

**Riverine Inputs and Direct Discharges
to Norwegian Coastal Waters - 2001
OSPAR Commission.
A: Principles, Results and
Discussions**

Aquateam – Norwegian Water Technology Centre A/S

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Summary

Riverine inputs to Norwegian coastal waters from 10 main and 145 tributary rivers were monitored during 2001 covering the nutrients (Tot-P, PO₄-P, Tot-N, NO₃-N, NH₄-N, SiO₂), 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 9300 tonnes of phosphorus and 118 000 tonnes of nitrogen. About 37 % of the phosphorus and 51 % of the nitrogen were inputs from the monitored rivers and tributaries. The environmental loading from fish farming contributes to approximately 42% of the total phosphorus loading and 15 % 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 193-195 and 607-625 tonnes, respectively. Inputs of cadmium were estimated to be 2.0-3.6 tonnes, lead 31-33 tonnes, mercury 1.8 - 2.1 tonnes, arsenic 24-29 tonnes, total chromium 37-58 tonnes and nickel 144-150 tonnes. The pesticide lindane was detected in most samples in very low concentrations. Total load of lindane was estimated to be about 48 kg.

Retention in the fjords, leaching from the marine sediments and discharge from landfills located near the coast are not taken into account in these figures.

Key words - English

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Pollution discharges	Forurensningstilførsler
Norwegian coastal waters	Norske kystområder
Riverine inputs	Elvetilførsler
Direct discharges	Direkte tilførsler

Preface

This report presents the results of the 2001 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 2001-investigation lasted from January throughout December. This report is the Norwegian part of the 2001 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 and Elisabeth Lyngstad. The names and responsibilities of all participants are listed in Section 5.

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), Trine Fjeldstad and Tone B. Husebye, are acknowledged for their kind cooperation.

Oslo, 18 December 2002

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 2001 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.

For most Norwegian rivers the input to the sea shows large annual variations due to large seasonal differences in runoff (water flow) and erosion. To control the fulfilment of the Ministerial Declaration of the North Sea, a “normalised” set of chemical data has also been prepared for 2001. The 2001 average monitored chemical concentrations in river water have been multiplied with long term average flow (LTA) for the period 1961-90 for the main rivers and for 1931-60 for the tributary rivers.

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 coast. The Skagerrak region receives approximately 22 % of the total phosphorus and 33% of the total nitrogen discharges. In this region about 85% of the P- and about 78% of the N-loads are found in the riverine inputs. During year 2001, all rivers with outlet in the Skagerrak area showed a decreased annual runoff compared to 2000. The floods in year 2000 gave an especially high load of most of the pollutants in the rivers in this region.

The results for nutrients of the 2001 investigation show that total annual loads to coastal waters from land-based sources in Norway include approximately 9 300 tonnes of total phosphorus (Tot-P) and 118 000 tonnes of total nitrogen (Tot-N). These loads were lower than in 2000, but higher than in 1999, since loads from fish farming was not included in 1999. Respectively, 37 and 51 % of the grand total inputs of phosphorus and nitrogen are monitored in the main and tributary rivers. The environmental loading from fish farming contributes to approximately 42% of the total phosphorus loading and 15 % of the total nitrogen loading.

It was found a decrease of 10 % for Tot-N and an increase of 5 % for Tot-P compared with the 2000 loads. Compared with the 1999 loads, the runoff in the Skagerrak area was approximately 10 % higher in 2001 than in 1999. Nitrogen had decreased with 8 % and phosphorus had increased with 43 %. This indicates that the increase in load is not only due to water flows alone, but also due to increased phosphorus concentrations. One major reason for the high phosphorus load is very high phosphorus concentrations in one of the main rivers, Skienselva, in the end of the year 2001 compared to 2000. The source of this discharge is unknown. The phosphorus concentration decreased to normal level in 2002.

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. Inputs of cadmium (Cd) were estimated to be 2.0-3.6 tonnes, lead (Pb) 31-33 tonnes, mercury (Hg) 1.8 – 2.1 tonnes, arsenic (As) 24-29 tonnes, total chromium (Cr) 37-58 tonnes and nickel (Ni) 144-150 tonnes. Copper (Cu) and

zinc (Zn) comprised the largest inputs of trace metals, which in 2001 amounted to approximately 193-195 and 607-625 tonnes, of which 87 and 90% respectively, were river monitored. The high uncertainty in the cadmium and chromium values is due to many analytical values below the detection limit, especially for Glomma. The reported concentrations of Hg were in the same range as in 2000 and 1999. The main river loading in the Skagerrak area was lower in 2001 than in 2000, but the total mercury loading in this area was higher in 2001 than in 2000. This was caused by high concentrations in some of the tributary rivers in 2001. The uncertainty in the estimated tributary river loads was, however, very high.

For all the metals, except mercury, the 2001 reported total loads to the Norwegian coastal waters were lower than in 2000. Total inputs of metals decreased between 6% for arsenic to 51% for lead. A major reason for this significant decrease was the unusual high runoff of all rivers in the Skagerrak area in year 2000. The runoff (water flow) in the Skagerrak area decreased approximately 20 % from 2000 to 2001. Flooding periods can give higher loads of metals, due to increased water flow, increased leaching from the ground and increased particle loss from erosion. The load of suspended particulate matter from the main rivers increased with 58 % from 1999 to 2000 and decreased with 43 % from 2000 to 2001. Also the loading of cadmium from direct discharge decreased from 2000 to 2001, due to decreased discharges of Cd from industrial and sewage effluents.

The pesticide lindane was found in most samples, but in very low concentrations. The substance has been banned in Norway, and should not have been used for the last 10 years. The findings of this substance in Norwegian rivers are therefore most likely due to long-range transported air pollutants. Total load of main rivers was estimated to 28 kg. Load of tributary rivers has been stipulated to approximately 20 kg. The total loads were stipulated to 48 kg. This is 22% decrease from 2000 to 2001.

On annual basis, statistical trend for total P, total N, the metals, and lindane have been carried out for all rivers. No significant trends for phosphorus were detected with use of the Trend-Y-Tector. An increased phosphorus load was, however, noticed in 2000 and 2001 for all main rivers except Vefsna. For Otra, the downward trend seen for phosphorus for the period 1980-1998 did not continue from 1999. Significant increases in the yearly inputs of nitrogen were found in Drammenselva and Numedalslågen. A downward trend was found for nitrogen in Otra in 1980-2001. In Vefsna a high increase of the yearly nitrogen input is found for the period 1990-1998. However, in 1999-2001 the load has decreased to the same level as in 1990-1992. Longer time series are needed to make conclusions about these variations.

Significant reductions in the yearly inputs of metals were found in Orkla (Cu and Zn), Suldalslågen (Pb, Cd, Cu and Zn), Vefsna (Cd) and Altaelva (Cd and Cu). Significant reductions in the yearly input of lindane were found in Drammenselva.

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, or remediation operations). Other proposed activities are analyses of particle bound metals and phosphorus, 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 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 anthropogenic 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 pollutant 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 - 2001).

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 2001. The load estimation was based on the results from the random sampling supplemented with other data from 2001-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	4.5 million
Area:	
- Mainland Norway	323 878 km ²
- The whole country incl. Svalbard and Jan Mayen	386 958 km ²
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 1990-2000 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 Section 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) should be “unpolluted” river systems.

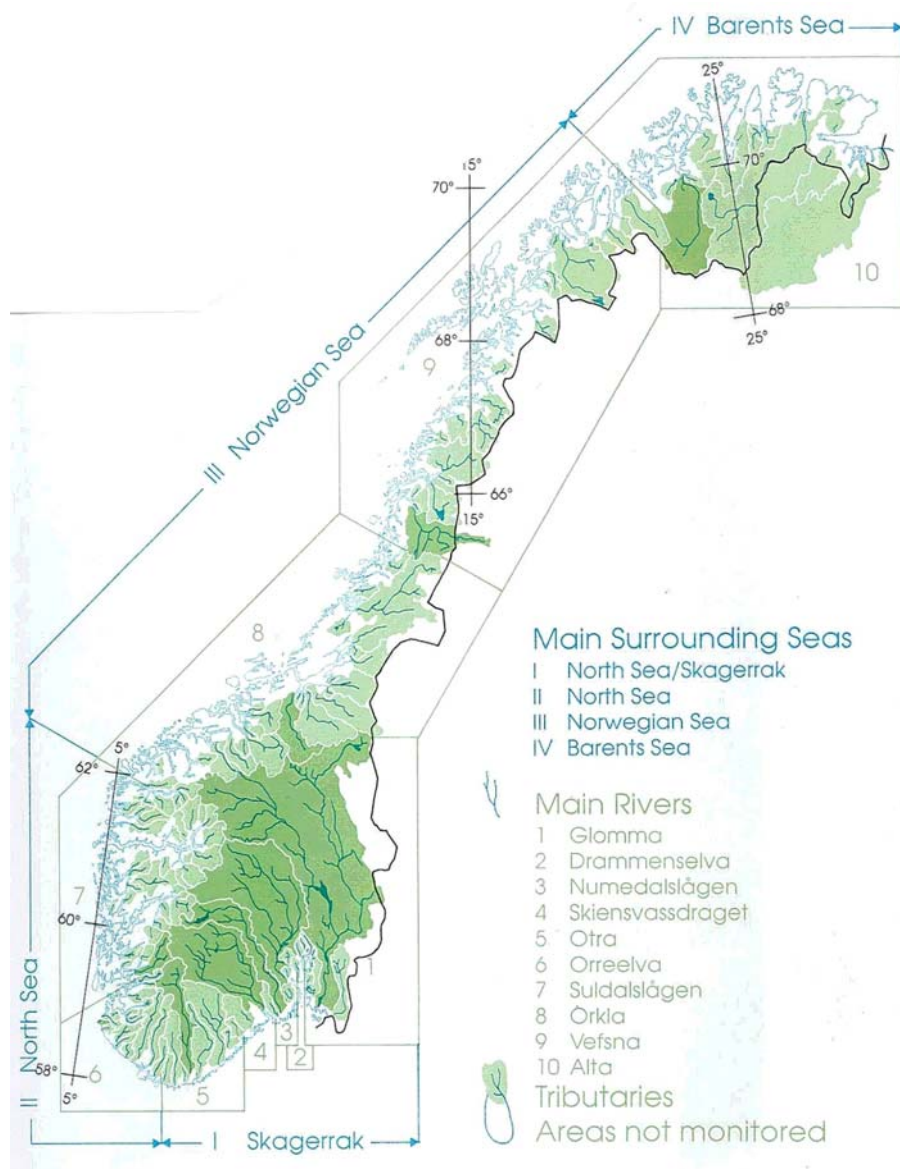


Figure 1. Norway divided into four Discharge Areas. Main Rivers and Tributaries with Drainage Basins. Source: Norwegian Water Resources and Energy Administration. Design: NIVA

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 - 2000 (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 2001 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). The original programme of 1990-1992 was reduced in 1993. Small changes in the programme were undertaken from 2000 to 2001. In the period 1990-2000, the river Vefsna has been anticipated variations due to differences in water drainages. Analytical results from the last year indicate that weekly sampling should not be necessary. The weekly sampling in river Vefsna in May – June was therefore left out in 2001.

In all main rivers, except Vefsna, 12 grab samples or more have been taken at regular monthly intervals during the sampling period from January to December 2001, as described in PARCOM 10/3/2. Two of the main rivers (Glomma and Drammenselva) were sampled weekly in the period with the highest anticipated flow (May – June). Vefsna was sampled 11 times in 2001. In all the main rivers the parameter lindane have been sampled and analysed 4 times in 2001. 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 ¹	x	x	xx	xxx	xxxx	xx	x	x	x	x	x ²
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
Skienelva at Klosterfoss	x	x	x	x	x	x	x	x	x	x	x	x
Otra at Skråstad	xx	x	x	x	x	x	x	x	x	x	x	x
Orreelva 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	x	x	x	x		x	x	x
Suldalslågen near the outlet	x	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

¹ Sample collected in late December 2000

² Sample collected in January 2002

The tributary rivers were all sampled once in 2001. 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 2001 the water samples from the main rivers were taken by local personnel and by the company BUVA (see Section 5). Aquateam personnel collected 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 (AnalyCen, Moss) 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 2001 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)	-	NS-ISO 7888
Suspended particulate matter (S.P.M.) (mg/L)	0.6	NS 4733
Total Organic Carbon (TOC) (mg C/L)	0.5	NS-EN 1484-1
Total Phosphorus ($\mu\text{g P/L}$)	1.0	NS 4724-2
Orthophosphate ($\text{PO}_4\text{-P}$) ($\mu\text{g P/L}$)	1.0	NS 4724-2
Total Nitrogen ($\mu\text{g N/L}$)	10	NS 4743-2
Nitrate and nitrite ($\text{NO}_3 + \text{NO}_2$) ($\mu\text{g N/L}$)	4-5	NS 4743-2
Ammonia (NH_4) ($\mu\text{g N/L}$)	1-2	NS 4746-1
Silicate (SiO_2) (mg/L)	0.09	NS-EN-ISO 1855
Lead (Pb) ($\mu\text{g Pb/L}$)	0.01-0.02	NS-EN-ISO 1855
Cadmium (Cd) ($\mu\text{g Cd/L}$)	0.01-0.02	NS-EN-ISO 1855
Copper (Cu) ($\mu\text{g Cu/L}$)	0.02-0.5	NS-EN-ISO 1855
Zinc (Zn) ($\mu\text{g Zn/L}$)	0.1-0.5	NS-EN-ISO 1855
Chromium (Cr-tot) ($\mu\text{g Cr/L}$)	0.02-0.2	NS-EN-ISO 1855
Nickel (Ni) ($\mu\text{g Ni/L}$)	0.03-0.2	NS-EN-ISO 1855
Arsenic (As) ($\mu\text{g As/L}$)	0.02-0.2	NS 4781-1
Mercury (Hg) (ng Hg/L)	2-5	NS 4768
Lindane (ng/L)	0.1	EPA 508 mod. – GC/ECD

In 2001 the following laboratories have carried out the water analyses in the riverine input project:

- AnalyCen, Moss: Analyses of total phosphorus, orthophosphate, total nitrogen, ammonia, nitrate + nitrite and total organic carbon (TOC), mercury and lindane
- AnalyCen Nordic, Lidköping, Sweden: Analyses of metals and silicate.

Since Aquateam took over the Riverine Input Project from NIVA the parallel analyses showed good correspondence between the laboratories, with exception of mercury. For mercury, the analytical results from AnalyCen (atomic fluorescence, CETAC) 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. 2001a). For the other analytical parameters it was concluded that the changes of laboratories would not influence the analytical results (Weideborg et al. 2001 (b), Appendix XIV).

For the main and tributary rivers, it was not possible to get >70% of the measurements above the 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.

In 2001, most nutrient measurements were above the detection limit, with more than 70% above limit in all main rivers. However, only 47% of the tributary rivers had $\text{PO}_4\text{-P}$ measurement above the detection limit. The two unpolluted main rivers, Suldalslågen and Alta, had less than 70% SPM measurement above the detection limit (respectively 25 and 58%).

The low concentration of heavy metals, especially lead, cadmium, chromium and mercury, made it difficult to obtain 70% measurements above the detection limit. The following of the main rivers had more than 70% metal measurement above the detection limit:

- Chromium: Orkla and Alta
- Cadmium: Drammenselva, Numedalslågen, Skienselva, Otra and Orkla
- Lead: Glomma, Drammenselva, Numedalslågen, Skienselva, Otra and Vefsna
- Zinc: Glomma, Drammenselva, Numedalslågen, Skienselva, Otra, Orreelva, Suldalslågen, Orkla and Vefsna
- Nickel: All main rivers
- Copper: All main rivers

None of the main rivers get 70% measurement above the detection limit for mercury (21-55% over limit).

However, these difficulties are not likely to affect the results and conclusions of the year 2001-study. In the cases where 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 equal 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, 1990-2001 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).

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).

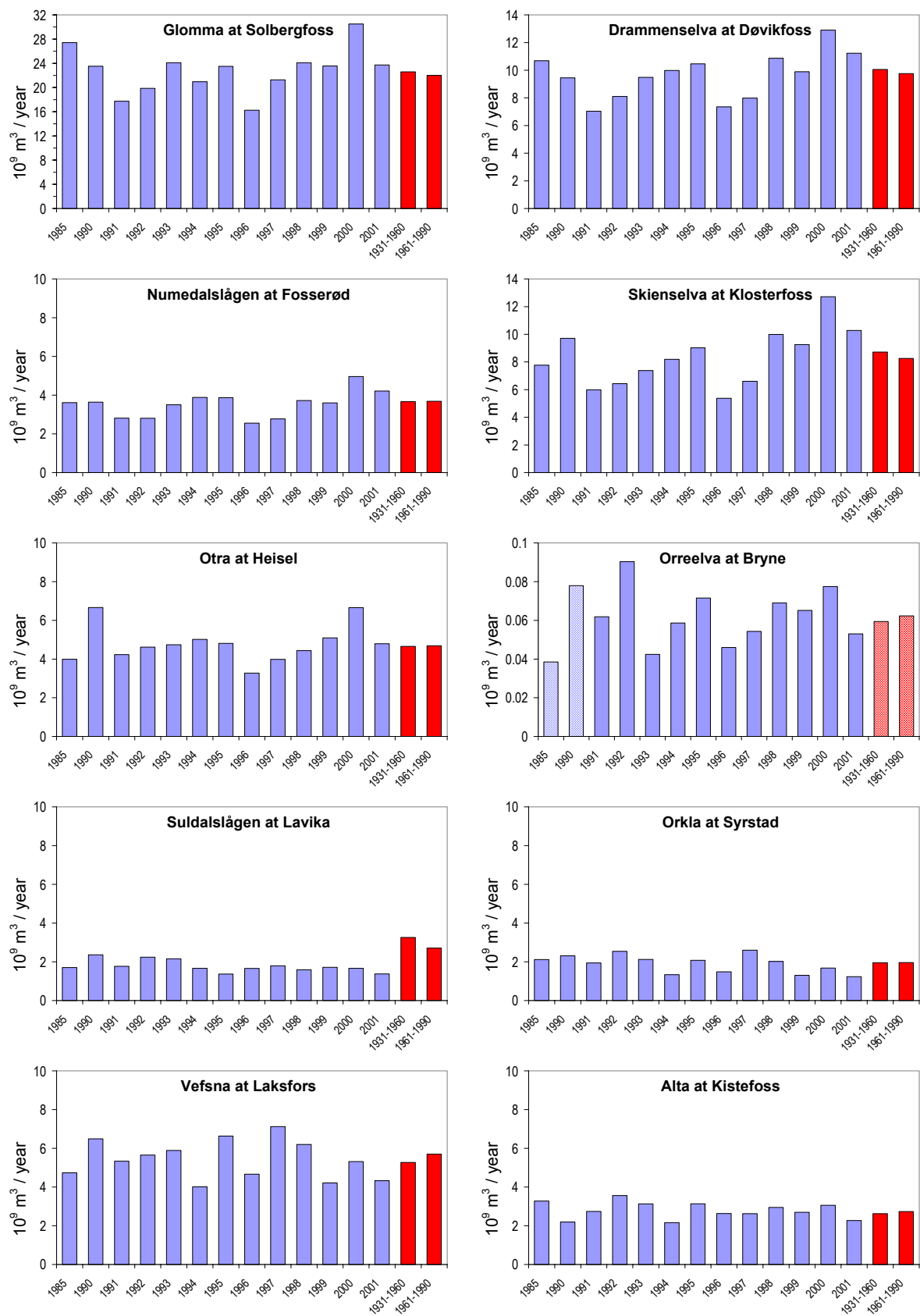


Figure 2. Main Rivers. Mean Annual runoff (1931-60 and 1961-90) and Annual Runoff for the year 1985, 1990-2001 ($10^9 m^3$). Source: Norwegian Water Resources and Energy Administration.

