Direct and riverine inputs to Norwegian coastal waters - 2000. OSPAR Commission. A: Principles, results and discussions

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Summary

Riverine inputs to Norwegian coastal waters from 10 main and 145 tributary rivers were monitored during 2000 covering the nutrients (Tot-P, PO_4-P, Tot-N, NO_3-N, NH_4-N, SiO_2), suspended particulate matter (S.P.M.), total organic carbon (TOC), selected trace metals (Pb, Cd, Cu, Zn, Tot-Cr, Ni, As, Hg) and the persistent organic pollutant lindane. Additionally inputs from rivers not part of the monitoring programme, as well as direct discharges to marine waters along the coast from Sweden to Russia, have been estimated.

The total annual nutrient load to coastal waters from land based sources was found to be 9842 tonnes of phosphorus and 131 410 tonnes of nitrogen. About 34 % of the phosphorus and 53 % of the nitrogen were inputs from the monitored rivers and tributaries. The environmental loading from fish farming has been included this year and contributes to approximately 46% of the total phosphorus loading and 16 % of the total nitrogen loading. Most inputs of trace metals were low, especially the riverine inputs of Cd, Pb and Hg. The largest discharges of trace metals comprise copper and zinc, with the input estimates of 243 and 827-829 tonnes, respectively. Inputs of cadmium were estimated to be 5.1 - 5.0 tonnes, lead 68 tonnes, mercury 1.6 - 2.2 tonnes, arsenic 30 - 31 tonnes, total chromium 73 - 75 tonnes and nickel 175 tonnes. The pesticide lindane was detected in most samples in very low concentrations. Total load of lindane was estimated to be about 55 kg. Retention in the fjords and leaching from the marine sediments are not taken into account in these figures.

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Riverine inputs	Elvetilførsler
Direct discharges	Direkte tilførsler

Preface

This report presents the results of the 2000 monitoring of waterborne pollutants discharged to the Norwegian coastal waters, both riverine and direct discharges. The study is part of a joint monitoring programme under the "OSPAR Commission for the Protection of the Marine Environment of the North-East Atlantic". The Norwegian contribution is administered by the Norwegian Pollution Control Authority (SFT), which has contracted Aquateam – Norwegian Water Technology Centre to perform the actual investigations. Aquateam has since 1999 been responsible for the Riverine Input Project (RID). The Norwegian Institute for Water Research (NIVA) was responsible from 1990-1998.

The 2000-investigation lasted from January throughout December. This report is the Norwegian part of the 2000 study, divided into two parts:

A: Principles, Results and Discussion
B: Data Report

The Programme Committee has consisted of Jon L. Fuglestad (SFT), Mona Weideborg and Eilen Arctander Vik (Aquateam). The practical investigations have been coordinated and the reporting has been performed by Mona Weideborg. Principal collaborator has been Eilen Arctander Vik. The data handling was performed by Pascale Stang. The names and responsibilities of all participants are listed in Chapter 6.

We would like to express our gratitude to all participants of the investigation, especially to the local fieldworkers for the collection and transport of the samples. The contact persons at the Norwegian Water Resources and Energy Administration (NVE) and The Norwegian Meteorological Institute (DNMI), Per Lofsberg and Stein Kristiansen, are acknowledged for their kind cooperation.

Oslo, 23 November, 2001

Mona Weideborg

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Summary and Conclusions

The objectives of the comprehensive study on riverine inputs and direct discharges are to assess all riverborne and direct inputs of selected pollutants to OSPAR Convention waters on an annual basis. This contributes to the Joint Assessment and Monitoring Programme (JAMP) by providing data on inputs to Convention waters on a subregional and a regional level. In this report the results from 2000 are given for riverine inputs of 10 main rivers and 145 tributaries. Thus the active monitoring programme covers drainage from approximately 75 % of the main land areas. For discharges entering directly into marine recipients, i.e. municipal wastewater and industrial discharges, estimates are based on data from effluent control programmes. Diffuse losses of total phosphorus, total nitrogen, phosphates, nitrates and ammonia from these coastal zones are estimated by using area specific runoff coefficients.

Greatest emphasis with regard to accuracy has been given to the input estimate to the Skagerrak region, as this is considered the most sensitive part of the Norwegian North Sea coast. The Skagerrak region received approximately 20 % of the phosphorus and 40% of the nitrogen discharges to the Norwegian coastal area. In this region 94 % of the area is river-monitored, and about 84% of both the P- and the N-loads, are found in the riverine inputs. During year 2000, all rivers with outlet in the Skagerrak area showed an increased annual runoff compared to 1999. The floods in year 2000 are also giving higher total load of most of the pollutants in the rivers in the Skagerrak region.

The results for nutrients of the 2000 investigation show that total annual loads to coastal waters from land-based sources in Norway include approximately 9 842 tonnes of total phosphorus (Tot-P) and 131 410 tonnes of total nitrogen (Tot-N). These loads were much higher than in 1999, since loads from fish farming was included in year 2000 for the first year. These loads contribute to approximately 46% of the total loading of Tot-P and 16% of the total loading of Tot-N from mainland Norway. Respectively, 34 and 53 % of the grand total inputs of Tot-P and Tot-N are monitored in the main and tributary rivers.

The loads when fish farming effluents are not included, were 109 953 tonnes for Tot-N and 5299 tonnes for Tot-P. This is an increase of 5% for Tot-N and 16% for Tot-P compared with 1999. In main rivers in the Skagerrak area, the calculated loads increased 40 % for Tot-N and 55 % for Tot-P. The increase in water flow for these rivers was approximately 32%. This indicates that increase in load is not only due to increased water flow, but also due to increased concentrations.

Riverine inputs of metals and persistent organic pollutants were relatively low. For some of the rivers, the concentrations found for some metals and lindane were lower than the detection limits given in the OSPAR Guidelines. In these cases a high and low discharge quantity has been estimated: the low assuming that the true concentration was zero and the high assuming that the true concentration was the limit of detection. This provides a basis for upper and lower input estimates.

Inputs of cadmium (Cd) were estimated to be 5.0 – 5.1 tonnes, lead (Pb) 68 tonnes, mercury (Hg) 1.6 – 2.2 tonnes, arsenic (As) 30 – 31 tonnes, total chromium (Cr) 73 – 75 tonnes and nickel (Ni) 175 tonnes. Copper (Cu) and zinc (Zn) comprised the largest inputs of trace metals, which in 2000 amounted to approximately 243 and 827 – 829 tonnes, of which 86 and 89% respectively, were river monitored.

The reported concentrations of Hg were in the same range as in 1999. This was, however, higher than the concentrations reported for the years 1990-1997. This could be influenced by the fact that different analytical methods were used. The results from parallel analysis showed that analytical results from KM Lab (ion fluorescence) were 2 – 8 times higher than the results from NIVA (gold trap and AAS). The Hg levels are extremely low and below normal detection limits for most laboratories. Several laboratories were involved in parallel testing, but the "correct result" could not be stated.

Total inputs of Pb, Cd and Zn increased 20%, 10 and 13% respectively. For other metals, As, Cu, Cr and Ni, the 2000 reported total load was lower than in 1999. However the discharges to the Skagerrak area were higher in 2000 than in 1999 for all metals except for Cr, where the load was the same as in 1999. In the Skagerrak area an increase in the load of 86% for Pb, 74% for Cd, 50% for Zn, 20 % for As, 30% for Cu, 30% for Ni and 40 – 60% for Hg was seen in 2000. A major reason for this increase is the unusual high runoff of all rivers in the Skagerrak area. The runoff (water flow) in the Skagerrak area increased 29-38% from 1999 to 2000. The increase in load is not only due to increased water flow, but also due to increased concentrations. Flooding periods can give higher loads of metals, due to increased water flow, increased leaching from the ground and increased particle content due to erosion. The load of suspended particulate matter from the main rivers increased with 58% from 1999 to 2000. It is not possible to estimate the percentile of the metals which is particle bound, but the increase in metal loads from 1999 to 2000 are probably mainly particle bound. The high Pb load increase from 1999 to 2000 was probably caused by the increased particle content in the water.

The pesticide lindane was found in most samples, but in very low concentrations. Lindane often is found in runoff water from areas where the compound has never been used. The substance is banned in Norway, and should not have been used in the last 10 years. The findings of this substance in Norwegian rivers are therefore most likely due to transport of long-range air pollutants. Total load from main riverine inputs is estimated to 35 - 36 kg. The load from tributary inputs is stipulated to approximately 20 kg. The total loads are stipulated to 55 kg.

A systematic correlation analysis between different parameters was performed. A positive correlation between suspended particulate matter (S.P.M.) and Tot-P is found for the rivers Glomma, Drammenselva, Numedalslågen, Orkla and Alta, and a positive correlation between S.P.M. and Pb is found for the rivers Glomma, Drammenselva, Numedalslågen, Skienselva, Otra and Alta. For the other rivers, Orreelva and Suldalslågen, no correlation at all is seen for either of the parameters. A significant positive correlation between S.P.M. and Pb was found in 1999 when all data were treated together.

Statistical trend analyses on annual basis for some of the rivers with long time continuous data (Otra, Orkla and Glomma) have been carried out for nutrients (Tot-P and Tot-N) and two metals (Cu and Zn). Significant reductions in the yearly inputs of nutrients were found in Otra (Tot-P 69%, Tot-N 29%), and significant reductions in the yearly inputs of metals were found in Orkla (Cu 81%, Zn 76%). For Glomma, the trend is significant neither for Tot-P nor for Tot-N. The large floods, especially in 1987,1995 and 2000 were complicating the trend analyses.

Using multivariate analysis on all the results might give more information about input pattern. Statistical analysis of analytical data and runoff data from the period 1990-2001 data will be available in the annual report for 2001.

For most Norwegian rivers the input to the sea show large annual variations due to differences in water discharge. A "normalised" set of chemical data has been prepared for 2000 to control the fulfilment of the Ministerial Declaration of the North Sea. The 2000 average monitored chemical concentrations in river water have been multiplied with long term average flow (LTA) in the period 1961-90 for the main rivers and from 1931-60 for the tributary rivers.

Retention in the fjords and leaching from the marine sediments are not taken into account in the figures mentioned above. Future calculations should include estimates of the exchange of substances between sediments and water and other discharges (i.e. from landfills located near the coast and from constructions of roads and tunnels). Other proposed activities are statistical analysis to obtain more detailed information about input pattern, parallel sampling, round-robin testing of analysis of mercury in low concentrations, further evaluation of new sampling procedure in continuation to monitoring with passive sampling devices performed in 2000, and evaluation of other parameters to be monitored.

1. Introduction

At the Eight meeting of the Paris Commission (Madrid, June 1986) it was decided to carry out a pilot project to test methods for estimating transport of pollutants from rivers to marine areas. The Norwegian part of the pilot study comprised the two rivers Glomma and Skienselva (Fig. 1). The project was carried out from August 1986 to August 1987, and reported in October 1987 (Lingsten, 1987).

At the Tenth Meeting of the Paris Commission (Lisbon, June 1988) the principles for the comprehensive study on riverine inputs were adopted. It was then decided to commence the study with measurements carried out in 1990, and to continue the work in the following years (PARCOM, 10/3/2).

The purpose is to provide the Commission with an assessment of the waterborne inputs to Convention waters. Besides riverine inputs, the information sought also relates to direct discharges. The objectives of the Comprehensive Study are:

1. To assess, as accurately as possible, all riverborne and direct inputs of selected pollutants to Convention waters on an annual basis. Inputs from lakes, polders and storm overflows are to be included where information is available.

2. To contribute to the implementation of the JAMP by providing data on inputs to Convention waters on a sub-regional and a regional level.

3. To report these data annually to the OSPAR Commission and:
    a. to review these data periodically with a view to determining temporal trends;
    b. to review, on the basis of the data for 1990 to 1995 whether the Principles of the Comprehensive Study on Riverine Inputs require revision.

4. Each Contracting Party bordering the maritime area and, excluding the EU, should:
    a. aim to monitor on a regular basis at least 90% of the inputs of each selected pollutant;
    b. provide, for a selection of their main rivers, information on the annual mean/-median concentrations of pollutants resulting from the monitoring according to paragraph 1.4a; and
    c. as far as is practicable, estimate inputs from diffuse sources, direct sources and minor rivers complementing the percentage monitored (cf. paragraph 1.4a) to 100%.

PARCOM Recommendation 88/2 stipulates that Contracting Parties should "take effective national steps in order to reduce nutrient inputs into areas where these inputs are likely, directly or indirectly, to cause pollution, and to achieve a substantial reduction (of the order of 50%) in inputs of phosphorus and nitrogen to these areas between 1985 and 1995".

At the Third International Conference on the Protection of the North Sea States in 1990, Ministers agreed that discharges of selected persistent organic pollutants to the whole North Sea area are to be reduced by 50-70% depending on the micropollutant in question.

2. River Systems Included in the Study

2.1. General Aspects

The length of the Norwegian mainland coastline, including fjords and bays is 21 347 km, and the length of the islands' coastline is 35 662 km (Table 1). Because of the length of the coast line, the great numbers of rivers, and retention processes in the fjords, in- and out-washing areas, monitoring of river-borne pollutants in Norway faces quite a few challenges with respect to assessing their impact on coastal waters. Further, to measure 90 % of the load from the Norwegian rivers, a great number of rivers would have to be included, which would be extremely expensive. It was therefore decided that 8 of the major load bearing rivers should be monitored in accordance with the objectives of the comprehensive study. Further it was decided that 2 "unpolluted" rivers should be monitored at a reduced, but appropriate frequency. In these 10 rivers a number of investigations have been carried out since 1990, and they have all been included in the National Monitoring Programme of Watercourses (SFT, 1980 - 2000).

These investigations have mainly concentrated on nutrients. Hence data on the load of the nutrients are satisfactory, while the data on trace metals and persistent organic pollutants are rather insufficient. In addition to the ten rivers it was decided to estimate the load of 145 other rivers (tributaries). Random samples were taken from all these rivers in 2000. The load estimation was based on the results from the random sampling supplemented with other data from 2000-monitoring programmes, and existing knowledge of the river systems concerned.

The total drainage area of these monitored rivers is 229 152 km², while the total area of mainland Norway is 323 878 km² (Table 1). Totally 30 6747 km² of the drainage area is included in the investigation, of which 75 % is river monitored (Table 6). It was of special importance to estimate the major loads to Skagerrak. In this region the monitored rivers and tributaries cover 94 % of the total area, whereof the main rivers alone cover 80 %.

The coastline is divided into subareas/regions, comprising the drainage basins of the ten main rivers with tributaries, as shown in Figure 1. Each subarea relates to one of the four discharge-/sub-regions (Figure 1 and Table I.I-I.IV (Report B, Appendix I,)) which are divided as follows (see also Table 5):

Barents Sea: From the Russian border (about 70°30'N, 70°30'E), to about 70°30'N, 21°E

Norwegian Sea: Southwards of 70°30'N, to about 62° N

North Sea: Southwards of 62° N, to the Swedish border

Skagerrak: From Lindesnes (the southernmost point of Norway), about 57°44'N to Sweden about 58°58'N, 11°E.

Some key information about Norway and the adjacent oceans is given in Table 1.

Table 1. Norway: Population, areas and length of coastline.

Population	4.4 million
Area:	
- Mainland Norway	323 878 km²
- The whole country incl. Svalbard and Jan Mayen	386 958 km²
Coastline:	
- Length of the continental coastline	21 347 km
- Not including fjords and bays	2 650 km
- Length of the islands' coastline	35 662 km

2.2. **Main Rivers**

The rivers chosen for the comprehensive study are the same as in 1990-1999 and presented in Table 2 and Figure 1. The rivers marked 1 to 5 represent the major load bearing rivers in Norway. As mentioned in chapter 2.1, it was of special importance to estimate the major loads to Skagerrak (Figure I.I, Report B, Appendix I,) which is an important part of the North Sea, and considered to be most susceptible to pollution. Five monitored rivers (No 1 to 5) drain into the Skagerrak area.

Orreelva (No 6) is draining the most intensive agricultural area in Norway especially concerning domestic animals (milk and meat production). Discharges from manure stores and silos together with area runoff from heavily manured fields are causing great problems (eutrophication, including toxic algal blooms) both in Orreelva and in the other water bodies in this area.

Orkla (No 8) is also draining agricultural area, but farming in this part of the country is less extensive compared to the Orre area. More important in this area are abandoned mines in the upper part of the watercourse. Several other rivers in this area also receive discharge from abandoned mines (heavy metals).

Vefsna (No 9) is a watercourse where the runoff in periods carries large concentrations of suspended solids and as such is representative of many rivers in this part of the country.

River Suldalslågen (No 7) and river Alta (No 10) are "unpolluted" river systems where actual measurements have been carried out at a reduced frequency.



Figure 1. Norway divided into four Discharge Areas. Main Rivers and Tributaries with Drainage Basins. Source: Norwegian Water Resources and Energy Administration. Design: NIVA

Table 2. The main rivers with catchment areas and long term average flow (LTA) 1961-90.

No.	River	Catchment area, km^2 (at outlet)	LTA, 1000 m^3/day (at outlet)
1	Glomma	41 918	61 350
2	Drammenselva	17 034	28 850
3	Numedalslågen	5 577	10 200
4	Skienselva	10 772	23 535
5	Otra	3 738	12 870
6	Orreelva	105	335
8	Orkla	3 053	5 710
9	Vefsna	4 122	15 655
7	Suldalslågen	1 457	7 420
10	Alta	7 373	7 495
Total		**95 149**	

The ten watercourses are all representing typical river systems in different parts of the country. As such they are very useful when estimating loads of comparable rivers, i.e. corrections and adjustments in the estimates of loads of tributaries, which are based on fewer data than the main rivers.

All these watercourses except Orreelva are regulated for hydroelectric power production.

2.3. **Tributary Rivers**

In addition to the ten main rivers, it was determined to assess inputs from the same 145 river systems as in 1990 - 1999 (Figure 1) using "best estimates" of concentrations and flows. In total all Norwegian rivers with catchment areas larger than 500 km² and several of the minor rivers (streams) also are included in the 2000 study. Some information about these rivers is shown in Tables 8.1-8.2 (Appendix VIII, Report B).

3. Methodology

3.1. Methodology for Assessment of Riverine Inputs

The methodology described in the Commissions Document "Principles of the Comprehensive Study on Riverine Inputs" (PARCOM, 1988,1993) was followed.

3.1.1. Objective

A riverine input is a mass of a determinant carried to the maritime area by a watercourse (natural river or man-made watercourse) per unit of time. The objective is to obtain as accurate as possible an estimate of the input load to Norwegian coastal water, and to obtain information on the long-term trends in inputs where such information might provide an additional or a better basis for a trend assessment.

3.1.2. Site Selection

The sampling sites are located in regions of unidirectional freshwater flow. The sites chosen, have been areas where the water is well mixed (such as, at or immediately downstream a weir, in waterfalls, rapids or in channels in connection with hydroelectric power stations) and where uniform water quality is expected. When possible, samples are taken from the middle of bridges across the rivers. The water should be well mixed both horizontally and vertically. Only one sampling site and one sampling depth have been used in each of the rivers.

The sampling sites were located as close to the freshwater limit as possible, but should not be influenced by seawater. Several of the most significant discharges from the industry and the municipal wastewater system are located downstream the sampling sites. These supplies will not be included in the riverine inputs, but are included in the direct discharge estimates (Table 1 (Appendix I) and Appendices II and III, Report B).

3.1.3. Sampling Strategy and Frequency

The sampling strategy has been designed on the basis of historical records. Although it should aim to cover the whole flow cycle, it has been concentrated on periods with expected high river-flow. Experience has shown that there is a positive correlation between periods of high river-flow and high input load, especially for suspended solids and trace metals.

Most monitoring effort has been directed towards the rivers with the highest input load (Glomma and Drammenselva), and the river Vefsna where the load to the sea shows large seasonal and annual variations due to differences in water drainage. The original programme of 1990-1992 was reduced in 1993. Small changes in the programme were undertaken from 1999 to 2000. PCB was left out from the programme in 1999, since the concentrations have been lower than the detection limit (0.03 ng/l) in most of the samples in the period 1990-1998.

In all main rivers, except Suldalslågen, 12 grab samples or more have been taken at regular monthly intervals during the sampling period from January to December 2000, as described in PARCOM 10/3/2. Three of the main rivers (Glomma, Drammenselva and Vefsna) were sampled weekly in the period with the highest anticipated flow (May – June). Suldalslågen was sampled 11 times in 2000. In all the main rivers the parameter lindane have been sampled

and analysed 4 times in 2000. The sampling frequency for the main rivers is shown in Table 3.

Table 3. Sampling sites and frequency of the main rivers.

River/Location	J	F	M	A	M	J	J	A	S	O	N	D
Glomma at Sarpsfoss	x	x	x	x	xxxx	xxxx	x	x	x	x	x	x
Drammenselva upstream the town bridge	x	x	x	x	xxxxx	xxxx	x	x	x	x	x	x
Numedalslågen at Bommestad	x	x	x	x	x	x	x	x	x	x	x	x
Skienselva at Klosterfoss	x	x	x	x	x	x	x	x	x	x	x	x
Otra at Skråstad	x	x	x	x	x	x	x	x	x	x	x	x
Orre near the outlet	x	x	x	x	x	x	x	x	x	x	x	x
Orkla at Vormstad	x	x	x	x	x	x	x	x	x	x	x	x
Vefsna at Kvalfors	x	x	x	x	xxxxx	xxxx	x	x	x	x	x	x
Suldalslågen near the outlet	x	x	x	x	x	x	x	x	x	x	x	
Alta just upstream Alta	x	x	x	x	x	x	x	x	x	x	x	x

The tributary rivers were all sampled once in 2000. Lindane was not analysed in the tributary rivers. The concentrations of lindane were estimated on the basis of knowledge about the activity in the different drainage areas, and the findings from the main rivers and samples/analyses from these areas in 1990-1997.

In 2000 the water samples from the main rivers were taken by local personnel and by the company BUVA (see Chapter 5). Aquateam personnel took most of the samples from the tributary rivers. The persons were carefully instructed in advance. The samples were sent to the laboratory used by Aquateam (KM–Lab, Grimstad/ AnalyCen, Grimstad) immediately after sampling, usually arriving at the laboratory within 1 to 2 days. The samples were not conserved in the field. They were either conserved at the laboratory immediately after receiving or the analytical work was started immediately.

3.2. Monitoring Parameters and Analytical Methods

3.2.1. Chemical parameters – detection limits and analytical methods

In 2000 the following parameters were monitored: 6 nutrients (total phosphorus, orthophosphates, total nitrogen, ammonia, nitrate + nitrite and silicate), 8 metals (copper, zinc, cadmium, lead, total chromium, nickel, mercury and arsenic), 1 pesticide (lindane) and two general parameters (suspended particulate matter (S.P.M.) and total organic carbon (TOC)).

Information on methodology and obtainable limits of detection for all parameters included in the sampling programme, are shown in Table 4. According to the document "Principles of the Comprehensive Study of Riverine Inputs and Direct Discharges" (PARCOM, 1988), it is necessary to choose an analytical method, which gives at least 70 % of positive findings (i.e. above the detection limit).

Table 4. Analytical methods and detection limits.

Parameter	**Detection limit**	**Analytical Methods** (NS: Norwegian Standard)
Conductivity (mS/m)	-	ISO 7888
Suspended particulate matter (S.P.M.) (mg/L)	0.5-2	NS 4733
Total Organic Carbon (TOC) (mg C/L)	0.5-1.0	ISO 8245
Total Phosphorus (µg P/L)	1.0-3.0	NS 4725 – Peroxidisulphate oxidation method
Orthophosphate (PO_4-P) (µg P/L)	0.5-1.8	NS 4724 – Automated molybdate method
Total Nitrogen (µg N/L)	10	NS 4743 – Peroxidisulphate oxidation method
Nitrate and nitrite (NO_3 + NO_2) (µgN/L)	5	NS 4745 – Automated cadmium reduction method
Ammonia (NH_4) (µg N/L)	2-10	NS 4746
Silicate (SiO_2) (mg/L)	0.09	Std.Met 3120 A-B
Lead (Pb) (µg Pb/L)	0.01	EPA2008M – ICP/MS
Cadmium (Cd) (µg Cd/L)	0.001-0.02	EPA2008M – ICP/MS
Copper (Cu) (µg Cu/L)	0.02	EPA2008M – ICP/MS
Zinc (Zn) (µg Zn/L)	0.1	EPA2008M – ICP/MS
Chromium (Cr-tot) (µg Cr/L)	0.01-0.2	EPA2008M – ICP/MS
Nickel (Ni) (µg Ni/L)	0.03	EPA2008M – ICP/MS
Arsenic (As) (µg As/L)	0.02-0.2	EPA2008M – ICP/MS
Mercury (Hg) (ng Hg/L)	5	Atomic fluorescence
Lindane (ng/L)	0.1	EPA 508 mod. – GC/ECD

Since Aquateam took over the Riverine Input Project from NIVA in 1999, parallel sampling and analyses were performed in all 10 rivers for all parameters. The conclusion from the parallel analyses was that the correspondence between NIVA's and KM Lab's analytical values was exceptionally good, except for mercury.

For mercury, the analytical results from KM Lab (atomic fluorescence) were 2-8 times higher than the results from NIVA (gold trap and AAS). Since there are no round robin test results or other relevant analytical results available for low level analysis of this parameter, it was concluded that the "correct" result couldn't be stated (Weideborg et al. 2001).

In the year 2000 the following laboratories have carried out the water analyses in the riverine input project:

- KM-Lab Grimstad: Analyses of total phosphorus, orthophosphate, total nitrogen, ammonia, nitrate+nitrite and total organic carbon (TOC) from January to April.
- Analycen, Moss: Analyses of total phosphorus, orthophosphate, total nitrogen, ammonia, nitrate+nitrite and total organic carbon (TOC) from May to December.
- Aquateam: Analyses of lindane.
- KM-Lab in Linköping, Sweden: Analyses of metals and silicate. From April 2000 the laboratory was renamed Alcontrol/Linköping.

Since a new laboratory (Analycen, Moss) had taken over the analyses of nutrients and TOC, parallel analyses of these parameters were performed between NIVA and Analycen. The analyses showed good correspondence between the two laboratories (see Appendix XIV, report B). Analycen has participated in several round-robin tests with acceptable results for all parameters. Youden diagrams for the parameters TOC, orthophosphate, total phosphorus, nitrate and total nitrogen from the last round-robin test (Hovind, 2000) show that Analycen's results were within the acceptance criteria for all parameters in 1999.

For the main and tributary rivers, it was not possible to get >70% of the measurements above detection limit for each parameter. An overview over parameters with less than 70% of the measurements above the detection limit is given in the Appendix IV and V (report B) for main and tributary rivers, respectively.

The main rivers had more positive Cd-findings in 2000 than in 1999. All the main rivers had 80-100% positive findings. For the tributary rivers draining to the Skagerrak area, the North Sea and the southern part of the Norwegian Sea, 100% of the Cd-samples were above the detection limit. In the remaining area most of the Cd-findings were below the detection limit. For the Pb-samples, all but one finding in the Skagerrak area, the North Sea and the southern part of the Norwegian Sea were above the detection limit. In the Barents area 68% of the Pb-findings were above the detection limit.

Only 5 of 10 main rivers had more than 70% positive orthophosphate findings whereas only Orkla had less than 70% positive orthophosphate findings in 1999. This is due to higher detection limit in the first months.

However, these difficulties are not likely to affect the results and conclusions of the year 2000-study. In the cases were the results recorded were lower than the detection limits, two load quantities have been estimated, one assuming that the true concentration is zero and the other assuming that the true concentration is the detection limit. This provides maximum and minimum concentrations within which the true estimate will fall. When used to evaluate inputs, these data provide upper and lower boundaries for the estimate.

3.2.2. Method used to estimate flow rate

For the period 1931-60 the annual specific runoff from the total area of Norway is estimated at 42.9 l/s km². Expressed in volumetric units this amounts to 438 km³ water, which distributed over the whole country equals a mean runoff of 1350 mm. Mean annual runoff in Norway and from the sub-regions to the main surrounding seas for the period 1931-60 are shown in Table 5. For the main rivers mean annual runoff for the last LTA-period (1961-90) have been estimated. For the main rivers mean annual runoff (1931-60 and 1961-90) together with annual runoff for the years 1985, 1990-2000 are shown in Figure 2. Mean annual and annual precipitation for the same stations and periods are presented in Figure 3. As for precipitation, normals for Norway based on the LTA-period 1961-90 were published in 1993 (DNMI, 1993).

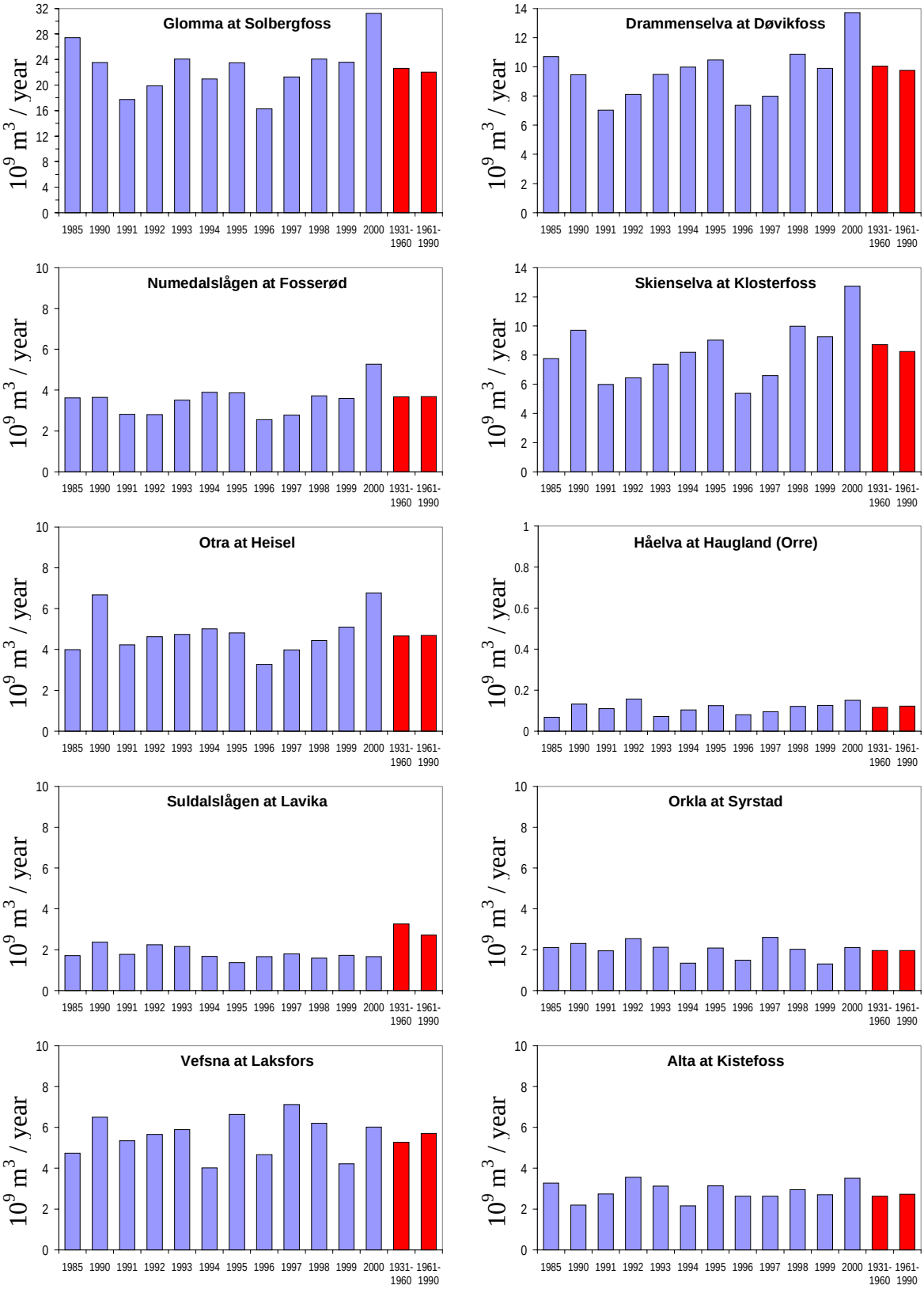


Figure 2. Main Rivers. Mean Annual Runoff (1931-60 and 1961-90) and Annual Runoff for the Years 1985, 1990-2000 (10^9 m^3). Source: Norwegian Water Resources and Energy Administration.

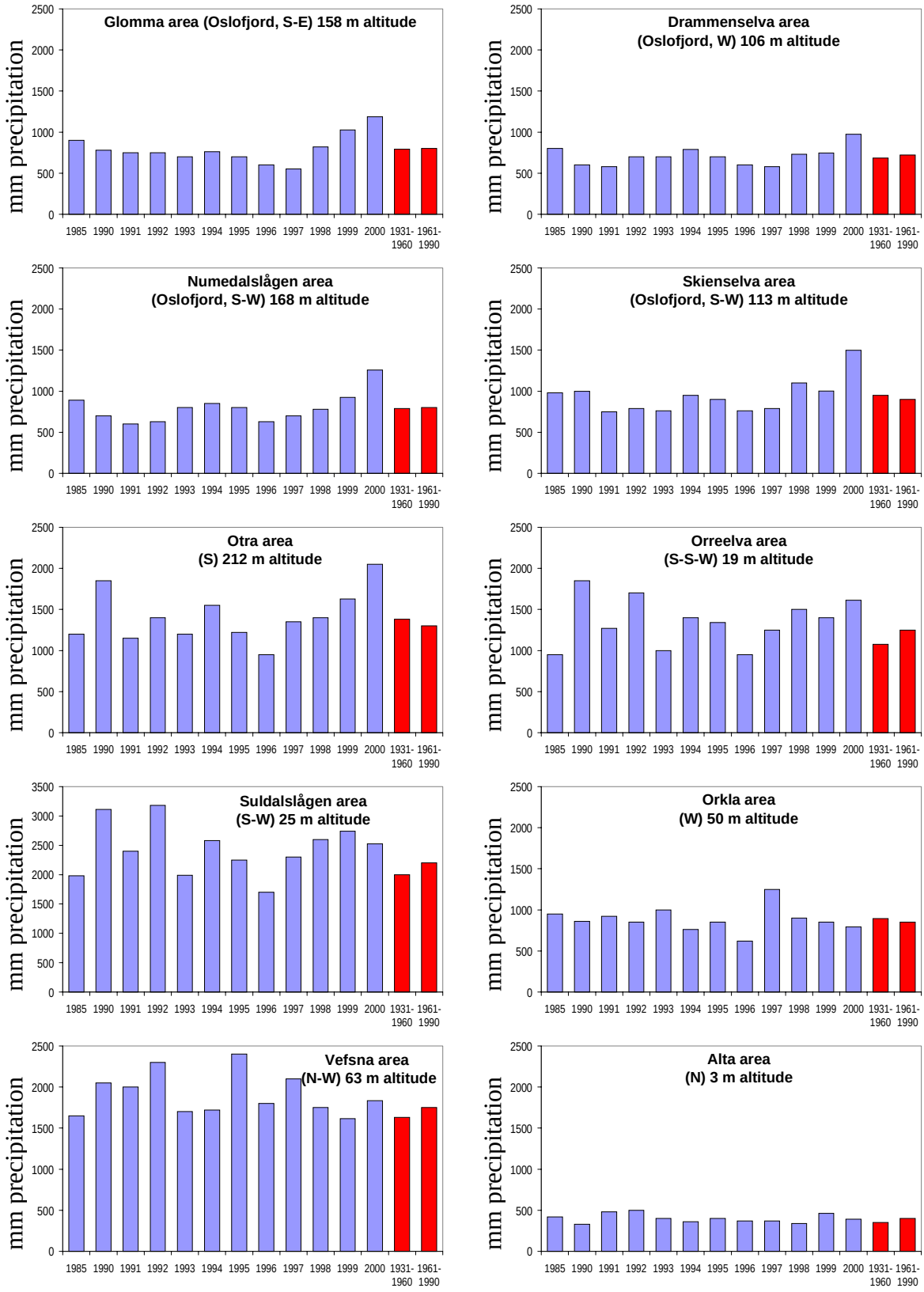


Figure 3. Main Rivers. Mean Annual Precipitation (1931-60 and 1961-90) at Stations near Outlet and Annual Precipitation in the Years 1985, 1990-2000 (mm/year). Source: The Norwegian Meteorological Institute. (S = South, E = East, W = West, N = North)

Table 5. Mean annual runoff (1931-60) from the subregions to the main surrounding seas.

Subregions	**Main Seas**	**Drainage area, km^2**	**Runoff, mill. m^3**
The Swedish border - Lindesnes	Skagerrak	98 699	57 934.47
Lindesnes - Stad	North Sea	138 902	164 875.88
Stad - the border of Finnmark	Norwegian Sea	94 704	231 928.67
Finnmark - the border of Russia	Barents Sea	73 141	41 462.90
Total		**405 446**	**496 201.92**

At a given location the runoff will change from one year to another and throughout the year. In natural river basins the seasonal variations will depend mostly on the distance from the coast, the altitude and the latitude, and on variations in precipitation. The mean discharge is determined both by the precipitation and the catchment area. Along the coast of Southern and Western Norway the summer low flows are usually dominant together with high runoff in autumn and winter. Thus although Western Norway has much more precipitation than Eastern Norway, its smaller catchment areas lead to much less absolute discharge in western rivers. In the central part of Southern Norway and in the northern part of the country low water flows are typical both in summer and winter, whereas periods of higher runoff will appear during the snow-melting period (spring and early summer). In late summer and in autumn the flow depends on the precipitation and may therefore vary considerably.

In all main rivers continuous observations of the rate of flow are collected. For most rivers these stations are located upstream the sampling stations (NVE, 2001). The additional water supplied is estimated using measured rainfall data from the local catchment areas (DNMI, 2001a). The same runoff stations were used from 1985, except for the river Orkla, where the station was changed from Vormstad to Syrstad in 1993 (Holtan et al., 1999).

For all main rivers, seasonal changes in runoff in 2000 are shown in Figure 4.

For the other rivers (tributaries) the mean runoff data (1931-60) and measured rainfall data (2000) are used for flow estimates.

The difference between the total area given in Table 5 and the area given in Table 1 is due to rivers that drain into the neighbouring countries (Sweden, Russia and Finland).

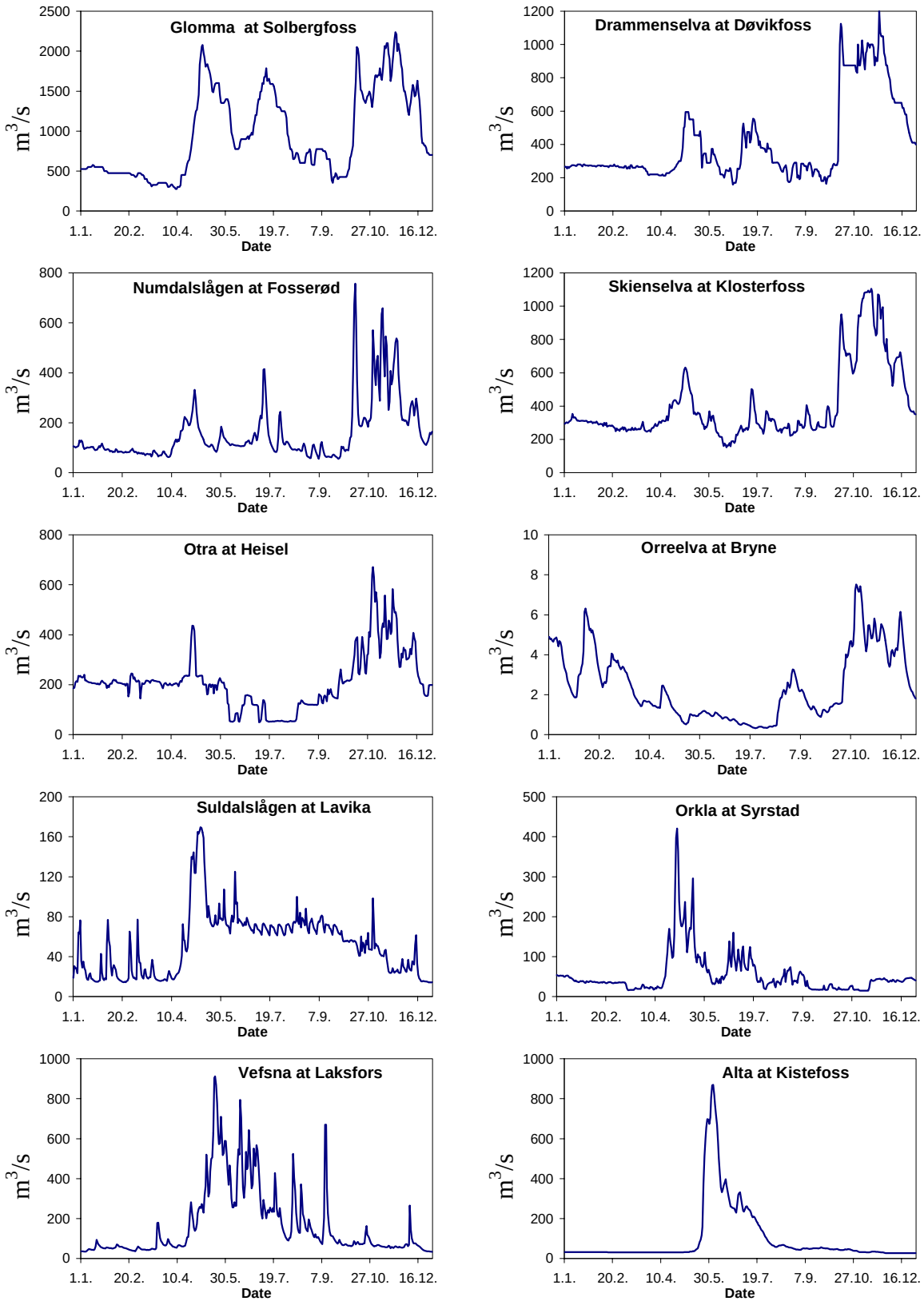


Figure 4. Main Rivers. Seasonal Changes in Daily Runoff (m³/s). Source: Norwegian Water Resources and Energy Administration.

3.2.3. Calculation of annual load

The first of the formulas given by the Paris Commission was used for calculating loads for all main rivers and most of the larger rivers. For the rivers with 12 or less measurements the following formula has been used:

$$Load = Q_r \frac{\sum_{i=1}^{n}(C_i \bullet Q_i)}{\sum_{i=1}^{n} Q_i}$$

C_i = measured concentration in sample *i*
Qi = corresponding flow for sample *i*
Qr =mean flow rate for each sampling period
N = number of samples taken in the sampling period

This equation is a formula suited for estimating annual load when sampling dates are evenly spaced in time. Essentially it expresses the annual load (L) as the product of a flow weighted estimate of annual mean concentration and annual flow (Qa). Then the annual load estimate can be strongly biased if the sampling frequency increases during periods of high flow. Incidents with high flow will have a great influence on the estimate, and high concentrations during such periods will eventually lead to an overestimated annual load. For the main rivers with more than 12 measurements (weekly measurements), the load for each month were therefore calculated and summarised:

$$Load_{month} = Q_{month} \frac{\sum_{i=1}^{n}(C_i \bullet Q_i)}{\sum_{i=1}^{n} Q_i}$$

Q_{month} = total monthly flow

For the other rivers (tributaries), which have been monitored only once (or a few times per year), the best available estimates of flow (catchment area multiplied by specific runoff adjusted for deviations from normal precipitation) and flow-weighted concentrations have been used to estimate contaminant loads.

The following procedure was used for estimation of flow in 2000:

- Precipitation data for 2000 and normal precipitation 1931 – 1960 were collected.
- Mean precipitation for the catchment area in percent of the normal precipitation was calculated and multiplied with normal water flow.

Drainage basins to the different areas and regions (km² and %) are shown in Table 6.

Table 6. Drainage areas of monitored main and tributary rivers and down stream areas (km^2 and % monitored/estimated in each subarea and subregion).
(Figure 1, Figures I.I-I.V, Report B).

Sub-regions	**Subareas**	**Drainage area of monitored rivers (km^2)**		**Down stream areas (km^2)**	**Total (km^2)**	**Monitored (%)**
		Main	**Tributary**			
Skagerak	No 1: Glomma	41 218	2 389	2 416	46 023	94.8
	No 1: Inner Oslofjord		959	342	1 301	73.7
	No 2: Dram-menselva	17 028	226	320	17 614	98.0
	No 3: Numedals-lågen	5 513	1 043	631	7 187	91.2
	No 4: Skienselva	10 348	1 200	1 283	12 831	90.0
	No 5: Otra	3 730	9 109	904	13 743	93.4
Subtotal		**77 837**	**14 926**	**5 896**	**98 699**	**94.0**
The re-maining North Sea	No 6: Orreelva	105	7 233	2 513	9 851	74.5
	No 7: Suldalslågen	1 466	16 205	12 681	30 352	58.2
Subtotal		**1 571**	**23 438**	**15 194**	**40 203**	**62.2**
The Nor-wegian Sea	No 8: Orkla	2 680	28 118	17 036	47 834	64.4
	No 9: Vefsna	4 113	23 907	18 850	46 870	59.8
Subtotal		**6 793**	**52 025**	**35 886**	**94 704**	**62.1**
The Bar-ents Sea	No 10: Alta	7 367	45 155	20 619	73 141	71.8
Total		**93 568**	**135 544**	**77 595**	**306 747**	**74.7**

3.3. **Methodology for assessment of direct discharges to marine waters**

The computer model TEOTIL (Tjomsland and Ibrekk, 1992) for estimation of the nutrient loadings to Norwegian coastal waters was used for assessment of direct discharges. The model includes anthropogenic and natural sources. The model uses statistical data from censuses of Agriculture and Forestry, Population and Housing from the Statistics Norway (SSB). The census data are available on small geographic units. As a whole, Norway is divided into more than 1500 geographical units. Each census unit is further assigned to drainage basins (NVE, 1990). By combining census data and drainage basins a comprehensive database was developed. The database includes the following data: number of people, houses, farms, agricultural land, aquaculture, forest land, wetland, upland areas and so forth. Nutrient discharges from each sewage treatment plant and from industry are also included.

3.3.1. Wastewater treatment plant effluents

Statistics Norway (SSB) and Norwegian Pollution Control Authority (SFT) have jointly initiated annual registration of data from all wastewater treatment plants in the country with a capacity of more than 50 person equivalents (p.e.). The data are updated each year by the County Environmental Agencies. The computer program SESAM has been installed at all county governors' environmental agencies, which are responsible for collecting effluent data from the municipalities. The county environmental agencies then send the data to SSB. Since 1994, the reporting system SESAM has been extended also to include data on smaller settlements. Discharge figures from SESAM are used in the model "TEOTIL" to calculate the total discharges of total phosphorus ammonia, nitrates, orthophosphates and total nitrogen to Norwegian coastal waters. NIVA has performed this modelling (Hopen, 2001). The figures take into account retention in water courses.

In 2000, 2882 wastewater treatment plants with a hydraulic capacity of at least 50 p.e. were registered in Norway (SSB, 2001). There were also 570 sewerage systems (serving more than 50 p.e.) with direct discharges of untreated wastewater (SSB, 2001). The major part (57%) of the treatment plants have only primary treatment, 9% chemical treatment, 4% biological treatment, 11 % chemical and biological treatment and 19% unconventional, unknown or other treatment. The major part of treatment plants with only primary treatment are serving smaller settlements, while the majority of advanced treatment plants (plants with chemical and/or biological treatment) are found near the larger cities, and therefore treat the main part of the produced wastewater. Of the total hydraulic capacity of 6.26 million p.e., chemical plants account for 35 %, primary treatment for 28%, chemical/biological for 25%, direct discharges for 9%, biological for 1% and others for 2%. In the North Sea area of Norway, most of the wastewater are treated in chemical or combined biological-chemical treatment plants, whereas the most common treatment methods along the coast from Hordaland county and northwards are primary treatment or no treatment.

Preferably, the annual loads from municipal wastewater effluents have been estimated as the product of annual flow and flow-weighted concentrations. For the rest of the municipal wastewater, the loads were estimated by multiplying the number of people with Norwegian per capita loads.

For raw (untreated) wastewater discharges, the document “Principles of the Comprehensive Study of Riverine Inputs and Direct Discharges” (Paris Commission, 1988), recommends the derived per capita loads listed in Table 7 to be used.

The Norwegian per capita loads are based on studies of Norwegian sewerage districts (SFT, 1995). These data are also used to calculate pollutional loads from the different treatment plants, reduced by the removal efficiency of the treatment plants. Municipal wastewater also includes a portion of industrial effluents. The fraction of the total person equivalents (p.e.) is proportioned between sewage and industrial wastewater according to the number of persons and the size of industrial effluents connected to each treatment plant.

Table 7. Per capita loads used for estimation of untreated sewage discharges.

Parameter	**Parcom**	**Norway**
BOD (kg O/person/day)	0.063	0.046
COD (kg O/person/day)		0.094
TOC (kg TOC /person/day)		0.023
S.P.M. (kg S.P.M./person/day)	0.063	0.042
Tot-N (kg N/person/day)	0.009	0.012
Tot-P (kg P/person/day)	0.0027	0.0016

The metal loads were estimated on the basis of data from 1999. Only small changes have occurred in 2000 from 1999 (Nedland, 2001). For metals in municipal wastewater discharges, calculated loads were based on measured concentrations in effluents from 14 treatment plants in Norway in 1999 (Nedland, 2000) and measured or calculated flows from the wastewater effluents in 1999 (from SESAM). For effluents without any measured flow, the 1999-flow was calculated to 600 litres per p.e. per day, (average for effluents with measured flows). The effluent metal concentrations used after different forms of treatment are given in Table 8.

Table 8. Concentrations of metals in discharges from Norwegian municipal wastewater treatment plants in 1999 (Nedland, 2000).

Metal	**Direct discharges**	**Primary + Unconventional (except infiltration) Other Unknown**		**Chemical Biological Biological/chemical Infiltration**	
	µg/L	**µg/L**	**% reduction**	**µg/L**	**% reduction**
Cadmium (Cd)	0.25	0.20	20	0.15	40
Mercury (Hg)	0.10	0.08	20	0.05	50
Lead (Pb)	4	2.7	33	1.4	65
Nickel (Ni)	7	6.0	14	5.0	29
Chromium (Cr)	7	5.0	29	3.0	57
Zinc (Zn)	90	63	30	36	60
Copper (Cu)	60	38	37	15	75

The annual discharge flows in 1000 m^3 from different types of plants and areas are listed in Table 9.

3.3.2. Industrial effluents

Sampling frequency for industrial wastewater varies from weekly composite samples to random grab samples, sampling is performed at least twice a year. Measured and estimated loads from industrial activities in the different areas are shown in Appendix III, Report B. NIVA has performed the TEOTIL modelling for total nitrogen and total phosphorus (Holtan and Hopen, 2001). The calculations of the other discharges were performed by Aquateam. The metal data were collected from SFT's data base INKOSYS (SFT, 2001).

Table 9. Annual discharges (in 1000 m^3) from different types of treatment plants, 1999 (Nedland, 2000).

Recipient	**Direct discharges**	**Primary + Unconventional (except infiltration)**	**Chemical Biological Biological/chemical Infiltration**	**Other Unknown**
Glomma	15	111	206 180	554
Drammenselva	0	0	19 395	131
Numedalslågen	0	6 286	42 718	7
Skiensvassdraget	0	554	22 543	78
Otra	0	8 517	20 673	210
Skagerrak	**15**	**15 468**	**311 509**	**980**
Orreelva	1 016	14 489	43 566	863
Suldalslågen	11 339	80 156	13 488	257
North Sea	**12 355**	**94 645**	**57 054**	**1 120**
Orkla	15 020	59 098	13 245	398
Vefsna	13 513	34 824	2 041	427
Norwegian Sea	**28 533**	**93 922**	**15 286**	**825**
Alta	6 471	1 906	203	400
Barents Sea	**6 471**	**1 906**	**203**	**400**

3.3.3. Fish farming effluents

Nutrient loading (Tot-N, NH4, Tot-P and PO4) from fish farming effluents in 2000 has been estimated by use of the computer model TEOTIL (Borgvang and Tjomsland, 2001). Equations and factors described in OSPAR's HARP Guidelines (Harmonised Quantifications and Reporting Procedures for Nutrients) (SFT, 2000b) are used. The results are presented in Table XII (Appendix XII, Report B).

In 2000, the loading has been included in the grand total values. These loads have not been included in the previous input calculations from 1990-1999, but they need to be taken into account when the results from different years are to be compared.

3.3.4. Other inputs (nutrients in runoff from "down stream areas" of main and tributary rivers and rivers not monitored)

The pollution load model calculates the load from each pollution source by using specific load coefficients (Holtan and Åstebøl, 1990) multiplied by areas (in square kilometres) of different categories and activity numbers, eg. population. The coefficients used are prepared according to precipitation, climate, vegetation and soil in the different areas. New coefficients have recently been calculated, giving higher differences between districts and higher background values (Ber, 2001).

Total direct nutrient discharges (Down stream areas) are shown in Table I (Appendix I, Report B), in the different subareas (1-10) in Appendix VI, Report B. Direct discharge areas (km^2) are shown in Table 6.

4. Results and Discussion

4.1. Measured concentrations and calculated loads

In this investigation riverine and direct inputs of nutrients (P- and N-compounds, silicate), suspended particulate matter (S.P.M.), total organic carbon (TOC), metals and lindane are measured or estimated.

The Norwegian Pollution Control Authority has prioritised elimination of the discharges of 13 micropollutants, presently in use in Norway, as fast as possible. Most of this pollution is caused by industrial effluents, but other sources are municipal wastewater, landfill leachate and pesticide residues from agriculture.

Local pollution by heavy metals and arsenic is caused by discharges from industry, discharges from existing and abandoned mines, leaching from landfills or atmospheric precipitation. The municipal wastewater is, however, another source of pollution by several heavy metals. Long range transboundary air pollution is another source of pollution both with respect to heavy metals and persistent organic pollutants (e.g. the pesticide lindane). Metals naturally associated with suspended particulate material will also influence on the analytical results.

Municipal wastewater and runoff from agricultural areas comprise the major sources of phosphorus and nitrogen pollution. In addition to these nutrients the water is polluted by dissolved organic matter, especially from fish farming, from the pulp and paper industry and from municipal wastewater. These sources have been taken into account in this investigation.

The results given for riverine inputs (main rivers and tributaries) and discharges entering directly into marine recipients are mainly based on direct measurements. Measured concentrations of the chemical parameters of the ten main rivers (2000), mean values, standard deviation and range are listed in Appendix VII, Report B. Total annual loads of the main rivers in 2000 are shown in Appendix IV, Report B. Total annual loads of the tributaries are shown in Appendix V, Report B. For the whole country, total annual loads (Direct discharges and Riverine inputs) are shown in Table I (Appendix I, Report B). Some results are also presented graphically in Figures 5-9.

For some of the rivers, the measured concentrations of metals and lindane were lower than the detection limit given in the OSPAR Guidelines. In these cases a high and low discharge quantity has been estimated: the low assuming that the true concentration is zero and the high assuming that the true concentration is the limit of detection. This provides maximum and minimum concentrations between which the true estimate lies. When evaluating inputs these data provide a basis for upper and lower estimates.

To adjust the 2000 transport values to a "normal year", approximations have been made by multiplying weighted mean concentrations by mean runoff (LTA, 1961-90). "Mean-values" (normals) for the ten main rivers and tributaries are given in Appendix X, Report B, where

also total discharges to the sub regions are shown. In Figure 5 the "normalised" nutrient transport values are compared with 2000-values.

Greatest emphasis with regard to accuracy has been given to the input estimate to the Skagerrak region, as this is considered the most sensitive part of the North Sea. The Skagerrak region receives approximately 20 % of the phosphorus and 40% of the nitrogen discharges. In this region 94 % of the area is river-monitored, and about 84% of both the P- and the N-loads, are included in the riverine inputs.

4.2. **Runoff**

In the region Østlandet south of Mjøsa and most of the Sørlandet region, the year 2000 had the highest precipitation since the Meteorological Institute began precipitation monitoring in 1895. Annual precipitation was dominated by the precipitation during October and November. Some regions received 40-50% of their annual precipitation during these two months. In November, it was measured more than 5 times higher precipitation than normal at some stations. On the contrary, part of Nordfjord, Møre and Trøndelag region had the driest autumn since 1895 (DNMI, 2001b).

All of the rivers with outlets in the Skagerrak area have their catchment areas in the Østlandet and Sørlandet regions. The rivers Glomma, Drammenselva, Numedalslågen, Skienselva, Otra and tributary rivers in this area show a higher annual runoff than earlier registered (Table 10 and Figure 2).

Table 10. Increase in runoff (flow) from 1999 to 2000 and from LTA (1961-90) in the Skagerrak area.

Rivers	**Increase in runoff from 1961-90 to 2000**	**Increase in runoff from 1999 to 2000**
River Glomma	42%	29%
River Drammenselva	40%	30%
River Numedalslågen	43%	38%
River Skienselva	54%	37%
River Otra	44%	31%

Recorded maximum runoffs were measured in October-November for all these rivers (Figure 4). This flooding situation will also give higher total load than normal for most of the pollutants in these rivers.

4.3. **Nutrients, particulate matter and total organic carbon**

Annual loads of nutrients (nitrogen and phosphorus compounds), suspended particulate matter (S.P.M.), total organic carbon (TOC) in the main rivers are presented in Figure 5. The normalised load is compared with the 2000 values.

