

(3) Only such analytical results are authoritative for the parameter values keeping appreciation, which are executed in the systematically and externally controlled laboratories.

Par. 6

(1) As if the contaminator discharges waste or special waters into surface waters beyond the limits of the water managing authorities requirements, according to the previous order, the water managing authority can give him a new water discharging licence after Par. 8, Act RN. 138/1973 On waters (further only "Water Act") He must perform an application till 12 months since the new regulation validity begin and this licence will be issued only to for such level of the contamination, which has been reached in the period of the last 12 months before this regulation started its validity.

Water managing authority lays down simultaneously a time period during which the discharged waters values must reach the parameters I and also the values of the parameters II and III and in the same time they can lay down duties or conditions to the consecutive achievement of the required discharged pollution level.

(2) The procedure described in the section 1 fulfils the requirement of the par. 23, sec. 1, of the Water Act in the cited cases till that time, when the discharged waters will be possible to be treated in a new technical and progressive way.

Par. 7

This regulation does not touch the orders on the reparations of damages caused by the waste waters or special waters discharging.

Par. 8

The regulation of the Government of the Czech Socialist Republic RN. 25/1975 which lays down the parameters of the allowable rate of water pollution is cancelled.

Par. 9

This regulation will enforce since the day of its proclamation.

AMENDMENT TO THE REGULATION OF THE GOVERNMENT OF THE CZECH REPUBLIC RN. 171/1992

PARAMETERS I

Sewage and municipal waste waters

Magnitude of the pollution source	PARAMETER									
Population equivalent (PE) (1)	BOD5(2)(mg/l)		COD-Cr(mg/l)		SS (3)(mg/l)		N-Nh4+(mg/l)		P-Total(mg/l)	
	till 31.12	after 1.1	till 31.12	after 1.1	till 31.12	after 1.1	till 31.12	after 1.1	till 31.12	after 1.1
(kg BOD5 at the inflow per day)	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005
To 50 PE (to 3 kg BOD5)	80	60	(-) (4)	(-)	65	50	(-)	(-)	(-)	(-)
To 500 PE (to 30 kg BOD5)	60	50	(-)	(-)	55	40	(-)	(-)	(-)	(-)
To 5000 PE (to 300 kg BOD5)	50	40	170	135	45	35	(-)	20	(-)	(-)
To 25000 PE (to 1500 kg BOD5)	45	35	150	120	35	30	25	15	(-)	5
To 100000 PE (to 6000 kg BOD5)	35	30	125	105	30	25	15	10	5	3
Over 100000 PE (over 6000 kg BOD5)	30	25	110	90	25	20	10	5	3	1.5

Notices to the previous table :

1) Population equivalent (PE) - specific contamination expressed in BOD5 produced by one inhabitant per 1 day (60 g BOD5 per 1 inhabitant per 1 day)
2) With suppression of nitrification
3) SS - Suspended solids
4) A value of this parameter has not been determined yet

PARAMETERS I (Continuation)

2. Industrial waste waters and special waters

Subsequently mentioned items include only some productions and basic parameters in this time. The other parameters are assessed namely from the kind of row materials being processed, from production technologies, water managing ways and water treatment methods.

Exploiting and processing ores and minerals

2.1.1	Uranium ores		till 31.12.2004	since 1.1.2005
	pH		6.5 - 9.0	6.5 - 9.0
	SS (1)	mg/l	30.0	25.0
	Radium	Bq/l	0.5	0.3
	Uranium	mg/l	0.3	0.2
2.1.2	Other ores			
	pH		6.0 - 9.0	6.0 - 9.0
	COD - Cr	mg/l	100.0	80.0
	SS	mg/l	80.0	60.0
	Iron	mg/l	5.0	4.0
	Zinc	mg/l	2.0	1.6
	Lead	mg/l	0.5	0.4
	Cooper	mg/l	1.0	0.8
	Arsenic	mg/l	0.5	0.4
2.1.3	Stones exploiting and processing			
	SS	mg/l	50.0	40.0
	NEM (2)	mg/l	5.0	2.0
2.2	**Coal exploiting and processing**			
2.2.1	Coal exploiting and briquettes production			
	pH		6.0 - 9.0	6.0 - 9.0
	SS	mg/l	100.0	80.0
	COD - Cr	mg/l	150.0	120.0
2.2.2	Thermic coal processing			
	pH		6.0 - 9.0	6.0 - 9.0
	SS	mg/l	50.0	40.0
	COD - Cr	mg/l	100.0	800.0
	Phenols	mg/l	5.0	4.0
	N - NH4	mg/l	200.0	150.0
	Cyanides total	mg/l	1.0	0.8
2.3	**Heat stations and power stations**			
2.3.1	Water treatment			
	SS	mg/l	50.0	40.0
	COD - Cr	mg/l	50.0	40.0
	Iron	mg/l	5.0	4.0
	Hydrazine	mg/l	5.0	4.0

2.4 Metallurgy

2.4.1 Iron production and processing

pH		6.5 - 9.0	6.5 - 9.0
SS	mg/l	50.0	40.0
COD - Cr	mg/l	50.0	40.0
Iron	mg/l	10.0	8.0
NEM	mg/l	3.0	2.0

2.4.2 Non - Ferrous metallurgy

pH		6.5 - 9.0	6.5 - 9.0
SS	mg/l	50.0	40.0
Copper	mg/l	1.0	0.8
Zinc	mg/l	2.0	1.6
Nickel	mg/l	1.0	0.8
Aluminium	mg/l	3.0	2.5
Vanadium	mg/l	2.0	1.6
Lead	mg/l	0.5	0.4
Chromium - Total	mg/l	1.0	0.8
Tin	mg/l	2.0	1.6
Mercury	mg/l	0.2	0.1

2.5 Machinery and electronic industry

2.5.1 Shaping

pH		6.5 - 9.5	6.5 - 9.5
SS	mg/l	50.0	40.0
COD - Cr	mg/l	1000.0	500.0
NEM	mg/l	10.0	5.0
N - NO2	mg/l	5.0	2.5

2.5.2 Galvanisation and coating of metals

pH		6.5 - 9.5	6.5 - 9.5
SS	mg/l	30.0	25.0
COD - Cr	mg/l	300.0	250.0
Fluorides	mg/l	20.0	15.0
N -NO2	mg/l	5.0	2.5
Sulphides	mg/l	1.0	0.5
Arsenic	mg/l	0.5	0.3
Aluminium	mg/l	3.0	2.0
Silver	mg/l	1.0	0.5
Barium	mg/l	3.0	2.0
Cadmium	mg/l	0.5	0.3
Cobalt	mg/l	1.0	0.5
N - NH4	mg/l	100.0	50.0
Phosphorus - Total	mg/l	5.0	2.0
Desultory Chlorinated Hydrocarbons (3) mg/l		1.0	0.5

Cyanides Toxical	mg/l	0.2	0.1
Cyanides Total	mg/l	1.0	0.5
Active Chlorine	mg/l	0.5	0.3
Chromium Total	mg/l	1.0	0.5
Chromium Cr VI	mg/l	0.2	0.1
Copper	mg/l	1.0	0.5
Molybdenum	mg/l	2.0	1.0
Mercury	mg/l	0.2	0.1
Nickel	mg/l	1.0	0.5
Lead	mg/l	0.5	0.3
Zinc	mg/l	2.0	1.0
NEM	mg/l	10.0	5.0

2.6 Chemical industry

2.6.1 Oil refineries and oil processing

pH		6.0 - 9.0	6.0 - 9.0
SS	mg/l	50.0	40.0
COD - Cr	mg/l	250.0	150.0
BOD5 (4)	mg/l	50.0	30.0
NEM	mg/l	20.0	15.0

2.6.2 Oil Products distribution stores

pH		6.0 - 9.0	6.0 - 9.0
SS	mg/l	100.0	50.0
EM	mg/l	25.0	15.0
COD - RC	mg/l	250.0	150.0

2.6.3 Pulp Production

BODE	mg/l	100.0	50.0
SS	mg/l	100.0	50.0
COD - RC	mg/l	500.0	250.0

2.6.4 Paper production

SS	mg/l	60.0	40.0
BODE	mg/l	50.0	40.0
COD - RC	mg/l	250.0	200.0

2.6.5 Other chemical productions

SS	mg/l	50.0	40.0
BODE	mg/l	50.0	40.0
COD - RC	mg/l	400.0	300.0

2.7 Consumption goods production

2.7.1 Textile industry

SS	mg/l	50.0	40.0
COD - RC	mg/l	300.0	240.0
BODE	mg/l	50.0	40.0
Active chlorine	mg/l	0.5	0.4
EM	mg/l	10.0	8.0

2.7.2 Glass works

SS	mg/l	30.0	25.0
COD - RC	mg/l	150.0	120.0
Fluorides	mg/l	30.0	25.0
Lead	mg/l	1.5	1.2
Arsenic	mg/l	1.0	0.8
Barium	mg/l	5.0	4.0

2.7.3 Pottery and china industry

SS	mg/l	50.0	40.0

2.7.4 Tanning factories

BODE	mg/l	50.0	40.0
COD - RC	mg/l	300.0	250.0
Chromium Total	mg/l	2.0	1.0
Sulphides	mg/l	2.0	1.0

2.8 Foodstuffs industry

2.8.1 Dairies

COD - RC	mg/l	200.0	160.0
BODE	mg/l	50.0	40.0

2.8.2 Breweries

COD - RC	mg/l	200.0	160.0
BODE	mg/l	50.0	40.0

2.8.3 Meat Processing

COD - RC	mg/l	250.0	200.0
BODE	mg/l	50.0	40.0
EM (5)	mg/l	10.0	5.0

2.8.4 Distilleries and yeast production

COD - RC	mg/l	250.0	200.0
BODE	mg/l	50.0	40.0

2.8.5 Starch Production

COD - RC	mg/l	250.0	200.0
BODE	mg/l	50.0	40.0

Notices to parameters I

(1) Suspended Solids (SS)
(2) Non - Polar extractable matters (EM)
(3) Namely trichlorethene, tetrachlorethene, tetrachlormethane, 1.1.1 trichlorethane
(4) It means BOD5 with a nitrification suppression
(5) Extractable matters - namely greases (EM)

PARAMETERS II

1. Biological water condition expressed in the saprobic index after Pantle - Buck, which is lower than then 2.2 in water supply stream and lower than 3.2 in other surface waters. (1)

2. Normal living of Salmonidae and Cyprinide in water supply streams and in other surface waters.

3. Water supply streams and impounding reservoirs conditions without odour and with a lightly strange odour in other waters.

4. The condition under which changes of colour of water supply streams do not go off in the zone to 20 cm, in other waters to 10 cm.

5. Temperature to 20oC in water supply streams and to 26oC in other surface waters.

6. An intact surface water self purification ability.

7. Surface water conditions under which :
   a) the excessive development of water organisms (e.g. water bloom) does not go off
   b) mud benches do not rise
   c) a water surface is not covered with foam, grease, oil or other matters

8. Surface water conditions under which the hygienic health protection rules against ionising radiation's are not braked (2).

9. Surface water conditions under which :
   a) the water ecosystem productivity does not decline on account of harmful matters activity
   b) a serious reduction of the water organisms species spectra/does not take place
   c) an excess of the maximally admissible dose values or of the radio nuclides volume activity does not appear.

Notices to parameters II

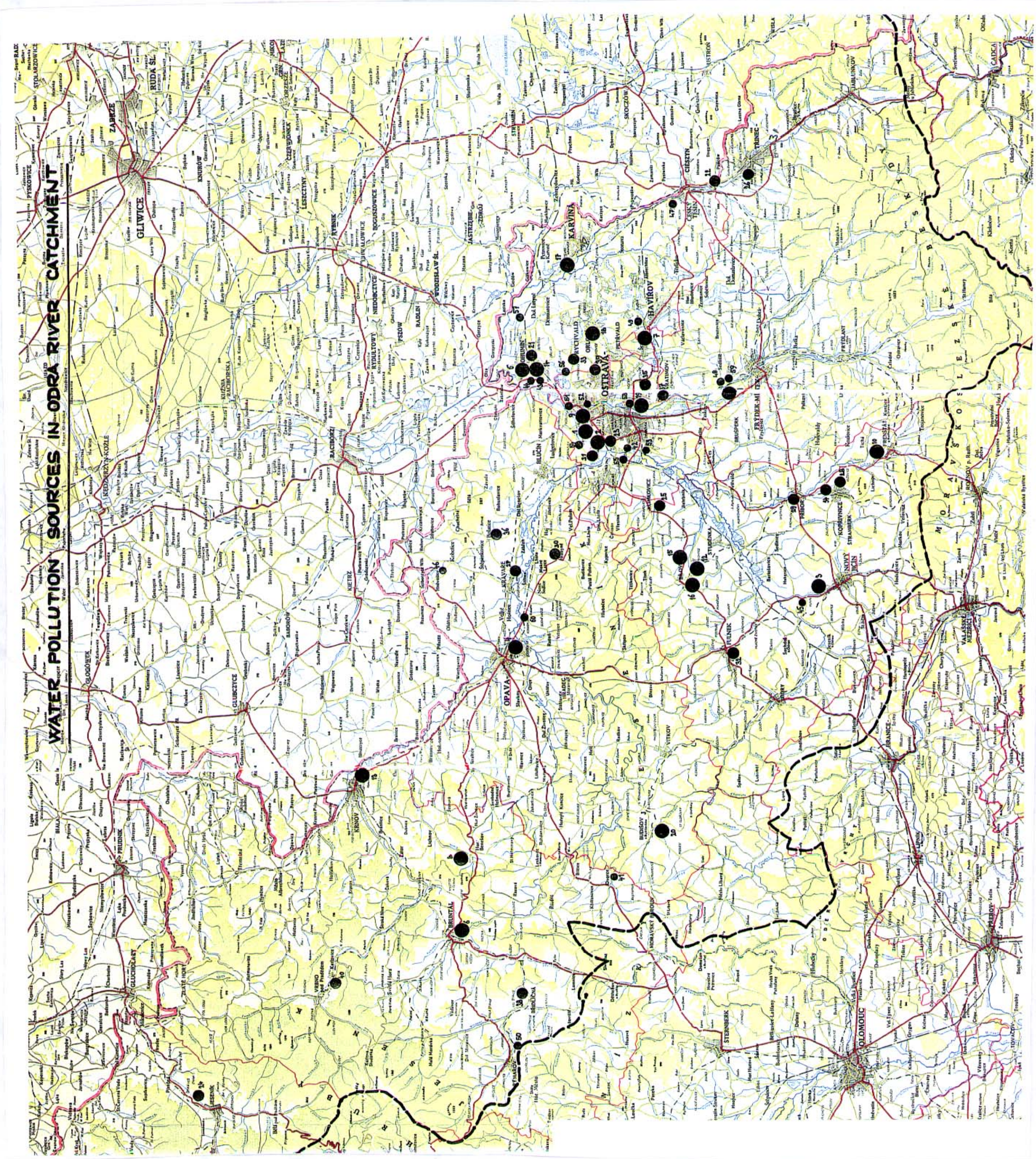
(1) Public notice of the Ministry of Forests and Hydrology of the Czech Socialist Republic RN. 28/1975, which specifies water supply streams and their basins and determines the hydrologically important streams.
(2) Public notice of the Health Ministry of the Czech Socialist Republic RN. 59/1972 on the protection against the ionising radiation.

PARAMETERS III

(Parameters of matters amounts in surface waters)

Parameter	Symbol	Unit	Values for Water supply	Values for Other surface
Dissolved oxygen	O2	mg/l	min. 6	min. 4
Biochemical oxygen demand	BOD5	mg/l	4.00	8.00
Permanganate chemical oxygen demand	COD - Mn	mg/l	8.00	20.00
Dichromate chemical oxygen demand	COD - Cr	mg/l	20.00	50.00
Sulphate and Sulphides	S2-	mg/l	ULD (2)	0.02
Water reaction	pH	mg/l	6.0 - 8.5	6.0 - 9.0
Dissolved Solids	DS	mg/l	500.00	1000.00
Iron total	Fe	mg/l	0.50	2.00
Manganese total	Mn	mg/l	0.20	0.50
Ammonia nitrogen	N - NH4	mg/l	0.50	2.50
Free ammonia	NH3	mg/l	ULD	0.50
Nitrite nitrogen	N - NO2	mg/l	0.02	0.05
Nitrate nitrogen	N - NO3	mg/l	3.40	11.00
Organic nitrogen	N - org.	mg/l	1.50	3.00
Phosphorus total	P - Tot.	mg/l	0.15	0.04
Chlorides	Cl -	mg/l	150.00	350.00
Sulphates	SO4 2-	mg/l	200.00	300.00
Calcium	Ca	mg/l	200.00	300.00
Magnesium	Mg	mg/l	100.00	200.00
Fluorides	F -	mg/l	1.00	1.50
Phenols	FN 1	mg/l	0.02	0.10
Anion - tensides	PAL - A	mg/l	0.20	1.00
Non - polar extractable matters	NEM	mg/l	0.05	0.20
Cyanides total	CN -	mg/l	ULD	0.20
Active chlorine	Cl2	mg/l	ULD	0.05
Extractable organic - bound chlorine	EOCl	mg/l	0.01	0.03
Boron	B	mg/l	0.30	0.50
Mercury	Hg	mg/l	0.0005	0.001
Cadmium	Cd	mg/l	0.005	0.015
Lead	Pb	mg/l	0.05	0.1
Arsenic	As	mg/l	0.05	0.1
Copper	Cu	mg/l	0.05	0.1
Chromium - Total	Cr	mg/l	0.1	0.3
Chromium VI	Cr VI	mg/l	0.02	0.05
Cobalt	Co	mg/l	0.05	0.1
Nickel	Ni	mg/l	0.05	0.1

10.4 Location of major pollutors in the catchment area



10.5 Water Quality data for drinking water reservoirs

TABULKA I:

K R U Z B E R K

PREHLED O ZNECISTENI NADRZE ANORGANICKYM DUSIKEM A CELKOVYM FOSFOREM

ROK	NO3 [mg/l]			NO2 [mg/l]			NH4 [mg/l]			celk. P [mg/l]		
	prumer	median	maximum	prumer	median	maximum	prumer	median	maximum	prumer	median	maximum
1985	21.21	20.00	37.00	0.180	0.100	0.900	0.340	0.400	1.000			
1986	20.13	22.50	29.50	0.140	0.105	0.270	0.530	0.525	0.900			
1987	17.90	18.00	29.50	0.140	0.135	0.280	0.500	0.300	1.700			
1988	15.80	13.00	35.00	0.117	0.098	0.280	0.610	0.550	1.600			
1989	16.80	16.75	25.00	0.250	0.220	0.650	0.630	0.550	1.100			
1990	19.46	18.75	40.50	0.200	0.150	0.730	0.710	0.570	1.500	0.170	0.045	0.690
1991	22.00	23.50	28.80	0.169	0.175	0.390	0.349	0.365	0.540	0.190	0.065	0.770
1992	15.10	13.50	32.50	0.172	0.125	0.590	0.725	0.420	1.800	0.072	0.065	0.140
1993	20.40	19.60	36.90	0.170	0.160	0.280	0.490	0.540	0.860	0.048	0.025	0.220

PREHLED O OBSAHU CHLOROFYLU A CELKOVEHO FOSFORU

DATUM	CHLOROFYL (hladina) [mikrog/l]	CHLOROFYL (dno) [mikrog/l]	Celk. P [mg/l]
01/21/91	2.0	1.5	0.007
03/04/91	2.0	1.3	0.160
05/27/91	2.8	3.0	0.170
07/02/91	7.1	6.2	
09/30/91	4.0	2.8	0.020
11/07/91		1.6	0.220
01/27/92	4.1	1.3	0.002
04/27/92	2.8	0.8	
06/04/92	2.7	2.8	0.040
07/07/92	2.1	1.3	0.190
09/10/92	2.0	1.3	0.140
10/22/92	2.0	3.5	0.060

TABULKA II.

S A N C E

PREHLED O ZNECISTENI NADRZE ANORGANICKYM DUSIKEM A CELKOVYM FOSFOREM

ROK	NO3 [mg/l]			NO2 [mg/l]			NH4 [mg/l]			celk. P [mg/l]		
	prumer	median	maximum	prumer	median	maximum	prumer	median	maximum	prumer	median	maximum
1985	9.37	7.00	34.00	0.035	0.030	0.080	0.140	0.100	0.700			
1986	6.66	7.00	10.00	0.054	0.050	0.110	0.240	0.200	0.450			
1987	7.92	7.25	10.50	0.035	0.020	0.090	0.196	0.125	0.700			
1988	7.20	7.75	9.50	0.021	0.018	0.048	0.160	0.145	0.350			
1989	7.30	7.75	17.50	0.030	0.020	0.095	0.200	0.125	0.560			
1990	7.20	7.00	10.00	0.032	0.029	0.060	0.510	0.620	0.890	0.160	0.025	0.620
1991	6.34	6.20	12.40	0.032	0.031	0.059	0.139	0.135	0.230	0.040	0.030	0.080
1992	4.95	4.60	8.50	0.040	0.030	0.110	0.400	0.210	1.120	0.055	0.040	0.160
1993	6.00	5.55	12.20	0.043	0.035	0.090	0.350	0.325	0.800	0.049	0.035	0.150

PREHLED O OBSAHU CHLOROFYLU A CELKOVEHO FOSFORU

DATUM	CHLOROFYL (hladina) [mikrog/l]	CHLOROFYL (dno) [mikrog/l]	Celk. P [mg/l]
01/22/91	2.0	2.1	0.040
04/22/91			0.110
08/29/91	2.8	2.2	0.020
10/24/91	1.6	1.8	0.020
01/28/92	2.2	1.1	0.030
03/31/92	2.6	2.0	0.080
08/20/92		1.6	0.100
10/15/92			0.050

TABULKA III.