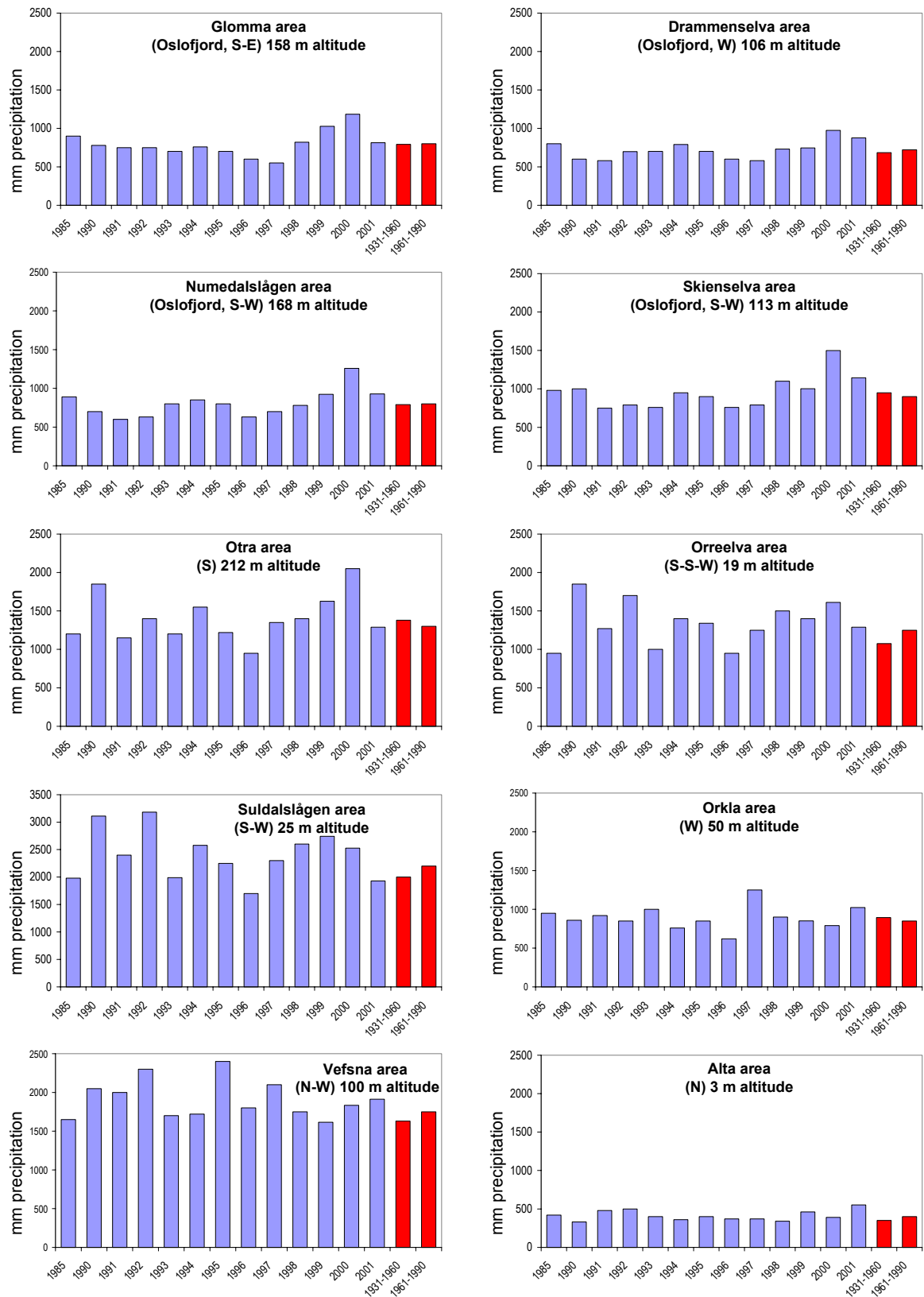


Figure 3. Main Rivers. Mean Annual Precipitation (1931-60 and 1961-90) at Stations near Outlet and Annual Precipitation in the Years 1985, 1990-2001 (mm/year). Source: The Norwegian Meteorological Institute. (S = South, E = East, W = West, N = North)

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

Subregions	Main Seas	Drainage area, km²	Runoff, mill. m³
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

The same runoff stations as in 2000 were used with exception of the station for Skienselva. The run of measurements at Klosterfoss station has been stopped in 2001. An upstream runoff station, Skotfoss was used instead. Figure 4 shows runoff at the new station. In Figure 2, the total annual runoff shown for Klosterfoss in 2001 is estimated from the runoff for Skotfoss.

In 2000 both data from Håelva at Haugland and Orreelva at Bryne have been used to estimate total runoff for Orreelva. Those two small rivers have catchment area in the same region. We found a good correlation between the two runoffs when annual runoff is considered (Runoff at Bryne = Runoff at Haugland *3.37 with a $R^2= 0.87$). When daily runoff is considered, the correlation is not so good ($R^2= 0.30$). Bryne data were therefore used. Since this station started up in 1991, runoff for 1985 and 1990 and mean annual runoff are estimated from Haugland.

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, 2002). The additional water supplied is estimated using measured rainfall data from the local catchment areas (DNMI, 2002a).

For all main rivers, seasonal changes in runoff in 2001 are shown in Figure 4. It is some uncertainty connected to the high runoff measured in February for Vefsna at Laksfors (Fjeldstad, 2002). The peak is ignored in the calculations since no concentration measurement at this date (14.02-16.02) is available.

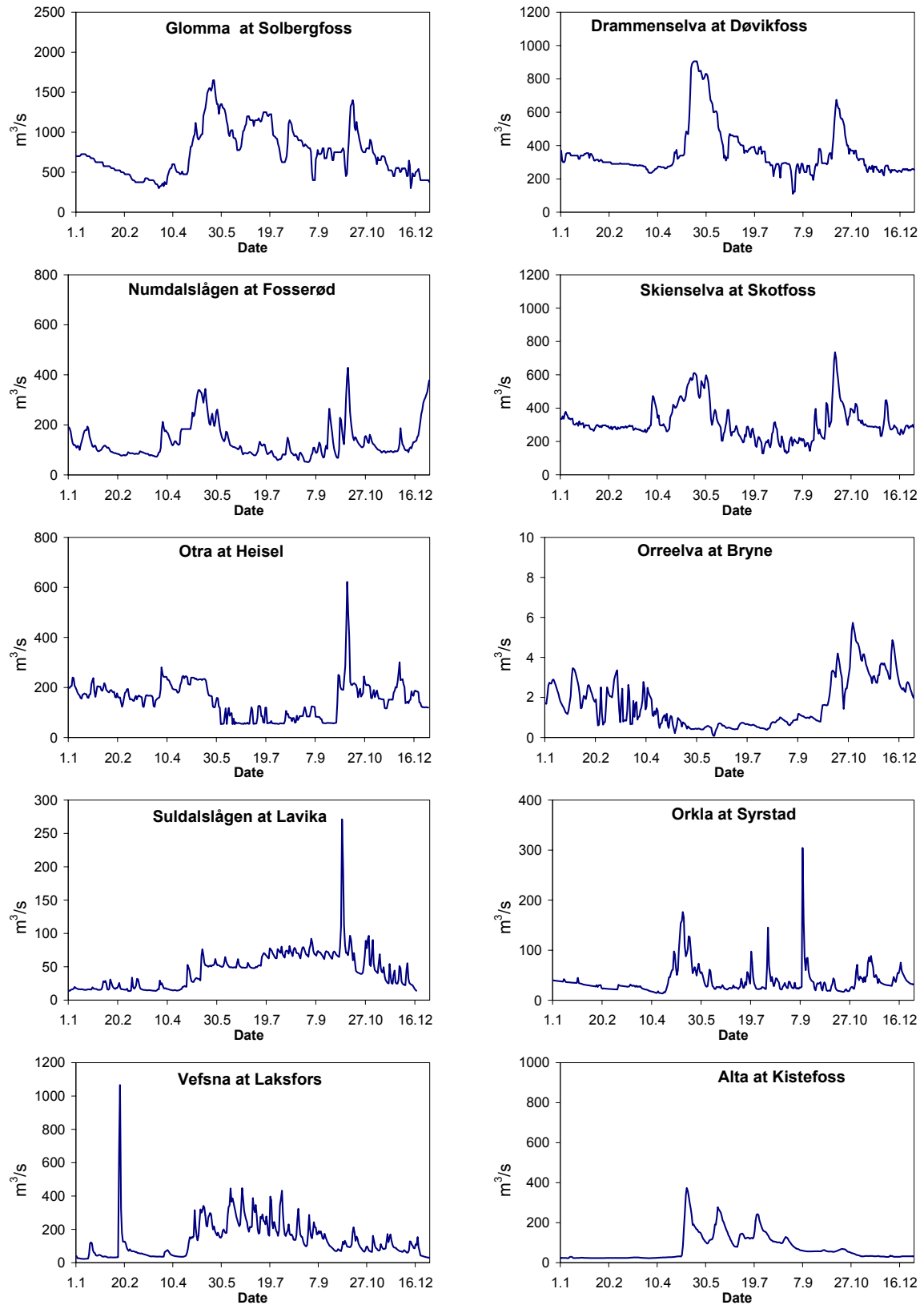


Figure 4. Main Rivers. Seasonal Changes in Daily Runoff (m^3/s). Source: Norwegian Water Resources and Energy Administration.

For the tributaries rivers the mean runoff data (1931-60) and measured rainfall data (2001) are used for flow estimates.

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:

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

C_i = measured concentration in sample i

Q_i = corresponding flow for sample i

Q_r = 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:

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

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 2001:

- Precipitation data for 2001 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 (km² 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: Drammenselva	17 028	226	320	17 614	98.0
	No 3: Numedalslågen	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 remaining 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 Norwegian 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 Barents 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 Ibrek, 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.

The metal loads from wastewater treatment plant effluents were estimated based on measured data from 2001 (SSB, 2002) and measured or calculated flows. The effluent metal concentrations used after different forms of treatment, based on Aquateam's investigation of metals in discharges from Norwegian municipal wastewater treatment plants in 1999 (Nedland, 2000)

were used when analytical data were unavailable. The metal loads from industrial effluents were calculated based on data from SFT's database INKOSYS (SFT, 2002).

3.3.1. Wastewater treatment plant effluents

Statistics Norway (SSB) is responsible for the annual registration of data from all wastewater treatment plants in the country. SFT's computer programme SESAM was used until 2000. From 2001, the Internet based reporting system KOSTRA is used. Discharge figures from KOSTRA 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 2001, 2639 wastewater treatment plants with a hydraulic capacity of at least 50 p.e. were registered in Norway (SSB, 2001). In 2001, it was registered 813 fewer wastewater treatment plants than in 2000, due to fusion of treatment plants to larger units. There were registered 700 sewerage systems (serving more than 50 p.e.) with direct discharges of untreated wastewater (SSB, 2001). The major part (51%) of the wastewater treatment plants have only primary treatment, 14% chemical treatment, 7% biological treatment, 15 % chemical and biological treatment and 14% 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 5.77 million p.e., advanced treatment account for 63% (chemical 36 %, chemical/biological 25%, biological 2%), primary treatment for 22%, direct discharges for 9%, and others for 6%. 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

For metals in municipal wastewater discharges, calculated loads were based on measured concentrations in effluents from 13 treatment plants in Norway in 2001 (SSB, 2002) and measured or calculated flows from the wastewater effluents in 2001 (from SESAM). For effluents without any measured flow, the 2001-flow was calculated to 600 litres per resident per day, (average for effluents with measured flows (Nedland, 2000)). 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

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 (Borgvang og Tjomsland, 2002). The calculations of the other discharges were performed by Aquateam. The metal data were collected from SFT's data base INKOSYS (SFT, 2002).

3.3.3. Fish farming effluents

Nutrient loading (Tot-N, NH₄, Tot-P and PO₄) from fish farming effluents in 2001 has been estimated by use of the computer model TEOTIL (Borgvang and Tjomsland, 2002). 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).

From 2000 on, the loading from fish farming has been included in the grand total values. These loads have not been included in the previous input calculations from 1990-1999.

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 (km²) 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 a number of organic pollutants and trace metals, presently in use in Norway (Miljøverndepartementet, 2001). Only a few of these substances are, however, included in the Norwegian part of the RID programme. PCB should be tried eliminated within 2005. The discharges of the following substances included in the RID programme should be considerably reduced within 2010:

- Lead
- Cadmium
- Copper
- Mercury
- Chromium

Most of this pollution is caused by industrial effluents, but other sources are municipal wastewater and landfill leachate.

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 (2001), mean values, standard deviation and range are listed in Appendix VII, Report B. Total annual loads of the main rivers in 2001 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 2001 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 2001-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 22 % of the phosphorus and 33% of the nitrogen discharges. In this region 94 % of the area is river-monitored, and about 85 % of the P- and about 78 % of the N-loads, are included in the riverine inputs.

4.2. Runoff

The monitored precipitations in 2001 varied less than 25 % from normal precipitation in most of the country. Only the Alta catchment area received precipitation more than 25 % from the normal. The rivers in the Skagerrak region (Glomma, Drammenselva, Numedalslågen, Skienselva and Otra) showed extremely high flow in the autumn 2000 (Weideborg et al. 2001b). No such flood episodes were observed in 2001 and the yearly runoff was almost back to a normal (Figures 2 and 3). The runoff in this area decreased approximately 20 % from 2000 to 2001. The high runoff gave in 2000 higher load for most pollutants to the Skagerrak region. Table 9 shows the changes in runoff from 1999 to 2001.

Table 9. Changes in runoff (flow) from 1999 to 2001 for the Skagerrak area.

Rivers	Flow 2001 (m³/d)	Change in runoff from 1999 to 2000	Change in runoff from 2000 to 2001
River Glomma	66 754 286	+29 %	-22 %
River Drammenselva	32 820 798	+30%	-13 %
River Numedalslågen	12 270 961	+38 %	-15 %
River Skienselva	28 174 951	+37 %	-19 %
River Otra	13 395 521	+31 %	-28 %

4.3. Nutrients, particulate matter and total organic carbon

Annual loads of nutrients (nitrogen and phosphorus compounds), suspended particulate matter (S.P.M.) and total organic carbon (TOC) in the main rivers are presented in Figure 5. The normalised load is compared with the 2001 values.

Total annual load of (year 2001) for the four subregions are shown in Tables 1.1-1.4 (Appendix I, Report B) and in Figure 6. The results of the 2001 investigation show that total annual nutrient loads to coastal waters from land-based sources in Norway include approximately 9300 tonnes of phosphorus and 118 000 tonnes of nitrogen. These loads are lower than in 2000, but higher than in 1999, since loads from fish farming was not included in 1999. About 37 and 51 % of the grand total inputs of phosphorus and nitrogen are monitored in the main

and tributary rivers. The environmental loading from fish farming contributes to approximately 42 % of the total phosphorus loading and 15 % of the total nitrogen loading.

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 these parameters have not been reported in the same way for all sources, no conclusion should be made on the basis of this figure.

It was found a decrease of 10 % for nitrogen and 5 % for phosphorus compared with the 2000 loads. A major decrease should be expected due to the unusual high runoff of all rivers in the Skagerrak area in 2000. 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 in 2000 increased by 40 % for total nitrogen and by 55 % for total phosphorus. The runoff increase for the rivers discharging to this region was 32 %.

Compared with the 1999 loads, the runoff in the Skagerrak area was approximately 10% higher in 2001 than in 1999. Nitrogen had decreased with 8 % and phosphorus had increased with 43 %. This indicates that the increase in load is not only due to water flows alone, but also due to increased phosphorus concentrations. One major reason for the high phosphorus load is very high phosphorus concentrations in Skienselva in November and December (Figure 12) compared to the other years. The source of this discharge is unknown.

A correlation analysis between nutrients and runoff (water flow) and suspended particulate matter was performed by Vik et al. (2002), and a significant positive correlation ($R^2 > 0.8$) was found for:

- Glomma: S.P.M. – tot-P
- Otra: S.P.M. – PO_4
- Orreelva: S.P.M. – tot-P
- Suldalslågen: Runoff – NO_3
- Orkla: Runoff – PO_4

This indicates that the nutrient loading in these rivers may depend on runoff and erosion.

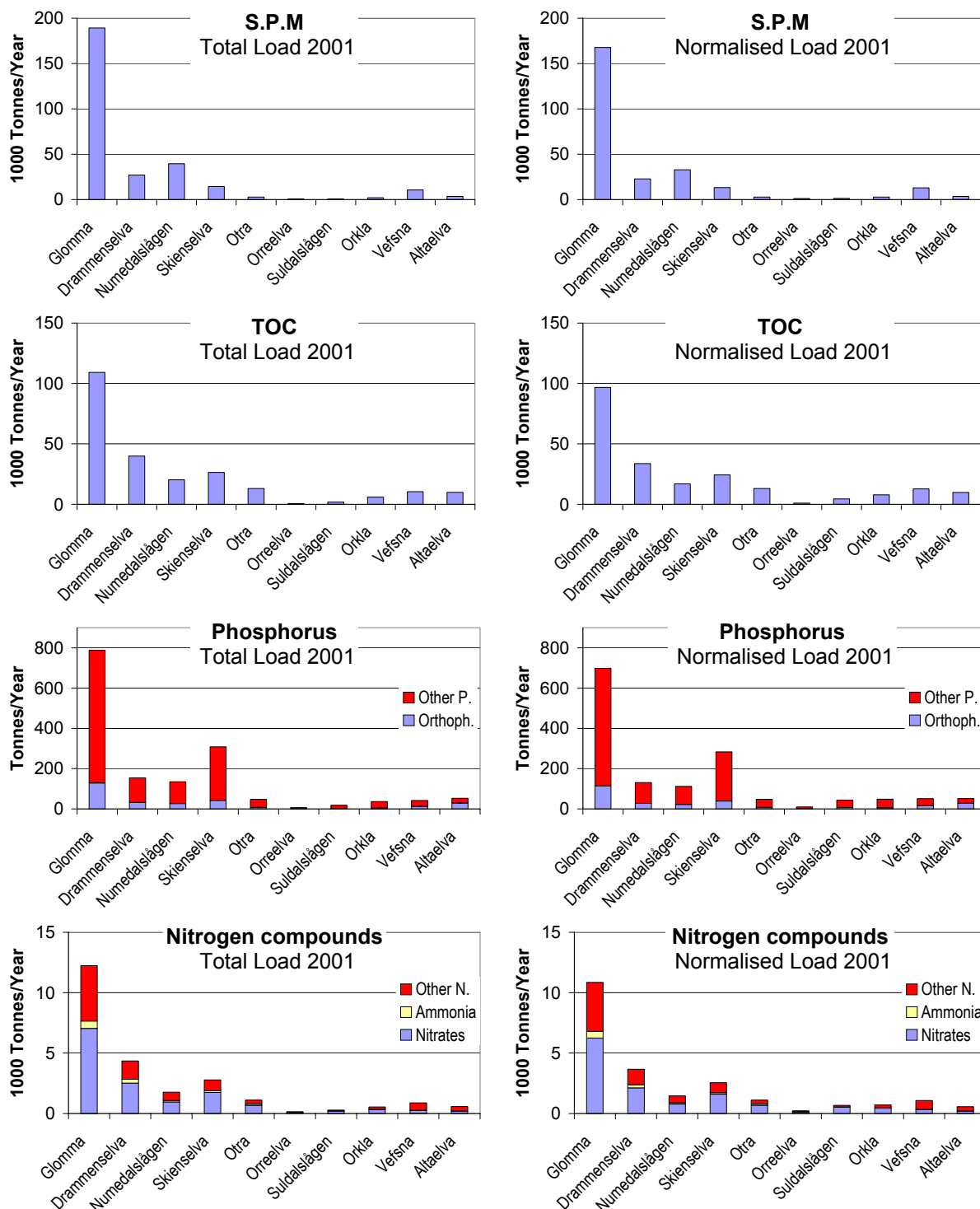


Figure 5. Main rivers. Suspended particulate matter (S.P.M.), total organic carbon (TOC) and nutrients (Tot-P, orthophosphate, Tot-N, nitrate, ammonia). Total loads 2001 and total normalised loads.