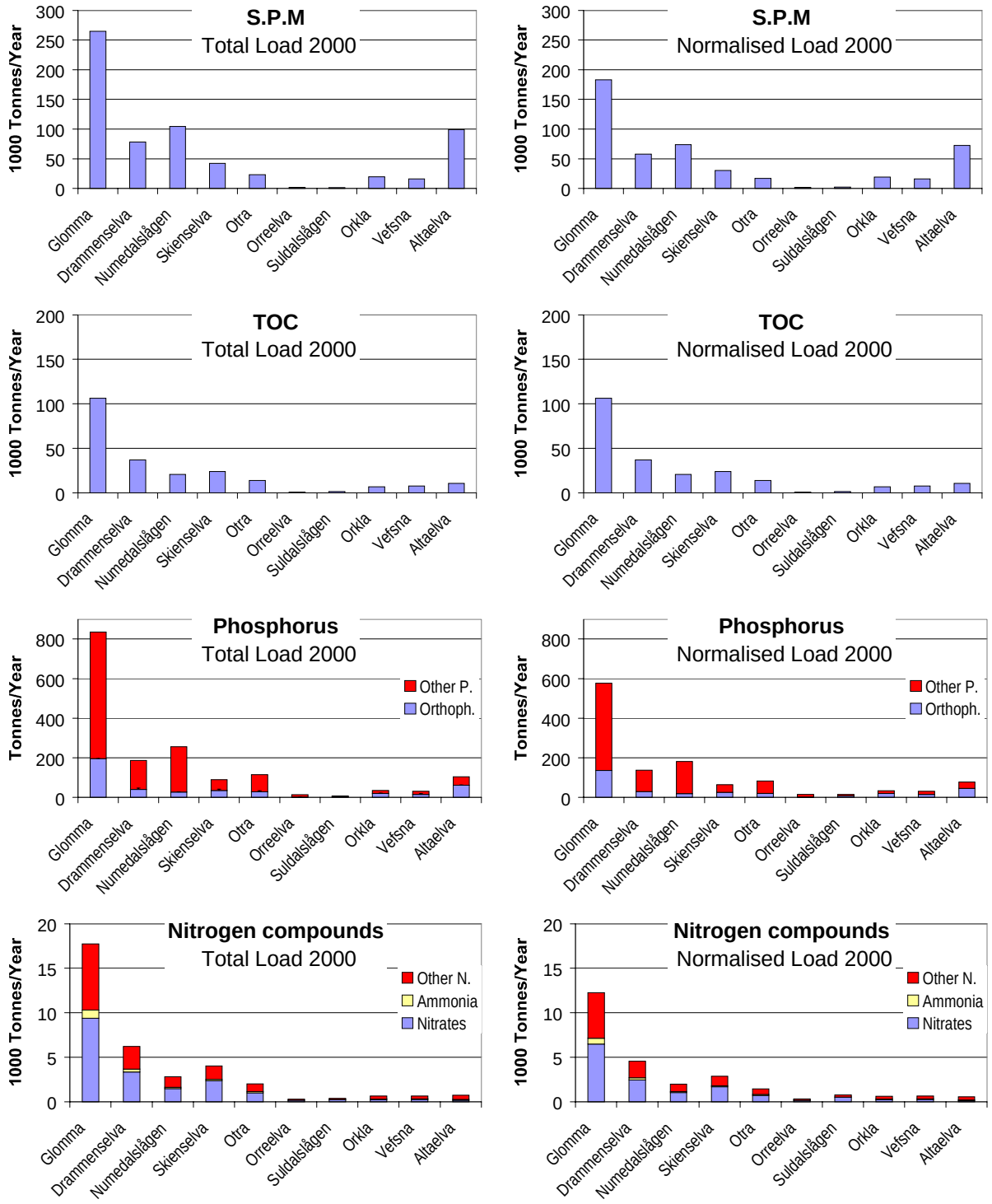


Figure 5. Main rivers. Suspended particulate matter (S.P.M.), total organic carbon (TOC) and nutrients (Tot-P, orthophosphate, Tot-N, nitrate, ammonia). Total loads 2000 and total normalised loads.

Total annual load of (year 2000) for the four subregions are shown in Tables 1.1-1.4 (Appendix I, Report B) and in Figure 6. The results of the 2000 investigation show that total annual nutrient loads to coastal waters from land-based sources in Norway include approximately 9842 tonnes of phosphorus and 131 410 tonnes of nitrogen. Those loads are much higher than in 1999. However loads from fish farming have been included in the above mentioned

values for the first time this year. These loads contribute to approximately 46% of the total loading of Tot-P and 16% of the total loading of Tot-N from mainland Norway. Respectively, 34 and 53 % of the grand total inputs of phosphorus and nitrogen are monitored in the main and tributary rivers.

Figure 6A shows the contribution from the 5 main sources of input: main rivers, tributary rivers, direct discharges, fish farming and area runoff. Figure 6B shows the contribution from the 5 main sources of input to the total load of TOC, S.P.M., orthophosphates, ammonia and nitrates. Since those parameters have not been reported in the same way for all sources, no conclusion should be given on this figure.

The loads without fish farming effluents are 109 953 tonnes for total nitrogen and 5299 tonnes for total phosphorus. This is an increase of 5% for nitrogen and 16% for phosphorus compared with the 1999 loads. A major reason for this increase is the unusual high runoff of all rivers in the Skagerrak area. In addition to high water flow, flooding periods can cause leaching of pollutants and nutrients from the catchment area and storm water discharge from wastewater treatment plants, giving rise to higher concentrations of these substances. In the main rivers in the Skagerrak region, the calculated loads increased by 40 % for total nitrogen and by 55 % for total phosphorus. The runoff increase for the rivers discharging to this region is 32%. This indicates that the increase in load is not only due to water flows alone, but also due to increased concentrations.

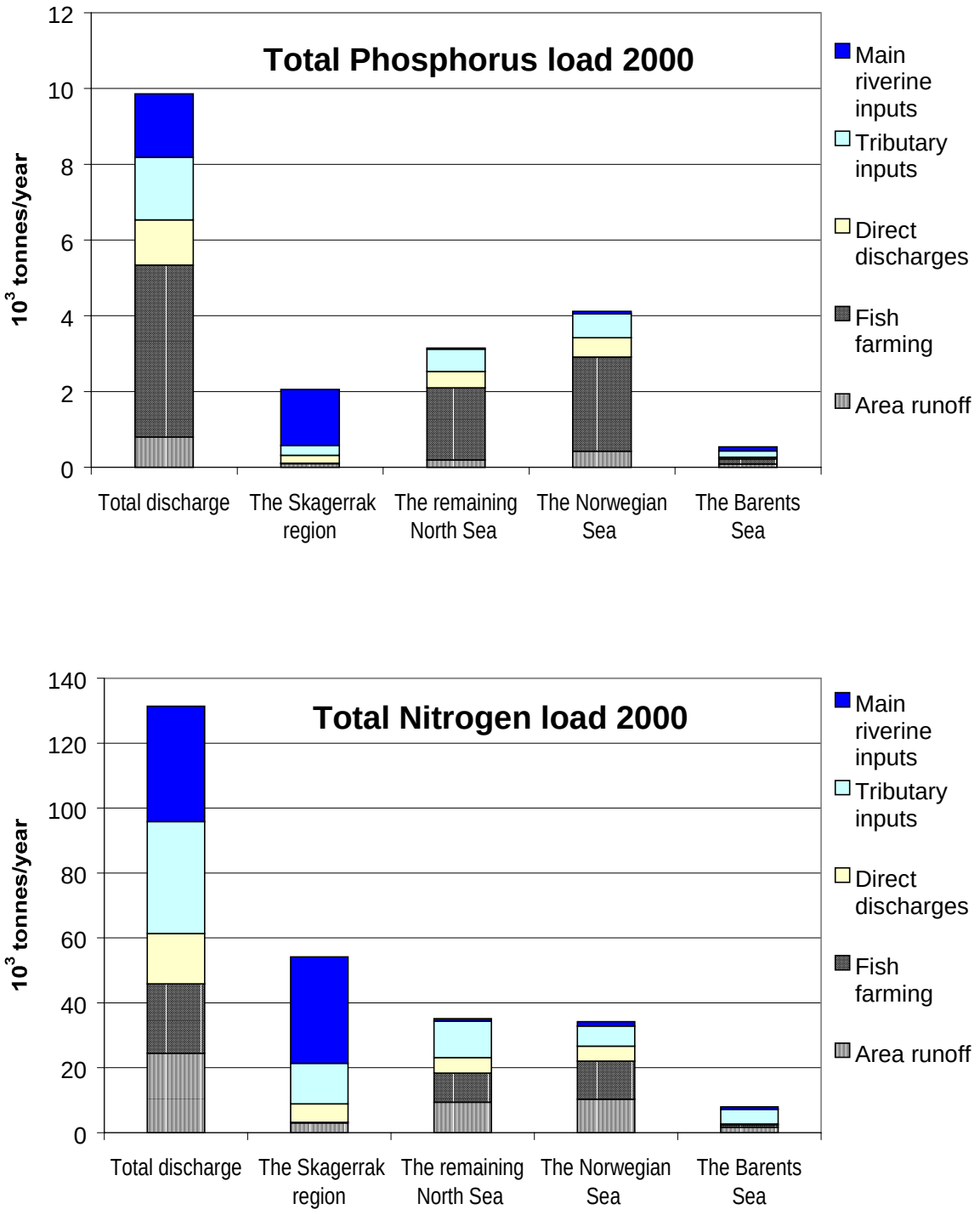


Figure 6A. Nutrients (Tot-P and Tot-N), total discharges in 2000 from mainland Norway to convention waters and the four subregions Contribution from the 5 main sources.

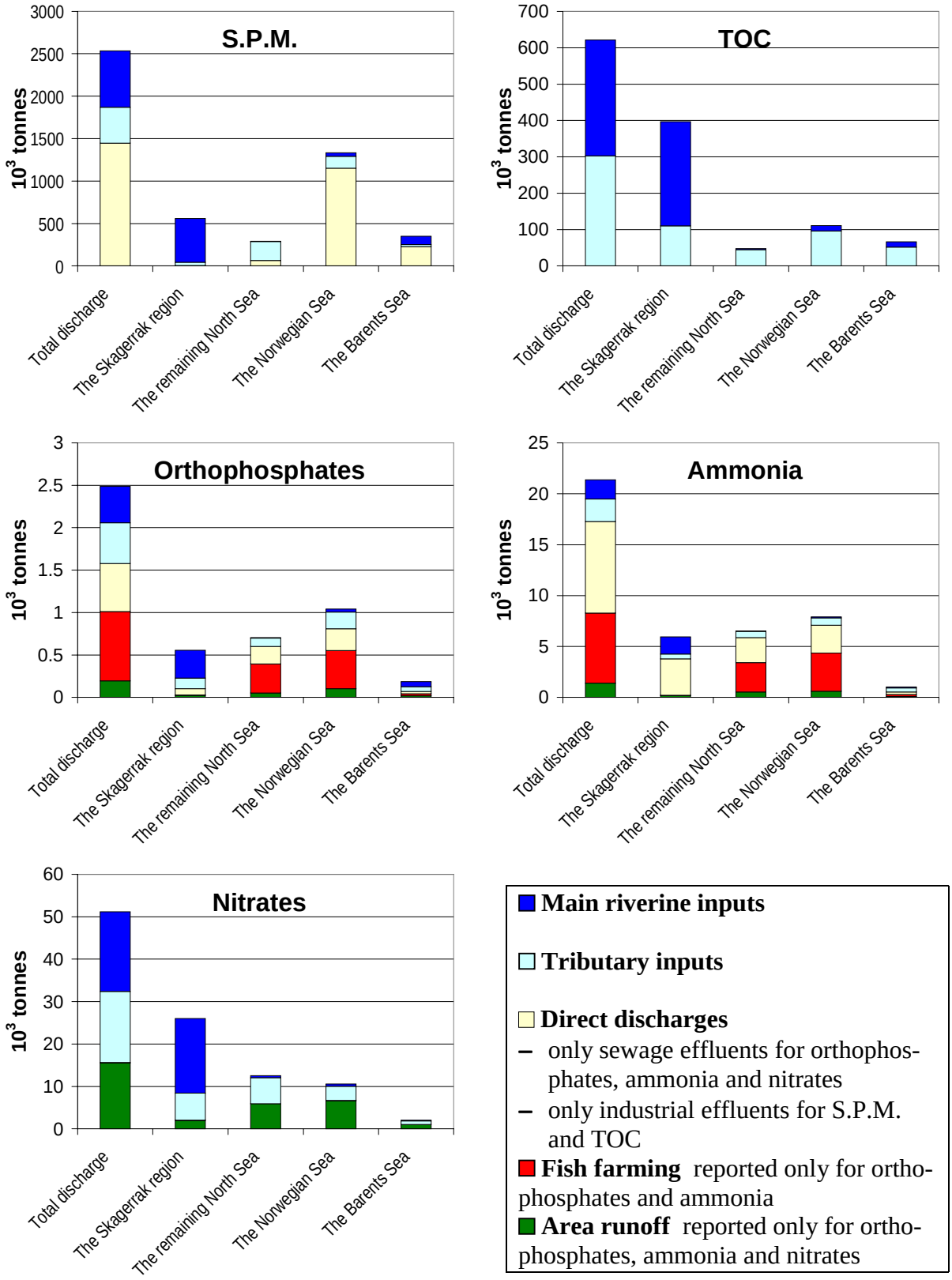


Figure 6B. S.P.M., TOC and nutrients (orthophosphate, ammonia and nitrate), total discharges in 2000 from mainland Norway to convention waters and the four subregions. Contribution from the 5 main sources.

4.4. Metals

Total inputs of cadmium have been estimated to be 5.0 – 5.1 tonnes, lead 68 tonnes, mercury 1.6 – 2.2 tonnes, arsenic 30 – 31 tonnes, total chromium 73 – 75 tonnes and nickel 175 tonnes. In Figure 7 the lower and upper loads of these substances from the ten main rivers are presented.

Copper and zinc comprised the largest inputs of trace metals, which in 2000 amounted to about 243 and 827 – 829 tonnes, of which 86 and 89% respectively, were river monitored. Figure 8 shows the contribution from the main rivers, tributary rivers and direct discharges of the metals to the four subregions (I: Skagerrak, II: The remaining North Sea, III: The Norwegian Sea, IV: The Barents Sea).

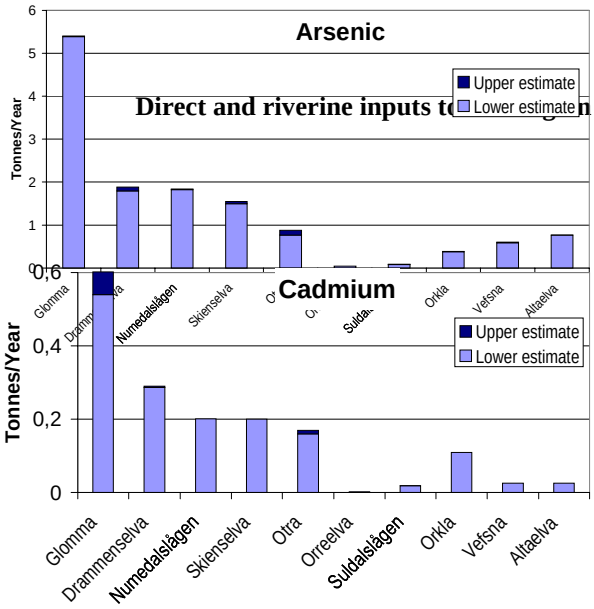
The reported concentrations of mercury were in the same range as in 1999. This was higher than the concentrations reported for the years 1990-1997 (Figure XVII, Appendix XIII, report B). This difference is most likely influenced by different analytical methods being used, as described in Chapter 3.2.

Total inputs of lead, cadmium and zinc increased 20%, 10% and 13% from 1999 to 2000, respectively. For the other metals (arsenic, copper, chromium and nickel) the 2000 reported total load was lower than in 1999. The loads to the Skagerrak area were, however, higher in 2000 than in 1999 for all metals except for chromium. In the Skagerrak area the increase in the load was 86% for lead, 74% for cadmium, 50% for zinc, 20 % for arsenic, 30% for copper, 30% for nickel and 40 – 60% for mercury. Chromium had the same loading in 2000 as in 1999.

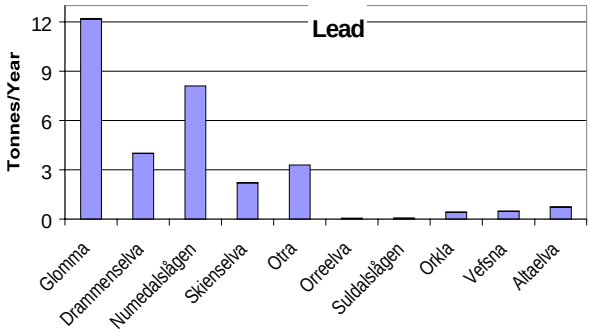
A major reason for this increase is the unusual high runoff of all rivers in the Skagerrak area in year 2000. The runoff (water flow) in the Skagerrak area increased 29-38% from 1999 to 2000. The increase in load is not only due to increased water flow, but also due to increased concentrations. Flooding periods can give higher loads of metals, due to increased water flow, increased leaching from the ground and increased particle content due to erosion. The load of suspended particulate matter from the main rivers increased with 58% from 1999 to 2000. It is not possible to estimate the percentile of the metals that is particle bound, but the increase in metal loads from 1999 to 2000 is probably mainly particle bound. The high Pb load increase from 1999 to 2000 is probably caused by the increased particle content in the water. A positive correlation between suspended materials (S.P.M.) and Pb is found for the rivers Glomma, Drammenselva, Numedalslågen, Skienselva and Otra (see Ch.4.6). No such correlation was found for the other metals.

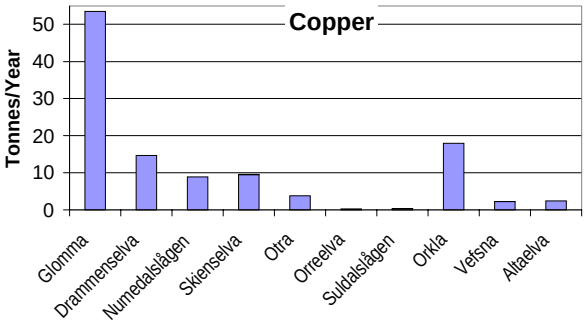
Figures 13 – 16 show the annual load of the metals in 1990-2000.

Using multivariate analysis on all the results might give more information about input pattern of the metals. Statistical analysis of analytical data and runoff data from 1990-2001 data will be available in the annual report for 2001.



Direct and riverine inputs to [illegible]n coastal waters – 2000. OSPAR Commision





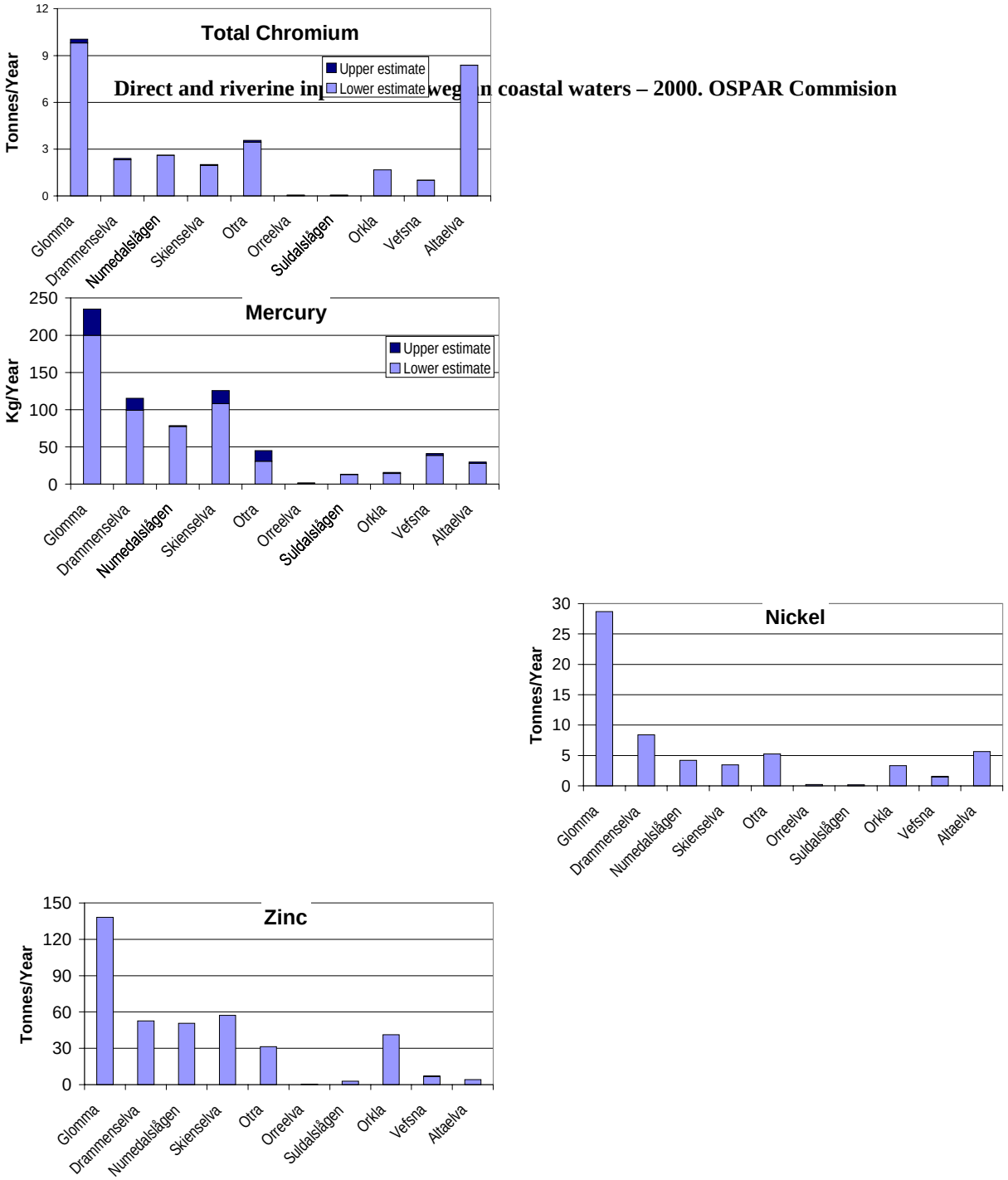


Figure 7. Main rivers. Metals (As, Pb, Cd, Cu, Total Cr, Ni, Zn and Hg). Total loads of the main rivers in 2000.

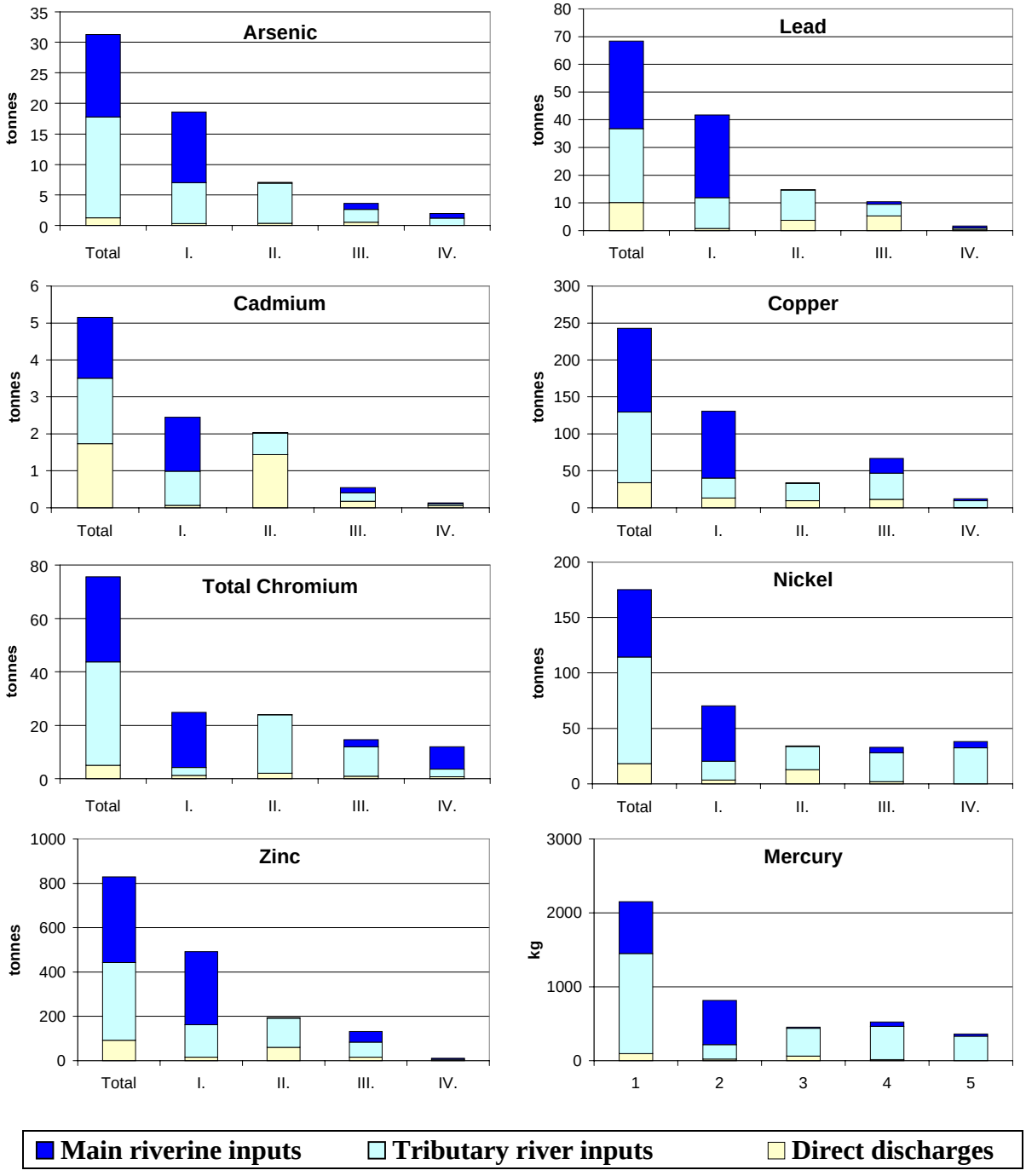


Figure 8. Metals, total discharges in 2000 from mainland Norway to convention waters and the four subregions. I: Skagerrak, II: The remaining North Sea, III: The Norwegian Sea, IV: The Barents Sea (upper estimates). Contribution from the main rivers, tributary rivers and direct discharges (industrial effluents and wastewater effluents).

4.5. Other parameters

Total annual load of silicate (SiO_2) is estimated to 321,135 – 321,394 tonnes (46% from tributary rivers and 54 % from main rivers). This is a 31% increase from 1999, due to increase in runoff and leaching in flooding periods.

The pesticide lindane was found in most samples, but in very low concentrations. Lindane often is found in runoff water from areas where the compound has never been used. The substance is banned in Norway, and should not have been used in the last 10 years. The findings of this substance in Norwegian rivers are therefore most likely due to transport of long-range air pollutants. Total load from main riverine inputs is estimated to 35 - 36 kg. Load from tributary inputs is stipulated to approximately 20 kg. The total loads are stipulated to 55 kg (Figure 9).

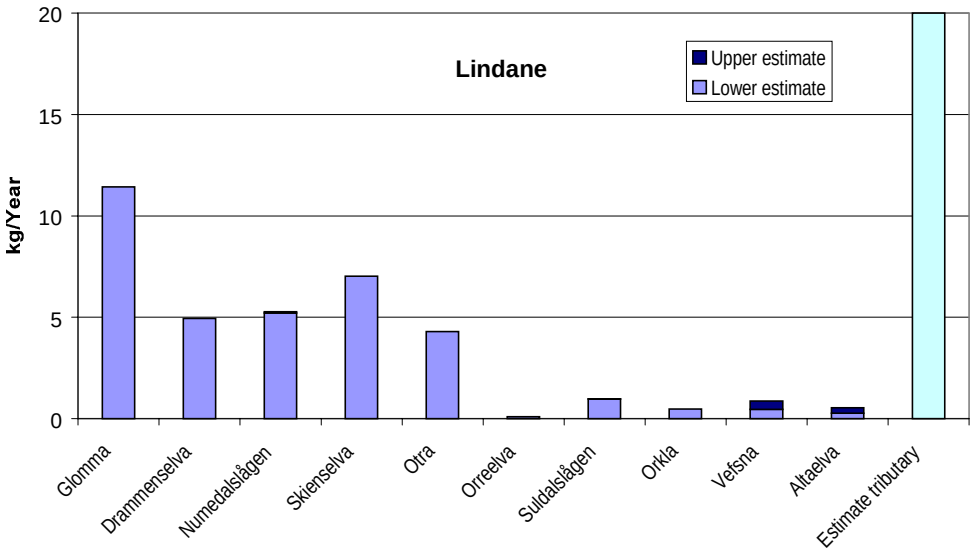


Figure 9. Lindane. Total loads of the main rivers in 2000 (lower and upper estimates) and estimate for the tributary rivers.

4.6. Correlation analysis

Some nutrients and metals are particulate bound. The concentration of nutrients is expected to be higher when the concentration of suspended particulate matter (S.P.M.) is high, i.e. in periods with high erosion or flow. A systematic correlation analysis between different parameters is performed (Figures 10 and 11, Tables 11 and 12). A positive correlation between S.P.M. and Tot-P is found for the rivers Glomma, Drammenselva, Numedalslågen, Orkla and Alta, and a positive correlation between S.P.M. and Pb is found for the rivers Glomma, Drammenselva, Numedalslågen, Skienselva, Otra and Alta. For the other rivers, Orreelva and Suldalslågen, no correlation at all is seen for either of the parameters.

These results indicate that phosphorus and lead are partly in particulate form. Using multivariate analysis on all the results might give more detailed information about input pattern.

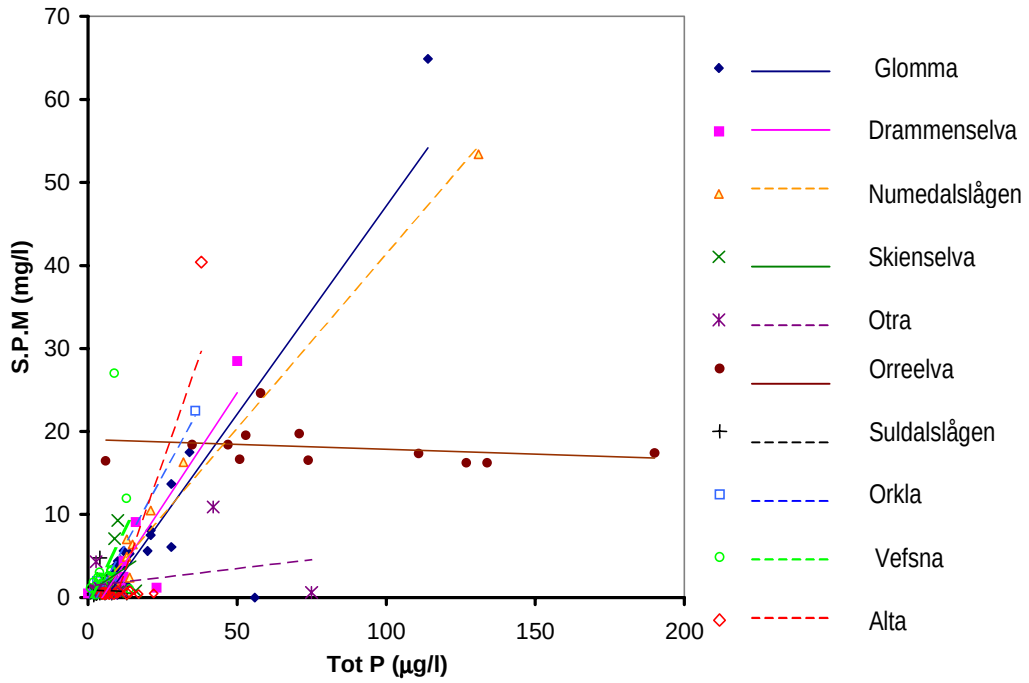


Figure 10. Correlation between suspended particulate matter (S.P.M.) and total phosphorus (Tot-P) in main rivers taken separately, 2000.

Table 11. Correlation formula and R^2 between suspended particulate matter and total phosphorus (Tot-P) in main rivers in 2000.

River	Formula	R^2
Glomma	S.P.M. = 0.50 Tot-P - 3.03	0.7718
Drammenselva	S.P.M. = 0.54 Tot-P - 2.59	0.8247
Numedalslågen	S.P.M. = 0.42 Tot-P - 0.50	0.9841
Skienselva	S.P.M. = 0.24 Tot-P + 0.59	0.1142
Otra	S.P.M. = 0.04 Tot-P + 1.36	0.1002
Orreelva	S.P.M. = - 0.01 Tot-P + 19.0	0.0609
Suldalslågen	S.P.M. = - 0.02 Tot-P + 0.96	0.002
Orkla	S.P.M. = 0.65 Tot-P - 1.74	0.9663
Vefsna	S.P.M. = 0.70 Tot-P - 0.66	0.1564
Alta	S.P.M. = 1.03 Tot-P - 9.54	0.7022
All rivers	S.P.M. = 0.22 Tot-P + 0.33	0.4068

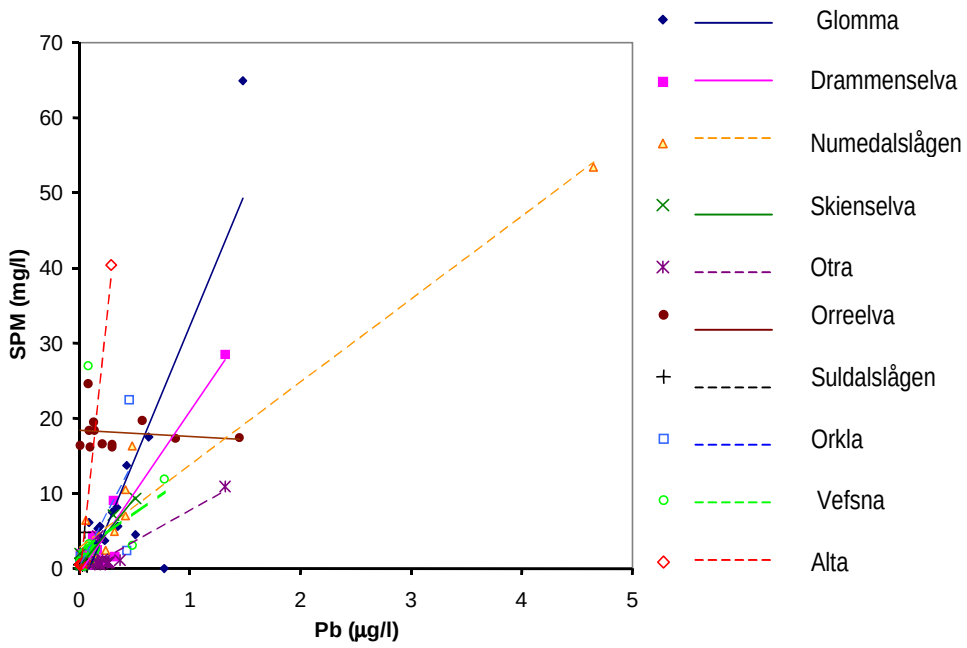


Figure 11. Correlation between suspended particulate matter (S.P.M.) and lead (Pb) in main rivers taken separately, 2000.

Table 12. Correlation formula and R^2 between suspended particulate matter (S.P.M.) and lead (Pb) in rivers in 2000.

River	Formula	R^2
Glomma	S.P.M. = 35.6 Pb - 3.38	0.7133
Drammenselva	S.P.M. = 21.6 Pb - 0.75	0.9236
Numedalslågen	S.P.M. = 11.1 Pb + 2.66	0.9492
Skienselva	S.P.M. = 18.3 Pb + 0.13	0.9067
Otra	S.P.M. = 8.31 Pb - 0.57	0.8293
Orreelva	S.P.M. = -0.81 Pb + 18.4	0.0207
Suldalslågen	S.P.M. = 11.6 Pb + 0.52	0.0469
Orkla	S.P.M. = 28.0 Pb + 0.33	0.5437
Vefsna	S.P.M. = 10.5 Pb + 2.13	0.0996
Alta	S.P.M. = 140 Pb - 1.97	0.9548
All rivers	S.P.M. = 1.32 Pb + 2.28	0.0982

4.7. **Trend analysis**

The yearly inputs to the different rivers are highly dependent on the water flow. It is therefore difficult to conclude regarding altered pollution levels in the different rivers, even if there may be indications of an improved situation for most rivers and most parameters. Carrying out trend analyses, especially for the rivers with long time series, is an important tool. The period from 1990 to 2000 may be too short to identify a real trend (Figures 12-16, see also Appendix XIII Report B), but it can give indications.

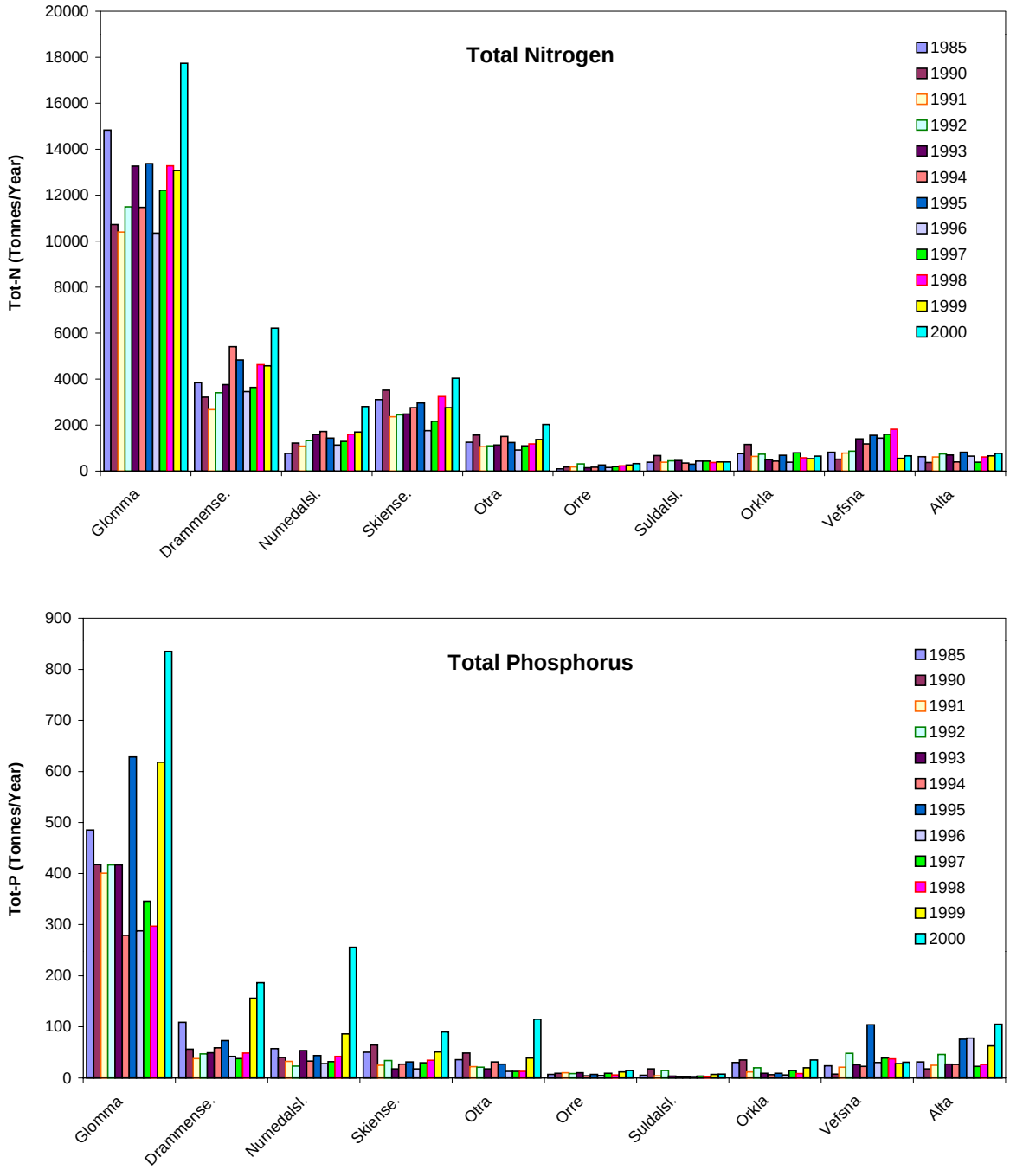


Figure 12. Main rivers. Annual total nitrogen and total phosphorus load in 1985, 1990-2000.

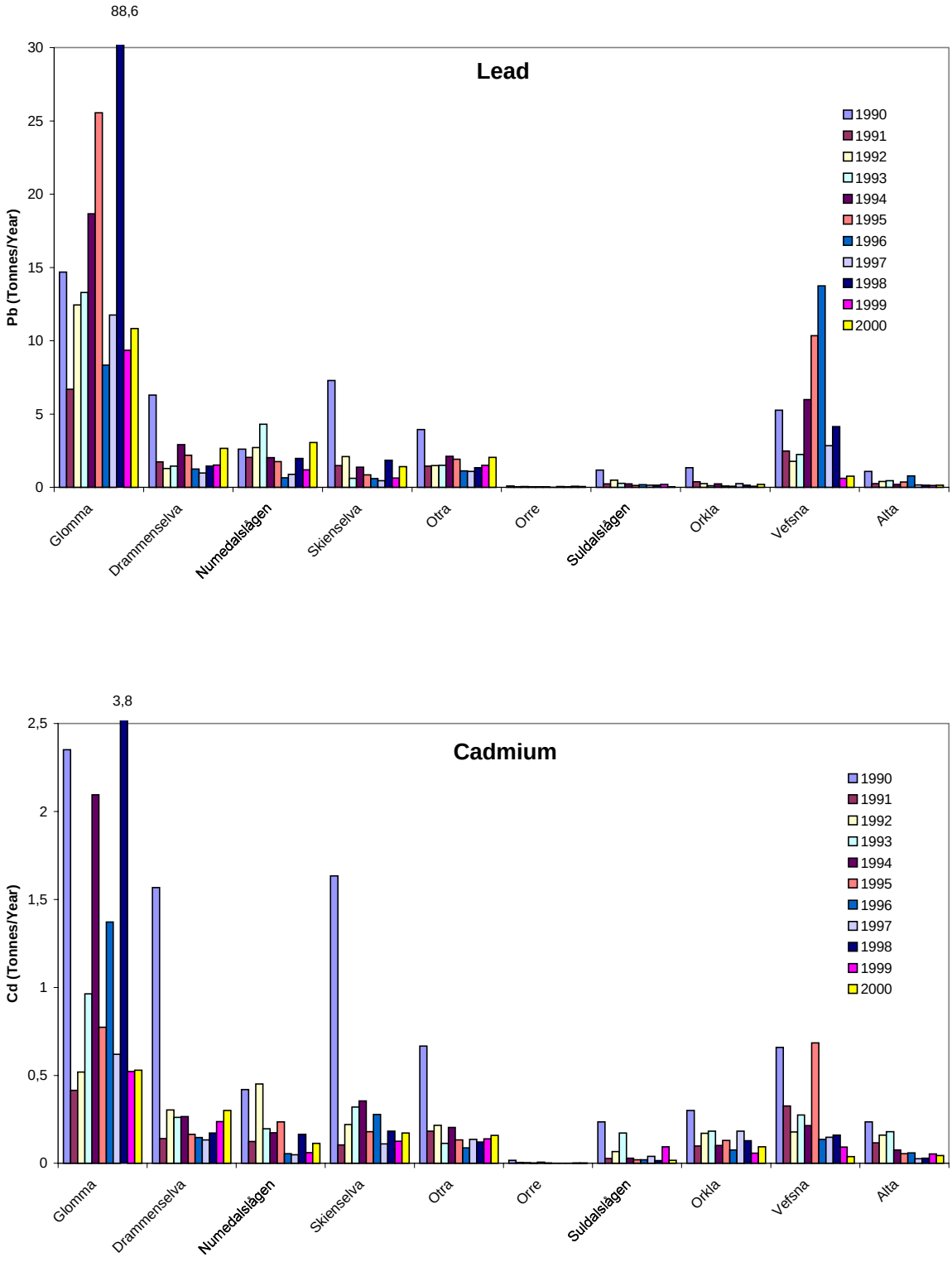


Figure 13. Main rivers. Annual total load of lead and cadmium in 1990-2000.

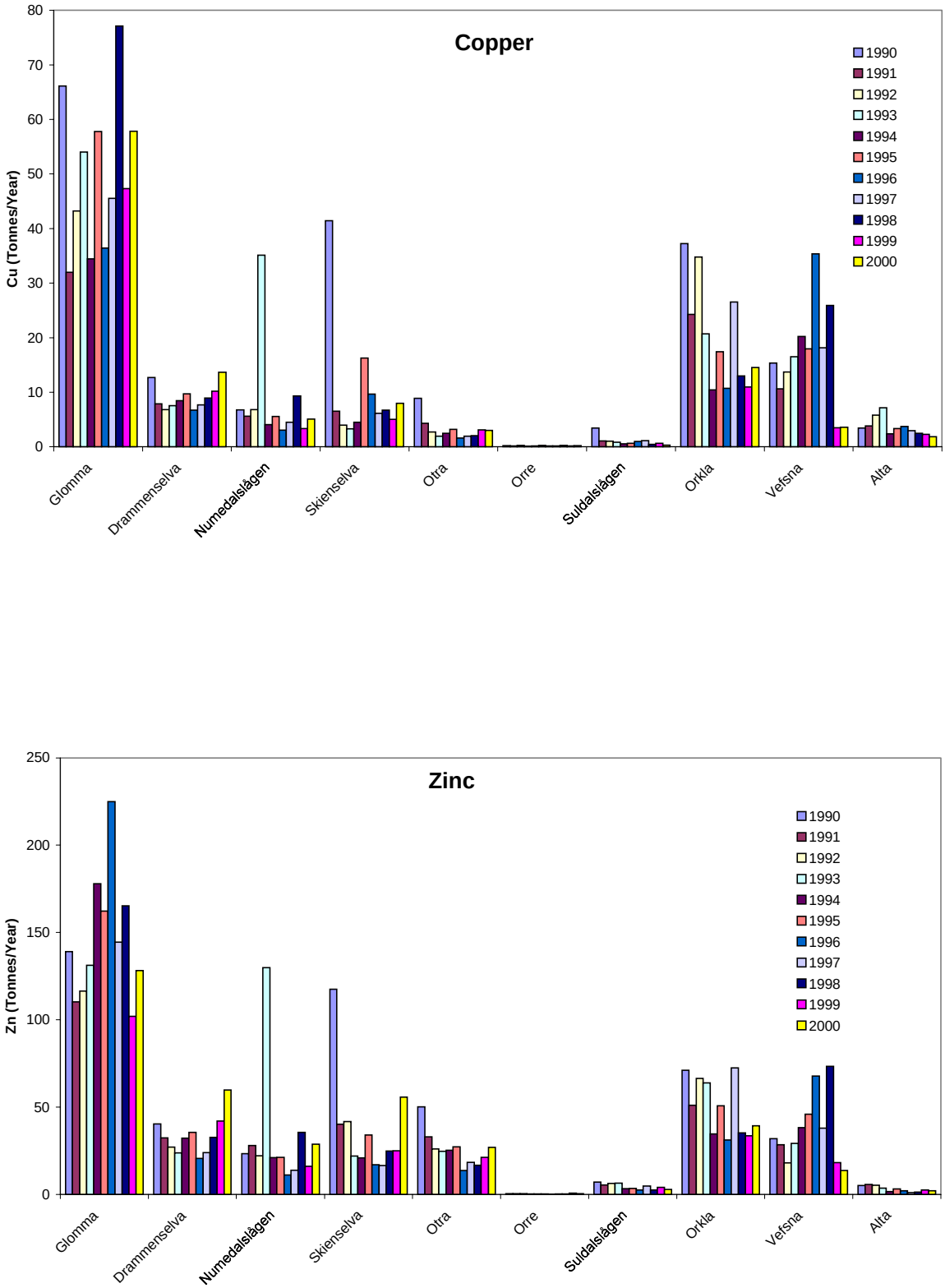


Figure 14. Main rivers. Annual total load of copper and zinc in 1990-2000.

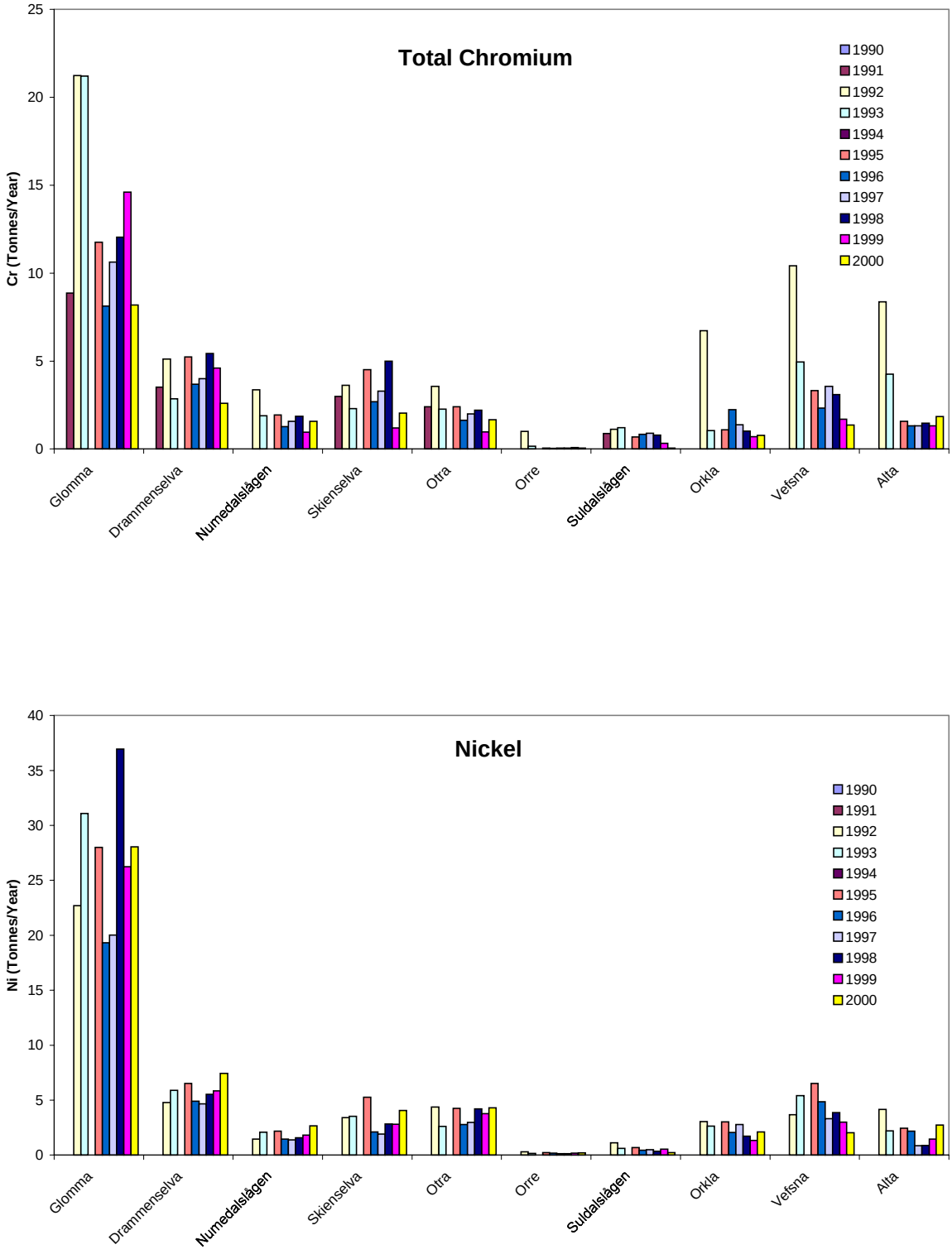
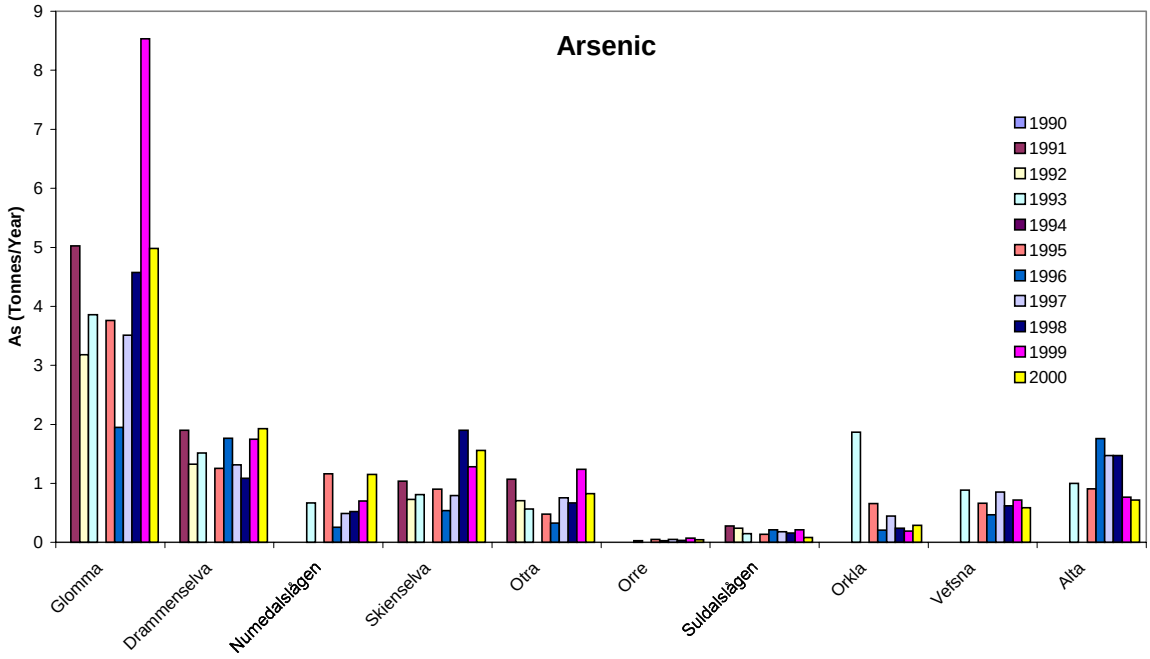


Figure 15. Main rivers. Annual total load of total chromium and nickel in 1990-2000.



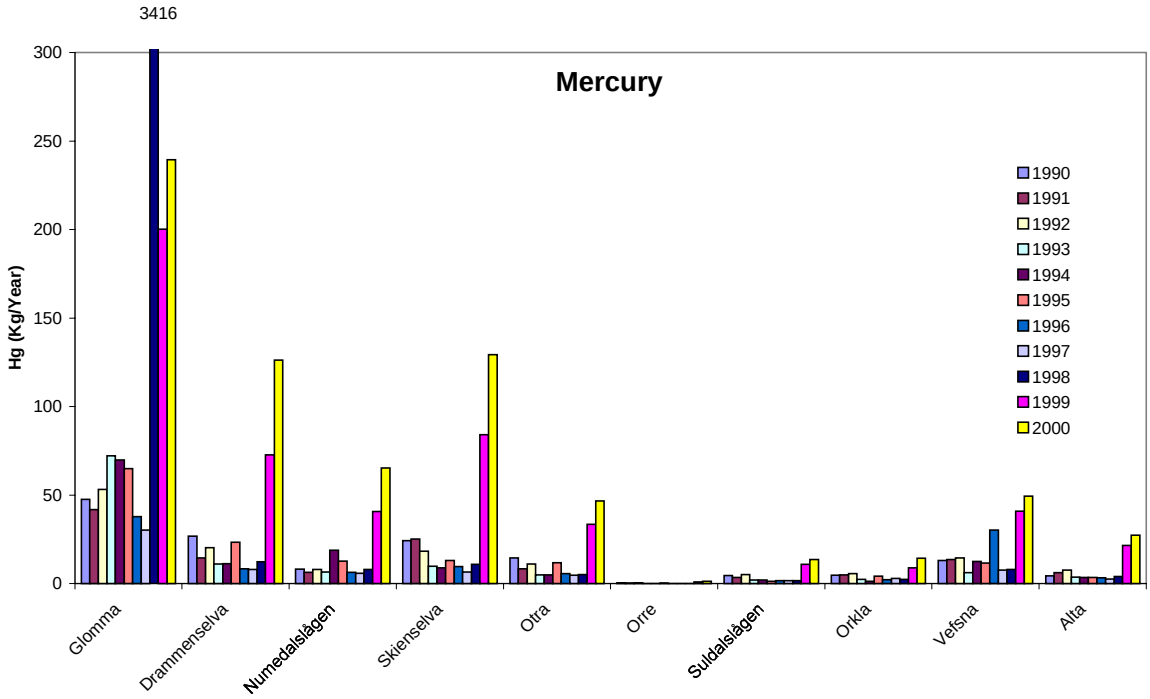
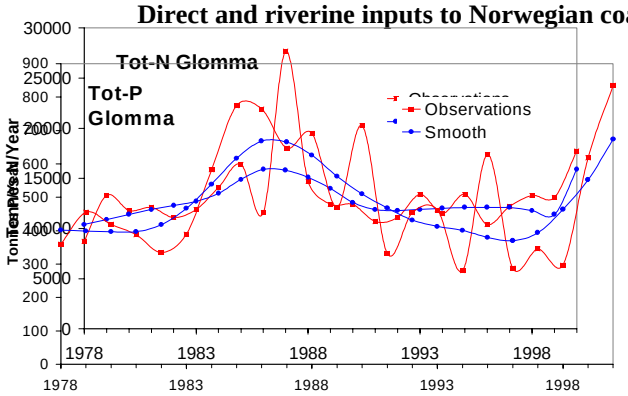


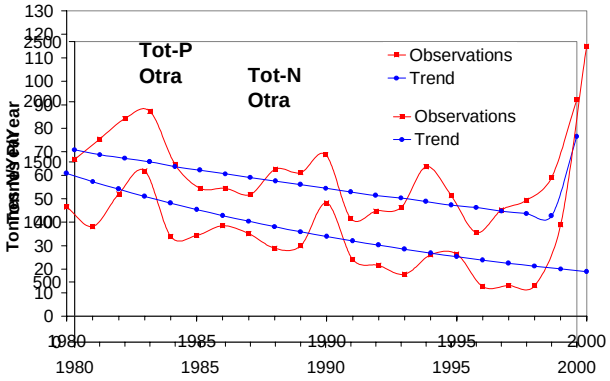
Figure 16. Main rivers. Annual total load of arsenic and mercury in 1990-2000.