MOŘAVKA

PREHLED O ZNECISTENI NADRZE ANORGANICKYM DUSIKEM A CELKOVYM FOSFOREM

ROK	NO3 [mg/l]			NO2 [mg/l]			NH4 [mg/l]			celk. P [mg/l]		
	prumer	median	maximum	prumer	median	maximum	prumer	median	maximum	prumer	median	maximum
1985												
1986												
1987	9.60	9.50	13.00	0.019	0.015	0.035	0.118	0.090	0.300			
1988												
1989	9.00	8.50	17.50	0.019	0.020	0.030	0.170	0.130	0.350			
1990	8.25	8.50	12.00	0.026	0.024	0.045	0.500	0.600	0.990			
1991	6.70	6.50	10.00	0.026	0.020	0.070	0.120	0.055	0.360			
1992	5.73	5.65	8.50	0.030	0.030	0.050	0.320	0.160	1.200			
1993	5.34	5.50	8.00	0.035	0.030	0.070	0.280	0.215	0.660	0.040	0.030	0.150

PREHLED O OBSAHU CHLOROFYLU A CELKOVEHO FOSFORU

DATUM	CHLOROFYL (hladina) [mikrog/l]	CHLOROFYL (dno) [mikrog/l]	Celk. P [mg/l]
05/23/91	1.2	1.1	0.020
07/01/91	2.0	1.8	0.020
10/03/91	2.0	1.4	0.020
05/14/92			0.020
07/09/92			0.020
10/19/92		1.2	0.130

10.6 C90 percentile and C median for water quality in Odra

Table 10.6.1: Water quality data in Odra 1991

PROFIL	Date	Date												C90	C, med.	C, av.	Ca/C90	Cmed./C90	Q Av.	Qmed	Q, 180	Param.	Cav,av	Cav,med	Cmed,av	Cmed,med
		08/01/	05/02/	12/03/	16/04/	30/05/	18/06/	09/07/	20/08/	03/09/	08/10/	05/11/	03/12/	mg/l	mg/l	mg/l			m3/s	m3/s	m3/s					
Odra -Bohumin	Q	38.9	15.0	28.8	19.2	34.6	52.3	26.0	20.0	12.0	10.6	11.3	38.5						25.60	23.00	25.20					
Odra -Bohumin	BOD5	10.0	7.8	7.2	7.0	3.0	13.0	3.2	4.8	3.8	4.8	10.0	2.0	10.00	5.90	6.8	0.68	0.59				BOD5	0.7	0.6	0.7	0.6
Odra -Bohumin	SS	7.0	6.0	46.0	6.0	46.0	756.0	23.0	5.0	9.0	11.0	20.0	27.0	46.00	15.50	146.9	3.19	0.34				SS	1.2	0.4	0.8	0.4
Odra -Bohumin	N-NH4	2.2	7.9	4.5	5.3	1.8	3.2	2.2	2.9	1.4	4.2	5.6	3.1	5.57	3.15	3.3	0.60	0.57				N-NH4	0.5	0.5	0.5	0.5
Odra -Bohumin	N-NO3	7.4	3.9	4.2	4.4	5.9	6.0	4.1	3.1	4.2	1.6	4.9	4.2	5.99	4.20	5.0	0.83	0.70				N-NO3	0.8	0.7	0.8	0.7
Odra -Bohumin	Tot -N	9.6	11.8	8.7	9.7	7.7	9.2	6.3	6.0	5.6	5.8	10.5	7.3	10.42	8.20	8.3	0.80	0.79				PO4	0.6	0.6	0.6	0.6
Odra -Bohumin	PO4	0.7	2.1	0.8	1.2	0.5	0.7	0.8	0.7	0.5	1.1	1.4	0.8	1.38	0.80	0.9	0.62	0.58				Tot-N	0.8	0.7	0.8	0.7
Odra-Svinov	Q	17.8	2.5	12.0	5.4	8.1	9.2	5.2	4.2	1.8	3.0	3.0	11.3						6.95	5.30	6.19					
Odra-Svinov	BOD5	4.2	10.6	12.0	13.5	5.8	12.0	5.2	5.5	4.4	9.0	7.6	3.6	12.00	6.70	7.5	0.62	0.56								
Odra-Svinov	SS	18.0	5.0	38.0	7.0	18.0	25.0	24.0	10.0	7.0	15.0	19.0	5.0	24.90	16.50	18.5	0.74	0.66								
Odra-Svinov	N-NH4	0.6	3.6	1.0	0.1	0.7	0.3	1.2	1.2	1.4	1.3	3.0	1.2	2.84	1.20	1.0	0.34	0.42								
Odra-Svinov	N-NO3	8.6	5.7	7.9	4.7	6.5	4.3	3.1	3.6	3.2	1.8	2.9	7.0	7.81	4.50	6.1	0.78	0.58								
Odra-Svinov	Tot -N	9.2	9.3	8.9	4.8	7.2	4.6	4.3	4.8	4.6	3.1	5.9	8.2	9.19	5.35	6.5	0.71	0.58								
Odra-Svinov	PO4	0.3	0.2	0.3	0.9	0.4	0.1	0.7	0.6	0.7	1.1	1.2	0.6	1.06	0.60	0.5	0.45	0.57								
	Date	07/01/	04/02/	11/03/	15/04/	29/05/	17/06/	08/07/	19/08/	02/09/	07/10/	04/11/	02/12/													
Odra-Petrkovice	Q	29.9	8.3	18.2	12.6	22.2	38.8	18.3	11.9	6.1	5.8	6.4	17.0						16.29	14.80	16.10					
Odra-Petrkovice	BOD5	3.0	11.0	5.8	9.4	2.2	10.0	3.2	5.0	4.6	6.0	6.8	2.2	9.94	5.40	5.6	0.57	0.54								
Odra-Petrkovice	SS	14.0	6.0	31.0	6.0	11.0	168.0	28.0	10.0	15.0	16.0	16.0	9.0	30.70	14.50	45.7	1.49	0.47								
Odra-Petrkovice	N-NH4	4.3	5.2	2.2	2.7	1.2	4.6	1.1	1.3	1.0	4.1	7.2	1.7	5.14	2.45	3.0	0.59	0.48								
Odra-Petrkovice	N-NO3	7.9	6.4	7.2	5.2	13.6	7.3	4.9	3.6	4.4	3.8	5.2	6.9	7.84	5.80	7.2	0.92	0.74								
Odra-Petrkovice	Tot -N	12.2	11.6	9.4	7.9	14.8	11.9	6.0	4.9	5.4	7.9	12.4	8.6	12.38	9.00	10.0	0.81	0.73								
Odra-Petrkovice	PO4	0.5	1.5	0.9	1.1	0.4	0.7	0.6	0.5	1.2	1.1	2.7	0.7	1.46	0.76	0.8	0.52	0.52								
Odra-Polanka	Q	21.1	2.2	10.6	5.3	8.4	8.8	5.5	4.9	1.9	2.7	3.0	12.2						7.21	5.42	5.87					
Odra-Polanka	BOD5	2.4	4.1	4.4	3.5	3.3	17.0	4.0	2.4	3.8	6.4	4.5	1.9	6.21	3.90	4.6	0.74	0.63								
Odra-Polanka	SS	31.0	6.0	5.0	180.0	8.0	432.0	32.0	20.0	21.0	7.0	9.0	11.0	165.20	15.50	69.7	0.42	0.09								
Odra-Polanka	N-NH4	0.5	0.3	0.9	0.4	0.9	0.9	0.6	0.4	0.2	0.6	2.3	0.8	0.92	0.60	0.7	0.76	0.65								
Odra-Polanka	N-NO3	8.9	6.1	7.2	5.2	7.7	7.2	4.2	3.6	3.7	1.8	3.3	4.6	7.65	4.90	6.4	0.83	0.64								
Odra-Polanka	Tot -N	9.4	6.4	8.1	5.6	8.6	8.1	4.8	4.0	3.9	2.4	5.6	5.4	8.51	5.60	6.7	0.79	0.66								
Odra-Polanka	PO4	1.0	2.8	0.4	1.0	2.1	6.6	1.6	1.0	0.8	1.5	1.7	2.2	2.75	1.55	1.9	0.69	0.56								
Odra-nad Jicinkou	Q	24.4	2.8	12.5	5.7	10.5	9.5	5.3	4.0	2.3	1.9	1.9	15.9						8.05	5.51	2.18					
Odra-nad Jicinkou	BOD5	1.1	3.5	2.7	0.9	3.1	5.0	2.4	1.0	2.3	3.8	4.2	1.9	4.16	2.55	2.3	0.55	0.61								
Odra-nad Jicinkou	SS	21.0	6.0	5.0	10.0	9.0	44.0	29.0	15.0	9.0	6.0	3.0	5.0	28.20	9.00	15.4	0.55	0.32								
Odra-nad Jicinkou	N-NH4	0.1	0.6	0.3	0.2	0.2	0.5	0.3	0.4	0.2	0.3	0.6	0.4	0.61	0.30	0.3	0.45	0.48								
Odra-nad Jicinkou	N-NO3	9.7	8.6	6.7	5.4	6.8	4.9	3.8	3.4	3.8	2.8	3.2	7.4	8.48	5.15	6.9	0.81	0.61								
Odra-nad Jicinkou	Tot -N	9.8	9.2	7.0	5.6	7.0	5.4	4.1	3.8	4.0	3.1	3.8	7.8	9.07	5.48	6.4	0.70	0.60								
Odra-nad Jicinkou	PO4	0.1	0.5	0.2	0.4	0.6	0.8	0.7	0.5	0.4	0.8	0.7	0.8	0.81	0.57	0.5	0.59	0.71								
Odra-Jakubcovice	Q	8.4	0.6	2.8	2.2	3.3	2.9	1.3	0.8	0.3	0.4	0.5	5.9						2.45	1.77	1.75					
Odra-Jakubcovice	BOD5	1.5	2.3	3.0	1.0	2.8	7.4	2.2	1.4	1.6	3.0	2.1	1.3	3.00	2.15	2.4	0.79	0.72								
Odra-Jakubcovice	SS	8.0	5.0	3.0	6.0	13.0	56.0	14.0	4.0	2.0	7.0	3.0	5.0	13.90	5.50	12.0	0.87	0.40								
Odra-Jakubcovice	N-NH4	<0.04	0.2	0.1	<0.04	0.1	0.4	0.3	0.1	0.1	0.1	0.2	0.2	0.27	0.16	0.1	0.48	0.58								
Odra-Jakubcovice	N-NO3	7.5	7.6	5.7	5.1	6.5	5.7	3.6	3.2	3.1	4.2	2.5	7.1	7.46	5.40	6.3	0.85	0.72								
Odra-Jakubcovice	Tot -N		7.78	5.84		6.62	6.10	3.86	3.27	3.23	4.34	2.71	7.31	7.36	5.09	4.54	0.62	0.69								
Odra-Jakubcovice	PO4	0.1	0.4	0.2	0.3	0.7	0.6	0.3	0.2	0.1	0.2	1.3	0.5	0.68	0.28	0.3	0.50	0.41								

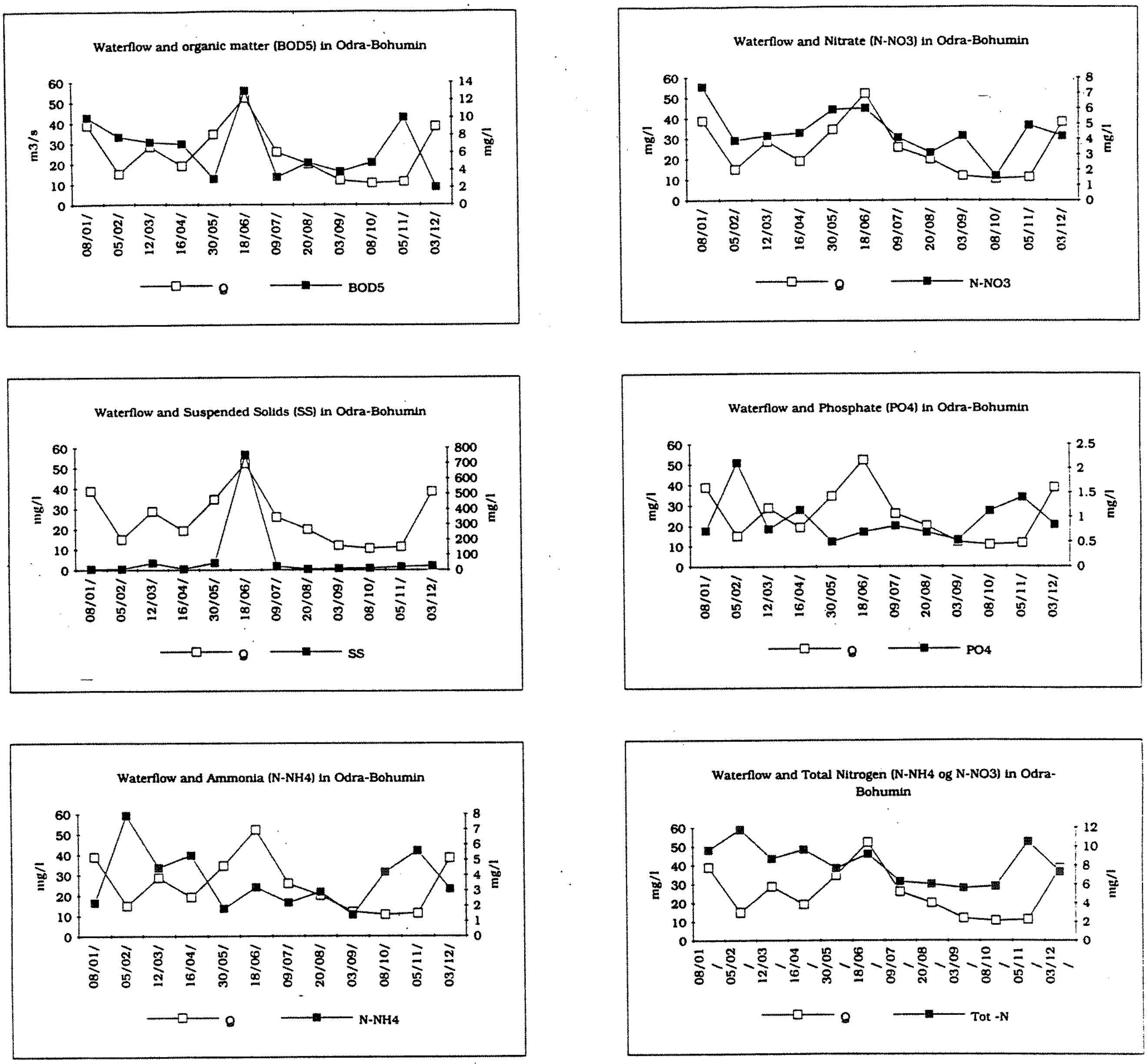


Figure 10.6.2: Variation in waterflow, BOD_5, $N\text{-}NH_4$, $N\text{-}NO_3$, PO_4, SS and Σ $N\text{-}NO_3$+$N\text{-}NH_4$ in Odra Bohumin, 1991

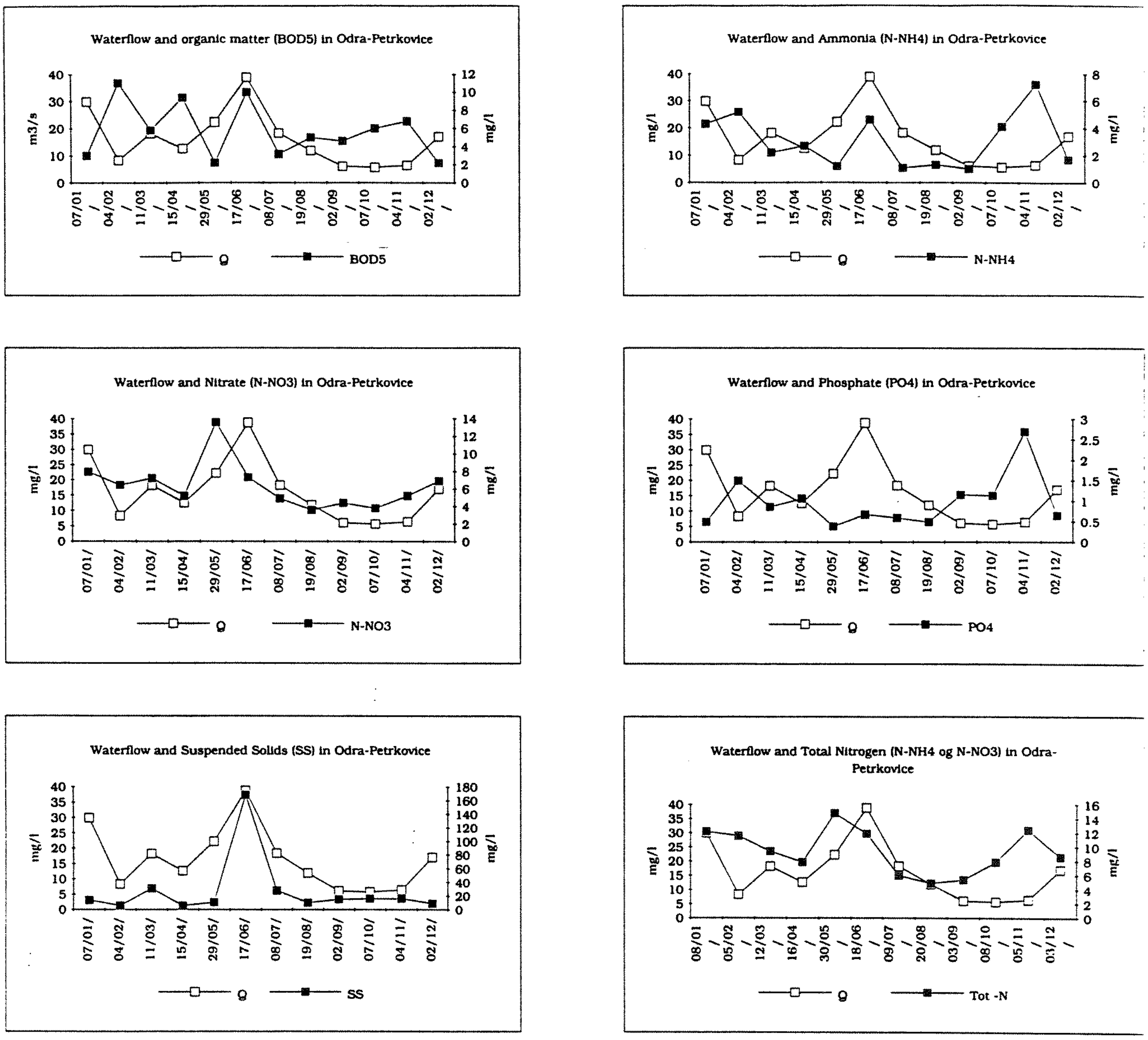


Figure 10.6.3: Variation in waterflow, BOD_5, $N\text{-}NH_4$, $N\text{-}NO_3$, PO_4, SS and $\Sigma\ N\text{-}NO_3 + N\text{-}NH_4$ in Odra Petrokovice, 1991

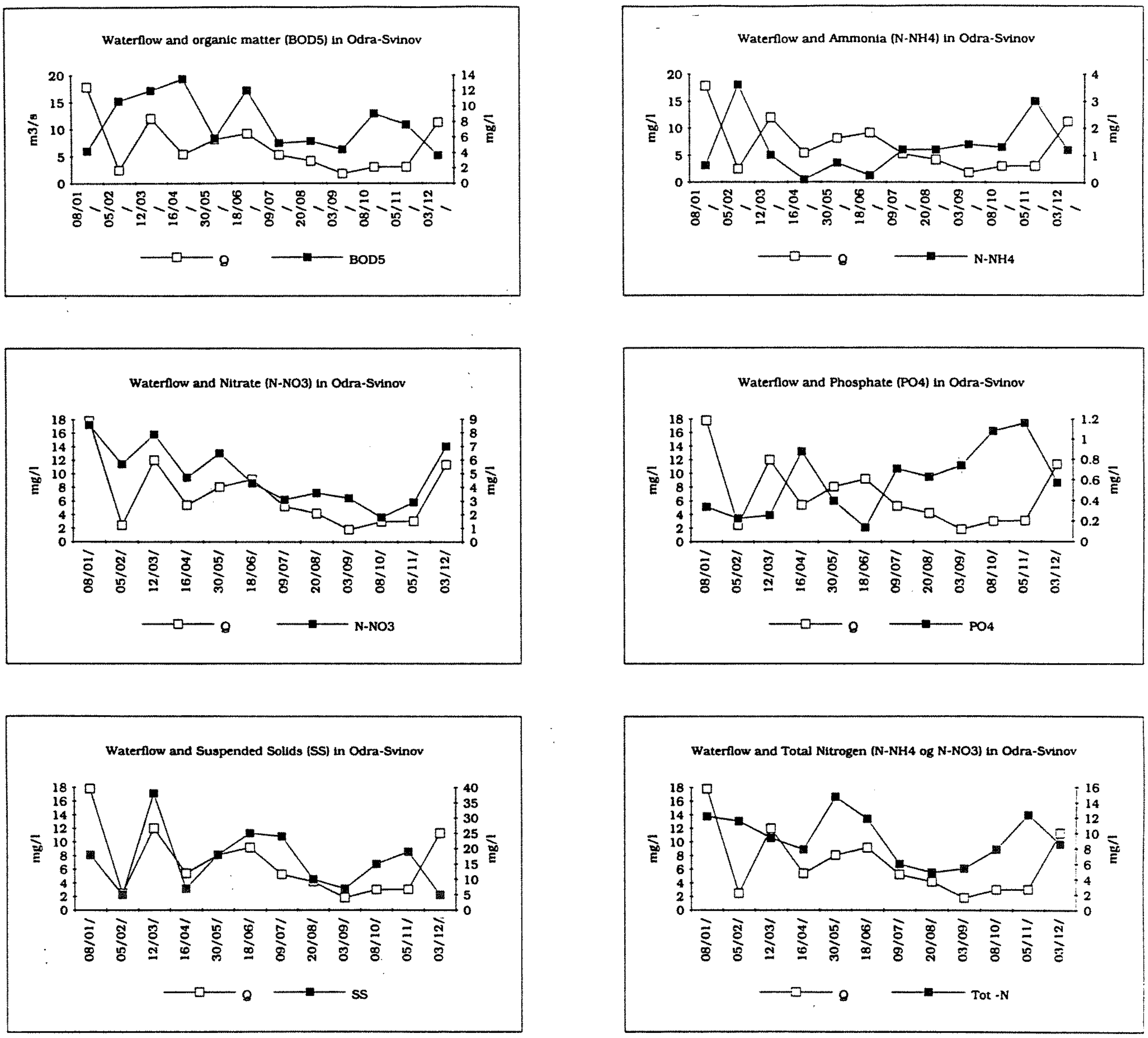
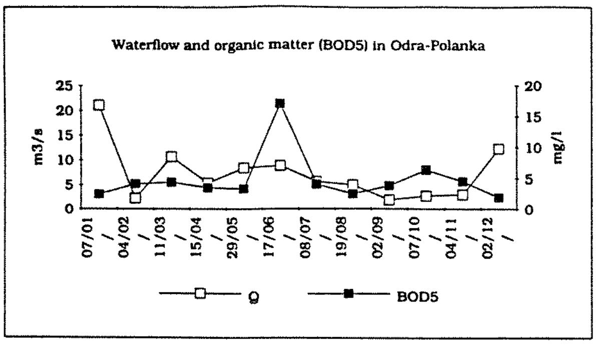
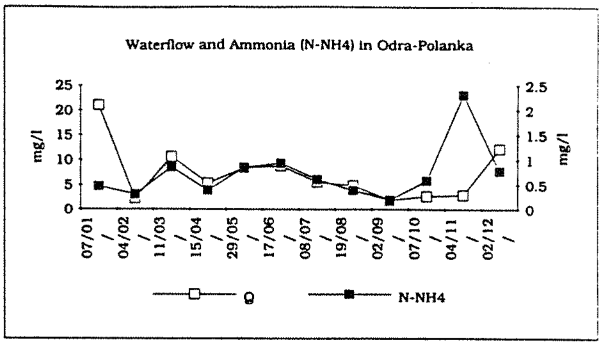
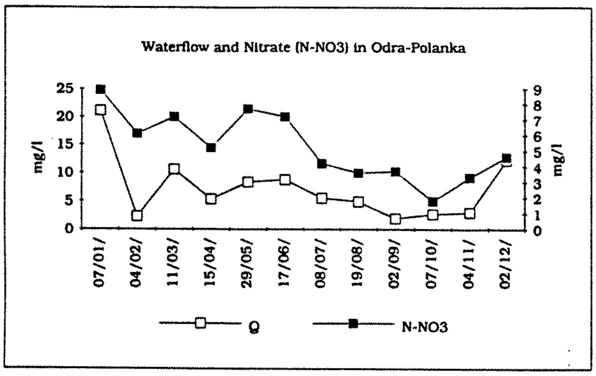
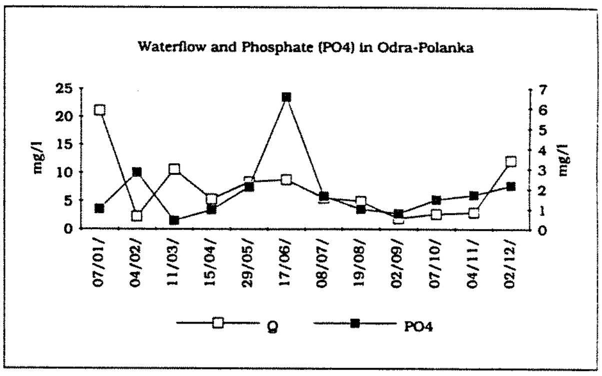