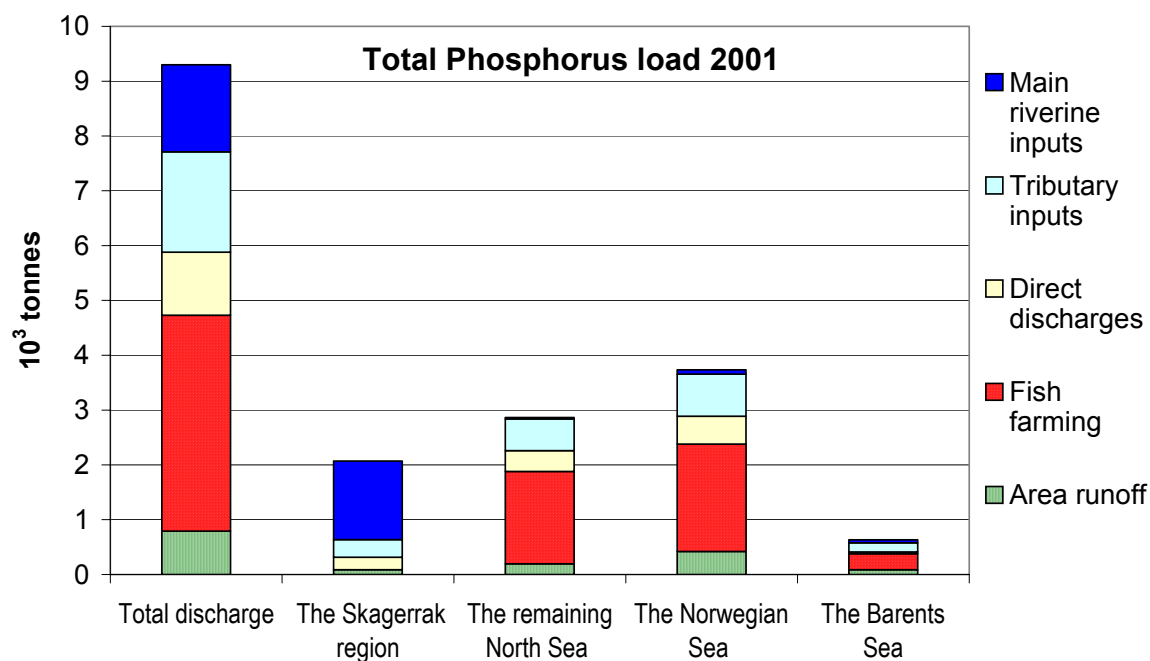
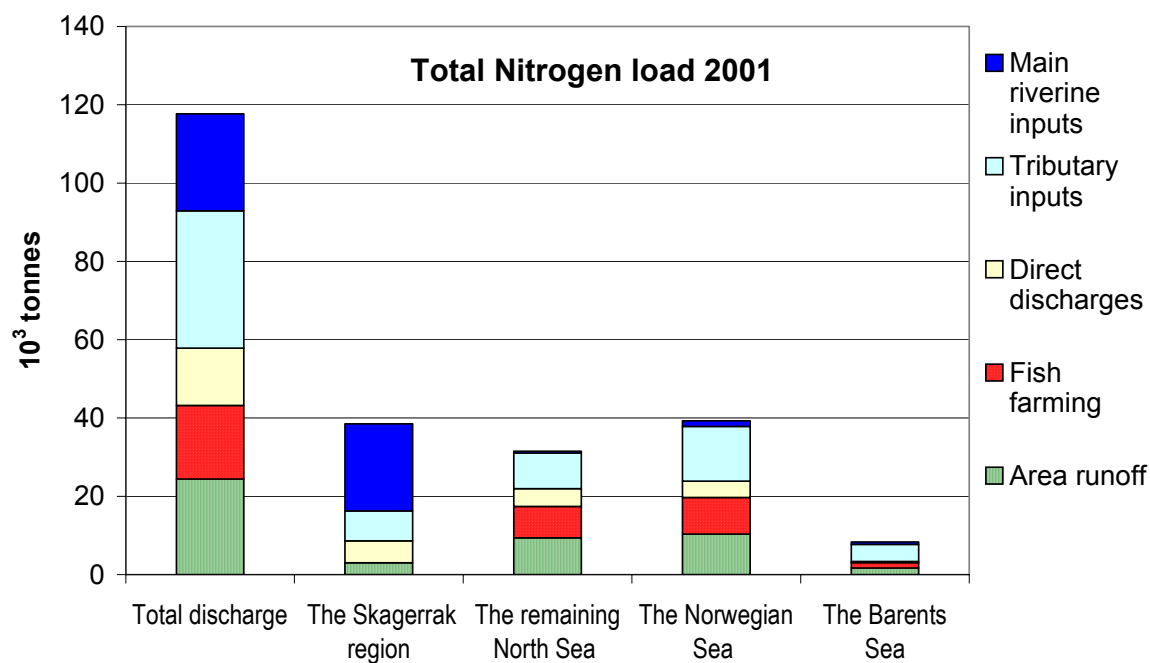


Figure 6A. Nutrients (Tot-P and Tot-N), total discharges in 2001 from mainland Norway to convention waters and the four subregions. Contribution from the 4 main sources and area runoff.

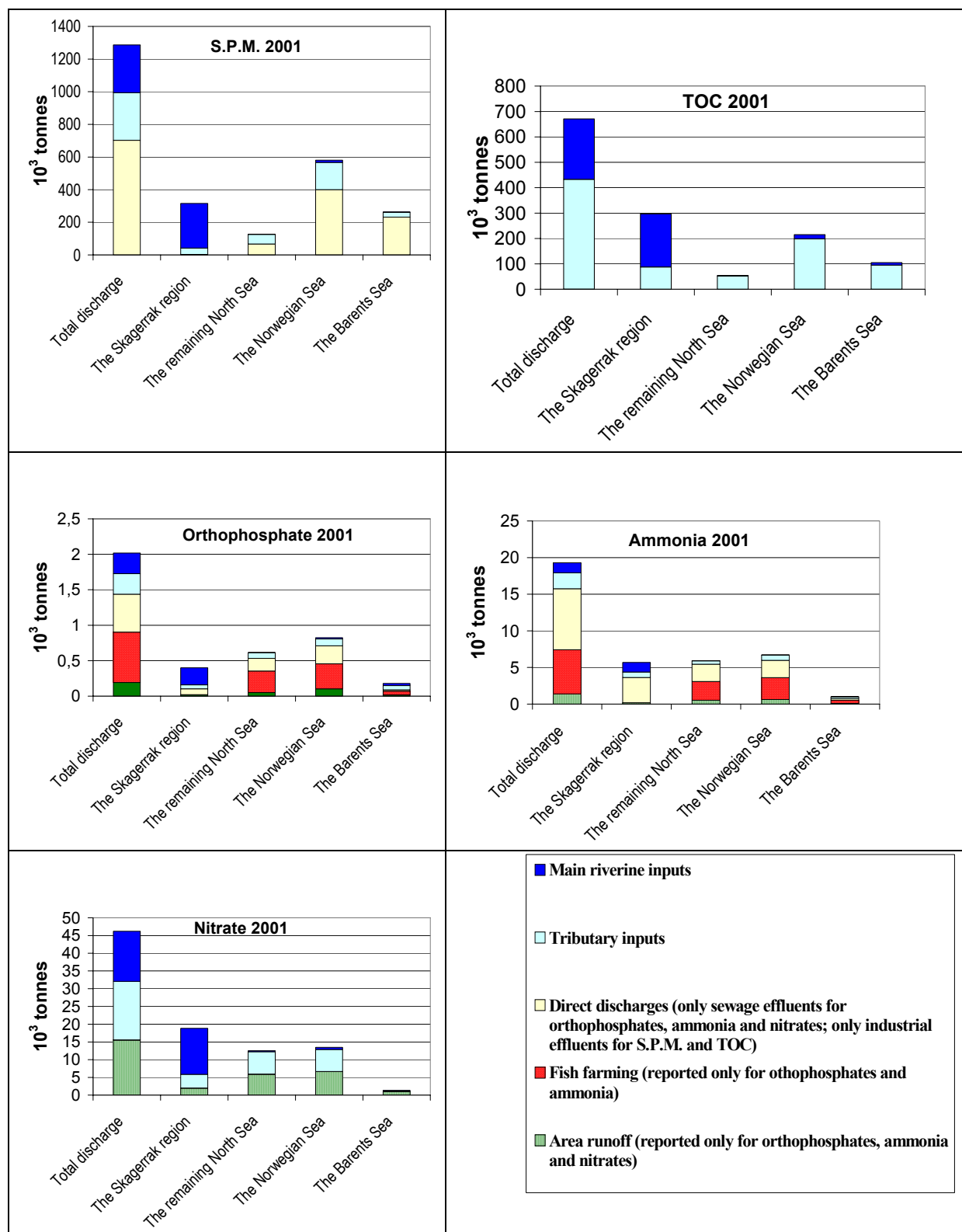


Figure 6B. S.P.M., TOC and nutrients (orthophosphate, ammonia and nitrate), total discharges in 2001 from mainland Norway to convention waters and the four subregions. Contribution from the 5 main sources.

4.4. Metals

Total inputs of metals in 2001 have been estimated to:

- Cadmium: 2-3.6 tonnes
- Lead: 31-33 tonnes
- Mercury: 1.8 – 2.1 tonnes
- Arsenic: 24-29 tonnes
- Chromium: 37-58 tonnes
- Nickel: 144-150 tonnes
- Copper: 193-195 tonnes
- Zinc: 607-625 tonnes

In Figure 7 the lower and upper loads of Cd, Pb, Hg, As and Cr from the ten main rivers are presented. The high uncertainty in the cadmium and chromium values is due to many analytical values below the detection limit, especially for Glomma.

Copper and zinc comprised the largest inputs of trace metals, of which 87 and 90 % 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 approximately in the same range as in 2000 and 1999. This was higher than the concentrations reported for the years 1990-1997 (Figure XVII, Appendix XIII, report B). This difference was most likely influenced by different analytical methods being used, as described in Section 3.2. The main river loading in the Skagerrak area was lower in 2001 than in 2000, but the total mercury loading in this area was higher in 2001 than in 2000. This was caused by the high concentrations in some of the tributary rivers in 2001 (Årungsøelva, Gjersjøelva, Alna, Nidelva og Mandalselva). The uncertainty in the estimated tributary river loads was, however, very high.

For all the metals, except mercury, the 2001 reported total loads to the Norwegian coastal waters were lower than in 2000. Total inputs of metals have decreased from 2000 to 2001:

- Lead: 51%
- Cadmium: 29%
- Zinc: 24%
- Arsenic: 6%
- Copper: 20%
- Chromium: 23%
- Nickel: 14%

In the Skagerrak area the decrease in the loads in 2001 were higher than the decrease in total loads to the Norwegian coastal waters for most of the metals:

- Lead: 60%
- Cadmium: 33%
- Zinc: 45%
- Arsenic: 32%
- Copper: 36%

- Chromium: 16%
- Nickel: 47%

A major reason for this significant decrease was 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 and decreased approximately 13-28 % from 2000 to 2001. Flooding periods can give higher loads of metals, due to increased water flow, increased leaching from the ground and increased particle loss from erosion. The load of suspended particulate matter from the main rivers increased with 58 % from 1999 to 2000 and decreased with 43 % from 2000 to 2001. The lack of information made it impossible to estimate the percentile of the particle bound metals, but the major part of the increase in metal loads from 1999 to 2000 was probably particle bound. The correlations between different parameters were evaluated by Vik et al. (2002). A significant positive correlation ($R^2 > 0.8$) between suspended particulate matter and metals was found for:

- Glomma: S.P.M. – Ni
- Drammenselva: S.P.M. – Pb
- Orreelva: S.P.M. – Pb

A possible correlation ($R^2 > 0.6$) between suspended particulate matter and metals was seen for:

- Glomma: S.P.M. – Pb, Cr
- Numedalslågen: S.P.M. – As, Cr, Cd, Cr, Ni
- Skienselva: S.P.M. – Pb
- Otra: S.P.M – Cr
- Alta: S.P.M – Cr

A possible correlation ($R^2 > 0.6$) between runoff and metals was seen for:

- Numedalslågen: runoff – Pb, Cd, Cu
- Otra: runoff – Pb, Cr
- Orkla: runoff – Cr, Ni
- Alta: runoff – Pb, Cr

The above correlation test indicates that several of the metals are mainly particulate bound.

Also the loading of cadmium from direct discharge decreased from 2000 to 2001, due to decreased discharges of Cd from industrial and sewage effluents.

Figures 13 – 16 show the annual load of the metals in 1990-2001.

A statistical analysis of analytical data and runoff data from 1990-2001 is shown in Appendix IVI, Report B.

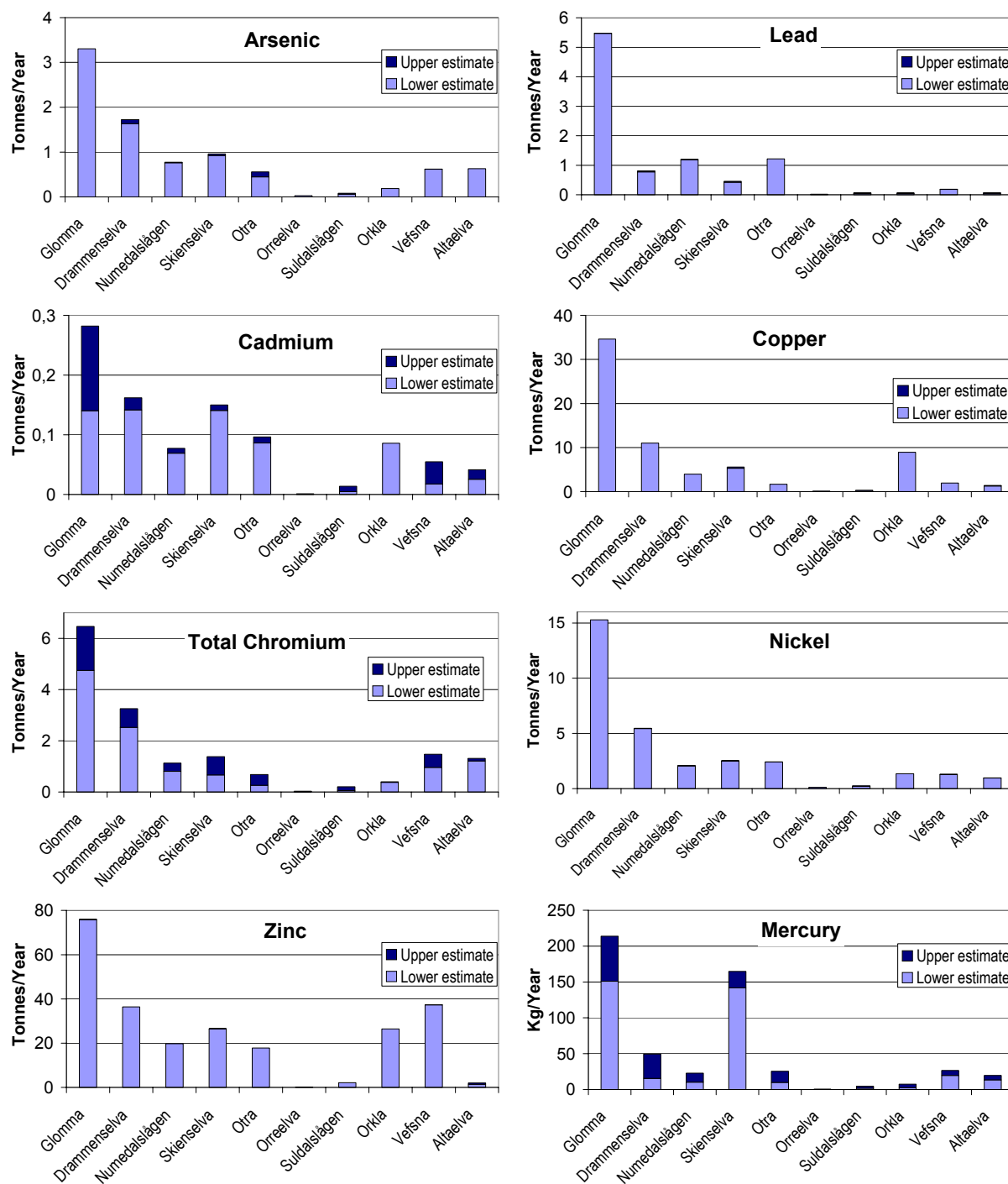


Figure 7. Main rivers. Metals (As, Pb, Cd, Cu, Total Cr, Ni, Zn and Hg). Total loads of the main rivers in 2001. Upper limit: limit= detection limit. Lower limit: limit=0.

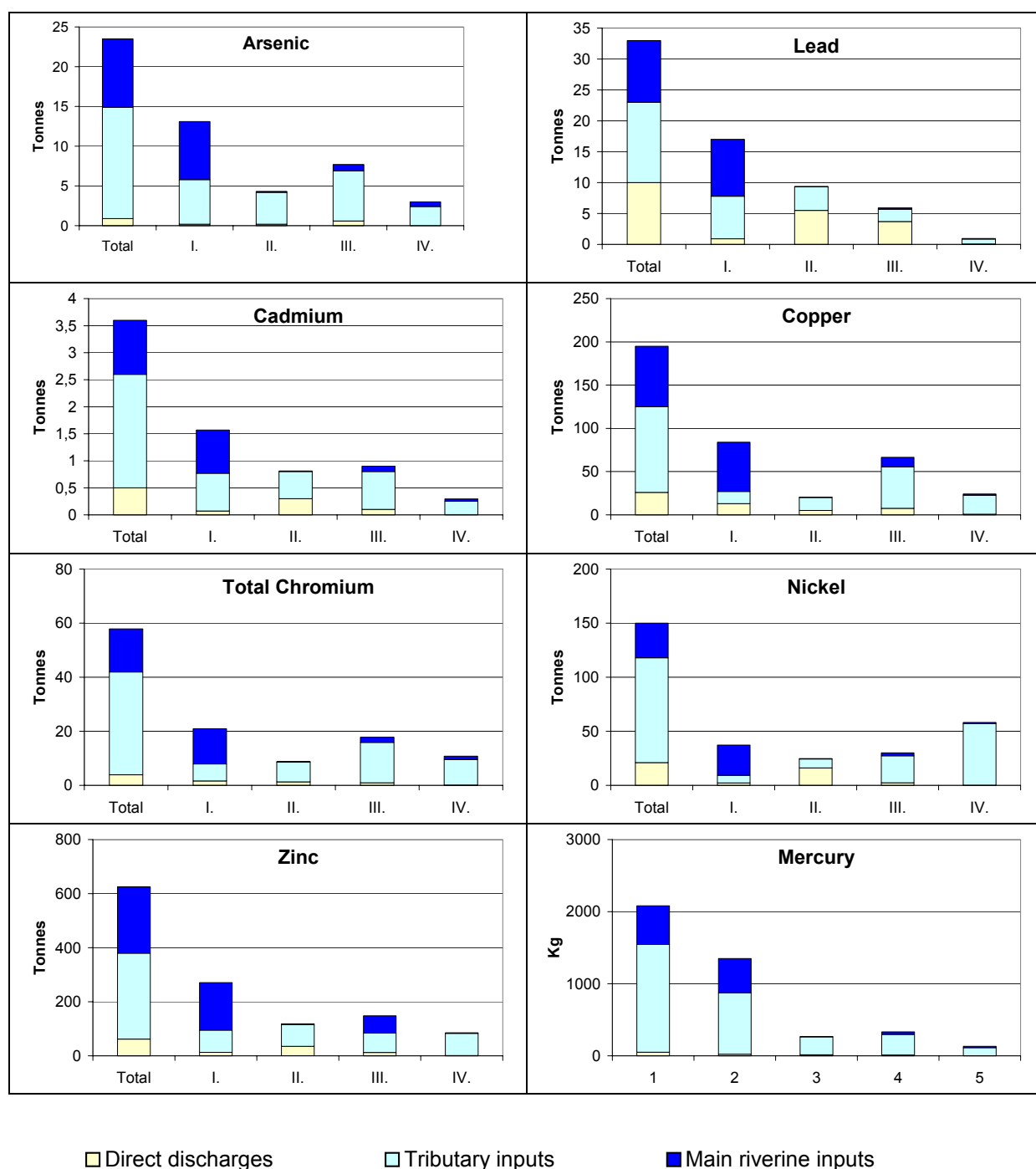


Figure 8. Metals, total discharges in 2001 from mainland Norway to convention waters and the four subregions (upper estimates). I: Skagerrak, II: The remaining North Sea, III: The Norwegian Sea, IV: The Barents Sea Contribution from the main rivers, tributary rivers and direct discharges.