On annual basis, statistical trend analysis (by the recommended tool "trend-y-tector" (ICES, 1999)) for nutrients and trace metals have been carried out for the following rivers having the longest time series of continuous data:

- River Glomma (1978-1999): Tot-P and Tot-N
- River Otra (1980-1999): Tot-P and Tot-N
- River Orkla (1974-1999): Cu and Zn

The results are presented in Figure 17.



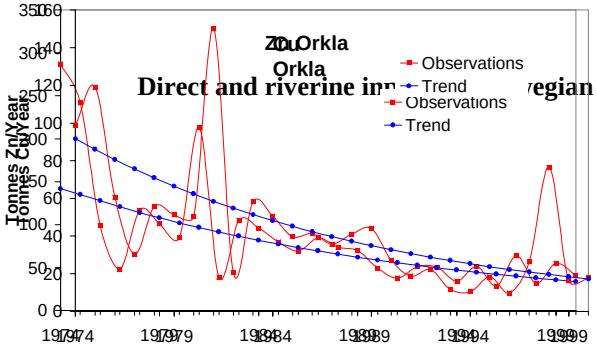


Figure 17. Observations and trends in loads of Tot-P and Tot-N (Glomma, Otra), and Cu and Zn (Orkla).

The trend analyses show significant reductions in the yearly inputs of nutrients to Otra (Tot-P 69%, Tot-N 29%) and significant reductions in the yearly inputs of heavy metals to Orkla (Cu 81%, Zn 76%). For Glomma, the trend is significant neither for Tot-P nor for Tot-N. In 1998 a slight reduction in Tot-P was seen. The large floods, especially in 1987, 1995 and 2000 have, however, complicated the trend analyses. Statistical analyses of phosphorus, lead and other substances are proposed for the future monitoring. Using multivariate analysis on all the results might give more detailed information about input pattern. Statistical analysis of analytical data and runoff data from 1990-2001 data will be available in the annual report for 2001.

4.8. **Mean annual runoff (1931-60, 1961-90) and mean load**

Mean annual runoff for the long term average (LTA) period 1961-90 has been estimated (Figure 2). For most main rivers the mean runoff 1961-90 is lower or at the same level as the 1931-60 period (DNMI, 1993).

Compared to Riverine Inputs to Marine Waters in 1990 - 1999, most calculated mean concentrations were at approximately the same level in 2000. Mercury was at the same level as in 1999 (described in Chapter 4.4). The mean concentrations of silicate were slightly higher in all the main rivers in 2000. The mean concentrations from 1990 to 1999 are presented in Appendix XIII, Report B.

Total flow for most Skagerrak rivers, and accordingly the calculated loads for most of the substances were considerably higher in 2000 than in 1999. Total flow for the other rivers were slightly higher in 2000 than in 1999. (Figure 2, Chapter 3.2).

The mass transport in the watercourses is strongly influenced by annual variations in precipitation/runoff, erosion and human activities in the drainage basins. The transport values may vary considerably from one year to another. These variations are complicating the estimation of "normal transport values" i.e. mass transport in a "normal" year.

During a normal winter the upland area of Norway together with the eastern part of the country show very little runoff. The frozen soil and snowcover protect vegetation and surface soil from erosion. But with the mild winters (1990-1993 and also 1995), especially soil in plowed fields is exposed to more frequent and larger flood erosion also during the winter (i.e. Glomma). As 1997 and 1998 were relatively mild winters compared to 1996, we suppose this is the main reason for somewhat higher concentrations in most rivers.

From experience we have learned that the product of weighted concentrations and mean runoff gives a relatively good estimate of the mass-transport in rivers, especially for the large rivers, and those not considerably exposed to erosion material. The river Suldalslågen is regulated (partly diverted to another catchment area) and has now considerably less annual flow than in the normal period (1931-60).

4.9. Retention of nutrients and micropollutants in fjords

Retention in watercourses is taken into account in the calculation of the Norwegian contribution to marine pollution, but in a conservative way. However, no corrections are so far made for retention in fjords and other marine areas.

Considering the inputs to the open marine waters, one should also take into account retention in fjords, at least in well-defined threshold fjords. As a result of high salinity compared to freshwater, marine waters have better conditions for sedimentation of particles than lakes, e.g. clay settles very poorly in lakes, but more efficient in fjords. The water masses are usually stratified, with light brackish water on top of heavier, saline waters. Thus the overall stratification in fjords is in most cases stronger than in lakes. This implies that particulate pollutants lost to deep waters by sedimentation have less chance to be brought back to the euphotic zone in the sea than in lakes.

In addition, stronger stratification implies greater chance for oxygen depletion in deep waters, which in fact is seen in many sheltered Norwegian fjords. Theoretically this will improve the conditions for denitrification. However, this greater stability is often reduced by rougher physical conditions in fjords compared to lakes.

Retention in Norwegian fjords is very poorly studied by direct budget measurements. In the Drammensfjord, Magnusson and Næss (1986) found that about 60% of the incoming phosphorus was retained in the fjord, while for nitrogen the retention was only about 15%. In the silled Inner Oslofjord preliminary calculations indicate that nitrogen retention is in the order of 30-50% (Baalsrud and Bjerkeng, 1991).

Thus, nutrient retention in threshold fjords seems to be of the similar magnitude as we find in lakes, and it is likely to believe that retention can be estimated from the same type of models that applies to lakes. The general lack of calibration data on retention models in fjords implies that it is too early, at this stage of knowledge, to include this correction in the Norwegian discharge budget. It should be kept in mind, however, that a significant part of the particulate pollutants, and pollutants with particle affinity, end up in fjord sediments and thus are prevented from reaching the coastal waters.

4.10. Leakage from sediments

Leaching of metals, organic micropollutants and nutrients from the marine sediments to the water is not taken into account in the calculations. The measurement of the river inputs includes the metals and lindane in particulate form in the rivers, but not leakage of these substances and other pollutants from previuosly accumulated suspended material in the fjords. Several studies have shown that large amounts of pollutants have been accumulated in some of the Norwegian harbour basins (Winther-Larsen, 1998). Resuspension of particles from the bottom, due to dredging, ship traffic etc. will increase the inputs of pollutants to the coastal water. Oxygen depletion in parts of the year may also cause increased leaching. More attention should be paid to these conditions.

Leaching of micropollutants from landfills located by the coast to the water is also poorly studied. More attention should also be paid to discharge from such landfills.

5. Proposed further activities

5.1. Other discharges

This report includes the discharges of nutrients from the fish farming industry and has shown the importance of such discharges to the total load. Discharge of other substances from the fish farming industry should also be included in the total loads, e.g. copper from copper preparations used in this industry.

Leaching of micropollutants from landfills located by the coast to the water should also be studied and estimated inputs included in the future load calculations.

The sedimentation and exchange of substances between sediments and water should be estimated and included in the future input calculations, concerning both retention in the fjords and leakage from the sediments.

Other local discharges requiring discharge permit by the local environmental authorities should be evaluated, e.g. loads of nitrogen compounds and other pollutants from constructions of roads, tunnels etc. High concentrations of nitrogen (from the explosives) and suspended matter in the drainage water have been found. A more detailed survey of the significance of such categories of discharges should be performed, as a basis for further evaluations of measures.

5.2. New monitoring procedures

Quality assurance procedures applied in the OSPAR framework have been reasonable well developed for monitoring in marine systems, while the procedures for monitoring of riverine input may consider the needs for improving the routines. The RID principles stress quality assurance, and refer to the general quality assurance requirements of OSPAR.

The RID program in Norway follows the RID-principles with regular monthly sampling in the rivers. The relatively low levels of contamination in many of the Norwegian rivers, as well as the OSPAR requirements for detection limits, lead to problems of creating valid data for mercury (Hg) and pesticides (presently: lindane) under Norwegian conditions. The selection of substances covered by RID can be expected to increase or change over time. For the future it seems necessary to prepare a suitable programme for monitoring the POPs (persistent organic pollutants). Following the existing approach may limit the suitability of the programme to document any change in environmental conditions. Today water samples are analysed for nutrients, conductivity, suspended matter, TOC, metals (Cd, Cu, Pb, Zn, Hg, Cr, Ni, As) and lindane (gamma-HCH).

Aquateam was in 1999 and 2000 responsible for the Norwegian OSPAR Riverine Input Project. From 1990-1998 the Norwegian Institute for Water Research (NIVA) was responsible. In 1999, parallel sampling and analyses were performed for all parameters (Appendix XII, Report B). The results illustrated clearly the uncertainty in sampling, analytical results and analytical detection limits. Based on the results it was concluded that in connection with future sampling and quality assurance activities, the following measures are proposed:

- Statistic analysis of phosphorus, lead and other substances. Using multivariate analysis on all the results might give more detailed information of the influence of variations in different input parameters such as temperature, precipitation, flooding in the watershed etc. Statistical analysis of analytical data and runoff data from 1990 to 2001 will be available in the annual report for 2001.
- A systematic program including analysis of several parallel samples from rivers with variable content of particulates. The samples will quantify the uncertainty in calculated river input depending on differences in samples (e.g. particulate matter).
- Round-robin testing of analyses of mercury in low concentrations should be arranged by OSPAR (equal techniques). This is especially important, since the detection limit of Hg is very low, and Hg is considered one of the potentially most important environmental hazards in marine systems.
- Further investigating passive sampling devices for their potential in future monitoring programmes for POPs and low level of heavy metals. Monitoring with passive sampling devices was performed in 2000. Results from this survey are presented in Appendix XV.
- Evaluating other sampling methods for POPs: particle trap, centrifugation, sampling of surface microlayers, etc. A preliminary evaluation of such methods will be included in the annual report for 2001.
- Prioritising POPs to be included in future surveillance programs with possible coordination with the work initiated by DYNAMEC on Risk Assessment for the marine environment. A preliminary evaluation of other substances to be monitored will be included in the annual report for 2001.

6. References

6.1. **Project Personnel**

Jon Fuglestad: Member of the Programme Comittee/Project Manager (SFT-2000)
Mona Weideborg: Member of the Programme Committee/Project Manager (Aquateam)
Eilen Arctander Vik: Member of the Programme Committee (Aquateam)

Project Manager: Mona Weideborg; Aquateam
Quality assurance: Ragnar Storhaug, Aquateam
Responsible for the logistic system: Eilen Arctander Vik
Contact with field workers/laboratory: Mona Weideborg, Hans Thoresen, Aquateam
Care of equipment, shipment of bottles etc.: Anita Fremmerlid, KM Lab Grimstad
Analysis of lindane: Axel Kelley, Aquateam
Analyses of metals: KM Lab Linköping
Other chemical analyses: KM Lab, Grimstad /Analycen, Moss.
External analysis (Intercalibration): Håvard Hovind, NIVA
Data Collection/evaluation: Mona Weideborg, Aquateam
Data Calculations: Pascale Stang, Aquateam
Reporting work: Mona Weideborg, Pascale Stang
Further project activities: Mona Weideborg, Eilen Arctander Vik, Bjarne Paulsrud

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Field workers main rivers:

(1) Glomma:	Mona Weideborg, Aquateam
(2) Drammensevla:	Ingrid Ann Berg, BUVA, Drammen
(3) Numedalslågen:	Ingrid Ann Berg, BUVA, Drammen
(4) Skiensvassdraget:	Ingrid Ann Berg, BUVA, Drammen
(5) Otra:	Magne Aadnevik, Ingeniørvesenet. Kristiansand kommune
(6) Orreelva:	Geir Undheim, Landbrukskontoret,Time kommune.
(7) Suldalslågen:	Øyvind Vårvik, Suldal Elveeigarlag, Suldalsosen
(8) Orkla:	Thor-Ola Svinsås, Vormsund
(9) Vefsna:	Pål Storeng, Teknisk etat. Vefsn kommune,Mosjøen.
(10) Alta:	Petter Nilsen, Finnmarksforskning, Alta

Field workers tributary rivers:

Erlend Tveekrem Lund, Øydegarden
Ingrid Ann Berg, BUVA, Drammen

6.2. Literature

Baalsrud, K. og B. Bjerkeng (1991): Tiltaksanalyse for Indre Oslofjord. Brukerkrav. Siktedyp og oksygen i dyvannet. En enkel lineær modell. NIVA-rapport O-90131 (l.nr. 2524). 79 s.

Ber, E. (2001): Avrenning av næringssaltene fosfor og nitrogen. Notat fra Landbrukspolitisk avdeling. Landbruksdepartementet. 27.08.2001.

Borgvang, A.A. og Tjomsland, T. (2001): Tilførsel av næringssalter til Norges kystområder 2000, beregnet med tilførselsmodellen TEOTIL. SFT rapport under udarbeidelse.

Bloom, N.S. and E.A. Crecelius (1983): Determination of Mercury in Seawater at sub-nanogram per liter levels. Marine Chem. 14, pp. 49- 59.

DNMI (1993): Nedbørnormaler 1961-90. DNMI. Oslo, 63 s.

DNMI (2001a): Nedbørdata fra 2000. DNMI. Oslo (unpublished).

DNMI (2001b): Klimatologisk hurtigoversikt, året 2000. DNMI, Oslo, 09.01.2001.

Holtan, G., Berge, D., Holtan, H. and T. Hopen (1991): Paris Convention. Annual report on direct and riverine inputs to Norwegian coastal waters during the year 1990: A: Principles, results and discussions. SFT-report 452A/91. NIVA-report 0-90001/Serial No.:2582. 43 pages, B: Data report. SFT-report 452B/91. NIVA-report 0-90001/Serial No.: 2577.103 p.

Holtan, G., Berge, D., Holtan, H. and T. Hopen (1992): Paris Convention. Annual report on direct and riverine inputs to Norwegian coastal waters during the year 1991: A: Principles, results and discussions. SFT-report 488A/92. NIVA-report 0-90001/Serial No.:2809. 40 pages, B: Data report. SFT-report 488B/92. NIVA-report 0-90001/Serial No.: 2777. 104 p.

Holtan, G., Berge, D., Holtan, H. and T. Hopen (1993): Annual report on direct and riverine Inputs to Norwegian coastal waters during the year 1992. A. Principles, results and discus sion. B Data report. SFT-report 542/93. NIVA-report O-90001/Serial No.: 2964. 137p.

Holtan, G., Berge, D., Holtan, H. and T. Hopen (1994): Annual report on direct and riverine inputs to Norwegian coastal waters during the year 1993. A. Principles, results and discus sion. B. Data report. SFT-report 580/94. NIVA-report O-90001/Serial No.:3162. 138 p.

Holtan, G., Berge, D., Holtan, H. and T. Hopen (1995). Paris Convention. Annual report on direct and riverine inputs to Norwegian coastal waters during the year 1994. A. Principles, results and discussion. B. Data report. SFT-report 623/95. NIVA-report O-90001/Serial no.: 3361. 136 p.

Holtan, G., Berge, D. Holtan, H. and T. Hopen (1996): Paris Convention. Annual report on direct and riverine inputs to Norwegian coastal waters during the year 1995. A. Principles, results and discussion. B. Data report. SFT-report 674/96. NIVA-report O-90001/Serial no.: 3568-96. 137 p.

Holtan, G., Berge, D., Holtan, H. and T. Hopen (1997): Paris Convention. Annual report on direct and riverine inputs to Norwegian coastal waters during the year 1996. A. Principles, results and discussion. B. Data report. SFT-report 715/97 NIVA-report O-90001/Serial no.: 3740-97. 138 p.

Holtan, G., Berge, D., Holtan, H. and T. Hopen (1998): Oslo and Paris Commissions (OSPAR). Annual report on direct and riverine inputs to Norwegian coastal waters during the year 1997. A. Principles, results and discussion. B. Data report. SFT-report 750/98 NIVA-report O-90001/Serial no.: 3952-98. 139 p.

Holtan, G., Berge, D. and T. Hopen (1999): Oslo and Paris Commissions (OSPAR). Annual report on direct and riverine inputs to Norwegian coastal waters during the year 1998. A. Principles, results and discussion. B. Data report. SFT-report 780/99 NIVA-report O-90001/Serial no.: 4116-99. 140 p.

Holtan, G., Hovind, H., Hopen, T. og B. H. Lauritsen (1999): Kvikksølv i 155 norske elver (1993-1997). En analyseteknisk utfordring. Vann 3b/1999. pp. 656-672.

Holtan, H., Berge, D. and J. Molvær (1990): Retention of nutrients in lakes and rivers with comments on retention in fjords. Paper prepared for PARCOM. NIVA-document 0-90145. 14 s. (unpublished).

Holtan, H. og S.O. Åstebøl (1990): Håndbok i innsamling av data om forurensningstilførsler til vassdrag og fjorder. Revidert utgave. NIVA-Jordforsk 0-89043/0-892301 (l.nr.2501). 53 s.

Holtan, H. og G. Holtan (1996): Flommen på Østlandet mai/juni 1995. Effekter på vannkvaliteten i Glomma og Drammenselva. SFT-rapport 641/96. NIVA-rapport O-90001 (l.nr. 3437-96). 47 s.

Holtan, G. og Hopen, T. (2001): Beregnede P-N-tilførsler fra avløp og industri for 2000 (upublisert).

Ibrekk, H.O., Holtan, H. Berge, D., Gulbrandsen, R. og K. Øren (1991): Nordsjøplan. Vass-drag. NIVA-rapport 0-902302 (l.nr. 2628). 92 s.

ICES (1999): Trend-Y-tector. Data program developed by "ICES working Group on Statistical Aspects of Environmental Monitoring" based on work in OSPAR working group INPUT. Available information on the Internet: http:/waterland.net/rikz/osparwg/trend-y-tector.

Lingsten, L. (1987): Pilot Study on Riverine Inputs to Marine Waters. NIVA- report 0-86201 37 p. (unpublished).

Magnusson, J. og Næs, K. (1986): Basisundersøkelser i Drammensfjorden 1982-84: Delrapport 6: hydrografi, vannkvalitet og vannutskuftning. Overvåkingsrapport nr. 243/86. NIVA-rapport 8000315 (L.nr. 1892).

Nedland, K.T. (2000): Utslipp av tungmetaller og organiske miljøgifter med avløpsvann i 1999. Aquateam-rapport 00-056. O-00203.

Nedland, K.T. (2001): Pers. Comm. Heavy metals in wastewater treament plant effluents 2000

NVE (1987): Avrenningskart over Norge. NVE. Oslo. 8 kartblad.

NVE (1990): Vassdragsregisterets kartbok. V 24. NVE. Oslo.

NVE (2001): Vannføringsdata fra 2000. NVE. Oslo (unpublished).

Nøst, T. and R.H. Daverdin (1999): Kjemisk overvåking av norske vassdrag - Elveserien 1998. NINA. Oppdragsmelding 608. 34 s.

OSPAR (1994). Oslo and Paris Conventions for the Prevention of Marine Pollution. Sixteenth Joint Meeting of the Oslo and Paris Commissions. Karlskrona 13-17 June 1994. OSPAR 16/4/8. 7 p.

OSPAR (1998): Principles of the Comprehensive Study on Riverine Inputs and Direct Dis- charges. Reference Number: Agreement 1998-05. Date of adoption: 1998, Sintra.

OSPAR (1998): OSPAR Strategy with regard to Hazardous Substances. Reference number 1998-16.

OSPAR (2000): Presentation of New Methods for monitoring Hazardous substances in the Aquatic environment, in relation to possible future development of OSPAR Monitoring programme. Presented by Denmark on the INPUT meeting Lisbon 12-21 January 2000. INPUT 00/7/5-E. 5 p.

Parcom (1986): Eighth Meeting of the Paris Commission. Annex 4-6. Madrid 2-4 June 1986.

Parcom (1988): Tenth Meeting of the Paris Commission. PARCOM 10/3/2. Lisbon 15-17 June 1988.

Parcom (1993): Convention for the Prevention of Marine Pollution from Land Based Sources. Fifth Meeting of the Ad hoc Working Group on Input Data. INPUT 5/6/1.

Rosland, D.S. (1998): Trender - transporter av nitrogen og fosfor i jord og vassdrag. Vann 3-98. pp. 334-344.

SFT (1980-1999): The National Monitoring Programme of Water Courses. Monitoring Re-sults.Annual Reports; TA-1980, 1981: TA-580, 1982: TA-588, 1983: TA-597, 1984: TA-607, 1985: TA-622, 1986: TA-628, 1987: TA-639, 1988: TA-629/1989, 1989: TA-711/1990.

SFT (1995): Miljømål for vannforekomstene. Tilførselsberegninger. SFT-rapport 95:02, 70 s.

SFT (1999): Overvåking av langtransportert forurenset luft og nedbør. Årsrapport – Effekter 1998. Rapport nr. 781/99. TA 1680/1999. 249 s.

SFT (2000): Development of HARP Guidelines; Harmonised Quantification and Reporting Procedures for Nutrients. Norwegian Pollution Control Authority Publication No 1759/2000, 179 p.

SFT (2001): Industriutslippstall for 2000 hentet fra INKOSYS (upublisert).

SNV (1991): Kvicksilver i Sverige. Problem och åtgärder. ISBN 91-620-1101-4. 36 s.

SSB (1979, 1980, 1990-2000): Statistical Yearbooks. SSB. Oslo.

SSB (2001): Kommunalt avløp, 2000. Anlegg og hydraulisk kapasitet. Halve Norge renses høygradig. Internet publication from SSB. http://www.ssb.no/emner/01/04/20/avlyd/

Storhaug, R. (2000): Overvåkning av utslippsvann fra tunneler i Oslo-området: T-baneringen, Ris-tunnelen (upublisert)

The County Environmental Agencies: Østfold, Oslo and Akershus, Buskerud,Vestfold, Telemark, Aust-Agder,Vest-Agder, Rogaland, Hordaland, Sogn og Fjordane, Møre og Romsdal, Sør-Trøndelag, Nord- Trøndelag, Nordland, Troms, Finnmark: Chemical data from monitored rivers in 2000.

Tjomsland, T. og H.O. Ibrekk (1992): TEOTIL. Modul for teoretisk beregning av fosfor- og nitrogentilførsler i Norge. NIVA-rapport 0-902301 (l.nr. 2786). 38 s.

Weideborg (1999): Erfaring med passive prøvetakere som hjelpemiddel i overvåkning av organiske miljøgifter og tungmetaller i vann. Presentasjon på Forum for offshore miljøovervåking, SFT, 23. Mars 1999. 3 s.

Weideborg, M. (2000): Should we improve the comprehensive study on riverine inputs and direct discharges? Notat til SFT/innspill til INPUT meeting Lisbon 17-21 January 2000. 5 s.

Weideborg, M., Kelley, A.E., and Vik, E.A. (2001): Experiences from use of passive samplers in monitoring of trace metals and organic pollutants in freshwater bodies. Paper presented at the SIL Congress, Melbourne 04.02 - 09.02, 2001.

Weideborg, M., Vik, E.A., Thorensen, H., Stang, P., Kelley, A.E., and Nedland K.T. (2001): OSPAR commission. Annual report on direct and riverine input to Norwegian water during the year 1999. A: Principles, results and dicussions. B. Data report. Aquateam Report 00-052, 2001.

Welz, B., Melcher, M. Sinerius, H.W. og D. Maier (1984): Picotrace Determination of Mercury, using the Amalgamation Technique. At. Spectrosc. 1984, 5.

Winther-Larsen, T. (1998): Forurensede marine sedimenter. Oversikt over tilstand og prioriteringer. SFT-rapport 98:11.

Wold, T. and F. Paulsen (2000): Vassdrag i Oslo. Datarapport 1999. Rapport 2000-13. Målefunksjonen, Miljøtilsyn, Avløp og miljø. VAV. 47 s.

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OSPAR Commission.

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Summary

This report contains Appendices to the report " Direct and riverine inputs to Norwegian coastal waters - 2000. OSPAR Commission. A: Principles, results and discussions".

The report contains data from the 2000 monitoring of 155 Norwegian rivers and tributaries in accordance with requirements of the Oslo and Paris Commission (OSPAR). Riverborne inputs of the nutrients, suspended particulate matter, total organic carbon, metals (Cd, Hg, Pb, Cu, Zn, Cr, Ni, As) and the pesticide lindane to Norwegian coastal waters are calculated based on concentration and flow data. Runoff from approximately 75% of the mainland areas, and 94 % of the Skagerrak region, has been monitored. Discharges from areas not covered by the river monitoring stations, are estimated by use of specific activity and runoff coefficients.

Key words - English	Key words - Norwegian
Pollution discharges	Forurensningstilførsler
Norwegian coastal waters	Norske kystområder
Riverine inputs	Elvetilførsler
Direct discharges	Direkte tilførsler

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Table I. Total discharge from mainland Norway to convention waters 2000

		Area runoff	Fish farming	Direct dis-charges	Tributary inputs	Main riverine inputs	Grand total	
S.P.M.	*	-	-	1 445 702	408 942	650 988	**2 505 632**	tonnes
	**	-	-	1 445 702	422 929	664 004	**2 532 635**	
TOC	*	-	-	206	291 103	318 176	**609 484**	tonnes
	**	-	-	206	302 291	318 653	**621 149**	
Orthoph.	*	190	818	564	440	409	**2 420**	tonnes
	**	190	818	564	480	431	**2 483**	
Total P	*	778	4 544	1 192	1 640	1 654	**9 807**	tonnes
	**	778	4 544	1 192	1 652	1 674	**9 839**	
Nitrates	*	15 295	-	59	16 788	18 751	**50 893**	tonnes
	**	15 295	-	59	16 800	18 751	**50 905**	
Ammonia	*	1 374	6 866	9 014	2 108	1 894	**21 257**	tonnes
	**	1 374	6 866	9 014	2 197	1 905	**21 356**	
Total N	*	24 066	21 456	15 495	34 431	35 579	**131 027**	tonnes
	**	24 066	21 456	15 495	34 465	35 579	**131 060**	
Silicate SiO2	*	-	-	-	321 135	375 890	**697 025**	tonnes
	**	-	-	-	321 394	375 890	**697 283**	
Arsenic	*	-	-	1.3	15	13	**30**	tonnes
	**	-	-	1.3	17	13	**31**	
Lead	*	-	-	10	27	32	**68**	tonnes
	**	-	-	10	27	32	**68**	
Cadmium	*	-	-	1.7	1.7	1.6	**5.0**	tonnes
	**	-	-	1.7	1.8	1.6	**5.1**	
Copper	*	-	-	34	95	113	**243**	tonnes
	**	-	-	34	95	113	**243**	
Total Cr-T	*	-	-	4.4	37	31	**73**	tonnes
	**	-	-	4.4	39	32	**75**	
Nickel	*	-	-	18	96	61	**175**	tonnes
	**	-	-	18	96	61	**175**	
Zinc	*	-	-	92	350	385	**826**	tonnes
	**	-	-	92	352	385	**829**	
Mercury	*	-	-	98	894	611	**1 603**	kg
	**	-	-	98	1 352	702	**2 151**	
Lindane	*	-	-	-	-	35	**35**	kg
	**	-	-	-	-	36	**36**	

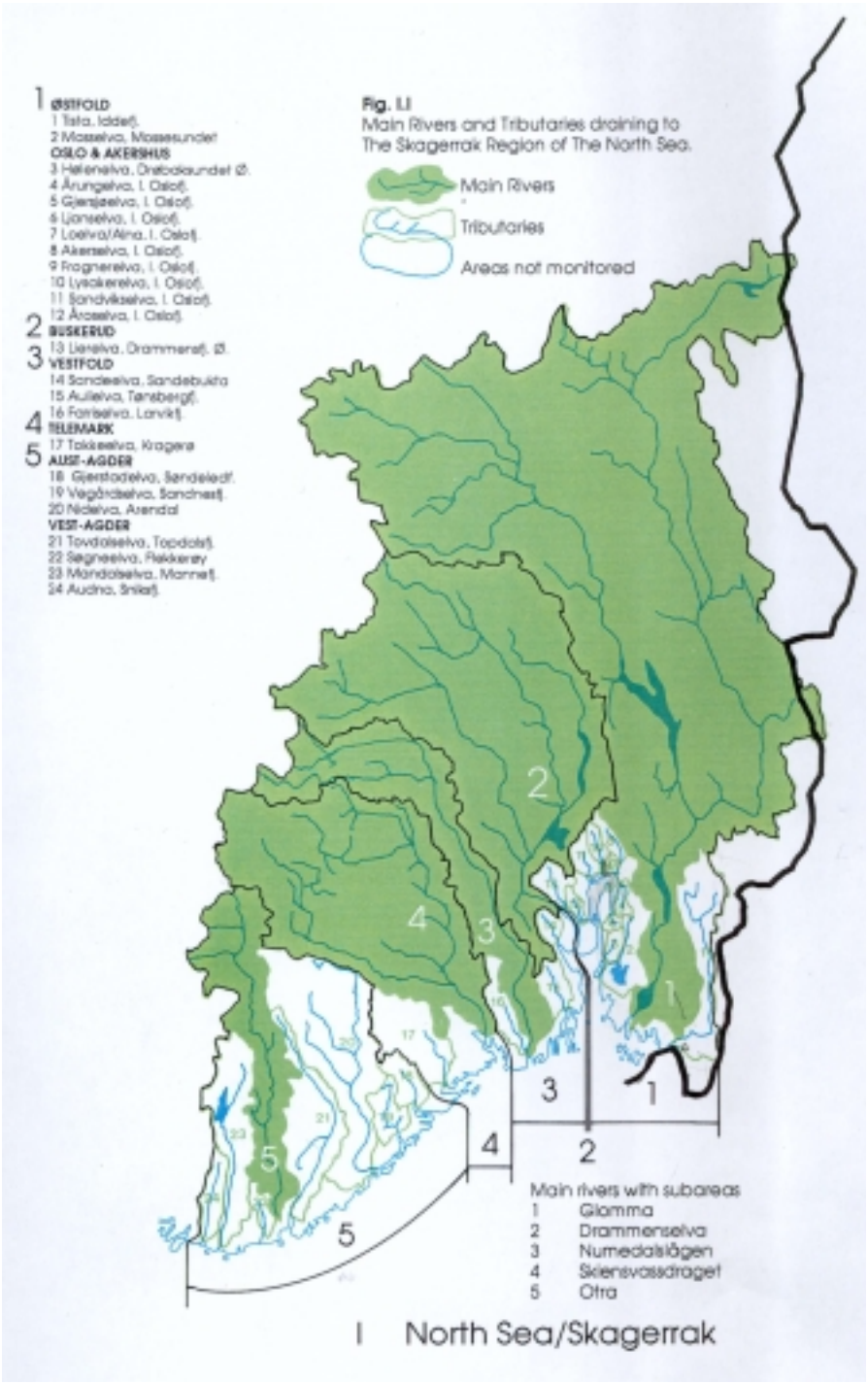
Measurements below detection limits are treated in two ways
*Detection limit = zero
** Detection limit = limit

Table I.I Total discharges to the Skagerrak region 2000 (Figure I.I)

The Skagerrak region with sub-areas: (1) Glomma, (2) Drammenselva, (3) Numedalslågen, (4) Skienselva, (5) Otra.

		Area runoff	Fish farming	Direct dis-charges	Tributary inputs	Main riverine inputs	Grand total	
S.P.M.	*			3 079	38 688	513 062	**554 829**	tonnes
	**			3 079	38 731	516 564	**558 374**	
TOC				29	110 237	286 783	**397 049**	tonnes
Orthoph.	*	18	2.7	77	124	310	**532**	tonnes
	**	18	2.7	77	124	328	**550**	
Total P	*	73	15	211	255	1 471	**2 025**	tonnes
	**	73	15	211	255	1 482	**2 036**	
Nitrates		1 793	-	23	6 418	17 580	**25 814**	tonnes
Ammonia	*	164	23	3 572	463	1 689	**5 911**	tonnes
	**	164	23	3 572	469	1 695	**5 924**	
Total N		2 777	72	5 744	12 507	32 792	**53 892**	tonnes
Silicate SiO2	*			-	47 364	325 462	**372 826**	tonnes
	**			-	47 468	325 462	**372 930**	
Arsenic	*			0.3	6	11	**18**	tonnes
	**			0.3	7	12	**19**	
Lead	*			0.7	11	30	**42**	tonnes
	**			0.7	11	30	**42**	
Cadmium	*			0.07	0.9	1.4	**2.4**	tonnes
	**			0.07	0.9	1.5	**2.4**	
Copper	*			13	27	90	**131**	tonnes
	**			13	27	90	**131**	
Total Cr-T	*			1.26	2	20	**24**	tonnes
	**			1.26	3	21	**25**	
Nickel				3	17	50	**70**	tonnes
Zinc				16	146	330	**492**	tonnes
Mercury	*			23	141	516	**680**	kg
	**			23	193	600	**816**	
Lindane				-	-	33	**33**	kg

Measurements below detection limits are treated in two ways
*Detection limit = zero
** Detection limit = limit


1 ØSTFOLD
1 Tista, Iddefj.
2 Mosselva, Mossesundet
OSLO & AKERSHUS
3 Hølenelva, Drøbaksundet Ø.
4 Årungelva, I. Oslofj.
5 Gjersjøelva, I. Oslofj.
6 Ljanselva, I. Oslofj.
7 Loelva/Alna, I. Oslofj.
8 Akerselva, I. Oslofj.
9 Fragnerelva, I. Oslofj.
10 Lysakerelva, I. Oslofj.
11 Sandvikselva, I. Oslofj.
12 Åroselva, I. Oslofj.
2 BUSKERUD
13 Lierelva, Drammensfj. Ø.
3 VESTFOLD
14 Sandeelva, Sandebukta
15 Aulielva, Tønsbergfj.
16 Fariselva, Larvikfj.
4 TELEMARK
17 Tokkeelva, Kragerø
5 AUST-AGDER
18 Gjerstadelva, Sandeidfj.
19 Vegårdselva, Sandnesfj.
20 Nidelva, Arendal
VEST-AGDER
21 Tovdalselva, Topdalsfj.
22 Søgneelva, Flekkerøy
23 Mandalselva, Mannefj.
24 Audna, Snikefj.
Fig. I.1
Main Rivers and Tributaries draining to
The Skagerrak Region of The North Sea.
Main Rivers
Tributaries
Areas not monitored
Main rivers with subareas
1 Glomma
2 Drammenselva
3 Numedalslågen
4 Skiensvassdraget
5 Otra
I North Sea/Skagerrak

Source: NIVA

Table I.II Total discharges to the remaining North Sea 2000 (Figure I.II)

The remaining North Sea Region with sub-areas: (6) Orreelva, (7) Suldalslågen

		Area runoff	Fish farming	Direct discharges	Tributary inputs	Main riverine inputs	Grand total	
S.P.M.	*			64 712	213 693	2 985	**281 389**	tonnes
	**			64 712	222 240	3 445	**290 396**	
TOC	*			136	38 657	1 751	**40 545**	tonnes
	**			136	44 766	2 228	**47 130**	
Orthoph.	*	51	343	206	87	5	**691**	tonnes
	**	51	343	206	100	6	**705**	
Total P	*	197	1904	427	586	21	**3 135**	tonnes
	**	197	1904	427	595	22	**3 144**	
Nitrates	*	5 835	-	16	6 153	446	**12 450**	tonnes
	**	5 835	-	16	6 155	446	**12 453**	
Ammonia	*	517	2883	2 464	612	13	**6 490**	tonnes
	**	517	2883	2 464	626	13	**6 504**	
Total N		9 281	9011	4 765	11 255	720	**35 032**	tonnes
Silicate SiO2	*			-	74 705	2 553	**77 258**	tonnes
	**			-	74 846	2 553	**77 399**	
Arsenic	*			0.4	7	0.13	**7**	tonnes
	**			0.4	7	0.14	**7**	
Lead	*			4	11	0.12	**15**	tonnes
	**			4	11	0.13	**15**	
Cadmium	*			1.4	0.6	0.02	**2.0**	tonnes
	**			1.4	0.6	0.02	**2.0**	
Copper	*			9.7	23	0.6	**34**	tonnes
	**			9.7	23	0.6	**34**	
Total Cr-T	*			2.1	22	0.1	**24**	tonnes
	**			2.1	22	0.1	**24**	
Nickel	*			13	21	0.4	**34**	tonnes
	**			13	21	0.4	**34**	
Zinc				60	131	3	**195**	tonnes
Mercury	*			61	310	14	**385**	kg
	**			61	376	15	**452**	
Lindane	*			-	-	1.1	**1.1**	kg
	**			-	-	1.1	**1.1**	

Measurements below detection limits are treated in two ways
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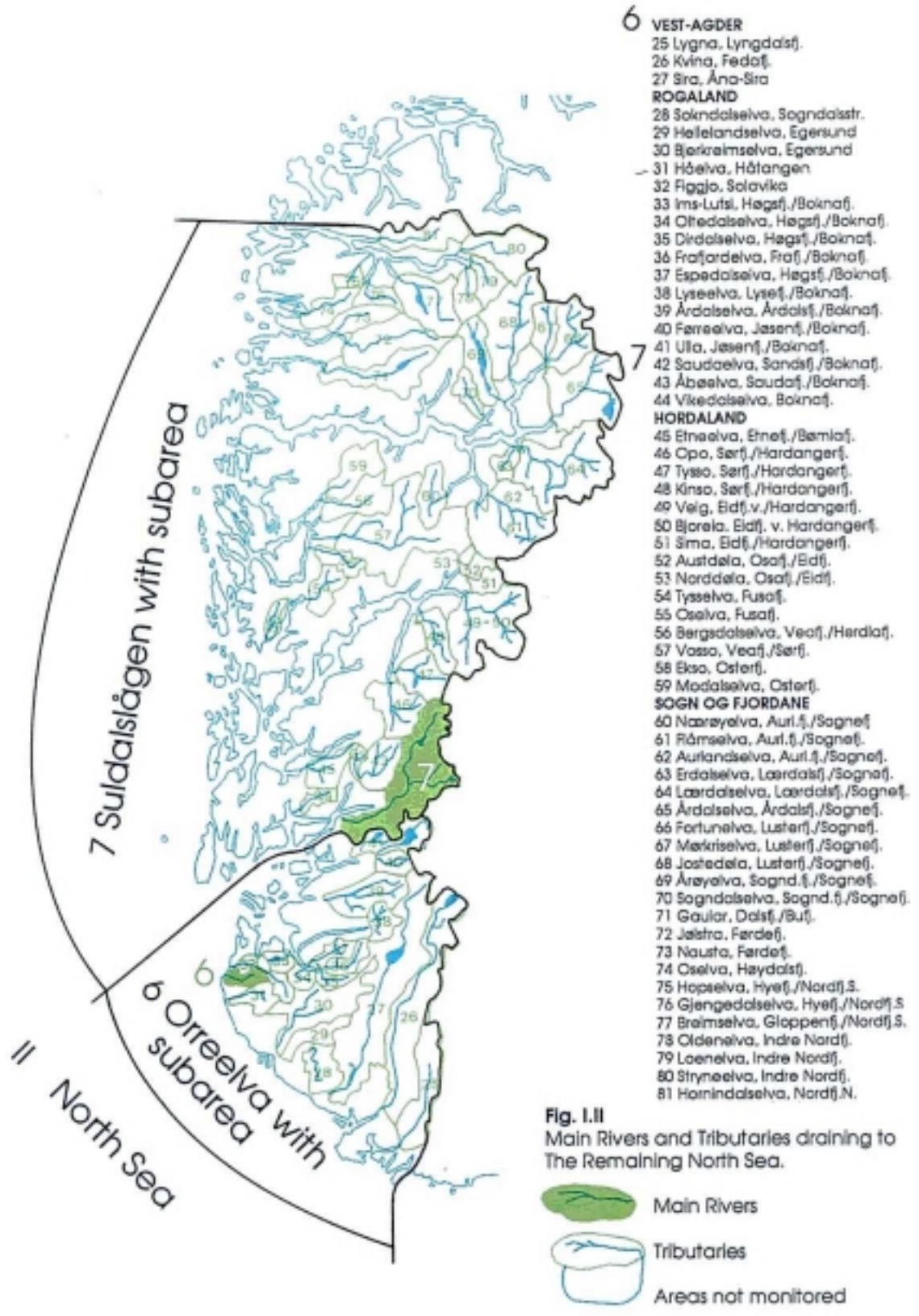


Fig. I.II
Main Rivers and Tributaries draining to The Remaining North Sea.

Source: NIVA

Table I.III Total discharges to the Norwegian Sea 2000 (Figure I.III)

The Norwegian Sea with sub-areas: (8) Orkla, (9) Vefsna

		Area runoff	Fish farming	Direct dis-charges	Tributary inputs	Main riverine inputs	Grand total	
S.P.M.	*			1 151 398	136 607	35 785	**1 323 789**	tonnes
	**			1 151 398	137 724	44 560	**1 333 683**	
TOC	*			40	91 899	14 814	**106 753**	tonnes
	**			40	95 869	14 814	**110 723**	
Orthoph.	*	103	448	256	181	32	**1 020**	tonnes
	**	103	448	256	199	36	**1 042**	
Total P	*	419	2488	512	631	57	**4 107**	tonnes
	**	419	2488	512	634	66	**4 119**	
Nitrates	*	6 652	-	18	3 376	547	**10 593**	tonnes
	**	6 652	-	18	3 385	547	**10 603**	
Ammonia	*	607	3752	2 730	657	87	**7 834**	tonnes
	**	607	3752	2 730	726	91	**7 906**	
Total N	*	10 327	11725	4 654	6 131	1 305	**34 142**	tonnes
	**	10 327	11725	4 654	6 165	1 305	**34 176**	
Silicate SiO2				-	94 387	15 626	**110 013**	tonnes
Arsenic	*			0.6	1.4	1	**3**	tonnes
	**			0.6	2.1	1	**4**	
Lead	*			5	4	1	**10**	tonnes
	**			5	4	1	**10**	
Cadmium	*			0.2	0.2	0.1	**0.5**	tonnes
	**			0.2	0.2	0.1	**0.5**	
Copper	*			11	35	20	**67**	tonnes
	**			11	35	20	**67**	
Total Cr-T	*			1.0	11	3	**14**	tonnes
	**			1.0	11	3	**15**	
Nickel	*			1.8	26	5	**33**	tonnes
	**			1.8	26	5	**33**	
Zinc	*			16	67	48	**130**	tonnes
	**			16	68	48	**132**	
Mercury	*			13.4	206	53	**272**	kg
	**			13.4	451	57	**521**	
Lindane	*			-	-	1	**1**	kg
	**			-	-	1	**1**	

Measurements below detection limits are treated in two ways
*Detection limit = zero
** Detection limit = limit

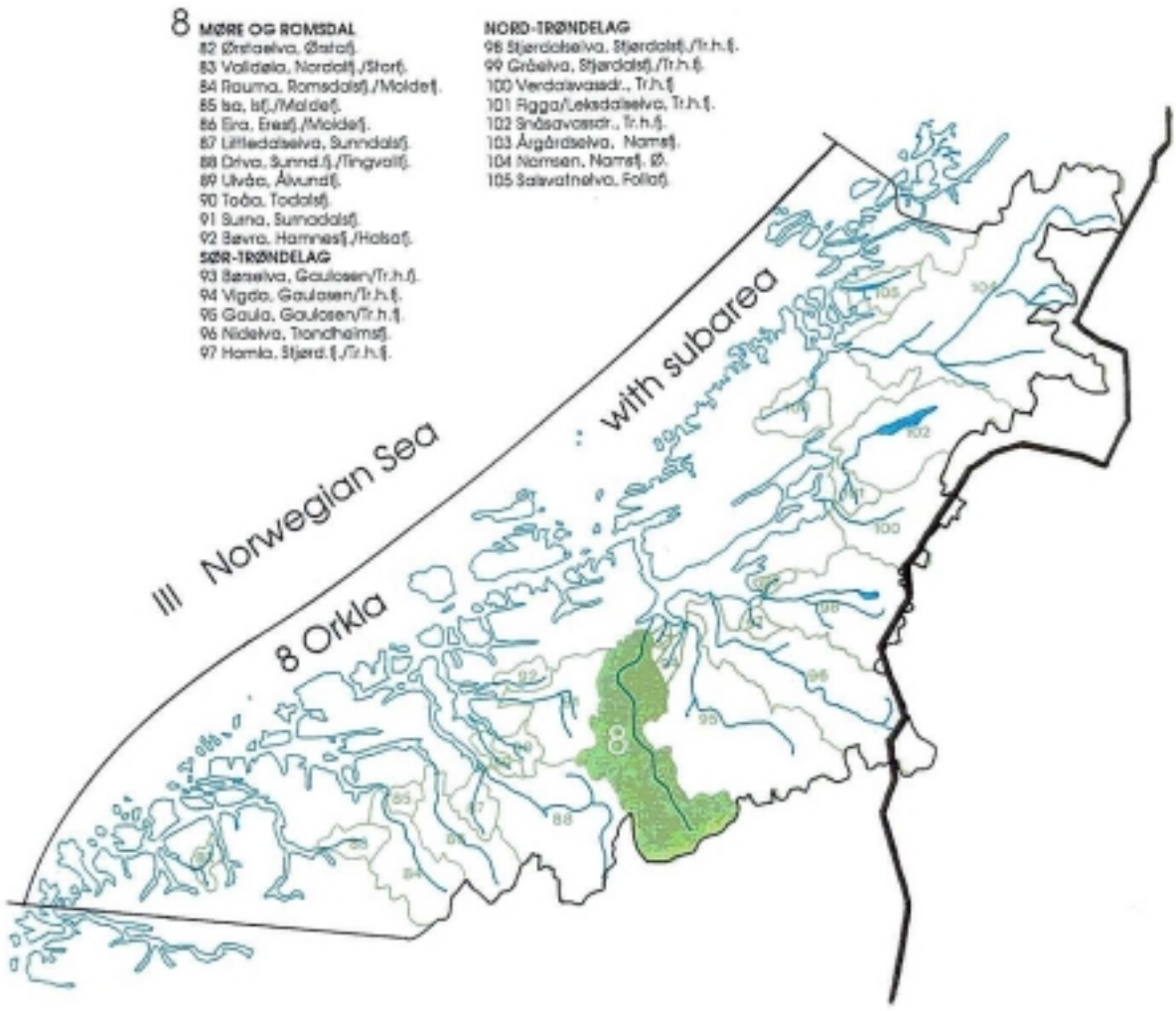


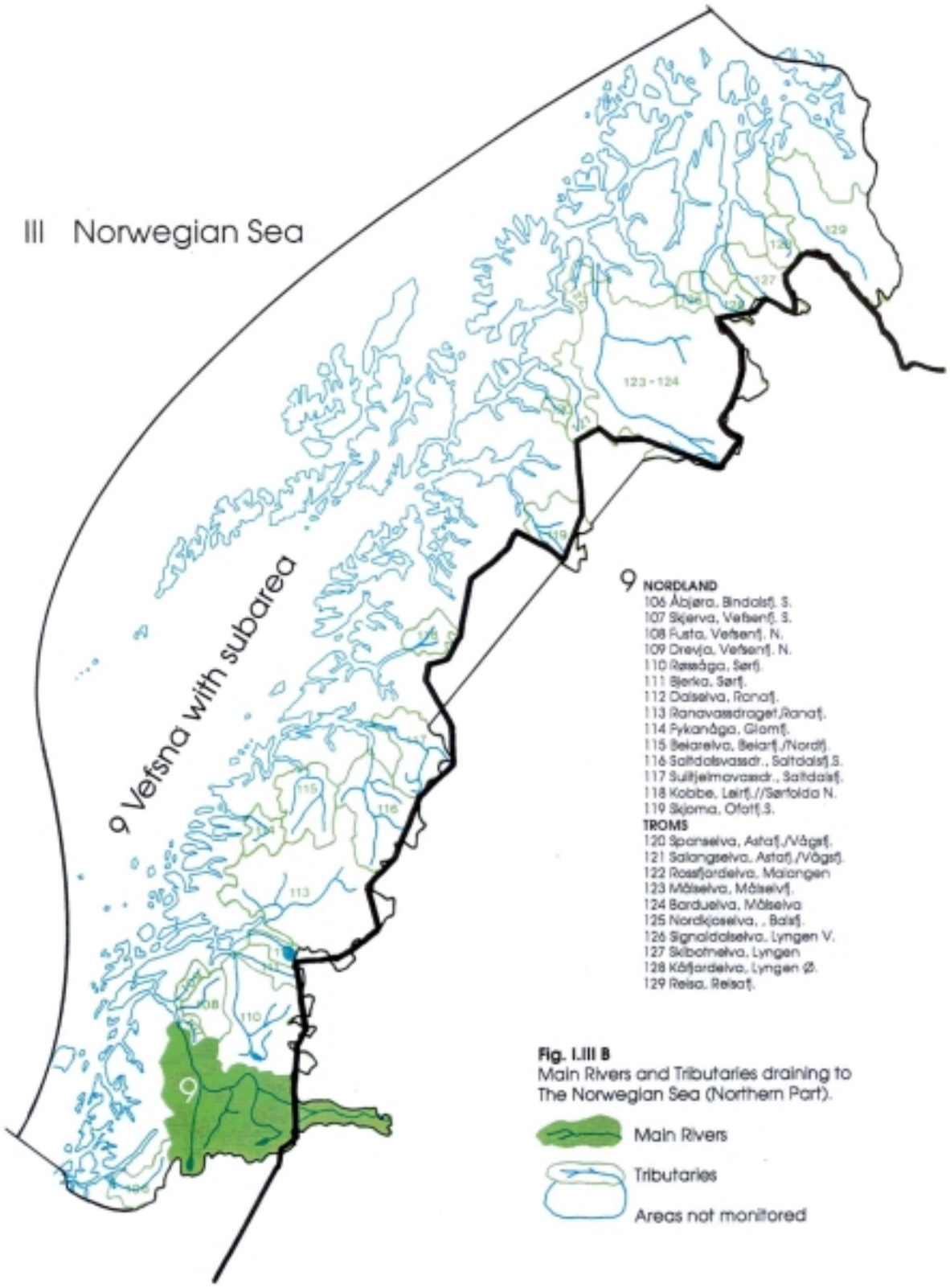
Fig. I.III A
Main Rivers and Tributaries draining to The Norwegian Sea (Southern Part).

Main Rivers

Tributaries

Areas not monitored

Source: NIVA


III Norwegian Sea
9 Vefsna with subarea
9 NORDLAND
106 Åbjøra, Bindalsf. S.
107 Skjerva, Vefsenf. S.
108 Fusta, Vefsenf. N.
109 Drevja, Vefsenf. N.
110 Rasåga, Sørf.
111 Bjerka, Sørf.
112 Dalselva, Ranaf.
113 Ranavassdraget/Ranaf.
114 Pykanåga, Glomf.
115 Beiarelva, Beiarf./Nordf.
116 Saltdalsvassdr., Saltdalsf.S.
117 Sulitjelmavassdr., Saltdalsf.
118 Kobbe, Leirf.//Sørfolda N.
119 Skjoma, Ofotf.S.
TROMS
120 Spanselva, Astaf./Vågsf.
121 Salangselva, Astaf./Vågsf.
122 Rossfjordelva, Malangen
123 Målselva, Målselvf.
124 Bardselva, Målselva
125 Nordkjoselva, , Balsf.
126 Signaldalselva, Lyngen V.
127 Skibotnelva, Lyngen
128 Kåfjordelva, Lyngen Ø.
129 Reisa, Reisaf.
Fig. I.III B
Main Rivers and Tributaries draining to The Norwegian Sea (Northern Part).
Main Rivers
Tributaries
Areas not monitored

Source: NIVA

Table I.IV Total discharges to the Barents Sea 2000 (Figure I.IV)

The Barents Sea with sub-area: (10) Alta

		Area runoff	Fish farming	Direct discharges	Tributary inputs	Main riverine inputs	Grand total	
S.P.M.	*			226 513	19 955	99 156	**345 624**	tonnes
	**			226 513	24 234	99 435	**350 183**	
TOC	*			-	50 310	14 827	**65 138**	tonnes
	**			-	51 419	14 827	**66 247**	
Orthoph.	*	18	25	25	47	62	**177**	tonnes
	**	18	25	25	56	62	**186**	
Total P		88	137	43	168	105	**540**	tonnes
Nitrates		1 015	-	2	841	177	**2 035**	tonnes
Ammonia		85	208	248	376	106	**1 022**	tonnes
Total N		1 681	649	332	4 537	762	**7 961**	tonnes
Silicate SiO2	*			-	104 680	32 249	**136 929**	tonnes
	**			-	104 693	32 249	**136 942**	
Arsenic	*			-	1.2	0.8	**1.9**	tonnes
	**			-	1.2	0.8	**2.0**	
Lead	*			0.03	0.3	0.7	**1.1**	tonnes
	**			0.03	0.4	0.7	**1.2**	
Cadmium	*			0.002	0.04	0.03	**0.07**	tonnes
	**			0.002	0.04	0.03	**0.07**	
Copper	*			0.49	9	2	**12**	tonnes
	**			0.49	9	2	**12**	
Total Cr-T	*			0.06	3	8	**11**	tonnes
	**			0.06	3	8	**11**	
Nickel	*			0.06	32	6	**38**	tonnes
	**			0.06	32	6	**38**	
Zinc	*			0.76	5	4	**10**	tonnes
	**			0.76	6	4	**11**	
Mercury	*			1.2	237	28	**266**	kg
	**			1.2	331	30	**362**	
Lindane	*			-	-	0.3	**0.3**	kg
	**			-	-	0.5	**0.5**	

Measurements below detection limits are treated in two ways
*Detection limit = zero
** Detection limit = limit

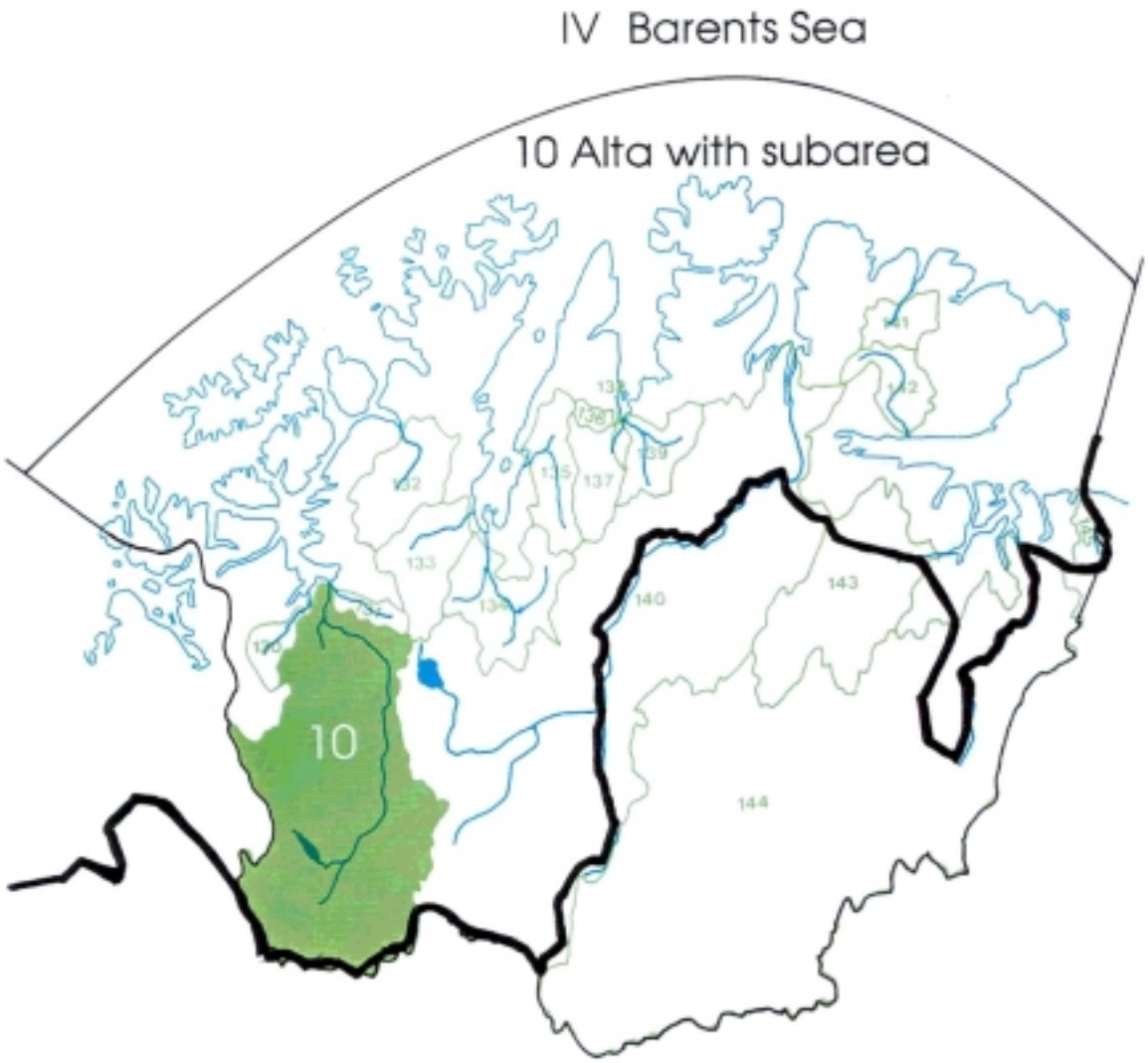


Fig. I.IV
Main Rivers and Tributaries draining to The Barents Sea.

Main Rivers

Tributaries

Areas not monitored

10 FINNMARK
130 Mattiselva, Kåfj./Altafj.
131 Tverrelva, Altafj.
132 Repparfjordelva, Repparf.
133 Stabburselva, I. Porsangen V.
134 Lakselva, I. Porsangen S.
135 Børselva, I. Porsangen Ø.
136 Mattusjåkka, I. Laksefj. V.
137 Storelva, I. Laksefj. V.
138 Soussjåkka, I. Laksefj. V.
139 Adamselva, I. Laksefj. Ø.
140 Tanavassdr., Tanaf. S.
141 Vesterelva, Syltefj.
142 V. Jakobselv, Y. Varangerf.
143 Neiden Munkf./Varangerf.
144 Passvikelva, Bøkf./Varangerf.
145 Grense Jakobselv, Varangerf.