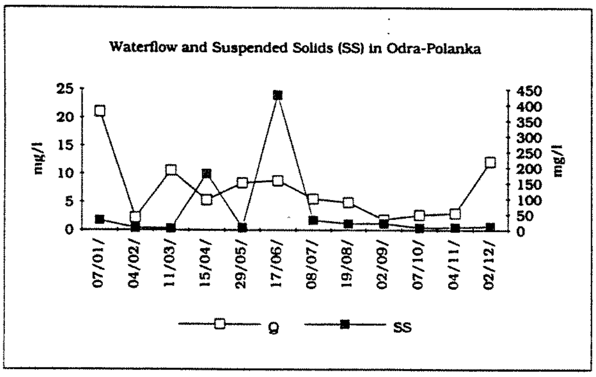
Figure 10.6.4: Variation in waterflow, BOD_5, $N\text{-}NH_4$, $N\text{-}NO_3$, PO_4, SS and Σ $N\text{-}NO_3$+$N\text{-}NH_4$ in Odra-Svinov, 1991











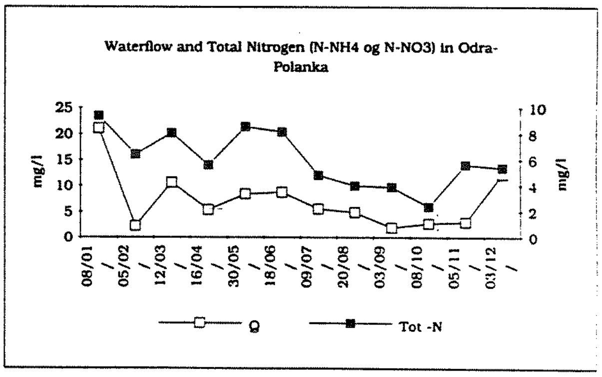


Figure 10.6.5: Variation in waterflow, BOD_5, $N\text{-}NH_4$, $N\text{-}NO_3$, PO_4, SS and Σ $N\text{-}NO_3$+$N\text{-}NH_4$ in Odra-Polanka, 1991

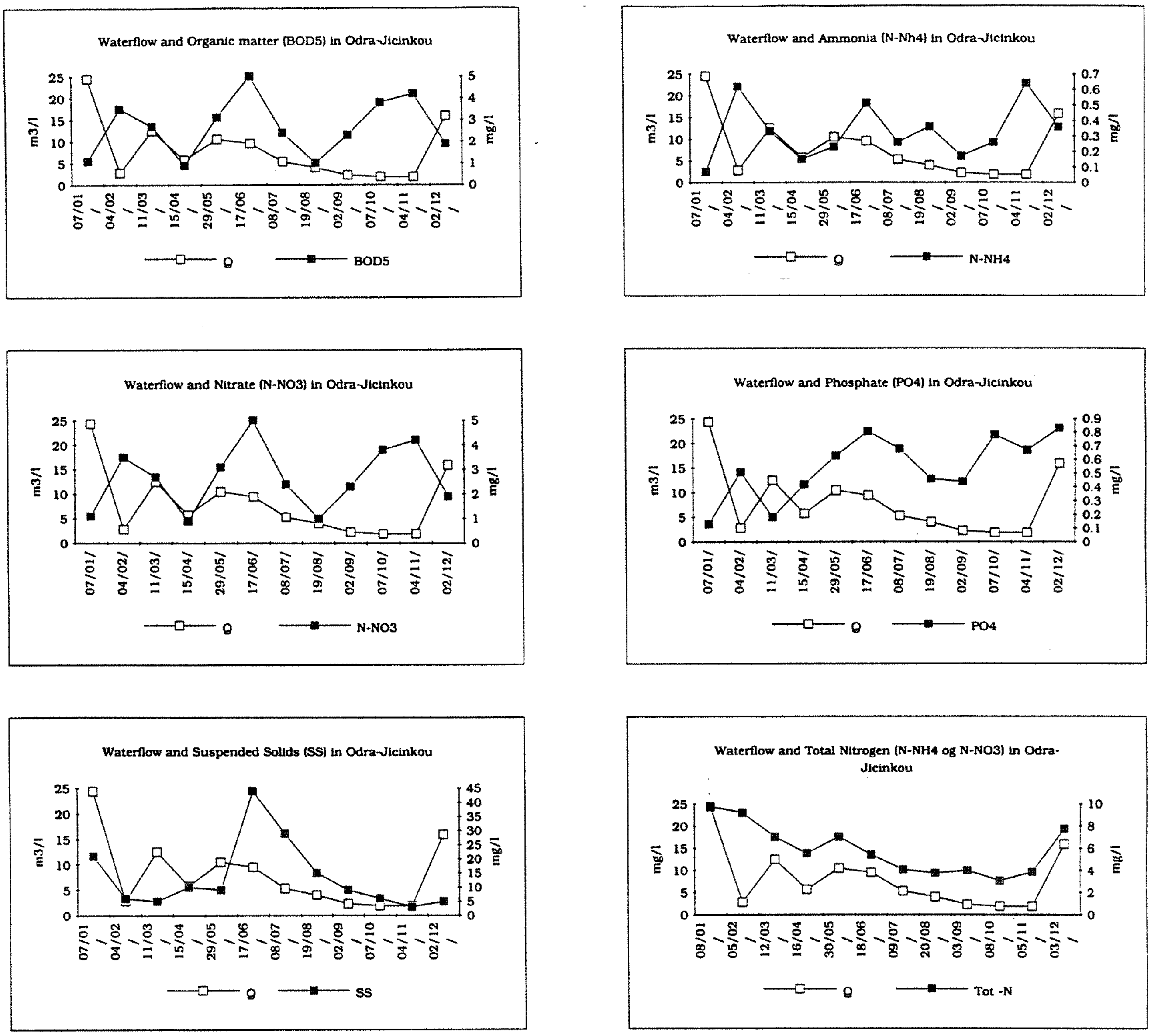


Figure 10.6.6: Variation in waterflow, BOD_5, $N\text{-}NH_4$, $N\text{-}NO_3$, PO_4, SS and Σ $N\text{-}NO_3$+$N\text{-}NH_4$ in Odra-nad Jicinkou, 1991

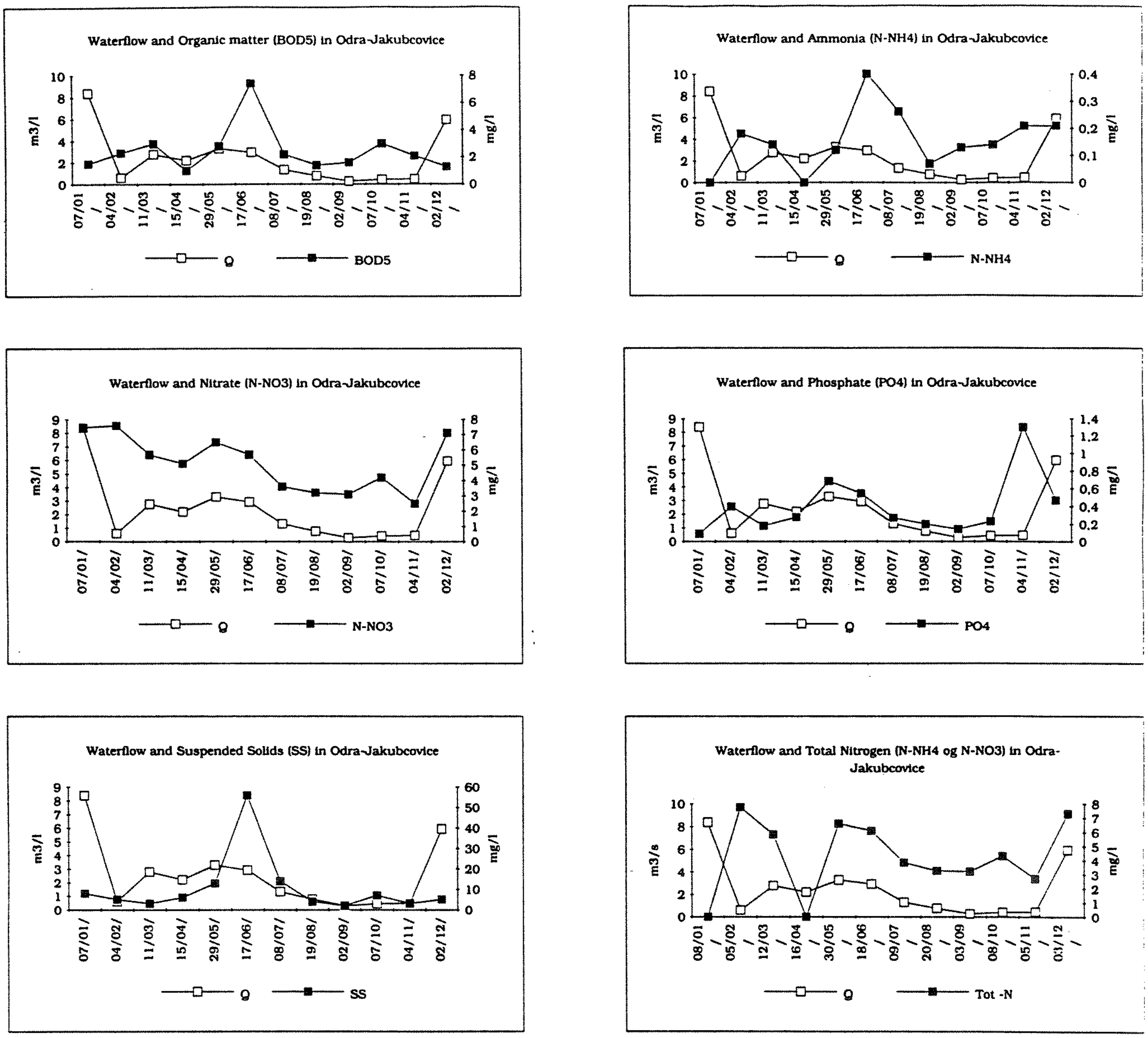


Figure 10.6.7: Variation in waterflow, BOD_5, $N\text{-}NH_4$, $N\text{-}NO_3$, PO_4, SS and Σ $N\text{-}NO_3$+$N\text{-}NH_4$ in Odra-Jakubcovice, 1991

10.7 Water quality objectives for Odra and need for pollution reduction

Table 10.7.1: Need for pollution reduction (tonnes/year), Objective 1

Nr.	Res.Cat.	Profile	Flow		Status 1992 and 1993, CAverage(mg/l)							Limits Obj. 1, CAverage (mg/l)							Balance Obj. 1, CAverage (Tonnes/year)					
			Q180m3/s)	BOD	N-NH4	N-NO3	N-NH4+N-NO3	TOT-P	SS	Zn	BOD	N-NH4	N-NO3	N-NH4+N-NO3	TOT-P	SS	Zn	BOD	N-NH4	N-NO3	N-NH4+N-NO3	TOT-P	SS	Zn
1	3	Odra -Bohumin	25,20	8,34	3,29	4,76	8,05	1,84	36,80	384,40	6,00					24,00	40,00	1860					10172	274
2	3	Odra-Petrkovice	16,10	6,18	2,38	5,53	7,91	0,72	47,60		6,00					24,00	40,00	91					11982	
3	3	Odra-Svinov	6,19	8,16	1,17	5,88	7,05	0,43	46,80		6,00					24,00	40,00	422					4451	
4	3	Odra-Polanka	5,87	8,28	0,97	5,46	6,43	0,76	120,40	37,60	6,00					24,00	40,00	422					17845	0
5	3	Odra-Studenka	3,72	5,70	1,22	6,86	8,08	0,92	35,60		6,00					24,00	40,00	-35					1361	
6	3	Odra-nad Jicinkou	2,18	3,96	0,54	5,95	6,49	0,27	35,20		6,00					24,00	40,00	-140					770	
7	2	Odra-Jakubcovice	1,75	2,04	0,34	5,25	5,59	0,20	14,00		3,00	0,75	4,90	5,65	0,20	16,00	20,00	-53	-23	19	-3	0	-110	
8	3	Cerny-Prikop									6,00					24,00	40,00						0	
9	3	Lubina-Kosatka	1,30	5,34	1,19	4,97	6,16	1,43	32,80		6,00					24,00	40,00	-27					361	
10	3	Bilovka pod Sezinou	0,30	7,44	4,53	9,66	14,19	(-)	40,80	34,40	6,00					24,00	40,00	14					159	0
11	3	Jicinka-Kunin	0,56	9,84	3,80	5,32	9,12	1,38	19,20	36,00	6,00					24,00	40,00	68					-85	0
12	3	Ostravice-Muglinov	8,09	7,56	2,36	3,43	5,79	0,92	38,40	161,20	6,00					24,00	40,00	398					3674	31
13	3	Ostravice-Vratimov	6,60	3,96	1,43	3,36	4,79	0,43	16,40		6,00					24,00	40,00	-425					-1582	
14	2	nad Maravkou	3,54	1,80	0,32	2,66	2,98	0,10	11,60	17,20	3,00	0,75	4,90	5,65	0,20	16,00	20,00	-134	-48	-250	-298	-12	-491	0
15	1	Pod nadrzi	1,63	1,38	0,32	1,26	1,58	0,05	10,80		1,20	0,25	2,38	2,63	0,08	8,00	8,00	9	3	-58	-54	-2	144	
16A	3	Olesna -ustí	0,48	2,04	0,55	4,83	5,38	0,27	14,80		6,00					24,00	40,00	-60					-139	
16B	3	Lucina	1,30	6,60	3,82	4,48	8,30	0,88	17,20		6,00					24,00	40,00	25					-279	
17	3	Opava Trebovice	9,05	4,32	1,35	5,67	7,02	0,64	21,20		6,00					24,00	40,00	-479					-799	
18	3	Opava-Hostice	4,13	11,16	1,98	4,62	6,60	1,14	29,20		6,00					24,00	40,00	672					677	
19	3	Opava-Vavrovice	4,09	2,58	0,48	4,13	4,61	0,43	26,80		6,00					24,00	40,00	-441					361	
20	2	Opava-pod Krnovem	3,41	3,12	0,70	5,39	6,09	0,62	16,00		3,00	0,75	4,90	5,65	0,20	16,00	20,00	13	-6	53	47	46	0	
21	2	Opava-nad Krnovem	2,28	2,22	0,20	3,85	4,05	0,15	11,60	18,40	3,00	0,75	4,90	5,65	0,20	16,00	20,00	-56	-40	-75	-115	-3	-316	0
22	3	Hvozdnice-usti	0,48	6,12	2,47	9,45	11,92	0,83	11,60		6,00					24,00	40,00	2					-188	
23	2	Hvozdnice-Mladecko	0,19	1,74	0,17	8,33	8,50	0,25	8,80		3,00	0,75	4,90	5,65	0,20	16,00	20,00	-8	-3	21	17	0	-43	
24A	3	Moravice-Branka	4,22	3,42	0,35	5,67	6,02	0,16	12,40		6,00					24,00	40,00	-343					-1544	
24B	1	Moravice-Slezska Hart	3,38	2,28	0,45	4,83	5,28	0,28	10,00	15,60	1,20	0,25	2,38	2,63	0,08	8,00	8,00	115	21	261	282	22	213	
25	1	Podolsky potok	1,05	3,12	0,70	3,71	4,41	0,20	8,80		1,20	0,25	2,38	2,63	0,08	8,00	8,00	64	15	44	59	4	26	
26	1	Zlata Opavice	1,25	2,52	0,31	6,30	6,61	0,19	12,40		1,20	0,25	2,38	2,63	0,08	8,00	8,00	52	2	155	157	5	173	
27	3	Olse-Vernovice	6,92	5,46	3,31	2,17	5,48	1,03	21,20		6,00					24,00	40,00	-118					-611	
28	3	Olse nad Stonavkou	4,76	4,02	1,83	2,87	4,70	0,78	22,80		6,00					24,00	40,00	-297					-180	
29	3	Olse pod Tesinem	4,07	6,00	3,76	2,66	6,42	0,85	14,80	35,20	6,00					24,00	40,00	0					-1181	-1
30	3	Olse nad Ropici	3,74	4,92	5,08	2,38	7,46	0,43	15,60	72,00	6,00					24,00	40,00	-127					-991	4
31	2	Olse nad Trincem	3,19	2,16	0,32	2,03	2,35	0,21	13,20		3,00	0,75	4,90	5,65	0,20	16,00	20,00	-85	-43	-289	-332	1	-282	
32	3	Stonavka-usti	0,80	2,04	0,34	2,73	3,07	0,17	12,00		6,00					24,00	40,00	-100					-303	

Table 10.7.2: Need for pollution reduction (tonnes/year), Objective 2

Nr.	Res.Cat.	Profile	Flow	Status 1992 and 1993, CAverage(mg/l)							Limits Obj. 2, CAverage (mg/l)							Balance Obj. 2, CAverage (Tonnes/year)						
			Q180m3/s	BOD	N-NH4	N-NO3	N-NH4+N-NO3	TOT-P	SS	Zn	BOD	N-NH4	N-NO3	N-NH4+N-NO3	TOT-P	SS	Zn	BOD	N-NH4	N-NO3	N-NH4+N-NO3	TOT-P	SS	Zn
1	3	Odra -Bohumin	25,20	8,34	3,29	4,76	8,05	1,84	36,80	384,40	6,00					24,00	40,00	1860					10172	274
2	3	Odra-Petrkovice	16,10	6,18	2,38	5,53	7,91	0,72	47,60		6,00					24,00	40,00	91					11982	
3	3	Odra-Svinov	6,19	8,16	1,17	5,88	7,05	0,43	46,80		6,00					24,00	40,00	422					4451	
4	3	Odra-Polanka	5,87	8,28	0,97	5,46	6,43	0,76	120,40	37,60	6,00					24,00	40,00	422					17845	0
5	3	Odra-Studenka	3,72	5,70	1,22	6,86	8,08	0,92	35,60		6,00					24,00	40,00	-35					1361	
6	3	Odra-nad Jicinkou	2,18	3,96	0,54	5,95	6,49	0,27	35,20		6,00					24,00	40,00	-140					770	
7	2	Odra-Jakubcovice	1,75	2,04	0,34	5,25	5,59	0,20	14,00		3,00	0,75	4,90	5,65	0,20	16,00	20,00	-53	-23	19	-3	0	-110	
8	3	Cerny-Prikop									6,00					24,00	40,00						0	
9	3	Lubina-Kosatka	1,30	5,34	1,19	4,97	6,16	1,43	32,80		6,00					24,00	40,00	-27					361	
10	3	Bilovka pod Sezinou	0,30	7,44	4,53	9,66	14,19	(-)	40,80	34,40	6,00					24,00	40,00	14					159	0
11	3	Jicinka-Kunin	0,56	9,84	3,80	5,32	9,12	1,38	19,20	36,00	6,00					24,00	40,00	68					-85	0
12	3	Ostravice-Muglinov	8,09	7,56	2,36	3,43	5,79	0,92	38,40	161,20	6,00					24,00	40,00	398					3674	31
13	3	Ostravice-Vratimov	6,60	3,96	1,43	3,36	4,79	0,43	16,40		6,00					24,00	40,00	-425					-1582	
14	2	nad Maravkou	3,54	1,80	0,32	2,66	2,98	0,10	11,60	17,20	3,00	0,75	4,90	5,65	0,20	16,00	20,00	-134	-48	-250	-298	-12	-491	0
15	1	Pod nadrzi	1,63	1,38	0,32	1,26	1,58	0,05	10,80		1,20	0,25	2,38	2,63	0,02	8,00	8,00	9	3	-58	-54	2	144	
16A	3	Olesna -usti	0,48	2,04	0,55	4,83	5,38	0,27	14,80		6,00					24,00	40,00	-60					-139	
16B	3	Lucina	1,30	6,60	3,82	4,48	8,30	0,88	17,20		6,00					24,00	40,00	25					-279	
17	3	Opava Trebovice	9,05	4,32	1,35	5,67	7,02	0,64	21,20		6,00					24,00	40,00	-479					-799	
18	3	Opava-Hostice	4,13	11,16	1,98	4,62	6,60	1,14	29,20		6,00					24,00	40,00	672					677	
19	3	Opava-Vavrovice	4,09	2,58	0,48	4,13	4,61	0,43	26,80		6,00					24,00	40,00	-441					361	
20	2	Opava-pod Krnovem	3,41	3,12	0,70	5,39	6,09	0,62	16,00		3,00	0,75	4,90	5,65	0,20	16,00	20,00	13	-6	53	47	46	0	
21	2	Opava-nad Krnovem	2,28	2,22	0,20	3,85	4,05	0,15	11,60	18,40	3,00	0,75	4,90	5,65	0,20	16,00	20,00	-56	-40	-75	-115	-3	-316	0
22	3	Hvozdnice-usti	0,48	6,12	2,47	9,45	11,92	0,83	11,60		6,00					24,00	40,00	2					-188	
23	2	Hvozdnice-Mladecko	0,19	1,74	0,17	8,33	8,50	0,25	8,80		3,00	0,75	4,90	5,65	0,20	16,00	20,00	-8	-3	21	17	0	-43	
24A	3	Moravice-Branka	4,22	3,42	0,35	5,67	6,02	0,16	12,40		6,00					24,00	40,00	-343					-1544	
24B	1	Moravice-Slezska Hart	3,38	2,28	0,45	4,83	5,28	0,28	10,00	15,60	1,20	0,25	2,38	2,63	0,02	8,00	8,00	115	21	261	282	28	213	
25	1	Podolsky potok	1,05	3,12	0,70	3,71	4,41	0,20	8,80		1,20	0,25	2,38	2,63	0,02	8,00	8,00	64	15	44	59	6	26	
26	1	Zlata Opavice	1,25	2,52	0,31	6,30	6,61	0,19	12,40		1,20	0,25	2,38	2,63	0,02	8,00	8,00	52	2	155	157	7	173	
27	3	Olse-Vernovice	6,92	5,46	3,31	2,17	5,48	1,03	21,20		6,00					24,00	40,00	-118					-611	
28	3	Olse nad Stonavkou	4,76	4,02	1,83	2,87	4,70	0,78	22,80		6,00					24,00	40,00	-297					-180	
29	3	Olse pod Tesinem	4,07	6,00	3,76	2,66	6,42	0,85	14,80	35,20	6,00					24,00	40,00	0					-1181	-1
30	3	Olse nad Ropici	3,74	4,92	5,08	2,38	7,46	0,43	15,60	72,00	6,00					24,00	40,00	-127					-991	4
31	2	Olse nad Trincem	3,19	2,16	0,32	2,03	2,35	0,21	13,20		3,00	0,75	4,90	5,65	0,20	16,00	20,00	-85	-43	-289	-332	1	-282	
32	3	Stonavka-usti	0,80	2,04	0,34	2,73	3,07	0,17	12,00		6,00					24,00	40,00	-100					-303	