4.5. Other parameters

Total annual load of silicate (SiO_2) is estimated to 424 857 – 425 136 tonnes (53 % from tributary rivers and 47 % from main rivers). This is a 39 % decrease from 2000 when flooding gave high silicate loading, and a 11 % decrease from 1999.

The pesticide lindane was found in most samples, but in very low concentrations. Lindane has often been found in runoff water from areas where the compound has never been used. The substance has been banned in Norway, and should not have been used for the last 10 years. The findings of this substance in Norwegian rivers are therefore most likely due to long-range transported air pollutants. Total load of main rivers was estimated to 28 kg. Load of tributary rivers has been stipulated to approximately 20 kg. The total loads were stipulated to 48 kg (Figure 9). This is 22% decrease from 2000 to 2001.

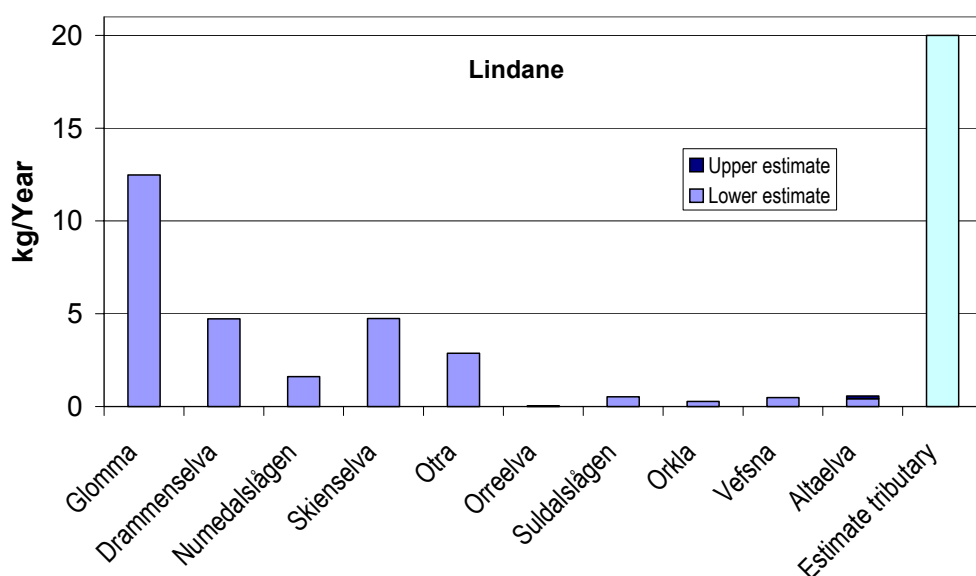


Figure 9. Lindane. Total loads of the main rivers in 2001 (lower and upper estimates) and estimate for the tributary rivers.

4.6. Trend analysis

The yearly inputs from 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 2001 is too short to identify a real trend but it can give indications, which can lead to a closer study of the information.

On annual basis, statistical trend analysis (by the recommended tool “Trend-y-Tector” (ICES, 1999)) for total P, total N, the metals, and lindane have been carried out for all rivers.

Following rivers have the longest time series of continuous data:

- River Glomma (1978-2001): Tot-P and Tot-N
- River Otra (1980-2001): Tot-P and Tot-N
- River Orkla (1974-2001): Cu and Zn

For the other parameters the 1990-2001 series have been used, with exception of lindane where the lindane data for 1990 were ignored because of high analytical detection limit in 1990 (see Figure 22 for Drammenselva).

4.6.1. Nutrient trends

Phosphorus and nitrogen annual load for main rivers (1990-2001) are shown in Figure 10 and Appendix XIII, Report B.

No trends for phosphorus and nitrogen were detected in Glomma with use of the Trend-Y-Tector, even when long time series (1978-2001) were used. It seems, however, that the total phosphorus load for Glomma has increased during the last two years (Figure 10). For Otra, the downward trend seen for phosphorus for the period 1980-1998 (74%) stopped from 1999 (see Figure 11). No trend was seen for Otra when data for the whole period 1980-2001 was analysed. However, a downward trend (29 %) was found for nitrogen for the same period (Figure 11).

No other rivers show significant trends for phosphorus. An increased phosphorus load was noticed in 2000 and 2001 for all main rivers except Vefsna (Figure XIX.XIX, Appendix XIX). A significant increase was especially found for phosphorus in Skienselva in 2001. A general increase in measured tot-P concentration in Skienselva was noticed from 1999. Additionally, two extremely high values by the end of the year contributed to a rise in the average values (Figure 12). The source of this increased discharge is unknown. The phosphorus concentration decreased to "normal" level in 2002.

Drammenselva and Numedalslågen show significant increase of the yearly input of nitrogen (66 % in period 1990-2001 for Drammenselva, 126 % in period 1985-2001 for Numedalslågen). The sources of these increases are not found. A similar increase is not found for Glomma. In Vefsna a high increase of the yearly nitrogen input (171 %) was found for the period 1990-1998. However, in 1999-2001 the load decreased to the same level as in 1990-1992, and no trend was seen for 1990-2001 or 1985-2001. Longer time series are needed to make conclusions about these variations (Figure 13).

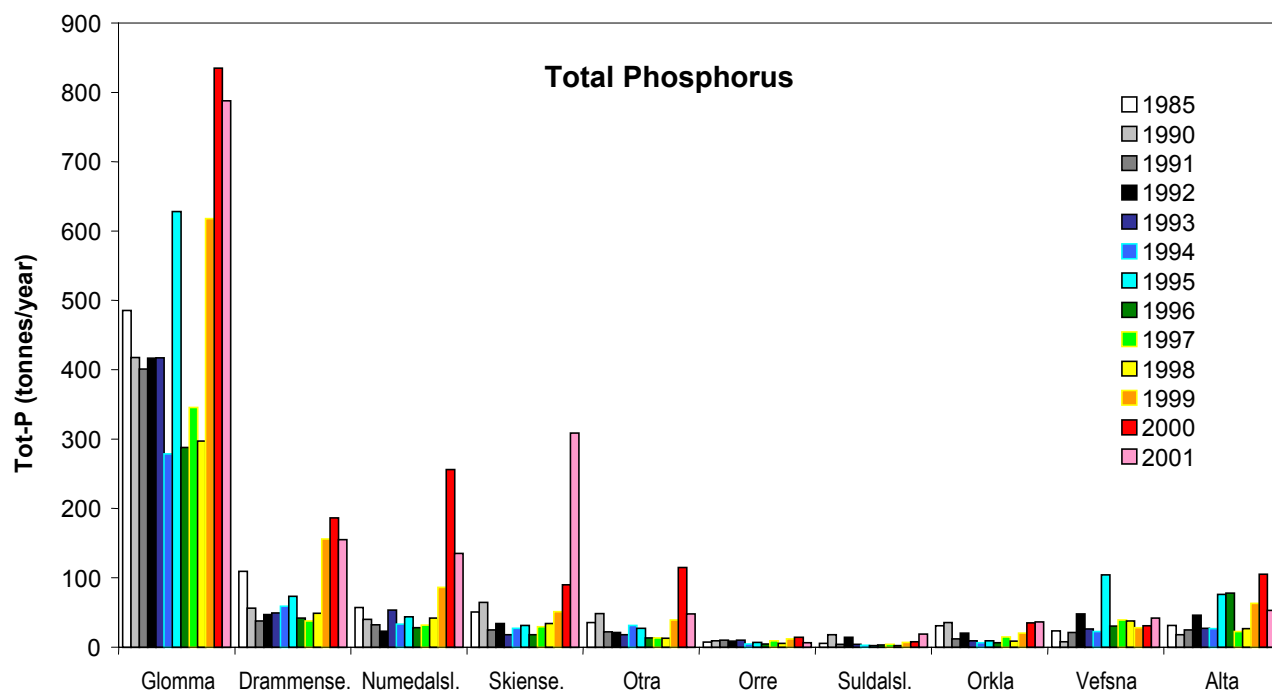
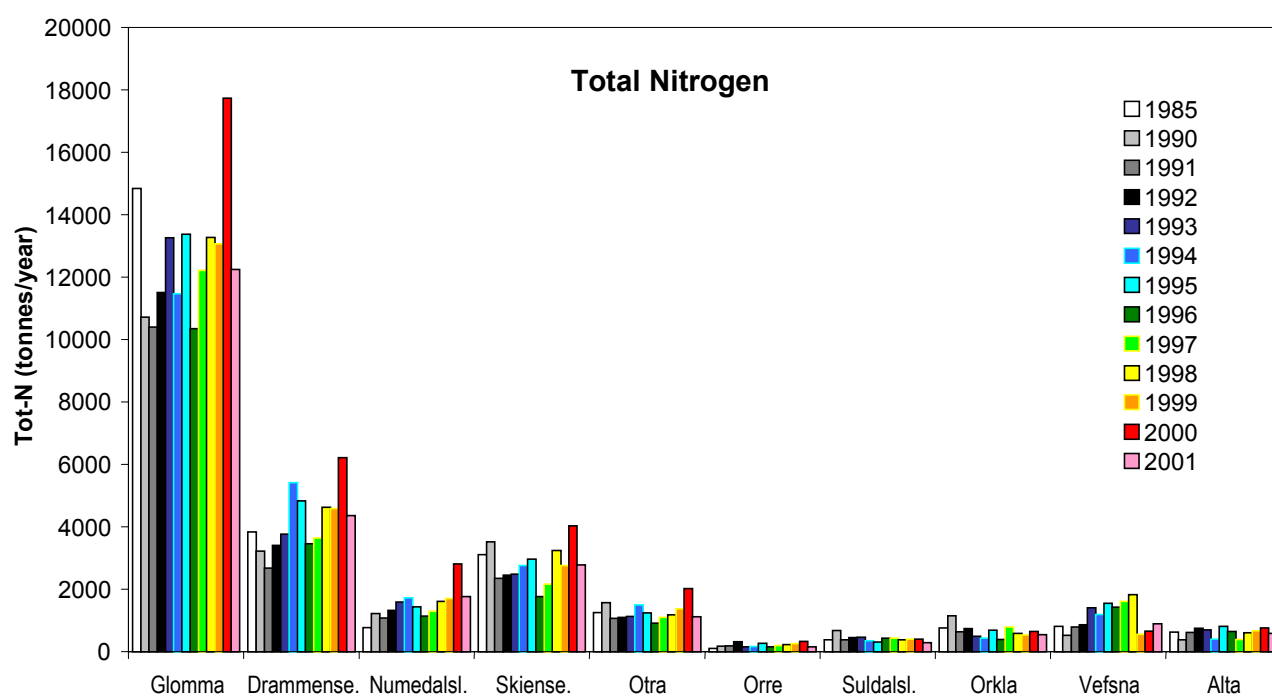


Figure 10. Main rivers. Annual total nitrogen and total phosphorus load in 1985, 1990- 2001.

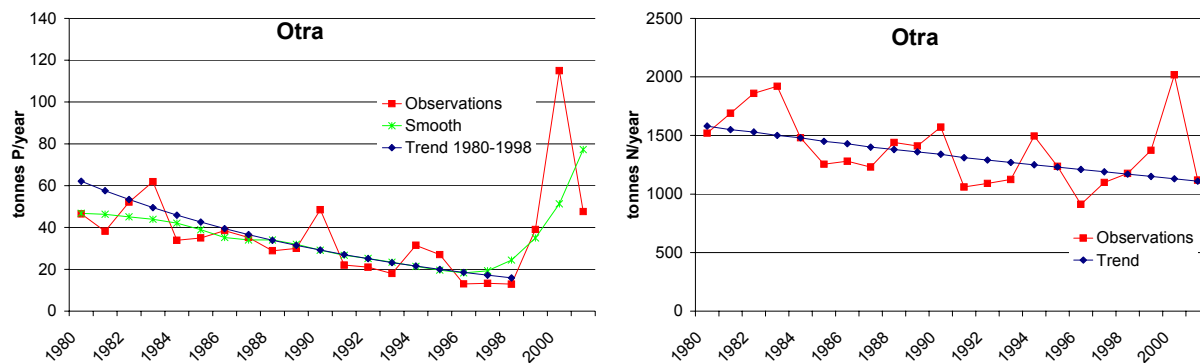


Figure 11. Observations and trends in load of tot-P and tot-N for Otrå (1980-2001)

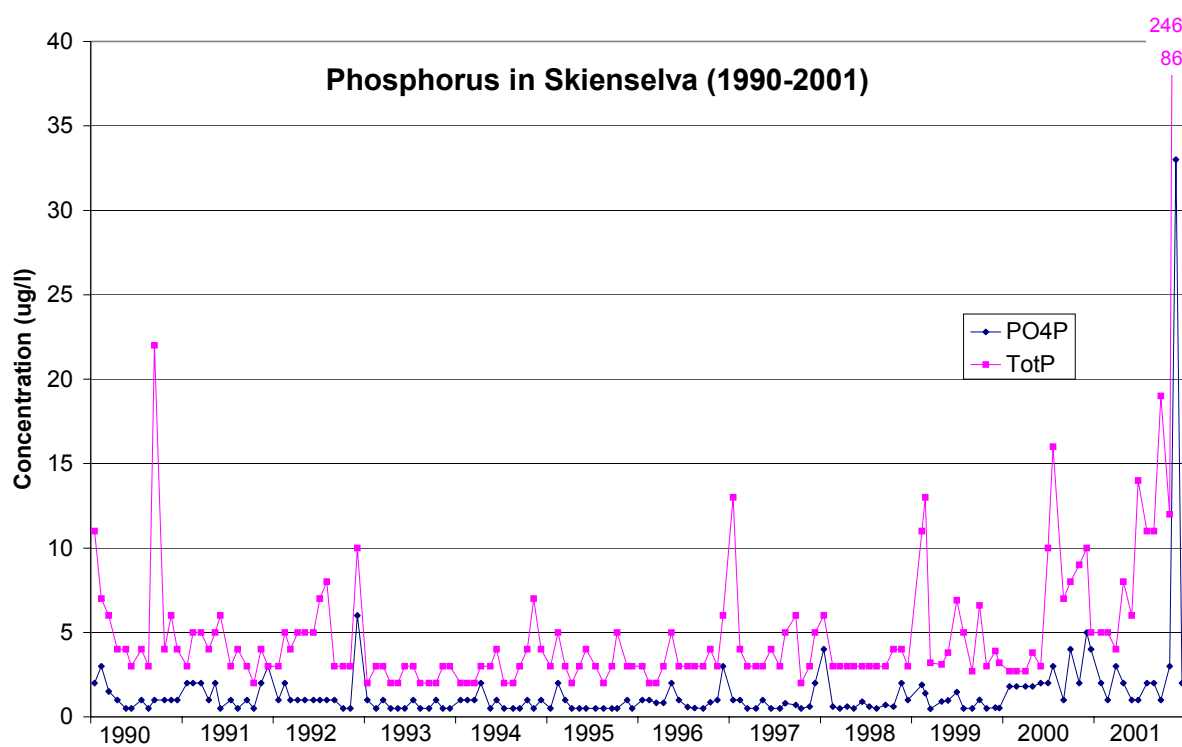


Figure 12. Concentration of tot-P and PO₄-P in Skienselva (1990-2001), all measurements included.

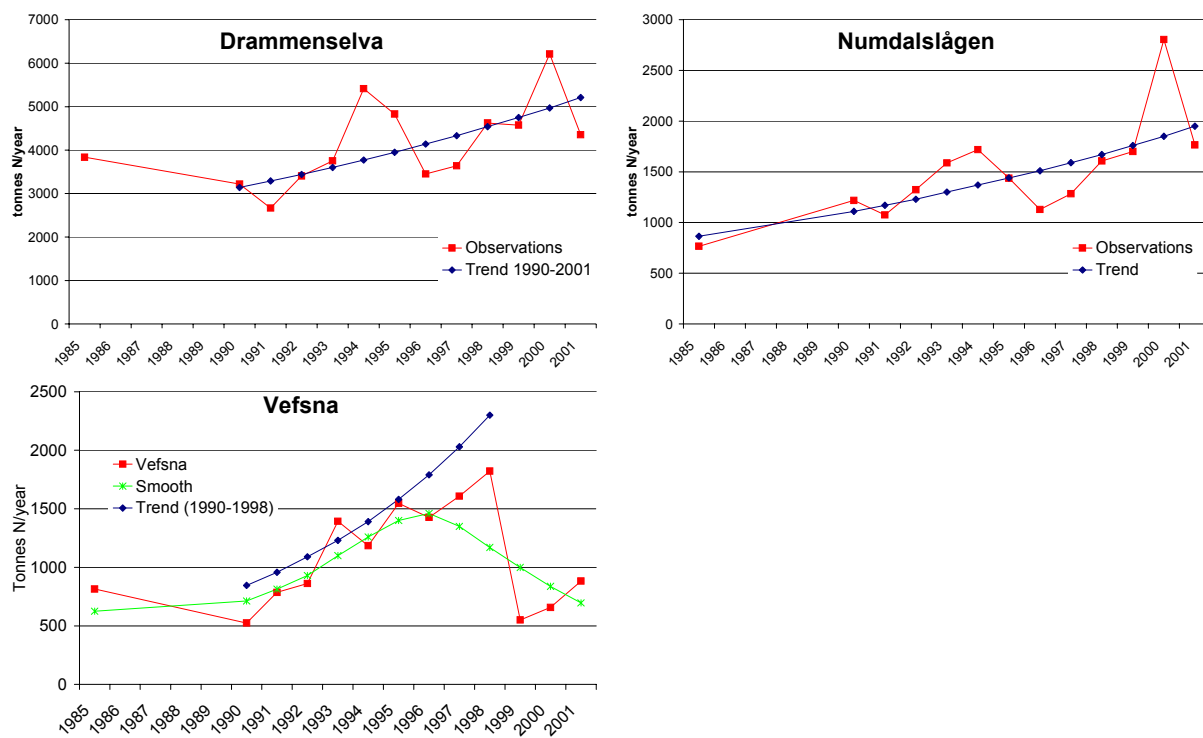


Figure 13. Observations and trend in loads for nitrogen in rivers with a significant trend for nitrogen: Drammenselva (1990-2001), Numdalslågen (1985-2001) and Vefsna (1990-1998).

4.6.2. Metals trends

Annual load for metals in main rivers (1990-2001) are shown in figs. 14-17.