Source: NIVA

Appendix II. Sewage effluents from downstream areas of main and tributary rivers and rivers not monitored 2000

Table II	Sewage effluents from down stream areas of mainland Norway to convention waters 2000
Table II.I	Sewage effluents to the Skagerrak region
Table II.II	Sewage effluents to the remaining North Sea
Table II.III	Sewage effluents to the Norwegian Sea
Table II.IV	Sewage effluents to the Barents Sea

Table II Sewage effluents from down stream areas of mainland Norway to convention waters 2000

Total quantity of substance discharge per year:

	I The Skagerrak Region	II The North Sea	III The Norwegian Sea	IV The Barents Sea	Sum	
S.P.M.						
TOC						
PO4-P	77	206	256	25	**564**	tonnes
Tot-P	128	343	426	42	**939**	tonnes
NO3-N	23	16	18	2	**59**	tonnes
NH4-N	3 572	2 464	2 730	248	**9 014**	tonnes
Tot-N	4 509	3 285	3 640	330	**11 764**	tonnes
SiO_2						
As						
Pb	612	742	435	33	**1 822**	kg
Cd	58	70	31	2	**161**	kg
Cu	7 266	8 877	6 202	494	**22 839**	kg
Cr	1 247	1 502	796	59	**3 604**	kg
Ni	1 886	2 244	921	62	**5 113**	kg
Zn	15 203	18 361	10 078	758	**44 400**	kg
Hg	21	26	13	1	**61**	kg
g-HCH						

Table II.I Sewage effluents to the Skagerrak Region 2000

Total quantity of substance discharge per year:

The Skagerrak region with sub-areas: (1) Glomma, (2) Drammenselva, (3) Numedalslågen, (4) Skienselva, (5) Otra.

	1	2	3	4	5	
S.P.M.						
TOC						
PO4-P	38	3.8	13	2.7	20	tonnes
Tot-P	64	6.4	21	4.5	33	tonnes
NO3-N	13	1.9	3.2	1.4	3.0	tonnes
NH4-N	2 144	284	475	217	452	tonnes
Tot-N	2 604	379	634	290	602	tonnes
SiO_2						
As						
Pb	373	35	96	43	64	kg
Cd	36	3.4	8.9	4.1	5.6	kg
Cu	4 360	413	1 174	501	818	kg
Cr	767	73	194	87	126	kg
Ni	1 180	111	286	133	176	kg
Zn	9 327	882	2 375	1 060	1 559	kg
Hg	12.8	1.3	3.1	1.5	2.2	kg
g-HCH						

Table II.II Sewage effluents to the remaining North Sea 2000

Total quantity of substance discharge per year:

The remaining North Sea Region with sub-areas: (6) Orreelva, (7) Suldalslågen

	6	7	
S.P.M.			
TOC			
PO4-P	36	170	tonnes
Tot-P	60	283	tonnes
NO3-N	4	12	tonnes
NH4-N	660	1 804	tonnes
Tot-N	880	2 405	tonnes
SiO_2			
As			
Pb	612	130	kg
Cd	58	11	kg
Cu	7226	1651	kg
Cr	1246	256	kg
Ni	1886	358	kg
Zn	15204	3157	kg
Hg	21	5	kg
g-HCH			

Table II.III Sewage effluents to the Norwegian Sea 2000

Total quantity of substance discharge per year:

The Norwegian Sea with sub-areas: (8) Orkla, (9) Vefsna

	8	9	
S.P.M.			
TOC			
PO4-P	144	112	tonnes
Tot-P	239	187	tonnes
NO3-N	11	7	tonnes
NH4-N	1 624	1 106	tonnes
Tot-N	2 165	1 475	tonnes
SiO_2			
As			
Pb	268	167	kg
Cd	19	12	kg
Cu	3797	2405	kg
Cr	493	303	kg
Ni	579	342	kg
Zn	6232	3846	kg
Hg	8	5	kg
g-HCH			

Table II.IV Sewage effluents to the Barents Sea 2000

Total quantity of substance discharge per year:

The Barents Sea with sub-area: (10) Alta

	10	
S.P.M.		
TOC		
PO4-P	25	tonnes
Tot-P	42	tonnes
NO3-N	1.7	tonnes
NH4-N	248	tonnes
Tot-N	330	tonnes
SiO_2		
As		
Pb	33	kg
Cd	2.2	kg
Cu	494	kg
Cr	59	kg
Ni	62	kg
Zn	758	kg
Hg	1.2	kg
g-HCH		

Appendix III. Industrial effluents from downstream areas of main and tributary rivers and rivers not monitored 2000

Table III	Industrial effluents from down stream areas of mainland Norway to convention waters 2000
Table III.I	Industrial effluents to the Skagerrak region
Table III.II	Industrial effluents to the remaining North Sea
Table III.III	Industrial effluents to the Norwegian Sea
Table III.IV	Industrial effluents to the Barents Sea

Table III Industrial effluents from down stream areas of mainland Norway to convention waters 2000

Total quantity of substance discharged per year:

	I The Skagerrak Region	II The North Sea	III The Norwegian Sea	IV The Barents Sea	Sum	
SS	3 079	64 712	1 151 398	226 513	**1 445 702**	tonnes
TOC	29	136	40	-	**206**	tonnes
PO4-P	-	-	-	-	**-**	
Tot-P	82	84	86	1	**253**	tonnes
NO3-N	-	-	-	-	**-**	
NO4-N	-	-	-	-	**-**	
Tot-N	1 235	1 480	1 014	2	**3 731**	tonnes
SiO2	-	-	-	-	**-**	
As	321	357	573	-	**1 251**	kg
Pb	113	2 925	4 800	-	**7 838**	kg
Cd	9	1 364	142	-	**1 514**	kg
Cu	5 815	780	4 978	-	**11 573**	kg
Cr-tot	13	570	166	-	**750**	kg
Ni	1 540	10 556	891	-	**12 987**	kg
Zn	729	41 704	5 427	-	**47 861**	kg
Hg	2.0	35.2	0.5	-	**38**	kg

Table III.I Industrial effluents to the Skagerrak Region 2000

The Skagerrak Region with sub-areas: (1) Glomma, (2) Drammenselva, (3) Numedalslågen, (4) Skienselva, (5) Otra

Total quantity of substance discharged per year:

	1	2	3	4	5	
SS	796	139	1515	442	188	tonnes
TOC	0.6	0	16.1	12.2	0	tonnes
PO4-P						
Tot-P	29	20.871	17.8	13	2.1	tonnes
NO3-N						
NO4-N						
Tot-N	204	89	96	841	3.7	tonnes
SiO2						
As	0	0.25	0	50	270	kg
Pb	56	0.23	29	0.4	28	kg
Cd	1.8	0.012	5.01	1.5	0.37	kg
Cu	4853	0.05	3.1	54	904	kg
Cr-tot	1.6	1.2	2.7	0	7.2	kg
Ni	271	0.07	243	64	961	kg
Zn	575	1.1	39	2.7	112	kg
Hg	1.5	0.001	0.05	0.4	0.008	kg

Table III.II Industrial Effluents to The remaining North Sea 2000

The remaining North Sea Region with sub-areas: (6) Orreelva, (7) Suldalslågen

Total quantity of substance discharged per year:

	6	7	
SS	1564	63148	tonnes
TOC	47	89	tonnes
PO4-P			
Tot-P	5.1	79	tonnes
NO3-N			
NO4-N			
Tot-N	54	1425	tonnes
SiO2			
As	1.4	356	kg
Pb	1.0	2924	kg
Cd	1.2	1363	kg
Cu	115	665	kg
Cr-tot	7.8	563	kg
Ni	7240	3316	kg
Zn	633	41071	kg
Hg	0.003	35	kg

Table III.III Industrial Effluents to The Norwegian Sea 2000

The Norwegian Sea Region with sub-areas: (8) Orkla, (9) Vefsna

Total quantity of substance discharged per year:

	8	9	
SS	559621	591777	tonnes
TOC	40	0.45	tonnes
PO4-P			
Tot-P	51	35	tonnes
NO3-N			
NO4-N			
Tot-N	428	586	tonnes
SiO2			
As	0.08	573	kg
Pb	1367	3433	kg
Cd	88	54	kg
Cu	369	4609	kg
Cr-tot	3.3	163	kg
Ni	42	849	kg
Zn	430	4998	kg
Hg	0.0014	0.473	kg

Table III.IV Industrial Effluents to The Barents Sea 2000

The Barents Sea Region with sub-area: (10) Alta

Total quantity of substance discharged per year:

	10	
SS	226513	tonnes
TOC		
PO4-P		
Tot-P	0.55	tonnes
NO3-N		
NO4-N		
Tot-N	1.99	tonnes
SiO2		
As		
Pb		
Cd		
Cu		
Cr-tot		
Ni		
Zn		
Hg		

Appendix IV. Main riverine inputs 2000

Table IV.I	Main riverine inputs 2000.	(1) Glomma
Table IV.II	Main riverine inputs 2000.	(2) Drammenselva
Table IV.III	Main riverine inputs 2000.	(3) Numedalslågen
Table IV.IV	Main riverine inputs 2000.	(4) Skienselva
Table IV.V	Main riverine inputs 2000.	(5) Otra
Table IV.VI	Main riverine inputs 2000.	(6) Orreelva
Table IV.VII	Main riverine inputs 2000.	(7) Suldalslågen
Table IV.VIII	Main riverine inputs 2000.	(8) Orkla
Table IV.IX	Main riverine inputs 2000.	(9) Vefsna
Table IV.X	Main riverine inputs 2000.	(10) Alta

Table IV.I Main riverine inputs 2000 (1) Glomma

Total volume: 85 576 496 m^3/d **Long term average flow (LTA):** 60 324 000 m^3/d
Minimum flow: 24 335 653 m^3/d **LTA period:** 1961 to 1990
Maximum flow: 198 047 968 m^3/d

		Mean	Number of measure-ments	Minimum concentration during the year	Maximum concentration during the year	Total quantity of substance discharge each year	Where 70% of the measurement above limit of detection?
S.P.M.		9.48	17	1.5	64.9 mg/l	264494 tonnes	yes
TOC		4.68	18	2.69	7.6 mg/l	153936 tonnes	yes
Orthoph.		7.04	18	1	19 µg/l	196 tonnes	yes
Total P		24	18	8	114 µg/l	835 tonnes	yes
Nitrates		326	18	162	661 µg/l	9374 tonnes	yes
Ammonia		32	18	13	85 µg/l	929 tonnes	yes
Total N		619	18	326	1310 µg/l	17731 tonnes	yes
SiO2		5.00	18	1.44	15.64 mg/l	193645 tonnes	yes
Arsenic	*	0.16	18	0	0.29 µg/l	5.4 tonnes	yes
	**	0.17	–	<0.02	– µg/l	5.4 tonnes	–
Lead	*	0.35	18	0	1.48 µg/l	12 tonnes	yes
	**	0.37	–	<0.01	– µg/l	12 tonnes	–
Cadmium	*	0.017	18	0	0.041 µg/l	0.54 tonnes	yes
	**	0.017	–	0.004	– µg/l	0.60 tonnes	–
Copper		1.85	18	0.2	3.6 µg/l	53 tonnes	yes
Total Cr-T	*	0.26	18	0	1.1 µg/l	10 tonnes	no
	**	0.42	–	<0.01	– µg/l	10 tonnes	–
Nickel		0.90	18	0.32	2.47 µg/l	29 tonnes	yes
Zinc		4.11	18	1.2	8.8 µg/l	138 tonnes	yes
Mercury	*	7.7	18	0	11 ng/l	200 kg	yes
	**	8.2	–	5	– ng/l	235 kg	–
Lindane		0.35	4	0.27	0.47 ng/l	11 kg	yes

Measurements below detection limits are treated in two ways
* Detection limit = zero
** Detection limit = limit

Table IV.IIMain riverine inputs 2000 (2) Drammenselva

Total volume: 37 565 115 m^3/d **Long term average flow (LTA): 26 743 000 m^3/d**
Minimum flow: 14 510 152 m^3/d **LTA period: 1961 to 1990**
Maximum flow: 110 203 685 m^3/d

		Mean	Number of measurements	Minimum concentration during the year	Maximum concentration during the year	Total quantity of substance discharge each year		Where 70% of the measurement above limit of detection?
S.P.M.	*	3.45	19	0	28.5 mg/l	78307	tonnes	yes
	**	3.71	–	<0.5	– mg/l	79594	tonnes	–
TOC		3.36	19	2.33	6.4 mg/l	50460	tonnes	yes
Orthoph.	*	2.77	19	0	8 µg/l	33	tonnes	yes
	**	3.02	–	1	– µg/l	40	tonnes	–
Total P		12	18	3.6	50 µg/l	187	tonnes	yes
Nitrates		244	19	58	361 µg/l	3348	tonnes	yes
Ammonia	*	26	18	0	41 µg/l	316	tonnes	yes
	**	27	–	<2	– µg/l	320	tonnes	–
Total N		468	19	351	677 µg/l	6212	tonnes	yes
SiO_2		3.23	19	2.36	6.00 mg/l	47278	tonnes	yes
Arsenic	*	0.14	19	0	0.33 µg/l	1.8	tonnes	yes
	**	0.16	–	<0.02	– µg/l	1.9	tonnes	–
Lead	*	0.19	19	0	1.32 µg/l	4	tonnes	yes
	**	0.20	–	<0.01	– µg/l	4	tonnes	–
Cadmium	*	0.022	19	0	0.16 µg/l	0.29	tonnes	yes
	**	0.023	–	<0.001	– µg/l	0.29	tonnes	–
Copper		1.00	19	0.15	2.41 µg/l	15	tonnes	yes
Total Cr-T	*	0.19	19	0	0.46 µg/l	2	tonnes	yes
	**	0.24	–	<0.01	– µg/l	2	tonnes	–
Nickel		0.54	19	0.27	1.26 µg/l	8	tonnes	yes
Zinc		4.36	19	1.59	28 µg/l	53	tonnes	yes
Mercury	*	9.2	19	0	25 ng/l	99	kg	yes
	**	9.7	–	5	– ng/l	115	kg	–
Lindane		0.41	3	0.32	0.58 ng/l	5	kg	yes

Measurements below detection limits are treated in two ways
* Detection limit = zero
** Detection limit = limit

Table IV.III Main riverine inputs 2000 (3) Numedalslågen

Total volume: **14 428 801 m^3/d** **Long term average flow (LTA):** **10 082 000 m^3/d**
Minimum flow: **5 035 443 m^3/d** **LTA period:** **1961 to 1990**
Maximum flow: **69 378 028 m^3/d**

		Mean	Number of measure-ments	Minimum concentration during the year	Maximum concentration during the year	Total quantity of substance discharge each year	Where 70% of the measurement above limit of detection?
S.P.M.	*	9.11	12	0	53.4 mg/l	104651 tonnes	yes
	**	9.75	–	1.40	– mg/l	104944 tonnes	–
TOC		4.30	12	2.09	8.6 mg/l	29242 tonnes	yes
Orthoph.	*	4.65	12	0	14 µg/l	26.7 tonnes	yes
	**	4.91	–	<1.8	– µg/l	27.1 tonnes	–
Total P		23	12	5.1	131 µg/l	256 tonnes	yes
Nitrates		235	12	77	655 µg/l	1488 tonnes	yes
Ammonia		27	12	14	42 µg/l	144 tonnes	yes
Total N		443	12	80	918 µg/l	2805 tonnes	yes
SiO_2		4.25	12	2.14	10.50 mg/l	31006 tonnes	yes
Arsenic	*	0.22	12	0	0.81 µg/l	1.83 tonnes	yes
	**	0.24	–	<0.02	– µg/l	1.84 tonnes	–
Lead	*	0.58	12	0	4.65 µg/l	8.1 tonnes	yes
	**	0.63	–	<0.01	– µg/l	8.1 tonnes	–
Cadmium		0.021	12	0.002	0.087 µg/l	0.20 tonnes	yes
Copper		0.97	12	0.22	3.80 µg/l	9 tonnes	yes
Total Cr-T	*	0.30	12	0	1.10 µg/l	2.62 tonnes	yes
	**	0.33	–	<0.01	– µg/l	2.62 tonnes	–
Nickel		0.50	12	0.18	1.63 µg/l	4.21 tonnes	yes
Zinc		5.47	12	2.28	22.1 µg/l	51 tonnes	yes
Mercury	*	12.4	12	0	23 ng/l	78 kg	yes
	**	13.1	–	<5	– ng/l	79 kg	–
Lindane	*	0.55	4	0	1.32 ng/l	5.2 kg	yes
	**	0.69	–	<0.1	– ng/l	5.3 kg	–

Measurements below detection limits are treated in two ways
* Detection limit = zero
** Detection limit = limit

Table IV.IV Main riverine inputs 2000 (4) Skienselva

Total volum: **34 847 144 m3/d** **Long term average flow (LTA):** **22 611 000 m3/d**
Minimum flow: **13 139 712 m3/d** **LTA period:** **1961 to 1990**
Maximun flow: **95 558 400 m3/d**

		Mean	Number of measure-ments	Minimum concentration during the year	Maximum concentration during the year	Total quantity of substance discharge each year	Where 70% of the measurement above limit of detection?
S.P.M.	*	2.18	12	0	9.3 mg/l	42231 tonnes	yes
	**	2.36	–	0.5	– mg/l	44007 tonnes	–
TOC		2.46	12	1.8	3.6 mg/l	33696 tonnes	yes
Orthoph.	*	2.52	12	0	5 µg/l	30 tonnes	no
	**	2.88	–	1	– µg/l	35 tonnes	–
Total P	*	7	12	0	16 µg/l	84 tonnes	yes
	**	8	–	<2.7	– µg/l	90 tonnes	–
Nitrates		184	12	99	216 µg/l	2370 tonnes	yes
Ammonia	*	13	12	0	29 µg/l	154 tonnes	yes
	**	15	–	<2	– µg/l	158 tonnes	–
Total N		318	12	244	529 µg/l	4027 tonnes	yes
SiO_2		2.57	12	2.08	3.21 mg/l	34864 tonnes	yes
Arsenic	*	0.12	12	0	0.23 µg/l	1.5 tonnes	yes
	**	0.14	–	<0.02	– µg/l	1.6 tonnes	–
Lead	*	0.11	12	0	0.51 µg/l	2.20 tonnes	yes
	**	0.13	–	<0.01	– µg/l	2.21 tonnes	–
Cadmium		0.014	12	0.002	0.022 µg/l	0.20 tonnes	yes
Copper	*	0.63	12	0	1.80 µg/l	10 tonnes	yes
	**	0.68	–	<0.02	– µg/l	10 tonnes	–
Total Cr-T	*	0.16	12	0	0.52 µg/l	1.96 tonnes	yes
	**	0.19	–	<0.01	– µg/l	2.01 tonnes	–
Nickel		0.26	12	0.12	0.40 µg/l	3.45 tonnes	yes
Zinc		4.38	12	1.53	19 µg/l	57 tonnes	yes
Mercury	*	10.2	12	0	24 ng/l	108 kg	yes
	**	11.9	–	<5	– ng/l	125 kg	–
Lindane		0.59	4	0.13	0.99 ng/l	7 kg	yes

Measurements below detection limits are treated in two ways
* Detection limit = zero
** Detection limit = limit

Table IV.V Main riverine inputs 2000 (5) Otra

Total volume: **18 542 810 m^3/d** **Long term average flow (LTA):** **12 841 000 m^3/d**
Minimum flow: **4 348 212 m^3/d** **LTA period:** **1961 to 1990**
Maximum flow: **58 971 910 m^3/d**

		Mean	Number of measure-ments	Minimum concentration during the year	Maximum concentration during the year	Total quantity of substance discharge each year	Where 70% of the measurement above limit of detection?
S.P.M.	*	1.94	12	0	10.9 mg/l	23379 tonnes	yes
	**	2.07	–	<0.5	– mg/l	23525 tonnes	–
TOC		2.84	12	1.7	8 mg/l	19450 tonnes	yes
Orthoph.	*	3.10	12	0	11 µg/l	24 tonnes	no
	**	4.14	–	1	– µg/l	28 tonnes	–
Total P	*	14	12	0	75 µg/l	109 tonnes	no
	**	19	–	<2.7	– µg/l	115 tonnes	–
Nitrates		160	12	66	544 µg/l	1001 tonnes	yes
Ammonia		18	12	7	49 µg/l	145 tonnes	yes
Total N		321	12	159	1405 µg/l	2017 tonnes	yes
SiO_2		2.48	12	1.24	8.36 mg/l	18669 tonnes	yes
Arsenic	*	0.12	12	0	0.21 µg/l	0.8 tonnes	yes
	**	0.12	–	<0.02	– µg/l	0.9 tonnes	–
Lead		0.30	12	0.08	1.32 µg/l	3 tonnes	yes
Cadmium	*	0.024	12	0	0.03 µg/l	0.16 tonnes	yes
	**	0.024	–	0.017	– µg/l	0.17 tonnes	–
Copper	*	0.45	12	0	1.04 µg/l	4 tonnes	yes
	**	0.48	–	<0.02	– µg/l	4 tonnes	–
Total Cr-T	*	0.25	12	0	1.84 µg/l	3 tonnes	no
	**	0.34	–	<0.01	– µg/l	4 tonnes	–
Nickel		0.64	12	0.36	1.35 µg/l	5 tonnes	yes
Zinc		3.97	12	2.9	7.40 µg/l	31 tonnes	yes
Mercury	*	6.9	12	0	11 ng/l	31 kg	no
	**	7.9	–	5	– ng/l	45 kg	–
Lindane		0.54	4	0.12	0.79 ng/l	4 kg	yes

Measurements below detection limits are treated in two ways
* Detection limit = zero
** Detection limit = limit

Table IV.VI Main riverine inputs 2000 (6) Orreelva

Total volume: 412 746 m^3/d **Long term average flow (LTA):** 333 000 m^3/d
Minimum flow: 53 760 m^3/d **LTA period:** 1961 to 1990
Maximum flow: 1 263 360 m^3/d

		Mean	Number of measure-ments	Minimum concentration during the year	Maximum concentration during the year	Total quantity of substance discharge each year	Where 70% of the measurement above limit of detection?
S.P.M.		10.46	12	3.9	23.8 mg/l	1741 tonnes	yes
TOC		6.17	12	2.7	8.10 mg/l	964 tonnes	yes
Orthoph.		9.33	12	2	25 µg/l	1.6 tonnes	yes
Total P		80	12	6	190 µg/l	14 tonnes	yes
Nitrates		862	12	7	2130 µg/l	172 tonnes	yes
Ammonia		23	12	2	74 µg/l	5 tonnes	yes
Total N		1753	12	174	3350 µg/l	321 tonnes	yes
SiO2		2.75	12	0.41	5.14 mg/l	470 tonnes	yes
Arsenic		0.31	12	0.06	0.60 µg/l	0.045 tonnes	yes
Lead	*	0.35	12	0	1.45 µg/l	0.066 tonnes	yes
	**	0.39	–	<0.01	– µg/l	0.066 tonnes	–
Cadmium		0.013	12	0.007	0.029 µg/l	0.0021 tonnes	yes
Copper		1.47	12	0.49	2.28 µg/l	0.23 tonnes	yes
Total Cr-T	*	0.35	12	0	0.85 µg/l	0.05 tonnes	yes
	**	0.46	–	<0.01	– µg/l	0.05 tonnes	–
Nickel		1.35	12	0.82	1.74 µg/l	0.21 tonnes	yes
Zinc		3.05	12	1.4	5.82 µg/l	0.53 tonnes	yes
Mercury	*	9.0	12	0	33 ng/l	1.6 kg	yes
	**	9.8	–	5	– ng/l	1.6 kg	–
Lindane		0.71	4	0.27	1.34 ng/l	0.094 kg	yes

Measurements below detection limits are treated in two ways
* Detection limit = zero
** Detection limit = limit

Table IV.VII Main riverine inputs 2000 (7) Suldalslågen

Total volume: **4 552 485 m^3/d** **Long term average flow (LTA):** **7 422 000 m^3/d**
Minimum flow: **1 211 328 m^3/d** **LTA period:** **1961 to 1990**
Maximum flow: **14 662 080 m^3/d**

		Mean	Number of measure-ments	Minimum concentration during the year	Maximum concentration during the year	Total quantity of substance discharge each year	Where 70% of the measurement above limit of detection?
S.P.M.	*	0.88	11	0	4.8 mg/l	1244 tonnes	no
	**	1.55	–	0.3	– mg/l	1704 tonnes	–
TOC	*	0.82	11	0	1.16 mg/l	787 tonnes	no
	**	0.83	–	0.5	– mg/l	1263 tonnes	–
Orthoph.	*	2.20	11	0	5 µg/l	3.3 tonnes	no
	**	2.67	–	1	– µg/l	3.9 tonnes	–
Total P	*	5	11	0	13 µg/l	6.7 tonnes	yes
	**	5	–	2	– µg/l	7.4 tonnes	–
Nitrates		191	11	123	313 µg/l	274 tonnes	yes
Ammonia	*	5	10	0	9 µg/l	8.0 tonnes	yes
	**	5	–	2	– µg/l	8.5 tonnes	–
Total N		254	11	143	475 µg/l	399 tonnes	yes
SiO_2		1.72	11	0.90	7.29 mg/l	2083 tonnes	yes
Arsenic	*	0.05	11	0	0.13 µg/l	0.080 tonnes	no
	**	0.07	–	<0.02	– µg/l	0.092 tonnes	–
Lead	*	0.03	11	0	0.07 µg/l	0.056 tonnes	no
	**	0.04	–	0.006	– µg/l	0.062 tonnes	–
Cadmium	*	0.011	11	0	0.02 µg/l	0.019 tonnes	yes
	**	0.012	–	<0.001	– µg/l	0.019 tonnes	–
Copper	*	0.19	11	0	0.40 µg/l	0.33 tonnes	yes
	**	0.22	–	0.01	– µg/l	0.34 tonnes	–
Total Cr-T	*	0.04	11	0	0.11 µg/l	0.04 tonnes	no
	**	0.07	–	0.01	– µg/l	0.06 tonnes	–
Nickel	*	0.14	11	0	0.27 µg/l	0.20 tonnes	yes
	**	0.15	–	0.02	– µg/l	0.20 tonnes	–
Zinc		1.69	11	0.65	2.50 µg/l	2.8 tonnes	yes
Mercury	*	8.2	11	0	13 ng/l	13 kg	yes
	**	8.5	–	5	– ng/l	14 kg	–
Lindane	*	0.47	4	0	0.76 ng/l	1.0 kg	yes
	**	0.59	–	<0.1	– ng/l	1.0 kg	–

Measurements below detection limits are treated in two ways
* Detection limit = zero
** Detection limit = limit

Table IV.VIII Main riverine inputs 2000 (8) Orkla

Total volume: **5 772 553 m^3/d** **Long term average flow (LTA):** **5 374 000 m^3/d**
Minimum flow: **1 564 177 m^3/d** **LTA period:** **1961 to 1990**
Maximum flow: **45 679 508 m^3/d**

		Mean	Number of measure-ments	Minimum concentration during the year	Maximum concentration during the year	Total quantity of substance discharge each year	Where 70% of the measurement above limit of detection?
S.P.M.	*	2.90	12	0	22.5 mg/l	19855 tonnes	yes
	**	3.12	–	0.4	– mg/l	19916 tonnes	–
TOC		2.39	12	1.5	5.15 mg/l	7123 tonnes	yes
Orthoph.	*	3.87	12	0	22 µg/l	20 tonnes	no
	**	5.00	–	1	– µg/l	21 tonnes	–
Total P	*	7	12	0	36 µg/l	34 tonnes	yes
	**	9	–	2	– µg/l	35 tonnes	–
Nitrates		157	12	36	307 µg/l	274 tonnes	yes
Ammonia		16	12	4	59 µg/l	24 tonnes	yes
Total N		316	12	188	472 µg/l	648 tonnes	yes
SiO2		3.30	12	2.36	5.57 mg/l	8348 tonnes	yes
Arsenic	*	0.14	12	0	0.26 µg/l	0.38 tonnes	yes
	**	0.16	–	<0.01	– µg/l	0.39 tonnes	–
Lead	*	0.09	12	0	0.45 µg/l	0.42 tonnes	no
	**	0.13	–	0.01	– µg/l	0.42 tonnes	–
Cadmium		0.045	12	0.013	0.102 µg/l	0.11 tonnes	yes
Copper		6.89	12	1.32	15 µg/l	18 tonnes	yes
Total Cr-T	*	0.36	12	0	1.56 µg/l	1.7 tonnes	yes
	**	0.43	–	0.01	– µg/l	1.7 tonnes	–
Nickel		1.00	12	0.41	2.80 µg/l	3.3 tonnes	yes
Zinc		18.66	12	4.1	47.7 µg/l	41 tonnes	yes
Mercury	*	6.8	12	0	11 ng/l	14 kg	yes
	**	7.4	–	<5	– ng/l	16 kg	–
Lindane		0.23	4	0.13	0.39 ng/l	0.47 kg	yes

Measurements below detection limits are treated in two ways
* Detection limit = zero
** Detection limit = limit

Table IV.IX Main riverine inputs 2000 (9) Vefsna

Total volume: **16 475 607 m^3/d** **Long term average flow (LTA):** **15 620 000 m^3/d**
Minimum flow: **3 197 878 m^3/d** **LTA period:** **1961 to 1990**
Maximum flow: **89 160 392 m^3/d**

		Mean	Number of measure-ments	Minimum concentration during the year	Maximum concentration during the year	Total quantity of substance discharge each year	Where 70% of the measurement above limit of detection?
S.P.M.	*	3.46	19	0	27 mg/l	15930 tonnes	yes
	**	4.01	–	0.3	– mg/l	24644 tonnes	–
TOC		1.69	19	0.8	3.33 mg/l	7691 tonnes	yes
Orthoph.	*	2.57	19	0	11 µg/l	12 tonnes	no
	**	2.68	–	1	– µg/l	15 tonnes	–
Total P	*	6	19	0	14 µg/l	23 tonnes	yes
	**	6	–	1	– µg/l	31 tonnes	–
Nitrates		65	19	21	140 µg/l	273 tonnes	yes
Ammonia	*	13	19	0	36 µg/l	63 tonnes	yes
	**	13	–	2	– µg/l	67 tonnes	–
Total N		151	19	80	663 µg/l	657 tonnes	yes
SiO2		1.65	19	0.90	2.79 mg/l	7278 tonnes	yes
Arsenic	*	0.10	19	0	0.27 µg/l	0.59 tonnes	yes
	**	0.11	–	0.02	– µg/l	0.60 tonnes	–
Lead	*	0.13	19	0	0.77 µg/l	0.47 tonnes	yes
	**	0.16	–	<0.01	– µg/l	0.48 tonnes	–
Cadmium		0.007	19	0.001	0.031 µg/l	0.026 tonnes	yes
Copper	*	0.60	19	0	2 µg/l	2.22 tonnes	yes
	**	0.67	–	<0.02	– µg/l	2.23 tonnes	–
Total Cr-T	*	0.23	18	0	0.59 µg/l	1.00 tonnes	yes
	**	0.29	–	<0.01	– µg/l	1.02 tonnes	–
Nickel	*	0.34	19	0	0.96 µg/l	1.49 tonnes	yes
	**	0.37	–	<0.03	– µg/l	1.52 tonnes	–
Zinc	*	2.29	19	0	15.4 µg/l	6.8 tonnes	yes
	**	2.87	–	<0.1	– µg/l	6.9 tonnes	–
Mercury	*	8.2	19	0	17 ng/l	39 kg	yes
	**	9.0	–	<2	– ng/l	41 kg	–
Lindane	*	0.18	4	0	0.42 ng/l	0.46 kg	no
	**	0.27	–	<0.1	– ng/l	0.87 kg	–

Measurements below detection limits are treated in two ways
* Detection limit = zero
** Detection limit = limit

Table IV.X Main riverine inputs 2000 (10) Alta

Total volume: **9 600 401 m^3/d** **Long term average flow (LTA):** **7 487 000 m^3/d**
Minimum flow: **2 572 952 m^3/d** **LTA period:** **1961 to 1990**
Maximum flow: **86 073 169 m^3/d**

		Mean	Number of measure-ments	Minimum concentration during the year	Maximum concentration during the year	Total quantity of substance discharge each year	Where 70% of the measurement above limit of detection?
S.P.M.	*	4.15	11	0	40.4 mg/l	99156 tonnes	no
	**	8.54	–	0.40	– mg/l	99435 tonnes	–
TOC		3.05	11	2.42	4.8 mg/l	14827 tonnes	yes
Orthoph.	*	6.95	11	0	23 µg/l	62 tonnes	yes
	**	7.46	–	1	– µg/l	62 tonnes	–
Total P		13	11	4.8	38 µg/l	105 tonnes	yes
Nitrates		91	11	31	138 µg/l	177 tonnes	yes
Ammonia	*	9	10	0	40 µg/l	106 tonnes	yes
	**	9	–	2	– µg/l	tonnes	–
Total N		211	11	155	346 µg/l	762 tonnes	yes
SiO2		6.72	11	5.14	10.50 mg/l	32249 tonnes	yes
Arsenic	*	0.21	11	0	0.42 µg/l	0.77 tonnes	yes
	**	0.22	–	<0.02	– µg/l	0.77 tonnes	–
Lead	*	0.04	11	0	0.29 µg/l	0.73 tonnes	no
	**	0.07	–	0.01	– µg/l	0.73 tonnes	–
Cadmium	*	0.013	11	0	0.085 µg/l	0.03 tonnes	yes
	**	0.015	–	0.001	– µg/l	0.03 tonnes	–
Copper		0.52	11	0.3	0.76 µg/l	2.4 tonnes	yes
Total Cr-T	*	0.53	11	0	3.32 µg/l	8.4 tonnes	yes
	**	0.64	–	0.01	– µg/l	8.4 tonnes	–
Nickel		0.78	11	0.02	4.67 µg/l	5.7 tonnes	yes
Zinc	*	0.58	11	0	2.10 µg/l	4.2 tonnes	yes
	**	0.69	–	0.04	– µg/l	4.2 tonnes	–
Mercury	*	7.8	11	0	11 ng/l	28 kg	yes
	**	8.9	–	<5	– ng/l	30 kg	–
Lindane	*	0.16	4	0	0.32 ng/l	0.27 kg	no
	**	0.32	–	<0.1	– ng/l	0.53 kg	–

Measurements below detection limits are treated in two ways
* Detection limit = zero
** Detection limit = limit

Appendix V. Input from the tributary rivers 2000

Table V.I	Tributary rivers in the sub - areas	(1-5) The Skagerrak region
Table V.II	Tributary rivers in the sub - areas	(6-7) Remaining North Sea
Table V.III	Tributary rivers in the sub - areas	(8-9) The Norwegian Sea
Table V.IV	Tributary rivers in the sub - area	(10) The Barents Sea

Table V.I. Inputs from tributary rivers in the Skagerrak Region 2000

The Skagerrak Region with sub-areas: (1A) Glomma, (1B) Inner Oslofjord, (2) Drammenselva, (3) Numedalslågen, (4) Skienselva, (5) Otra

Total quantity of substances discharged per year:

		1A	1B	2	3	4	5		Where 70% of the measurement above limit of detection?
S.P.M.	*	6564	2788	1134	5220	2066	20915	tonnes	yes
	**	6564	2831	1134	5220	2066	20915	tonnes	
TOC		11989	4286	851	3809	7630	81672	tonnes	yes
Orthoph.		2.7	13.9	5.7	6.3	1.6	94	tonnes	yes
Total P		27.6	22.2	10.3	19.7	1.6	174	tonnes	yes
Nitrates		1086	777	153	351	320	3731	tonnes	yes
Ammonia	*	35.5	48.8	8.0	33.3	3.2	334	tonnes	yes
	**	35.5	48.8	8.0	33.3	3.2	340	tonnes	
Total N		1758	1034	214	668	453	8379	tonnes	yes
Silicate SiO_2	*	307	3899	1270	3810	5450	32628	tonnes	yes
	**	411	3899	1270	3810	5450	32628	tonnes	
Arsenic	*	0.54	0.32	0.13	0.35	0.30	4.52	tonnes	yes
	**	0.54	0.32	0.13	0.90	0.30	4.52	tonnes	
Lead		0.43	0.51	0.06	0.29	0.40	9.45	tonnes	yes
Cadmium		0.029	0.030	0.008	0.050	0.054	0.747	tonnes	yes
Copper		2.43	2.02	0.42	7.81	0.91	13.58	tonnes	yes
Total Cr-T	*	0.060	0.251	0	2.063	0	0	tonnes	no
	**	0.060	0.260	0.005	2.063	0.032	0.532	tonnes	
Nickel		2.2	1.1	0.20	3.8	1.5	8.2	tonnes	yes
Zinc		5.2	5.5	1.2	9.1	9.9	115	tonnes	yes
Mercury	*	12.2	4.9	1.5	8.1	0	115	kg	yes
	**	12.2	6.1	1.5	8.1	7.9	158	kg	
Lindane									

Measurements below detection limits are treated in two ways:
* Detection limit = zero
** Detection limit = limit

Table V.II. Inputs from tributary rivers in the remaining North Sea 2000

The remaining North Sea Region with sub-areas: (6) Orreelva, (7) Suldalslågen

Total quantity of substances discharged per year:

		6	7		Where 70% of the measurement above limit of detection?
S.P.M.	*	4999	208694	tonnes	yes
	**	8578	213662	tonnes	
TOC	*	14707	23950	tonnes	yes
	**	14707	30059	tonnes	
Orthoph.	*	38	49	tonnes	yes
	**	38	62	tonnes	
Total P	*	130	457	tonnes	yes
	**	130	465	tonnes	
Nitrates	*	2677	3476	tonnes	yes
	**	2680	3475	tonnes	
Ammonia	*	220	393	tonnes	yes
	**	221	405	tonnes	
Total N		4483	6773	tonnes	yes
Silicate SiO_2	*	16325	58380	tonnes	yes
	**	16325	58521	tonnes	
Arsenic		1.74	4.83	tonnes	yes
Lead		2.24	8.68	tonnes	yes
Cadmium		0.18	0.40	tonnes	yes
Copper		3.7	19.6	tonnes	yes
Total Cr-T	*	1.5	20.3	tonnes	yes
	**	1.6	20.3	tonnes	
Nickel	*	6.6	14.2	tonnes	yes
	**	6.6	14.3	tonnes	
Zinc		30	101	tonnes	yes
Mercury	*	69	241	kg	yes
	**	82	294	kg	
Lindane					

Measurements below detection limits are treated in two ways:
* Detection limit = zero
** Detection limit = limit

Table V.III. Inputs from tributary rivers in the Norwegian Sea 2000

The Norwegian Sea Region with sub-areas: (8) Orkla, (9) Vefsna

Total quantity of substances discharged per year:

		8	9		Where 70% of the measurement above limit of detection?
S.P.M.	*	52561	84046	tonnes	yes
	**	53168	84556	tonnes	
TOC	*	68440	23459	tonnes	yes
	**	69209	26659	tonnes	
Orthoph.	*	24	157	tonnes	yes
	**	42	157	tonnes	
Total P	*	271	360	tonnes	yes
	**	274	360	tonnes	
Nitrates	*	2292	1084	tonnes	yes
	**	2292	1094	tonnes	
Ammonia	*	263	394	tonnes	yes
	**	290	437	tonnes	
Total N	*	4420	1711	tonnes	yes
	**	4420	1745	tonnes	
Silicate SiO_2		45103	49284	tonnes	yes
Arsenic	*	0.67	0.77	tonnes	no
	**	1.04	1.02	tonnes	
Lead	*	1.70	2.53	tonnes	yes
	**	1.70	2.53	tonnes	
Cadmium	*	0.081	0.120	tonnes	yes
	**	0.081	0.153	tonnes	
Copper		20.6	14.8	tonnes	yes
Total Cr-T	*	9.26	1.25	tonnes	yes
	**	9.26	1.76	tonnes	
Nickel		13.2	12.9	tonnes	yes
Zinc	*	37.7	29.3	tonnes	yes
	**	37.7	30.4	tonnes	
Mercury	*	196	9	kg	no
	**	262	188	kg	
Lindane					

Measurements below detection limits are treated in two ways:
* Detection limit = zero
** Detection limit = limit

Table V.IV. Inputs from tributary rivers in the Barents Sea 2000

The Barents Sea Region with sub-area: (10) Alta

Total quantity of substances discharged per year:

		10		Where 70% of the measurement above limit of detection?
S.P.M.	*	19955	tonnes	no
	**	24234		
TOC	*	50310	tonnes	yes
	**	51419		
Orthoph.	*	47	tonnes	yes
	**	56		
Total P		168	tonnes	yes
Nitrates		841	tonnes	yes
Ammonia		376	tonnes	yes
Total N		4537	tonnes	yes
Silicate SiO_2	*	104680	tonnes	yes
	**	104693		
Arsenic	*	1.16	tonnes	yes
	**	1.21		
Lead	*	0.32	tonnes	no
	**	0.41		
Cadmium		0.043	tonnes	yes
Copper	*	9.31	tonnes	no
	**	9.48		
Total Cr-T	*	2.63	tonnes	no
	**	2.86		
Nickel	*	32.2	tonnes	no
	**	32.3		
Zinc	*	5.1	tonnes	yes
	**	5.9		
Mercury	*	237	kg	no
	**	331		
Lindane				

Measurements below detection limits are treated in two ways:
* Detection limit = zero
** Detection limit = limit

Appendix VI. Other inputs 2000

Table VI Nutrients from “Down Stream Areas of main and tributary rivers and rivers not monitored 2000. Direct runoff P and N

Table VI Nutrients from "Down Stream Areas" of main and tributary rivers and rivesr not monitored 2000. Direct runnof of P and N

Sub-areas:		Background tonnes	Agriculture Area tonnes	Sum Tonnes	
1 Glomma	P	18.4	17.8	36.2	
	N	463.1	521.7	984.8	
	PO4-P	3.7	5.3	9.0	
	NO3-N	277.8	365.2	643.0	
	NH4-N	23.2	36.5	59.7	
1 Inner Oslofjord	P	3.4	3.8	7.2	
	N	72.8	110.8	183.6	
	PO4-P	0.7	1.1	1.8	
	NO3-N	43.7	77.6	121.3	
	NH4-N	3.6	7.8	11.4	
2 Drammenselva	P	1.4	2.5	4.0	
	N	64.0	96.2	160.1	
	PO4-P	0.3	0.8	1.0	
	NO3-N	38.4	67.3	105.7	
	NH4-N	3.2	6.7	9.9	
3 Numedalslågen	P	4.9	19.1	24.0	
	N	184.7	585.9	770.7	
	PO4-P	1.0	5.7	6.7	
	NO3-N	110.8	410.2	521.0	
	NH4-N	9.2	41.0	50.3	
4 Skienselva	P	6.8	2.9	9.7	
	N	331.3	103.5	434.8	
	PO4-P	1.4	0.9	2.2	
	NO3-N	198.8	72.5	271.2	
	NH4-N	16.6	7.2	23.8	
5 Otra	P	7.0	3.9	11.0	
	N	391.8	129.8	521.6	
	PO4-P	1.4	1.2	2.6	
	NO3-N	235.1	90.9	325.9	
	NH4-N	19.6	9.1	28.7	
6 Orreelva	P	22.8	47.5	70.4	
	N	1463.8	1394.6	2858.5	
	PO4-P	4.6	14.3	18.8	
	NO3-N	878.3	976.2	1854.5	
	NH4-N	73.2	97.6	170.8	
7 Suldalslågen	P	58.0	69.1	127.2	
	N	5151.3	1359.0	6510.3	
	PO4-P	11.6	20.7	32.3	
	NO3-N	3090.8	951.3	4042.0	
	NH4-N	257.6	95.1	352.7	
8 Orkla	P	142.1	153.4	295.5	
	N	3850.8	3626.9	7477.6	
	PO4-P	28.4	46.0	74.4	
	NO3-N	2310.5	2538.8	4849.3	
	NH4-N	192.5	253.9	446.4	
9 Vefsna	P	83.6	39.4	123.0	
	N	1920.5	929.0	2849.5	
	PO4-P	16.7	11.8	28.5	
	NO3-N	1152.3	650.3	1802.6	
	NH4-N	96.0	65.0	161.1	
10 Altaelva	P	86.1	2.1	88.2	
	N	1618.3	62.4	1680.7	
	PO4-P	17.2	0.6	17.9	
	NO3-N	971.0	43.7	1014.7	
	NH4-N	80.9	4.4	85.3	
SUM	**P**			**796**	**tonnes**
SUM	**N**			**24432**	**tonnes**
SUM	**PO4-P**			**195**	**tonnes**
SUM	**NO3-N**			**15551**	**tonnes**
SUM	**NH4-N**			**1400**	**tonnes**

Appendix VII. Main rivers 1-10. Measured concentrations 2000

Table VII.I	(1)	Glomma
Table VII.II	(2)	Drammenselva
Table VII.III	(3)	Numedalslågen
Table VII.IV	(4)	Skienselva
Table VII.V	(5)	Otra
Table VII.VI	(6)	Orreelva
Table VII.VII	(7)	Suldalslågen
Table VII.VIII	(8)	Orkla
Table VII.IX	(9)	Vefsna
Table VII.X	(10)	Alta

Table VII.IMeasured concentration 2000 – Watercourse: Glomma

Annual flow: **31235 10^6 m^3** **Min:** **282 m^3/s**
Drainage area: **41218 km^2** **Max:** **2292 m^3/s**

Date 2000	Qi m^3/s	Cond mS/m	S.P.M. mg/l	TOC mg/l	PO_4-P µg/l	Tot-P µg/l	NO_3-N µg/l	NH_4-N µg/l	Tot-N µg/l	SiO_2 mg/l	As µg/l	Pb µg/l	Cd µg/l	Cu µg/l	Cr µg/l	Ni µg/l	Zn µg/l	Hg ng/l	Lindane (γ-HCH) ng/l
2000-01-22	563	5.31	5.3	4.06	7	14	415	34	644	4.50	0.15	0.17	0.013	1.29	<0.01	0.75	3.06	10	
2000-02-29	487	5.32	64.9	3.43	2	114	661	85	1310	5.79	0.27	1.48	0.021	2.88	0.45	2.47	7.80	9	
2000-03-26	358	5.01	5.6	3.57	14	20	435	22	653	4.07	0.26	0.35	0.025	1.91	0.69	1.14	3.61	5	0.27
2000-05-01	1379	4.17	13.7	7.05	16	28	356	35	684	7.93	0.18	0.43	0.023	1.71	<0.02	1.00	6.50	7	
2000-05-07	2031	3.63	17.5	6.27	19	34	256	30	552	7.29	0.18	0.63	0.034	3.60	<0.02	1.30	8.80	8	
2000-05-14	1749	3.73	7.5	5.33	4	21	216	30	519	4.07	0.04	0.30	0.013	0.20	0.24	0.75	4.20	11	
2000-05-23	1639	3.67	4.4	4.56	11	10	208	13	502	3.64	<0.02	0.17	0.007	2.10	0.18	0.54	2.50	10	
2000-05-27	1383	3.84	3.7	2.69	3	9	231	21	536	1.44	0.14	0.23	0.011	2.49	0.56	0.77	2.10	8	
2000-06-03	1308	4.35	5.6	7.6	6	12	410	38	635	3.43	0.10	0.19	0.010	2.31	0.34	0.83	2.56	7	
2000-06-12	794	4.47	3.9	3.7	6	12	420	61	635	3.86	0.15	0.19	0.020	2.00	0.18	0.72	2.40	6	0.47
2000-06-19	922	4.04	3.7	3.7	5	10	306	25	463	3.64	0.14	0.16	0.010	1.75	<0.02	0.62	2.30	5	
2000-06-24	967	4.37	3.0	3.1	6	9	314	20	818	3.21	0.13	0.14	0.013	2.30	<0.02	0.66	2.40	<5	
2000-07-27	1280	3.65	4.5	3.3	2	11	190	16	326	3.43	0.08	0.51	0.014	1.66	<0.02	0.52	5.59	6	
2000-08-30	589	4.14	2.2	3.2	3	8	162	18	699	3.21	0.15	<0.01	0.004	0.84	0.40	0.32	1.20	11	0.32
2000-09-30	435	4.31	1.5	3.5	1	13	330	34	470	3.64	0.17	0.08	0.010	1.67	0.15	0.53	5.40	10	
2000-10-28	1400	4.22	8.1	6.1	12	21	352	61	582	5.14	0.20	0.34	0.016	1.43	<0.02	1.03	3.97	<5	0.35
2000-11-29	1820	–	–	6.8	3	56	316	21	591	15.64	0.29	0.77	0.041	2.30	1.10	1.60	5.60	10	
2000-12-28	717	3.82	6.1	6.2	6	28	288	20	520	6.00	0.22	0.09	<0.02	0.88	0.30	0.62	3.90	<5	
Min.:	358	3.63	1.50	2.69	1	8	162	13	326	1.44	<0.02	<0.01	0.004	0.20	<0.01	0.32	1.20	<5	0.27
Max.:	2031	5.32	64.9	7.6	19	114	661	85	1310	15.64	0.29	1.48	0.041	3.60	1.10	2.47	8.80	11	0.47
Aver.:	1101	4.24	9.5	4.68	7	24	326	32	619	5.00	0.16	0.35	0.017	1.85	0.26	0.90	4.11	8	0.35
St.dev.:	522	0.54	14.8	1.59	5	26	118	19	204	3.08	0.07	0.35	0.009	0.79	0.29	0.50	2.11	2	0.08
Numb.:	18	17	17	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	4

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Table VII.II Measured concentration 2000 – Watercourse: Drammenselva

Annual flow: 13711 10^6 m^3 **Min:** 168 m^3/s
Drainage area: 17028 km^2 **Max:** 1276 m^3/s

Date	Qi	Cond	S.P.M.	TOC	PO_4-P	Tot-P	NO_3-N	NH_4-N	Tot-N	SiO_2	As	Pb	Cd	Cu	Cr	Ni	Zn	Hg	Lindane (γ-HCH)
2000	m^3/s	mS/m	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	ng/l	ng/l
2000-01-26	290	3.70	0.9	2.44	<1.8	5.3	277	20	412	3.00	0.10	0.06	0.009	0.89	<0.01	0.39	3.03	16	
2000-02-23	284	3.27	0.9	2.33	<1.8	7.5	259	29	379	2.79	0.13	0.11	<0.001	1.05	0.19	0.45	2.45	6	
2000-03-30	234	3.68	1.1	2.5	<1.8	3.6	257	27	402	2.36	0.23	0.11	0.041	1.04	0.33	0.86	2.82	< 5	–
2000-04-27	305	3.39	2.3	3.68	2	8.2	247	23	488	3.64	0.10	0.13	0.021	0.89	0.16	0.44	3.2	9	
2000-05-03	531	2.98	9.1	3.83	8.3	16	245	17	505	4.29	0.12	0.31	0.160	0.89	<0.02	0.54	3.3	8	
2000-05-09	585	2.88	1.4	3.17	1	8	249	11	412	3.00	<0.02	0.10	0.004	0.63	0.05	0.48	2.1	6	
2000-05-15	484	3.40	1.2	3.03	2	11	196	24	446	2.79	<0.02	0.10	0.003	0.58	0.04	0.34	1.8	8	
2000-05-22	276	3.57	1.1	2.65	2	7	361	34	489	2.57	<0.2	0.20	<0.02	1	<0.2	0.5	28	13	
2000-05-30	307	3.59	2.5	3.3	3	12	261	41	536	3.00	0.12	0.16	0.011	1.29	0.31	0.55	2.87	7	
2000-06-05	340	3.70	0.8	2.9	2	9	255	15	485	3.21	0.13	0.07	0.007	0.94	0.24	0.58	1.59	9	
2000-06-14	213	3.90	<0.5	3.3	3	9831*	255	389*	468	3.00	0.16	0.09	0.010	1.01	0.42	0.57	2.5	7	
2000-06-21	260	3.54	1.2	2.9	2	23	217	36	429	2.79	0.14	0.15	0.011	1.46	<0.02	0.4	3.2	7	
2000-06-27	213	3.62	1.6	3.3	3	8	214	16	476	2.79	0.23	0.12	0.009	0.79	0.41	0.49	2.5	7	0.58
2000-07-18	494	3.18	2	3.5	3	9	186	31	351	2.79	0.03	0.13	0.009	0.94	0.19	0.44	3.16	17	
2000-08-30	226	3.40	2.4	3.3	1	8	58	38	677	2.79	0.17	0.08	0.006	0.15	0.21	0.27	2.2	5	0.34
2000-09-26	217	3.05	<2	2.8	4	9	174	39	351	2.79	0.17	<0.01	0.008	0.9	0.12	0.31	2.3	25	
2000-10-31	1063	3.44	28.5	6.4	4	50	337	25	635	6.00	0.33	1.32	0.034	2.41	<0.02	1.26	8.4	7	0.32
2000-11-30	930	3.83	4.4	4.4	5	12	300	32	518	3.86	<0.02	0.12	0.021	1.01	0.19	0.65	3.3	<5	
2000-12-17	659	3.80	1.6	4.1	<2	4	292	<2	427	3.86	0.25	0.32	0.031	1.07	0.46	0.77	4.05	8	
Min.:	213	2.88	<0.5	2.33	1	4	58	<2	351	2.36	<0.02	<0.01	<0.001	0.15	<0.01	0.27	1.59	<5	0.32
Max.:	1063	3.90	28.5	6.4	8	50	361	41	677	6.00	0.33	1.32	0.160	2.41	0.46	1.26	28	25	0.58
Aver.:	372	3.47	3.4	3.4	3	12	244	26	468	3.23	0.14	0.19	0.022	1.00	0.19	0.54	4.36	9	0.41
St.dev.:	215	0.29	6.4	0.9	2	11	65	11	85	0.83	0.08	0.28	0.035	0.44	0.14	0.23	5.90	5	0.14
Numb.:	19	19	19	19	19	18	19	18	19	19	19	19	19	19	19	19	19	19	3

* Value not used in calculations.