Table 10.7.3: Need for pollution reduction (tonnes/year), Objective 3

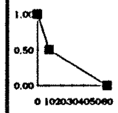
Nr.	Res.Cat.	Profile	Flow	Status 1992 and 1993, CAverage(mg/l)							Limits Obj. 3, CAverage (mg/l)							Balance Obj. 3, CAverage (Tonnes/year)						
			Q180m3/s	BOD	N-NH4	N-NO3	N-NH4+N-NO3	TOT-P	SS	Zn	BOD	N-NH4	N-NO3	N-NH4+N-NO3	TOT-P	SS	Zn	BOD	N-NH4	N-NO3	N-NH4+N-NO3	TOT-P	SS	Zn
1	3	Odra -Bohumin	25,20	8,34	3,29	4,76	8,05	1,84	36,80	384,40	6,00				0,20	24,00	40,00	1860				1299	10172	274
2	3	Odra-Petrkovice	16,10	6,18	2,38	5,53	7,91	0,72	47,60		6,00				0,20	24,00	40,00	91				264	11982	
3	3	Odra-Svinov	6,19	8,16	1,17	5,88	7,05	0,43	46,80		6,00				0,20	24,00	40,00	422				45	4451	
4	3	Odra-Polanka	5,87	8,28	0,97	5,46	6,43	0,76	120,40	37,60	6,00				0,20	24,00	40,00	422				103	17845	0
5	3	Odra-Studenka	3,72	5,70	1,22	6,86	8,08	0,92	35,60		6,00				0,20	24,00	40,00	-35				84	1361	
6	3	Odra-nad Jicinkou	2,18	3,96	0,54	5,95	6,49	0,27	35,20		6,00				0,20	24,00	40,00	-140				5	770	
7	2	Odra-Jakubcovice	1,75	2,04	0,34	5,25	5,59	0,20	14,00		3,00	0,75	4,90	5,65	0,08	16,00	20,00	-53	-23	19	-3	7	-110	
8	3	Cerny-Prikop									6,00				0,20	24,00	40,00	0				0	0	
9	3	Lubina-Kosatka	1,30	5,34	1,19	4,97	6,16	1,43	32,80		6,00				0,20	24,00	40,00	-27				50	361	
10	3	Bilovka pod Sezinou	0,30	7,44	4,53	9,66	14,19	(-)	40,80	34,40	6,00				0,20	24,00	40,00	14				-2	159	0
11	3	Jicinka-Kunin	0,56	9,84	3,80	5,32	9,12	1,38	19,20	36,00	6,00				0,20	24,00	40,00	68				21	-85	0
12	3	Ostravice-Muglinov	8,09	7,56	2,36	3,43	5,79	0,92	38,40	161,20	6,00				0,20	24,00	40,00	398				182	3674	31
13	3	Ostravice-Vratimov	6,60	3,96	1,43	3,36	4,79	0,43	16,40		6,00				0,20	24,00	40,00	-425				48	-1582	
14	2	nad Maravkou	3,54	1,80	0,32	2,66	2,98	0,10	11,60	17,20	3,00	0,75	4,90	5,65	0,08	16,00	20,00	-134	-48	-250	-298	2	-491	0
15	1	Pod nadrzi	1,63	1,38	0,32	1,26	1,58	0,05	10,80		1,20	0,25	2,38	2,63	0,02	8,00	8,00	9	3	-58	-54	1	144	
16A	3	Olesna -usti	0,48	2,04	0,55	4,83	5,38	0,27	14,80		6,00				0,20	24,00	40,00	-60				1	-139	
16B	3	Lucina	1,30	6,60	3,82	4,48	8,30	0,88	17,20		6,00				0,20	24,00	40,00	25				28	-279	
17	3	Opava Trebovice	9,05	4,32	1,35	5,67	7,02	0,64	21,20		6,00				0,20	24,00	40,00	-479				126	-799	
18	3	Opava-Hostice	4,13	11,16	1,98	4,62	6,60	1,14	29,20		6,00				0,20	24,00	40,00	672				123	677	
19	3	Opava-Vavrovice	4,09	2,58	0,48	4,13	4,61	0,43	26,80		6,00				0,20	24,00	40,00	-441				30	361	
20	2	Opava-pod Krnovem	3,41	3,12	0,70	5,39	6,09	0,62	16,00		3,00	0,75	4,90	5,65	0,08	16,00	20,00	13	-6	53	47	59	0	
21	2	Opava-nad Krnovem	2,28	2,22	0,20	3,85	4,05	0,15	11,60	18,40	3,00	0,75	4,90	5,65	0,08	16,00	20,00	-56	-40	-75	-115	6	-316	0
22	3	Hvozdnice-usti	0,48	6,12	2,47	9,45	11,92	0,83	11,60		6,00				0,20	24,00	40,00	2				10	-188	
23	2	Hvozdnice-Mladecko	0,19	1,74	0,17	8,33	8,50	0,25	8,80		3,00	0,75	4,90	5,65	0,08	16,00	20,00	-8	-3	21	17	1	-43	
24A	3	Moravice-Branka	4,22	3,42	0,35	5,67	6,02	0,16	12,40		6,00				0,20	24,00	40,00	-343				-5	-1544	
24B	1	Moravice-Slezska Hart	3,38	2,28	0,45	4,83	5,28	0,28	10,00	15,60	1,20	0,25	2,38	2,63	0,02	8,00	8,00	115	21	261	282	28	213	
25	1	Podolsky potok	1,05	3,12	0,70	3,71	4,41	0,20	8,80		1,20	0,25	2,38	2,63	0,02	8,00	8,00	64	15	44	59	6	26	
26	1	Zlata Opavice	1,25	2,52	0,31	6,30	6,61	0,19	12,40		1,20	0,25	2,38	2,63	0,02	8,00	8,00	52	2	155	157	7	173	
27	3	Olse-Vernovice	6,92	5,46	3,31	2,17	5,48	1,03	21,20		6,00				0,02	24,00	40,00	-118				221	-611	
28	3	Olse nad Stonavkou	4,76	4,02	1,83	2,87	4,70	0,78	22,80		6,00				0,20	24,00	40,00	-297				86	-180	
29	3	Olse pod Tesinem	4,07	6,00	3,76	2,66	6,42	0,85	14,80	35,20	6,00				0,20	24,00	40,00	0				83	-1181	-1
30	3	Olse nad Ropici	3,74	4,92	5,08	2,38	7,46	0,43	15,60	72,00	6,00				0,20	24,00	40,00	-127				28	-991	4
31	2	Olse nad Trincem	3,19	2,16	0,32	2,03	2,35	0,21	13,20		3,00	0,75	4,90	5,65	0,08	16,00	20,00	-85	-43	-289	-332	13	-282	
32	3	Stonavka-usti	0,80	2,04	0,34	2,73	3,07	0,17	12,00		6,00				0,20	24,00	40,00	-100				-1	-303	-1009

Table 10.7.4: Need for pollution reduction (tonnes/year), Objective 4

Nr.	Res.Cat.	Profile	Flow	Status 1992 and 1993, CAverage(mg/l)							Limits Obj. 4, CAverage (mg/l)							Balance Obj. 4, CAverage (Tonnes/year)						
			Q180m3/s)	BOD	N-NH4	N-NO3	N-NH4+N-NO3	TOT-P	SS	Zn	BOD	N-NH4	N-NO3	N-NH4+N-NO3	TOT-P	SS	Zn	BOD	N-NH4	N-NO3	N-NH4+N-NO3	TOT-P	SS	Zn
1	3	Odra -Bohumin	25,20	8,34	3,29	4,76	8,05	1,84	36,80	384,40	6,00	0,75	4,90	5,65	0,20	24,00	40,00	1860	2019	-111	1907	1299	10172	274
2	3	Odra-Petrkovice	16,10	6,18	2,38	5,53	7,91	0,72	47,60		6,00	0,75	4,90	5,65	0,20	24,00	40,00	91	828	320	1147	264	11982	
3	3	Odra-Svinov	6,19	8,16	1,17	5,88	7,05	0,43	46,80		6,00	0,75	4,90	5,65	0,20	24,00	40,00	422	82	191	273	45	4451	
4	3	Odra-Polanka	5,87	8,28	0,97	5,46	6,43	0,76	120,40	37,60	6,00	0,75	4,90	5,65	0,20	24,00	40,00	422	40	104	143	103	17845	0
5	3	Odra-Studenka	3,72	5,70	1,22	6,86	8,08	0,92	35,60		6,00	0,75	4,90	5,65	0,20	24,00	40,00	-35	55	230	284	84	1361	
6	3	Odra-nad Jicinkou	2,18	3,96	0,54	5,95	6,49	0,27	35,20		6,00	0,75	4,90	5,65	0,20	24,00	40,00	-140	-15	72	57	5	770	
7	2	Odra-Jakubcovice	1,75	2,04	0,34	5,25	5,59	0,20	14,00		3,00	0,75	4,90	5,65	0,08	16,00	20,00	-53	-23	19	-3	7	-110	
8	3	Cerny-Prikop									6,00	0,75	4,90	5,65	0,20	24,00	40,00	0	0	0	0	0	0	
9	3	Lubina-Kosatka	1,30	5,34	1,19	4,97	6,16	1,43	32,80		6,00	0,75	4,90	5,65	0,20	24,00	40,00	-27	18	3	21	50	361	
10	3	Bilovka pod Sezinou	0,30	7,44	4,53	9,66	14,19	(-)	40,80	34,40	6,00	0,75	4,90	5,65	0,20	24,00	40,00	14	36	45	81	-2	159	
11	3	Jicinka-Kunin	0,56	9,84	3,80	5,32	9,12	1,38	19,20	36,00	6,00	0,75	4,90	5,65	0,20	24,00	40,00	68	54	7	61	21	-85	
12	3	Ostravice-Muglinov	8,09	7,56	2,36	3,43	5,79	0,92	38,40	161,20	6,00	0,75	4,90	5,65	0,20	24,00	40,00	398	409	-375	34	182	3674	31
13	3	Ostravice-Vratimov	6,60	3,96	1,43	3,36	4,79	0,43	16,40		6,00	0,75	4,90	5,65	0,20	24,00	40,00	-425	140	-321	-180	48	-1582	
14	2	nad Maravkou	3,54	1,80	0,32	2,66	2,98	0,10	11,60	17,20	3,00	0,75	4,90	5,65	0,08	16,00	20,00	-134	-48	-250	-298	2	-491	
15	1	Pod nadrzi	1,63	1,38	0,32	1,26	1,58	0,05	10,80		1,20	0,25	2,38	2,63	0,02	8,00	8,00	9	3	-58	-54	1	144	
16A	3	Olesna -usti	0,48	2,04	0,55	4,83	5,38	0,27	14,80		6,00	0,75	4,90	5,65	0,20	24,00	40,00	-60	-3	-1	-4	1	-139	
16B	3	Lucina	1,30	6,60	3,82	4,48	8,30	0,88	17,20		6,00	0,75	4,90	5,65	0,20	24,00	40,00	25	126	-17	108	28	-279	
17	3	Opava Trebovice	9,05	4,32	1,35	5,67	7,02	0,64	21,20		6,00	0,75	4,90	5,65	0,20	24,00	40,00	-479	171	220	391	126	-799	-11
18	3	Opava-Hostice	4,13	11,16	1,98	4,62	6,60	1,14	29,20		6,00	0,75	4,90	5,65	0,20	24,00	40,00	672	160	-36	123	123	677	
19	3	Opava-Vavrovice	4,09	2,58	0,48	4,13	4,61	0,43	26,80		6,00	0,75	4,90	5,65	0,20	24,00	40,00	-441	-35	-99	-135	30	361	
20	2	Opava-pod Krnovem	3,41	3,12	0,70	5,39	6,09	0,62	16,00		3,00	0,75	4,90	5,65	0,08	16,00	20,00	13	-6	53	47	59	0	
21	2	Opava-nad Krnovem	2,28	2,22	0,20	3,85	4,05	0,15	11,60	18,40	3,00	0,75	4,90	5,65	0,08	16,00	20,00	-56	-40	-75	-115	6	-316	
22	3	Hvozdnice-usti	0,48	6,12	2,47	9,45	11,92	0,83	11,60		6,00	0,75	4,90	5,65	0,20	24,00	40,00	2	26	69	95	10	-188	
23	2	Hvozdnice-Mladecko	0,19	1,74	0,17	8,33	8,50	0,25	8,80		3,00	0,75	4,90	5,65	0,08	16,00	20,00	-8	-3	21	17	1	-43	
24A	3	Moravice-Branka	4,22	3,42	0,35	5,67	6,02	0,16	12,40		6,00	0,75	4,90	5,65	0,20	24,00	40,00	-343	-53	102	49	-5	-1544	
24B	1	Moravice-Slezska Hart	3,38	2,28	0,45	4,83	5,28	0,28	10,00	15,60	1,20	0,25	2,38	2,63	0,02	8,00	8,00	115	21	261	282	28	213	
25	1	Podolsky potok	1,05	3,12	0,70	3,71	4,41	0,20	8,80		1,20	0,25	2,38	2,63	0,02	8,00	8,00	64	15	44	59	6	26	
26	1	Zlata Opavice	1,25	2,52	0,31	6,30	6,61	0,19	12,40		1,20	0,25	2,38	2,63	0,02	8,00	8,00	52	2	155	157	7	173	
27	3	Olse-Vernovice	6,92	5,46	3,31	2,17	5,48	1,03	21,20		6,00	0,75	4,90	5,65	0,02	24,00	40,00	-118	558	-596	-38	221	-611	
28	3	Olse nad Stonavkou	4,76	4,02	1,83	2,87	4,70	0,78	22,80		6,00	0,75	4,90	5,65	0,20	24,00	40,00	-297	162	-305	-143	86	-180	
29	3	Olse pod Tesinem	4,07	6,00	3,76	2,66	6,42	0,85	14,80	35,20	6,00	0,75	4,90	5,65	0,20	24,00	40,00	0	386	-288	98	83	-1181	-1
30	3	Olse nad Ropici	3,74	4,92	5,08	2,38	7,46	0,43	15,60	72,00	6,00	0,75	4,90	5,65	0,20	24,00	40,00	-127	511	-297	213	28	-991	4
31	2	Olse nad Trincem	3,19	2,16	0,32	2,03	2,35	0,21	13,20		3,00	0,75	4,90	5,65	0,08	16,00	20,00	-85	-43	-289	-332	13	-282	
32	3	Stonavka-usti	0,80	2,04	0,34	2,73	3,07	0,17	12,00		6,00	0,75	4,90	5,65	0,20	24,00	40,00	-100			-65	-1	-303	-1009

10.8 Distance between profiles and effect coefficients

Table 10.8.1 Distance (km) between profiles and effect coefficients for BOD_5



Distance (km) between profiles

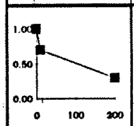
BOD5		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16A	16B	17	18	19	20	21	22	23	24A	24B	25	26	27	28	29	30	31	32
		Odra -Bohumin	Odra-Petrkovice	Odra-Svinov	Odra-Polanka	Odra-Studenka	Odra-nad Jicinkou	Odra-Jakubcovice	Cerny-Prikop	Lubina-Kosatka	Bilovka pod Sezinou	Jicinka--Kunin	Ostravice-Muglinov	Ostravice-Vratimov	nad Maravkou	Pod nadrzi	Olesna -usti	Lucina Utsi	Opava Trebovice	Opava-Hostice	Opava-Vavrovice	Opava-pod Krnovem	Opava-nad Krnovem	Hvozdnice-usti	Hvozdnice-Mladecko	Moravice-Branka	Moravice Slezska Harta	Podolsky potok	Zlata Opavice	Olse-Vernovice	Olse nad Stonavkou	Olse pod Tesinem	Olse nad Ropici	Olse nad Trincem	Stonavka-usti
1	Odra -Bohumin	0.0																																	
2	Odra-Petrkovice	9.4	0.0																																
3	Odra-Svinov	15.8	6.4	0.0																															
4	Odra-Polanka	22.0	12.6	6.2	0.0																														
5	Odra-Studenka	44.2	34.8	28.4	22.2	0.0																													
6	Odra-nad Jicinkou	56.5	47.1	40.7	34.5	12.3	0.0																												
7	Odra-Jakubcovice	82.8	73.4	67.0	60.8	38.6	26.3	0.0																											
8	Cerny-Prikop	7.7							0.0																										
9	Lubina-Kosatka	30.1	20.7	14.3	8.1					0.0																									
10	Bilovka pod Sezinou	37.1	27.7	21.3	15.1						0.0																								
11	Jicinka-Kunin	56.5	47.1	40.7	34.5	12.3						0.0																							
12	Ostravice-Muglinov	9.3											0.0																						
13	Ostravice-Vratimov	19.6											10.3	0.0																					
14	nad Moravkou	32.8											23.5	13.2	0.0																				
15	Pod nadrzi	52.1											42.6	32.5	19.3	0.0																			
16A	Olesna -usti	23.3											26.3	16.0			0.0																		
16B	Lucina Usti	28.4											19.1					0.0																	
17	Opava Trebovice	14.3	4.9																0.0																
18	Opava-Hostice	50.8	41.1																36.2	0.0															
19	Opava-Vavrovice	59.6	50.2																45.3	9.1	0.0														
20	Opava-pod Krnovem	75.4	66.0																61.1	24.9	15.8	0.0													
21	Opava-nad Krnovem	89.0	79.6																74.7	38.5	29.4	13.6	0.0												
22	Hvozdnice-usti	55.2	45.8																40.8					0.0											
23	Hvozdnice-Mladecko	72.2	62.8																57.9					17.0	0.0										
24A	Moravice-Branka	56.6	47.2																42.3							0.0									
24B	Moravice-Slezska Harta	104.6	95.2																90.3							48.0	0.0								
25	Podolsky potok	135.2	125.8																120.9							78.6	30.6	0.0							
26	Zlata Opavice	88.0	78.6																73.7	37.5	28.4	12.6	1.0						0.0						
27	Olse-Vernovice																													0.0					
28	Olse nad Stonavkou																													14.1	0.0				
29	Olse pod Tesinem																													25.4	11.3	0.0			
30	Olse nad Ropici																													32.5	18.4	7.1	0.0		
31	Olse nad Trincem																													43.2	29.1	17.8	10.7	0.0	
32	Stonavka-usti																													13.7	0.4	11.7			0.0

Effect coefficients

BOD5		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16A	16B	17	18	19	20	21	22	23	24A	24B	25	26	27	28	29	30	31	32
		Odra -Bohumin	Odra-Petrkovice	Odra-Svinov	Odra-Polanka	Odra-Studenka	Odra-nad Jicinkou	Odra-Jakubcovice	Cerny-Prikop	Lubina-Kosatka	Bilovka pod Sezinou	Jicinka-Kunin	Ostravice-Muglinov	Ostravice-Vratimov	nad Maravkou	Pod nadrzi	Olesna -usti	Lucina Utsi	Opava Trebovice	Opava-Hostice	Opava-Vavrovice	Opava-pod Krnovem	Opava-nad Krnovem	Hvozdnice-usti	Hvozdnice-Mladecko	Moravice-Branka	Moravice Slezska Harta	Podolsky potok	Zlata Opavice	Olse-Vernovice	Olse nad Stonavkou	Olse pod Tesinem	Olse nad Ropici	Olse nad Trincem	Stonavka-usti
1	Odra -Bohumin	1.00																																	
2	Odra-Petrkovice	0.53	1.00																																
3	Odra-Svinov	0.44	0.68	1.00																															
4	Odra-Polanka	0.38	0.47	0.69	1.00																														
5	Odra-Studenka	0.16	0.25	0.32	0.38	1.00																													
6	Odra-nad Jicinkou	0.04	0.13	0.19	0.26	0.48	1.00																												
7	Odra-Jakubcovice	0.00	0.00	0.00	0.00	0.21	0.34	1.00																											
8	Cerny-Prikop	0.62							1.00																										
9	Lubina-Kosatka	0.30	0.39	0.46	0.60					1.00																									
10	Bilovka pod Sezinou	0.23	0.32	0.39	0.45						1.00																								
11	Jicinka-Kunin	0.04	0.13	0.19	0.26	0.48						1.00																							
12	Ostravice-Muglinov	0.54											1.00																						
13	Ostravice-Vratimov	0.40											0.50	1.00																					
14	nad Moravkou	0.27											0.37	0.47	1.00																				
15	Pod nadrzi	0.06											0.17	0.28	0.41	1.00																			
16A	Olesna -usti	0.37											0.34	0.44			1.00																		
16B	Lucina Usti	0.32											0.41					1.00																	
17	Opava Trebovice	0.46	0.76																1.00																
18	Opava-Hostice	0.10	0.19																0.24	1.00															
19	Opava-Vavrovice	0.00	0.10																0.15	0.55	1.00														
20	Opava-pod Krnovem	0.00	0.00																0.00	0.35	0.44	1.00													
21	Opava-nad Krnovem	0.00	0.00																0.00	0.22	0.31	0.46	1.00												
22	Hvozdnice-usti	0.05	0.14																0.19					1.00											
23	Hvozdnice-Mladecko	0.00	0.00																0.02					0.43	1.00										
24A	Moravice-Branka	0.03	0.13																0.18							1.00									
24B	Moravice-Slezska Harta	0.00	0.00																0.00							0.27	1.00								
25	Podolsky potok	0.00	0.00																0.00							0.04	0.29	1.00							
26	Zlata Opavice	0.00	0.00																0.00	0.23	0.32	0.47	0.95						1.00						
27	Olse-Vernovice																													1.00					
28	Olse nad Stonavkou																													0.46	1.00				
29	Olse pod Tesinem																													0.35	0.49	1.00			
30	Olse nad Ropici																													0.28	0.42	0.65	1.00		
31	Olse nad Trincem																													0.17	0.31	0.42	0.49	1.00	
32	Stonavka-usti																													0.46	0.98	0.48			1.00

Table 10.8.2 Distance (km) between profiles and effect coefficients for $N\text{-}NO_3+N\text{-}NH_4$

Distance (km) between profiles

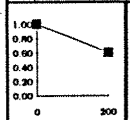
No.	Tot - N 	1 Odra -Bohumin	2 Odra-Petrkovice	3 Odra-Svinov	4 Odra-Polanka	5 Odra-Studenka	6 Odra-nad Jicinkou	7 Odra-Jakubcovice	8 Cerny-Prikop	9 Lubina-Kosatka	10 Bilovka pod Sezinou	11 Jicinka--Kunin	12 Ostravice-Muglinov	13 Ostravice-Vratimov	14 nad Maravkou	15 Pod nadrzi	16A Olesna -usti	16B Lucina Utsi	17 Opava Trebovice	18 Opava-Hostice	19 Opava-Vavrovice	20 Opava-pod Krnovem	21 Opava-nad Krnovem	22 Hvozdnice-usti	23 Hvozdnice-Mladecko	24A Moravice-Branka	24B Moravice Slezska Harta	25 Podolsky potok	26 Zlata Opavice	27 Olse-Vernovice	28 Olse nad Stonavkou	29 Olse pod Tesnem	30 Olse nad Ropici	31 Olse nad Trincem	32 Stonavka-usti
1	Odra -Bohumin	0.0																																	
2	Odra-Petrkovice	9.4	0.0																																
3	Odra-Svinov	15.8	6.4	0.0																															
4	Odra-Polanka	22.0	12.6	6.2	0.0																														
5	Odra-Studenka	44.2	34.8	28.4	22.2	0.0																													
6	Odra-nad Jicinkou	56.5	47.1	40.7	34.5	12.3	0.0																												
7	Odra-Jakubcovice	82.8	73.4	67.0	60.8	38.6	26.3	0.0																											
8	Cerny-Prikop	7.7							0.0																										
9	Lubina-Kosatka	30.1	20.7	14.3	8.1					0.0																									
10	Bilovka pod Sezinou	37.1	27.7	21.3	15.1						0.0																								
11	Jicinka-Kunin	56.5	47.1	40.7	34.5	12.3						0.0																							
12	Ostravice-Muglinov	9.3											0.0																						
13	Ostravice-Vratimov	19.6											10.3	0.0																					
14	nad Moravkou	32.8											23.5	13.2	0.0																				
15	Pod nadrzi	52.1											42.8	32.5	19.3	0.0																			
16A	Olesna -usti	23.3											26.3	16.0			0.0																		
16B	Lucina Usti	26.4											19.1					0.0																	
17	Opava Trebovice	14.3	4.9																0.0																
18	Opava-Hostice	50.5	41.1																36.2	0.0															
19	Opava-Vavrovice	59.6	50.2																45.3	9.1	0.0														
20	Opava-pod Krnovem	75.4	66.0																61.1	24.9	15.8	0.0													
21	Opava-nad Krnovem	89.0	79.6																74.7	38.5	29.4	13.6	0.0												
22	Hvozdnice-usti	55.2	45.8																40.8					0.0											
23	Hvozdnice-Mladecko	72.2	62.8																57.9					17.0	0.0										
24A	Moravice-Branka	56.6	47.2																42.3							0.0									
24B	Moravice-Slezska Ha	104.6	95.2																90.3							48.0	0.0								
25	Podolsky potok	135.2	125.8																120.9							78.6	30.6	0.0							
26	Zlata Opavice	88.0	78.6																73.7	37.5	28.4	12.6	1.0						0.0						
27	Olse-Vernovice																													0.0					
28	Olse nad Stonavkou																													14.1	0.0				
29	Olse pod Tesinem																													25.4	11.3	0.0			
30	Olse nad Ropici																													32.5	18.4	7.1	0.0		
31	Olse nad Trincem																													43.2	29.1	17.8	10.7	0.0	
32	Stonavka-usti																													13.7	0.4	11.7			0.0