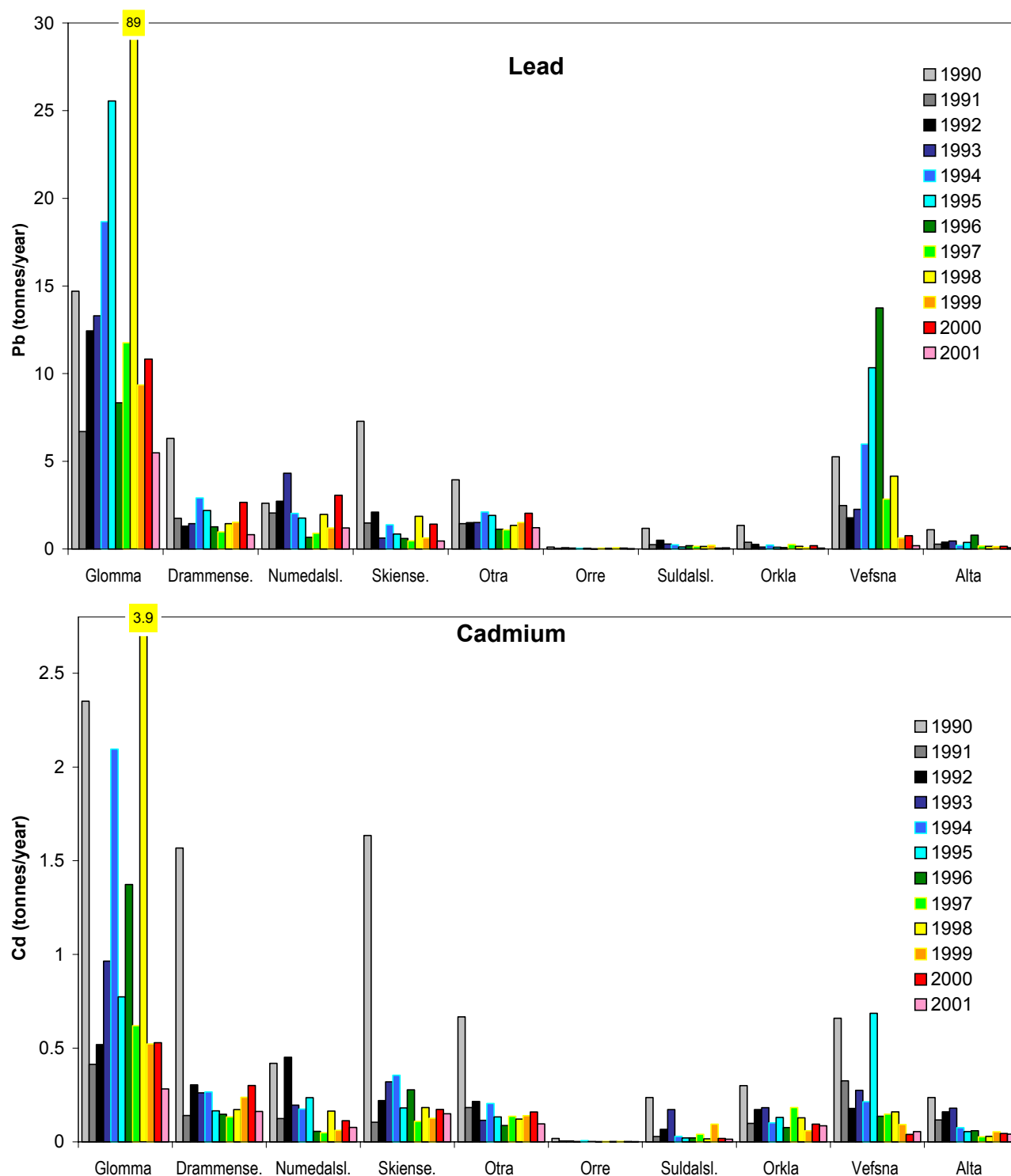


Figure 14. Main rivers. Annual total load of lead and cadmium in 1990-2001.

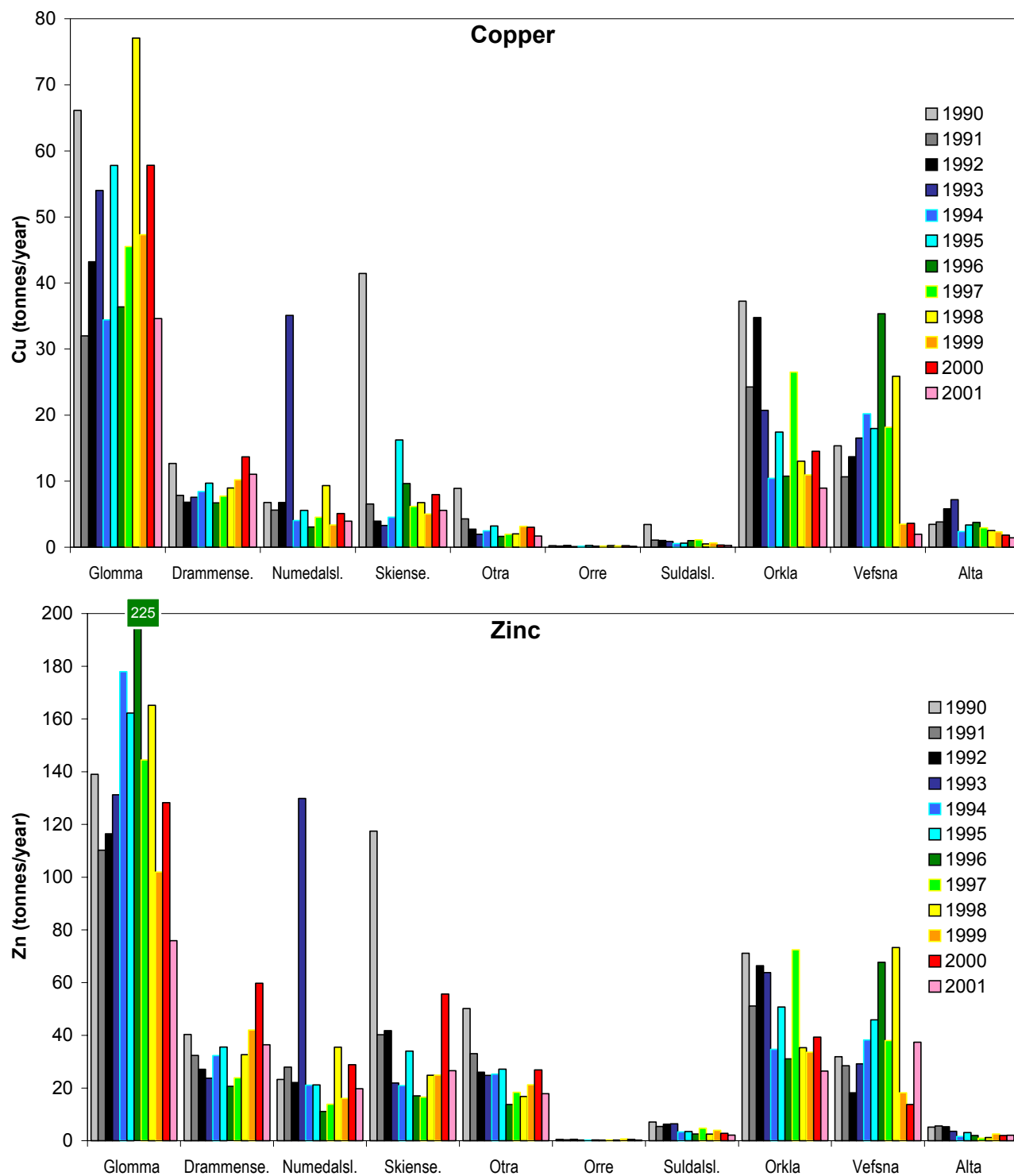


Figure 15. Main rivers. Annual total load of copper zinc and in 1990-2001.

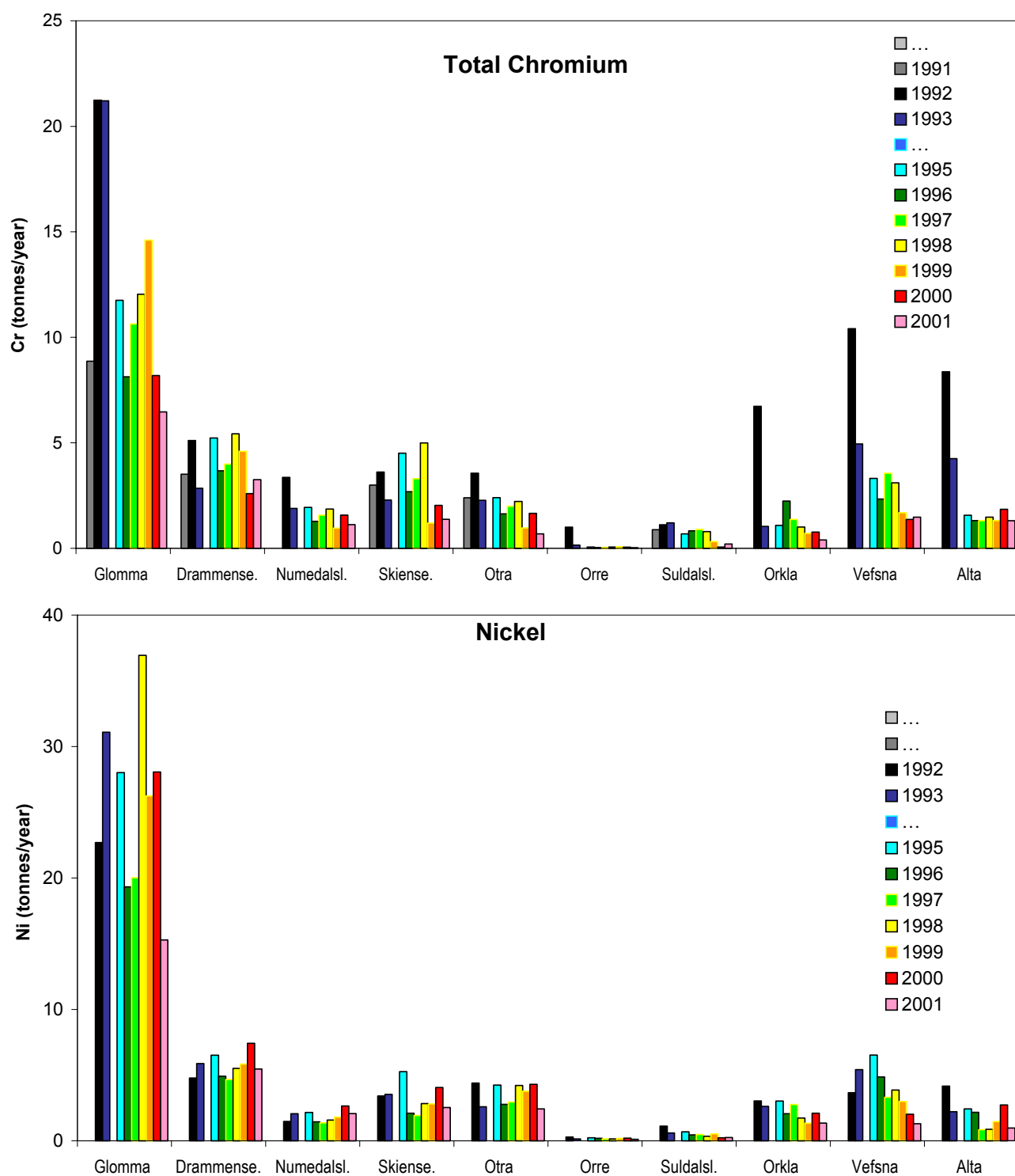


Figure 16. Main rivers. Annual total load of total chromium and nickel in 1990-2001. No measurement has been performed in 1990 and 1994 for those two parameters. In 1991 chromium has only been measured in Glomma, Drammenselva, Skienselva, Otra and Suldalslågen and no nickel measurement has been performed.

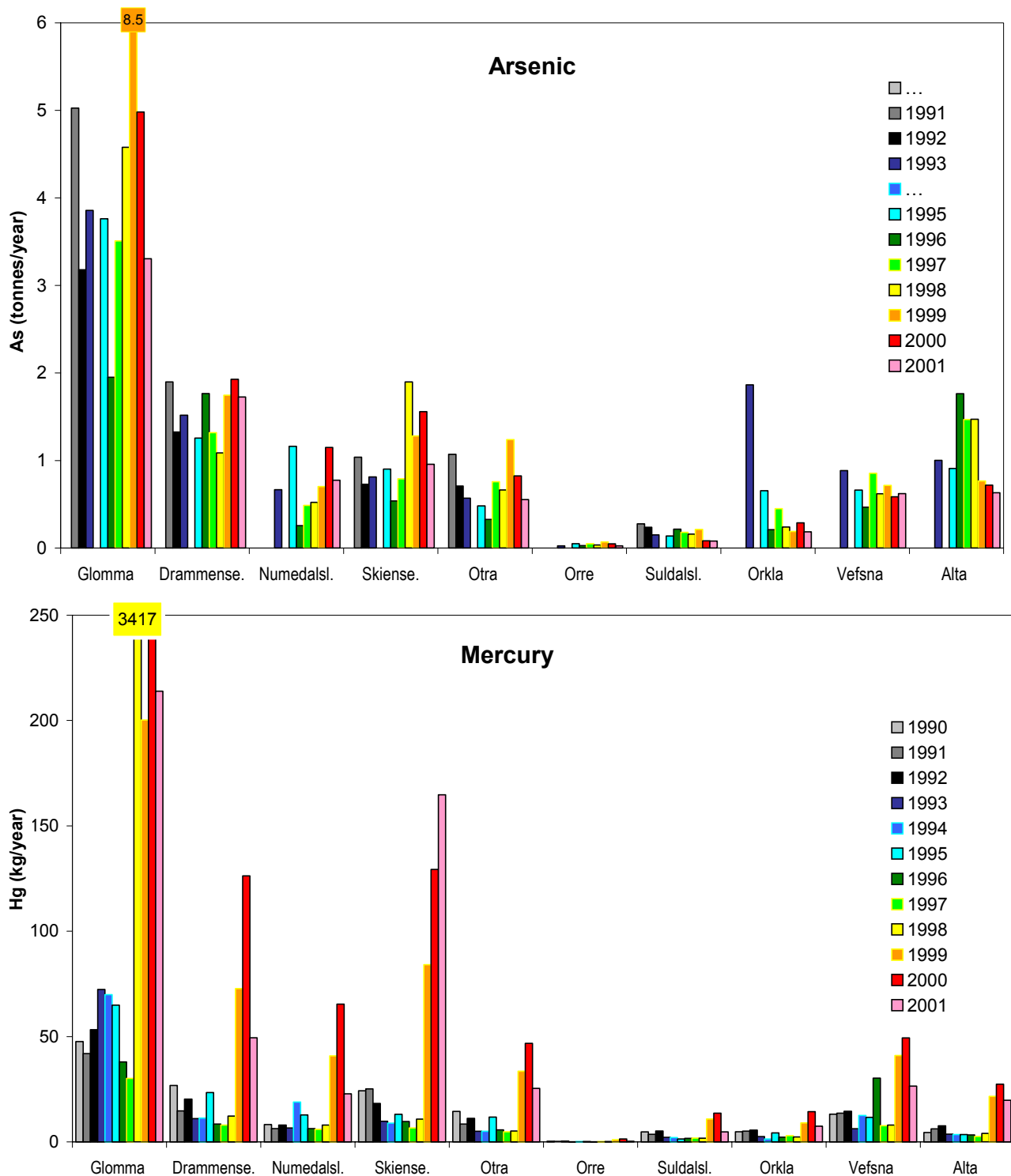


Figure 17. Main rivers. Annual total load of arsenic and mercury in 1990-2001. No arsenic measurement has been performed in 1990 and 1994 and in 1991 and 1992 arsenic has only been measured in Glomma, Drammenselva, Skienselva, Otra and Suldalslågen.

The long time series for copper and zinc in Orkla (1974-2001) show a significant reduction (84 % and 80 %) (Figure18). However if only the period 1990-2001 is considered, no significant trend is found for Orkla by the Trend-Y-Tector. This means that the 10-year period is probably too short to give a significant trend even if such a trend exists. For the other metals

in Orkla and for all metals in the other rivers no data before 1990 are available. Negative results in trend analysis for the time period 1990-2001 do not necessarily mean that there is no trend for the period, but the period can be too short for this trend to be statistically significant.

Trend analyses for the time period 1990-2001 for all 10 rivers were performed for lead, cadmium, copper and zinc. All significant trends for metals are downward trends. Overviews of the rivers with significant reduction in metal concentrations in 1990-2001 are summarised in Table 11 and illustrated in Figures 18 and 19. The results show a decrease in metal loading over time.

No trend analysis where performed for mercury because of the change in analytical methods in 1999 and the general high analytical uncertainty of this parameter. A trend analysis of mercury might only reflect an analytical artefact rather than a real change. For Glomma, however, a significant increase in mercury concentration, with more frequent cases of high concentration can be noticed for 1998 and again from September 2001 (Figure 20). Results for the first 6 months of 2002 seem to confirm that high concentrations are also repeated for 2002. These data will be presented in the RID 2002 report. An investigation is needed to find the source of increased mercury discharges to Glomma. For Glomma, the correlation analysis indicated no significant correlation between mercury and particulate suspended matter or run-off.