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Table VII.III Measured concentration 2000 – Watercourse: Numedalslågen

Annual flow: **5267 10^6 m^3** **Min:** **58 m^3/s**
Drainage area: **5513 km^2** **Max:** **803 m^3/s**

Date	Qi	Cond	S.P.M.	TOC	PO_4-P	Tot-P	NO_3-N	NH_4-N	Tot-N	SiO_2	As	Pb	Cd	Cu	Cr	Ni	Zn	Hg	Lindane (γ-HCH)
2000	m^3/s	mS/m	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	ng/l	ng/l
2000-01-26	105	2.73	1.5	2.41	2.7	5.7	165	42	276	3.43	0.1	0.09	0.011	0.52	<0.01	0.24	3.13	14	
2000-02-23	89	2.58	1.6	2.09	<1.8	8	160	31	265	3.21	0.26	0.12	0.002	0.44	0.13	0.43	2.33	8	
2000-03-30	73	3.16	1.9	2.45	2.9	5.1	198	28	321	2.14	0.13	0.04	0.010	0.42	0.15	0.27	2.28	< 5	0.28
2000-04-27	200	2.57	4.9	5.29	4.4	13	186	14	385	4.29	0.19	0.32	0.020	0.67	0.24	0.45	5.2	12	
2000-05-30	195	3.57	16.3	4.6	14	32	655	36	918	4.71	0.2	0.48	0.021	1.09	0.35	0.56	4.56	9	
2000-06-28	124	2.39	1.4	2.3	3	9	77	20	80	2.36	0.15	0.14	0.010	0.40	0.17	0.29	2.6	14	0.48
2000-07-18	143	2.50	2.4	4.2	3	14	111	22	248	2.79	0.05	0.24	0.013	0.90	0.29	0.38	4.01	18	
2000-08-30	87	3.36	6.4	5.4	3	15	189	26	788	4.07	0.24	0.06	0.012	0.22	0.40	0.26	3.7	13	<0.1
2000-09-26	58	2.71	<2	3.2	4	9	154	24	331	3.00	0.15	<0.01	0.013	0.54	0.10	0.18	2.4	10	
2000-10-31	605	2.91	53.4	8.6	4	131	347	27	742	10.50	0.81	4.65	0.087	3.80	1.10	1.63	22.1	23	1.32
2000-11-30	224	3.18	10.5	5.8	10	21	303	36	511	5.36	<0.02	0.42	0.032	1.14	0.28	0.82	6.9	7	
2000-12-17	195	2.90	7.0	5.3	3	13	272	23	455	5.14	0.32	0.42	0.026	1.46	0.37	0.53	6.4	16	
Min.:	58	2.39	1.40	2.09	<1.8	5.1	77	14	80	2.14	<0.02	<0.01	0.002	0.22	<0.01	0.18	2.28	<5	<0.1
Max.:	605	3.57	53.4	8.6	14	131	655	42	918	10.50	0.81	4.65	0.087	3.80	1.10	1.63	22.1	23	1.32
Aver.:	175	2.88	9.11	4.30	4.7	23.0	235	27	443	4.25	0.22	0.58	0.021	0.97	0.30	0.50	5.47	12	0.55
St.dev.:	147	0.37	14.67	1.93	3.6	34.8	153	8	252	2.23	0.21	1.29	0.022	0.97	0.28	0.40	5.47	5	0.54
Numb.:	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	4

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Table VII.IV Measured concentration 2000 – Watercourse: Skienselva

Annual flow: 12719 10^6 m^3 **Min:** 152 m^3/s
Drainage area: 10348 km^2 **Max:** 1106 m^3/s

Date	Qi	Cond	S.P.M.	TOC	PO_4-P	Tot-P	NO_3-N	NH_4-N	Tot-N	SiO_2	As	Pb	Cd	Cu	Cr	Ni	Zn	Hg	Lindane (γ-HCH)
2000	m^3/s	mS/m	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	ng/l	ng/l
2000-01-26	305	2.17	<0.5	2.61	<1.8	<2.7	209	22	287	2.36	0.08	0.02	0.019	0.39	<0.01	0.23	2.1	24	
2000-02-23	249	2.02	0.6	2.15	<1.8	<2.7	216	5	267	2.36	0.15	0.03	0.002	0.31	0.12	0.30	1.91	10	
2000-03-30	245	2.22	0.7	2.14	<1.8	<2.7	209	8	288	2.79	0.19	0.12	0.011	0.55	0.21	0.33	2.78	< 5	0.13
2000-04-27	417	2.09	0.5	2.52	<1.8	3.8	209	<2	348	2.79	0.08	0.03	0.020	0.39	0.07	0.40	3.0	13	
2000-05-30	368	2.05	0.9	1.8	2	3	212	12	283	2.36	0.06	0.03	0.010	0.52	0.10	0.22	1.53	10	
2000-06-28	224	28.2	0.7	2.2	2	10	162	<2	351	2.14	0.22	0.09	0.014	0.87	0.37	0.31	3.3	10	0.99
2000-07-18	299	1.90	0.8	2	3	16	152	25	244	2.08	<0.02	0.05	0.009	0.47	0.14	0.17	2.4	<5	
2000-08-30	312	2.16	0.7	2.5	1	7	99	21	529	2.14	0.11	<0.01	0.007	<0.02	0.14	0.12	19	11	0.74
2000-09-26	270	1.79	<2	2.1	4	8	169	29	270	2.36	0.12	<0.01	0.011	0.33	0.08	0.16	2.2	9	
2000-10-31	864	2.09	7.1	2.6	2	9	204	6	268	3.21	0.19	0.31	0.022	0.44	<0.02	0.26	4.6	12	0.49
2000-11-30	804	2.07	9.3	3.6	5	10	178	19	340	3.21	<0.02	0.51	0.020	1.42	0.14	0.33	4.4	<5	
2000-12-17	607	2.10	2.3	3.3	4	5	187	6	335	3.00	0.23	0.13	0.018	1.8	0.52	0.30	5.29	8	
Min.:	224	1.79	<0.5	1.80	1	<2.7	99	<2	244	2.08	<0.02	<0.01	0.002	<0.02	<0.01	0.12	1.53	<5	0.13
Max.:	864	28.20	9.3	3.6	5	16	216	29	529	3.21	0.23	0.51	0.022	1.80	0.52	0.40	19	24	0.99
Aver.:	414	4.24	2.2	2.46	2.5	6.7	184	13	318	2.57	0.12	0.11	0.014	0.63	0.16	0.26	4.38	10	0.59
St.dev.:	222	7.55	2.9	0.53	1.2	4.1	34	10	76	0.42	0.07	0.15	0.006	0.51	0.15	0.08	4.75	5	0.37
Numb.:	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	4

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Table VII.V Measured concentration 2000 – Watercourse: Otra

Annual flow: **6768 10^6 m^3** **Min:** **50.3 m^3/s**
Drainage area: **3730 km^2** **Max:** **682.5 m^3/s**

Date	Qi	Cond	S.P.M.	TOC	PO_4-P	Tot-P	NO_3-N	NH_4-N	Tot-N	SiO_2	As	Pb	Cd	Cu	Cr	Ni	Zn	Hg	Lindane (γ-HCH)
2000	m^3/s	mS/m	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	ng/l	ng/l
2000-02-01	210	1.72	0.8	2.32	<1.8	3.5	148	15	225	2.10	0.11	0.16	0.029	0.34	<0.01	0.70	3.4	10	
2000-02-29	249	2.26	0.8	2.07	<1.8	<2.7	192	49	313	2.36	0.12	0.27	0.029	0.31	0.15	0.51	5.4	10	
2000-03-30	207	1.71	0.9	1.7	<1.8	<2.7	128	10	195	1.86	0.13	0.17	0.018	0.42	0.25	0.53	2.9	<5	0.12
2000-04-26	239	1.73	0.7	2.54	<1.8	<2.7	148	10	249	2.36	0.1	0.25	0.027	0.48	0.10	0.70	4.4	11	
2000-05-29	230	1.78	1.2	1.72	2	7	137	11	234	8.36	0.1	0.21	0.024	0.57	0.19	0.36	2.9	6	
2000-06-26	161	1.54	4.3	2.2	5	<2.7	97	8	159	1.46	0.08	0.17	0.017	0.47	<0.02	0.36	3.0	5	0.73
2000-07-24	54	1.66	0.8	2.8	6	11	99	23	183	1.24	0.06	0.26	0.023	0.44	<0.02	0.62	3.5	8	
2000-08-28*	121	1.64	<0.5	2.2	1	8	66	12	175	1.41	0.21	0.19	0.020	<0.02	0.06	0.55	3.0	<5	0.52
2000-09-25	148	1.6	0.6	8.0	2	75	544	7	1405	1.74	0.14	0.17	0.021	0.48	0.07	0.58	3.9	7	
2000-11-01	683	1.78	10.9	3.8	11	42	100	34	255	3.21	0.19	1.32	0.030	1.04	1.84	1.35	7.4	<5	0.79
2000-11-27	320	1.8	1.1	2.2	<1	4	135	25	266	1.97	<0.02	0.37	0.024	0.53	0.03	0.96	3.7	6	
2001-01-02	202	1.4	0.7	2.5	2	3	121	10	194	1.65	<0.2	0.08	<0.02	0.25	<0.2	0.4	4.2	<5	
Min.:	54	1.40	<0.5	1.70	<1	<2.7	66	7	159	1.24	<0.02	0.08	0.017	<0.02	<0.01	0.36	2.90	<5	0.12
Max.:	683	2.26	10.9	8.0	11	75	544	49	1405	8.36	0.21	1.32	0.030	1.04	1.84	1.35	7.40	11	0.79
Aver.:	235	1.72	1.9	2.84	3.1	14	160	18	321	2.48	0.12	0.30	0.024	0.45	0.25	0.64	3.97	7	0.54
St.dev.:	156	0.21	3.0	1.72	2.9	22	125	13	344	1.93	0.06	0.33	0.004	0.24	0.51	0.28	1.31	2	0.30
Numb.:	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	4

* Lindan sample for august taken 2000-09-04

Table VII.VI Measured concentration 2000 – Watercourse: Orreelva

Annual flow: **151 10^6 m^3** **Min:** **0.622 m^3/s**
Drainage area: **105 km^2** **Max:** **14.622 m^3/s**

Date 2000	Qi m^3/s	Cond mS/m	S.P.M. mg/l	TOC mg/l	PO_4-P µg/l	Tot-P µg/l	NO_3-N µg/l	NH_4-N µg/l	Tot-N µg/l	SiO_2 mg/l	As µg/l	Pb µg/l	Cd µg/l	Cu µg/l	Cr µg/l	Ni µg/l	Zn µg/l	Hg ng/l	Lindane (γ-HCH) ng/l
2000-01-31	5.87	17.40	23.8	5.73	9.4	190	2130	22	3350	4.50	0.53	1.45	0.029	1.80	<0.01	1.48	5.82	8	
2000-02-28	6.55	17.30	19.3	5.37	2.7	111	1590	17	3350	1.48	0.33	0.87	0.010	1.70	0.26	1.44	4.45	8	
2000-03-27	3.56	16.60	6.2	5.09	13	51	1670	16	3310	2.01	0.24	0.21	0.015	2.28	0.64	1.61	3.71	7	0.27
2000-04-26	4.14	18.40	3.9	5.14	4.9	35	1160	8	1660	0.49	0.18	0.14	0.009	1.50	0.38	0.82	1.9	5	
2000-05-29	2.00	19.70	11.2	4.66	5	71	265	29	1450	1.86	0.31	0.57	0.013	1.88	0.85	1.69	2.7	<5	
2000-06-26	1.63	19.50	8.0	7.7	7	53	7	14	334	0.41	0.26	0.13	0.008	1.54	<0.02	1.14	1.6	7	0.59
2000-07-26	0.68	24.62	5.75	8.1	8	58	26	21	670	0.58	0.21	0.08	0.007	0.95	<0.02	1.13	1.57	<5	
2000-08-28	4.96	18.40	8.6	7.1	24	47	224	15	938	4.07	0.31	0.09	0.007	0.49	0.30	0.96	1.4	6	
2000-09-25	1.85	16.40	11.6	2.7	2	6	80	8	174	5.14	0.27	<0.01	0.010	1.17	0.51	1.16	1.8	10	1.34
2000-10-16*	3.01	16.20	9.2	7.6	5	134	720	2	1681	4.50	0.6	0.10	0.013	1.17	0.47	1.47	4.2	7	0.62
2000-11-20	10.79	16.20	11.7	7.8	6	127	1100	51	2085	3.21	0.06	0.30	0.017	1.60	0.39	1.74	4	7	
2000-12-19	7.86	16.50	6.3	7.1	25	74	1369	74	2036	4.71	0.42	0.30	0.013	1.59	0.37	1.51	3.41	33	
Min.:	0.68	16.20	3.9	2.70	2	6	7	2	174	0.41	0.06	<0.01	0.007	0.49	<0.01	0.82	1.40	<5	0.27
Max.:	10.79	24.62	23.8	8.10	25	190	2130	74	3350	5.14	0.60	1.45	0.029	2.28	0.85	1.74	5.82	33	1.34
Aver.:	4.41	18.10	10.5	6.17	9	80	862	23	1753	2.75	0.31	0.35	0.013	1.47	0.35	1.35	3.05	9	0.71
St.dev.:	2.96	2.40	5.8	1.65	8	51	740	20	1135	1.81	0.15	0.42	0.006	0.47	0.26	0.30	1.43	8	0.45
Numb.:	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	4

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Table VII.VII Measured concentration 2000 – Watercourse: Suldalslågen

Annual flow: **1662 10^6 m^3** **Min:** **14.02 m^3/s**
Drainage area: **1457 km^2** **Max:** **169.70 m^3/s**

Date	Qi	Cond	S.P.M.	TOC	PO_4-P	Tot-P	NO_3-N	NH_4-N	Tot-N	SiO_2	As	Pb	Cd	Cu	Cr	Ni	Zn	Hg	Lindane (γ-HCH)
2000	m^3/s	mS/m	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	ng/l	ng/l
2000-01-26	15	2.44	<0.5	<1.00	<1.8	5.7	294	6	326	1.52	0.04	0.006	0.015	0.18	<0.01	0.15	1.84	7	
2000-02-21	14	2.59	<0.5	<1.00	<1.8	<2.7	313	<2	351	1.71	0.07	0.03	0.007	0.27	0.11	0.27	1.9	12	
2000-04-10	18	2.37	0.6	1.16	<1.8	<2.7	220	2	251	7.29	<0.02	<0.01	<0.001	<0.02	<0.02	<0.03	0.65	9	<0.1
2000-04-26	49	2.06	<0.5	1.07	<1.8	<2.7	166	<2	195	1.26	0.04	0.07	0.02	0.26	0.08	0.20	2.5	9	
2000-05-22	70	1.6	0.5	<1.00	1	2	155	6	191	0.90	<0.02	0.05	0.006	0.38	<0.02	0.08	1.3	13	
2000-06-26	76	1.58	0.3	0.74	5	2	160	9	231	0.94	0.06	0.07	0.011	0.40	<0.02	0.12	1.5	5	0.72
2000-07-31	66	1.52	4.8	0.5	4	4	170	4	475	0.92	<0.02	0.05	0.014	0.15	<0.02	0.17	1.89	8	
2000-08-28	73	1.45	<0.5	<0.5	1	8	123	<10*	180	0.90	0.13	<0.01	0.01	<0.02	0.08	0.02	1.3	10	0.76
2000-09-25	67	1.59	<0.5	0.7	1	3	134	3	143	0.92	0.07	<0.01	0.011	0.20	0.01	0.10	1.69	6	
2000-10-23	43	1.58	<0.5	0.8	4	13	162	9	207	1.22	0.06	0.03	0.013	0.01	<0.02	0.15	1.9	<5	0.28
2000-11-27	24	1.92	<0.5	<0.5	<1	4	206	2	243	1.29	<0.02	<0.01	0.011	0.16	<0.02	0.25	2.1	6	
Min.:	14	1.45	0.3	<0.5	<1	2	123	<2	143	0.90	<0.02	<0.01	<0.001	0.01	0.01	0.02	0.65	<5	<0.1
Max.:	76	2.59	4.8	1.2	5	13	313	9	475	7.29	0.13	0.07	0.020	0.40	0.11	0.27	2.50	13	0.76
Aver.:	47	1.88	0.9	0.8	2.2	4.5	191	5	254	1.72	0.05	0.03	0.011	0.19	0.04	0.14	1.69	8	0.47
St.dev.:	25	0.42	1.3	0.2	1.4	3.3	62	3	96	1.87	0.03	0.02	0.005	0.14	0.03	0.08	0.49	3	0.33
Numb.:	11	11	11	11	11	11	11	10	11	11	11	11	11	11	11	11	11	11	4

*Value not used in calculations. The laboratory could not give a better value.

Table VII.VIIIMeasured concentration 2000 – Watercourse: Orkla

Annual flow: **2107 10^6 m^3** **Min:** **18.1 m^3/s**
Drainage area: **2872 km^2** **Max:** **528.7 m^3/s**

Date	Qi	Cond	S.P.M.	TOC	PO_4-P	Tot-P	NO_3-N	NH_4-N	Tot-N	SiO_2	As	Pb	Cd	Cu	Cr	Ni	Zn	Hg	Lindane (γ-HCH)
2000	m^3/s	mS/m	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	ng/l	ng/l
2000-02-02	45.0	6.69	0.7	2.45	<1.8	<2.7	253	12	331	3.43	<0.01	0.01	0.044	9.85	0.01	0.82	32.4	11	
2000-02-29	43.9	5.77	0.7	1.92	<1.8	<2.7	210	14	304	3.43	0.19	0.04	0.032	6.76	0.33	0.83	16.4	7	
2000-03-31*	29.1	8.3	1	3.08	<1.8	<2.7	307	4	397	3.64	0.15	0.03	0.102	15	0.52	1.26	47.7	6	0.13
2000-04-30	331.0	4.12	22.5	5.15	22	36	114	7	344	5.57	0.26	0.45	0.070	13	1.56	2.80	25	9	
2000-06-01	81.3	4.44	1.3	2.5	2	4	122	12	225	2.79	0.07	0.03	0.037	7.01	0.39	0.87	14.9	7	0.26
2000-06-30	108.4	4.28	2	2.6	3	3	65	5	220	2.36	0.26	0.05	0.058	4.36	0.53	0.86	13.6	6	
2000-07-31	22.9	7.03	0.4	1.5	5	2	267	8	472	3.00	0.04	0.02	0.038	6.89	<0.02	0.46	14.7	7	
2000-08-31	50.0	5.42	<0.5	2.6	<1	5	125	22	459	2.36	0.21	<0.01	0.028	1.32	0.19	0.41	11.6	<5	0.14
2000-09-30	21.0	6.68	0.6	1.7	1	5	192	13	296	2.79	0.21	<0.01	0.044	5.33	0.10	0.69	19.2	8	
2000-10-31	21.3	6.41	2.4	1.5	4	8	36	59	355	3.86	0.14	0.43	0.058	8.29	<0.02	1.46	19.1	<5	0.39
2000-11-30	52.6	4.94	1.1	1.9	2	6	91	15	201	3.00	<0.02	<0.01	0.013	2.77	0.25	0.73	4.1	6	
2000-12-31	50.3	5.4	1.6	1.8	1	8	102	20	188	3.43	0.08	<0.01	0.014	2.13	0.44	0.76	5.2	<5	
Min.:	21.0	4.12	0.4	1.5	<1	2	36	4	188	2.36	<0.01	<0.01	0.013	1.32	0.01	0.41	4.1	<5	0.13
Max.:	331.0	8.30	22.5	5.2	22	36	307	59	472	5.57	0.26	0.45	0.102	15	1.56	2.80	47.7	11	0.39
Aver.:	71.4	5.79	2.9	2.39	3.9	7.1	157	16	316	3.30	0.14	0.09	0.045	6.89	0.36	1.00	18.7	7	0.23
St.dev.:	85.7	1.27	6.2	1.00	5.8	9.3	87	15	96	0.86	0.09	0.16	0.025	4.19	0.42	0.64	12.0	2	0.12
Numb.:	12.0	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	4

* Lindan sample for march taken 2000-03-11

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Table VII.IX Measured concentration 2000 – Watercourse: Vefsna

Annual flow: 6014 10^6 m^3 **Min:** 37 m^3/s
Drainage area: 4113 km^2 **Max:** 1032 m^3/s

Date	Qi	Cond	S.P.M.	TOC	PO_4-P	Tot-P	NO_3-N	NH_4-N	Tot-N	SiO_2	As	Pb	Cd	Cu	Cr	Ni	Zn	Hg	Lindane (γ-HCH)
2000	m^3/s	mS/m	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	ng/l	ng/l
2000-01-24	58	8.55	3.1	3.33	<1.8	7.9	115	24	663	2.14	0.2	0.48	0.031	2.08	<0.01	0.59	15.4	9	
2000-02-07	79	9.43	11.9	1.91	4.3	13	95	12	146	2.79	0.02	0.77	0.001	1.66	0.593	0.96	13.9	14	
2000-03-07	50	8.98	0.3	2.01	<1.8	<2.7	140	17	221	2.57	0.09	0.04	0.017	0.84	3100*	0.72	2.2	6	<0.1
2000-04-02	86	8.99	<0.5	1.86	<1.8	<2.7	89	4	131	1.78	0.1	0.03	0.002	0.48	0.39	0.34	0.93	<2	
2000-05-02	282	7.24	2.4	2.39	<1.8	4.3	67	2	102	2.14	0.07	0.14	0.016	0.44	0.32	0.20	1.3	6	
2000-05-08	358	6.19	2.4	1.88	<1.8	3.4	59	7	146	1.97	0.06	0.11	0.014	0.47	<0.02	0.28	1.6	6	
2000-05-15	564	5.5	27	2.04	3	9	41	5	88	1.41	0.02	0.08	0.006	0.45	0.13	0.30	0.6	8	
2000-05-22	714	4.61	3.3	1.81	1	<8	49	17	99	1.37	<0.02	0.09	0.002	0.59	0.10	0.32	0.5	15	
2000-05-29	667	4.03	1.5	1.22	1	3	37	9	84	0.94	0.08	0.06	0.002	0.52	0.39	0.39	<0.1	7	
2000-06-05	340	4.33	1.1	1.6	2	1	43	3	99	1.37	0.06	0.06	0.003	0.60	0.34	0.42	0.43	6	<0.1
2000-06-14	898	3.5	0.7	1.2	4	<8	37	17	94	1.20	0.1	0.06	0.003	0.40	0.15	0.27	0.5	9	
2000-06-20	604	3.77	1.5	2.1	<5	5	30	3	89	1.24	0.09	0.06	0.003	0.43	<0.02	0.21	0.5	<5	
2000-06-28	623	3.0	3.0	1.1	2	4	21	4	143	1.18	0.08	0.09	0.002	0.31	<0.02	0.24	0.5	5	
2000-07-03	526	2.93	1.8	0.8	2	2	21	21	123	1.01	0.27	0.14	0.005	0.18	0.24	0.33	0.93	9	
2000-08-07	316	2.79	1.0	0.9	11	14	37	15	80	0.90	0.15	<0.01	0.002	<0.02	0.19	<0.03	<0.1	10	
2000-09-04	109	4.44	<0.5	1.6	1	7	58	<10	91	1.24	0.18	<0.01	0.002	<0.02	0.26	<0.03	<0.1	7	0.11
2000-10-02	79	5.86	<0.5	1.4	0.5	4	138	36	193	1.97	0.13	<0.01	0.004	0.59	0.17	0.36	1.09	10	
2000-11-05	75	6.45	0.6	1.2	1	6	76	14	117	2.08	<0.02	<0.01	0.004	0.32	0.33	0.22	<0.1	<5	0.42
2000-12-11	86	5.94	2.6	1.8	2	7	88	20	165	2.04	0.11	0.15	0.005	0.97	0.42	0.2	2.7	17	
Min.:	50	2.79	0.3	0.8	1	1	21	2	80	0.90	<0.02	<0.01	0.001	<0.02	<0.01	<0.03	<0.1	<2	<0.1
Max.:	898	9.43	27	3.3	11	14	140	36	663	2.79	0.27	0.77	0.031	2.08	0.59	0.96	15.4	17	0.42
Aver.:	357	5.61	3.5	1.7	2.6	5.9	65	13	151	1.65	0.10	0.13	0.007	0.60	0.23	0.34	2.29	8	0.18
St.dev.:	274	2.19	6.2	0.6	2.4	3.5	37	9	130	0.56	0.07	0.19	0.008	0.51	0.17	0.22	4.42	4	0.16
Numb.:	18	19	19	19	19	19	19	19	19	19	19	19	19	19	18	19	19	19	4

*Value not used for calculation. The result is checked with the laboratory. The high concentration is probably due to contamination of the sample.

Table VII.X Measured concentration 2000 – Watercourse: Alta

Annual flow: **3504 10^6 m^3** **Min:** **29.8 m^3/s**
Drainage area: **7367 km^2** **Max:** **996.2 m^3/s**

Date	Qi	Cond	S.P.M.	TOC	PO_4-P	Tot-P	NO_3-N	NH_4-N	Tot-N	SiO_2	As	Pb	Cd	Cu	Cr	Ni	Zn	Hg	Lindane (γ-HCH)
2000	m^3/s	mS/m	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	ng/l	ng/l
2000-01-02	36.6	11.2	< 0.5	2.62	5.7	8.8	134	4	224	5.79	0.19	0.01	0.085	0.64	< 0.01	0.2	0.04	6	
2000-02-01	36.0	10.7	<0.5	2.9	4.7	7.1	109	4	181	6.43	0.18	<0.01	0.006	0.52	<0.01	4.67	0.34	10	
2000-02-29	35.4	12	<0.5	2.42	<1.8	4.8	111	18	206	7.50	0.18	0.01	<0.001	0.47	0.37	0.2	<0.1	10	
2000-04-03*	34.8	11.4	<0.5	2.86	2.8	5.5	83	2	166	6.86	0.13	<0.01	<0.001	0.33	0.16	0.02	0.45	9	<0.1
2000-05-02	34.8	12.8	0.7	2.74	5.4	10	78	6	174	8.14	0.18	0.02	0.002	0.51	<0.02	0.02	0.6	7	
2000-06-02	993.3	3.96	40.4	4.8	23	38	31	40	221	10.50	0.22	0.29	0.005	0.76	3.32	2.05	1.5	9	
2000-08-05*	72.9	16.4	0.4	2.5	11	17	69	4	186	5.79	0.24	0.03	0.004	0.54	0.07	0.2	0.07	<5	<0.1
2000-09-05	58.2	12	0.7	4.2	4	14	138	3	254	5.14	0.42	0.07	0.028	0.3	0.45	0.61	2.1	<5	<0.1
2000-10-03	52.1	1.38	<0.5	2.9	1	6	75	5	155	5.57	0.23	<0.01	0.001	0.52	0.44	0.22	0.19	9	0.32
2000-11-14	37.4	11.5	<0.5	2.9	3	13	99	–	346	6.21	<0.02	<0.01	0.002	0.54	0.38	0.23	<0.1	11	
2000-12-06	30.7	17.2	<0.5	2.7	14	22	72	7	209	6.00	0.27	<0.01	0.005	0.64	0.56	0.16	0.9	<5	
Min.:	30.7	1.38	0.40	2.42	1	4.8	31	2	155	5.14	<0.02	<0.01	<0.001	0.30	<0.01	0.02	0.04	<5	<0.1
Max.:	993.3	17.20	40.4	4.8	23	38	138	40	346	10.50	0.42	0.29	0.085	0.76	3.32	4.67	2.10	11	<0.3
Aver.:	129.3	10.96	4.2	3.0	6.9	13.3	91	9	211	6.72	0.21	0.04	0.013	0.52	0.53	0.78	0.58	8	<0.2
St.dev.:	286.8	4.64	12.0	0.7	6.6	9.8	31	12	53	1.53	0.10	0.08	0.025	0.13	0.95	1.41	0.67	2	0
Numb.:	11.0	11	11	11	11	11	11	10	11	11	11	11	11	11	11	11	11	11	4

* Lindan sample for april taken 2000-04-07, for august taken 2000-08-24

Appendix VIII. Tributary Rivers. Measured concentrations 2000

Table VIII. Tributary Rivers, Measured Concentrations 2000

County		Watercourse	Drainage area			Dicharge Sampl. station Normal	Precip. 2000 % of 1930 - 1960	Discharge (outlet)		Parameter																
			Outlet	Sampl station	Disch. gaug. station			Norm 1930-1960	2000	Cond	S.P.M.	TOC	PO_4-P	Tot-P	NO_3-N	NH_4-N	Tot-N	SiO_2	As	Pb	Cd	Cu	Cr	Ni	Zn	Hg
			km²	km²	km²	l.s⁻¹km²		$10^6 m^3$/år		mS/m	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	ng/l
Østfold (1.)	001	Tista. Iddefj.	1588	1582	1582	14.4	160 %	721	1156	5.43	2.14	7.1	1	15	574	21	936	<0.09	0.31	0.27	0.021	1.27	0.03	1.37	3.8	7
	003	Mosselva. Mossesundet	690	689	689	14.5	162 %	316	511	9.11	8	7.4	3	20	827	22	1323	0.60	0.35	0.23	0.01	1.88	0.05	1.11	1.6	8
Oslo og Akershus (1.)	004	Hølenelva. Drøbaksundet	137	121		14.0	143 %	60	87	29.8	<0.5	8	38	87	2612	72	3239	1.97	0.62	0.27	0.036	2.7	0.43	4.3	4.6	8
	005	Årungelva. I. Oslofj.	52	50		13.0	143 %	21	31	28.2	2.1	5.3	23	43	3089	22	3684	2.57	0.43	0.12	0.018	2.14	0.22	1.93	1.4	6
	006	Gjersjøelva. I. Oslofj.	86	85	85	14.0	161 %	38	61	18.5	0.9	6.2	2	17	1163	32	1585	4.29	0.28	0.08	0.01	1.54	0.15	2.94	1.3	<5
	007	Ljanselva. I. Oslofj.	42	41	41	13.0	158 %	17	27	27	1.66	4.1	26	38	730	41	1038	7.07	0.37	0.25	0.036	2.37	0.31	1.56	4.4	5
	008	Loelva/Alna. I. Oslofj.	75	69	69	13.0	158 %	31	49	33.1	36.2	4.9	59	73	1372	269	1718	10.93	0.72	4.96	0.174	11.5	1.13	2.35	41.4	13
	009	Akerselva. I. Oslofj.	227	225	225	17.5	158 %	125	198	4.76	1.5	3.6	8	9	264	55	404	4.07	0.23	0.61	0.029	1.58	<0.02	0.46	8.6	7
	010	Frognerelva. I. Oslofj.	23	20	20	15.0	158 %	11	17	29.6	3.6	3.9	8	9	1287	127	1473	6.64	0.49	0.41	0.031	4.64	0.09	1.62	6.3	7
	011	Lysakerelva. I. Oslofj.	178	173	173	16.8	158 %	94	149	8.25	1.5	4.7	6	6	281	38	559	4.07	0.24	0.2	0.019	0.92	<0.02	0.3	3.7	6
	012	Sandvikselva.I. Oslofj.	223	187	187	18.4	147 %	129	191	18.3	1.2	3.9	17	17	618	30	754	4.29	0.3	0.3	0.02	1.7	0.7	0.6	2	<5
	013	Åroselva. I. Oslofj.	113	109	109	17.0	156 %	61	94	16.8	0.6	5.1	4	18	692	14	1067	3.43	0.46	0.15	0.031	1.6	<0.02	0.62	1.4	9
Buskerud (2)	014	Lierelva. Drammensfj. Ø	309	266	222	18.6	142 %	181	258	15.8	4.4	3.3	22	40	593	31	832	4.93	0.51	0.24	0.032	1.63	<0.02	0.79	4.8	6
Vesfold (3.)	016	Sandeelva. Sandebukta	193	190		17.0	156 %	103	161	0.99	18.9	4.9	15	35	605	32	1008	5.79	1.51	1.04	0.078	31.2	1.7	2.1	23.2	9
	017	Aulielva. Tønsbergfj.	363	362	362	14.9	161 %	171	275	3.08	6.7	2.9	10	39	139	54	558	0.94	<2	0.3	0.07	9.2	6.1	12	2	10
	019	Farriselva. Larvikfj.	491	491	491	21.6	166 %	334	556	3.72	0.6	4	2	6	387	24	634	4.71	0.2	0.08	0.033	0.45	0.2	0.2	8.7	7

aquateam

County	Watercourse	Drainage area			Dicharge Sampl. station Normal	Precip. 2000 % of 1930 - 1960	Discharge (outlet)		Parameter																
		Outlet	Sampl station	Disch. gaug. station			Norm 1930-1960	2000	Cond	S.P.M.	TOC	PO_4-P	Tot-P	NO_3-N	NH_4-N	Tot-N	SiO_2	As	Pb	Cd	Cu	Cr	Ni	Zn	Hg
		km²	km²	km²	l.s⁻¹km²		10^6m^3/år		mS/m	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	ng/l
Telemark (4.)	021 Tokkeelva. Kragerø	1238	1200	1200	26.7	152 %	1042	1590	2.45	1.3	4.8	1	1	201	2	285	3.43	0.19	0.25	0.034	0.57	<0.02	0.96	6.2	<5
Aust-Agder (5.)	022 Gjerstadelva. Søndeledfj.	419	414	291	27.0	157 %	357	562	2.81	1.2	4.7	6	6	211	27	316	2.57	0.23	0.36	0.038	0.72	<0.02	0.93	6.6	8
	023 Vegårdselva. Sandnesfj.	457	429	291	29.3	151 %	422	639	3.12	1.1	4.3	5	5	180	9	281	1.63	0.25	0.24	0.031	0.71	<0.02	0.51	6.5	8
	024 Nidelva. Arendal	4025	4020	3956	29.8	150 %	3783	5661	1.77	0.6	2.8	5	5	160	<1	508	1.89	0.14	0.25	0.031	0.93	<0.02	0.19	4.6	<5
Vest-Agder (5.)	025 Tovdalselva. Topdalsfj.	1856	1854	1794	33.9	149 %	1984	2948	2.18	0.8	3.4	4	4	140	9	231	1.44	0.21	0.24	0.03	0.38	<0.02	0.3	4.8	<5
	027 Søgneelva. Flekkerøy	204	192	192	38.0	156 %	244	381	4.4	1	6.6	6	6	265	26	405	1.71	0.3	0.43	0.08	0.73	<0.02	0.59	9.5	6
	028 Mandalselva. Mannefj.	1809	1800	1740	46.0	160 %	2624	4198	2.07	1	3.5	5	5	142	25	176	1.20	0.16	0.47	0.03	0.48	<0.02	0.17	4.4	6
	029 Audna. Sniksfj.	450	400	59	45.0	172 %	639	1096	4	0.9	3.6	2	7	184	11	388	1.82	0.2	0.4	0.057	0.46	<0.02	0.27	8	6
	030 Lygna. Lyngdalsfj.	664	660	266	48.0	156 %	1005	1566	2.83	0.9	3.2	2	11	104	11	339	0.43	0.19	0.35	0.032	0.28	<0.02	1.56	4.7	7
	031 Kvina. Fedafj.	1445	1140	1140	57.6	156 %	2625	4091	2.74	1	4.2	2	14	62	3	290	0.43	0.25	0.45	0.021	0.39	<0.02	0.27	3.5	8
	032 Sira. Åna-Sira	1916	1872	1872	59.4	151 %	3589	5436	1.87	0.5	1.3	2	4	159	24	263	0.94	0.09	0.37	0.016	0.28	<0.02	0.11	2.7	5
Rogaland (6.)	033 Sokndalselva. Sogndalsstr.	294	293	107	51.1	152 %	474	722	4.57	0.6	1.3	2	6	210	2	324	1.44	0.13	0.21	0.037	0.61	<0.02	3.37	5.2	7
	034 Hellelandselva. Egersund	241	240	194	57.5	152 %	437	666	3.3	1.3	1.8	4	10	213	7	419	0.79	0.12	0.42	0.027	0.42	<0.02	0.36	4.3	11
	035 Bjerkreimselva. Egersund	705	704	639	77.7	152 %	1727	2632	3.36	<0.5	0.9	1	13	281	17	344	1.61	0.09	0.17	0.022	0.29	<0.02	0.9	2.9	5
	036 Håelva. Håtangen	165	160	135	46.9	150 %	244	366	9.6	3.8	4.8	33	66	1096	127	1701	3.21	0.31	0.23	0.019	0.94	<0.02	0.41	5.1	<5
	038 Figgjo. Solavika	229	218	135	50.0	150 %	361	541	9.15	3.1	2.6	16	27	667	53	1061	2.57	0.17	0.53	0.01	0.78	<0.02	0.37	2.1	6
	039 Ims-Lutsi. Høgsfj.Boknafj.	127	127	127	34.9	128 %	140	179	20.4	1.1	3.1	3	8	552	8	857	0.45	0.33	0.08	0.01	0.74	0.61	0.82	3.3	<5
	040 Oltedalse.. Høgsfj.Boknafj.	102	101	129	70.0	128 %	225	288	4.39	0.5	0.86	2	11	257	10	404	2.06	0.08	0.12	0.023	0.38	<0.02	1.1	4.2	<5

County		Watercourse	Drainage area			Dicharge Sampl. station Normal	Precip. 2000 % of 1930 - 1960	Discharge (outlet)		Parameter															
			Outlet	Sampl station	Disch. gaug. station			Norm 1930-1960	2000	Cond	S.P.M.	TOC	PO_4-P	Tot-P	NO_3-N	NH_4-N	Tot-N	SiO_2	As	Pb	Cd	Cu	Cr	Ni	Zn	Hg
			km²	km²	km²	l.s⁻¹km²		10^6m^3/år		mS/m	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	ng/l
Hordaland (7.)	041	Dirdalselva Høgsfj.Boknafj.	158	158	95	83.0	128 %	414	529	2.3	0.3	1	1	7	205	6	332	1.16	0.07	0.24	0.012	0.38	<0.02	0.09	2	<5
	042	Frafjordelva Frafj. Boknafj.	178	178	124	94.4	128 %	530	677	2.12	0.2	0.69	1	3	208	9	287	0.84	0.09	0.24	0.011	0.33	<0.02	0.08	1.3	<5
	043	Espedalselva Høgsfj.Boknafj.	138	138	124	90.0	128 %	392	501	2.65	<0.5	0.9	2	5	152	<1	613	1.67	0.25	0.13	0.01	0.13	0.28	0.22	1	7
	044	Lyseelva Lysefj.Boknafj.	182	182	46	74.0	130 %	425	553	1.67	<0.5	1.2	1	4	<5	10	89	0.90	0.2	0.15	0.007	0.26	0.37	0.38	1.4	7
	045	Årdalselva Årdalsfj.Boknafj.	519	516	501	81.4	128 %	1332	1704	2.27	<0.5	1	2	4	158	30	329	1.20	0.22	0.19	0.011	0.28	0.29	0.15	3.7	9
	046	Førreelva. Jøsenfj.Boknafj.	163	163	163	85.8	120 %	441	529	2.03	<0.5	0.6	2	5	63	<1	132	1.91	0.16	0.04	0.004	0.03	0.35	0.03	0.7	<5
	047	Ulla. Jøsenfj.Boknafj.	393	393	385	83.4	120 %	1034	1239	2.15	<0.5	1.7	2	17	66	19	196	1.39	0.2	0.13	0.008	0.1	0.27	0.08	1.1	14
	049	Saudaelva. Saudafj.Boknafj.	353	353		85.0	122 %	946	1152	1.58	<0.5	<0.5	3	5	236	<1	317	0.88	0.16	0.18	0.041	0.52	0.29	0.11	10.4	7
	050	Åbøelva. Saudafj.Boknafj.	82	82		85.0	122 %	220	268	1.01	<0.5	<0.5	2	6	113	1	176	0.51	0.13	0.13	0.009	0.07	0.27	0.16	1.4	8
	051	Vikedalselva Boknafj.	118	117		80.0	135 %	298	401	2.5	<0.5	0.8	3	6	224	3	372	0.86	0.34	0.12	0.015	0.21	0.21	0.29	2	<5
	052	Etneelva. Etnefj. Bømlafj.	252	250	127	48.8	135 %	388	522	2.62	<0.5	0.6	2	3	383	39	500	1.01	0.26	0.09	0.013	0.44	0.28	1.22	2	6
	053	Opo. Sørfj. Hardangerfj.	482	480	464	79.3	115 %	1205	1390	1.42	0.6	0.6	3	6	127	<1	251	0.79	0.14	0.27	0.019	0.23	0.37	0.29	4	<5
	054	Tysso. Sørfj. Hardangerfj.	388	385	407	79.3	115 %	970	1119	1.94	<0.5	0.8	2	10	73	4	168	1.46	0.16	0.22	0.023	0.76	0.26	0.33	4.3	9
	055	Kinso. Sørfj. Hardangerfj.	281	281	232	46.0	124 %	408	506	1.9	0.8	<0.5	2	3	61	<1	138	0.51	0.12	0.18	0.008	0.19	0.71	0.12	1.2	5
	056	Veig. Eidfjv. Hardangerfj.	496	496	386	41.8	132 %	654	864	1.46	10	1	2	13	24	4	150	1.78	0.23	0.53	0.027	0.42	0.76	1.02	3.8	<5
	057	Bjoreia. " . Hardangerfj.	592	592	592	26.0	140 %	485	681	1.43	1.9	1.6	2	10	12	<1	149	1.03	0.12	0.24	0.011	0.31	0.18	0.46	1.6	<5
	058	Sima. Eidfj. Hardangerfj.	145	145	128	69.2	132 %	316	418	1.13	4.5	0.5	2	6	26	<1	116	1.18	0.1	0.66	0.013	0.33	0.42	0.52	2.1	6
	059	Austdøla. Osafj. Eidfj.	131	130	89	74.6	132 %	308	407	0.61	0.6	<0.5	2	3	59	11	111	0.36	0.07	0.18	0.007	0.23	0.21	0.08	1.7	5
	060	Norddøla. Osafj. Eidfj.	40	39	89	74.6	132 %	94	124	1.99	17.3	<0.5	2	16	42	<1	147	1.39	0.53	1.11	0.05	1.1	0.82	1.31	4.2	7

County		Watercourse	Drainage area			Dicharge Sampl. station Normal	Precip. 2000 % of 1930 - 1960	Discharge (outlet)		Parameter																
			Outlet	Sampl station	Disch. gaug. station			Norm 1930-1960	2000	Cond	S.P.M.	TOC	PO_4-P	Tot-P	NO_3-N	NH_4-N	Tot-N	SiO_2	As	Pb	Cd	Cu	Cr	Ni	Zn	Hg
			km²	km²	km²	l.s⁻¹km²		10^6m^3/år		mS/m	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	ng/l
Sogn og Fjordane (7.)	061	Tysseelva. Fusafj.	240	240		85.0	121 %	643	777	1.32	1.4	0.6	2	6	76	<1	187	0.34	0.12	0.26	0.012	0.19	0.22	0.11	1.8	9
	062	Oselva. Fusafj.	109	108	50	91.7	115 %	315	363	3.68	3.6	3.5	2	20	167	7	446	1.01	0.3	0.25	0.017	1.18	0.47	0.68	4.1	9
	063	Bergsdalse. Veafj.Herdlafj	198	198		80.0	124 %	500	622	1.46	0.9	0.7	2	4	78	<1	184	0.60	0.06	0.25	0.014	0.44	0.4	0.27	3.8	9
	064	Vosso. Veafj. Sørfj.	1492	1465	1102	58.2	127 %	2738	3489	1.13	0.9	0.7	3	8	80	63	202	0.99	0.08	0.1	0.011	0.14	0.27	0.18	1.9	7
	065	Ekso. Osterfj.	414	400	342	86.2	129 %	1125	1456	0.88	<0.5	0.6	2	7	60	12	123	0.34	0.08	0.15	0.007	0.1	0.23	0.09	1.4	5
	066	Modalselva. Osterfj.	385	384	248	95.5	129 %	1159	1497	1.22	0.6	0.6	1	5	78	1	157	0.58	0.07	0.19	0.007	0.03	0.22	<0.03	1.2	11
	067	Nærøyelva Aurl.fj. Sognefj.	290	290	267	59.5	139 %	544	754	0.98	1.1	<0.5	3	8	58	4	138	1.50	0.06	0.07	0.005	0.14	0.38	0.06	1.4	5
	068	Flåmselva Aurl.fj. Sognefj.	280	275	275	52.4	113 %	463	522	1.43	3	<0.5	1	11	83	35	138	1.09	0.1	0.21	0.012	0.32	0.29	0.4	1.8	9
	069	Aurlandv.Aurl.fj. Sognefj.	800	799	762	48.6	113 %	1226	1384	1.3	1.3	<0.5	1	7	90	4	160	1.31	0.12	0.28	0.006	0.31	0.35	0.22	1.3	14
	070	Erdalse.Lærd.fj. Sognefj.	138	138		30.0	113 %	131	147	0.83	0.8	<0.5	1	6	33	3	136	1.31	0.06	0.07	0.004	0.07	0.24	0.07	0.86	6
	071	Lærdalsv.Lærd. fj. Sognefj.	1184	1172	1172	30.0	136 %	1120	1529	1.22	1.2	<0.5	<1	12	36	2	87	1.67	0.06	0.08	0.004	0.35	0.21	0.15	1.15	7
	072	Årdalsv. Årdalsfj.Sognefj.	989	989	989	44.9	124 %	1400	1741	1.13	0.7	0.7	1	8	81	1	142	1.84	0.05	0.05	0.008	0.96	0.19	0.15	1.4	11
	073	Fortunv. Lusterfj.Sognefj.	508	508	367	51.0	124 %	817	1016	0.75	4.7	<0.5	1	10	68	2	105	1.54	0.12	0.31	0.008	1.03	0.41	0.41	2.7	6
	074	Mørkrisv. Lusterfj.Sognefj.	282	282	203	54.7	124 %	486	605	0.68	1.4	<0.5	1	21	69	2	105	2.36	0.05	0.32	0.008	0.89	0.89	0.69	3.2	10
	075	Jostedøla. " Sognefj.	865	864	573	68.0	130 %	1855	2408	0.88	69.4	<0.5	1	99	45	9	120	7.71	0.07	1.13	0.007	2.67	3.2	2.4	9.8	<5
	076	Årøye.Sognd.fj. Sognefj.	449	446	384	77.2	128 %	1093	1396	1.45	0.8	<0.5	<1	10	70	<1	200	1.59	0.04	0.06	0.004	0.14	0.24	0.1	1.1	10
	077	Sogndalse. " Sognefj.	175	172	111	66.1	128 %	365	467	1.01	0.6	0.8	3	3	80	<1	96	0.90	0.22	0.1	0.007	0.12	0.38	0.05	1.2	8
	078	Gaular. Dalsfj. Bufj.	627	625	505	79.3	110 %	1568	1728	1.33	<0.5	1.6	<1	<1	81	<1	186	0.79	0.19	0.17	0.009	0.12	0.4	0.03	1.8	14
	079	Jølstra. Førdefj.	714	709	384	74.3	109 %	1673	1829	1.44	<0.5	1	<1	<1	87	<1	157	0.81	0.16	0.06	0.008	0.11	0.44	0.01	1.5	6

County		Watercourse	Drainage area			Dicharge Sampl. station Normal	Precip. 2000 % of 1930 - 1960	Discharge (outlet)		Parameter																
			Outlet	Sampl station	Disch. gaug. station			Norm 1930-1960	2000	Cond	S.P.M.	TOC	PO_4-P	Tot-P	NO_3-N	NH_4-N	Tot-N	SiO_2	As	Pb	Cd	Cu	Cr	Ni	Zn	Hg
			km²	km²	km²	l.s⁻¹km²		10^6m^3/år		mS/m	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	ng/l
Møre ogRomsdal (8.)	080	Nausta. Førdefj.	277	273	232	81.7	109 %	714	780	1.07	<0.5	0.9	<1	<1	26	<1	151	<0.09	0.15	0.13	0.005	2	0.39	1.28	2.6	6
	081	Oselva. Høydalsfj.	287	285	225	78.7	111 %	712	791	2.11	0.7	2.1	<1	6	30	2	158	<0.09	0.18	0.17	0.009	0.1	0.41	0.09	1.8	12
	082	Hopselva Hyefj. Nordfj.S	73	73	161	75.0	129 %	173	223	1.92	<0.5	0.5	<1	<1	104	<1	135	0.43	0.15	0.16	0.011	0.03	0.41	0.04	1.16	12
	083	Gjengedalselva" Nordfj.S	170	168	161	75.0	114 %	402	458	0.98	<0.5	0.8	<1	<1	34	<1	81	0.60	0.15	0.12	0.006	0.02	0.46	0.01	0.93	12
	084	BreimselvaGloppenfj. "	636	634	585	68.0	116 %	1364	1579	1.78	0.8	1.1	<1	3	179	25	239	1.44	0.13	0.05	0.005	0.15	0.34	0.1	1.06	<5
	085	Oldenelva Indre Nordfj.	226	225	204	70.1	121 %	500	603	1.52	0.9	0.6	<1	<1	153	13	207	1.69	0.4	0.12	0.01	0.28	0.38	0.12	1.08	<5
	086	Loenelva. Indre Nordfj.	261	260	234	65.0	121 %	535	646	1.63	1.1	0.5	<1	<1	107	4	165	1.97	0.21	0.1	0.005	0.43	0.42	0.1	1.07	<5
	087	Stryneelva Indre Nordfj.	531	530	493	60.2	111 %	1008	1120	1.81	1	0.6	<1	<1	115	6	160	1.54	0.12	0.1	0.006	0.61	0.43	0.13	0.9	<5
	088	Hornindalselva Nordfj. N	428	424	378	58.1	117 %	784	916	1.81	0.6	1	<1	<1	167	2	188	1.44	0.13	0.04	0.006	0.37	0.43	0.19	1.2	<5
	089	Ørstaelva Ørstafj.	160	155		70.0	101 %	353	357	2.11	0.5	1.7	<1	<1	92	2	150	1.89	0.11	0.03	0.002	0.34	0.42	0.16	0.8	<5
	090	Valldøla. Nordalfj.Storfj.	359	357		60.0	87 %	679	593	1.01	0.6	0.5	<1	<1	19	<1	57	1.24	0.12	0.02	0.002	0.4	0.39	0.04	0.4	<5
	091	Rauma.Roms-dalsfj. Moldefj.	1202	1190	1142	32.8	99 %	1243	1231	1	1.2	<0.5	<1	<1	25	2	78	1.61	0.16	0.08	0.004	0.48	0.31	0.13	1.1	<5
	092	Isa. Isfj. Moldefj.	175	175	89	57.0	98 %	315	308	1.4	1.2	<0.5	<1	<1	44	6	116	1.71	0.1	0.03	0.002	0.43	0.49	0.12	0.56	<5
	093	Eira. Eresfj. Moldefj.	1119	1119	1085	34.8	99 %	1228	1215	2.14	<0.5	0.5	<1	<1	107	4	158	2.10	0.1	0.01	0.004	0.47	0.41	0.07	0.42	<5
	094	Littledalselva Sunndalsfj.	359	330	330	41.0	92 %	464	429	1.5	1.1	0.5	<1	20	87	<1	117	1.91	0.09	0.03	0.002	0.48	0.55	0.13	0.45	<5
	095	Driva.Sunnd.fj. Tingvollfj.	2487	2435	2435	27.9	108 %	2188	2372	1.83	5.4	2.2	5	5	41	<10	89	2.57	<0.02	0.12	0.002	0.86	0.68	0.39	1.1	<5
	096	Ulvåa. Ålvundfj.	199	199	207	57.0	112 %	358	400	2.84	0.4	2.4	<1	14	310	14	381	3.43	<0.02	0.05	0.002	1.03	0.18	0.22	1.4	<5
	097	Toåa. Todalsfj.	251	251	207	58.5	112 %	463	518	1.65	0.5	1	6	11	44	7	135	1.39	<0.02	0.03	0.002	0.45	0.17	0.04	0.63	<5
	098	Surna. Surnadalsfj.	1200	1200	1125	48.0	96 %	1816	1739	2.31	0.7	1.6	<1	11	51	<1	112	1.22	<0.02	0.06	0.002	0.48	0.25	0.19	0.87	<5
	099	Bøvra.Hamnesfj. Halsafj.	243	243	196	55.0	90 %	421	377	2.28	0.3	2.7	<1	10	31	3	109	0.88	<0.02	0.04	0.002	0.33	0.2	0.14	0.4	<5

County		Watercourse	Drainage area			Dicharge Sampl. station Normal	Precip. 2000 % of 1930 - 1960	Discharge (outlet)		Parameter															
			Outlet	Sampl station	Disch. gaug. station			Norm 1930-1960	2000	Cond	S.P.M.	TOC	PO_4-P	Tot-P	NO_3-N	NH_4-N	Tot-N	SiO_2	As	Pb	Cd	Cu	Cr	Ni	Zn	Hg
			km²	km²	km²	l.s⁻¹km²		10^6m^3/år		mS/m	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	ng/l
Sør-Trøndelag (8.)	101	Børselva. Gaulosen.Tr.h.fj	110	100		30.0	101 %	104	105	9.55	5.3	5.7	2	49	335	38	557	1.50	0.06	0.08	0.002	1.35	0.27	1.34	1.01	<5
	102	Vigda.Gaulosen Tr.h.fj.	150	150		30.0	101 %	142	143	11.43	10	3.3	8	23	302	8	382	3.00	0.09	0.17	0.012	1.33	0.9	1.56	1.49	<5
	103	Gaula.Gaulosen Tr.h.fj.	3659	3650	3062	26.4	89 %	3046	2718	4.38	4.3	2.4	1	12	52	6	118	2.57	<0.02	0.09	0.005	1.33	0.26	1.26	2.38	17
	104	Nidelva. Trondheimsfj.	3110	3100	3049	35.5	96 %	3482	3335	3.14	0.7	2.8	<1	11	71	8	154	1.65	0.02	0.04	0.002	0.76	0.33	0.68	1.29	16
	105	Homla. Stjørd.fj.Tr.h.fj.	157	157		30.0	81 %	149	120	5.21	0.4	4.7	<1	12	33	6	166	1.48	0.25	0.03	0.002	0.71	0.33	0.29	0.79	6
Nord-Trøndelag (8.)	106	Stjørdalsv. " Tr.h.fj.	2117	2117	1863	38.5	92 %	2570	2373	2.82	1.2	2.5	1	10	75	9	137	1.01	<0.02	0.04	0.004	1.22	0.28	0.4	2.9	11
	107	Gråelva " Tr.h.fj.	93	93		25.0	82 %	73	60	8.99	1.6	4.8	3	18	289	21	373	1.91	0.1	0.07	0.002	0.94	0.41	0.57	0.86	11
	108	Verdalsvassdr.. Tr.h.fj.	1472	1472	898	40.0	102 %	1857	1902	4.43	1.1	2.8	<1	14	83	22	156	1.29	<0.02	0.06	0.002	0.73	0.32	0.96	1.52	<5
	109	Figga/Leksdalse ..Tr.h.fj.	1080	1073	1267	40.4	96 %	1376	1316	5.37	5.2	5.5	2	19	324	38	464	1.91	0.04	0.13	0.002	1.03	0.52	0.76	1.5	14
	110	Snåsavassdr.. Trondh.fj.	1095	1088	1287	39.9	108 %	1376	1489	4.08	1.2	3.8	<1	11	140	14	271	1.22	<0.02	0.03	0.002	0.58	0.23	0.39	0.85	16
	111	Årgårdselva. Namsfj.	1110	1103	1307	39.3	111 %	1376	1529	4.79	1.8	5.6	<1	11	76	11	223	1.22	<0.02	0.1	0.004	0.55	0.31	0.28	1.12	10
	112	Namsen. Namsfj. Ø	1124	1118	1326	38.8	96 %	1376	1319	2.39	1.6	2.5	<1	11	40	22	139	0.96	<0.02	0.05	0.002	0.66	0.29	0.28	1.49	9
	113	Salsvatnelva. Follafj.	1154	1147	1366	37.7	104 %	1374	1425	4.65	0.4	1.7	<1	9	52	9	98	1.05	<0.02	0.03	0.005	0.19	0.1	0.08	1.34	<5
Norland (9.)	114	Åbjøra. Bindalsfj. S	526	520	384	80.2	103 %	1330	1374	2.2	0.6	1.8	1	6	11	16	78	0.51	<0.02	0.05	0.002	0.21	0.08	0.08	0.57	<5
	116	Skjerva. Vefsenfj. S	104	104	98	41.3	112 %	135	152	6.55	2.4	1.9	4	16	63	58	201	1.31	0.05	0.15	0.002	0.8	0.36	0.76	1.65	<5
	117	Fusta. Vefsenfj. N	544	543	520	63.4	112 %	1088	1223	2.6	0.9	1.1	2	11	<5	26	54	0.64	<0.02	0.04	0.002	0.27	0.07	0.21	0.93	<5
	118	Drevja. Vefsenfj. N	177	176	98	65.0	112 %	363	408	3.49	1.1	0.6	3	11	9	11	50	0.60	<0.02	0.05	0.002	0.19	0.1	0.15	0.58	<5
	119	Røssåga. Sørfj.	2092	2087	1880	45.4	112 %	2995	3363	4.43	3	0.7	3	10	34	9	<10	0.11	<0.02	0.08	0.004	0.56	0.2	0.65	3.88	<5

County		Watercourse	Drainage area			Dicharge Sampl. station Normal	Precip. 2000 % of 1930 - 1960	Discharge (outlet)		Parameter																
			Outlet	Sampl station	Disch. gaug. station			Norm 1930-1960	2000	Cond	S.P.M.	TOC	PO_4-P	Tot-P	NO_3-N	NH_4-N	Tot-N	SiO_2	As	Pb	Cd	Cu	Cr	Ni	Zn	Hg
			km²	km²	km²	l.s⁻¹km²		10^6m^3/år		mS/m	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	ng/l
Troms (9.)	120	Bjerka. Sørfj.	385	385	273	55.4	94 %	673	629	2.44	0.3	<0.5	3	8	<5	<10	32	0.75	<0.02	<0.01	0.002	0.2	0.05	0.18	0.45	<5
	121	Dalselva. Ranafj. N	211	211	129	39.5	94 %	263	246	1.92	0.1	0.7	11	13	30	–*	37	0.79	<0.02	0.02	0.003	0.21	<0.02	0.21	0.37	<5
	122	Ranavassdraget. Ranafj. N	3847	3846	1892	44.9	108 %	5447	5884	2	1.2	0.6	8	11	27	8	34	0.99	0.04	0.06	0.004	0.17	<0.02	0.08	0.51	<5
	123	Fykanåga. Glomfjord	297	297	243	103.7	105 %	971	1021	4.03	<0.5	0.8	4	26	55	13	75	0.77	<0.02	0.02	0.004	0.18	<0.02	0.13	0.35	<5
	124	Beiare..Beiarfj. Nordfj.	1064	875	797	45.1	108 %	1513	1641	1.92	2.9	<0.5	5	11	18	<10	28	1.31	<0.02	0.06	<0.02	0.27	<0.02	0.28	0.4	<5
	125	Saltdalsvassdr.. Saltd.fj.S	1544	1543	1168	32.1	124 %	1563	1944	1.98	12.2	0.7	4	14	37	<10	59	1.89	0.11	0.21	0.005	0.51	<0.02	0.58	1.34	<5
	126	Sulitjelmavassdr ..Saltd.fj	1028	800	791	44.0	112 %	1426	1591	1.3	1	<0.5	4	12	12	16	21	0.54	<0.02	0.02	0.003	0.46	<0.02	0.09	0.56	<5
	127	Kobbe. Leirfj. Sørfolda N	405	405	386	66.9	99 %	854	849	1.71	0.55	<0.5	5	12	42	19	65	1.03	<0.02	0.03	0.006	0.07	<0.02	0.03	0.79	<5
	128	Skjoma. Ofotfj.S	845	840	797	36.3	125 %	967	1212	1.04	1.4	0.6	7	11	20	15	49	1.24	0.05	0.25	0.014	0.47	<0.02	1.33	2.29	<5
	129	Spanselva. Astafj. Vågsfj.	142	142	142	50.0	157 %	224	351	5.64	0.6	0.5	8	8	30	13	50	1.26	0.01	0.02	0.002	0.36	0.32	0.26	<0.1	<5
	130	Salangselva Astafj. Vågsfj.	539	539	539	40.9	132 %	695	916	6.17	0.5	<0.5	4	4	27	10	40	1.03	0.04	0.04	0.002	0.26	0.06	0.28	<0.1	<5
	131	Rossfjordelva Malangen	196	190	190	39.5	147 %	244	358	6.15	0.2	1.5	2	3	10	8	95	0.92	0.02	0.02	0.002	0.32	0.05	0.31	<0.1	<5
	132	Målselva Målselvfj. "	3239	3200	3200	28.7	176 %	2932	5157	4.9	0.9	0.9	4	5	45	15	61	2.14	0.01	0.03	0.002	0.41	<0.02	0.39	<0.1	<5
	133	Barduelva Målselva	2906	2906	2906	28.3	176 %	2594	4562	3.81	2.9	0.5	4	7	27	14	47	1.69	0.01	0.09	0.002	0.5	<0.02	0.34	<0.1	<5
	134	Nordkjoselva. Balsfj.	191	191	191	27.7	138 %	167	231	3.4	1.4	<0.5	1	5	19	6	43	2.36	0.06	0.02	0.002	0.38	<0.02	0.28	<0.1	<5
	135	Signaldalselva. Lyngen V	473	467	467	27.7	131 %	413	543	2.76	3.2	<0.5	3	10	18	4	34	2.36	0.03	0.05	0.002	0.6	<0.02	0.44	0.27	<5
	136	Skibotnelva. Lyngen	770	770	770	18.0	125 %	437	545	2.38	1	1	1	7	21	3	42	2.10	<0.02	0.02	0.004	0.56	<0.02	0.96	0.33	<5
	137	Kåfjordelva. Lyngen Ø	358	358	358	20.0	107 %	226	242	2.94	3	0.6	2	6	68	2	214	2.01	0.03	0.04	0.003	2.02	<0.02	0.6	3.08	39

* Sample misted. 1999 data (<2) used for further calculation.