Effect coefficients

No.	Tot - N	1 Odra -Bohumin	2 Odra-Petrkovice	3 Odra-Svinov	4 Odra-Polanka	5 Odra-Studenka	6 Odra-nad Jicinkou	7 Odra-Jakubcovice	8 Cerny-Prikop	9 Lubina-Kosatka	10 Bilovka pod Sezinou	11 Jicinka-Kunin	12 Ostravice-Muglinov	13 Ostravice-Vratimov	14 nad Maravkou	15 Pod nadrzi	16A Olesna -usti	16B Lucina Utsi	17 Opava Trebovice	18 Opava-Hostice	19 Opava-Vavrovice	20 Opava-pod Krnovem	21 Opava-nad Krnovem	22 Hvozdnice-usti	23 Hvozdnice-Mladecko	24A Moravice-Branka	24B Moravice Slezska Harta	25 Podolsky potok	26 Zlata Opavice	27 Olse-Vernovice	28 Olse nad Stonavkou	29 Olse pod Tesnem	30 Olse nad Ropici	31 Olse nad Trincem	32 Stonavka-usti
1	Odra -Bohumin	1.00																																	
2	Odra-Petrkovice	0.72	1.00																																
3	Odra-Svinov	0.69	0.81	1.00																															
4	Odra-Polanka	0.67	0.69	0.81	1.00																														
5	Odra-Studenka	0.63	0.65	0.66	0.67	1.00																													
6	Odra-nad Jicinkou	0.60	0.62	0.64	0.65	0.70	1.00																												
7	Odra-Jakubcovice	0.55	0.57	0.58	0.59	0.64	0.67	1.00																											
8	Cerny-Prikop	0.77							1.00																										
9	Lubina-Kosatka	0.66	0.68	0.69	0.76					1.00																									
10	Bilovka pod Sezinou	0.64	0.66	0.68	0.69						1.00																								
11	Jicinka-Kunin	0.60	0.62	0.64	0.65	0.70						1.00																							
12	Ostravice-Muglinov	0.72											1.00																						
13	Ostravice-Vratimov	0.68											0.70	1.00																					
14	nad Moravkou	0.65											0.67	0.69	1.00																				
15	Pod nadrzi	0.61											0.63	0.65	0.68	1.00																			
16A	Olesna -usti	0.67											0.67	0.69			1.00																		
16B	Lucina Usti	0.66											0.68					1.00																	
17	Opava Trebovice	0.69	0.85																1.00																
18	Opava-Hostice	0.61	0.63																0.64	1.00															
19	Opava-Vavrovice	0.60	0.62																0.63	0.73	1.00														
20	Opava-pod Krnovem	0.56	0.58																0.59	0.67	0.69	1.00													
21	Opava-nad Krnovem	0.53	0.55																0.56	0.64	0.66	0.69	1.00												
22	Hvozdnice-usti	0.60	0.62																0.64					1.00											
23	Hvozdnice-Mladecko	0.57	0.59																0.60					0.89	1.00										
24A	Moravice-Branka	0.60	0.62																0.63							1.00									
24B	Moravice-Slezska Ha	0.50	0.52																0.53							0.68	1.00								
25	Podolsky potok	0.44	0.46																0.47							0.38	0.66	1.00							
26	Zlata Opavice	0.54	0.56																0.57	0.64	0.66	0.69	0.97						1.00						
27	Olse-Vernovice																													1.00					
28	Olse nad Stonavkou																													0.69	1.00				
29	Olse pod Tesinem																													0.67	0.70	1.00			
30	Olse nad Ropici																													0.65	0.68	0.79	1.00		
31	Olse nad Trincem																													0.63	0.66	0.68	0.70	1.00	
32	Stonavka-usti																													0.69	0.99	0.70			1.00

Table 10.8.3 Distance (km) between profiles and effect coefficients for Tot-P

Tot - P



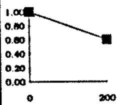
Distance (km) between profiles

No.	Profile	1 Odra -Bohumin	2 Odra-Petrkovice	3 Odra-Svinov	4 Odra-Polanka	5 Odra-Studenka	6 Odra-nad Jicinkou	7 Odra-Jakubcovice	8 Cerny-Prikop	9 Lubina-Kosatka	10 Bilovka pod Sezinou	11 Jicinka--Kunin	12 Ostravice-Muglinov	13 Ostravice-Vratimov	14 nad Maravkou	15 Pod nadrzi	16A Olesna -usti	16B Lucina Utsi	17 Opava Trebovice	18 Opava-Hostice	19 Opava-Vavrovice	20 Opava-pod Krnovem	21 Opava-nad Krnovem	22 Hvozdnice-usti	23 Hvozdnice-Mladecko	24A Moravice-Branka	24B Moravice Slezska Harta	25 Podolsky potok	26 Zlata Opavice	27 Olse-Vernovice	28 Olse nad Stonavkou	29 Olse pod Tesinem	30 Olse nad Ropici	31 Olse nad Trincem	32 Stonavka-usti
1	Odra -Bohumin	0.0																																	
2	Odra-Petrkovice	9.4	0.0																																
3	Odra-Svinov	15.8	6.4	0.0																															
4	Odra-Polanka	22.0	12.6	6.2	0.0																														
5	Odra-Studenka	44.2	34.8	28.4	22.2	0.0																													
6	Odra-nad Jicinkou	56.5	47.1	40.7	34.5	12.3	0.0																												
7	Odra-Jakubcovice	82.8	73.4	67.0	60.8	38.6	26.3	0.0																											
8	Cerny-Prikop	7.7							0.0																										
9	Lubina-Kosatka	30.1	20.7	14.3	8.1					0.0																									
10	Bilovka pod Sezinou	37.1	27.7	21.3	15.1						0.0																								
11	Jicinka-Kunin	56.5	47.1	40.7	34.5	12.3						0.0																							
12	Ostravice-Muglinov	9.3											0.0																						
13	Ostravice-Vratimov	19.6											10.3	0.0																					
14	nad Moravkou	32.8											23.5	13.2	0.0																				
15	Pod nadrzi	52.1											42.8	32.5	19.3	0.0																			
16A	Olesna -usti	23.3											26.3	16.0			0.0																		
16B	Lucina Usti	28.4											19.1					0.0																	
17	Opava Trebovice	14.3	4.9																0.0																
18	Opava-Hostice	50.5	41.1																36.2	0.0															
19	Opava-Vavrovice	59.6	50.2																45.3	9.1	0.0														
20	Opava-pod Krnovem	75.4	66.0																61.1	24.9	15.8	0.0													
21	Opava-nad Krnovem	89.0	79.6																74.7	38.5	29.4	13.6	0.0												
22	Hvozdnice-usti	55.2	45.8																40.8					0.0											
23	Hvozdnice-Mladecko	72.2	62.8																57.9					17.0	0.0										
24A	Moravice-Branka	56.6	47.2																42.3							0.0									
24B	Moravice-Slezska H	104.6	95.2																90.3							48.0	0.0								
25	Podolsky potok	135.2	125.8																120.9							78.6	30.6	0.0							
26	Zlata Opavice	88.0	78.6																73.7	37.5	28.4	12.6	1.0						0.0						
27	Olse-Vernovice																													0.0					
28	Olse nad Stonavkou																													14.1	0.0				
29	Olse pod Tesinem																													25.4	11.3	0.0			
30	Olse nad Ropici																													32.5	18.4	7.1	0.0		
31	Olse nad Trincem																													43.2	29.1	17.8	10.7	0.0	
32	Stonavka-usti																													13.7	0.4	11.7			0.0

Effect coefficients

No.	Profile	1 Odra -Bohumin	2 Odra-Petrkovice	3 Odra-Svinov	4 Odra-Polanka	5 Odra-Studenka	6 Odra-nad Jicinkou	7 Odra-Jakubcovice	8 Cerny-Prikop	9 Lubina-Kosatka	10 Bilovka pod Sezinou	11 Jicinka--Kunin	12 Ostravice-Muglinov	13 Ostravice-Vratimov	14 nad Maravkou	15 Pod nadrzi	16A Olesna -usti	16B Lucina Utsi	17 Opava Trebovice	18 Opava-Hostice	19 Opava-Vavrovice	20 Opava-pod Krnovem	21 Opava-nad Krnovem	22 Hvozdnice-usti	23 Hvozdnice-Mladecko	24A Moravice-Branka	24B Moravice Slezska Harta	25 Podolsky potok	26 Zlata Opavice	27 Olse-Vernovice	28 Olse nad Stonavkou	29 Olse pod Tesinem	30 Olse nad Ropici	31 Olse nad Trincem	32 Stonavka-usti
1	Odra -Bohumin	1.00																																	
2	Odra-Petrkovice	0.98	1.00																																
3	Odra-Svinov	0.97	0.99	1.00																															
4	Odra-Polanka	0.96	0.97	0.99	1.00																														
5	Odra-Studenka	0.91	0.93	0.94	0.96	1.00																													
6	Odra-nad Jicinkou	0.89	0.91	0.92	0.93	0.96	1.00																												
7	Odra-Jakubcovice	0.83	0.85	0.87	0.88	0.92	0.95	1.00																											
8	Cerny-Prikop	0.98							1.00																										
9	Lubina-Kosatka	0.94	0.96	0.97	0.98					1.00																									
10	Bilovka pod Sezinou	0.93	0.94	0.96	0.97						1.00																								
11	Jicinka-Kunin	0.89	0.91	0.92	0.93	0.96						1.00																							
12	Ostravice-Muglinov	0.98											1.00																						
13	Ostravice-Vratimov	0.96											0.98	1.00																					
14	nad Moravkou	0.93											0.95	0.97	1.00																				
15	Pod nadrzi	0.90											0.91	0.94	0.98	1.00																			
16A	Olesna -usti	0.95											0.95	0.97			1.00																		
16B	Lucina Usti	0.94											0.96					1.00																	
17	Opava Trebovice	0.97	0.99																1.00																
18	Opava-Hostice	0.90	0.92																0.93	1.00															
19	Opava-Vavrovice	0.88	0.90																0.91	0.98	1.00														
20	Opava-pod Krnovem	0.85	0.87																0.88	0.95	0.97	1.00													
21	Opava-nad Krnovem	0.82	0.84																0.85	0.92	0.94	0.97	1.00												
22	Hvozdnice-usti	0.89	0.91																0.92					1.00											
23	Hvozdnice-Mladecko	0.86	0.87																0.88					0.97	1.00										
24A	Moravice-Branka	0.89	0.91																0.92							1.00									
24B	Moravice-Slezska H	0.79	0.81																0.82							0.59	1.00								
25	Podolsky potok	0.73	0.75																0.76							0.51	0.94	1.00							
26	Zlata Opavice	0.82	0.84																0.85	0.93	0.94	0.97	1.00						1.00						
27	Olse-Vernovice																													1.00					
28	Olse nad Stonavkou																													0.97	1.00				
29	Olse pod Tesinem																													0.95	0.98	1.00			
30	Olse nad Ropici																													0.94	0.96	0.99	1.00		
31	Olse nad Trincem																													0.91	0.94	0.96	0.98	1.00	
32	Stonavka-usti																													0.87	1.00	0.98			1.00

Table 10.8.4 Distance (km) between profiles and effect coefficients for SS

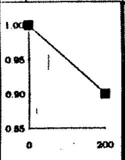


No.	SS	1 Odra -Bohumin	2 Odra-Petrkovice	3 Odra-Svinov	4 Odra-Polanka	5 Odra-Studenka	6 Odra-nad Jicinkou	7 Odra-Jakubcovice	8 Cerny-Prikop	9 Lubina-Kosatka	10 Bilovka pod Sezinou	11 Jicinka-Kunin	12 Ostravice-Muglinov	13 Ostravice-Vratimov	14 nad Maravkou	15 Pod nadrzi	16A Olesna -usti	16B Lucina Utsi	17 Opava Trebovice	18 Opava-Hostice	19 Opava-Vavrovice	20 Opava-pod Krnovem	21 Opava-nad Krnovem	22 Hvozdnice-usti	23 Hvozdnice-Mladecko	24A Moravice-Branka	24B Moravice Slezska Harta	25 Podolsky potok	26 Zlata Opavice	27 Olse-Vernovice	28 Olse nad Stonavkou	29 Olse pod Tesinem	30 Olse nad Ropici	31 Olse nad Trincem	32 Stonavka-usti
1	Odra -Bohumin	0.0																																	
2	Odra-Petrkovice	9.4	0.0																																
3	Odra-Svinov	15.8	6.4	0.0																															
4	Odra-Polanka	22.0	12.6	6.2	0.0																														
5	Odra-Studenka	44.2	34.8	28.4	22.2	0.0																													
6	Odra-nad Jicinkou	56.5	47.1	40.7	34.5	12.3	0.0																												
7	Odra-Jakubcovice	82.8	73.4	67.0	60.8	38.6	26.3	0.0																											
8	Cerny-Prikop	7.7							0.0																										
9	Lubina-Kosatka	30.1	20.7	14.3	8.1					0.0																									
10	Bilovka pod Sezinou	37.1	27.7	21.3	15.1						0.0																								
11	Jicinka-Kunin	56.5	47.1	40.7	34.5	12.3						0.0																							
12	Ostravice-Muglinov	9.3											0.0																						
13	Ostravice-Vratimov	19.6											10.3	0.0																					
14	nad Moravkou	32.8											23.5	13.2	0.0																				
15	Pod nadrzi	52.1											42.8	32.5	19.3	0.0																			
16A	Olesna -usti	23.3											26.3	16.0			0.0																		
16B	Lucina Usti	28.4											19.1					0.0																	
17	Opava Trebovice	14.3	4.9																0.0																
18	Opava-Hostice	50.5	41.1																36.2	0.0															
19	Opava-Vavrovice	59.6	50.2																45.3	9.1	0.0														
20	Opava-pod Krnovem	75.4	66.0																61.1	24.9	15.8	0.0													
21	Opava-nad Krnovem	89.0	79.6																74.7	38.5	29.4	13.6	0.0												
22	Hvozdnice-usti	55.2	45.8																40.8					0.0											
23	Hvozdnice-Mladecko	72.2	62.8																57.9					17.0	0.0										
24A	Moravice-Branka	56.6	47.2																42.3							0.0									
24B	Moravice-Slezska Ha	104.6	95.2																90.3							48.0	0.0								
25	Podolsky potok	135.2	125.8																120.9							78.6	30.6	0.0							
26	Zlata Opavice	88.0	78.6																73.7	37.5	28.4	12.6	1.0						0.0						
27	Olse-Vernovice																													0.0					
28	Olse nad Stonavkou																													14.1	0.0				
29	Olse pod Tesinem																													25.4	11.3	0.0			
30	Olse nad Ropici																													32.5	18.4	7.1	0.0		
31	Olse nad Trincem																													43.2	29.1	17.8	10.7	0.0	
32	Stonavka-usti																													13.7	0.4	11.7			0.0

No.	SS	1 Odra -Bohumin	2 Odra-Petrkovice	3 Odra-Svinov	4 Odra-Polanka	5 Odra-Studenka	6 Odra-nad Jicinkou	7 Odra-Jakubcovice	8 Cerny-Prikop	9 Lubina-Kosatka	10 Bilovka pod Sezinou	11 Jicinka-Kunin	12 Ostravice-Muglinov	13 Ostravice-Vratimov	14 nad Maravkou	15 Pod nadrzi	16A Olesna -usti	16B Lucina Utsi	17 Opava Trebovice	18 Opava-Hostice	19 Opava-Vavrovice	20 Opava-pod Krnovem	21 Opava-nad Krnovem	22 Hvozdnice-usti	23 Hvozdnice-Mladecko	24A Moravice-Branka	24B Moravice Slezska Harta	25 Podolsky potok	26 Zlata Opavice	27 Olse-Vernovice	28 Olse nad Stonavkou	29 Olse pod Tesinem	30 Olse nad Ropici	31 Olse nad Trincem	32 Stonavka-usti
1	Odra -Bohumin	1.00																																	
2	Odra-Petrkovice	0.98	1.00																																
3	Odra-Svinov	0.97	0.99	1.00																															
4	Odra-Polanka	0.96	0.97	0.99	1.00																														
5	Odra-Studenka	0.91	0.93	0.94	0.96	1.00																													
6	Odra-nad Jicinkou	0.89	0.91	0.92	0.93	0.98	1.00																												
7	Odra-Jakubcovice	0.83	0.85	0.87	0.88	0.92	0.95	1.00																											
8	Cerny-Prikop	0.98							1.00																										
9	Lubina-Kosatka	0.94	0.96	0.97	0.98					1.00																									
10	Bilovka pod Sezinou	0.93	0.94	0.96	0.97						1.00																								
11	Jicinka-Kunin	0.89	0.91	0.92	0.93	0.98						1.00																							
12	Ostravice-Muglinov	0.98											1.00																						
13	Ostravice-Vratimov	0.96											0.98	1.00																					
14	nad Moravkou	0.93											0.95	0.97	1.00																				
15	Pod nadrzi	0.90											0.91	0.94	0.98	1.00																			
16A	Olesna -usti	0.95											0.95	0.97			1.00																		
16B	Lucina Usti	0.94											0.98					1.00																	
17	Opava Trebovice	0.97	0.99																1.00																
18	Opava-Hostice	0.90	0.92																0.93	1.00															
19	Opava-Vavrovice	0.88	0.90																0.91	0.98	1.00														
20	Opava-pod Krnovem	0.85	0.87																0.88	0.95	0.97	1.00													
21	Opava-nad Krnovem	0.82	0.84																0.85	0.92	0.94	0.97	1.00												
22	Hvozdnice-usti	0.89	0.91																0.92					1.00											
23	Hvozdnice-Mladecko	0.86	0.87																0.88					0.97	1.00										
24A	Moravice-Branka	0.89	0.91																0.92							1.00									
24B	Moravice-Slezska Ha	0.79	0.81																0.82							0.90	1.00								
25	Podolsky potok	0.73	0.75																0.78							0.84	0.94	1.00							
26	Zlata Opavice	0.82	0.84																0.85	0.93	0.94	0.97	1.00						1.00						
27	Olse-Vernovice																													1.00					
28	Olse nad Stonavkou																													0.97	1.00				
29	Olse pod Tesinem																													0.95	0.98	1.00			
30	Olse nad Ropici																													0.94	0.96	0.99	1.00		
31	Olse nad Trincem																													0.91	0.94	0.96	0.98	1.00	
32	Stonavka-usti																													0.97	1.00	0.98			##

Table 10.8.5 Distance (km) between profiles and effect coefficients for Zinc

Zn



Distance (km) between profiles

No.	Profile	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16A	16B	17	18	19	20	21	22	23	24A	24B	25	26	27	28	29	30	31	32
1	Odra-Bohumin	0.0																																	
2	Odra-Petrkovice	9.4	0.0																																
3	Odra-Svinov	15.8	6.4	0.0																															
4	Odra-Polanka	22.0	12.6	6.2	0.0																														
5	Odra-Studenka	44.2	34.8	28.4	22.2	0.0																													
6	Odra-nad Jicinkou	56.5	47.1	40.7	34.5	12.3	0.0																												
7	Odra-Jakubcovice	82.8	73.4	67.0	60.8	38.6	26.3	0.0																											
8	Cerny-Prikop	7.7							0.0																										
9	Lubina-Kosatka	30.1	20.7	14.3	8.1					0.0																									
10	Bilovka pod Sezinou	37.1	27.7	21.3	15.1						0.0																								
11	Jicinka-Kunin	56.5	47.1	40.7	34.5	12.3						0.0																							
12	Ostravice-Muglinov	9.3											0.0																						
13	Ostravice-Vratimov	19.6											10.3	0.0																					
14	nad Moravkou	32.8											23.5	13.2	0.0																				
15	Pod nadrzi	52.1											42.8	32.5	19.3	0.0																			
16A	Olesna -usti	23.3											26.3	16.0			0.0																		
16B	Lucina Usti	28.4											19.1					0.0																	
17	Opava Trebovice	14.3	4.9																0.0																
18	Opava-Hostice	50.5	41.1																36.2	0.0															
19	Opava-Vavrovice	59.6	50.2																45.3	9.1	0.0														
20	Opava-pod Krnovem	75.4	66.0																61.1	24.9	15.8	0.0													
21	Opava-nad Krnovem	89.0	79.6																74.7	38.5	29.4	13.6	0.0												
22	Hvozdnice-usti	55.2	45.8																40.8					0.0											
23	Hvozdnice-Mladecko	72.2	62.8																57.9					17.0	0.0										
24A	Moravice-Branka	56.6	47.2																42.3							0.0									
24B	Moravice Slezska Harta	104.6	95.2																90.3							48.0	0.0								
25	Podolsky potok	135.2	125.8																120.9							78.6	30.6	0.0							
26	Zlata Opavice	88.0	78.6																73.7	37.5	28.4	12.6	1.0						0.0						
27	Olse-Vernovice																													0.0					
28	Olse nad Stonavkou																													14.1	0.0				
29	Olse pod Tesinem																													25.4	11.3	0.0			
30	Olse nad Ropici																													32.5	18.4	7.1	0.0		
31	Olse nad Trincem																													43.2	29.1	17.8	10.7	0.0	
32	Stonavka-usti																													13.7	0.4	11.7			0.0