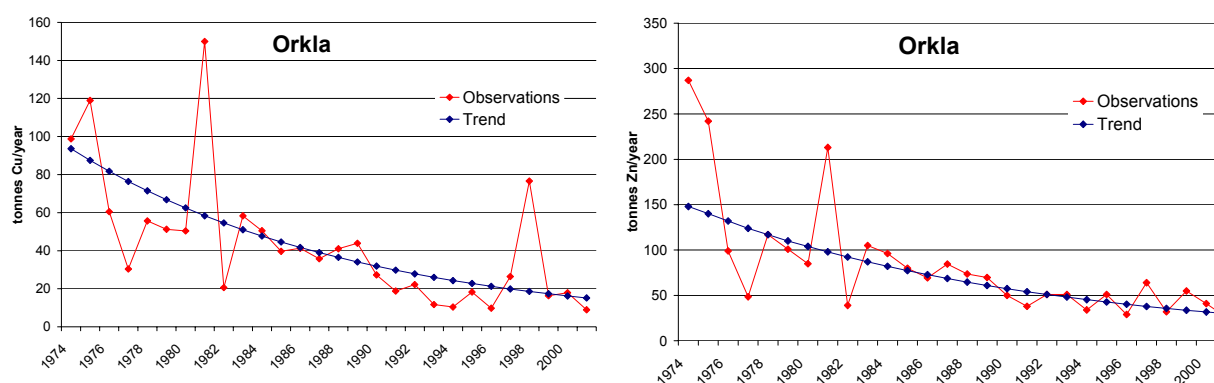


Figure 18. Observations and trends in load of copper and zinc for Orkla (1974-2001)

Table 11. Rivers where significant downward trend was detected for metals in the period 1990-2001

River	Parameter	Downward trend size
Suldalslågen	Lead	86%
	Cadmium	82%
	Copper	79%
	Zinc	56%
Vefsna	Cadmium	89%
Alta	Cadmium	85%
	Copper	58%

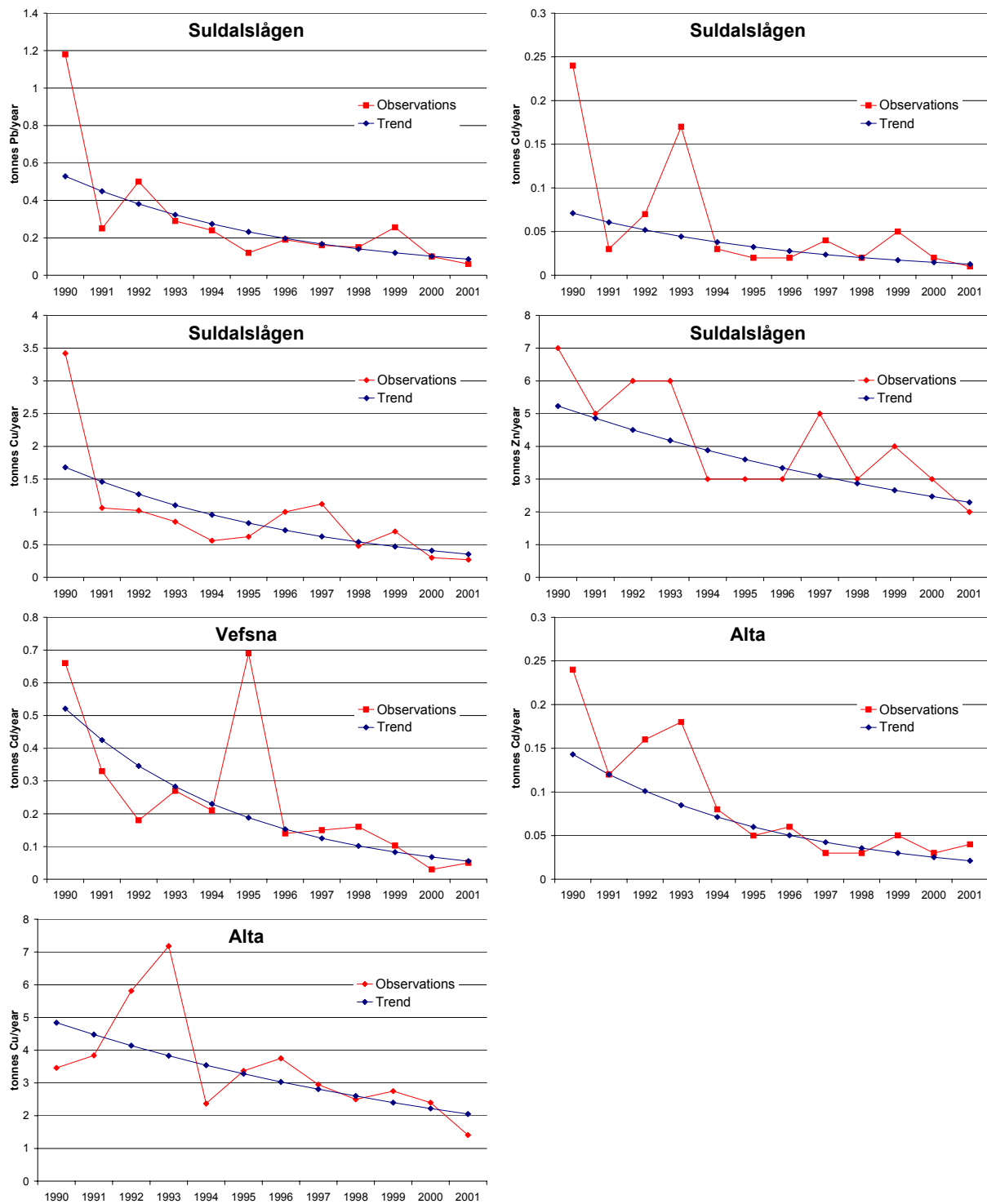


Figure 19. Observation and trend in metals load for the rivers: Suldalslågen (Pb, Cd, Cu, and Zn), Vefsna (Cd), and Alta (Cd, Cu, Zn).

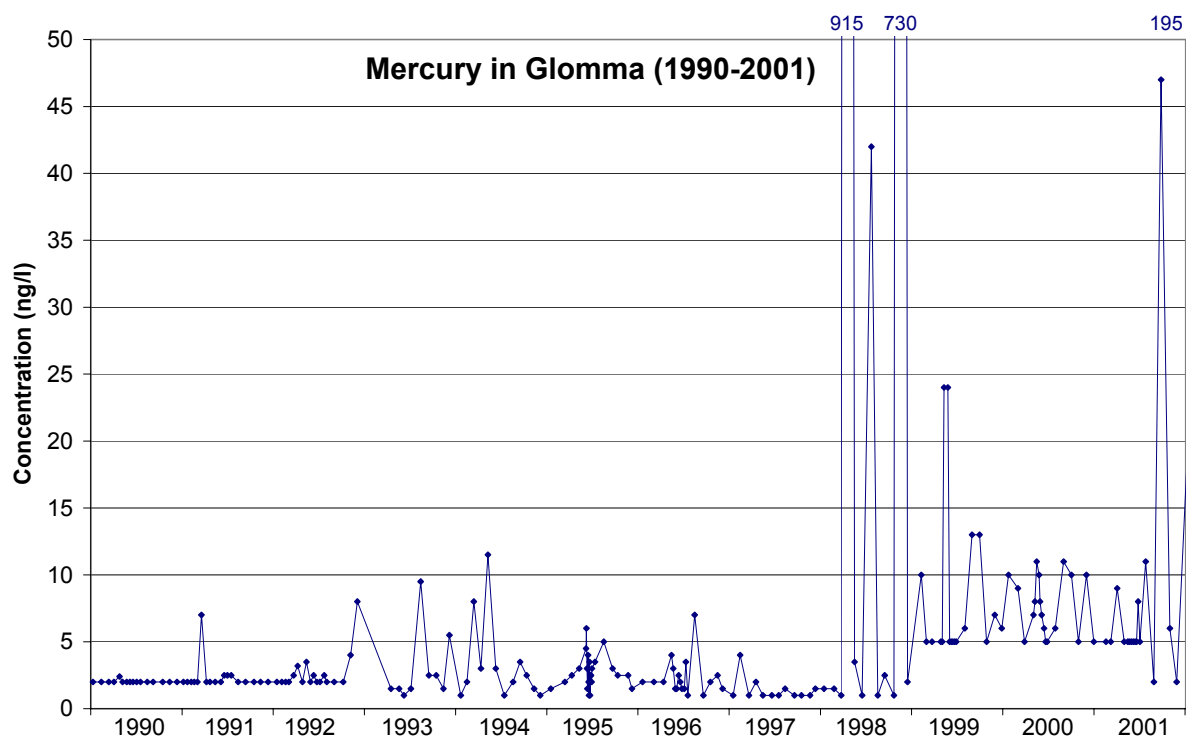


Figure 20. Concentration of mercury in Glomma (1990-2001), all measurements included

4.6.3. Lindane trends

Annual load for lindane in main rivers (1990-2001) are shown in Figure 21.

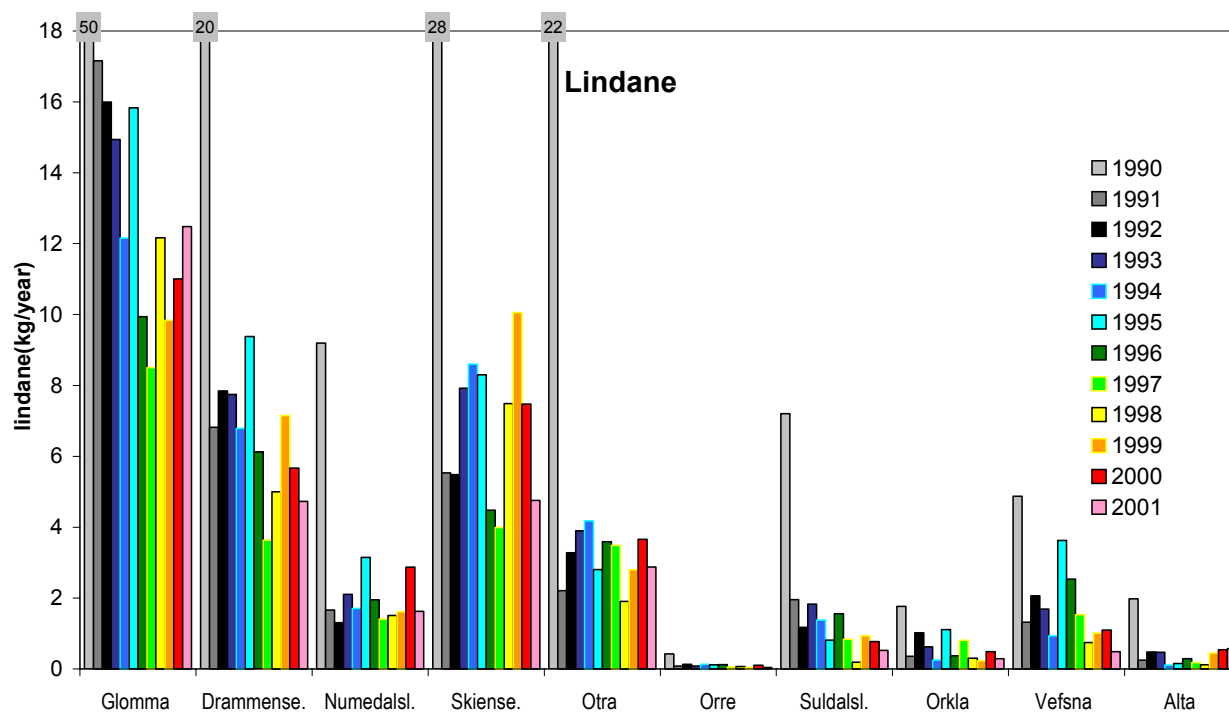


Figure 21. Main rivers. Annuals loads of lindane in 1990-2001.

The 1990 data for lindane were for all rivers all significantly higher than later monitored data. It was therefore assumed that these high values were due to analytical problems. These data were ignored in the trend analysis of lindane. Trend analyses were performed for all main rivers but a statistically significant trend was only seen for Drammenselva (downward trend 40%, Figure 22). As described for metals, negative results in trend analyse for 1991-2001 do not necessarily mean that no trend exist, but rather that the period used could be too short for the trend to be statistically significant.

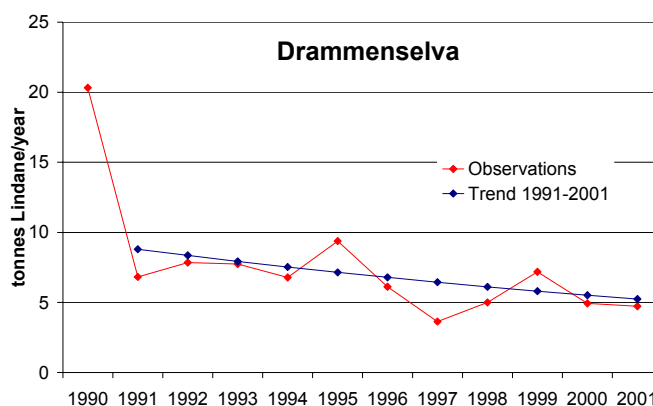


Figure 22. Observation and trend in load of lindane for Drammenselva (1990-2001).

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

Mean annual runoff (river flow) for the long term average (LTA) period 1961-90 has been estimated (Figure 2). For most of the 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 - 2000, most calculated mean concentrations were approximately at the same level in 2001. Mercury was at the same level as in 1999 (described in Section 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 all the rivers, and accordingly the calculated loads for most of the substances were considerably lower in 2001 than in 2000 (Figure 2, Section 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 low runoff. The frozen soil and snowcover protect vegetation and surface soil from erosion. But with the mild winters (1990-1993, 1995 and 1999 - 2000), 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 measured in most rivers during these years.

From experience we have learned that the product of weighted concentrations and mean run-off 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 before the regulation took place (the time period 1931-60).

4.8. Retention in fjords

Retention in watercourses is taken into account in the calculation of the Norwegian contribution to marine pollution, but using conservative figures. However, no corrections have been 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, but it implies also that fine particulate matters during stratification periods are not easily precipitated.

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 in threshold fjords can be estimated from the same type of models that applies to lakes. The general lack of calibration data on retention models for threshold 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.

4.9. Leakage from sediments

Leaching of metals, organic substances 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 previously 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 changes in leaching depending on the actual substances present. More attention should be paid to these conditions.

5. References

5.1. Project Personnel

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Summary - sammendrag The report contains results from the 2001 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 2001 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.

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Riverine Inputs and Direct Discharges to Norwegian Coastal Waters - 2001. OSPAR Commission.

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Summary This report contains Appendices to the report “ Riverine Inputs and Direct Discharges to Norwegian coastal waters - 2001. OSPAR Commission. A: Principles, results and discussions”. The report contains data from the 2001 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.
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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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Appendix I. Total discharges 2001

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Table I. Total discharge from mainland Norway to convention waters 2001

		Area runoff	Fish farming	Direct dis- charges	Tributary inputs	Main river- ine inputs	Grand total	
S.P.M.	*	-	-	702 491	271 592	288 937	1 263 020	tonnes
	**	-	-	702 491	292 390	291 634	1 286 515	
TOC		-	-	249	432 847	238 848	671 944	tonnes
Orthoph.	*	194	709	535	173	286	1 897	tonnes
	**	194	709	535	289	291	2 018	
Total P	*	792	3 937	1 150	1 799	1 600	9 278	tonnes
	**	792	3 937	1 150	1 830	1 602	9 311	
Nitrates	*	15 531	-	53	16 524	14 144	46 252	tonnes
	**	15 531	-	53	16 526	14 144	46 254	
Ammonia	*	1 398	6 007	8 346	2 177	1 364	19 292	tonnes
	**	1 398	6 007	8 346	2 177	1 369	19 297	
Total N		24 403	18 772	14 668	35 093	24 807	117 743	tonnes
Silicate SiO₂	*	-	-	-	223 769	201 966	425 735	tonnes
	**	-	-	-	224 017	201 996	426 013	
Arsenic	*	-	-	0.9	14	8.6	24	tonnes
	**	-	-	0.9	19	9.	29	
Lead	*	-	-	10	12	9.5	32	tonnes
	**	-	-	10	13	10	33	
Cadmium	*	-	-	0.5	0.9	0.7	2.1	tonnes
	**	-	-	0.5	2.1	1.0	3.6	
Copper	*	-	-	26	98	70	194	tonnes
	**	-	-	26	99	70	195	
Total Cr-T	*	-	-	3.9	21	12	37	tonnes
	**	-	-	3.9	38	16	58	
Nickel	*	-	-	21	91	32	144	tonnes
	**	-	-	21	97	32	150	
Zinc	*	-	-	62	301	245	608	tonnes
	**	-	-	62	318	246	626	
Mercury	*	-	-	49	1 351	371	1 771	kg
	**	-	-	49	1 496	541	2 086	
Lindane	*	-	-	-	-	28	28	kg
	**	-	-	-	-	29	29	

Measurements below detection limits are treated in two ways

*Detection limit = zero, ** Detection limit = limit

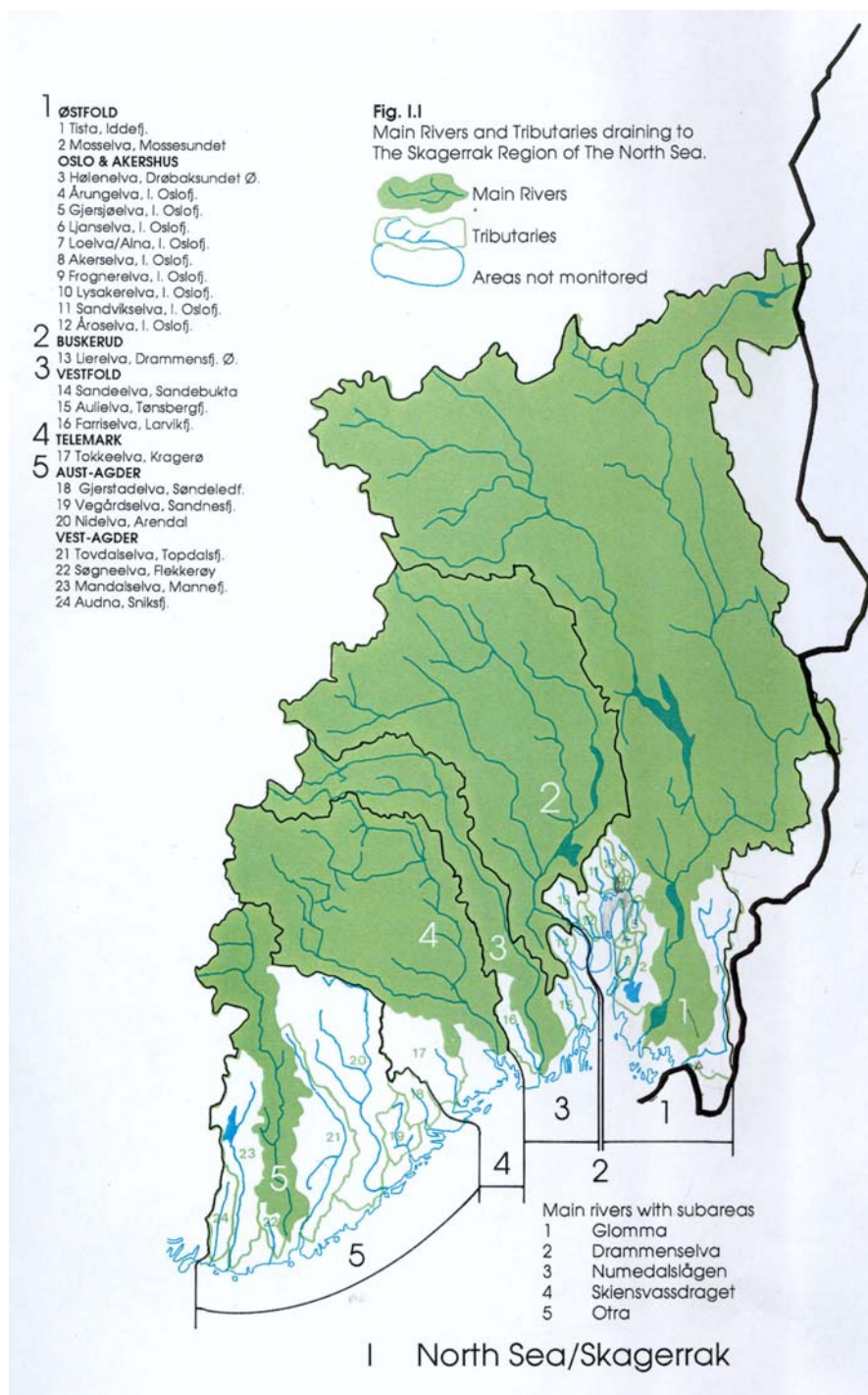
Table I.I Total discharges to the Skagerrak region 2001 (Figure I.I)

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 river-ine inputs	Grand total
S.P.M.	*			3 321	38 497	271 166	313 984 tonnes
	**			3 321	38 497	273 708	315 526
TOC				21	87 618	209 939	297 578 tonnes
Orthoph.	*	22	0.1	83	20	236	361 tonnes
	**	22	0.1	83	55	241	401
Total P	*	88	0	228	302	1 443	2 061 tonnes
	**	88	0	228	320	1 446	2 082
Nitrates		1 967	-	21	3 872	13 023	18 883 tonnes
Ammonia		182	1	3 442	760	1 297	5 682 tonnes
Total N		3 026	2	5 639	7 623	22 363	38 653 tonnes
Silicate SiO ₂	*			-	27 326	176 319	203 645 tonnes
	**			-	27 574	176 319	203 893
Arsenic	*			0.2	4.9	7.1	12 tonnes
	**			0.2	5.6	7.7	14
Lead	*			0.9	6.9	9.1	17 tonnes
	**			0.9	6.9	9.2	17
Cadmium	*			0.07	0.6	0.6	1.3 tonnes
	**			0.07	0.7	0.8	1.6
Copper	*			13	13	57	83 tonnes
	**			13	14	57	84
Total Cr-T	*			1.6	4.5	9.0	15 tonnes
	**			1.6	6.3	13	21
Nickel	*			2.2	4.6	28	35 tonnes
	**			2.2	7.0	28	37
Zinc	*			13	82	177	272 tonnes
Mercury	*			23	818	334	1 175 kg
	**			23	851	483	1 357
Lindane				-	-	27	27 kg