County		Watercourse	Drainage area			Dicharge Sampl. station Normal	Precip. 2000 % of 1930 - 1960	Discharge (outlet)		Parameter																
			Outlet	Sampl station	Disch. gaug. station			Norm 1930-1960	2000	Cond	S.P.M.	TOC	PO_4-P	Tot-P	NO_3-N	NH_4-N	Tot-N	SiO_2	As	Pb	Cd	Cu	Cr	Ni	Zn	Hg
			km^2	km^2	km^2	$l.s^{-1}km^2$		10^6m^3/år		mS/m	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	ng/l
Finnmark (10.)	138	Reisa. Reisafj.	2702	2702	2702	16.0	122 %	1363	1657	3.19	5.9	1.1	1	20	62	8	92	4.07	0.04	0.11	0.004	1.14	0.04	0.64	0.86	<5
	139	Mattiselva. Kåfj. Altafj.	325	325	325	26.5	112 %	272	303	2.3	0.5	1.2	3	3	14	5	47	1.31	0.08	0.01	0.002	0.49	<0.02	0.16	0.08	6
	141	Tverrelva. Altafj.	234	233	233	15.1	112 %	111	124	4.6	0.5	2.6	3	12	64	8	164	2.36	0.05	0.02	0.002	0.57	<0.02	0.3	0.21	<5
	142	Repparfjordv.. Repparfj.	1090	1089	1089	25.0	110 %	859	948	2.87	0.1	1.5	8	24	46	3	79	1.69	<0.02	0.01	0.002	0.4	<0.02	0.27	0.15	14
	143	Stabburse..I. Porsangen V	1108	1102	1102	18.3	110 %	639	706	2.61	0.2	1.6	4	4	17	1	43	3.00	<0.02	0.01	0.002	0.17	<0.02	0.11	0.36	<5
	144	Lakse.. Indre Porsangen S	1533	1532	1532	15.9	110 %	769	848	4.31	15.7	2.1	<1	17	10	4	62	4.07	<0.02	0.14	0.002	1.2	0.63	1.02	1.21	<5
	145	Børselva.Indre Porsangen Ø	883	883	883	29.8	133 %	830	1103	4.59	<0.5	<0.5	3	5	18	25	43	4.07	0.04	<0.01	0.002	<0.02	0.14	<0.03	<0.1	200
	146	Mattusjåkka. I. Laksefj. V	101	101	101	22.8	95 %	73	69	5.34	<0.5	0.8	1	4	11	19	48	1.65	0.07	<0.01	0.002	<0.02	0.15	<0.03	<0.1	<5
	147	Storelva.Indre Laksefj. V	690	690	690	21.9	95 %	477	455	2.98	<0.5	<0.5	1	6	37	22	55	3.43	0.07	<0.01	0.002	<0.02	0.1	<0.03	0.4	<5
	148	Soussjåkka. I. Laksefj. V	92	92	92	25.3	95 %	73	70	4.95	<0.5	<0.5	2	4	25	13	66	4.07	0.03	<0.01	0.002	<0.02	0.1	<0.03	0.5	13
	149	Adamselva. I. Laksefj. Ø	705	705	705	19.9	95 %	442	422	5.82	<0.5	2.9	2	3	16	15	66	3.86	0.05	<0.01	0.002	<0.02	0.15	<0.03	0.4	<5
	150	Tanavassdraget. Tanafj. S	16389	15713	15713	11.5	108 %	5944	6439	4.31	<0.5	2.5	4	6	37	32	140	6.64	0.06	<0.01	0.002	<0.02	0.25	0.11	<0.1	<5
	151	Vesterelva. Syltefj.	469	469	469	34.6	115 %	512	591	5.86	0.2	<0.5	3	7	45	3	410	3.21	0.16	<0.01	0.002	0.1	<0.02	0.05	0.08	<5
	152	V. Jakobselva Y.Varangerfj.	627	627	627	18.1	136 %	358	487	24.93	0.2	0.5	5	5	30	3	341	6.00	0.1	0.01	0.002	0.16	0.42	0.12	0.14	<5
	153	Passvike..Bøkfj. Varang.fj.	18404	18400	18400	9.3	136 %	5398	7343	2.95	0.7	3.2	<1	8	54	13	324	5.14	0.06	0.02	0.002	0.88	<0.02	3.92	0.4	<5
	154	Neiden. Munkfj. Varang.fj.	2960	2960	2960	9.8	143 %	915	1312	2.61	0.6	3	<1	8	24	11	390	2.57	0.03	0.02	0.002	0.52	<0.02	0.23	0.09	<5
	155	Grense.Jakobse. Varang.fj.	234	234	234	18.0	110 %	133	145	4.34	0.3	1.6	3	5	80	5	247	<0.09	0.12	0.02	0.006	2.01	<0.02	7.34	0.63	<5

Appendix IX. Tributary Rivers. Annual Load 2000

Table IX. Tributary Rivers. Annual Load 2000

County	Watercourse	Parameter															
		S.P.M. tonnes	TOC tonnes	PO_4-P tonnes	Tot-P Tonnes	NO_3-N tonnes	NH_4-N tonnes	Tot-N tonnes	SiO_2 tonnes	As kg	Pb kg	Cd kg	Cu kg	Cr kg	Ni kg	Zn kg	Hg kg
Østfold	001 Tista. Iddefj.	2473	8205	1.16	17.33	663	24.3	1082	< 104	358	312	24.3	1468	35	1583	4391	8.09
(1.)	003 Mosselva. Mossesundet	4091	3784	1.53	10.23	423	11.3	677	307	179	118	5.1	961	26	568	818	4.09
Oslo og	004 Hølenelva. Drøbaksundet Ø	< 43	693	3.29	7.54	226	6.2	281	171	54	23	3.1	234	37	373	399	0.69
Akershus	005 Årungelva. I. Oslofj.	64	162	0.70	1.31	94	0.7	112	79	13	4	0.5	65	7	59	43	0.18
(1.)	006 Gjersjøelva. I. Oslofj.	55	379	0.12	1.04	71	2.0	97	262	17	5	0.6	94	9	180	79	< 0.3
	007 Ljanselva. I. Oslofj.	45	111	0.71	1.03	20	1.1	28	192	10	7	1.0	64	8	42	120	0.14
	008 Loelva/Alna. I. Oslofj.	1757	238	2.86	3.54	67	13.1	83	530	35	241	8.4	558	55	114	2009	0.63
	009 Akerselva. I. Oslofj.	297	712	1.58	1.78	52	10.9	80	805	45	121	5.7	312	< 4	91	1700	1.38
	010 Frognerelva. I. Oslofj.	62	67	0.14	0.15	22	2.2	25	114	8	7	0.5	80	2	28	108	0.12
	011 Lysakerelva. I. Oslofj.	223	700	0.89	0.89	42	5.7	83	606	36	30	2.8	137	< 3	45	551	0.89
	012 Sandvikselva.I. Oslofj.	229	743	3.24	3.24	118	5.7	144	817	57	57	3.8	324	133	114	381	< 1.0
	013 Åroselva. I. Oslofj.	57	481	0.38	1.70	65	1.3	101	324	43	14	2.9	151	< 2	59	132	0.85
Buskerud	014 Lierelva. Drammensfj. Ø	1134	851	5.67	10.31	153	8.0	214	1270	131	62	8.2	420	< 5	204	1237	1.55
(2.)																	
Vestfold	016 Sandeelva. Sandebukta	3044	789	2.42	5.64	97	5.2	162	932	243	167	12.6	5024	274	338	3736	1.45
(3.)	017 Aulielva. Tønsbergfj.	1843	798	2.75	10.73	38	14.9	154	259	< 550	83	19.3	2531	1678	3301	550	2.75
	019 Farriselva. Larvikfj.	333	2222	1.11	3.33	215	13.3	352	2619	111	44	18.3	250	111	111	4834	3.89
Telemark	021 Tokkeelva. Kragerø	2066	7630	1.59	1.59	320	3.2	453	5450	302	397	54.0	906	< 32	1526	9856	< 7.9
(4.)																	
Aust-	022 Gjerstadelva. Søndeledfj.	674	2640	3.37	3.37	119	15.2	178	1445	129	202	21.3	404	< 11	522	3708	4.49
Agder	023 Vegårdselva. Sandnesfj.	703	2747	3.19	3.19	115	5.7	180	1040	160	153	19.8	454	< 13	326	4152	5.11
(5.)	024 Nidelva. Arendal	3396	15850	28.30	28.30	906	< 6	2876	10674	792	1415	175	5264	< 113	1076	26039	< 28
Vest-	025 Tovdalselva. Topdalsfj.	2358	10023	11.79	11.79	413	26.5	681	4233	619	708	88.4	1120	< 59	884	14151	< 15
Agder	027 Søgneelva. Flekkerøy	381	2515	2.29	2.29	101	9.9	154	653	114	164	30.5	278	< 8	225	3620	2.29
(5.)	028 Mandalselva. Mannefj.	4198	14691	20.99	20.99	596	104.9	739	5037	672	1973	126	2002	< 84	726	18469	25.2
	029 Audna. Sniksfj.	986	3944	2.19	7.67	202	12.1	425	1995	219	438	62.4	504	< 22	296	8764	6.57
	030 Lygna. Lyngdalsfj.	1410	5013	3.13	17.23	163	17.2	531	671	298	548	50.1	439	< 31	2444	7363	11
	031 Kvina. Fedafj.	4091	17181	8.18	57.27	254	12.3	1186	1753	1023	1841	85.9	1595	< 82	1105	14318	32.7
	032 Sira. Åna-Sira	2718	7067	10.87	21.74	864	130.5	1430	5125	489	2011	87.0	1522	< 109	598	14677	27.2

County	Watercourse	Parameter															
		S.P.M. tonnes	TOC tonnes	PO_4-P tonnes	Tot-P Tonnes	NO_3-N tonnes	NH_4-N tonnes	Tot-N tonnes	SiO_2 tonnes	As kg	Pb kg	Cd kg	Cu kg	Cr kg	Ni kg	Zn kg	Hg kg
Rogaland	033 Sokndalselva. Sogndalsstr.	433	938	1.44	4.33	152	1.4	234	1036	94	152	26.7	440	< 14	2433	3754	5.05
(6.)	034 Hellelandselva. Egersund	866	1199	2.66	6.66	142	4.7	279	528	80	280	18.0	281	< 13	240	2863	7.32
	035 Bjerkreimselva. Egersund	< 1316	2369	2.63	34.22	740	44.7	905	4230	237	447	57.9	750	< 53	2369	7633	13.2
	036 Håelva. Håtangen	1389	1755	12.06	24.13	401	46.4	622	1175	113	84	6.9	344	< 7	150	1864	< 1.8
	038 Figgjo. Solavika	1677	1406	8.65	14.60	361	28.7	574	1391	92	287	5.4	422	< 11	200	1136	3.25
	039 Ims-Lutsi. Høgsfj.Boknafj.	197	554	0.54	1.43	99	1.4	153	80	59	14	1.8	132	109	147	590	< 0.9
	040 Oltedalselva Høgsfj.Boknafj.	144	248	0.58	3.17	74	2.9	116	592	23	35	6.6	109	< 6	317	1209	< 1.4
	041 Dirdalselva Høgsfj.Boknafj.	159	529	0.53	3.70	108	3.2	176	612	37	127	6.3	201	< 11	48	1057	< 2.6
	042 Frafjordelva Frafj. Boknafj.	135	467	0.68	2.03	141	6.1	194	566	61	163	7.5	224	< 14	54	881	< 3.4
	043 Espedalse..Høgsfj.Boknafj.	< 250	451	1.00	2.50	76	< 1	307	837	125	65	5.0	65	140	110	501	3.5
	044 Lyseelva Lysefj.Boknafj.	< 277	664	0.55	2.21	< 3	5.5	49	498	111	83	3.9	144	205	210	775	3.87
	045 Årdalselva Årdalsfj.Boknafj.	< 852	1704	3.41	6.82	269	51.1	561	2045	375	324	18.7	477	494	256	6305	15.3
	046 Førreelva Jøsenfj.Boknafj.	< 264	317	1.06	2.64	33	< 1	70	1008	85	21	2.1	16	185	16	370	< 2.6
	047 Ulla. Jøsenfj.Boknafj.	< 620	2107	2.48	21.07	82	23.5	243	1726	248	161	9.9	124	335	99	1363	17.3
(7.)	049 Saudaelva Saudafj.Boknafj.	< 576	< 576	3.46	5.76	272	< 1	365	1012	184	207	47.2	599	334	127	11982	8.06
	050 Åbøelva. Saudafj.Boknafj.	< 134	< 134	0.54	1.61	30	0.3	47	138	35	35	2.4	19	72	43	375	2.14
	051 Vikedalselva Boknafj.	< 200	321	1.20	2.40	90	1.2	149	343	136	48	6.0	84	84	116	801	< 2.0
Horda-	052 Etneelva. Etnefj. Bømlafj.	< 261	313	1.04	1.57	200	20.4	261	526	136	47	6.8	230	146	637	1044	3.13
land	053 Opo. Sørfj. Hardangerfj.	834	834	4.17	8.34	177	< 1	349	1102	195	375	26.4	320	514	403	5560	< 7.0
(7.)	054 Tysso. Sørfj. Hardangerfj.	< 560	895	2.24	11.19	82	4.5	188	1631	179	246	25.7	850	291	369	4812	10.1
	055 Kinso. Sørfj. Hardangerfj.	405	< 253	1.01	1.52	31	< 1	70	260	61	91	4.0	96	359	61	607	2.53
	056 Veig. Eidfjv. Hardangerfj.	8637	864	1.73	11.23	21	3.5	130	1536	199	458	23.3	363	656	881	3282	< 4.3
	057 Bjoreia. " . Hardangerfj.	1295	1090	1.36	6.81	8	< 1	102	701	82	164	7.5	211	123	313	1090	< 3.4
	058 Sima. Eidfj. Hardangerfj.	1881	209	0.84	2.51	11	< 0	48	493	42	276	5.4	138	176	217	878	2.51
	059 Austdøla. Osafj. Eidfj.	244	< 204	0.81	1.22	24	4.5	45	148	28	73	2.8	94	85	33	692	2.04
	060 Norddøla. Osafj. Eidfj.	2151	< 62	0.25	1.99	5	< 0	18	173	66	138	6.2	137	102	163	522	0.87
	061 Tysseelva. Fusafj.	1088	466	1.55	4.66	59	< 1	145	266	93	202	9.3	148	171	85	1398	6.99
	062 Oselva. Fusafj.	1307	1271	0.73	7.26	61	2.5	162	366	109	91	6.2	428	171	247	1489	3.27
	063 Bergsdalse. Veafj.Herdlafj	560	435	1.24	2.49	48	< 1	114	373	37	155	8.7	274	249	168	2363	5.6
	064 Vosso. Veafj. Sørfj.	3140	2442	10.47	27.91	279	219.8	705	3439	279	349	38.4	488	942	628	6629	24.4
	065 Ekso. Osterfj.	< 728	873	2.91	10.19	87	17.5	179	499	116	218	10.2	146	335	131	2038	7.28
	066 Modalselva. Osterfj.	898	898	1.50	7.49	117	1.5	235	866	105	285	10.5	45	329	< 45	1797	16.5

County	Watercourse	Parameter															
		S.P.M. tonnes	TOC tonnes	PO_4-P tonnes	Tot-P Tonnes	NO_3-N tonnes	NH_4-N tonnes	Tot-N tonnes	SiO_2 tonnes	As kg	Pb kg	Cd kg	Cu kg	Cr kg	Ni kg	Zn kg	Hg kg
Sogn og Fjordane (7.)	067 Nærøyelva Aurl.fj. Sognefj.	829	< 377	2.26	6.03	44	3.0	104	1131	45	53	3.8	106	286	45	1055	3.77
	068 Flåmselva Aurl.fj. Sognefj.	1567	< 261	0.52	5.74	43	18.3	72	571	52	110	6.3	167	151	209	940	4.7
	069 Aurlandv. Aurl.fj. Sognefj.	1799	< 692	1.38	9.69	125	5.5	221	1809	166	387	8.3	429	484	304	1799	19.4
	070 Erdalselva Lærd.fj. Sognefj.	118	< 74	0.15	0.88	5	0.4	20	193	9	10	0.6	10	35	10	127	0.88
	071 Lærdalsv. Lærd.fj. Sognefj.	1835	< 764	< 1.5	18.35	55	3.1	133	2555	92	122	6.1	535	321	229	1758	10.7
	072 Årdalsv. Årdalsfj.Sognefj.	1219	1219	1.74	13.93	141	1.7	247	3209	87	87	13.9	1672	331	261	2438	19.2
	073 Fortunv. Lusterfj.Sognefj.	4775	< 508	1.02	10.16	69	2.0	107	1568	122	315	8.1	1046	417	417	2743	6.1
	074 Mørkrisv. Lusterfj.Sognefj.	847	< 302	0.60	12.70	42	1.2	64	1426	30	194	4.8	538	538	417	1936	6.05
	075 Jostedøla. " Sognefj.	167129	< 1204	2.41	238.41	108	21.7	289	18578	169	2721	16.9	6430	7706	5780	23600	< 12
	076 Årøyelva Sognd.fj. Sognefj.	1117	< 698	< 1.4	13.96	98	< 1	279	2214	56	84	5.6	196	335	140	1536	14
	077 Sogndalselva " Sognefj.	280	374	1.40	1.40	37	< 0	45	421	103	47	3.3	56	178	23	561	3.74
	078 Gaular. Dalsfj. Bufj.	< 864	2765	< 1.7	< 1.7	140	< 2	321	1370	328	294	15.6	207	691	52	3111	24.2
	079 Jølstra. Førdefj.	< 915	1829	< 1.8	< 1.8	159	< 2	287	1490	293	110	14.6	201	805	18	2744	11
	080 Nausta. Førdefj.	< 390	702	< 0.8	< 0.8	20	< 1	118	< 70	117	101	3.9	1561	304	999	2029	4.68
	081 Oselva. Høydalsfj.	554	1661	< 0.8	4.75	24	1.6	125	< 71	142	134	7.1	79	324	71	1424	9.49
	082 Hopselva Hyefj. Nordfj.S	< 111	111	< 0.2	< 0.2	23	< 0	30	96	33	36	2.5	7	91	9	259	2.68
	083 Gjengedalselva " Nordfj.S	< 229	366	< 0.5	< 0.5	16	< 0	37	275	69	55	2.7	9	211	5	426	5.49
	084 Breimselva Gloppenfj. "	1263	1737	< 1.6	4.74	283	39.5	377	2267	205	79	7.9	237	537	158	1674	< 7.9
	085 Oldenelva Indre Nordfj.	543	362	< 0.6	< 0.6	92	7.8	125	1021	241	72	6.0	169	229	72	651	< 3.0
	086 Loenelva Indre Nordfj.	710	323	< 0.6	< 0.6	69	2.6	107	1273	136	65	3.2	278	271	65	691	< 3.2
	087 Stryneelva Indre Nordfj.	1120	672	< 1.1	< 1.1	129	6.7	179	1728	134	112	6.7	683	481	146	1008	< 5.6
	088 Hornindalselva Nordfj. N	550	916	< 0.9	< 0.9	153	1.8	172	1316	119	37	5.5	339	394	174	1100	< 4.6
Møre og Romsdal (8.)	089 Ørstaelva Ørstafj.	179	607	< 0.4	< 0.4	33	0.7	54	673	39	11	0.7	121	150	57	286	< 1.8
	090 Valldøla. Nordalfj.Storfj.	356	297	< 0.6	< 0.6	11	< 1	34	737	71	12	1.2	237	231	24	237	< 3.0
	091 Rauma. Romsdalsfj.Moldefj.	1477	< 615	< 1.2	< 1.2	31	2.5	96	1978	197	98	4.9	591	381	160	1354	< 6.2
	092 Isa. Isfj. Moldefj.	370	< 154	< 0.3	< 0.3	14	1.9	36	529	31	9	0.6	133	151	37	173	< 1.5
	093 Eira. Eresfj. Moldefj.	< 607	607	< 1.2	< 1.2	130	4.9	192	2551	121	12	4.9	571	498	85	510	< 6.1
	094 Littledalselva Sunndalsfj.	472	215	< 0.4	8.58	37	< 0	50	818	39	13	0.9	206	236	56	193	< 2.1
	095 Driva.Sunnd.fj.Tingvollfj.	12807	5218	11.86	11.86	97	< 24	211	6099	< 47	285	4.7	2040	1613	925	2609	< 11.9
	096 Ulvåa. Ålvundfj.	160	961	< 0.4	5.60	124	5.6	153	1373	< 8	20	0.8	412	72	88	560	< 2.0
	097 Toåa. Todalsfj.	259	518	3.11	5.70	23	3.6	70	722	< 10	16	1.0	233	88	21	326	< 2.6
	098 Surna. Surnadalsfj.	1217	2782	< 1.7	19.13	89	< 2	195	2124	< 35	104	3.5	835	435	330	1513	< 8.7
	099 Bøvra. Hamnesfj. Halsafj.	113	1019	< 0.4	3.77	12	1.1	41	332	< 8	15	0.8	125	75	53	151	< 1.9

County	Watercourse	Parameter															
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Sør-	101 Børselva Gaulosen Tr.h.fj.	555	596	0.21	5.13	35	4.0	58	157	6	8	0.2	141	28	140	106	< 0.5
Trønde-	102 Vigda. Gaulosen Tr.h.fj.	1427	471	1.14	3.28	43	1.1	55	428	13	24	1.7	190	128	223	213	< 0.7
lag	103 Gaula. Gaulosen Tr.h.fj.	11688	6524	2.72	32.62	141	16.3	321	6990	< 54	245	13.6	3615	707	3425	6469	46.2
(8.)	104 Nidelva. Trondheimsfj.	2334	9337	< 3.3	36.68	237	26.7	514	5502	67	133	6.7	2534	1100	2268	4302	53.4
	105 Homla. Stjørd.fj.Tr.h.fj.	48	563	< 0.1	1.44	4	0.7	20	177	30	4	0.2	85	39	35	95	0.72
Nord	106 Stjørdalsv. " Tr.h.fj.	2848	5933	2.37	23.73	178	21.4	325	2390	< 47	95	9.5	2895	665	949	6883	26.1
Trønde-	107 Gråelva " Tr.h.fj.	96	288	0.18	1.08	17	1.3	22	114	6	4	0.12	56	25	34	52	0.66
lag	108 Verdalsvassdr. Tr.h.fj.	2092	5325	< 1.9	26.63	158	41.8	297	2445	< 38	114	3.8	1388	609	1826	2891	< 9.5
(8.)	109 Figga/LeksdalselvaTr.h.fj.	6844	7239	2.63	25.01	426	50.0	611	2510	53	171	2.6	1356	684	1000	1974	18.4
	110 Snåsavassdr.. Trondh.fj.	1787	5658	< 1.5	16.38	208	20.8	403	1819	< 30	45	3.0	864	342	581	1266	23.8
	111 Årgårdselva. Namsfj.	2752	8563	< 1.5	16.82	116	16.8	341	1868	< 31	153	6.1	841	474	428	1713	15.3
	112 Namsen. Namsfj. Ø	2110	3296	< 1.3	14.50	53	29.0	183	1271	< 26	66	2.6	870	382	369	1965	11.9
	113 Salsvatnelva. Follafj.	570	2423	< 1.4	12.83	74	12.8	140	1497	< 29	43	7.1	271	143	114	1910	< 7.1
Norland	114 Åbjøra. Bindalsfj. S	824	2473	1.37	8.24	15	22.0	107	706	< 27	69	2.7	288	110	110	783	< 6.9
(9.)	116 Skjerva. Vefsenfj. S	365	289	0.61	2.44	10	8.8	31	199	8	23	0.3	122	55	116	251	< 0.8
	117 Fusta. Vefsenfj. N	1100	1345	2.45	13.45	< 6	31.8	66	786	< 24	49	2.4	330	86	257	1137	< 6.1
	118 Drevja. Vefsenfj. N	449	245	1.22	4.49	4	4.5	20	245	< 8	20	0.8	77	41	61	237	< 2.0
	119 Røssåga. Sørfj.	10088	2354	10.09	33.63	114	30.3	< 34	360	< 67	269	13.5	1883	673	2186	13047	< 17
	120 Bjerka. Sørfj.	189	< 315	1.89	5.03	< 3	< 6	20	472	< 13	< 6	1.3	126	31	113	283	< 3.1
	121 Dalselva. Ranafj. N	25	172	2.71	3.20	7	<0.5*	9	195	< 5	5	0.7	52	< 5	52	91	< 1.2
	122 Ranavassdraget. Ranafj. N	7061	3530	47.07	64.72	159	47.1	200	5800	235	353	23.5	1000	< 118	471	3001	< 29
	123 Fykanåga. Glomfjord	< 510	817	4.08	26.54	56	13.3	77	787	< 20	20	4.1	184	< 20	133	357	< 5.1
	124 Beiarelva Beiarfj. Nordfj.	4758	< 820	8.20	18.05	30	< 16	46	2145	< 33	98	< 32.8	443	< 33	459	656	< 8.2
	125 Saltdalsvassdr..Saltd.fj.S	23712	1361	7.77	27.21	72	< 19	115	3665	214	408	9.7	991	< 39	1127	2604	< 9.7
	126 Sulitjelmavassdr..Saltd.fj	1591	< 795	6.36	19.09	19	25.4	33	852	< 32	32	4.8	732	< 32	143	891	< 8.0
	127 Kobbe. Leirfj. Sørfolda N	467	< 425	4.25	10.19	36	16.1	55	874	< 17	25	5.1	59	< 17	25	671	< 4.2
	128 Skjoma. Ofotfj. S	1697	727	8.49	13.34	24	18.2	59	1507	61	303	17.0	570	< 24	1612	2776	< 6.1

* 1999 concentration used for calculation

County	Watercourse	Parameter															
		S.P.M. tonnes	TOC tonnes	PO_4-P tonnes	Tot-P Tonnes	NO_3-N tonnes	NH_4-N tonnes	Tot-N tonnes	SiO_2 tonnes	As kg	Pb kg	Cd kg	Cu kg	Cr kg	Ni kg	Zn kg	Hg kg
Troms (9.)	129 Spanselva. Astafj. Vågsfj.	210	175	2.81	2.81	11	4.6	18	443	4	7	0.7	126	112	91	< 35	< 1.8
	130 Salangselva Astafj. Vågsfj.	458	< 458	3.66	3.66	25	9.2	37	942	37	37	1.8	238	55	256	< 92	< 4.6
	131 Rossfjordelva Malangen	72	537	0.72	1.07	4	2.9	34	330	7	7	0.7	114	18	111	< 36	< 1.8
	132 Målselva Målselvfj. "	4641	4641	20.63	25.78	232	77.4	315	11051	52	155	10.3	2114	< 103	2011	< 516	< 26
	133 Barduelva Målselva	13231	2281	18.25	31.94	123	63.9	214	7723	46	411	9.1	2281	< 91	1551	< 456	< 23
	134 Nordkjoselva. Balsfj.	323	< 115	0.23	1.15	4	1.4	10	544	14	5	0.5	88	< 5	65	< 23	< 1.2
	135 Signaldalselva. Lyngen V	1738	< 272	1.63	5.43	10	2.2	18	1280	16	27	1.1	326	< 11	239	147	< 2.7
	136 Skibotnelva. Lyngen	545	545	0.54	3.81	11	1.6	23	1144	< 11	11	2.2	305	< 11	523	180	< 2.7
	137 Kåfjordelva. Lyngen Ø	726	145	0.48	1.45	16	0.5	52	488	7	10	0.7	489	< 5	145	745	9.44
	138 Reisa. Reisafj.	9777	1823	1.66	33.14	103	13.3	152	6747	66	182	6.6	1889	66	1061	1425	< 8.3
Finnmark (10.)	139 Mattiselva. Kåfj. Altafj.	152	364	0.91	0.91	4	1.5	14	396	24	3	0.6	149	< 6	49	24	1.82
	141 Tverrelva. Altafj.	62	323	0.37	1.49	8	1.0	20	293	6	2	0.2	71	< 2	37	26	< 0.6
	142 Repparfjordv.. Repparfj.	95	1423	7.59	22.76	44	2.8	75	1605	< 19	9	1.9	379	< 19	256	142	13.3
	143 Stabburse..I. Porsangen V	141	1129	2.82	2.82	12	0.7	30	2117	< 14	7	1.4	120	< 14	78	254	< 3.5
	144 Lakselva Indre Porsangen S	13318	1781	< 0.8	14.42	8	3.4	53	3454	< 17	119	1.7	1018	534	865	1026	< 4.2
	145 Børselva IndrePorsangen Ø	< 551	< 551	3.31	5.51	20	27.6	47	4490	44	< 11	2.2	< 22	154	< 33	< 110	221
	146 Mattusjåkka. I. Laksefj. V	< 35	55	0.07	0.28	1	1.3	3	114	5	< 1	0.14	< 1	10	< 2	< 7	< 0.3
	147 Storelva Indre Laksefj. V	< 227	< 227	0.45	2.73	17	10.0	25	1560	32	< 5	0.9	< 9	45	< 14	182	< 2.3
	148 Soussjåkka. I. Laksefj. V	< 35	< 35	0.14	0.28	2	0.9	5	285	2	< 1	0.14	< 1	7	< 2	35	0.91
	149 Adamselva. I. Laksefj. Ø	< 211	1225	0.84	1.27	7	6.3	28	1629	21	< 4	0.8	< 8	63	< 13	169	< 2.1
	150 Tanavassdraget. Tanafj. S	< 3220	16098	25.76	38.64	238	206.1	902	42776	386	< 64	12.9	< 129	1610	708	< 644	< 32
	151 Vesterelva. Syltefj.	118	< 295	1.77	4.14	27	1.8	242	1899	95	< 6	1.2	59	< 12	30	47	< 3.0
	152 V. Jakobselva Y.Varangerfj.	97	243	2.43	2.43	15	1.5	166	2921	49	5	1.0	78	205	58	68	< 2.4
	153 Passvikelva Bøkfj.Varang.fj.	5140	23499	< 7.3	58.75	397	95.5	2379	37766	441	147	14.7	6462	< 147	28786	2937	< 36.7
	154 Neiden. Munkfj. Varang.fj.	787	3936	< 1.3	10.50	31	14.4	512	3374	39	26	2.6	682	< 26	302	118	< 6.6
	155 Grense Jakobse..Varang.fj.	44	233	0.44	0.73	12	0.7	36	< 13	17	3	0.9	292	< 3	1068	92	< 0.7

Appendix X. Tributary Rivers. "Mean" Load 2000

Table X. Tributary Rivers, "Mean" Load 2000

County	Watercourse	Parameter															
		S.P.M. tonnes	TOC tonnes	PO_4-P tonnes	Tot-P tonnes	NO_3-N tonnes	NH_4-N tonnes	Tot-N tonnes	SiO_2 tonnes	As kg	Pb kg	Cd kg	Cu kg	Cr kg	Ni kg	Zn kg	Hg kg
Østfold (1.)	001 Tista. Iddefj.	1543	5120	0.72	10.82	414	15.1	675	< 65	224	195	15.1	916	22	988	2740	5.05
	003 Mosselva. Mossesundet	2524	2335	0.95	6.31	261	6.9	417	189	110	73	3.2	593	16	350	505	2.52
Oslo og Akershus (1.)	004 Hølenelva. Drøbaksundet Ø	< 30	484	2.30	5.26	158	4.4	196	119	38	16	2.2	163	26	260	278	0.48
	005 Årungelva. I. Oslofj.	45	113	0.49	0.92	66	0.5	79	55	9	3	0.4	46	5	41	30	0.13
	006 Gjersjøelva. I. Oslofj.	34	235	0.08	0.65	44	1.2	60	163	11	3	0.4	58	6	112	49	< 0.2
	007 Ljanselva. I. Oslofj.	29	71	0.45	0.65	13	0.7	18	122	6	4	0.6	41	5	27	76	0.09
	008 Loelva/Alna. I. Oslofj.	1113	151	1.81	2.24	42	8.3	53	336	22	153	5.4	354	35	72	1273	0.4
	009 Akerselva. I. Oslofj.	188	451	1.00	1.13	33	6.9	51	510	29	76	3.6	198	< 3	58	1077	0.88
	010 Frognerelva. I. Oslofj.	39	42	0.09	0.10	14	1.4	16	72	5	4	0.3	50	1	18	69	0.08
	011 Lysakerelva. I. Oslofj.	141	443	0.57	0.57	26	3.6	53	384	23	19	1.8	87	< 2	28	349	0.57
	012 Sandvikselva.I. Oslofj.	155	505	2.20	2.20	80	3.9	98	555	39	39	2.6	220	91	78	259	< 0.6
	013 Åroselva. I. Oslofj.	36	309	0.24	1.09	42	0.8	65	208	28	9	1.9	97	< 1	38	85	0.55
Buskerud (2.)	014 Lierelva. Drammensfj. Ø	798	598	3.99	7.25	107	5.6	151	893	92	44	5.8	295	< 4	143	870	1.09
Vestfold (3.)	016 Sandeelva. Sandebukta	1956	507	1.55	3.62	63	3.3	104	599	156	108	8.1	3228	176	217	2400	0.93
	017 Aulielva. Tønsbergfj.	1143	495	1.71	6.65	24	9.2	95	161	< 341	51	11.9	1569	1040	2047	341	1.71
	019 Farriselva. Larvikfj.	201	1338	0.67	2.01	129	8.0	212	1577	67	27	11.0	151	67	67	2910	2.34
Telemark (4.)	021 Tokkeelva. Kragerø	1355	5004	1.04	1.04	210	2.1	297	3574	198	261	35.4	594	< 21	1001	6463	< 5.2
Aust-Agder (5.)	022 Gjerstadelva. Søndeledfj.	428	1677	2.14	2.14	75	9.6	113	917	82	128	13.6	257	< 7	332	2355	2.85
	023 Vegårdselva. Sandnesfj.	464	1816	2.11	2.11	76	3.8	119	688	106	101	13.1	300	< 8	215	2745	3.38
	024 Nidelva. Arendal	2270	10591	18.91	18.91	605	< 4	1922	7133	530	946	117	3518	< 76	719	17400	< 18.9
Vest-Agder (5.)	025 Tovdalselva. Topdalsfj.	1587	6746	7.94	7.94	278	17.9	458	2849	417	476	59.5	754	< 40	595	9524	< 9.9
	027 Søgneelva. Flekkerøy	244	1613	1.47	1.47	65	6.4	99	419	73	105	19.6	178	< 5	144	2322	1.47
	028 Mandalselva. Mannefj.	2624	9185	13.12	13.12	373	65.6	462	3149	420	1233	79	1252	< 52	454	11547	15.7
	029 Audna. Sniksfj.	575	2299	1.28	4.47	118	7.0	248	1163	128	255	36.4	294	< 13	172	5109	3.83
	030 Lygna. Lyngdalsfj.	905	3216	2.01	11.06	105	11.1	341	431	191	352	32.2	281	< 20	1568	4724	7.04

County	Watercourse	Parameter															
		S.P.M. tonnes	TOC tonnes	PO_4-P tonnes	Tot-P tonnes	NO_3-N tonnes	NH_4-N tonnes	Tot-N tonnes	SiO_2 tonnes	As kg	Pb kg	Cd kg	Cu kg	Cr kg	Ni kg	Zn kg	Hg kg
	031 Kvina. Fedafj.	2625	11024	5.25	36.75	163	7.9	761	1125	656	1181	55.1	1024	< 52	709	9187	21
	032 Sira. Åna-Sira	1795	4666	7.18	14.36	571	86.1	944	3384	323	1328	57.4	1005	< 72	395	9691	17.9
Rogaland (6.)	033 Sokndalselva. Sogndalsstr.	284	616	0.95	2.84	99	0.9	154	680	62	99	17.5	289	< 9	1597	2464	3.32
	034 Hellelandselva. Egersund	568	787	1.75	4.37	93	3.1	183	346	52	184	11.8	184	< 9	157	1879	4.81
	035 Bjerkreimselva. Egersund	< 864	1555	1.73	22.46	485	29.4	594	2776	155	294	38.0	492	< 35	1555	5010	8.64
	036 Håelva. Håtangen	927	1171	8.05	16.11	267	31.0	415	784	76	56	4.6	229	< 5	100	1245	< 1.2
	038 Figgjo. Solavika	1119	939	5.78	9.75	241	19.1	383	929	61	191	3.6	282	< 7	134	758	2.17
	039 Ims-Lutsi. Høgsfj.Boknafj.	154	433	0.42	1.12	77	1.1	120	63	46	11	1.4	103	85	115	461	< 0.7
	040 Oltedalselv.Høgsfj.Boknafj.	113	194	0.45	2.48	58	2.3	91	463	18	27	5.2	86	< 5	248	946	< 1.1
	041 Dirdalselva Høgsfj.Boknafj.	124	414	0.41	2.89	85	2.5	137	479	29	99	5.0	157	< 8	37	827	< 2.1
	042 Frafjordelva Frafj. Boknafj.	106	366	0.53	1.59	110	4.8	152	443	48	127	5.8	175	< 11	42	689	< 2.6
	043 Espedalse..Høgsfj.Boknafj.	< 196	353	0.78	1.96	60	< 0	240	655	98	51	3.9	51	110	86	392	2.74
	044 Lyseelva Lysefj.Boknafj.	< 212	510	0.42	1.70	< 2	4.2	38	382	85	64	3.0	110	157	161	595	2.97
	045 Årdalselva Årdalsfj.Boknafj.	< 666	1332	2.66	5.33	211	40.0	438	1599	293	253	14.7	373	386	200	4929	12
	046 Førreelva Jøsenfj.Boknafj.	< 221	265	0.88	2.21	28	< 0	58	841	71	18	1.8	13	154	13	309	< 2.2
	047 Ulla. Jøsenfj.Boknafj.	< 517	1757	2.07	17.57	68	19.6	203	1440	207	134	8.3	103	279	83	1137	14.5
(7.)	049 Saudaelva Saudafj.Boknafj.	< 473	< 473	2.84	4.73	223	< 1	300	831	151	170	38.8	492	274	104	9841	6.62
	050 Åbøelva. Saudafj.Boknafj.	< 110	< 110	0.44	1.32	25	0.2	39	113	29	29	2.0	15	59	35	308	1.76
	051 Vikedalselva Boknafj.	< 149	238	0.89	1.79	67	0.9	111	255	101	36	4.5	63	63	86	595	< 1.5
Hordaland (7.)	052 Etneelva. Etnefj. Bømlafj.	< 194	233	0.78	1.16	149	15.1	194	391	101	35	5.0	171	109	473	776	2.33
	053 Opo. Sørfj. Hardangerfj.	723	723	3.62	7.23	153	< 1	303	956	169	325	22.9	277	446	350	4822	< 6.0
	054 Tysso. Sørfj. Hardangerfj.	< 485	776	1.94	9.70	71	3.9	163	1414	155	213	22.3	737	252	320	4172	8.73
	055 Kinso. Sørfj. Hardangerfj.	326	< 204	0.82	1.22	25	< 0	56	210	49	73	3.3	77	289	49	489	2.04
	056 Veig. Eidfjv. Hardangerfj.	6538	654	1.31	8.50	16	2.6	98	1163	150	347	17.7	275	497	667	2485	< 3.3
	057 Bjoreia. " . Hardangerfj.	922	777	0.97	4.85	6	< 0	72	499	58	116	5.3	150	87	223	777	< 2.4
	058 Sima. Eidfj. Hardangerfj.	1424	158	0.63	1.90	8	< 0	37	373	32	209	4.1	104	133	165	665	1.9
	059 Austdøla. Osafj. Eidfj.	185	< 154	0.62	0.92	18	3.4	34	112	22	55	2.2	71	65	25	524	1.54
	060 Norddøla. Osafj. Eidfj.	1628	< 47	0.19	1.51	4	< 0	14	131	50	104	4.7	104	77	123	395	0.66
	061 Tysseelva. Fusafj.	901	386	1.29	3.86	49	< 1	120	221	77	167	7.7	122	142	71	1158	5.79
	062 Oselva. Fusafj.	1135	1103	0.63	6.30	53	2.2	141	317	95	79	5.4	372	148	214	1292	2.84
	063 Bergsdalse. Veafj.Herdlafj	450	350	1.00	2.00	39	< 0	92	300	30	125	7.0	220	200	135	1898	4.5
	064 Vosso. Veafj. Sørfj.	2465	1917	8.22	21.91	219	172.5	553	2699	219	274	30.1	383	739	493	5203	19.2
	065 Ekso. Osterfj.	< 563	675	2.25	7.88	68	13.5	138	386	90	169	7.9	113	259	101	1576	5.63
	066 Modalselva. Osterfj.	696	696	1.16	5.80	90	1.2	182	671	81	220	8.1	35	255	< 35	1391	12.8

aquateam

County	Watercourse	Parameter															
		S.P.M.	TOC	PO_4-P	Tot-P	NO_3-N	NH_4-N	Tot-N	SiO_2	As	Pb	Cd	Cu	Cr	Ni	Zn	Hg
		tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	kg	kg	kg	kg	kg	kg	kg	kg
Sogn og Fjordane (7.)	067 Nærøyelva Aurl.fj. Sognefj.	599	< 272	1.63	4.35	32	2.2	75	816	33	38	2.7	76	207	33	762	2.72
	068 Flåmselva Aurl.fj. Sognefj.	1388	< 231	0.46	5.09	38	16.2	64	506	46	97	5.6	148	134	185	833	4.16
	069 Aurlandv. Aurl.fj. Sognefj.	1594	< 613	1.23	8.58	110	4.9	196	1603	147	343	7.4	380	429	270	1594	17.2
	070 Erdalselva Lærd.fj. Sognefj.	104	< 65	0.13	0.78	4	0.4	18	171	8	9	0.5	9	31	9	112	0.78
	071 Lærdalsv. Lærd.fj. Sognefj.	1344	< 560	< 1.1	13.44	40	2.2	97	1872	67	90	4.5	392	235	168	1288	7.84
	072 Årdalsv. Årdalsfj.Sognefj.	980	980	1.40	11.20	113	1.4	199	2581	70	70	11.2	1344	266	210	1961	15.4
	073 Fortunv. Lusterfj.Sognefj.	3840	< 409	0.82	8.17	56	1.6	86	1261	98	253	6.5	842	335	335	2206	4.9
	074 Mørkrisv. Lusterfj.Sognefj.	681	< 243	0.49	10.22	34	1.0	51	1147	24	156	3.9	433	433	336	1557	4.86
	075 Jostedøla. " Sognefj.	128733	< 927	1.85	183.64	83	16.7	223	14310	130	2096	13.0	4953	5936	4452	18178	< 9.3
	076 Årøyelva Sognd.fj. Sognefj.	875	< 547	< 1.1	10.93	77	< 1	219	1733	44	66	4.4	153	262	109	1202	10.9
	077 Sogndalselva " Sognefj.	219	292	1.09	1.09	29	< 0	35	328	80	36	2.6	44	139	18	438	2.92
	078 Gaular. Dalsfj. Bufj.	< 784	2509	< 1.6	< 1.6	127	< 2	292	1243	298	267	14.1	188	627	47	2822	22
	079 Jølstra. Førdefj.	< 836	1673	< 1.7	< 1.7	146	< 2	263	1362	268	100	13.4	184	736	17	2509	10
	080 Nausta. Førdefj.	< 357	642	< 0.7	< 0.7	19	< 1	108	< 64	107	93	3.6	1427	278	914	1856	4.28
	081 Oselva. Høydalsfj.	499	1496	< 0.7	4.27	21	1.4	113	< 64	128	121	6.4	71	292	64	1282	8.55
	082 Hopselva Hyefj. Nordfj.S	< 86	86	< 0.2	< 0.2	18	< 0	23	74	26	28	1.9	5	71	7	200	2.07
	083 Gjengedalselva " Nordfj.S	< 201	322	< 0.4	< 0.4	14	< 0	33	241	60	48	2.4	8	185	4	374	4.83
	084 Breimselva Gloppenfj. "	1091	1500	< 1.4	4.09	244	34.1	326	1958	177	68	6.8	205	464	136	1446	< 6.8
	085 Oldenelva Indre Nordfj.	450	300	< 0.5	< 0.5	76	6.5	103	846	200	60	5.0	140	190	60	540	< 2.5
	086 Loenelva Indre Nordfj.	589	268	< 0.5	< 0.5	57	2.1	88	1055	112	54	2.7	230	225	54	572	< 2.7
	087 Stryneelva Indre Nordfj.	1008	605	< 1.0	< 1.0	116	6.0	161	1555	121	101	6.0	615	433	131	907	< 5.0
	088 Hornindalselva Nordfj. N	471	784	< 0.8	< 0.8	131	1.6	147	1126	102	31	4.7	290	337	149	941	< 3.9
Møre og Romsdal (8.)	089 Ørstaelva Ørstafj.	177	600	< 0.4	< 0.4	32	0.7	53	666	39	11	0.7	120	148	57	283	< 1.8
	090 Valldøla. Nordalfj.Storfj.	408	340	< 0.7	< 0.7	13	< 1	39	844	82	14	1.4	272	265	27	272	< 3.4
	091 Rauma Romsdalsfj.Moldefj.	1492	< 622	< 1.2	< 1.2	31	2.5	97	1998	199	99	5.0	597	385	162	1368	< 6.2
	092 Isa. Isfj. Moldefj.	377	< 157	< 0.3	< 0.3	14	1.9	36	539	31	9	0.6	135	154	38	176	< 1.6
	093 Eira. Eresfj. Moldefj.	< 614	614	< 1.2	< 1.2	131	4.9	194	2579	123	12	4.9	577	504	86	516	< 6.1
	094 Littledalselva Sunndalsfj.	511	232	< 0.5	9.28	40	< 0	54	885	42	14	0.9	223	255	60	209	< 2.3
	095 Driva.Sunnd.fj.Tingvollfj.	11816	4814	10.94	10.94	90	< 22	195	5627	< 44	263	4.4	1882	1488	853	2407	< 10.9
	096 Ulvåa. Ålvundfj.	143	859	< 0.4	5.01	111	5.0	136	1226	< 7	18	0.7	368	64	79	501	< 1.8
	097 Toåa. Todalsfj.	232	463	2.78	5.09	20	3.2	63	645	< 9	14	0.9	208	79	19	292	< 2.3
	098 Surna. Surnadalsfj.	1272	2906	< 1.8	19.98	93	< 2	203	2219	< 36	109	3.6	872	454	345	1580	< 9.1
	099 Bøvra. Hamnesfj. Halsafj.	126	1138	< 0.4	4.21	13	1.3	46	370	< 8	17	0.8	139	84	59	169	< 2.1

aquateam

County	Watercourse	Parameter															
		S.P.M. tonnes	TOC tonnes	PO_4-P tonnes	Tot-P tonnes	NO_3-N tonnes	NH_4-N tonnes	Tot-N tonnes	SiO_2 tonnes	As kg	Pb kg	Cd kg	Cu kg	Cr kg	Ni kg	Zn kg	Hg kg
Sør-Trøndelag (8.)	101 Børselva Gaulosen Tr.h.fj.	552	593	0.21	5.10	35	4.0	58	156	6	8	0.2	140	28	139	105	< 0.5
	102 Vigda. Gaulosen Tr.h.fj.	1419	468	1.14	3.26	43	1.1	54	426	13	24	1.7	189	128	221	211	< 0.7
	103 Gaula. Gaulosen Tr.h.fj.	13099	7311	3.05	36.56	158	18.3	359	7833	< 61	274	15.2	4052	792	3838	7250	51.8
	104 Nidelva. Trondheimsfj.	2437	9749	< 3.5	38.30	247	27.9	536	5745	70	139	7.0	2646	1149	2368	4491	55.7
	105 Homla. Stjørd.fj.Tr.h.fj.	59	698	< 0.1	1.78	5	0.9	25	220	37	4	0.3	105	49	43	117	0.89
Nord Trøndelag (8.)	106 Stjørdalsv. " Tr.h.fj.	3084	6426	2.57	25.70	193	23.1	352	2589	< 51	103	10.3	3136	720	1028	7454	28.3
	107 Gråelva " Tr.h.fj.	117	352	0.22	1.32	21	1.5	27	140	7	5	0.15	69	30	42	63	0.81
	108 Verdalsvassdr. Tr.h.fj.	2043	5199	< 1.9	26.00	154	40.9	290	2387	< 37	111	3.7	1355	594	1783	2822	< 9.3
	109 Figga/LeksdalselvaTr.h.fj.	7155	7567	2.75	26.14	446	52.3	638	2624	55	179	2.8	1417	715	1046	2064	19.3
	110 Snåsavassdr.. Trondh.fj.	1652	5230	< 1.4	15.14	193	19.3	373	1681	< 28	41	2.8	798	317	537	1170	22
	111 Årgårdselva. Namsfj.	2478	7708	< 1.4	15.14	105	15.1	307	1681	< 28	138	5.5	757	427	385	1542	13.8
	112 Namsen. Namsfj. Ø	2202	3440	< 1.4	15.14	55	30.3	191	1327	< 28	69	2.8	908	399	385	2050	12.4
	113 Salsvatnelva. Follafj.	549	2335	< 1.4	12.36	71	12.4	135	1442	< 27	41	6.9	261	137	110	1841	< 6.9
Norland (9.)	114 Åbjøra. Bindalsfj. S	798	2395	1.33	7.98	15	21.3	104	684	< 27	67	2.7	279	106	106	758	< 6.7
	116 Skjerva. Vefsenfj. S	325	257	0.54	2.17	9	7.9	27	177	7	20	0.3	108	49	103	223	< 0.7
	117 Fusta. Vefsenfj. N	979	1196	2.18	11.96	< 5	28.3	59	699	< 22	44	2.2	294	76	228	1012	< 5.4
	118 Drevja. Vefsenfj. N	399	218	1.09	3.99	3	4.0	18	218	< 7	18	0.7	69	36	54	210	< 1.8
	119 Røssåga. Sørfj.	8986	2097	8.99	29.95	102	27.0	< 30	321	< 60	240	12.0	1677	599	1947	11621	< 15
	120 Bjerka. Sørfj.	202	< 336	2.02	5.38	< 3	< 7	22	504	< 13	< 7	1.3	135	34	121	303	< 3.4
	121 Dalselva. Ranafj. N	26	184	2.89	3.42	8	< 1*	10	208	< 5	5	0.8	55	< 5	55	97	< 1.3
	122 Ranavassdraget. Ranafj. N	6537	3268	43.58	59.92	147	43.6	185	5369	218	327	21.8	926	<109	436	2778	< 27.2
	123 Fykanåga. Glomfjord	< 486	777	3.89	25.25	53	12.6	73	749	< 19	19	3.9	175	< 19	126	340	< 4.9
	124 Beiarelva Beiarfj. Nordfj.	4389	< 757	7.57	16.65	27	< 15	42	1978	< 30	91	< 30	409	< 30	424	605	< 7.6
	125 Saltdalsvassdr..Saltd.fj.S	19069	1094	6.25	21.88	58	< 16	92	2947	172	328	7.8	797	< 31	907	2094	< 7.8
	126 Sulitjelmavassdr..Saltd.fj	1426	< 713	5.71	17.12	17	22.8	30	764	< 29	29	4.3	656	< 29	128	799	< 7.1
	127 Kobbe. Leirfj. Sørfolda N	470	< 427	4.27	10.25	36	16.2	56	879	< 17	26	5.1	60	< 17	26	675	< 4.3
	128 Skjoma. Ofotfj. S	1354	580	6.77	10.64	19	14.5	47	1202	48	242	13.5	455	< 19	1287	2215	< 4.8

* 1999 concentration used for calculation

County	Watercourse	Parameter															
		S.P.M. tonnes	TOC tonnes	PO_4-P tonnes	Tot-P tonnes	NO_3-N tonnes	NH_4-N tonnes	Tot-N tonnes	SiO_2 tonnes	As kg	Pb kg	Cd kg	Cu kg	Cr kg	Ni kg	Zn kg	Hg kg
Troms	129 Spanselva. Astafj. Vågsfj.	134	112	1.79	1.79	7	2.9	11	283	2	4	0.4	81	72	58	< 22	< 1.1
(9.)	130 Salangselva Astafj. Vågsfj.	348	< 348	2.78	2.78	19	7.0	28	715	28	28	1.4	181	42	195	< 70	< 3.5
	131 Rossfjordelva Malangen	49	366	0.49	0.73	2	2.0	23	225	5	5	0.5	78	12	76	< 24	< 1.2
	132 Målselva Målselvfj. "	2638	2638	11.73	14.66	132	44.0	179	6282	29	88	5.9	1202	< 59	1143	< 293	< 15
	133 Barduelva Målselva	7521	1297	10.37	18.15	70	36.3	122	4390	26	233	5.2	1297	< 52	882	< 259	< 13
	134 Nordkjoselva. Balsfj.	234	< 83	0.17	0.83	3	1.0	7	393	10	3	0.3	63	< 3	47	< 17	< 0.8
	135 Signaldalselva. Lyngen V	1322	< 207	1.24	4.13	7	1.7	14	974	12	21	0.8	248	< 8	182	112	< 2.1
	136 Skibotnelva. Lyngen	437	437	0.44	3.06	9	1.3	18	918	< 9	9	1.7	245	< 9	420	144	< 2.2
	137 Kåfjordelva. Lyngen Ø	677	135	0.45	1.35	15	0.5	48	455	7	9	0.7	456	< 5	135	695	8.81
	138 Reisa. Reisafj.	8044	1500	1.36	27.27	85	10.9	125	5551	55	150	5.5	1554	55	873	1172	< 6.8
Finnmark	139 Mattiselva. Kåfj. Altafj.	136	326	0.81	0.81	4	1.4	13	355	22	3	0.5	133	< 5	43	22	1.63
	141 Tverrelva. Altafj.	56	290	0.33	1.34	7	0.9	18	263	6	2	0.2	64	< 2	33	23	< 0.6
(10.)	142 Repparfjordv.. Repparfj.	86	1289	6.87	20.62	40	2.6	68	1455	< 17	9	1.7	344	< 17	232	129	12
	143 Stabburse..I. Porsangen V	128	1023	2.56	2.56	11	0.6	27	1918	< 13	6	1.3	109	< 13	70	230	< 3.2
	144 Lakselva I. Porsangen S	12068	1614	< 0.8	13.07	8	3.1	48	3130	< 15	108	1.5	922	484	784	930	< 3.8
	145 Børselva I. Porsangen Ø	< 415	< 415	2.49	4.15	15	20.7	36	3379	33	< 8	1.7	< 17	116	< 25	< 83	166
	146 Mattusjåkka. I. Laksefj. V	< 36	58	0.07	0.29	1	1.4	3	120	5	< 1	0.15	< 1.5	11	< 2	< 7	< 0.4
	147 Storelva Indre Laksefj. V	< 238	< 238	0.48	2.86	18	10.5	26	1634	33	< 5	1.0	< 9.5	48	< 14	191	< 2.4
	148 Soussjåkka. I. Laksefj. V	< 37	< 37	0.15	0.29	2	1.0	5	299	2	< 1	0.15	< 1.5	7	< 2	37	0.95
	149 Adamselva. I. Laksefj. Ø	< 221	1283	0.88	1.33	7	6.6	29	1707	22	< 4	0.9	< 8.8	66	< 13	177	< 2.2
	150 Tanavassdraget. Tanafj. S	< 2972	14859	23.77	35.66	220	190.2	832	39483	357	< 59	11.9	< 119	1486	654	< 594	< 30
	151 Vesterelva. Syltefj.	102	< 256	1.54	3.58	23	1.5	210	1645	82	< 5	1.0	51	< 10	26	41	< 2.6
	152 V. Jakobselva Y.Varangerfj.	72	179	1.79	1.79	11	1.1	122	2147	36	4	0.7	57	150	43	50	< 1.8
	153 Passvikelva Bøkfj.Varang.fj.	3778	17272	< 5.4	43.18	291	70.2	1749	27759	324	108	10.8	4750	<108	21159	2159	< 27
	154 Neiden. Munkfj. Varang.fj.	549	2744	< 0.9	7.32	22	10.1	357	2352	27	18	1.8	476	< 18	210	82	< 4.6
	155 Grense Jakobse..Varang.fj.	40	213	0.40	0.66	11	0.7	33	< 12	16	3	0.8	267	< 3	975	84	< 0.7

aquateam

Appendix XI. "Mean" total discharges.

(mean concentrations of main and tributary rivers multiplied with mean runoff. 1961 – 90 main rivers and 1931 – 60 tributary rivers).

Table XI Mean total discharges from mainland Norway to conventional water

Table XI.I Mean total discharges to the Skagerak Region

Table XI.II Mean total discharges to The Remaining North Sea

Table XI.III Mean total discharges to The Norwegian Sea

Table XI.IV Mean total discharges to The Barents Sea

Table XI Mean total discharges from mainland Norway to conventional water

(Mean runnoff 1961-1990, main river, 1931-1960, tributary rivers)

		Area runoff	Fish farming	Direct discharges	Tributary inputs	Main riverine inputs	Grand total	
S.P.M.	*	-	-	1 445 702	326 845	473 718	**2 246 265**	tonnes
	**	-	-	1 445 702	338 808	486 110	**2 270 620**	
TOC	*	-	-	206	230 612	230 445	**461 262**	tonnes
	**	-	-	206	240 063	231 380	**471 649**	
Orthoph.	*	190	818	564	341	303	**2 215**	tonnes
	**	190	818	564	377	321	**2 269**	
Total P	*	778	4 544	1 192	1 333	1 196	**9 042**	tonnes
	**	778	4 544	1 192	1 344	1 213	**9 071**	
Nitrates	*	15 295	-	59	12 750	13 802	**41 905**	tonnes
	**	15 295	-	59	12 761	13 802	**41 916**	
Ammonia	*	1 374	6 866	9 014	1 664	1 377	**20 295**	tonnes
	**	1 374	6 866	9 014	1 742	1 386	**20 382**	
Total N	*	24 066	21 456	15 495	26 256	26 114	**113 387**	tonnes
	**	24 066	21 456	15 495	26 286	26 114	**113 417**	
Silicate SiO2	*	-	-	-	259 865	272 663	**532 528**	tonnes
	**	-	-	-	260 070	272 663	**532 733**	
Arsenic	*	-	-	1.3	12	10	**23**	tonnes
	**	-	-	1.3	13	10	**24**	
Lead	*	-	-	10	20	23	**52**	tonnes
	**	-	-	10	20	23	**52**	
Cadmium	*	-	-	1.7	1.3	1.2	**4.1**	tonnes
	**	-	-	1.7	1.3	1.2	**4.2**	
Copper	*	-	-	34	76	86	**196**	tonnes
	**	-	-	34	76	86	**196**	
Total Cr-T	*	-	-	4	32	23	**59**	tonnes
	**	-	-	4	33	24	**61**	
Nickel	*	-	-	18	75	45	**137**	tonnes
	**	-	-	18	75	45	**138**	
Zinc	*	-	-	92	267	289	**649**	tonnes
	**	-	-	92	268	289	**650**	
Mercury	*	-	-	98	735	465	**1 299**	kg
	**	-	-	98	1 111	532	**1 741**	
Lindane	*	-	-	-	-	26	**26**	kg
	**	-	-	-	-	27	**27**	

Measurements below detection limits are treated in two ways
*Detection limit = zero
** Detection limit = limit

Table XI.I Mean total discharges to the Skagerak Region

(Mean runnoff 1961-1990, main river, 1931-1960, tributary rivers)

The Skagerrak region with sub-areas: (1) Glomma, (2) Drammenselva, (3) Numedalslågen, (4) Skienselva, (5) Otra.