Effect coefficients

No.	Profile	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16A	16B	17	18	19	20	21	22	23	24A	24B	25	26	27	28	29	30	31	32
1	Odra-Bohumin	1.00																																	
2	Odra-Petrkovice	1.00	1.00																																
3	Odra-Svinov	0.99	1.00	1.00																															
4	Odra-Polanka	0.99	0.99	1.00	1.00																														
5	Odra-Studenka	0.98	0.98	0.99	0.99	1.00																													
6	Odra-nad Jicinkou	0.97	0.98	0.98	0.98	0.99	1.00																												
7	Odra-Jakubcovice	0.96	0.96	0.97	0.97	0.98	0.99	1.00																											
8	Cerny-Prikop	1.00							1.00																										
9	Lubina-Kosatka	0.98	0.99	0.99	1.00					1.00																									
10	Bilovka pod Sezinou	0.98	0.99	0.99	0.99						1.00																								
11	Jicinka-Kunin	0.97	0.98	0.98	0.98	0.99						1.00																							
12	Ostravice-Muglinov	1.00											1.00																						
13	Ostravice-Vratimov	0.99											0.99	1.00																					
14	nad Moravkou	0.98											0.99	0.99	1.00																				
15	Pod nadrzi	0.97											0.98	0.98	0.99	1.00																			
16A	Olesna -usti	0.99											0.99	0.99			1.00																		
16B	Lucina Usti	0.99											0.99					1.00																	
17	Opava Trebovice	0.99	1.00																1.00																
18	Opava-Hostice	0.97	0.98																0.98	1.00															
19	Opava-Vavrovice	0.97	0.97																0.98	1.00	1.00														
20	Opava-pod Krnovem	0.98	0.97																0.97	0.99	0.99	1.00													
21	Opava-nad Krnovem	0.98	0.96																0.96	0.98	0.99	0.99	1.00												
22	Hvozdnice-usti	0.97	0.98																0.98					1.00											
23	Hvozdnice-Mladecko	0.96	0.97																0.97					0.99	1.00										
24A	Moravice-Branka	0.97	0.98																0.98							1.00									
24B	Moravice Slezska Harta	0.95	0.95																0.95							0.81	1.00								
25	Podolsky potok	0.93	0.94																0.94							0.74	0.98	1.00							
26	Zlata Opavice	0.96	0.98																0.96	0.98	0.99	0.99	1.00						1.00						
27	Olse-Vernovice																													1.00					
28	Olse nad Stonavkou																													0.99	1.00				
29	Olse pod Tesinem																													0.99	0.99	1.00			
30	Olse nad Ropici																													0.98	0.99	1.00	1.00		
31	Olse nad Trincem																													0.98	0.99	0.99	0.99	1.00	
32	Stonavka-usti																													0.99	1.00	0.99			1.00

10.9 Land use coefficients and non point pollution sources

Table 10.9.1: Land use coefficients (part of total area)

Profile	Location	Frydek-Mistek			Karvina			Opava			Ostrava			Novy Jicin			Bruntal			Olomouc			SUM		
		Agriculture	Forest	Other	Agriculture	Forest	Other	Agriculture	Forest	Other	Agriculture	Forest	Other	Agriculture	Forest	Other	Agriculture	Forest	Other	Agriculture	Forest	Other	Agriculture	Forest	Other
	Odra at the border	0,395	0,491	0,114	0,512	0,136	0,356	0,614	0,279	0,109	0,406	0,106	0,490	0,659	0,225	0,116	0,462	0,458	0,080	0,557	0,267	0,176	0,51	0,35	0,14
1	Odra -Bohumin	0,395	0,491	0,114	0,512	0,136	0,356	0,614	0,279	0,109	0,406	0,106	0,490	0,659	0,225	0,116	0,462	0,458	0,080	0,557	0,267	0,176	0,51	0,35	0,14
2	Odra-Petrkovice	0,395	0,491	0,114				0,614	0,279	0,109	0,406	0,106	0,490	0,659	0,225	0,116	0,462	0,458	0,080	0,557	0,267	0,176	0,51	0,37	0,12
3	Odra-Svinov	0,395	0,491	0,114				0,614	0,279	0,109	0,406	0,106	0,490	0,659	0,225	0,116	0,462	0,458	0,080	0,557	0,267	0,176	0,51	0,37	0,12
4	Odra-Polanka	0,395	0,491	0,114				0,614	0,279	0,109	0,406	0,106	0,490	0,659	0,225	0,116	0,462	0,458	0,080	0,557	0,267	0,176	0,55	0,32	0,12
5	Odra-Studenka							0,614	0,279	0,109				0,659	0,225	0,116	0,462	0,458	0,080	0,557	0,267	0,176	0,56	0,34	0,10
6	Odra-nad Jicinkou							0,614	0,279	0,109				0,659	0,225	0,116	0,462	0,458	0,080	0,557	0,267	0,176	0,56	0,34	0,10
7	Odra-Jakubcovice							0,614	0,279	0,109				0,659	0,225	0,116	0,462	0,458	0,080	0,557	0,267	0,176	0,56	0,34	0,10
8	Cerny-Prikop	0,395	0,491	0,114				0,614	0,279	0,109	0,406	0,106	0,490	0,659	0,225	0,116	0,462	0,458	0,080	0,557	0,267	0,176	0,51	0,37	0,12
9	Lubina-Kosatka	0,395	0,491	0,114										0,659	0,225	0,116							0,50	0,38	0,11
10	Bilovka pod Sezinou							0,614	0,279	0,109				0,659	0,225	0,116							0,63	0,25	0,11
11	Jicinka--Kunin													0,659	0,225	0,116							0,66	0,23	0,12
12	Ostravice-Muglinov	0,395	0,491	0,114	0,512	0,136	0,356	0,614	0,279	0,109	0,406	0,106	0,490	0,659	0,225	0,116	0,462	0,458	0,080	0,557	0,267	0,176	0,51	0,35	0,14
13	Ostravice-Vratimov	0,395	0,491	0,114							0,406	0,106	0,490										0,40	0,44	0,17
14	nad Maravkou	0,395	0,491	0,114																			0,40	0,49	0,11
15	Pod nadrzi	0,395	0,491	0,114																			0,40	0,49	0,11
16A	Olesna -usti	0,395	0,491	0,114																			0,40	0,49	0,11
16B	Lucina	0,395	0,491	0,114	0,512	0,136	0,356				0,406	0,106	0,490										0,42	0,38	0,20
17	Opava Trebovice							0,614	0,279	0,109	0,406	0,106	0,490				0,462	0,458	0,080				0,52	0,36	0,12
18	Opava-Hostice							0,614	0,279	0,109							0,462	0,458	0,080				0,53	0,38	0,09
19	Opava-Vavrovice							0,614	0,279	0,109							0,462	0,458	0,080				0,53	0,38	0,09
20	Opava-pod Krnovem																0,462	0,458	0,080				0,46	0,46	0,08
21	Opava-nad Krnovem																0,462	0,458	0,080				0,46	0,46	0,08
22	Hvozdnice-usti							0,614	0,279	0,109							0,462	0,458	0,080				0,53	0,38	0,09
23	Hvozdnice-Mladecko							0,614	0,279	0,109							0,462	0,458	0,080				0,53	0,38	0,09
24A	Moravice-Branka							0,614	0,279	0,109							0,462	0,458	0,080				0,53	0,38	0,09
24B	Moravice-Slezska Harta							0,614	0,279	0,109							0,462	0,458	0,080				0,53	0,38	0,09
25	Podolsky potok																0,462	0,458	0,080				0,46	0,46	0,08
26	Zlata Opavice																0,462	0,458	0,080				0,46	0,46	0,08
27	Olse-Vernovice	0,395	0,491	0,114	0,512	0,136	0,356																0,42	0,41	0,16
28	Olse nad Stonavkou	0,395	0,491	0,114	0,512	0,136	0,356																0,42	0,41	0,16
29	Olse pod Tesinem	0,395	0,491	0,114	0,512	0,136	0,356																0,42	0,41	0,16
30	Olse nad Ropici	0,395	0,491	0,114																			0,40	0,49	0,11
31	Olse nad Trincem	0,395	0,491	0,114																			0,40	0,49	0,11
32	Stonavka-usti	0,395	0,491	0,114	0,512	0,136	0,356																0,42	0,41	0,16

Table 10.9.2: Run off from agriculture, forest and "other" area (tonnes/year)

Profile	Location	Catchment Area	Run off Agricultur				Run off Forest		Run off from other areas			
		km2	Agriculture	ton P/year	ton N/year	Forest	ton P/year	ton N/year	"other"	ton P/year	ton N/year	tonBOF/year
	Odra at the border	6250,00	0,51	71	7390	0,35	44	548	0,14	68	422	2535
1	Odra -Bohumin	4662,33	0,51	53	5513	0,35	33	409	0,14	50	315	1891
2	Odra-Petrkovice	3744,15	0,51	42	4429	0,37	27	342	0,12	36	226	1356
3	Odra-Svinov	1615,12	0,51	18	1910	0,37	12	147	0,12	16	97	585
4	Odra-Polanka	1492,70	0,55	18	1897	0,32	10	121	0,12	15	92	551
5	Odra-Studenka	917,27	0,56	11	1184	0,34	6	77	0,10	7	47	281
6	Odra-nad Jicinkou	605,51	0,56	7	781	0,34	4	51	0,10	5	31	185
7	Odra-Jakubcovice	355,51	0,56	4	459	0,34	2	30	0,10	3	18	109
8	Cerny-Prikop	(-)	0,51	(-)	(-)	0,37	(-)	(-)	0,12	(-)	(-)	(-)
9	Lubina-Kosatka	194,14	0,50	2	225	0,38	1	18	0,11	2	11	67
10	Bilovka pod Sezinou	131,50	0,63	2	192	0,25	1	8	0,11	1	7	44
11	Jicinka--Kunin	113,87	0,66	2	173	0,23	1	6	0,12	1	7	40
12	Ostravice-Muglinov	826,79	0,51	9	978	0,35	6	72	0,14	9	56	335
13	Ostravice-Vratimov	567,15	0,40	5	518	0,44	5	62	0,17	8	47	285
14	nad Maravkou	322,09	0,40	3	293	0,49	3	40	0,11	3	18	110
15	Pod nadrzi	146,35	0,40	1	133	0,49	1	18	0,11	1	8	50
16A	Olesna -usti	59,31	0,40	1	54	0,49	1	7	0,11	1	3	20
16B	Lucina	197,14	0,42	2	190	0,38	1	19	0,20	3	20	120
17	Opava Trebovice	2088,40	0,52	24	2492	0,36	15	188	0,12	20	127	762
18	Opava-Hostice	945,85	0,53	11	1149	0,38	7	90	0,09	7	43	261
19	Opava-Vavrovice	840,01	0,53	10	1020	0,38	6	80	0,09	6	39	232
20	Opava-pod Krnovem	566,25	0,46	6	601	0,46	5	65	0,08	4	23	136
21	Opava-nad Krnovem	352,33	0,46	4	374	0,46	3	40	0,08	2	14	85
22	Hvozdnice-usti	163,45	0,53	2	198	0,38	1	16	0,09	1	8	45
23	Hvozdnice-Mladecko	64,29	0,53	1	78	0,38	0	6	0,09	0	3	18
24A	Moravice-Branka	716,33	0,53	8	870	0,38	5	68	0,09	5	33	197
24B	Moravice-Slezska Ha	461,96	0,53	5	561	0,38	4	44	0,09	3	21	127
25	Podolsky potok	81,08	0,46	1	86	0,46	1	9	0,08	1	3	20
26	Zlata Opavice	195,44	0,46	2	208	0,46	2	22	0,08	1	8	47
27	Olse-Vernovice	1068,00	0,42	10	1033	0,41	9	111	0,16	14	88	528
28	Olse nad Stonavkou	537,29	0,42	5	520	0,41	4	56	0,16	7	44	266
29	Olse pod Tesinem	420,66	0,42	4	407	0,41	3	44	0,16	6	35	208
30	Olse nad Ropici	383,00	0,40	3	348	0,49	4	47	0,11	3	22	131
31	Olse nad Trincem	296,58	0,40	3	270	0,49	3	36	0,11	3	17	101
32	Stonavka-usti	131,34	0,42	1	127	0,41	1	14	0,16	2	11	65

10.10 Pollution from atmospheric deposition

Table 10.10: Pollution from atmospheric deposition (tonnes/year)

Profile	Location	Area of Surface water (ha)	Area of Surface Water Accumulated (ha)	Total Load Tot-P tonnes/year	Total Load Tot-N tonnes/year
	Odra at the Border	**3093,50**	**3093,50**	**1,86**	**24,75**
1	Odra -Bohumin	216,00	2551,70	1,53	20,41
2	Odra-Petrkovice		1527,80	0,92	12,22
3	Odra-Svinov		862,20	0,52	6,90
4	Odra-Polanka	620,40	862,20	0,52	6,90
5	Odra-Studenka	78,40	241,60	0,14	1,93
6	Odra-nad Jicinkou	117,00	158,30	0,09	1,27
7	Odra-Jakubcovice	41,30	41,30	0,02	0,33
8	Cerny-Prikop	(-)		0,00	0,00
9	Lubina-Kosatka			0,00	0,00
10	Bilovka pod Sezinou			0,00	0,00
11	Jicinka-Kunin	4,90	4,90	0,00	0,04
12	Ostrávice-Muglinov		807,90	0,48	6,46
13	Ostravice-Vratimov	85,40	541,70	0,33	4,33
14	nad Maravkou	33,00	368,50	0,22	2,95
15	Pod nadrzi	335,50	335,50	0,20	2,68
16A	Olesna -usti	87,80	87,80	0,05	0,70
16B	Lucina	266,40	266,20	0,16	2,13
17	Opava Trebovice	282,20	665,80	0,40	5,33
18	Opava-Hostice	7,40	68,20	0,04	0,55
19	Opava-Vavrovice	24,00	60,80	0,04	0,49
20	Opava-pod Krnovem	36,80	36,80	0,02	0,29
21	Opava-nad Krnovem			0,00	0,00
22	Hvozdnice-usti	6,20	6,20	0,00	0,05
23	Hvozdnice-Mladecko			0,00	0,00
24A	Moravice-Branka	295,70	309,20	0,19	2,47
24B	Moravice-Slezska Hart	13,50	13,50	0,01	0,11
25	Podolsky potok			0,00	0,00
26	Zlata Opavice			0,00	0,00
27	Olse-Vernovice	261,00	541,60	0,32	4,33
28	Olse nad Stonavkou			0,00	0,00
29	Olse pod Tesinem			0,00	0,00
30	Olse nad Ropici			0,00	0,00
31	Olse nad Trincem			0,00	0,00
32	Stonavka-usti	280,60	280,60	0,17	2,24

10.11 WWTP not complying with reg. 171-I

Table 10.11.1 WWTP exceeding regulation 171-I before and after 2005 (mg/l)

			Concentrations exceeding regulation 171-I (mg/l)									
			Till 2004					After 2005				
	Source	Q, m3/y ('000)	BOD	COD- Cr	NH4-N	Tot-P	SS	BOD	COD- Cr	NH4-N	Tot-P	SS
1	OVAK OSTRAVA-UCOV PRIVOZ	32103			13,7	1,60	8			18,7	3,10	23
2	BYPASS : OVAK OSTRAVA-UCOV PRIVOZ	2346	140	231	27,0	7,90		145	251	32,0	9,40	8
3	OVAK OSTRAVA-COV O-TREBOVICE	10393				4,80			2	3,3	6,30	14
4	SMVAK 03-COV HAVIROV	10285			21,0	11,10	43		5	26,0	12,60	58
5	SMVAK 02-COV FRYDEK-MISTEK	9768	71	150	3,4	2,68	36	76	170	8,4	4,18	51
6	SMVAK 06-COV OPAVA	7380	23	185	17,7	0,48	3	28	205	22,7	1,98	18
7	SMVAK 03-COV KARVINA	7379		31	19,0	9,10	158		51	24,0	10,60	173
8	OVAK OSTRAVA-CERNY PRIKOP	4346	105	168	9,0			110	188	14,0	0,30	
9	VAK BRUNTAL-COV BRUNTAL	4334					13			3,3		18
10	VAK BRUNTAL-COV KRNOV	4288	18	43	9,0			23	63	14,0	0,50	
11	SMVAK 02-COV TRINEC	4260			66,0				10	71,0	1,42	
12	SMVAK 04-COV NOVY JICIN	4150		20	1,5	2,31			40	6,5	4,31	
13	OVAK OSTRAVA-KANALIZACE ZABREH	2788		35					55			
14	SMVAK 04-COV KOPRIVNICE	2778			14,0	12,30			3	19,0	14,30	
15	SM VAK-COV FRENSTAT	2704				2,10					4,10	
16	SMVAK 03-COV ORLOVA-PORUBA	2452			21,0	2,55				26,0	4,55	
17	SMVAK 03-COV CESKY TESIN	2348			6,0	0,41	195			11,0	2,41	200
18	SMVAK 03-KANALIZACE BOHUMIN	2100	255	355	11,5		239	260	375	16,5		244
19	VAK BRUNTAL-COV RYMAROV	1800										
20	OVAK COV ZABREH	1789			4,0		0			14,0	1,20	5
21	OVAK OSTRAVA-VYUST CERVENY POTOK	1378					21					26
22	VAK BRUNTAL-COV VRBNO P/PR	943										
23	SMVAK 04-COV PRIBOR	940										
24	OVAK OSTRAVA KANALIZ. MICHALKOVICE	510	5				30	15		5,0	0,50	35
25	VAK BRUNTAL-COV DVORCE	422										
26	SMVAK 04-KANALIZACE BILOVEC	352	25	210			35	35	245	5,0		45
27	SMVAK 02-KANALIZACE VRATIMOV	340	85	290			35	95	325	5,0		45
28	SMVAK 04 COV FULNEK	263								1,0		
29	SMVAK 03-COV RYCHVALD	220	44				26	54	33	13,0		36
30	VAK BRUNTAL-KANALIZACE BRIDLICNA	130	10	40			105	20	75	0,0		115
31	VAK BRUNTAL KANAL. HORNI BENESOV	98	0	90			5	10	125			15
32	SMVAK 04-KANALIZACE KLIMKOVICE	78	50	130			35	60	165	0,0		45
33	SMVAK 06-COV BUDISOV	65		230			35	45	265	5,0		45

10.12 Cost/benefit for technical measures

Table 10.12.1 Cost benefit for technical measures at the "Hot-spots"

	Parameter	BOD			Total-N			Total-P			Other (COD, SS, heavy metals)											
	Source	Reduction, t/y	Cost, US$ ('000)	Cost/Benefit, kg rem/US$	Reduction, t/y	Cost, US$ ('000)	Cost/Benefit, kg rem/US$	Reduction, t/y	Cost, US$ ('000)	Cost/Benefit, kg rem/US$	Reduction, t/y				Reduction, t/y					Cost, US$ ('000)	Cost/Benefit, kg rem/US$	SUM, US$ ('000)
											COD	SS	Fe	Zn	Hg	Cd	Pb	Cu	Ni			
1	OVAK OSTRAVA-CERNY PRIKOP	522	626	0.83	17			0			665	730	0	0	0	0	0	0	0			626
2	OVAK OSTRAVA-UCOV PRIVOZ	536	161	3.30	795	7953	0.10	139	1388	0.10	1838	761	0	0	0	0	0	0	0			8523
3	SMVAK 04-COV NOVY JICIN	33	10	3.33	28			28	283	0.10	394	8	0	0	0	0	0	0	0			293
4	SMVAK 03-KANALIZACE BOHUMIN	567	680	0.83	12			0			714	533	0	0	0	0	0	0	0			680
5	SMVAK 03-COV HAVIROV	123	37	3.33	367	3672	0.10	135	1347	0.10	463	144	0	0	0	0	0	0	0			5056
6	SMVAK 02-COV TRINEC	77	23	3.33	207	2070	0.10	15	146	0.10	277	38	0	0	0	0	0	0	0			2239
7	OKD KOKSOVNA SVERMA MAR.HORY	0			0			0			0	789	11	0	0	0	0	0	0	1000		1000
8	SMVAK 02-COV FRYDEK-MISTEK	889	267	3.33	97	967	0.10	46	457	0.10	2051	567	0	0	0	0	0	0	0			1691
9	SMVAK 04-KANALIZACE BILOVEC	19	23	0.83	1			0			84	23	0	0	0	0	0	0	0			23
10	SMVAK 06-COV OPAVA	317	95	3.33	0			22	220	0.10	1808	339	0	0	0	0	0	0	0			315
11	SMVAK 03-COV KARVINA	89	27	3.33	146	1461	0.10	82	819	0.10	671	133	0	0	0	0	0	0	0			2307
12	TRINECKE ZELEZARNY	0			71			0			642	321	21	0	0	0	0	0	0	7300		7300
13	ZD BOHUMIN ZELEZARNY	0			0			0			1209	85	9	1	0	0	0	0	0	1400		1400
14	BOCHEMIE BOHUMIN-HLAVNI ODPAD	41			9			0			224	10	8	7	5	12	48	18	81	1900		1900
15	BIOCEL PASKOV	221			29			0			4199	176	0	0	0	0	0	0	0	3600		3600
16	HRUSOVSKA CHEMICKA SPOLECNOST	0			0			0			0	210	16	13	0	3	40	18	30	1400		1400
17	OVAK OSTRAVA-COV O-TREBOVICE	125	37	3.33	483	4833	0.10	71	707	0.10	437	239	0	0	0	0	0	0	0			5577
18	VAK BRUNTAL-COV KRNOV	142	113	1.25	0			0			120	56	0	0	0	0	0	0	0			113
19	MASSAG BILOVEC - NS	0			0			0			0	0	0	0	0	0	0	6	176	1900		1900
20	KOKSOVNA SVOBODA - FIEBIGH	0			0			0			0	0	0	0	0	0	0	0	0			0
21	NOVA HUT - COV OSTRAVICE	0			0			0			0	0	0	0	0	0	0	0	0			3100
22	NOVA HUT OSTRAVA-COV LUCINA	0			186			0			0	0	7	5	0	0	0	0	0	3100		0
23	VALCOVNY PLECHU - HLAVNI ODPAD	0			0			0			0	0	0	0	0	0	32	32	16	1500		1500
24	OVAK COV ZABREH	29	9	3.33	50	497	0.10	8	82	0.10	98	21	0	0	0	0	0	0	0			588
25	VAK BRUNTAL-COV BRUNTAL	52	16	3.33	8			10	95	0.10	217	26	0	0	0	0	0	0	0			111
			2123			21453			5544				71	27	5	15	119	74	303	23100		52221

10.13 Benefits from pollution abatement

Table 10.13.1 Reduction in pollution compared with the water quality objectives.