Measurements below detection limits are treated in two ways

*Detection limit = zero, ** Detection limit = limit



Source: NIVA

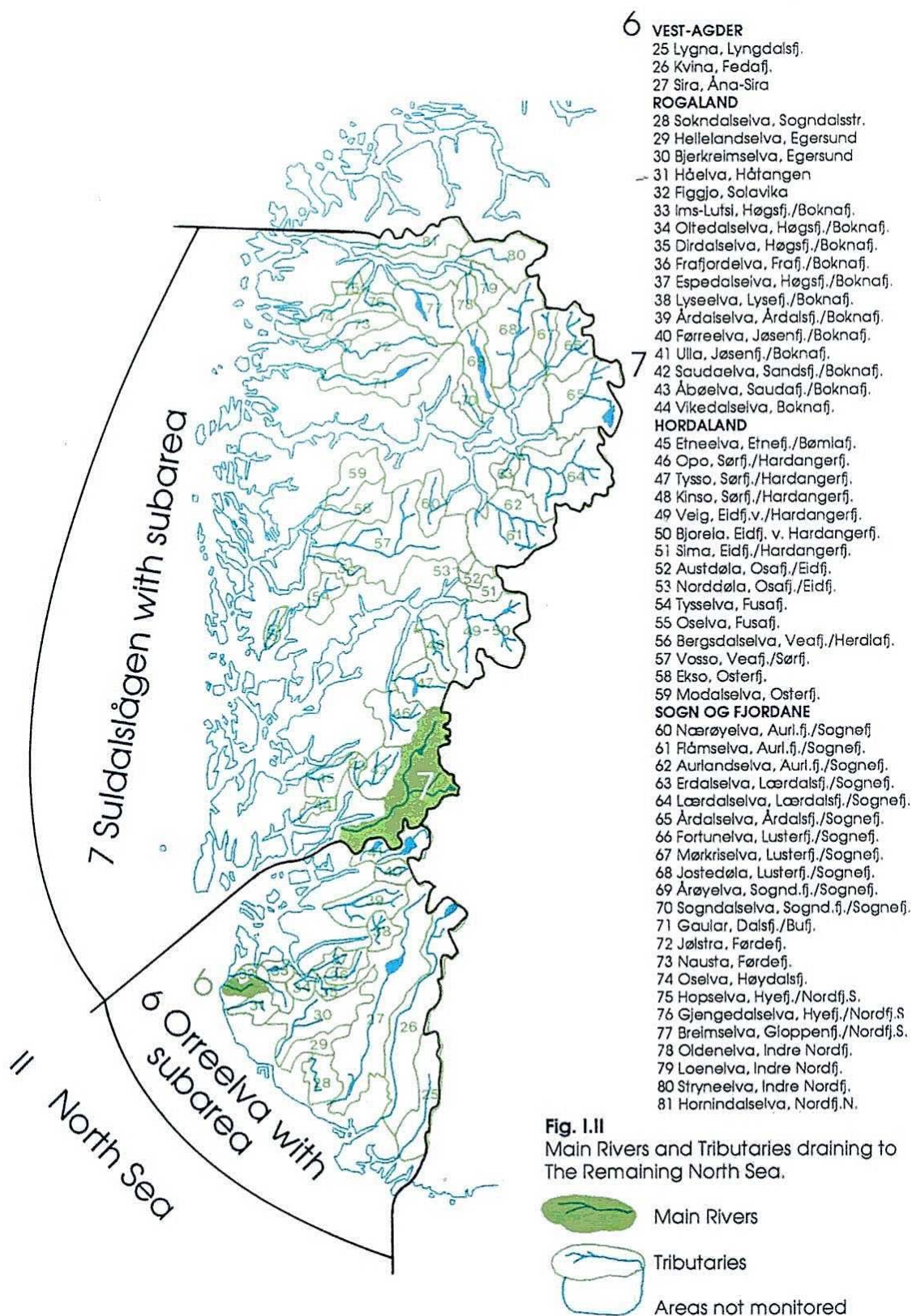
Table I.II **Total discharges to the remaining North Sea 2001**
(Figure I.II)

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

		Area runoff	Fish farm- ing	Direct dis- charges	Tributary inputs	Main river- ine inputs	Grand total
S.P.M.	*			66 791	54 170	1 210	122 171 tonnes
	**			66 791	58 557	1 674	127 022
TOC				148	51 680	2 576	54 404 tonnes
Orthoph.	*	51	303	178	51	4	587 tonnes
	**	51	303	178	80	4	616
Total P		198	1683	379	580	25	2 865 tonnes
Nitrates		5 897	-	16	6 309	321	12 543 tonnes
Ammonia	*	524	2564	2 347	463	12	5 910 tonnes
	**	524	2564	2 347	463	12	5 910
Total N		9 369	8013	4 608	9 067	441	31 498 tonnes
Silicate SiO₂	*			-	40 235	1 442	41 677 tonnes
	**			-	40 235	1 473	41 708
Arsenic	*			0.2	1.7	0.09	2.0 tonnes
	**			0.2	4.0	0.11	4.3
Lead	*			5.5	3.2	0.06	8.8 tonnes
	**			5.5	3.8	0.08	9.4
Cadmium	*			0.3	0.2	0.01	0.5 tonnes
	**			0.3	0.5	0.01	0.8
Copper	*			5.1	15	0.4	21 tonnes
	**			5.1	15	0.4	21
Total Cr-T	*			1.3	2.3	0.1	3.7 tonnes
	**			1.3	7.3	0.2	8.8
Nickel	*			16	5.5	0.3	22 tonnes
	**			16	8.3	0.4	25
Zinc	*			35	75	2.3	112 tonnes
	**			35	81	2.4	118
Mercury	*			14	171	1.9	187 kg
	**			14	248	5.0	267
Lindane				-	-	0.6	0.6 kg

Measurements below detection limits are treated in two ways

*Detection limit = zero, ** Detection limit = limit



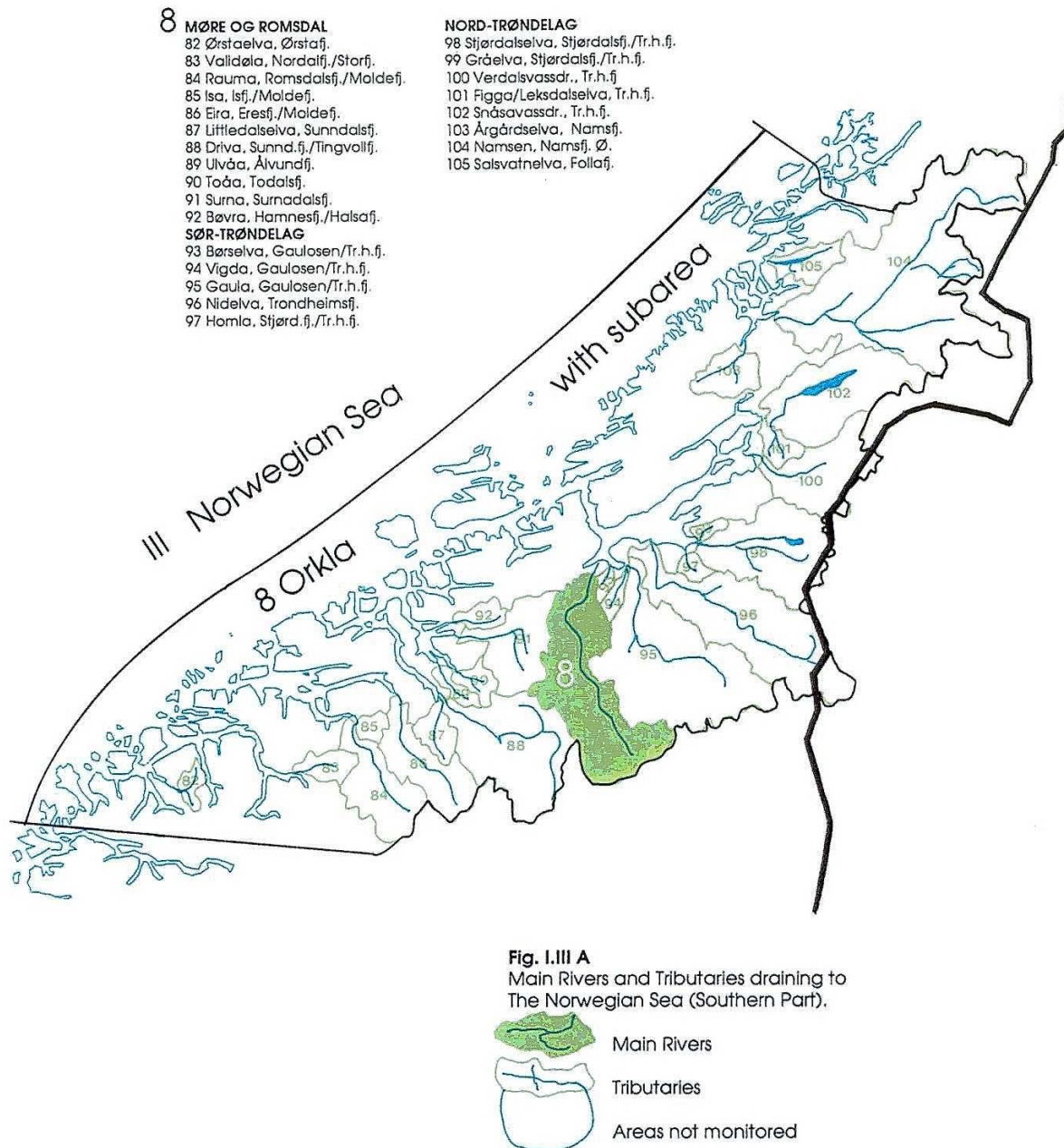
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Table I.III **Total discharges to the Norwegian Sea 2001**
(Figure I.III)

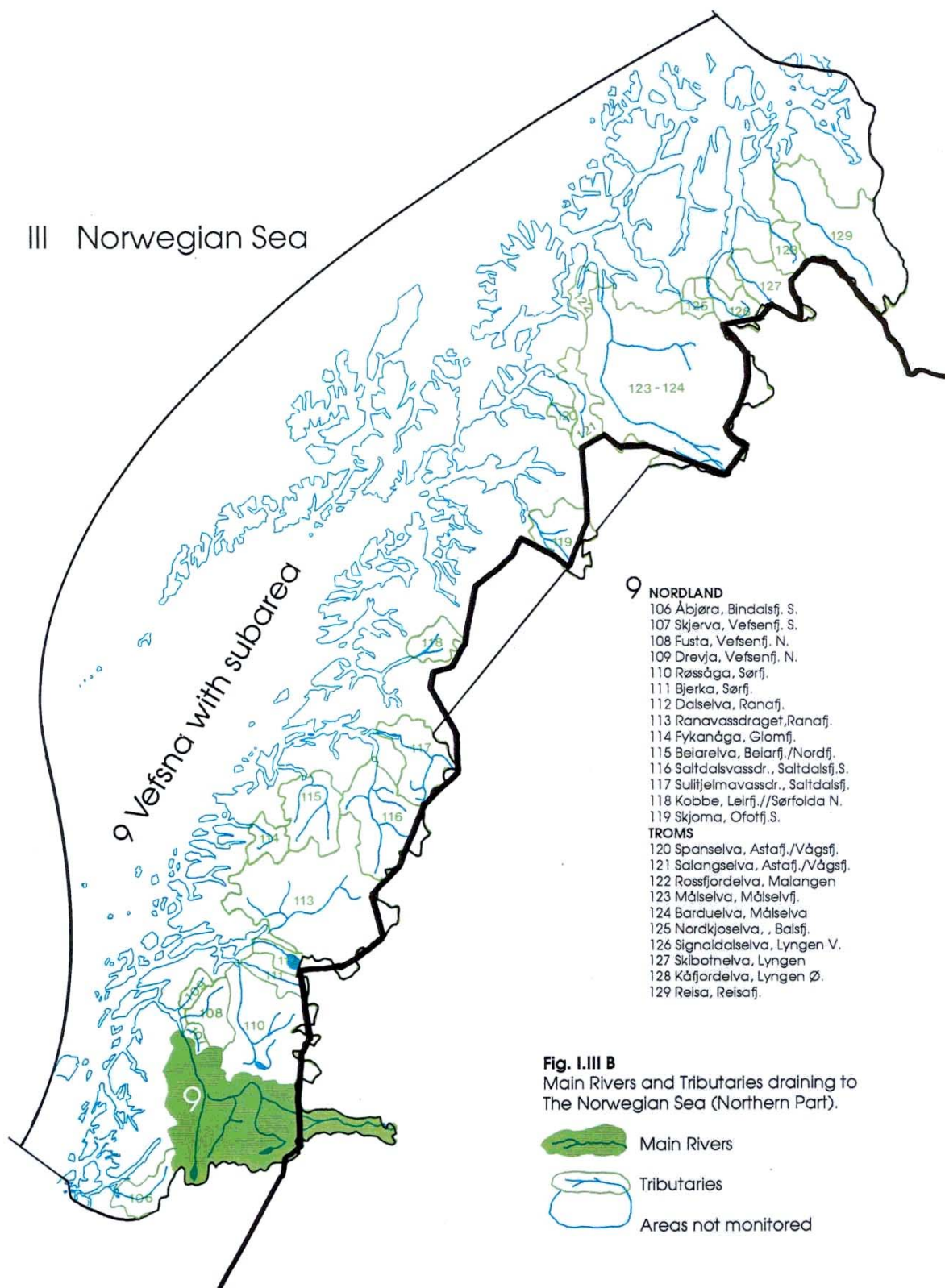
		Area runoff	Fish farm- ing	Direct dis- charges	Tributary inputs	Main river- ine inputs	Grand total
S.P.M.	*			400 223	152 707	12 658	565 588 tonnes
	**			400 223	167 075	12 974	580 272
TOC				80	198 516	16 391	214 987 tonnes
Orthoph.	*	103	353	254	52	17	779 tonnes
	**	103	353	254	97	17	824
Total P	*	419	1962	508	752	79	3 720 tonnes
	**	419	1962	508	765	79	3 733
Nitrates		6 652	-	15	6 207	607	13 481 tonnes
Ammonia	*	607	3000	2 363	708	33	6 711 tonnes
	**	607	3000	2 363	708	36	6 714
Total N		10 327	9375	4 160	13 976	1 424	39 262 tonnes
Silicate SiO₂				-	79 938	11 315	91 253 tonnes
Arsenic	*			0.6	5.3	0.8	6.7 tonnes
	**			0.6	6.3	0.8	7.7
Lead	*			3.7	1.5	0.2	5.4 tonnes
	**			3.7	2.0	0.2	5.9
Cadmium	*			0.1	0.0	0.1	0.2 tonnes
	**			0.1	0.7	0.1	0.9
Copper				7.5	48	11	67 tonnes
Total Cr-T	*			0.9	6.3	1.3	8.5 tonnes
	**			0.9	15	1.9	18
Nickel	*			2.3	24	2.6	29 tonnes
	**			2.3	25	2.7	30
Zinc	*			12	63	64	139 tonnes
	**			12	72	64	148
Mercury	*			10.5	253	22	286 kg
	**			10.5	286	34	331
Lindane				-	-	0.8	0.8 kg

Measurements below detection limits are treated in two ways

*Detection limit = zero, ** Detection limit = limit



Source: NIVA



Source: NIVA

Table I.IV Total discharges to the Barents Sea 2001 (Figure I.IV)**The Barents Sea with sub-area: (10) Alta**

		Area runoff	Fish farm- ing	Direct dis- charges	Tributary inputs	Main river- ine inputs	Grand total
S.P.M.	*			232 156	26 218	2 903	261 277 tonnes
	**			232 156	28 262	3 279	263 697
TOC				-	95 034	9 942	104 976 tonnes
Orthoph.	*	18	53	20	50	30	171 tonnes
	**	18	53	20	58	30	179
Total P	*	88	292	35	165	53	633 tonnes
	**	88	292	35	166	53	634
Nitrates	*	1 015	-	1	137	193	1 346 tonnes
	**	1 015	-	1	139	193	1 348
Ammonia	*	85	442	194	246	23	990 tonnes
	**	85	442	194	246	23	990
Total N		1 681	1382	260	4 427	579	8 329 tonnes
Silicate SiO₂				-	76 271	12 889	89 160 tonnes
Arsenic	*			-	2.4	0.6	3.0 tonnes
	**			-	2.6	0.6	3.2
Lead	*			0.05	0.5	0.0	0.6 tonnes
	**			0.05	0.8	0.1	1.0
Cadmium	*			0.003	0.01	0.03	0.04 tonnes
	**			0.003	0.25	0.04	0.29
Copper	*			0.69	22	1.3	24 tonnes
	**			0.69	22	1.4	24
Total Cr-T	*			0.08	8.0	1.2	9.3 tonnes
	**			0.08	9.4	1.3	11
Nickel	*			0.083	57	1.0	58 tonnes
	**			0.083	57	1.0	58
Zinc	*			1.0	81	1.4	83 tonnes
	**			1.0	82	2.0	85
Mercury	*			1.2	108	13	122 kg
	**			1.2	111	20	132
Lindane	*			-	-	0.4	0.4 kg
	**			-	-	0.6	0.6

Measurements below detection limits are treated in two ways

*Detection limit = zero, ** Detection limit = limit

IV Barents Sea

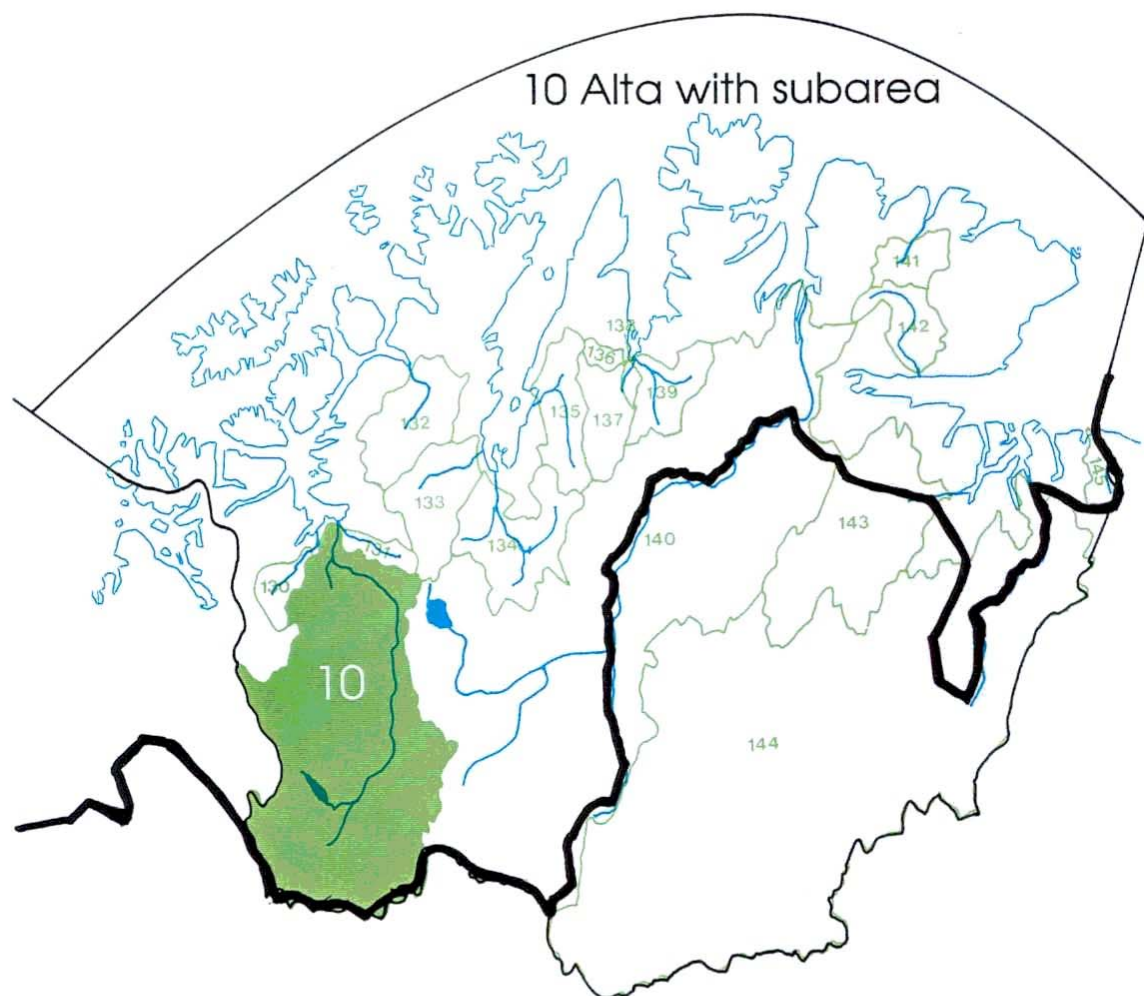


Fig. I.IV
Main Rivers and Tributaries draining to
The Barents Sea.