		Area runoff	Fish farming	Direct discharges	Tributary inputs	Main riverine inputs	Grand total	
S.P.M.	*			3 079	24 817	361 647	**389 543**	tonnes
	**			3 079	24 847	364 178	**392 104**	
TOC				29	71 034	202 464	**273 527**	tonnes
Orthoph.	*	18	2.7	77	81	218	**397**	tonnes
	**	18	2.7	77	81	231	**409**	
Total P	*	73	15	211	165	1 035	**1 499**	tonnes
	**	73	15	211	165	1 043	**1 507**	
Nitrates		1 793	-	23	4 153	12 419	**18 388**	tonnes
Ammonia	*	164	23	3 572	297	1 193	**5 250**	tonnes
	**	164	23	3 572	301	1 197	**5 258**	
Total N		2 777	72	5 744	8 105	23 160	**39 857**	tonnes
Silicate SiO2	*			-	30 774	229 097	**259 870**	tonnes
	**			-	30 839	229 097	**259 935**	
Arsenic	*			0.32	4	8	**12**	tonnes
	**			0.32	4	8	**13**	
Lead	*			0.72	7	21	**29**	tonnes
	**			0.72	7	21	**29**	
Cadmium	*			0.067	0.6	1.0	**2**	tonnes
	**			0.067	0.6	1.0	**2**	
Copper	*			13	18	64	**94**	tonnes
	**			13	18	64	**94**	
Total Cr-T	*			1.26	1	14	**17**	tonnes
	**			1.26	2	15	**18**	
Nickel				3.4	11	35	**50**	tonnes
Zinc				16	94	234	**344**	tonnes
Mercury	*			23	90	366	**479**	kg
	**			23	125	426	**573**	
Lindane	*			-	-	23	**23**	kg
	**			-	-	23	**23**	

Measurements below detection limits are treated in two ways
*Detection limit = zero
** Detection limit = limit

Table XI.II Mean total discharges to The Remaining North Sea

(Mean runnoff 1961-1990, main river, 1931-1960, tributary rivers)

The remaining North Sea Region with sub-areas: (6) Orreelva, (7) Sulalslågen

		Area runoff	Fish farming	Direct discharges	Tributary inputs	Main riverine inputs	Grand total	
S.P.M.	*			64 712	165 251	4 231	**234 194**	tonnes
	**			64 712	172 165	5 133	**242 010**	
TOC	*			136	30 832	2 536	**33 505**	tonnes
	**			136	35 688	3 471	**39 295**	
Orthoph.	*	51	343	206	66	8	**673**	tonnes
	**	51	343	206	77	9	**686**	
Total P	*	197	1904	427	451	28	**3 007**	tonnes
	**	197	1904	427	458	29	**3 015**	
Nitrates	*	5 835	-	16	4 749	715	**11 316**	tonnes
	**	5 835	-	16	4 752	715	**11 318**	
Ammonia	*	517	2883	2 464	472	21	**6 357**	tonnes
	**	517	2883	2 464	483	21	**6 369**	
Total N		9 281	9011	4 765	8 772	1 113	**32 941**	tonnes
Silicate SiO2	*			-	58 709	4 570	**63 279**	tonnes
	**			-	58 837	4 570	**63 407**	
Arsenic	*			0.4	5.3	0.2	**5.9**	tonnes
	**			0.4	5.3	0.2	**5.9**	
Lead	*			3.67	9	0.2	**12**	tonnes
	**			3.67	9	0.2	**12**	
Cadmium	*			1.43	0.45	0.04	**1.9**	tonnes
	**			1.43	0.45	0.04	**1.9**	
Copper	*			9.7	18.6	0.9	**29**	tonnes
	**			9.7	18.6	0.9	**29**	
Total Cr-T	*			2.07	18	0.1	**20**	tonnes
	**			2.07	18	0.2	**20**	
Nickel	*			13	16	0.6	**29**	tonnes
	**			13	16	0.6	**29**	
Zinc				60	104	6	**170**	tonnes
Mercury	*			61	251	27	**338**	kg
	**			61	304	28	**393**	
Lindane	*			-	-	2.0	**2.0**	kg
	**			-	-	2.0	**2.0**	

Measurements below detection limits are treated in two ways
*Detection limit = zero
** Detection limit = limit

Table XI.III Mean total discharges to The Norwegian Sea

(Mean runnoff 1961-1990, main river, 1931-1960, tributary rivers)

The Norwegian Sea with sub-areas: (8) Orkla, (9) Vefsna

		Area runoff	Fish farming	Direct discharges	Tributary inputs	Main riverine inputs	Grand total	
S.P.M.	*			1 151 398	119 762	35 117	**1 306 278**	tonnes
	**			1 151 398	120 862	43 872	**1 316 132**	
TOC	*			40	87 595	14 570	**102 206**	tonnes
	**			40	91 245	14 570	**105 856**	
Orthoph.	*	103	448	256	152	32	**990**	tonnes
	**	103	448	256	169	35	**1 011**	
Total P	*	419	2488	512	578	56	**4 053**	tonnes
	**	419	2488	512	582	64	**4 065**	
Nitrates	*	6 652	-	18	3 158	538	**10 366**	tonnes
	**	6 652	-	18	3 167	538	**10 375**	
Ammonia	*	607	3752	2 730	572	86	**7 747**	tonnes
	**	607	3752	2 730	635	90	**7 814**	
Total N	*	10 327	11725	4 654	5 803	1 283	**33 792**	tonnes
	**	10 327	11725	4 654	5 833	1 283	**33 822**	
Silicate SiO2				-	82 738	15 344	**98 082**	tonnes
Arsenic	*			0.6	1.3	1.0	**2.9**	tonnes
	**			0.6	1.9	1.0	**3.5**	
Lead	*			5.2	3.7	0.9	**10**	tonnes
	**			5.2	3.7	0.9	**10**	
Cadmium	*			0.17	0.18	0.13	**0.5**	tonnes
	**			0.17	0.21	0.13	**0.5**	
Copper	*			11	33	19.6	**63**	tonnes
	**			11	33	19.6	**63**	
Total Cr-T	*			1.0	10	3	**14**	tonnes
	**			1.0	11	3	**14**	
Nickel	*			1.8	24	5	**30**	tonnes
	**			1.8	24	5	**30**	
Zinc	*			16	65	47	**127**	tonnes
	**			16	65	47	**128**	
Mercury	*			13.4	214	52	**279**	kg
	**			13.4	422	57	**492**	
Lindane	*			-	-	1	**1**	kg
	**			-	-	1	**1**	

Measurements below detection limits are treated in two ways
*Detection limit = zero
** Detection limit = limit

Table XI.IV Mean total discharges to The Barents Sea

(Mean runnoff 1961-1990, main river, 1931-1960, tributary rivers)

The Barents Sea with sub-area: (10) Alta

		Area runoff	Fish farming	Direct discharges	Tributary inputs	Main riverine inputs	Grand total	
S.P.M.	*			226 513	17 015	72 723	**316 251**	tonnes
	**			226 513	20 934	72 928	**320 374**	
TOC	*			-	41 151	10 875	**52 025**	tonnes
	**			-	42 096	10 875	**52 971**	
Orthoph.	*	18	25	25	42	45	**155**	tonnes
	**	18	25	25	49	46	**162**	
Total P		88	137	43	140	77	**484**	tonnes
Nitrates		1 015	-	2	689	130	**1 836**	tonnes
Ammonia		85	208	248	322	78	**941**	tonnes
Total N		1 681	649	332	3 576	559	**6 796**	tonnes
Silicate SiO2	*			-	87 645	23 652	**111 297**	tonnes
	**			-	87 657	23 652	**111 309**	
Arsenic	*			-	1.0	0.6	**1.5**	tonnes
	**			-	1.0	0.6	**1.6**	
Lead	*			0.03	0.3	0.5	**0.8**	tonnes
	**			0.03	0.3	0.5	**0.9**	
Cadmium	*			0.002	0.04	0.02	**0.06**	tonnes
	**			0.002	0.04	0.02	**0.06**	
Copper	*			0.49	7.2	1.7	**9.4**	tonnes
	**			0.49	7.3	1.7	**9.6**	
Total Cr-T	*			0.06	2.4	6.1	**8.6**	tonnes
	**			0.06	2.5	6.2	**8.8**	
Nickel	*			0.1	24.2	4.1	**28.4**	tonnes
	**			0.1	24.3	4.1	**28.5**	
Zinc	*			0.76	4.2	3.1	**8.0**	tonnes
	**			0.76	4.8	3.1	**8.7**	
Mercury	*			1.2	181	20	**202**	kg
	**			1.2	259	22	**282**	
Lindane	*			-	-	0.2	**0.2**	kg
	**			-	-	0.4	**0.4**	

Measurements below detection limits are treated in two ways
*Detection limit = zero
** Detection limit = limit

Appendix XII.

Fish farming effluents to convention water 1999

Table XII	Fish farming effluents from down stream areas of mainland Norway to convention waters (2000)
Table XII.I	Fish farming effluents to the Skagerrak region (2000)
Table XII.II	Fish farming effluents to the Remaining North Sea region(2000)
Table XII.III	Fish farming effluents to the Norwegian Sea region (2000)
Table XII.IV	Fish farming effluents to the Barents Sea region (2000)

Table XII Fish Farming Effluents from down stream areas of mainland Norway to convention waters (2000)

Total quantity of substance discharged per year:

Sub-areas:		tonnes	
1 Glomma	P	0.0	
	N	0.1	
	PO4-P	0.0	
	NH4-N	0.0	
1 Inner Oslofjord	P	0.0	
	N	0.0	
	PO4-P	0.0	
	NH4-N	0.0	
2 Drammenselva	P	0.0	
	N	0.0	
	PO4-P	0.0	
	NH4-N	0.0	
3 Numedalslågen	P	0.0	
	N	0.0	
	PO4-P	0.0	
	NH4-N	0.0	
4 Skienselva	P	0.0	
	N	0.1	
	PO4-P	0.0	
	NH4-N	0.0	
5 Otra	P	15.0	
	N	71.9	
	PO4-P	2.7	
	NH4-N	23.0	
6 Orreelva	P	360.8	
	N	1699.4	
	PO4-P	64.9	
	NH4-N	543.8	
7 Suldalslågen	P	1542.8	
	N	7311.3	
	PO4-P	277.7	
	NH4-N	2339.6	
8 Orkla	P	1389.1	
	N	6570.6	
	PO4-P	250.0	
	NH4-N	2102.6	
9 Vefsna	P	1098.9	
	N	5154.0	
	PO4-P	197.8	
	NH4-N	1649.3	
10 Altaelva	P	137.0	
	N	648.9	
	PO4-P	24.7	
	NH4-N	207.7	
SUM	**P**	**4544**	**tonnes**
SUM	**N**	**21456**	**tonnes**
SUM	**PO4-P**	**818**	**tonnes**
SUM	**NH4-N**	**6866**	**tonnes**

Appendix XIII. Mean Concentrations and loads from 1990 to 2000. Main Rivers

Figure XIII.I	Conductivity, mean concentrations* in main rivers	(mS/m)
Figure XIII.II	Suspended particulate matter, mean concentrations* in main rivers	(mg/l)
Figure XIII.III	Total organic carbon, mean concentrations* in main rivers	(mg/l)
Figure XIII.IV	Orthophosphate, mean concentrations* in main rivers	(µg/l)
Figure XIII.V	Total phosphorus, mean concentrations* in main rivers	(µg/l)
Figure XIII.VI	Nitrate and nitrite, mean concentrations* in main rivers	(µg/l)
Figure XIII.VII	Ammonia, mean concentrations* in main rivers	(µg/l)
Figure XIII.VIII	Total nitrogen, mean concentrations* in main rivers	(µg/l)
Figure XIII.IX	Silicate, mean concentrations* in main rivers	(mg/l)
Figure XIII.X	Arsenic, mean concentrations* in main rivers	(µg/l)
Figure XIII.XI	Lead, mean concentrations* in main rivers	(µg/l)
Figure XIII.XII	Cadmium, mean concentrations* in main rivers	(µg/l)
Figure XIII.XIII	Copper, mean concentrations* in main rivers	(µg/l)
Figure XIII.XIV	Total, mean concentrations* in main rivers	(µg/l)
Figure XIII.XV	Nickel, mean concentrations* in main rivers	(µg/l)
Figure XIII.XVI	Zinc, mean concentrations* in main rivers	(µg/l)
Figure XIII.XVII	Mercury, mean concentrations* in main rivers	(ng/l)
Figure XIII.XVIII	Lindane, mean concentrations* in main rivers	(ng/l)
Figure XIII.XIX	Total nitrogen and total phosphorus, load in main rivers	(tonnes/year)

*Mean of reported values, for measurement below detection limits, detection limit is used as value for calculation.

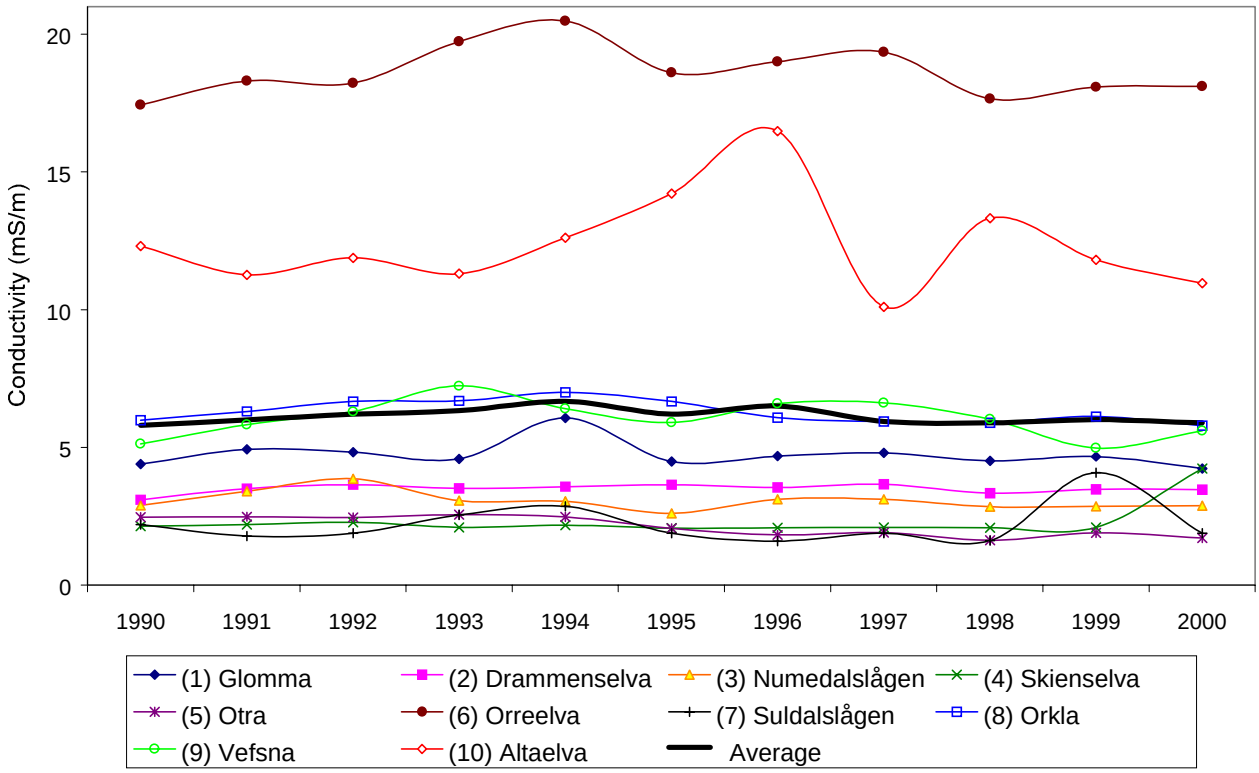


Figure XIII.I ***Specific conductivity in main rivers.***
Mean value from 1990 to 2000 (mS/m).

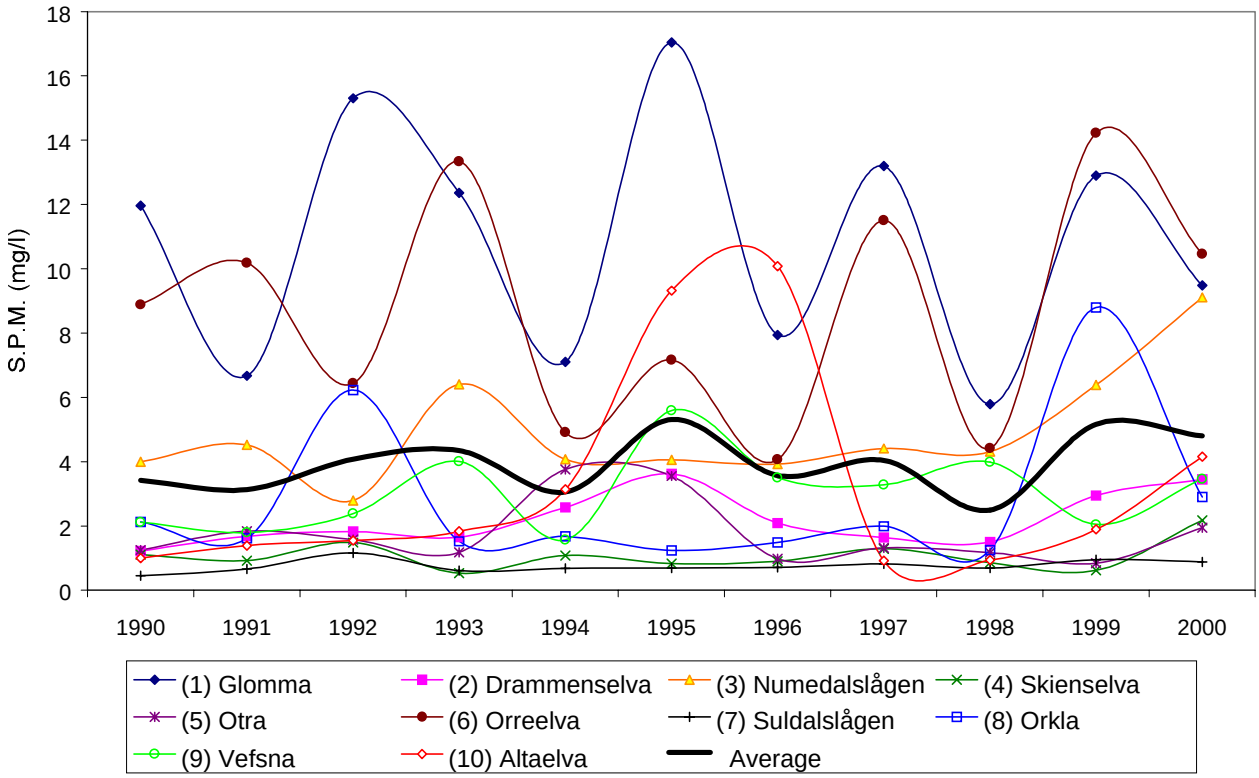


Figure XIII.II ***Suspended particulate matter (S.P.M.) concentration in main rivers.***
Mean value from 1990 to 2000 (mg/l).

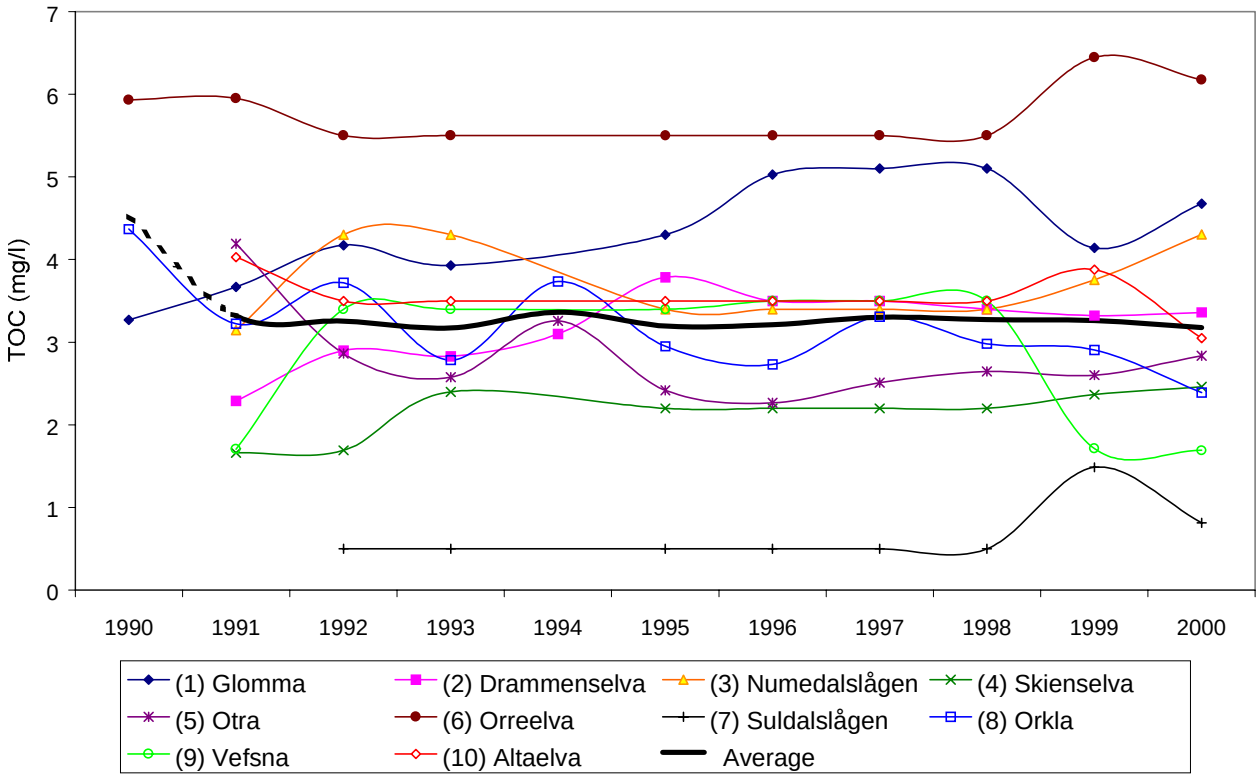


Figure XIII.III ***Total organic carbon (TOC) concentration in main rivers.***
Mean value from 1990 to 2000 (mg/l).

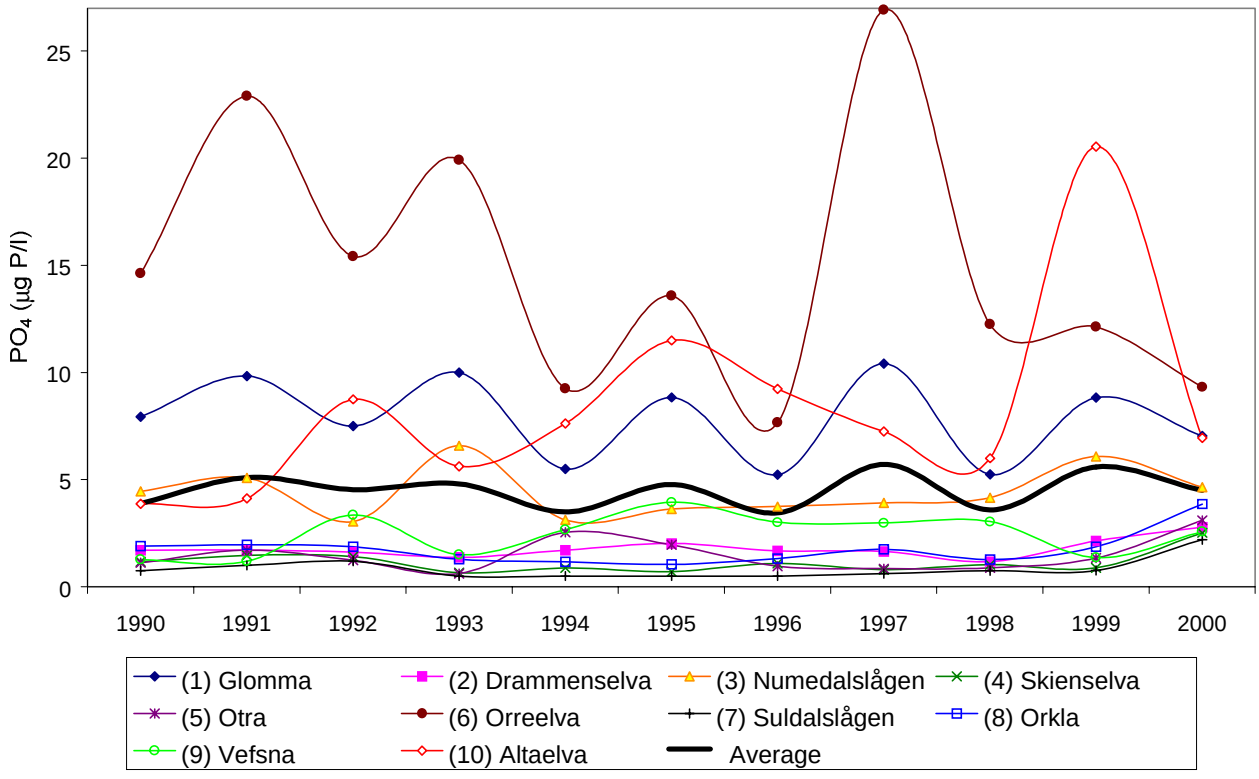


Figure XIII.IV ***Orthophosphate (PO_4) concentration in main rivers.***
Mean value from 1990 to 2000 (µg/l).

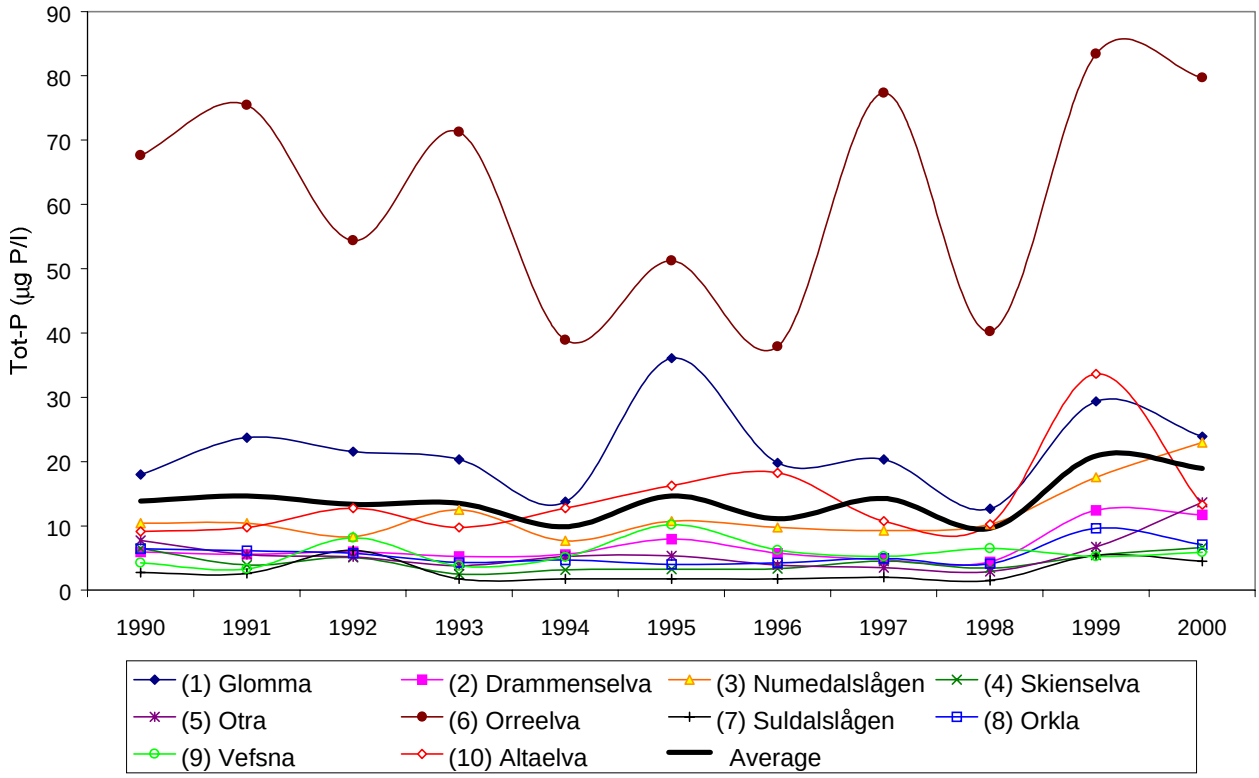


Figure XIII.V Total phosphorus (Tot-P) concentration in main rivers.
Mean value from 1990 to 2000 (µg/l).

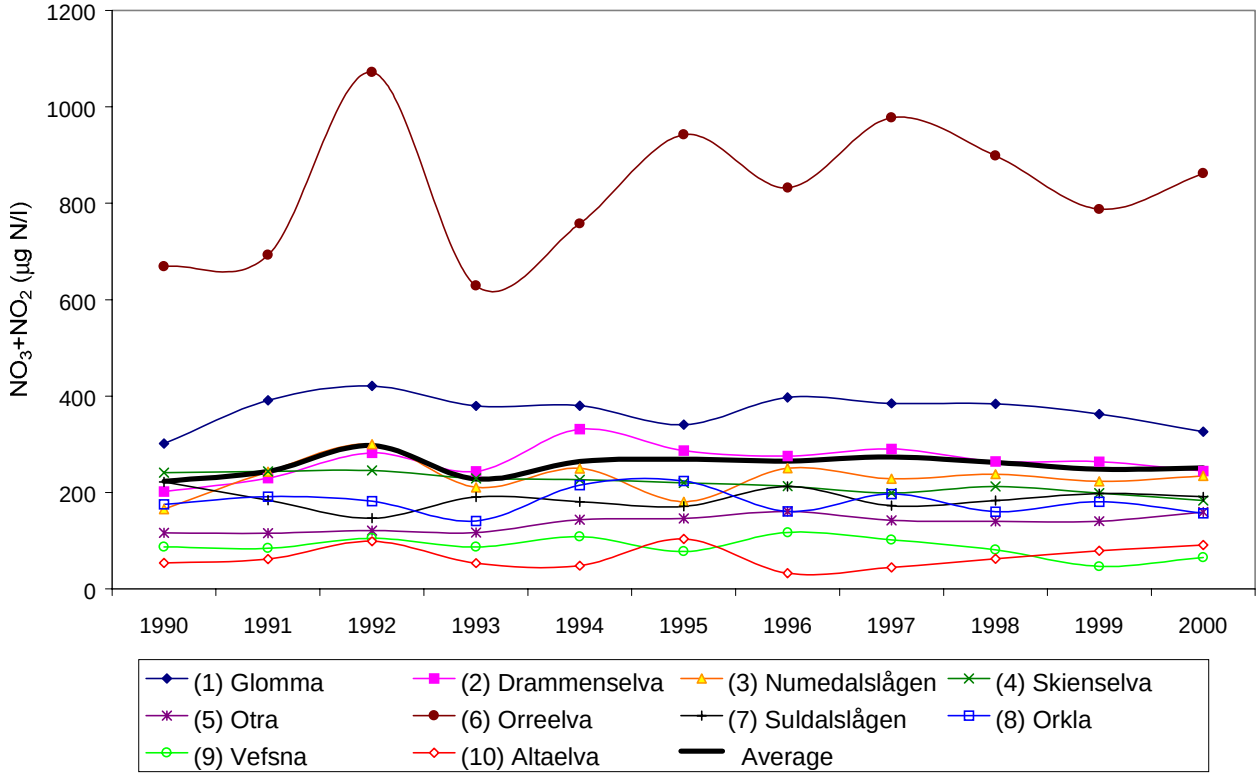


Figure XIII.VI Nitrate and nitrite (NO_2+NO_3) concentration in main rivers.
Mean value from 1990 to 2000 (µg/l).

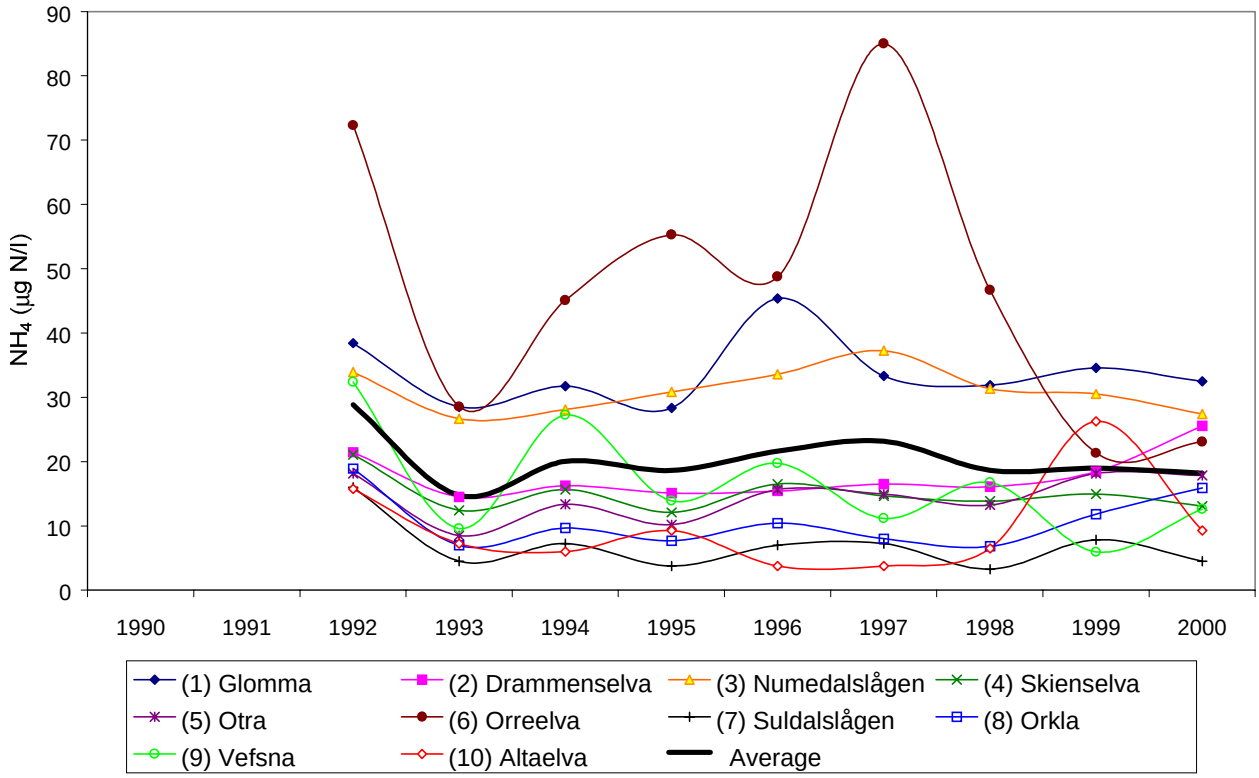


Figure XIII.VII Ammonia (NH_4) concentration in main rivers.
Mean value from 1990 to 2000 (µg/l).

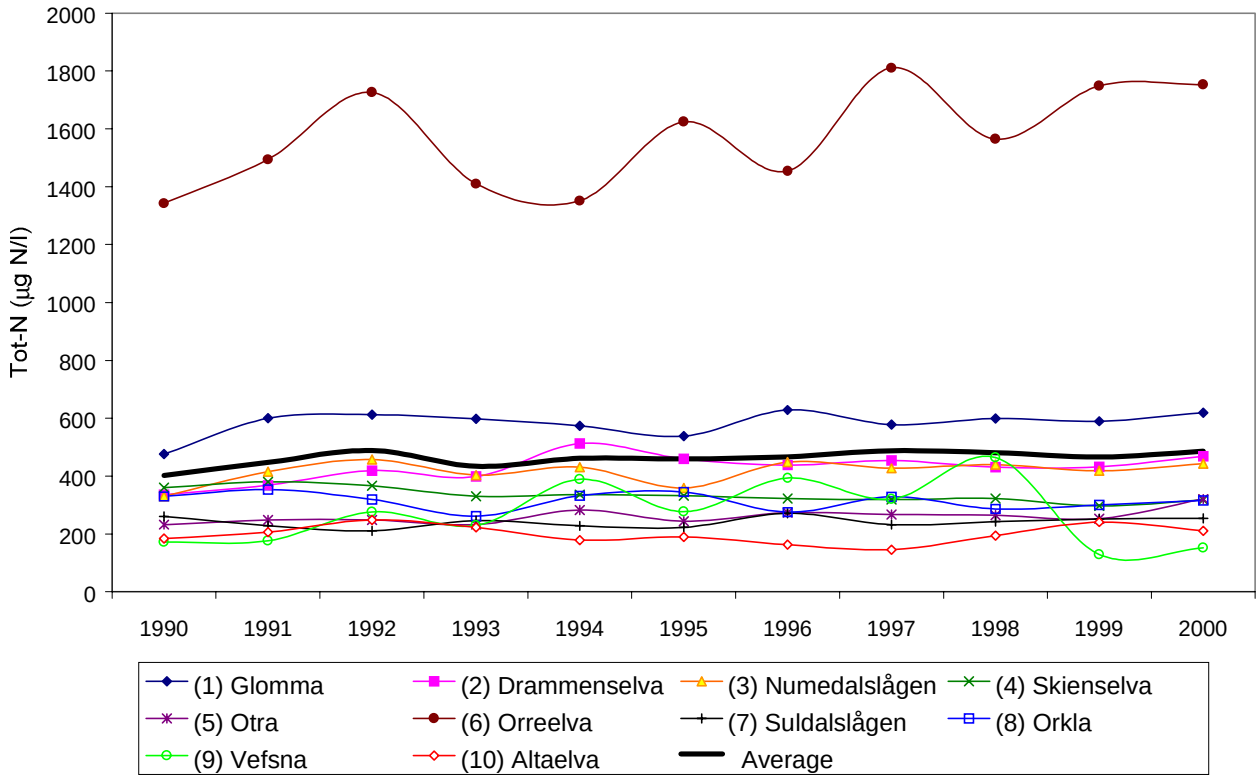


Figure XIII.VIII Total nitrogen (Tot-N) concentration in main rivers.
Mean value from 1990 to 2000 (µg/l).

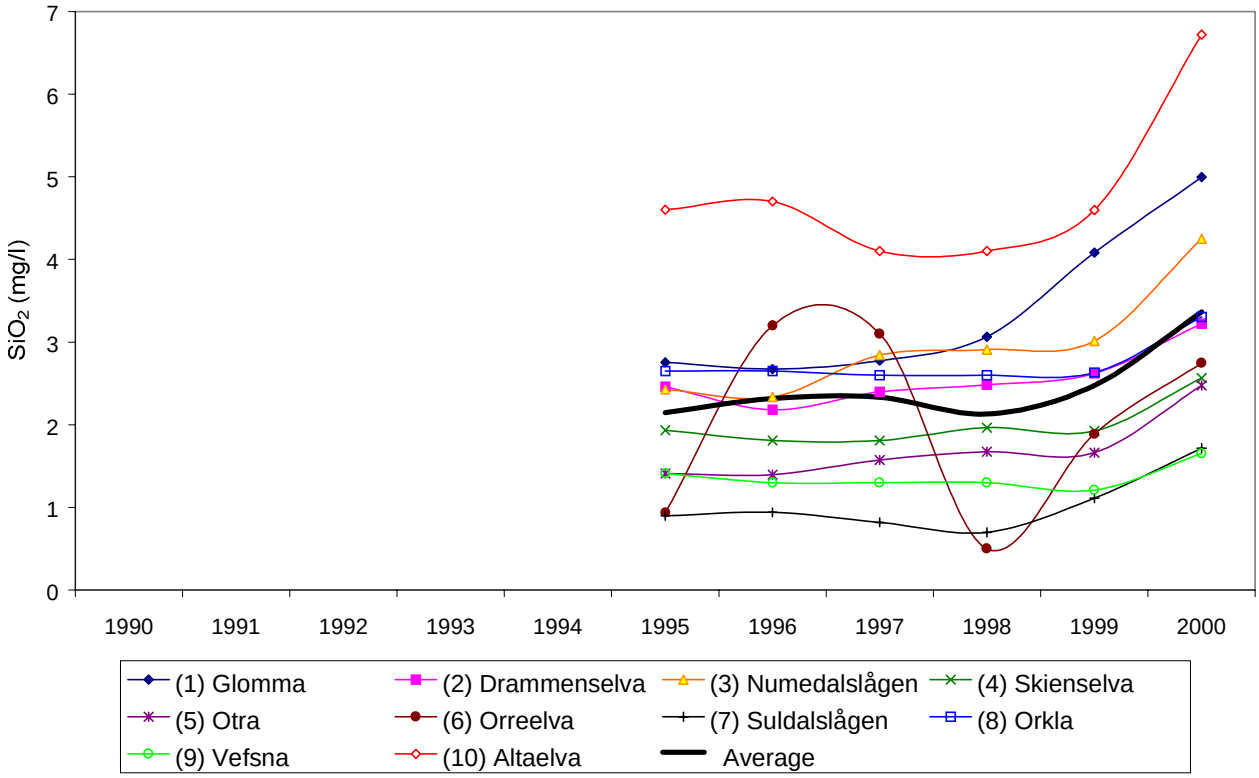


Figure XIII.IX Silicate (SiO_2) concentration in main rivers.
Mean value from 1990 to 2000 (mg/l).

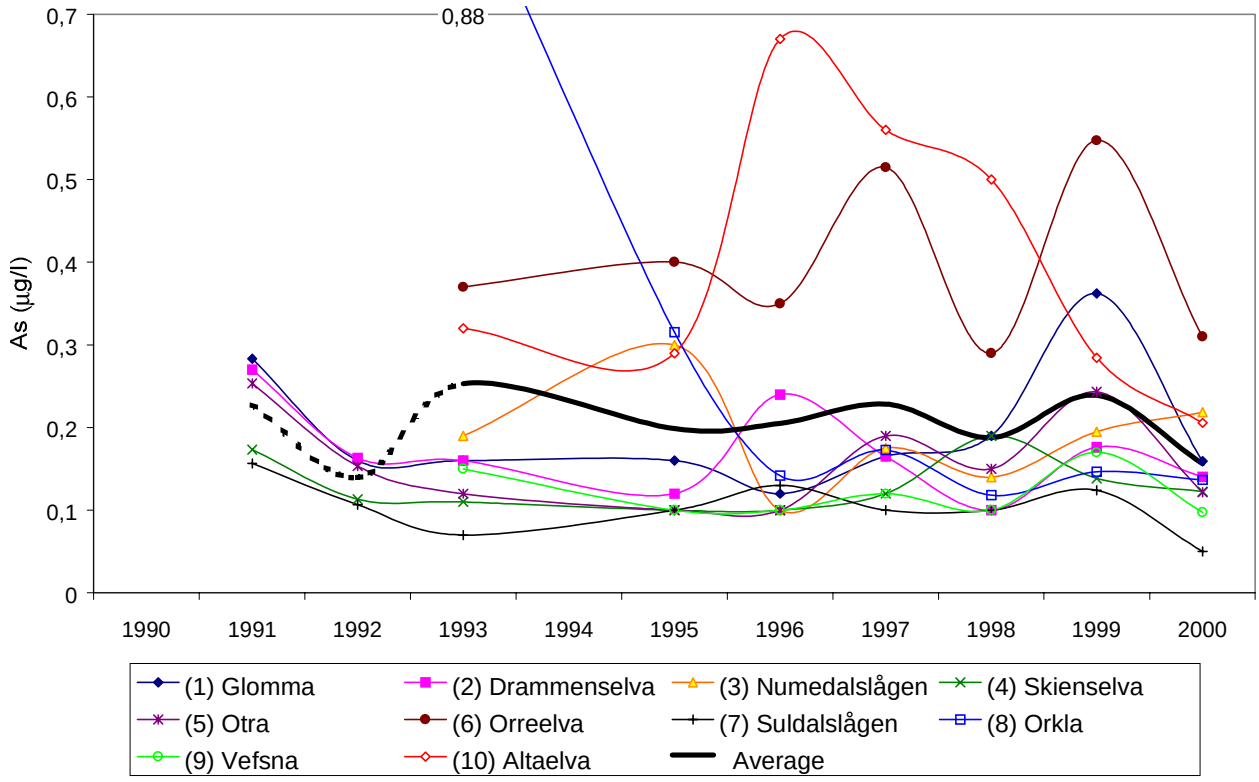


Figure XIII.X Arsenic (As) concentration in main rivers.
Mean value from 1990 to 2000 (µg/l).

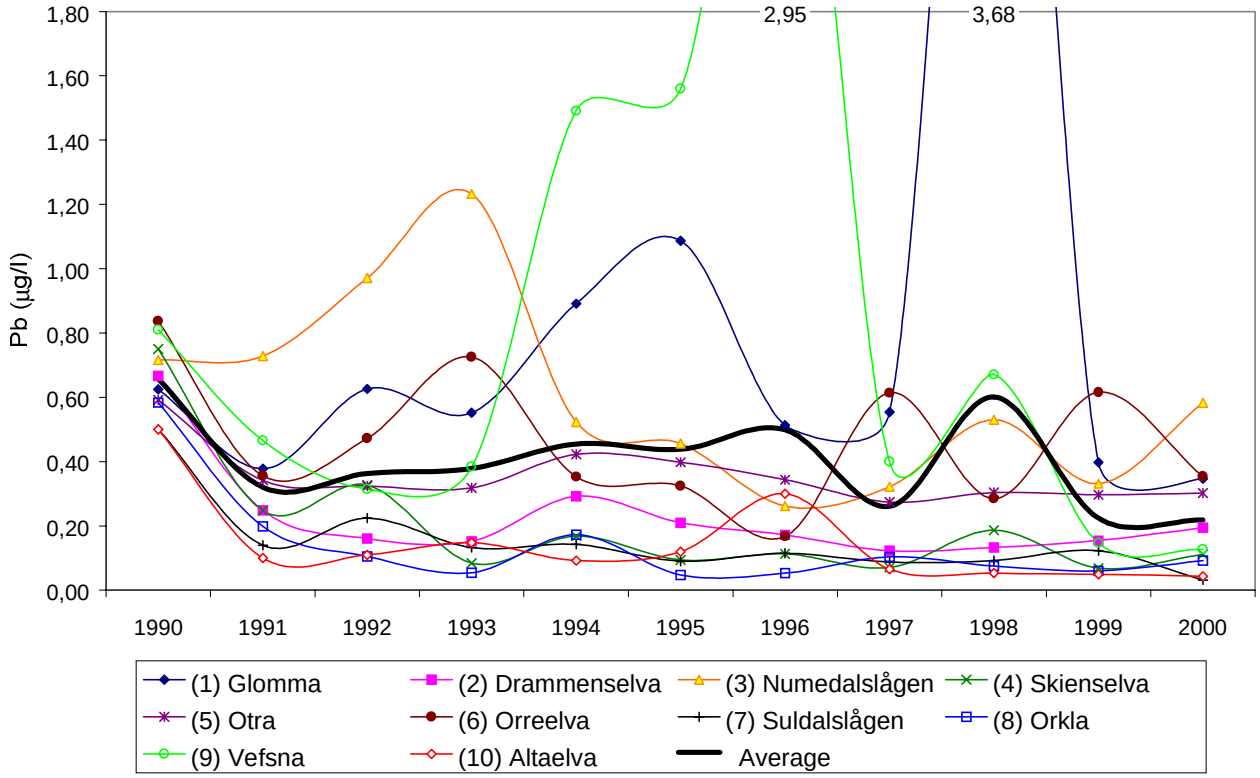


Figure XIII.XI Lead (Pb) concentration in main rivers.
Mean value from 1990 to 2000 (µg/l).

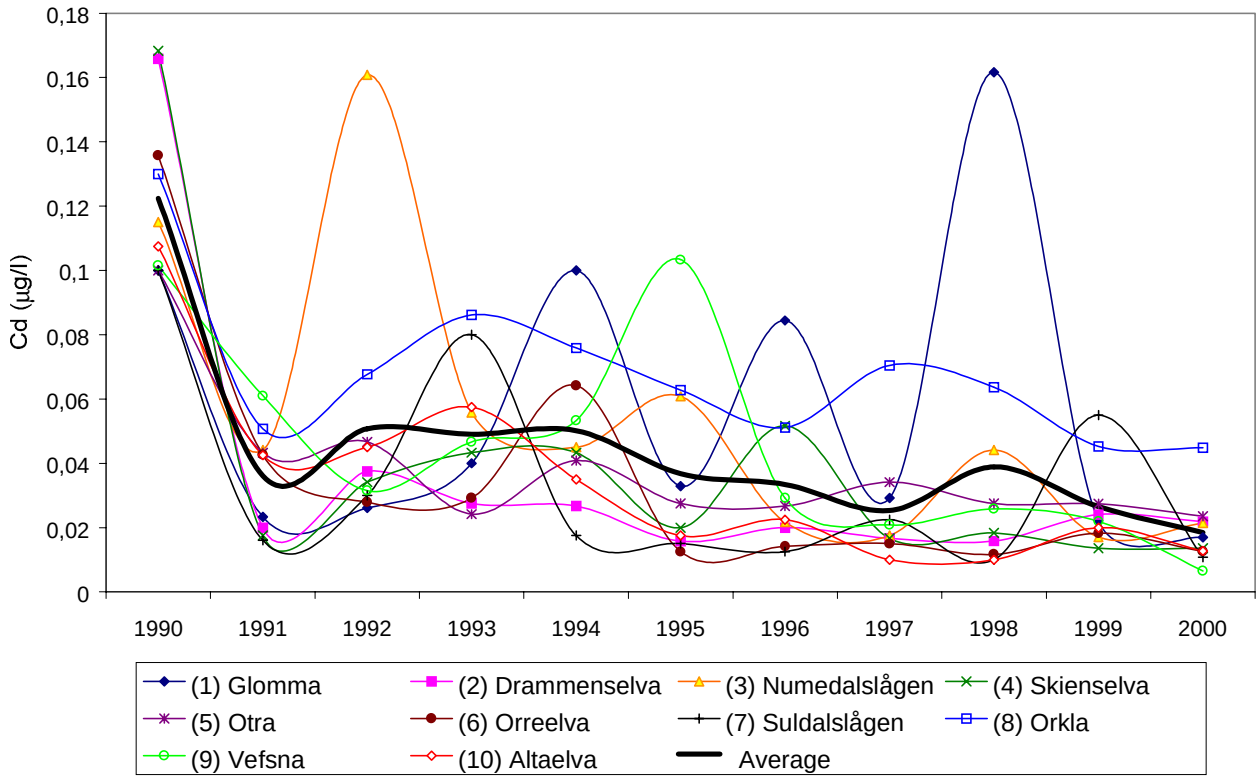


Figure XIII.XII Cadmium (Cd) concentration in main rivers.
Mean value from 1990 to 2000(µg/l).

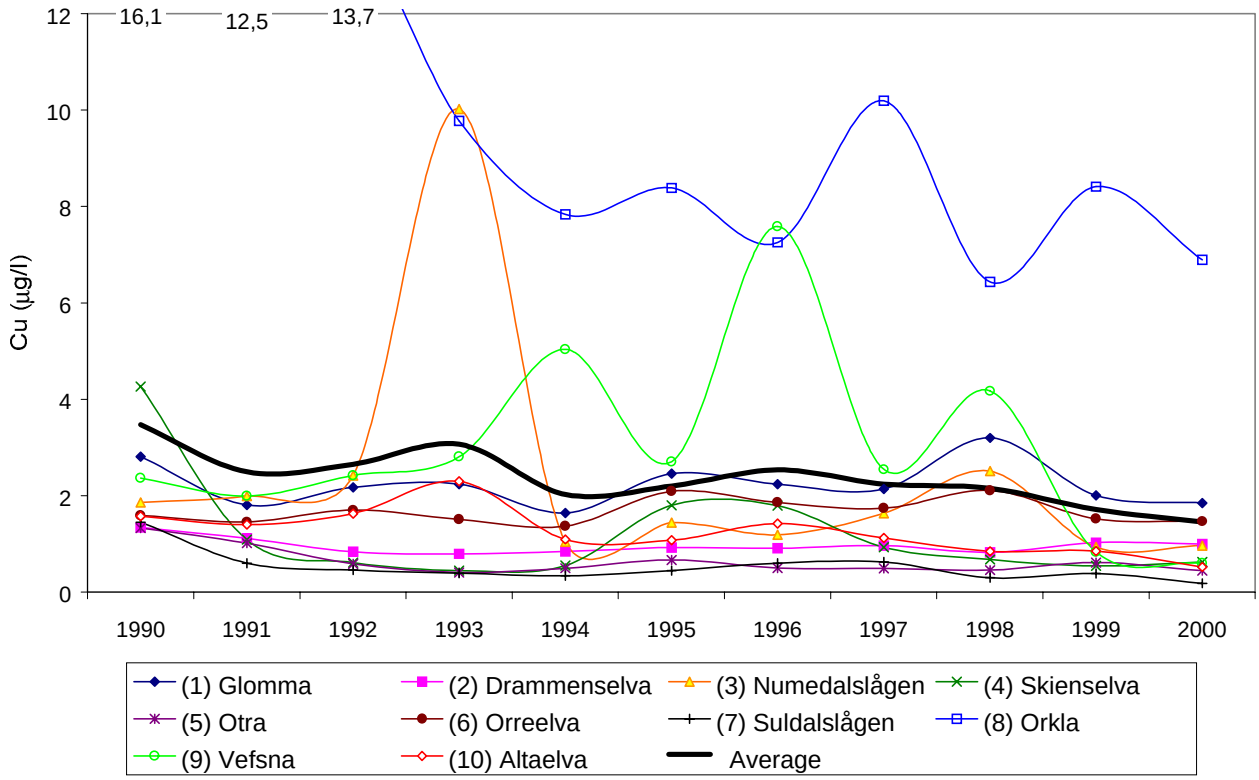


Figure XIII.XIII Copper (Cu) concentration in main rivers.
Mean value from 1990 to 2000 (µg/l).

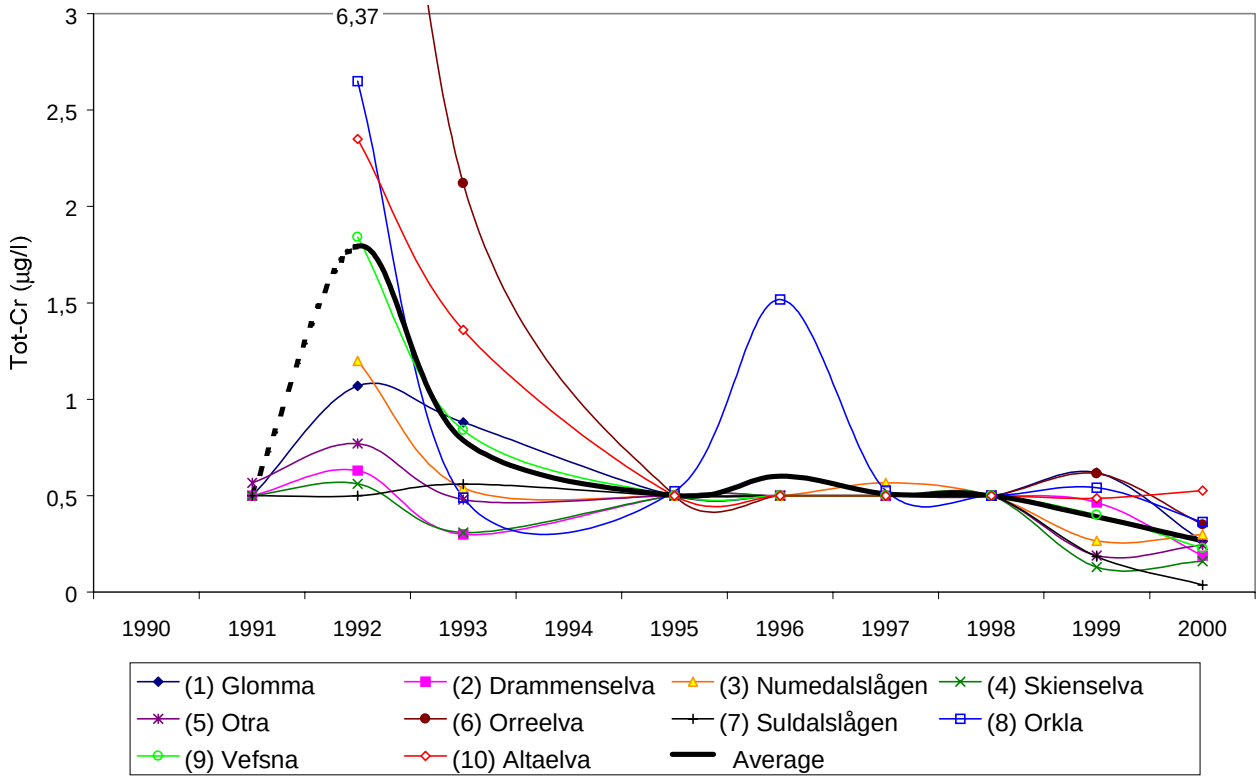


Figure XIII.XIV Total chromium (Tot-Cr) concentration in main rivers.
Mean value from 1990 to 2000 (µg/l). Since 1999 a lower limit of detection has been reported.