NB.	Profile	BOD [Tonnes/Year]			SS [Tonnes/Year]			Zn [Tonnes/Year]			Tot-P, objective 1 [Tonnes/Year]			Tot-P Objective 2 [Tonnes/Year]			Tot-P, Objective 3(4) [Tonnes/Year]			Tot-N, objective 1(2 and 3) [Tonnes/Year]			Tot-N Objective 4 [Tonnes/Year]		
		Goal	Reduction	%	Goal	Reduction	%	Goal	Reduction	%	Goal	Reduction	%	Goal	Reduction	%	Goal	Reduction	%	Goal	Reduction	%	Goal	Reduction	%
1	Odra -Bohumin	1861	2296	123	10172	4628	45	274	27	10		440			440		1299	440	34		1688		2098	1688	80
2	Odra-Petrkovice	91	215	236	11982	669	6					133			133		264	133	50		546		1262	546	43
3	Odra-Svinov	422	43	10	4451	50	1					34			34		45	34	76		68		300	68	23
4	Odra-Polanka	422	17	4	17845	30	0					26			26		103	26	25		19		157	19	12
5	Odra-Studenka		16		1361	8	1					27			27		84	27	32		19		312	19	6
6	Odra-nad Jicinkou		0		770	0	0					0			0		5	0	0		0		63	0	0
7	Odra-Jakubcovice		0		0	0						0			0		7	0	0	21	0	0	0	0	
10	Bilovka pod Sezinou	14	19	136	159	23	14					0			0		0	0			1		89	1	1
11	Jicinka-Kunin	68	33	49	0	8						28			28		21	28	133		28		67	28	42
12	Ostravice-Muglinov	398	713	179	3674	870	24	31	5	16		175			175		182	175	96		473		37	473	1265
13	Ostravice-Vratimov		889		0	567						46			46		48	46	96		97		0	97	
16B	Lucina	25	123	492	0	144		0	5			135			135		28	135	482		553		119	553	465
18	Opava-Hostice	672	367	55	677	392	58					22			22		123	22	18		0		135	0	0
20	Opava-pod Krnovem	13	142	1092	0	56					46	0	0	46	0	0	59	0	0	52	0	0	52	0	0
22	Hvozdnice-usti	2	0	0	0	0						0			0		10	0	0		0		105	0	0
24B	Moravice-Slezska Hart	115	52	45	213	26	12				22	10	45	28	10	36	28	10	36	310	8	3	310	8	3
26	Zlata Opavice	52	0	0	173	0	0				5	0	0	7	0	0	7	0	0	173	0	0	173	0	0
27	Olse-Vernovice		110		0	470						96			96		221	96	43		327		0	327	
28	Olse nad Stonavkou		32		0	347						14			14		86	14	16		190		0	190	
29	Olse pod Tesinem		50		0	355						15			15		83	15	18		219		108	219	203

Table 10.13.2 Reduction of BOD for "Hot-spots" sources and effects on the water quality in different river profiles (tonnes/year)

Nr.	Profile	Source	Tonn BOD/year	1 Odra-Bohumin	2 Odra-Petrkovice	3 Odra-Svinov	4 Odra-Polanka	5 Odra-Studenka	6 Odra-nad Jicinkou	7 Odra-Jakubcovice	8 Cerny-Prikop	9 Lubina-Kosatka	10 Bilovka pod Sezinou	11 Jicinka-Kunin	12 Ostravice-Muglinov	13 Ostravice-Vratimov	14 nad Maravkou	15 Pod nadrzi	16A Olesna -usti	16B Lucina Utsi	17 Opava Trebovice	18 Opava-Hostice	19 Opava-Vavrovice	20 Opava-pod Krnovem	21 Opava-nad Krnovem	22 Hvozdnice-usti	23 Hvozdnice-Mladecko	24A Moravice-Branka	24B Moravice Slezska Harta	25 Podolsky potok	26 Zlata Opavice	27 Olse-Vernovice	28 Olse nad Stonavkou	29 Olse pod Tesinem	30 Olse nad Ropici	31 Olse nad Trincem	32 Stonavka-usti
1	Odra -Bohumin	OVAK OSTRAVA-CERNY PRIKOP	522	522																																	
1	Odra-Bohumin	OVAK OSTRAVA-UCOV PRIVOZ	161	161																																	
1	Odra-Bohumin	BYPASS: OVAK OSTRAVA-UCOV	375	375																																	
1	Odra-Bohumin	SMVAK 03-KANALIZACE BOHUMIN	567	567																																	
1	Odra-Bohumin	OKD KOKSOVNA SVERMA MAR.HORY-hl.o.	0	0																																	
1	Odra-Bohumin	ZD BOHUMIN ZELEZARNY	0	0																																	
1	Odra-Bohumin	BOCHEMIE BOHUMIN-HLAVNI ODPAD	41	41																																	
1	Odra-Bohumin	HRUSOVSKA CHEMICKA SPOLECNOST	0	0																																	
1	Odra-Bohumin	KOKSOVNA SVOBODA - FIEBIGH	0	0																																	
2	Odra-Petrkovice	OVAK OSTRAVA-COV O-TREBOVICE	125	66	125																																
3	Odra-Svinov	OVAK COV ZABREH	29	13	20	29																															
10	Bilovka pod Sezinou	SMVAK 04-KANALIZACE BILOVEC	19	4	6	7	9						19																								
10	Bilovka pod Sezinou	MASSAG BILOVEC - NS	0	0	0	0	0						0																								
11	Jicinka-Kunin	SMVAK 04-COV NOVY JICIN	33	1	4	6	8	16						33																							
12	Ostravice-Muglinov	NOVA HUT - COV OSTRAVICE	0	0											0																						
12	Ostravice-Muglinov	BIOCEL PASKOV	221	118											221																						
13	Ostravice-Vratimov	SMVAK 02-COV FRYDEK-MISTEK	889	359											442	889																					
13	Ostravice-Vratimov	VALCOVNY PLECHU - HLAVNI ODPAD	0	0											0	0																					
16B	Lucina Usti	SMVAK 03-COV HAVIROV	123	39											50					123																	
16B	Lucina Usti	NOVA HUT OSTRAVA-COV LUCINA	0	0											0					0																	
18	Opava-Hostice	SMVAK 06-COV OPAVA	317	30	60																75	317															
20	Opava-pod Krnovem	VAK BRUNTAL-COV KRNOV	142	0	0																0	50	63	142													
24B	Moravice-Slezskta Hart	VAK BRUNTAL-COV BRUNTAL	52	0	0																0							14	52								
27	Olse-Vernovice	SMVAK 03-COV KARVINA	89																													89					
30	Olse nad Ropici	SMVAK 02-COV TRINEC	77																													21	32	50	77		
30	Olse nad Ropici	TRINECKE ZELEZARNY	0																													0	0'	0	0		
		SUM	3782	2297	215	43	17	16					19	33	713	889				123	75	367	63	142				14	52			110	32	50	77		

Table 10.13.3 Reduction of Tot-N for "Hot-spots" sources and effects on the water quality in different river profiles (tonnes/year)

Nr.	Profile	Source		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16A	16B	17	18	19	20	21	22	23	24A	24B	25	26	27	28	29	30	31	32
			Tonn Tot-N/Year	Odra -Bohumin	Odra-Petrkovice	Odra-Svinov	Odra-Polanka	Odra-Studenka	Odra-nad Jicinkou	Odra-Jakubcovice	Cerny-Prikop	Lubina-Kostka	Bilovka pod Sezinou	Jicinka-Kunin	Ostravice-Muglinov	Ostravice-Vratimov	nad Maravkou	Pod nadrzi	Olesna -usti	Lucina Utsi	Opava Trebovice	Opava-Hostice	Opava-Vavrovice	Opava-pod Krnovem	Opava-nad Krnovem	Hvozdnice-usti	Hvozdnice-Mladecko	Moravice-Branka	Moravice Slezska Harta	Podolsky potok	Zlata Opavice	Olse-Vernovice	Olse nad Stonavkou	Olse pod Tesinem	Olse nad Ropici	Olse nad Trincem	Stonavka-usti
1	Odra -Bohumin	OVAK OSTRAVA-CERNY PRIKOP	17	17																																	
1	Odra-Bohumin	OVAK OSTRAVA-UCOV PRIVOZ	732	732																																	
1	Odra-Bohumin	BYPASS: OVAK OSTRAVA-UCOV	63	63																																	
1	Odra-Bohumin	SMVAK 03-KANALIZACE BOHUMIN	12	12																																	
1	Odra-Bohumin	OKD KOKSOVNA SVERMA MAR.HORY-hl.o.	0	0																																	
1	Odra-Bohumin	ZD BOHUMIN ZELEZARNY	0	0																																	
1	Odra-Bohumin	BOCHEMIE BOHUMIN-HLAVNI ODPAD	9	9																																	
1	Odra-Bohumin	HRUSOVSKA CHEMICKA SPOLECNOST	0	0																																	
1	Odra-Bohumin	KOKSOVNA SVOBODA - FIEBIGH	0	0																																	
2	Odra-Petrkovice	OVAK OSTRAVA-COV O-TREBOVICE	483	347	483																																
3	Odra-Svinov	OVAK COV ZABBREH	50	34	40	50																															
10	Bilovka pod Sezinou	SMVAK 04-KANALIZACE BILOVEC	1	1	1	1	1						1																								
10	Bilovka pod Sezinou	MASSAG BILOVEC - NS	0	0	0	0	0						0																								
11	Jicinka-Kunin	SMVAK 04-COV NOVY JICIN	28	17	17	18	18	19						28																							
12	Ostravice-Muglinov	NOVA HUT - COV OSTRAVICE	0	0											0																						
12	Ostravice-Muglinov	BIOCEL PASKOV	29	21											29																						
13	Ostravice-Vratimov	SMVAK 02-COV FRYDEK-MISTEK	97	66											68	97																					
13	Ostravice-Vratimov	VALCOVNY PLECHU - HLAVNI ODPAD	0	0											0	0																					
16B	Lucina Usti	SMVAK 03-COV HAVIROV	367	243											250					367																	
16B	Lucina Usti	NOVA HUT OSTRAVA-COV LUCINA	186	123											127					186																	
18	Opava-Hostice	SMVAK 06-COV OPAVA	0	0	0																0	0															
20	Opava-pod Krnovem	VAK BRUNTAL-COV KRNOV	0	0	0																0	0	0	0													
24	Moravice-Slezskta Hart	VAK BRUNTAL-COV BRUNTAL	8	4	4																4							5	8								
27	Olse-Vernovice	SMVAK 03-COV KARVINA	146																													146					
30	Olse nad Ropici	SMVAK 02-COV TRINEC	207																													135	141	163	207		
30	Olse nad Ropici	TRINECKE ZELEZARNY	71																													46	48	56	71		
		Sum	2506	1688	546	68	19	19					1	28	473	97				553	4	0	0	0	0			5	8			327	190	219	278		

Table 10.13.4 Reduction of Tot-P for "Hot-spots" sources and effects on the water quality in different river profiles (tonnes/year)

Nr.	Profile	Source		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16A	16B	17	18	19	20	21	22	23	24A	24B	25	26	27	28	29	30	31	32
			Tonn Tot-P/Year	Odra -Bohumin	Odra-Petrkovice	Odra-Svinov	Odra-Polanka	Odra-Studenka	Odra-nad Jicinkou	Odra-Jakubcovice	Cerny-Prikop	Lubina-Kosatka	Bilovka pod Sezinou	Jicinka-Kunin	Ostravice-Muglinov	Ostravice-Vratimov	nad Maravkou	Pod nadrzi	Olesna -usti	Lucina Usti	Opava Trebovice	Opava-Hostice	Opava-Vavrovice	Opava-pod Krnovem	Opava-nad Krnovem	Hvozdnice-usti	Hvozdnice-Mladecko	Moravice-Branka	Moravice Slezska Harta	Podolsky potok	Zlata Opavice	Olse-Vernovice	Olse nad Stonavkou	Olse pod Tesinem	Olse nad Ropici	Olse nad Trincem	Stonavka-usti
1	Odra -Bohumin	OVAK OSTRAVA-CERNY PRIKOP	0	0																																	
1	Odra-Bohumin	OVAK OSTRAVA-UCOV PRIVOZ	116	116																																	
1	Odra-Bohumin	BYPASS: OVAK OSTRAVA-UCOV	23	23																																	
1	Odra-Bohumin	SMVAK 03-KANALIZACE BOHUMIN	0	0																																	
1	Odra-Bohumin	OKD KOKSOVNA SVERMA MAR.HORY-hl.o.	0	0																																	
1	Odra-Bohumin	ZD BOHUMIN ZELEZARNY	0	0																																	
1	Odra-Bohumin	BOCHEMIE BOHUMIN-HLAVNI ODPAD	0	0																																	
1	Odra-Bohumin	HRUSOVSKA CHEMICKA SPOLECNOST	0	0																																	
1	Odra-Bohumin	KOKSOVNA SVOBODA - FIEBICH	0	0																																	
2	Odra-Petrkovice	OVAK OSTRAVA-COV O-TREBOVICE	71	70	71																																
3	Odra-Svinov	OVAK COV ZABREH	8	8	8	8																															
10	Bilovka pod Sezinou	SMVAK 04-KANALIZACE BILOVEC	0	0	0	0	0						0																								
10	Bilovka pod Sezinou	MASSAG BILOVEC - NS	0	0	0	0	0						0																								
11	Jicinka-Kunin	SMVAK 04-COV NOVY JICIN	28	25	25	26	26	27						28																							
12	Ostravice-Muglinov	NOVA HUT - COV OSTRAVICE	0	0											0																						
12	Ostravice-Muglinov	BIOCEL PASKOV	0	0											0																						
13	Ostravice-Vratimov	SMVAK 02-COV FRYDEK-MISTEK	46	44											45	46																					
13	Ostravice-Vratimov	VALCOVNY PLECHU - HLAVNI ODPAD	0	0											0	0																					
16B	Lucina Usti	SMVAK 03-COV HAVIROV	135	127											130					135																	
16B	Lucina Usti	NOVA HUT OSTRAVA-COV LUCINA	0	0											0					0																	
18	Opava-Hostice	SMVAK 06-COV OPAVA	22	20	20																20	22															
20	Opava-pod Krnovem	VAK BRUNTAL-COV KRNOV	0	0	0																0	0	0	0													
24	Moravice-Slezskta Har	VAK BRUNTAL-COV BRUNTAL	10	8	8																8							6	10								
27	Olse-Vernovice	SMVAK 03-COV KARVINA	82																													82					
30	Olse nad Ropici	SMVAK 02-COV TRINEC	15																													14	14	15	15		
30	Olse nad Ropici	TRINECKE ZELEZARNY	0																													0	0	0	0		
		Sum	556	440	133	34	26	27					0	28	175	46				135	29	22	0	0	0			6	10			96	14	15	15		

Table 10.13.5 Reduction of SS for "Hot-spots" sources and effects on the water quality in different river prof

Nr.	Profile	Source		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16A	16B	17	18	19	20	21	22	23	24A	24B	25	26	27	28	29	30	31	32
			Tonn SS/Year	Odra -Bohumin	Odra-Petrkovice	Odra-Svinov	Odra-Polanka	Odra-Studenka	Odra-nad Jicinkou	Odra-Jakubcovice	Cerny-Prikop	Lubina-Kosatka	Bilovka pod Sezinou	Jicinka-Kunin	Ostravice-Muglinov	Ostravice-Vratimov	nad Maravkou	Pod nadrzi	Olesna -usti	Lucina Utsi	Opava Trebovice	Opava-Hostice	Opava-Vavrovice	Opava-pod Krnovem	Opava-nad Krnovem	Hvozdnice-usti	Hvozdnice-Mladecko	Moravice-Branka	Moravice Slezska Harta	Podolsky potok	Zlata Opavice	Olse-Vernovice	Olse nad Stonavkou	Olse pod Tesinem	Olse nad Ropici	Olse nad Trincem	Stonavka-usti
1	Odra -Bohumin	OVAK OSTRAVA-CERNY PRIKOP	730	730																																	
1	Odra-Bohumin	OVAK OSTRAVA-UCOV PRIVOZ	257	257																																	
1	Odra-Bohumin	BYPASS: OVAK OSTRAVA-UCOV	504	504																																	
1	Odra-Bohumin	SMVAK 03-KANALIZACE BOHUMIN	533	533																																	
1	Odra-Bohumin	OKD KOKSOVNA SVERMA MAR.HORY-hl.e.	789	789																																	
1	Odra-Bohumin	ZD BOHUMIN ZELEZARNY	85	85																																	
1	Odra-Bohumin	BOCHEMIE BOHUMIN-HLAVNI ODPAD	10	10																																	
1	Odra-Bohumin	HRUSOVSKA CHEMICKA SPOLECNOST	210	210																																	
1	Odra-Bohumin	KOKSOVNA SVOBODA - FIEBICH	0	0																																	
2	Odra-Petrkovice	OVAK OSTRAVA-COV O-TREBOVICE	239	235	239																																
3	Odra-Svinov	OVAK COV ZABREH	21	20	21	21																															
10	Bilovka pod Sezinou	SMVAK 04-KANALIZACE BILOVEC	23	21	22	22	22						23																								
10	Bilovka pod Sezinou	MASSAG BILOVEC - NS	0	0	0	0	0						0																								
11	Jicinka-Kunin	SMVAK 04-COV NOVY JICIN	8	7	7	7	7	8						8																							
12	Ostravice-Muglinov	NOVA HUT - COV OSTRAVICE	0	0											0																						
12	Ostravice-Muglinov	BIOCEL PASKOV	176	173											176																						
13	Ostravice-Vratimov	SMVAK 02-COV FRYDEK-MISTEK	567	545											555	567																					
13	Ostravice-Vratimov	VALCOVNY PLECHU - HLAVNI ODPAD	0	0											0	0																					
16B	Lucina Usti	SMVAK 03-COV HAVIROV	144	136											138					144																	
16B	Lucina Usti	NOVA HUT OSTRAVA-COV LUCINA	0	0											0					0																	
18	Opava-Hostice	SMVAK 06-COV OPAVA	339	305	311																314	339															
20	Opava-pod Krnovem	VAK BRUNTAL-COV KRNOV	56	48	49																49	53	54	56													
24	Moravice-Slezskta Ha	VAK BRUNTAL-COV BRUNTAL	26	21	21																21							24	26								
27	Olse-Vernovice	SMVAK 03-COV KARVINA	133																													133					
30	Olse nad Ropici	SMVAK 02-COV TRINEC	38																													36	37	37	38		
30	Olse nad Ropici	TRINECKE ZELEZARNY	321																													300	309	316	321		
		Sum	5209	4627	669	50	30	8					23	8	870	567				144	385	392	54	56	0			24	26			469	346	354	359		

Table 10.13.6 Reduction of Zinc for "Hot-spots" sources and effects on the water quality in different river profiles (tonnes/year)

Nr.	Profile	Source		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16A	16B	17	18	19	20	21	22	23	24A	24B	25	26	27	28	29	30	31	32
			Tonn Zn/Year	Odra -Bohumin	Odra-Petrkovice	Odra-Svinov	Odra-Polanka	Odra-Studenka	Odra-nad Jicinkou	Odra-Jakubcovice	Cerny-Prikop	Lubina-Kosatka	Bilovka pod Sezinou	Jicinka-Kunin	Ostravice-Muglinov	Ostravice-Vratimov	nad Maravkou	Pod nadrzi	Olesna -usti	Lucina Utsi	Opava Trebovice	Opava-Hostice	Opava-Vavrovice	Opava-pod Krnovem	Opava-nad Krnovem	Hvozdnice-usti	Hvozdnice-Mladecko	Moravice-Branka	Moravice Slezska Harta	Podolsky potok	Zlata Opavice	Olse-Vernovice	Olse nad Stonavkou	Olse pod Tesinem	Olse nad Ropici	Olse nad Trincem	Stonavka-usti
1	Odra -Bohumin	OVAK OSTRAVA-CERNY PRIKOP	0	0																																	
1	Odra-Bohumin	OVAK OSTRAVA-UCOV PRIVOZ	0	0																																	
1	Odra-Bohumin	BYPASS: OVAK OSTRAVA-UCOV	0	0																																	
1	Odra-Bohumin	SMVAK 03-KANALIZACE BOHUMIN	0	0																																	
1	Odra-Bohumin	OKD KOKSOVNA SVERMA MAR.HORY-hl.o.	0	0																																	
1	Odra-Bohumin	ZD BOHUMIN ZELEZARNY	1	1																																	
1	Odra-Bohumin	DOCHEMIE BOHUMIN-HLAVNI ODPAD	7	7																																	
1	Odra-Bohumin	HRUSOVSKA CHEMICKA SPOLECNOST	13	13																																	
1	Odra-Bohumin	KOKSOVNA SVOBODA - FIEBIGH	0	0																																	
2	Odra-Petrkovice	OVAK OSTRAVA-COV O-TREBOVICE	0	0	0																																
3	Odra-Svinov	OVAK COV ZABREH	0	0	0	0																															
10	Bilovka pod Sezinou	SMVAK 04-KANALIZACE BILOVEC	0	0	0	0	0						0																								
10	Bilovka pod Sezinou	MASSAG BILOVEC - NS	0	0	0	0	0						0																								
11	Jicinka-Kunin	SMVAK 04-COV NOVY JICIN	0	0	0	0	0	0						0																							
12	Ostravice-Muglinov	NOVA HUT - COV OSTRAVICE	0	0											0																						
12	Ostravice-Muglinov	BIOCEL PASKOV	0	0											0																						
13	Ostravice-Vratimov	SMVAK 02-COV FRYDEK-MISTEK	0	0											0	0																					
13	Ostravice-Vratimov	VALCOVNY PLECHU - HLAVNI ODPAD	0	0											0	0																					
16B	Lucina Usti	SMVAK 03-COV HAVIROV	0	0											0					0																	
16B	Lucina Usti	NOVA HUT OSTRAVA-COV LUCINA	5	5											5					5																	
18	Opava-Hostice	SMVAK 06-COV OPAVA	0	0	0																0	0															
20	Opava-pod Krnovem	VAK BRUNTAL-COV KRNOV	0	0	0																0	0	0	0													
24	Moravice-Slezskta Hart	VAK BRUNTAL-COV BRUNTAL	0	0	0																0							0	0								
27	Olse-Vernovice	SMVAK 03-COV KARVINA	0																													0					
30	Olse nad Ropici	SMVAK 02-COV TRINEC	0																													0	0	0	0		
30	Olse nad Ropici	TRINECKE ZELEZARNY	0																													0	0	0	0		
		Sum	26	26	0	0	0	0					0	0	5	0				5	0	0	0	0	0			0	0			0	0	0	0		

10.14 Interviews and visits - NIVA

Mission 1: 04.10-08.10.1993: Meetings with PO, EI and WRI and the following enterprises:

Biocel Paskov, pulp mill, 04.10.1993
Hrusovska Spolecnost, Chemical plant 04.10.1993
Frydek Mistek, WWTP, 05.10.1993
Ostrava Cov, WWTP, 05.10.1993
Trinec, WWTP, 07.10.1993
Trinec Steel plant (Trinecke Zelezarny), 07.10.1993

Mission 2: 14.03-18.03.1994, meetings with PO, WRI and EI and the following enterprises:

OKd Dul Dukla-Havirov, Coal mine, 14.03.1994
Bochemie Bohumin a.s, Chemical plant, 15.03.1994
Bohumínské Zelezárny a Drátovny a.s (ZDB a.s.) Bohumín ,Iron and Wire Works, 15.03.1994
Moravolen Bruntál a.s, Textile fabric, 16.03.1994
Slechtitelský a Rozmonozovací Velkochov Prasat (Breeding Farm), Velké Albrechtice, 16.03.1994
Nova Hut, steel work , 17.03.94
Massag, Chemical plant, 17.03.94

Mission 3, 18.09-22.09.1994, meeting with PO, WRI and EI and the following enterprises

The Regional Department of the Ministry of Environment, 19.09.1994
Ovak, Sewage company, 19.09.1994
Trebovice, WWTP, 19.09.1994
Share-holding company Northern Moravian Water Supply and Sewage (SmVak), Sewage company, 20.09.1994
Havirov, WWTP 20.09.1994
Dul Dukla Sverma, coke plant, 22.09.1994

10.15 Interviews-NIBR

The Regional Department of the Ministry of Environment
Helena Cízková (September 8th 1993)
Lukás Zenatý (March 17th 1994)

Povodí Odry
Petr Brezina,
October 4th 1993 (and at several occasions later)

Inspectorate of the Czech Environmental Inspection
Petr Pomazal, director of the Division for Water Protection in the Ostrava branch
October 4th 1993

Share-holding company Northern Moravian Water Supply and Sewage (Severomoravské vodovody a kanalizace a.s.)
Miroslav Kyncl, director
October 5th 1993

Hygienic Institute of Ostrava
Mr. Charvath
October 5th 1993

Hydrometeorological Institute
Rostislav Sochorec, director
October 6th 1993

Division for Ecology, Ostrava magistrát
Milan Fencl, head of division
October 6th 1993

Trinec Steelplant (Trinecke Zelezarny)
Otakar Litera, head of the Environmental Department ; Miroslav Pietrosz, head of the Water Protection Department; Veslav Maroszczyk, technical director
October 7th 1993

The EIA Office in the Division for Ecology of the Ostrava magistrát.
Zdenek Rozehnal, head of the office
March 7th 1994

The Environmental Division at the District Office of Karviná
Petr Hok, head of the division
March 9th 1994

Project Master Plan for Karviná and Trinec.
Jan Weber, chairman of Karviná District Office; Ceslav Valosek, mayor of Albrechtice
March 9th 1994

The Division for Environment of Karviná city
Zdenek Vajter, head of the Division
March 9th 1994

City of Karviná
Jaroslav Vencek, mayor
March 9 1994

Bochemie a.s.
Evzen Fukala, technical director and Emil Pastucha, leader of the Environmental Department of the enterprise
March 15th 1994

Bohumínské Zelezárny a Drátovny a.s (ZDB a.s.) Bohumín Iron and Wire Works
Josef Hladík, responsible for water management in the enterprise environmental department (oddelení zivotního prostredí).
March 15th 1994

Moravolen Bruntál a.s.
Mr. Janosík, Petr Svoboda (responsible for environment in the enterprise, 'energetyk' of the enterprise) and Mr. Strouhal.
March 16th 1994

Slechtitelský a Rozmonozovací Velkochov Prasat (Breeding Farm), Velké Albrechtice.
Mr. Anton Solár (farm director), Ms. Pavla Lisifková (chemist) and Mr. Jan Kotela (machine engineer/water specialist).
March 16th 1994

Water Management and Agriculture Department
of the Environmental Division of Ostrava magistrát
Pavel Valerián, head of the department
March 17th 1994

Magistrát of Ostrava (Department for Ecology
Vlasta Pipková,
21 September 1994

Czech Union of Nature Protectors (Ceský svaz ochráncu prírody)
Frantisek Zahradník, chairman in Havírov branch
21 September 1994

Department of Area Planning, District of Ostrava
Jaroslàv Kotik
22 September 1994

EIA Office in Environmental Divison, District of Opava
Ján Klapetek
22 September 1994

Czech Ecological Institute - Prague
Jaroslav Benes, Director of Conceptual Division
23 September 1994

Czech Ministry of Environment , Prague
Václav Obluk, director of the EIA Department
23 September 1994

Vita - Association for Ecological Education (Sdruzení pro ekologickou výchovu)
Radim Jarosek
26 September 1994

10.16 Recommendations

10.16.1 PROTECTION OF DRINKING WATER QUALITY

1. Optimal Abatement programme for drinking water reservoirs

Background:

The water supply in the Ostrava region is mainly based on surface water. The three reservoirs Sance, Kruzberk and Moravka cover 65% of the demands.