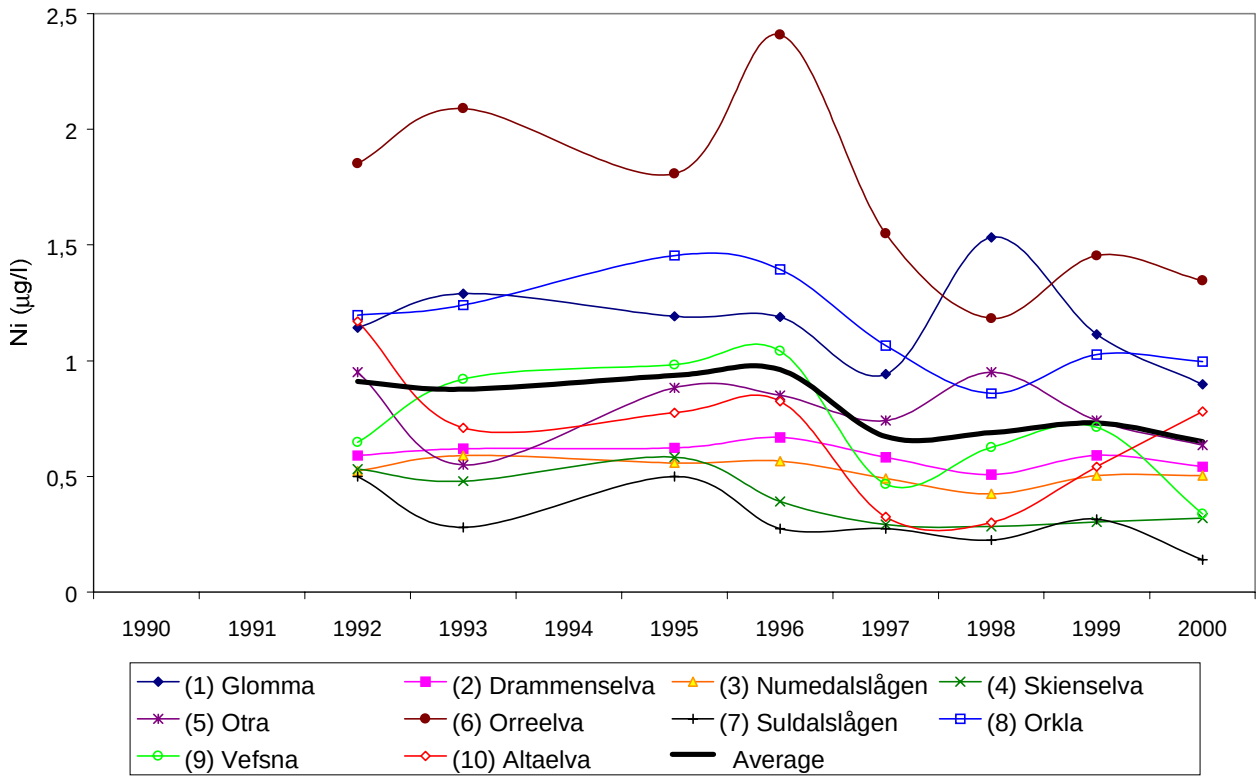


Figure XIII.XV Nickel (Ni) concentration in main rivers.
Mean value from 1990 to 2000 (µg/l).

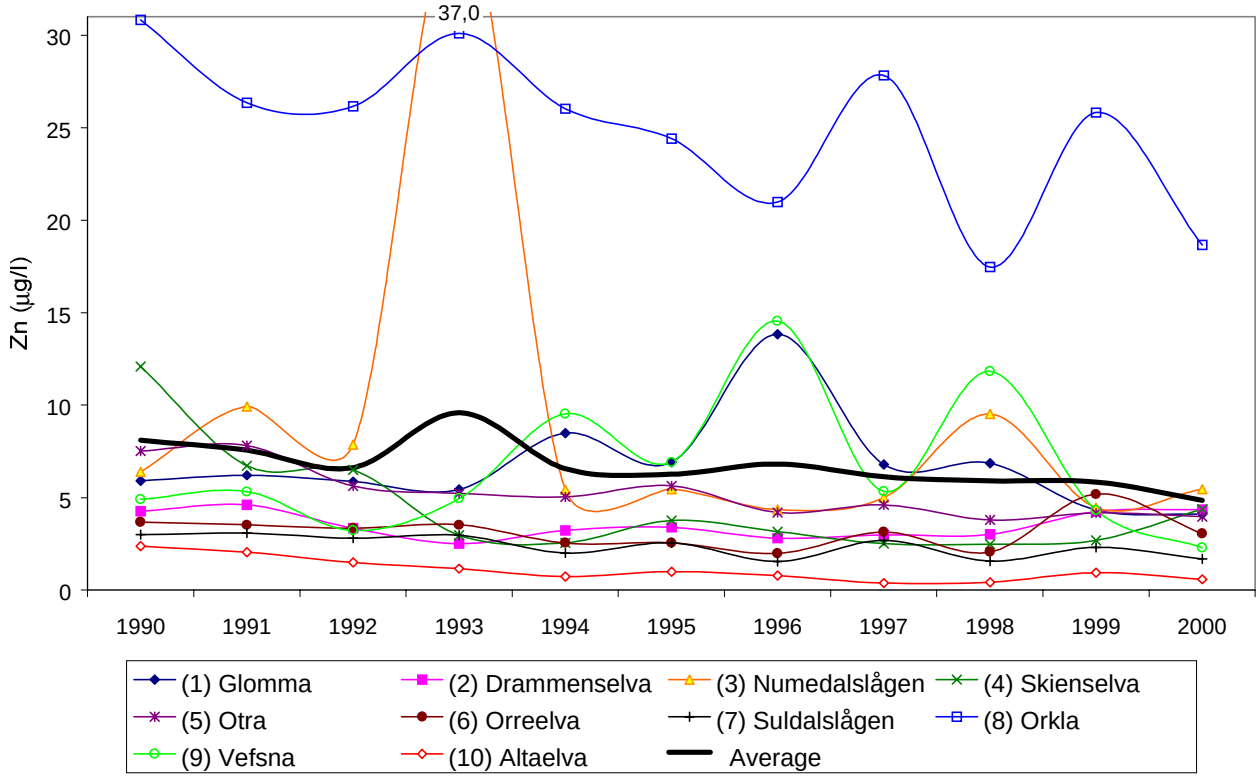


Figure XIII.XVI Zinc (Zn) concentration in main rivers .
Mean value from 1990 to 2000 (µg/l).

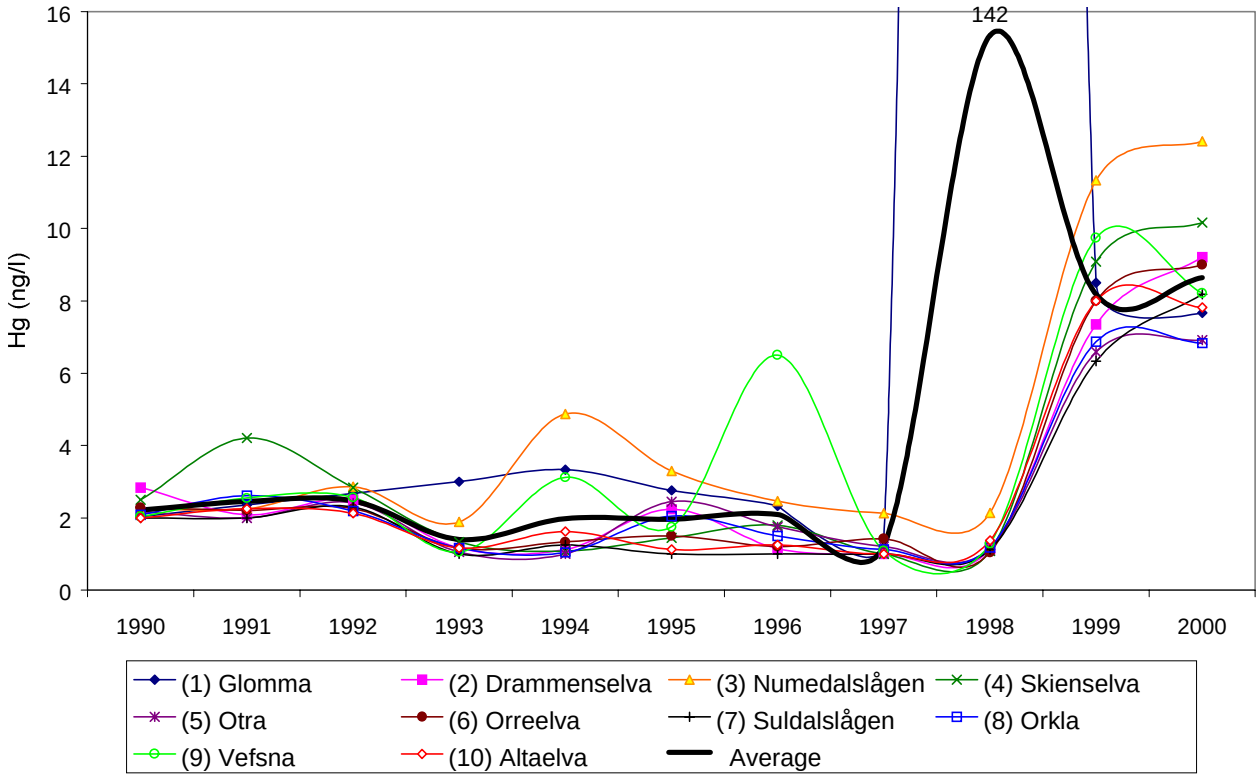


Figure XIII.XVII Mercury (Hg) concentration in main rivers.
Mean value from 1990 to 2000 (ng/l). Since 1999 a new analitical method is used.

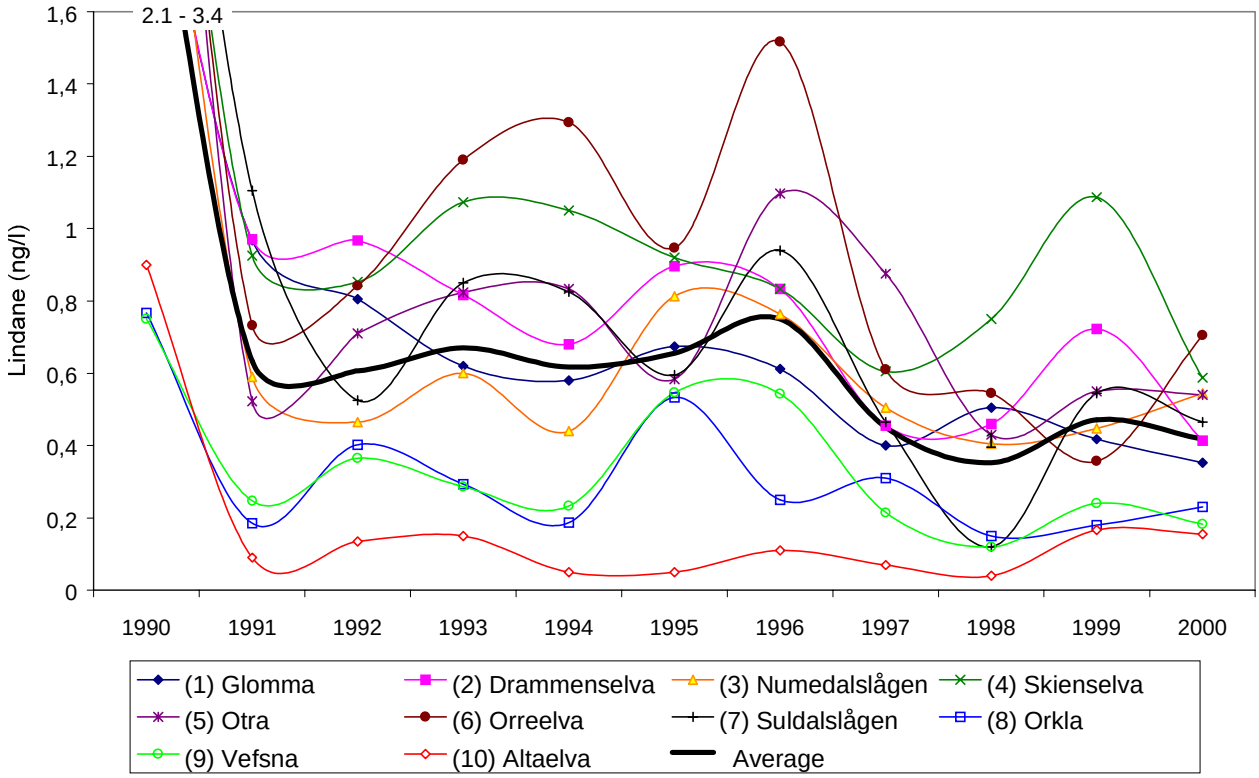


Figure XIII.XVIII Lindane concentration in main rivers
Mean value from 1990 to 2000 (ng/l).

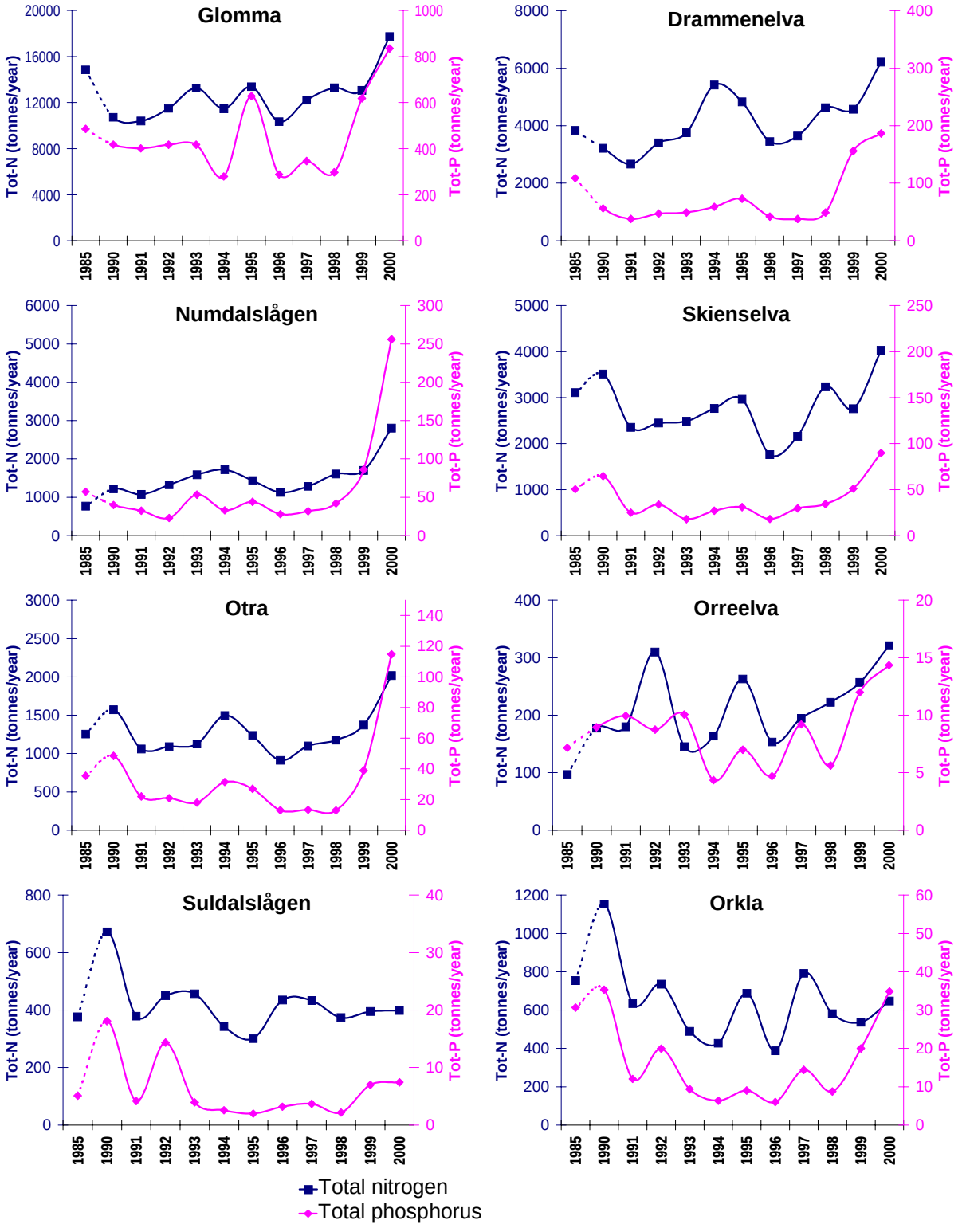


Figure XIX.XIX Total nitrogen (Tot-N) and total phosphorus (Tot-P), load in main rivers.

Calculated load for 1985, 1990-2000 (tonnes/years).

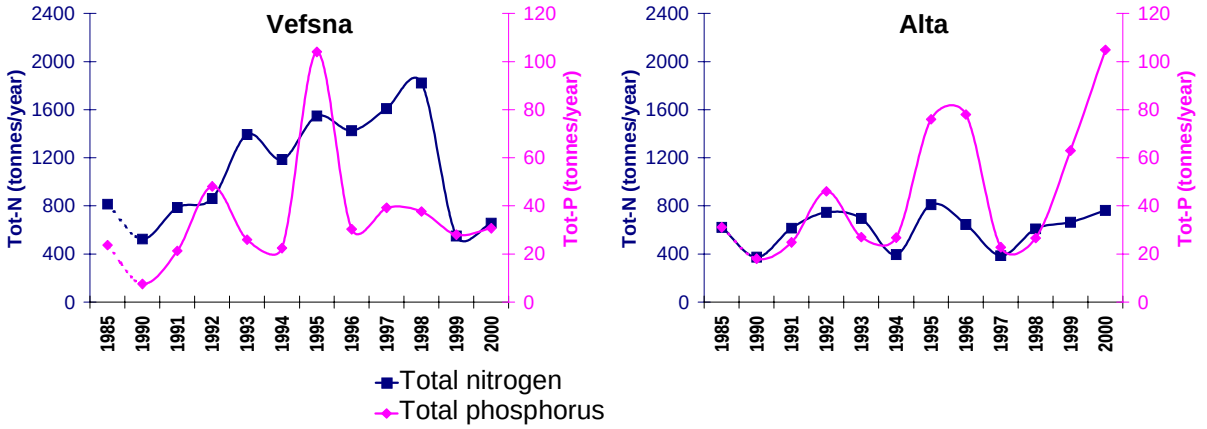


Fig. XIX.XIX (continue)

Appendix XIV. Comparison of results from parallel analysis performed by the laboratories Analycen AS and NIVA, and by Analycen AS and Alcontrol.

1. Introduction

In 2000 several changes in the Scandinavian laboratory structure took place, and different laboratories have carried out the water analysis in the riverine input project. From 01.06.00 the KM Lab in Norway was taken over by Analycen AS. The analyses of total phosphorus, orthophosphate, total nitrogen, ammonia, nitrate+nitrite and TOC were no longer carried out in Grimstad, and from May these analyses were carried out by Analycen's laboratory in Moss. The metals and silicate were in 2000 analysed by the same laboratory as earlier (KM-Lab in Linköping, Sweden, although this laboratory from April 2000 was renamed Alcontrol). It has, however, for a long period been planned to change laboratory for the metal analyses from 2001 from KM-Lab (Alcontrol in Linköping) to Analycen's laboratory in Moss.

Parallel analyses of nutrients and total organic carbon were performed by NIVA and Analycen. Parallel analyses of metals were also performed by Analycen and Alcontrol.

2. Nutrients and TOC

Results from the parallel analysis are shown in Table 14.1.

Table 14.1. Results from parallel analysis by Analycen, Moss (AN) and Norwegian Institute for Water Research (NIVA)

Sample no.	Tot-P (µg P/l)		PO_4-P (µg P/l)		Tot-N (µg N/l)		NH_4 (µg N/l)		NO_3+NO_2 (µg N/l)		TOC (mg/l)	
	AN	NIVA	AN	NIVA	AN	NIVA	AN	NIVA	AN	NIVA	AN	NIVA
1	3	4	3	1	220	185	5	10	65	67	2,6	2,2
2	2	2	2	<1	**123**	**66**	**21**	**<5**	21	29	0,8	0,73
3	75	79	**2**	**7**	1405	1450	7	6	544	605	**8**	**5,7**
4	3	2	1	<1	143	175	3	<5	134	132	0,7	0,72

Sample no. 1: Orkla 30.06.00
Sample no. 2: Vefsna 03.07.00
Sample no. 3: Otra 25.09.00
Sample no. 4: Suldalslågen 25.09.00

The conclusions from this study are:

- Total phosphorus (tot-P): only small differences were found, the correspondence is good.
- Orthophosphate (PO_4): good correspondence, except for sample no. 3, where NIVA's result was higher.
- Total nitrogen (tot-N): good correspondence, except for sample no. 2, where NIVA's result was a little lower.
- Ammonia (NH_4): good correspondence, except for sample no. 2, where NIVA's result was lower. NIVA's detection limit was higher than Analycen's detection limit.
- Nitrate and nitrite (NO_3+NO_2): only small differences were found, the correspondence is good.

- Total organic carbon (TOC): only small differences were found,good correspondence except for sample no. 3 where NIVA's result was lower.

As seen from Table 14.1, some irregularities in sample 2 and 3 were observed. The irregularities could be due to small differences in the parallel samples.

Analycen has participated in several round-robin tests with acceptable results. Youden diagrams for the parameters TOC, orthophosphate, total phosphorus, nitrate and total nitrogen from the last round-robin test (Hovind, 2000) show that Analycen's results were within the acceptance criteria for all parameters. In this round-robin test Analycen had laboratory number 51.

3. Metals and silicate

Results from the parallel analysis are shown in Table 14.2.

Table 14.2. Results from parallel analysis by Analycen (AN) and Alcontrol (AL).

samples	Si (mg/l)		As (µg/l)		Pb (µg/l)		Cd (µg/l)		Cu (µg/l)		Cr (µg/l)		Ni (µg/l)		Zn (µg/l)	
	AN	AL	AN	AL	AN	AL	AN	AL	AN	AL	AN	AL	AN	AL	AN	AL
1	7,3	7,3	0,35	0,29	1,1	0,77	<0,02	0,04	3,1	2,3	2,1	1,1	2,9	1,6	9,7	5,6
2	1,5	1,8	<0,2	<0,02	0,05	0,12	0,03	0,021	0,68	1,01	<0,2	0,19	0,49	0,65	4,1	3,3
3	2,1	2,5	<0,2	<0,02	0,05	0,42	0,03	0,032	0,65	1,14	<0,2	0,28	0,35	0,82	6,9	6,9
4	1,4	1,5	<0,2	<0,02	0,04	0,51	0,03	0,02	0,62	1,42	<0,2	0,14	<0,2	0,33	4,2	4,4
5	0,4	0,64	<0,2	<0,02	0,04	<0,1	<0,02	<0,02	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2	2	2
6	0,87	1,1	<0,2	0,14	0,37	0,28	0,08	0,029	0,5	0,36	<0,2	0,25	<0,2	0,36	5	4,58

Sample no. 1 Glomma 25.11.00
Sample no. 2 Drammenselva 30.11.00
Sample no. 3 Numedalslågen 30.11.00
Sample no. 4 Skienselva 30.11.00
Sample no. 5 Suldalslågen 29.01.01
Sample no. 6 Otra Skråstad 30.01.01

Figure 14.1 shows an overview of the results with uncertainty marked. 20% uncertainty was used for silicate, a definite uncertainty of 0,2 µg/l was used for arsenic, and for the other parameters 30% uncertainty were used. Table 14.2 shows the lower limits for accreditation for the actual analytical methods, and the uncertainties given for the lower limits. The laboratories will not give percentile measure uncertainty for analytical values lower than the accredited values. It is, however, not unusual to anticipate an analytical uncertainty higher than 50% at nanogram level.

Table 14.3. Overview of analytical methods, lowest limits for accredition, and measurement uncertainty. Alcontrol and Analycen.

Parameter	Alcontrol			Analycen		
	Analytical method	Lowest accredited value	Uncertainty for low accredited level	Analytical method	Lowest accredited value [1)]	Uncertainty for low accredited level
Silicate (Si)	ICP/AES	0,01 mg/l	20%	ICP/AES	0,1 mg/l	20%
Arsenic (As)	ICP/MS	0,2 µg/l	30%	ICP/MS	0,2 (0,05) µg/l	7% [2)]
Lead (Pb)	ICP/MS	0,1 µg/l	30%	ICP/MS	0,02 µg/l	7% [2)]
Cadmium (Cd)	ICP/MS	0,02 µg/l	30%	ICP/MS	0,01 µg/l	7% [2)]
Copper (Cu)	ICP/MS	0,2 µg/l	30%	ICP/MS	0,5 (0,05) µg/l	7% [2)]
Chromium (Cr)	ICP/MS	0,2 µg/l	30%	ICP/MS	0,2 µg/l	5% [2)]
Nickel (Ni)	ICP/MS	0,3 µg/l	30%	ICP/MS	0,2 (0,05) µg/l	7% [2)]
Zinc (Zn)	ICP/MS	1 µg/l	30%	ICP/MS	0,5 µg/l	10% [2)]
Mercury (Hg)	Atomic fluorescence	-	-	CETAC	10 (2) ng/l	20%

1) The percentiles give the lowest given values on request. The uncertainty will then be 20% or higher.
2) Measurement uncertainty for this type of water samples is anticipated to be 20%.

The analytical methods used by Analycen and Alcontrol were identical, except for mercury. Si-analyses were performed with ICP/EAS at both laboratories, mercury was analysed by atomic fluorescence at Alcontrol and by CETAC at Analycen, and the other metals were analysed by ICP/MS at both laboratories. The sample preparation methods were not quite identical. Both laboratories desolve particulates in the samples with suprapure HNO_3. Analycen analyses the sample as it is, but Alcontrol perform the analysis after sedimentation of larger particles.

Analycen's method for analysis of mercury is based on traditional cold vapour technique. Hg ions are reduced to Hg^0 by tin(II)chloride, thereafter carried to a cuvette by argon. Here the reduction in the light intensity from a Hg lamp is measured. A dedicated Hg instrument improved in relation to former cold vapour instruments is used. The improvements are a more effective phase separator and a reference cuvette for continuous adjustment of blind value in the atmosphere, where Hg lamp and detector read the signals. The gas stream carrying the Hg^0 to the cuvette can also be adjusted (reduced) to increase the sensitivity.

The conclusions from this study are:

- Systematic higher or lower values have not been found for any of the parameters. In the sample from Glomma were Analycen's values higher than Alcontrol's values, except for cadmium. The irregularities could be due to small differences in the parallel samples (e.g. one of the samples contains more particles than the other one).
- Silicate (Si): Only small differences were found, the correspondence is good (all results within 20% uncertainty).
- Arsenic (As): It is difficult to say something about the uncertainty, since most of the results were lower than the detection limit.
- Lead (Pb): Relatively large differences between the results.
- Cadmium (Cd): Only small differences were found, the correspondence is good (all results within 30% uncertainty, except for Otra, all results within 50% uncertainty).
- Copper (Cu): Only small differences were found, the correspondence is good (all results within 30% uncertainty, except for Skienselva, all results within 50% uncertainty).
- Chromium (Cr): Only small differences were found, the correspondence is good (all results within 30% uncertainty).
- Nickel (Ni): Only small differences were found, the correspondence is good (all results within 30% uncertainty, except for Numedalslågen, all results within 50% uncertainty).
- Zinc (Zn): Only small differences were found, the correspondence is good (all results within 30% uncertainty).
- Mercury (Hg): Analytical results for mercury are not presented, since all results were lower than the detection limit at Alcontrol (5 ng/l). Analycen will, however, present results lower than 2 ng/l.

4. Conclusion

We propose that all the discussed analysis can be taken over by Analycen. It is assumed that Analycen will keep informed about all arranged round-robin tests with low concentrations of metals (both Norwegian and foreign tests), participate in such round-robin tests, and that the results from these tests automatically will be made available for Aquateam.

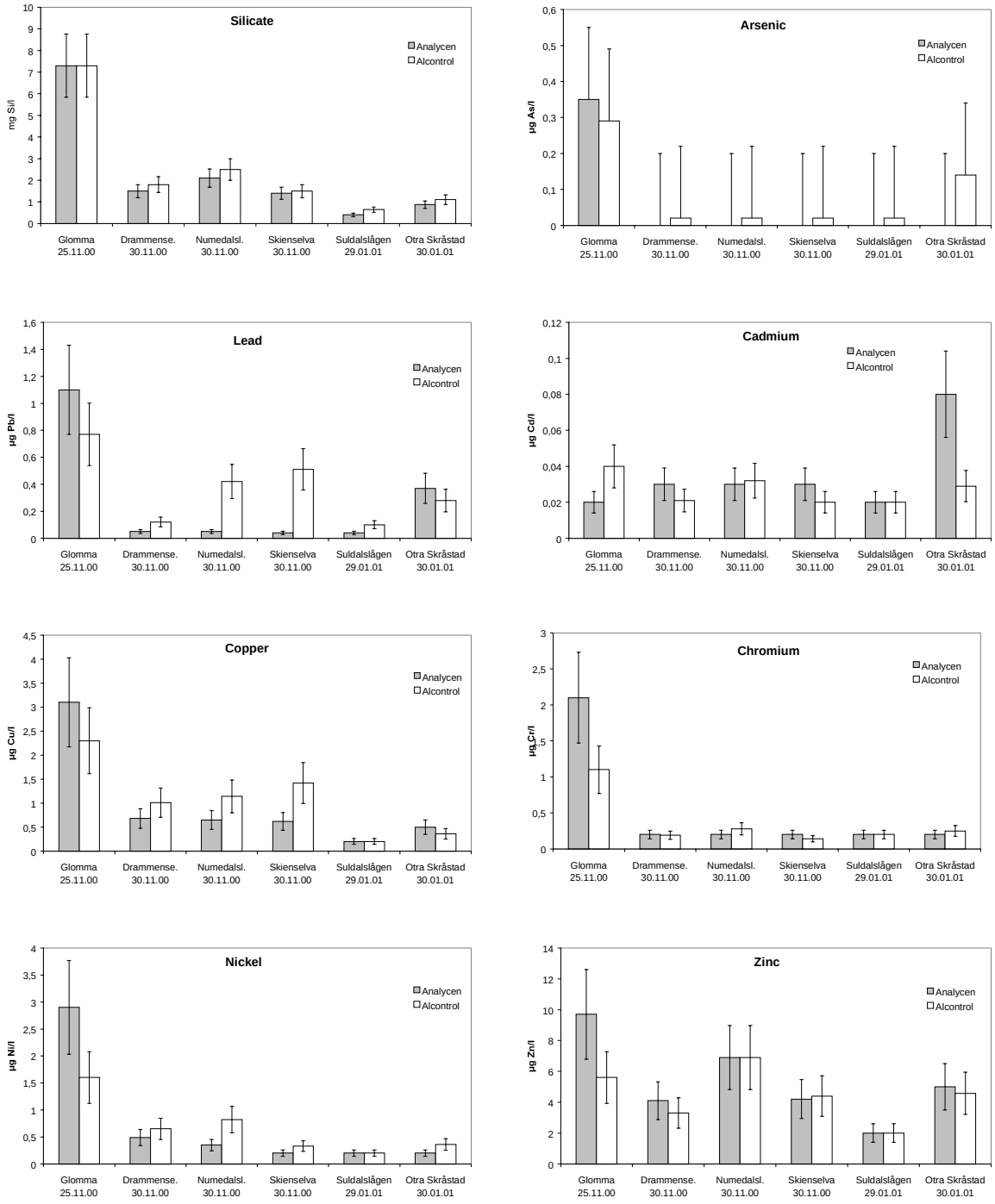


Figure 14.1. Results from parallel analysis of Si and metals performed by the laboratories Analycen and Alcontrol.

5. References

Hovind, H. (2000): Ringtester – Vassdragsanalyse. Ringtest 00-09. NIVA rapport 4275-2000.

Appendix XV. Results from use of passive samplers in the Norwegian riverine monitoring project, July – September 2000

1. Introduction

There is a lack of appropriate methods for monitoring low levels of pollutants in rivers. Spot sampling will not catch short temporal variations or peaks in contaminant concentrations. Continuous monitoring has shown to be expensive, and robust chemical/technical on-line methods for monitoring low levels of metals and organic micropollutants are yet not developed. Aquatic mosses have been used as indicators of metal pollution in streams, since they efficiently accumulate metals from water. Mussels have been used in many marine-monitoring programmes. No organisms, however, have been found which satisfy the requirements of quantification of environmental pollution with regard to variation in site and time (Markert 1994). Concentrations of metals in aquatic mosses are not easy to calibrate with natural water concentrations, because of the plant's natural growth phases (Bruns et al. 1995, Siebert et al. 1996) and influences from other ions (Claveri et al. 1995).

In the Norwegian riverine monitoring project to the North Sea during year 2000, it was decided to investigate the suitability of passive monitoring devices to monitor low levels of heavy metals and organic pollutants in running water. The riverine monitoring project is a part of a joint monitoring programme under the "OSPAR Commission for the Protection of the Marine Environment of the North-East Atlantic". The Norwegian contribution is administered by the Norwegian Pollution Control Authority (SFT).

Passive accumulation devices (PADs) were exposed to two rivers over a time span to test the suitability of the method. These devices are deployed over longer time periods, and are presumed to give more accurate time-weighted average concentrations of heavy metals and organic compounds in running waters than spot samples. Use of PADs, if it proves suitable, is considered cost-efficient and less time-consuming method than spot sampling. The PADs can also be used on places where biological growth will not occur, e.g. in channels and pipes. Two types of PADs were employed:

- Ecoscope: Ecoscopes consist of two independant units; one cellulose bag containing n-hexane, which accumulates hydrophobic organic molecules, and a polystyrene tube containing ion-exchange material, which accumulates heavy metals (and other cations) from the waters. This unit is developed by KM Lab AB, Sweden.
- A second generation of Ecoscopes, here called Passive Samplers. This sampler was developed by Chalmers University, Sweden and the University of Portsmouth, UK, in cooperation with KM Lab, within the EU's 4th framework program (Environment and Climate). Two separate samplers were deployed; one containing a "chelating disc", accumulating heavy metals, and one containing a C18-disc, accumulating hydrophobic organic compounds.

Use of PADs has given satisfactory results for monitoring heavy metals in sewage (Storhaug, 1998) and for monitoring organic contaminants in the environment (Sverdrup et al. 1999, Johnsen et al. 1998, Røe 1998, Hofelt and Shea 1997; Peven et al. 1995, Peterson et al. 1995). Aquateam has also used Ecoscopes for monitoring of rotenone in ultra-oligotrophic alpine streams and lakes (Kelley et al.1999, 2000). Several Swedish municipalities use Ecoscopes for monitoring of storm water runoff. If properly calibrated for the purpose, the Passive Sampler can be used to assess time-proportional water concentrations based on accumulated amounts of contaminants in the

Passive Samplers. The samplers will probably be saturated or the equilibrium will be reached after several months, depending on the concentration level of the pollutants. The Passive Samplers have previously been calibrated for several heavy metals and organic contaminants (Persson 1999). Similar calibrations have not been performed for Ecoscopes.

This appendix presents the results and experiences from the first two months of riverine monitoring using Passive Samplers and Ecoscopes.

2. Materials and methods

2.1. Spot sampling and water analysis

In this study, two rivers in the southern part of Norway were selected for the study, Drammenselva and Glomma. These rivers have been included in the Norwegian monitoring riverine project since 1990. Sampling sites have been located in areas where the water is well mixed. Twelve or more spot samples have been taken at regular monthly intervals. In May-June (the period with the highest anticipated flow) weekly samples were taken. This paper includes the results from January to November 2000. The water samples for heavy metals (Cu, Cr, Zn, Ni, Pd, Cd, Hg) were analyzed by the laboratory Alcontrol, Sweden, and the samples for organic pollutants (lindane) were analyzed by Aquateam.

2.2. Deployment and collection of the PADs

The samplers were deployed near the sites for spot sampling. Eight Passive Samplers were placed at each site (4 parallel units for heavy metals, 4 parallel units for organic contaminants), and 4 Ecoscopes (each unit collects both heavy metals and organics). The samplers were placed on site 26 June 2000 in Glomma and 27 June in Drammenselva. One half of the samplers were collected after one month (30 July), the remainders after approximately two months (6 September). The samplers were analyzed by the laboratory Analycen AS, Norway, with exception of lindane, which was analyzed by Aquateam.

2.3. Ecoscope preparation

Procedure after exposure in the rivers:

- Heavy metals: The ion-exchange material was extracted with 4 M HNO_3 and the extract analyzed with ICP for Cu, Cr, Zn, Ni, Pd, Cd and Hg.

- Organic contaminants: The n-hexane was collected and added internal standard (pentachloronitrobenzene dissolved in acetone) and evaporated to dryness. The concentrate was then dissolved in n-hexane and treated with conc. sulfuric acid. The n-hexane fraction was evaporated to 0.2 ml and analyzed with GC/ECD for lindane.

2.4. Passive Samplers preparation

Procedure after exposure in the rivers:

- Heavy metals: The chelating disc was cut into small pieces and extracted three times with 3 M HNO_3. The volume was adjusted to 25 ml and the extract was analyzed with ICP. The same heavy metals as described for Ecoscopes were analyzed.
- Organic contaminants: The C18-disc was cut into small pieces, added internal standard (as for Ecoscopes) and extracted with 3 times 10 ml acetone/n-hexane (1/1). The sample was evaporated to dryness, treated with conc. sulfuric acid and evaporated to 0.2 ml. The samples were then analyzed with GC/ECD. The samples were analyzed for lindane, DDT, PCB and PAH, but only the lindane was quantified.

3. Results and Discussions

3.1. Metals – Passive Samplers

The measured concentrations of heavy metals in the spot samples from Glomma and Drammenselva are shown in Figures 15.1 and 15.2, respectively. Average concentrations during the PAD sampling period are presented in Table 15.1.

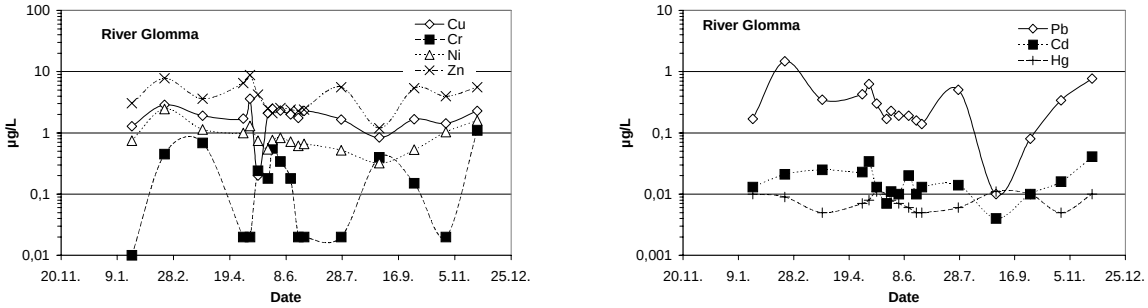


Figure 15.1. Measured water concentrations of metals in spot samples from the river Glomma during 2000.

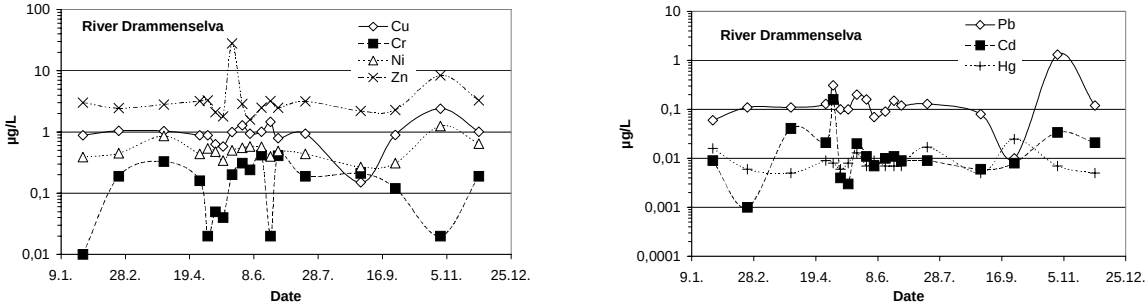


Figure 15.2. Measured water concentrations of metals in spot samples from the river Drammenselva during 2000.

Table 15.1. Average concentrations of metals measured in the spot samples from the river Glomma and Drammenselva, June – August 2000.

Metal	Glomma		Drammenselva	
	First month	Two months	First month	Two months
Pb (µg/l)	0.33	0.22[1)]	0.13	0.11
Cd (µg/l)	0.014	0.010	0.009	0.008
Cu (µg/l)	2.0	1.6	0.87	0.63
Cr (µg/l)	0.01[1)]	0.14[1)]	0.3	0.27
Ni (µg/l)	0.59	0.50	0.47	0.40
Zn (µg/l)	4.0	3.1	2.8	2.6
Hg (ng/l)	4.3[1)]	6.5[1)]	12	9.7

[1)] Estimated values, given the non-detect values are 50 % of the detection limits.

The assessed concentrations of heavy metals based on the Passive Samplers are shown in Table 15.2, and based on the Ecoscopes are shown in Table 15.3.

Table 15.2. Accumulated amounts of heavy metals in Passive Samplers exposed in the rivers Drammenselva and Glomma, June – August 2000. All values are in µg/device.

Metal	Drammenselva				Glomma		
	Exposed 1 month		Exposed 2 months		Exposed 1 month		Exposed 2 months
Pb	0.48	0.98	0.55	1.65	0.53	0.75	0.43
Cd	0.23	0.17	0.078	0.10	0.085	0.11	0.16
Cu	2.60	3.68	4.08	14.70	3.23	6.58	4.23
Cr	6.53	6.73	1.50	1.60	5.30	3.08	1.43
Ni	1.15	1.30	3.58	1.63	1.48	1.58	2.25
Zn	7.83	8.08	24.20	30.25	8.95	10.75	24.33
Hg	0.0005	0.00025	<0.00025	<0.00025	0.00025	0.00075	<0.00025

Table 15.3. Accumulated concentrations of heavy metals in Ecoscopes exposed in the rivers Drammenselva and Glomma, June – August 2000. All values are in mg/kg dw ion exchange material, except mercury, which is given in µg/kg dw.

Metal	Drammenselva				Glomma			
	Exposed 1 month		Exposed 2 months		Exposed 1 month		Exposed 2 months	
Pb	< 0.32	< 0.32	< 0.32	< 0.32	< 0.32	< 0.32	< 0.32	< 0.32
Cd	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	<0.02	<0.02
Cu	0.25	0.16	0.9	0.8	< 0.1	< 0.1	< 0.1	< 0.1
Cr	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Ni	< 0.68	< 0.68	< 0.68	< 0.68	< 0.68	< 0.68	<0.68	<0.68
Zn	1.62	1.42	4.62	4.52	1.62	1.32	1.22	0.82
Hg	1.04	1.14	5.74	9.64	0.71	0.49	0.25	2.54

The Passive Samplers were deployed in the rivers for one and two months. Relationships between the amounts of heavy metals accumulated in the Passive Samplers and the average concentrations in spot samples during the first month of deployment are shown in Figure 15.3.

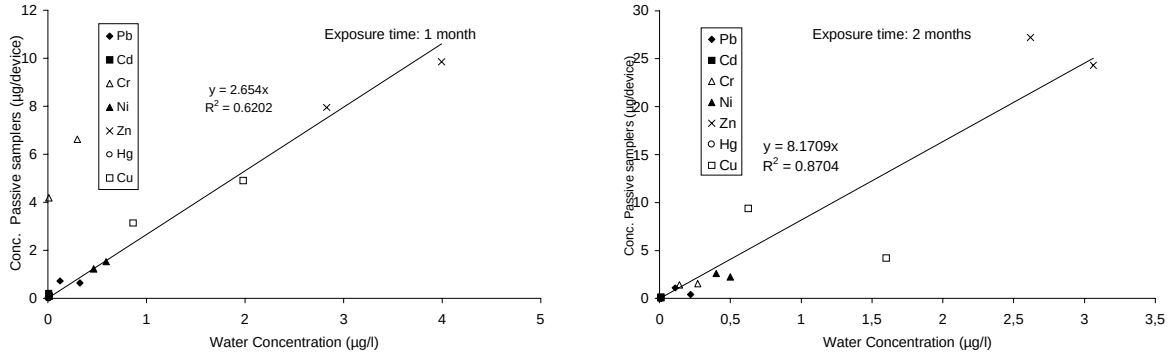


Figure 15.3. Accumulated amounts of heavy metals in Passive Samplers in the two rivers versus average concentrations in spot samples.

Figure 15.3 shows a good correlation between the amounts in the Passive Samplers and the water concentrations. There are a few out-liers, especially chromium, which appears to accumulate significantly faster than the other heavy metals during the first month, and mercury, which does not accumulate significantly. Cadmium is present at such low concentrations that the measured concentrations are rather uncertain in both the water samples and in the Passive Samplers. The concentrations of chromium in the rivers varied greatly during the monitoring period, and it is possible that the measured concentrations in the Passive Samplers reflect the time-weighted average con-

centrations better than the spot samples. When considering the situation after two months, there is a reduction in the accumulation of chromium.

The differences in the results for the one and two months' exposures may be due to the fact that the water concentrations have varied over a large scale during this period, or source of errors as increased biofouling of the samplers or reduced membrane quality over time.

Calculated uptake rates in this experiment are significantly lower than observed in laboratory trials (k = approximately 0.9 Liter*device $^{-1}$*day^{-1}) (Persson, 1999). Our uptake rates, approximately 0.09 Liter*device $^{-1}$*day^{-1}, are in the same order of magnitude as in the field trials seen in the same calibration study. The difference between the two uptake constants seems mostly due to the fact that clean, non-particulate water has been used for the uptake experiments in the laboratory. Also, the concentrations used (10 – 100 mg/l of each metal) are many orders of magnitude higher than the concentrations observed in unpolluted rivers. Further calibrations are needed for realistic environmental conditions.

3.2. Metals - Ecoscopes

Only zinc and mercury were detected in both rivers using the Ecoscopes, while copper was detected in the river Drammenselva only. Relationships between concentrations in the water phase and in the Ecoscopes are shown in Figure 15.4. While the Ecoscopes give quantifiable results for mercury, the correlation of mercury compared to the other heavy metals is poor. It may however be suitable to use the Ecoscopes for mercury, and the Passive Samplers for the other heavy metals.

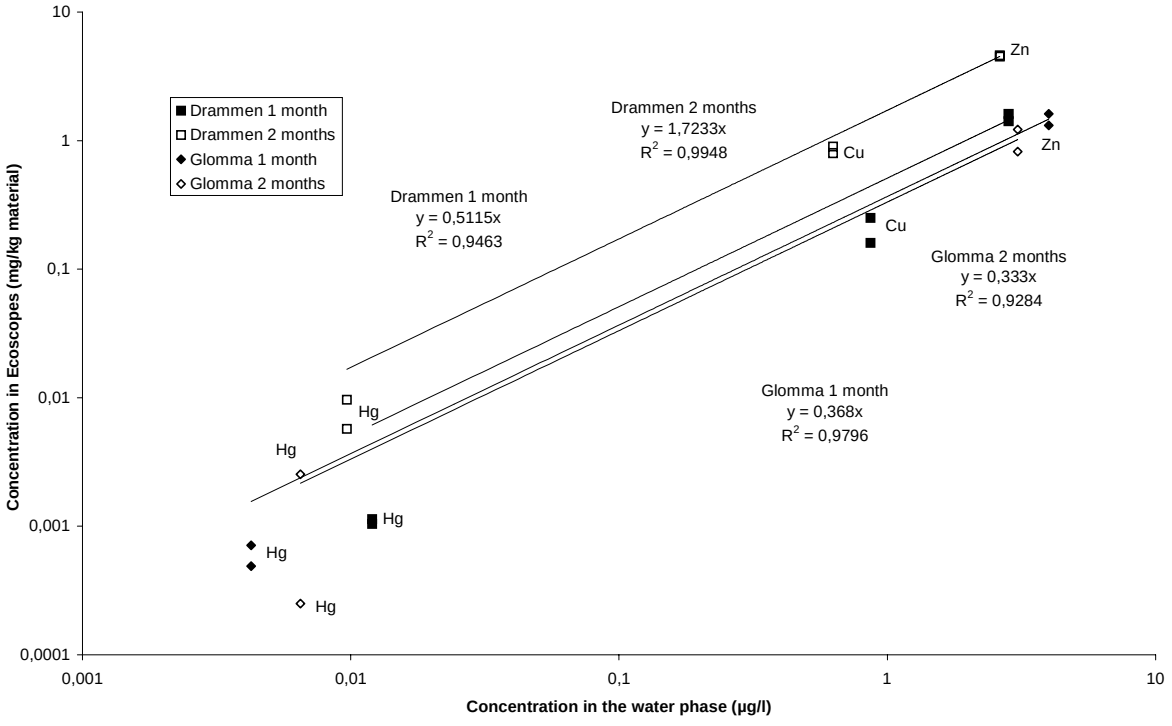


Figure 15.4. Concentrations of Hg, Cu and Zn in Ecoscopes versus average concentrations in spot samples from the rivers.

3.3. Results for lindane (γ-HCH)

The measured water concentrations of lindane from the two rivers are shown in Table 15.4.

Table 15.4. Concentration of lindane (γ-HCH) in water samples from Drammenselva and Glomma.

Rivers	Sample date	ng/l γ-HCH
Drammenselva	27 June 2000	0.58
	30 August 2000	0.34
Glomma	12 June 2000	0.47
	30 August 2000	0.32

The cellulose membranes of the Ecoscopes were severely covered by biofilm (algae and bacteria), and the samplers had also lost significant amounts of n-hexane (diffusion and leakage). It was therefore not possible to quantify the concentration of lindane in the Ecoscopes. The measured concentrations of lindane in the Passive Samplers are shown in Table 15.5.

Table 15.5. Measured concentrations of lindane in the Passive Samplers. Concentrations are in ng/device.

Parameter	Drammenselva (ng/device)				Glomma (ng/device)			
	Exposed 1 month		Exposed 2 months		Exposed 1 month		Exposed 2 months	
Lindane	125	92	126	---[1)]	126	96	197	108

[1)] Not quantifiable due to interference

The riverine monitoring project includes only one organic compound, lindane. The measured concentrations in the rivers Glomma and Drammenselva have been found to be rather stable, and no significant trends in the accumulation of lindane from the waters can be found in this study. The average concentrations of the substance in the water phase were rather similar for the two water bodies, and the concentrations in the Passive Samplers were also quite similar. Since we have no gradient in concentrations between the two sampling periods, it has not been possible to conclude on the efficiency of the Passive Samplers for monitoring time averaged water concentrations of lindane. It is clear however, that Passive Samplers accumulate significant amounts of the substance from the water. The rather large differences between the parallels are probably due to differing degrees of biofouling of the samplers. In future sampling periods, adding an internal standard to the samplers should to some extent compensate for this.

The Passive Samplers were also analyzed for DDT, PCB and PAH. These substances were not quantified, since the concentrations were lower than the detection limits.

The Ecoscopes should in principle also be suitable for continued monitoring of lindane. However, based on our experience with these samplers, they accumulate less material than the Passive Samplers. The Ecoscopes have been recommended used for primarily monitoring of the heavy metals.

4. Conclusions

Average concentrations of heavy metals in river waters and amounts accumulated in Passive Samplers show good correlations. Passive Samplers, therefore, are considered to be well suited for monitoring time weighted average concentrations in running water. However, further studies of the accumulation of the heavy metals under different environmental conditions (e.g. temperature, ionic strength), should be performed.

The Ecoscopes show poor accumulation for most heavy metals, except for zinc, mercury and for one river, copper. The Ecoscopes are suitable for monitoring mercury while the Passive Samplers are recommended employed for other heavy metals.

There is one limitation related to the use of PADs that should be emphasized here. The devices are primarily designed only to accumulate cationic metal species. The degree to which neutral, anionic and particulate metals will accumulate on the chelating disc is not known and will, most probably, differ between metal species. Therefore, non-specific water analysis that detects all metal species may result in underestimation of the accumulation. This may be the case for organic lead and mercury compounds, as well as for chromate.

The initial monitoring results for lindane, using Passive Samplers show that the samplers accumulate the pesticide to a great extent. Since it is no gradient in concentrations between the two sampling periods, it has not been possible to conclude on the efficiency of the Passive Samplers for monitoring time averaged water concentrations of lindane. Further calibration experiments are therefore necessary.

As a next step for using PADs in riverine monitoring, it has been suggested to improve the next stage of monitoring using the reported experience. This can be done by monitoring a few rivers with different concentration gradients, and perform a controlled laboratory trial using natural water from one of the rivers and environmentally realistic heavy metal concentrations and hydraulic conditions. Further trials will give a broader data-set, which in turn may improve the calibration curves for the heavy metal species. Continued monitoring of lindane should be done, using Passive Samplers. These should be spiked with a suitable internal standard that may compensate for reduced accumulation due to biofouling or other disturbances. The PADs should be deployed only for one month to avoid biofouling.

5. References

Bruns, I., Siebert, A., Baumbach, R., Miersch, J., Günther, D., Markert, B. & G.-J. Krauss, 1995: *Fresenius' J Anal Chem* (1995) **353**: 101-104.

Claveri, B., Guerold, F. & J.C. Pihan, 1995: Use of transplanted mosses and autochthonous liverworts to monitor trace metals in acidic and non-acidic headwater streams (Vosges mountains, France). *The Science of the Total Environment* **175**(1995): 235-244.

Hofelt, C.S. & D. Shea, 1997: Accumulation of organochlorine pesticides and PCBs by semipermeable membrane devices and *Mytilus edulis* in New Bedford Haven. *Environmental Science and Technology* **31**, (1, 1997): 154-159.

Johnsen, A., Olsen, J.S., Rossland, H., Ljønes, M. & S.K. Hartvig, 1998: Accumulation of environmental pollutants in blue mussels and semipermeable membrane devices in dredging areas in area 1 Haakonsvern. (Akkumulering av miljøgifter i blåskjell og semipermeable membraner under mudring i delområde 1, Haakonsvern). Report from Norwegian Defence Research Institute (FFI) 98/05088, FFI, Kjeller, Norway (in Norwegian).

Kelley, A.E., Hansen, H. & M. Weideborg, 2000: Monitoring and biodegradation of rotenone in ultra-oligotrophic alpine streams and lakes. Poster presentation at third SETAC World Conference 22-25 May 2000, Brighton, England.

Kelley, A.E., Charnock, C. & M. Weideborg, 1999: Monitoring of rotenone treatment in the watercourse Holmetjørndvassdraget. (Overvåkning av rotenonbehandling av Holmetjørnsvassdraget). Aquateam report 99-049. Aquateam, Oslo, Norway (in Norwegian).

Markert, B., 1994: Plants as biomonitors – Potential advantages and problems. In Adriano, D.C., Chen, Z.S., and S.S. Yang 1994: Biogeochemistry of Trace Elements, Science and Technology Letters, Northwood

Persson, L. B.,1999. Report on passive sampler; inorganic analytes, june 1999. Chalmers Univ. Of Technology (Confidential).

Peterson, S.M., Apte, S.C., Batley, G.M. &G. Coade, 1995: Passive sampler for chlorinated pesticides in estuarine waters. *Chemical Speciation and Bioavailability* **7** (3): 83-88.

Peven, C.S., Uhler, A.D. & F.J. Querzoli, 1995: Caged mussels and semipermeable membrane devices as indicators of organic contaminant uptake in Dorchester and Duxbury bays, Massachusetts. *Environmental Toxicology and Chemistry* **15** (2): 144-149.

Røe, T.I., 1998: Produced water discharges to the North Sea: A study of bioavailability of organic produced water compounds to marine organisms. Dr. scient. thesis. Norwegian University of Science and Technology, Trondheim, Norway.

Siebert, A., Bruns, I., Krauss, G.-J., Miersch, J. & B. Markert, 1996: The use of the aquatic moss *Fontinalis antipyretica* L. Ex Hedw. As a bioindicator for heavy metals. *The Science of the Total Environment* **177**(1996): 137-144.

Storhaug, R., 1998: Survey of sources of metal inputs to the municipal waste water system in Sandefjord, Norway. (Kartlegging av kilder for tilførsler av tungmetaller til avløpsnettet i Sandefjord). *Proceedings from Norwegian Water and Wastewater Association (NORVAR) Conference 22-23 September 1998*. NORVAR, Ottestad, Norway (in Norwegian)

Sverdrup, L.E., Vik, E.A., Weideborg, M., Kelley, A.E., Fürst, C.S., Källqvist, T., Molvær, J. & K. Ødegård, 1999: Discharges connected to use of chemical grouting agents in Romeriksporten. Final report. (Sluttrapport. Utslipp knyttet til bruk av kjemiske tetningsmidler i Romeriksporten). Aquateam report 99-010, Aquateam, Oslo, Norway (in Norwegian).

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Title – English and Norwegian
Direct and riverine inputs to Norwegian coastal waters – 2000. OSPAR Commission. A: Principles, results and discussions.
Direkte tilførsler og elvetilførsler til norske kystområder – 2000. OSPAR Commission. A: Prinsipper, resultater og diskusjoner.

Summary - sammendrag
The report contains results from the 2000 monitoring of 155 Norwegian rivers and tributaries in accordance with requirements of the Oslo and Paris Commission (OSPAR). Riverborne inputs of the nutrients, suspended particulate matter, total organic carbon, metals (Cd, Hg, Pb, Cu, Zn, Cr, Ni, As) and the pesticide lindane to Norwegian coastal waters are calculated based on concentration and flow data.

Rapporten inneholder resultater fra overvåkning i år 2000 av 155 norske elver samt beregnede direkte tilførsler til norske kystområder. Elvetilførsler av næringssalter, suspendert stoff, total organisk karbon, tungmetaller (Cd, Hg, Pb, Cu, Zn, Cr, Ni, As) og lindan til norske kystområder er beregnet, basert på konsentrasjons- og vannføringsdata.

4 subject words	4 emneord
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