In the catchment of Kruzberk several industries are located including aluminum-, textile- and plastic industries. The industries represents a pollution risk both to the environment and to human health, and the discharges of heavy metals and other micro pollutants may be significant with respect to the quality in the drinking water reservoirs. Sewage from smaller villages and from insufficiently treated waste water from the largest cities, Bruntal, Rymarov and Dvorce do also represent a serious risk for contamination of the drinking water not only with respect to pathogenic bacteria, but the sewage also contribute with nitrate and phosphorus pollution. There are also several smaller pig and cattle breeding farms, and as much as 48% of the catchment area constitute of arable land. Agriculture in the area contribute especially with nitrogen pollution, but agriculture's contribution to phosphorus pollution is also significant. We have no information about concentartions of pecticides in the reservoirs.

The anthropogenic pollution sources are not so dominating in the catchments to Sance and Moravka reservoirs. Agriculture gives a significant contribution, especially to bacteria contamination, nitrogen and phosphorus. Large parts of the catchment constitute of forest.

Pollution effects can be seen on the water quality in the reservoirs.

Nutrients concentrations, especially inorganic nitrogen compounds (ammonia, nitrate and nitrite), has been measured in the three reservoirs over a number of years. Phosphorus concentrations (Total-P) have been measured the last 4 years.

The available data indicate that light is probably the most growth limiting factor for phytoplankton, but phosphorus may be limiting in periods. The chlorophyll-a concentrations are extremely low compared to the rather high levels of P and N. This may have three possible explanations;

-High flushing rate in the reservoirs
-Few measurements pr. season means that larger peaks of phytoplankton are omitted
-The chlorophyll and the phosphorus concentrations may be incorrect, there are some discrepancy in the data.

With the high P values there is rather high risk of blooming of toxic bluegreen algae, and there has also been some reports about eutrophication problems. The high content of phosphorus, nitrates and bacteria in the inflows to the reservoirs, especially to Kruzberk, are also alarming. According to the pollution sources in the catchment area bacteria content as well as micropollutants (organic micro pollutants and heavy metal) can be a problem. There are no available data on micro pollutants in the reservoirs, but the concentration of heavy metals in Odra and in the tributaries are however high and indicates that these components may be a problem in the drinking water reservoirs as well.

There is a need for further investigations and measures not only to confirm the environmental status of the reservoirs and the effects of pollution, but also to determine the need for pollution abatement.

Project ideas and objectives:

The objectives of the study is to ensure a safe drinking water supply which comply with Czech and international standards for drinking water. There is also a need reduce the pollution to obtain a sound ecological balance in the reservoirs.

The reduction of pollution will not only reduce the risk for eutrophication and blooming of toxic blue green algae, reduce the risk for nitrate contamination and the levels of micro pollutants, but also avoid practical problems and reduce the treatment costs of drinking water.

The study should include all three drinking reservoirs, but a focus on Kruzberk reservoir, which is vulnerable to pollution from its catchment, is special recommended. A cost-efficient abatement programme which includes municipal sources, industry and agriculture should be carried out. The project should use the results or include activities outlined in recommendations 10.16.2 to be able to quantify the pollution from agriculture activities. Restoration measures in the reservoirs (biomanipulation, technical measures in the reservoir, regulating of water levels etc.) should also be considered as a part of the programme. It can also be valuable to include water mangement issues into this project (see recommendation 10-16.1-2 for Slezska Harta)

The objectives of the study is also to get a better understanding of eutrophication effects and possible measures in the reservoirs, and to outline a strategy for water resources management in the future (including monitoring, interpretation and presentation of data, restriction in the catchment area, need for two hygienic barriers etc)

The study ought to include the following activities;

-Environmental status and trends in the reservoirs, review of existing monitoring data including data on micro pollutants.
-Selected water quality sampling; parallel analysis, micro pollutants and nutrients
-Quality control of measurements, exchange of knowledge and methods, assure the optimal sampling strategy and interpretation of the data from the reservoirs.
-Adaptation of methods, knowledge and models to calculate eutrophication effects
-Registration of point and non-point pollution sources
-Evaluation of proposed actions/cost-effective abatement strategies including biomanipulation.
-Adapting of methods to calculate non point pollution sources (see recommendation 10.16.2)
-Water resources management for drinking water reservoirs (monitoring and restrictions)

Project team, work schedule and budget for the study:

A detailed work programme will be prepared in co-operation with the Czech collaborative partners and presented in a separate application report.

The project team will consist of Norwegian and Czech Scientists. NIVA will invite the University in Oslo (Åge Brabrand) to participate.

The Norwegian Scientists will apply for funding from the Norwegian State Pollution Control, and the activities executed by the Czech team members must be funded locally.

Contact person at NIVA will be Research Managers Bjørn Faafeng and Jon Lasse Bratli.

2. Restrictions and land use planning for Slezska Harta drinking Reservoir

Background

The large drinking reservoir Slezska Harta is under construction. To ensure a safe drinking water quality, there is need for restrictions on the activities in the region.

Project Ideas and objectives

The objectives of the study are to exchange and transfer knowledge and methods of how land use planning or other legislation can be used as an efficient tool to obtain a wanted development. Norwegian and Czech rules and methods will be evaluated. The Norwegian principle of establishing two hygienic barriers will be discussed.

The study should involve the following activities:

- Registration of pollution sources
- Need for restrictions on the activities in the region
- How to use land use planning or other legislation as an efficient tool
- Other guidelines or criteria for protection of drinking water quality

Project team, work schedule and budget for the study:

If there is local interest for such a study a detailed work programme will be prepared with the Czech collaborative partners and presented in a separate application report.

The project team will consist of Norwegian and Czech Scientists. NIVA will together with the Czech parts contribute with effect studies of pollution and need for reduction and/or restriction on pollution sources especially to obtain two hygienic barriers. NIBR will study the possibilities for land use planning as an efficient tool and compare the Norwegian and Czech methods. NIVA will also be involved in this task.

Norwegian Scientists will apply for funding to the Norwegian State Pollution Control, and the activities executed by the Czech team members must be funded locally.

3 Protection of Ground water

Background

35 % of the water supply in the region come from private or public ground water wells. The study reported here has primarily addressed surface water and there are no detailed information about the ground water quality or the need for pollution abatement to reduce the impacts on these wells.

There has been reported about some high nitrate content, which may be caused by agriculture activities or municipal waste water. With the high influence of anthropogenic sources in the catchment area, municipal waste water both from treatment plants and from inhabitants without public sewage, industry and from agriculture, there is a rather high risk of bacteria contamination of the wells, but also nitrate pollution and micro pollutants.

Project Ideas

-Review of existing water quality, including water quality sampling if needed
-Location of Ground waters
-Identification of wells with a high health risk and where pollution abatement must be considered
-Identification of point and non point pollution sources
-Evaluation of proposed actions/cost-effective abatement strategy.

Project team, work schedule and budget for the study:

NIVA are not specialised within ground water, and the study will not be prioritised by NIVA.

10.16.2 ABATEMENT STRATEGIES FOR AGRICULTURE AND METHODS TO CALCULATE POLLUTION FROM NON-POINT POLLUTION SOURCES

Background

Agriculture is a main activity in the area, and the Baltic Sea study indicate that agriculture give significant contribution to pollution. Based on crude estimation agriculture contributes with approximately 50% of the anthropogenic nitrogen loads and 12% of the anthropogenic phosphorus pollution.

Agriculture contribute with pollution from both point and non point pollution sources. As a result of the high prices on mineral fertiliser, the pollution from run-off due to fertiliser consumption seem to be less important than run-off from manured fields. Manure pollution are also large as a point pollution while the storage conditions and capacity for manure are poor. This results in leakage of manure into the river and ground water. Direct effects like for example fish kills, resulting from discharge of organic oxygen consuming compounds like manure and silage effluents are common. Manure do also contain high levels of ammonia, which is direct acute toxic to fish. Acute toxic effects can also appear from pesticides.

There is need for technical and accompanying measures in the agriculture sector to reduce the total loads of pollution and restore the ecological balance as well as for municipal and industrial sources. Measures in the agriculture sector can be cost-efficient An abatement programme including both technical and accompanying measures ought to be carried out in the area.

The agriculture sector has undergone large changes the last years changing from big state co-operatives to smaller units. To calculate the pollution from agriculture in detail a lot of data are required, both on agricultural activities and empirical coefficients. The pollution from run-off depends on the size of agriculture area, applied amount of mineral fertiliser/ manure and coefficients for nutrient-runoff. The coefficients for nutrients run-off are empirical and based on soil type, type of crop, slope of fields, land use practice, ploughing and soil handling, climatic conditions and the applications of manure and fertiliser. Pollution from point sources will mainly depend on type of animal, number of animals and storage/disposal conditions for silage and manure. In Norway there is a permanent system for handling of these statistics, and models (TEOTIL) make it possible to calculate the pollution from agriculture based on this statistical information.

The existing data and methods to calculate agriculture pollution in the study area seem to be poor, and a programme/routines to register pollution from agriculture and methods to calculate the pollution loading ought to be established in the region.

Project Ideas

- -Registration of pollution sources and other site specific data to calculate the contribution to pollution from agriculture-establish routines for collecting and compiling of data.
- -Transfer and adapting of methods
- -Implementation of a simple model for calculation of non-point sources
- -Cost-effective abatement programme included both technical and accompanying measures

The study can also be one of the main activity in recommendations 10.16.1.

Project team, work schedule and budget for the study:

A detailed work programme will be prepared with the Czech collaborative partners and presented in a separate application report.

The project team will consist of Norwegian and Czech Scientists. NIVA will invite the Environmental Institute for soil management and conservation to participate.

The Norwegian Scientists will apply for funding from the Norwegian State Pollution Control, and the activities executed by the Czech team members must be funded locally.

Contact person at NIVA: Jon Lasse Bratli

10.16.3 EUTROPHICATION EFFECTS IN POLLUTED RIVERS-NEED FOR PHOSPHORUS REMOVAL AND STRICTER WATER QUALITY CRITERIA

Background

The need for abatement to reduce phosphorus according to the Baltic Sea obligations and the new discharge standards at municipal waste water treatment plants (reg 171/92) are obvious. The need for phosphorus removal according to the potential risk for eutrophication and mass development of algae must however be investigated further in order to implement the necessary measures in time.

The phosphorus content in all river profiles are extremely high (above 1000 ug/l at many sites). The Norwegian and Czech standards for phosphorus can not be compared directly because of the differences in natural water quality . The phosphorus content in bedrock and soils may be higher in the Czech republic compared to Norwegian conditions, and this can be an explanation for the relative small problems eutrophication has caused so far. The most possible explanation though, as explained below, is that eutrophication is prevented due to other types of pollution (organic matter, toxic micropollutants, particles....)

The water quality in Norway is generally good with a low content of organic matters, particles and heavy metals. The content of calcium and other electrolytes are also very low. The typical "Norwegian water"; softwater rivers with low content of electrolytes, organic matter and nutrients salts respond to very low concentrations of phosphorus (Lindstrøm, 1994). Eutrophication effects with substantial increases in production and accumulation of alga biomass can occur in rivers with concentrations of total phosphorus in the range of 5-20 ug/l. Eutrophication has until recently been a major pollution problem in Norway.

Factors which may reduce the eutrophication effect of phosphorus in the Czech rivers are the content of particles, calcium and other electrolytes, pH, organic matter (both humic matter and various types of organic pollutants), heavy metals (and other toxic pollutants), but also physical conditions in the rivers such as flow conditions, water velocity, transport of particles, movements in the river bed etc.

The content of heavy metals and other toxic pollutants will be essential for the living conditions in the recipient, and can suppress (cover) the eutrophication effects of phosphorus pollution..

Particles normally reduce the biological availability of the phosphorus. The phosphorus which is connected to particles will normally not be available for algae growth (ref. chapter 4.1.3). Particles can also reduce the eutrophication effect by preventing the sun light from reaching down to the algae, but also stimulate the eutrophication process by binding heavy metals and other toxic pollutants.

High content of electrolytes in the water can effect the biological availability of phosphorus by reducing the solubility of most phosphorus salts. The effect of pH on the bio-availability of P is somewhat uncertain. On one hand the solubility of several P-salts increase with decreasing pH. On the other hand low pH liberate low soluble aluminium complexes.

The influence of organic matter on the primary production is hard to predict. The primary production (building of organic matter) and the degradation process are in the same cycle, and it can not be seen separately from each other. A high content of organic matter can however disturb the normal balance, and heterotrophic species may compete with the primary producers. A large amount of the organic matter can also be present as particles and thereby have the same effects as described above.

There is need for more research to predict the effects of phosphorus in this types of recipients when other types of pollution, especially heavy metals and other toxic pollution, are reduced. The Norwegian experience about eutrophication effects caused by phosphorus and technical measures/technology to reduce the pollution, will be very important to transfer to Eastern Europe where the concern so far has been on reducing organic matter, but where the extremely high phosphorus content may cause problems in the future. The need for abatement of different pollution parameters must therefore be studied in an interact study and not separately.

As a part of the study the The Czech classification criteria for phosphorus may be evaluated

Project Ideas

The study must be executed within a long time perspective. The need for background information and knowledge are essential before any effect of phosphorus on the eutrophication process can be predicted in the Czech rivers.

- Review of natural background levels of water quality in pristine and unpolluted areas (reference water)
- Laboratory experiments to determine algae growth potential in pristine and unpolluted waters with a known P-concentration and in references water which has been added phosphorus to the same levels as in polluted water.
- Evaluation of measure methods for phosphorus- quality assurance.
- Predicted effects of phosphorus pollution when other pollution are reduced in the rivers.
- Evaluate the need for phosphorus removal to prevent local and regional effects.
- Evaluate the need for stricter water quality criteria

Project team, work schedule and budget for the study:

A detailed work programme can be prepared with the Czech collaborative partners if there are local interests for such a study, and presented in a separate application report.

The project team will consist of Norwegian and Czech Scientists. The Norwegian Scientists will apply for funding from the Norwegian State Pollution Control, and the activities executed by the Czech team members must be funded locally.

Contact person at NIVA: Eli Anne Lindstrøm and Svein Wisthus Johansen

10.16.4 MEASURES TO REDUCE POLLUTION FROM MUNICIPAL WASTE WATER-EXCHANGE OF KNOWLEDGE AND TECHNOLOGY

1. Municipal waste water treatment plants

Background:

The need for pollution abatements at municipal sources and studies to exchange knowledge are obvious because;

- There are need for reduction in total pollution loads to recipients due to
  --their current deteriorated conditions
  --future recipient criteria and objectives for water quality
  --transboundary effects.

-More stringent discharge limits will be imposed:
  --to comply with reg 171
  --to comply with common requirements from the neighbouring and European countries

-Waste water is insufficiently treated today:
  --WWTP are designed for lower efficiencies (lack of specific unit processes) and are overloaded
  --Operational problems (instrumentation, process knowledge, toxic industrial WW)

-The new Processes require advanced process knowledge
  --Nitrogen removal are sensitive process
  --Influence of industrial waste water can cause problems on biological treatment plants
  --Phosphorous removal is uncommon and will require a new thinking, biological or chemical phosphorus removal.
  --need for "consultancy for optimisation"- evaluation tools, lab-and pilot-scale experimental facilities.

-Operation and Maintenance of WWTP can be harmonised
  --few large WWTP have contracted international companies for O&M (OTV, etc.) and SmVAK and OVAK does O&M for the remaining plants
  --instrumentation and the level of modernisation varies
  --some WWTP gets support from industries to upgrade, O&M,...

-Reliability of pollution loads measurements can be improved
  --there are inconsistency of data from different sources
  --reliability of grab samples vs. composite samples
  --reliability and agreement of analytical standards & instruments

Project ideas:

1.Building up SmVAK's (or/and OVAK's) capacity to have efficient O&M in WWTP:

-technology transfer related to plant upgrading
- --"---- re: process optimisation
-Participation in technical education (student thesis's, in-plant training, short courses...)
-Modern plant efficiency evaluation tools (simulation programmes, lab/pilot-scale exp....)
-Locally well organised and internationally-assisted "case-study/demo" optimisation projects

2. Accreditation (Quality Assurance) of pollution loads measurement and their use

--Understanding the advantages of accredited analysis and exchange of info
--automatisation of analysis vs manual (cost-benefit)
--Revision of current reporting schedules (check with Norwegian/European routines)
--Technology transfer related to "SSB-Avløp/SFT"-type databases
--clear policy on discharge fees & penalties (simple and common calculation procedure)

3. "NORVAR" concept

-common forum for exchange of ideas and concentrated actions
-forum for dialogues between PO, WWTP, and WRI
-influence on project proposal evaluations based on customers premises
-recognition by authorities with funds for operation (can start with bilateral funds.....)
-national & international collaboration / rational utilisation of resources and knowledge

4. Demonstration projects for optimisation/upgrading : "KOMTEK"-concept
-catalogue/hand book on experiences from past projects (Norwegian, etc, in Poland)
-Active participation of PO/WRI/SmVAK/OVAK on definition of need (to assure after use)
-Demo project on medium size WWTP optimisation (medium size=without OTV aid)
-Allocation of state funds for projects with simple transferability to similar WWTP / problems
-awareness among plant personnel that they can actively take part in the process

2 Local abatement analysis for smaller WWTP and in areas without public sewage systems

Background

Approximately 75% of all inhabitants in the catchment area are connected to public sewage, and 15% (ca. 200.000) are served by smaller waste water treatment plants (mechanical treatment plants). The remaining inhabitants, 25%, are not connected to sewage systems.

These sources give a significant contribution to the total anthropogenic pollution loads in the catchment area (13 % of Tot-N and 32% of Tot-P). The sources contribute with 57% of BOD when only municipal and industrial sources are considered.

The pollution are spread on a high number of polluters and will not one by one give significant contribution to the total loads. The self purification in local water sheds is also considerable, and the majority of sources will not give a significant contribution to the regional water quality problems.

Local pollution problems in smaller creeks can however be considerable, especially where the outlets influence on local ground waters which are used for drinking water supply.

A detailed study is recommended to review the extent of the problem. Local abatement to reduce pollution from these sources can be necessary. Norway is a sparsely populated country, and the problems and technological opportunities are well known. Norwegian and Czech knowledge can be combined and used to solve possible problems in the area.

Project Ideas and Objectives

Objectives of the study:

- To prepare an inventory of pollution sources (size, location and existing technology)
- Determine effects on local surface water quality and possible effects on ground water
- Technical solutions and need for pollution abatement-review of alternative methods in rural areas and upgrading of existing WWTP.
- Transfer of knowledge and technology

Project team, work schedule and budget for the study:

A detailed work programme will be prepared with the Czech collaborative partners and presented in a separate application report.

The project team will consist of Norwegian and Czech Scientists.

The Norwegian Scientists will apply for funding from the Norwegian State Pollution Control. The activities executed by the Czech team members must be funded locally.

Contact person at NIVA: Svein Stene-Johansen

10.16.5 WATER QUALITY DATA AND MONITORING

1 Statistical evaluation of water quality data

Background

A comprehensive water quality monitoring programme is executed in the Czech part of the Odra River Basin. The water quality is monitored in 80 control points, once or twice every month. Normally 30 water quality parameters are analysed. In addition there are 5 automatic monitoring stations.

A statistical analysis of water quality and water flow over the last years ought to be carry out to find correlation's between water quality parameters. The objectives will be to reduce the extent of the water quality monitoring program, and to find some central parameters. The central parameters must give a good covering of the main pollution problems and be valuable to use as a planning tool when pollution abatement analysis are carried out. These parameters can also from a statistical correlation analysis say something about other parameters, and thereby reduce the extent of the monitoring programme without reducing the information.

An objective may also be to find the relationship between C_{90}, Cmedian and water flow, in order to be able to use relatively simple methods in some cases (instead of advanced dose-respond models) to calculate need for reduction in pollution to obtain a specific water quality.

Project Ideas

- Statistical analysis of water quality and water flow

Project team, work schedule and budget for the study:

If there are local interest, a detailed work programme can be worked out with the Czech collaborative partners and presented in a separate application report.

The project team will consist of Norwegian and Czech Scientists.

2 Implementation of an information and surveillance system

Background

It is not only on water quality an extensive monitoring programme is carried out. There are also a lot of hydrological data and data on discharges from pollution sources. The data are spread on different owners and water managers, and it can be hard to get an assess to information.

The measurements is however a valuable contribution for water manager, scientists and politicians to understand and predict effects of pollution and be a planning tool for proposing measures. The water quality data in the region should also be more available for the public.

A new system for Environmental Information and Surveillance (ENSIS) have been developed in Norway, and the Slovakian Government intend to implement the system.

The system can include all kind of pollution also air pollution which is a sever problem in the Ostrava region.

Project Ideas

-Systematising of data information for water quality (both on-line monitoring and periodic sampling)
-systematising of other relevant environmental information
-discharge loads from pollution sources

Project team, work schedule and budget for the study:

A detailed work programme can be prepared with the Czech collaborative partners and presented in a separate application report.

The project team will consist of Norwegian and Czech Scientists and NIVA will invite the Norwegian Institute for Air Research (NILU) and NORGIT (information technology) to participate in the project.

3 Classification of water quality according to median, average or maximum values

Background

The water quality can be classified according to maximum, median and average values. The classification varies form system to system.

With focus on the effects on ecology and human health, a study ought to address different approaches in different systems.

Project Ideas

- Discussions between Norwegian and Czech Scientists for classification of water quality according to median, average or maximum values- evaluation of different methods..

Project team, work schedule and budget for the study:

If there are interest for a study like this a detailed work programme will be prepared with the Czech collaborative partners and presented in a separate application report. The project team will consist of Norwegian and Czech Scientists.

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