- 10 FINNMARK**
- 130 Mattiselva, Kåfj./Altafj.
 - 131 Tverrelva, Altafj.
 - 132 Repparfjordelva, Repparfj.
 - 133 Stabburselva, I. Porsangen V.
 - 134 Lakselva, I. Porsangen S.
 - 135 Børselva, I. Porsangen Ø.
 - 136 Mattusjåkkka, I. Laksefj. V.
 - 137 Storelva, I. Laksefj. V.
 - 138 Soussjåkkka, I. Laksefj. V.
 - 139 Adamselva, I. Laksefj. Ø.
 - 140 Tanavassdr., Tanafj. S.
 - 141 Vesterelva, Syltefj.
 - 142 V. Jakobselv, Y. Varangerfj.
 - 143 Neiden Munkfj./Varangerfj.
 - 144 Passvikelva, Bøkfj./Varangerfj.
 - 145 Grense Jakobselv, Varangerfj.

Source: NIVA

Appendix II. Sewage effluents from downstream areas of main and tributary rivers and rivers not monitored 2001

Table II	Sewage effluents from down stream areas of mainland Norway to convention waters 2001
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 2001**

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	83	178	254	20	535	tonnes
Tot-P	138	296	424	34	892	tonnes
NO3-N	21	16	15	1	53	tonnes
NH4-N	3 442	2 347	2 363	194	8 346	tonnes
Tot-N	4 396	3 129	3 150	258	10 933	tonnes
SiO₂						
As						
Pb	773	337	365	46	1 521	kg
Cd	52	27	26	3.0	108	kg
Cu	5 689	4 209	5 211	691	15 800	kg
Cr	1 615	640	663	82	3 000	kg
Ni	2 217	927	758	83	3 985	kg
Zn	13 040	6 373	8 410	1 047	28 870	kg
Hg	23	10	10	1.2	44	kg
g-HCH						

Table II.I Sewage effluents to the Skagerrak Region 2001**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	41	5.0	13	3.0	21	tonnes
Tot-P	69	8.0	21	5.0	35	tonnes
NO3-N	11	2.0	4.0	1.0	3.0	tonnes
NH4-N	1 841	325	560	223	493	tonnes
Tot-N	2 260	434	747	298	657	tonnes
SiO₂						
As						
Pb	311	29	306	29	98	kg
Cd	28	2.9	12.1	3.0	6.3	kg
Cu	2 894	326	882	323	1 264	kg
Cr	771	60	116	62	606	kg
Ni	1 208	94	347	101	467	kg
Zn	6 607	721	2 773	745	2 194	kg
Hg	12.4	1.0	5.5	1.0	2.7	kg
g-HCH						

Table II.II Sewage effluents to the remaining North Sea 2001**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	34	144	tonnes
Tot-P	57	239	tonnes
NO3-N	5	11	tonnes
NH4-N	763	1 584	tonnes
Tot-N	1 017	2 112	tonnes
SiO₂			
As			
Pb	108	229	kg
Cd	10.5	16.6	kg
Cu	958	3251	kg
Cr	219	421	kg
Ni	433	494	kg
Zn	1054	5319	kg
Hg	3.2	6.6	kg
g-HCH			

Table II.III Sewage effluents to the Norwegian Sea 2001**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	154	100	tonnes
Tot-P	257	167	tonnes
NO3-N	9	6	tonnes
NH4-N	1 390	973	tonnes
Tot-N	1 853	1 297	tonnes
SiO₂			
As			
Pb	187	178	kg
Cd	13.7	12.0	kg
Cu	2622	2589	kg
Cr	344	319	kg
Ni	409	349	kg
Zn	4345	4065	kg
Hg	5.3	4.8	kg
g-HCH			

Table II.IV Sewage effluents to the Barents Sea 2001

Total quantity of substance discharge per year:

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

10

S.P.M.

TOC

PO4-P	20	tonnes
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Tot-P	34	tonnes
-------	----	--------

NO3-N	1.0	tonnes
-------	-----	--------

NH4-N	194	tonnes
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Tot-N	258	tonnes
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SiO₂

As

Pb	46	kg
----	----	----

Cd	3.0	kg
----	-----	----

Cu	691	kg
----	-----	----

Cr	82	kg
----	----	----

Ni	83	kg
----	----	----

Zn	1047	kg
----	------	----

Hg	1.2	kg
----	-----	----

g-HCH

Appendix III. Industrial effluents from downstream areas of main and tributary rivers and rivers not monitored 2001

Table III	Industrial effluents from down stream areas of mainland Norway to convention waters 2001
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 2001**

Total quantity of substance discharged per year:

	I	II	III	IV	Sum	
	The	The	The	The		
	Skagerrak	North	Norwegian	Barents		
	Region	Sea	Sea	Sea		
SS	3 321	66 791	400 223	232 156	702 491	tonnes
TOC	21	148	80	-	249	tonnes
PO4-P	-	-	-	-	-	
Tot-P	90	83	84	0.6	258	tonnes
NO₃-N	-	-	-	-	-	
NH₄-N	-	-	-	-	-	
Tot-N	1 243	1 479	1 010	2	3 734	tonnes
SiO₂	-	-	-	-	-	
As	218	160	554	-	931	kg
Pb	105	5 162	3 308	-	8 575	kg
Cd	14	315	43	-	372	kg
Cu	7 140	893	2 337	-	10 370	kg
Cr-tot	1 153	627	248	-	2 028	kg
Ni	2 090	15 471	1 523	-	19 084	kg
Zn	1 463	28 759	3 951	-	34 173	kg
Hg	4.1	4.6	0.36	-	9.0	kg

Table III.I Industrial Effluents to the Skagerrak Region 2001

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	1109	156	1463	417	175	tonnes
TOC	0	0	11.2	10.0	0	tonnes
PO₄-P						
Tot-P	26	23.1	22	17	2.1	tonnes
NO₃-N						
NH₄-N						
Tot-N	237	148	107	749	3.0	tonnes
SiO₂						
As	0	0.15	0	50.4	167	kg
Pb	42	0.11	31	0.06	32	kg
Cd	2.07	0	10.4	1.5	0.40	kg
Cu	6249	0.26	1.43	44.1	845	kg
Cr-tot	467	0.14	2.9	501	181	kg
Ni	313	0.67	526	410	840	kg
Zn	783	0.6	505	4.3	170	kg
Hg	3.5	0	0.15	0.41	0.010	kg

Table III.II Industrial Effluents to The remaining North Sea 2001

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

Total quantity of substance discharged per year:

	6	7	
SS	1353	65438	tonnes
TOC	36	112	tonnes
PO₄-P			
Tot-P	4.9	79	tonnes
NO₃-N			
NH₄-N			
Tot-N	49	1430	tonnes
SiO₂			
As	1.9	158	kg
Pb	0.4	5162	kg
Cd	2.1	313	kg
Cu	111	783	kg
Cr-tot	30	597	kg
Ni	11774	3698	kg
Zn	782	27976	kg
Hg	0.052	4.52	kg

Table III.III Industrial Effluents to The Norwegian Sea 2001**The Norwegian Sea Region with sub-areas: (8) Orkla, (9) Vefsna****Total quantity of substance discharged per year:**

	8	9	
SS	389993	10230	tonnes
TOC	80	0.45	tonnes
PO₄-P			
Tot-P	49	35	tonnes
NO₃-N			
NH₄-N			
Tot-N	424	586	tonnes
SiO₂			
As	0.252	554	kg
Pb	6.0	3302	kg
Cd	0.82	42	kg
Cu	53	2283	kg
Cr-tot	4.7	243	kg
Ni	13	1510	kg
Zn	98	3852	kg
Hg	0.068	0.296	kg

Table III.IV Industrial Effluents to The Barents Sea 2001

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

Total quantity of substance discharged per year:

10

SS 232156 tonnes

TOC

PO4-P

Tot-P 0,6 tonnes

NO3-N

NH4-N

Tot-N 2 tonnes

SiO2

As

Pb

Cd

Cu

Cr-tot

Ni

Zn

Hg

Appendix IV. Main riverine inputs 2001

Table IV.I	Main riverine inputs 2001.	(1) Glomma
Table IV.II	Main riverine inputs 2001.	(2) Drammenselva
Table IV.III	Main riverine inputs 2001.	(3) Numedalslågen
Table IV.IV	Main riverine inputs 2001.	(4) Skienselva
Table IV.V	Main riverine inputs 2001.	(5) Otra
Table IV.VI	Main riverine inputs 2001.	(6) Orreelva
Table IV.VII	Main riverine inputs 2001.	(7) Suldalslågen
Table IV.VIII	Main riverine inputs 2001.	(8) Orkla
Table IV.IX	Main riverine inputs 2001.	(9) Vefsna
Table IV.X	Main riverine inputs 2001.	(10) Alta

Table IV.I Main riverine inputs 2001 (1) Glomma

Total volume: 66 754 286 m³/d **Long term average flow (LTA):** 61 350 000 m³/d
Minimum flow: 26 547 985 m³/d **LTA period:** 1961 to 1990
Maximum flow: 146 013 917 m³/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.		8.02	19	1.2	60.5 mg/l	189166	tonnes	yes
TOC		4.35	19	3.1	6.3 mg/l	109157	tonnes	yes
Orthoph.	*	4.26	19	1	25 µg/l	127	tonnes	yes
	**	4.37	–	–	– µg/l	129	tonnes	–
Total P	*	32	19	<2	93 µg/l	786	tonnes	yes
	**	32	–	–	– µg/l	788	tonnes	–
Nitrates		298	19	180	524 µg/l	7045	tonnes	yes
Ammonia		28	19	10	76 µg/l	613	tonnes	yes
Total N		526	19	347	1127 µg/l	12240	tonnes	yes
Silicate SiO₂		3.96	19	1.99	6.00 mg/l	92301	tonnes	yes
Arsenic	*	0.13	19	<0.02	0.3 µg/l	3.3	tonnes	yes
	**	0.15	–	–	– µg/l	3.6	tonnes	–
Lead	*	0.23	19	<0.01	1.6 µg/l	5.5	tonnes	yes
	**	0.24	–	–	– µg/l	5.5	tonnes	–
Cadmium	*	0.007	19	0.005	0.026 µg/l	0.14	tonnes	no
	**	0.012	–	–	– µg/l	0.28	tonnes	–
Copper		1.46	19	0.86	2.6 µg/l	35	tonnes	yes
Total Cr-T	*	0.22	19	<0.02	0.85 µg/l	4.8	tonnes	no
	**	0.28	–	–	– µg/l	6.5	tonnes	–
Nickel		0.65	19	0.32	1.54 µg/l	15	tonnes	yes
Zinc	*	3.30	19	<0.10	8 µg/l	76	tonnes	yes
	**	3.31	–	–	– µg/l	76	tonnes	–
Mercury	*	5.4	19	2	47 ng/l	151	kg	no
	**	8.4	–	–	– ng/l	214	kg	–
Lindane		0.52	4	0.49	0.57 ng/l	12	kg	yes

Measurements below detection limits are treated in two ways

* Detection limit = zero, ** Detection limit = limit

Table IV.II Main riverine inputs 2001 (2) Drammenselva

Total volume: 32 820 798 m³/d **Long term average flow (LTA):** 28 850 000 m³/d
Minimum flow: 10 102 004 m³/d **LTA period:** 1961 to 1990
Maximum flow: 83 111 946 m³/d

		Mean	Number of meas- urements	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.	*	2.63	19	<0.6	10.7 mg/l	26988 tonnes	yes
	**	2.66	–	–	– mg/l	27431 tonnes	–
TOC		3.60	19	2.5	4.6 mg/l	39935 tonnes	yes
Orthoph.	*	2.79	19	1	8 µg/l	32 tonnes	yes
	**	2.84	–	–	– µg/l	32 tonnes	–
Total P		13	19	6	42 µg/l	155 tonnes	yes
Nitrates		227	19	143	369 µg/l	2526 tonnes	yes
Ammonia		26	19	12	45 µg/l	311 tonnes	yes
Total N		399	19	283	604 µg/l	4354 tonnes	yes
SiO₂		3.12	19	1.44	4.93 mg/l	33796 tonnes	yes
Arsenic	*	0.16	18	<0.02	0.51 µg/l	1.6 tonnes	yes
	**	0.16	–	–	– µg/l	1.7 tonnes	–
Lead	*	0.07	19	0.01	0.36 µg/l	0.8 tonnes	yes
	**	0.07	–	–	– µg/l	0.8 tonnes	–
Cadmium	*	0.013	19	0.007	0.08 µg/l	0.14 tonnes	yes
	**	0.015	–	–	– µg/l	0.16 tonnes	–
Copper		0.95	19	0.329	2.49 µg/l	11 tonnes	yes
Total Cr-T	*	0.25	19	<0.02	1.3 µg/l	2.5 tonnes	no
	**	0.30	–	–	– µg/l	3.3 tonnes	–
Nickel	*	0.50	19	<0.03	1.37 µg/l	5.4 tonnes	yes
	**	0.50	–	–	– µg/l	5.5 tonnes	–
Zinc		3.16	19	0.6	8.4 µg/l	36 tonnes	yes
Mercury	*	0.9	19	<2	7 ng/l	16 kg	no
	**	4.6	–	–	– ng/l	49 kg	–
Lindane		0.44	4	0.28	0.7 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 2001 (3) Numedalslågen

Total volume: 12 270 961 m³/d **Long term average flow (LTA):** 10 200 000 m³/d
Minimum flow: 4 664 246 m³/d **LTA period:** 1961 to 1990
Maximum flow: 39 301 934 m³/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.		6.74	12	1.1	45.4 mg/l	39569 tonnes	yes
TOC		4.08	12	2	8.1 mg/l	20310 tonnes	yes
Orthoph.	*	7.83	12	1	60 µg/l	26.7 tonnes	yes
	**	7.92	–	–	– µg/l	27.0 tonnes	–
Total P		31	12	3	136 µg/l	135 tonnes	yes
Nitrates		200	12	79	539 µg/l	955 tonnes	yes
Ammonia		31	12	6	51 µg/l	130 tonnes	yes
Total N		371	12	226	876 µg/l	1766 tonnes	yes
SiO₂		3.66	12	1.54	7.50 mg/l	17553 tonnes	yes
Arsenic	*	0.15	12	<0.02	0.39 µg/l	0.76 tonnes	yes
	**	0.15	–	–	– µg/l	0.77 tonnes	–
Lead	*	0.21	12	<0.01	1.09 µg/l	1.2 tonnes	yes
	**	0.21	–	–	– µg/l	1.2 tonnes	–
Cadmium	*	0.013	12	0.009	0.035 µg/l	0.07 tonnes	yes
	**	0.015	–	–	– µg/l	0.08 tonnes	–
Copper		0.79	12	0.38	1.99 µg/l	4 tonnes	yes
Total Cr-T	*	0.19	12	<0.02	0.95 µg/l	0.81 tonnes	no
	**	0.26	–	–	– µg/l	1.13 tonnes	–
Nickel	*	0.41	12	<0.03	1.02 µg/l	2.07 tonnes	yes
	**	0.42	–	–	– µg/l	2 tonnes	–
Zinc		3.88	12	1.8	10.2 µg/l	20 tonnes	yes
Mercury	*	2.0	12	<2	9 ng/l	10 kg	no
	**	4.8	–	–	– ng/l	23 kg	–
Lindane		0.36	4	0.17	0.79 ng/l	1.6 kg	yes

Measurements below detection limits are treated in two ways

* Detection limit = zero, ** Detection limit = limit

Table IV.IV Main riverine inputs 2001 (4) Skienselva

Total volum: 28 174 951 m³/d **Long term average flow (LTA):** 23 535 000 m³/d
Minimum flow: 11 528 313 m³/d **LTA period:** 1961 to 1990
Maximum flow: 65 929 725 m³/d

		Mean	Number of meas- urements	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.	*	1.27	12	0.6	4 mg/l	13667 tonnes	yes
	**	1.33	–	–	– mg/l	14162 tonnes	–
TOC		2.66	12	2.4	3.1 mg/l	27450 tonnes	yes
Orthoph.	*	4.42	12	<1	33 µg/l	43 tonnes	yes
	**	4.73	–	–	– µg/l	44 tonnes	–
Total P		36	12	4	246 µg/l	320 tonnes	yes
Nitrates		172	12	116	213 µg/l	1811 tonnes	yes
Ammonia		15	12	5	26 µg/l	145 tonnes	yes
Total N		274	12	222	391 µg/l	2884 tonnes	yes
SiO₂		2.26	12	1.03	3.00 mg/l	24341 tonnes	yes
Arsenic	*	0.09	12	<0.02	0.21 µg/l	0.96 tonnes	yes
	**	0.11	–	–	– µg/l	0.99 tonnes	–
Lead	*	0.042	12	0.009	0.12 µg/l	0.44 tonnes	yes
	**	0.052	–	–	– µg/l	0.47 tonnes	–
Cadmium	*	0.015	12	0.01	0.02 µg/l	0.15 tonnes	yes
	**	0.016	–	–	– µg/l	0.16 tonnes	–
Copper		0.56	12	0.24	1.15 µg/l	5.79 tonnes	yes
Total Cr-T	*	0.16	12	<0.02	0.59 µg/l	0.69 tonnes	yes
	**	0.28	–	–	– µg/l	1.43 tonnes	–
Nickel	*	0.25	12	<0.03	0.38 µg/l	2.60 tonnes	yes
	**	0.27	–	–	– µg/l	2.63 tonnes	–
Zinc	*	2.62	12	<0.1	5 µg/l	27.5 tonnes	yes
	**	2.85	–	–	– µg/l	27.6 tonnes	–
Mercury	*	14.2	12	<2	86 ng/l	147 kg	no
	**	28.8	–	–	– ng/l	171 kg	–
Lindane		0.51	4	0.35	0.70 ng/l	4.93 kg	yes

Measurements below detection limits are treated in two ways

* Detection limit = zero, ** Detection limit = limit

Table IV.V Main riverine inputs 2001 (5) Otra

Total volume: 13 395 521 m³/d **Long term average flow (LTA):** 12 870 000 m³/d
Minimum flow: 4 630 244 m³/d **LTA period:** 1961 to 1990
Maximum flow: 54 632 484 m³/d

		Mean	Number of meas- urements	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.	*	0.60	13	<0.1	0.9 mg/l	2776 tonnes	yes
	**	0.70	–	–	– mg/l	3380 tonnes	–
TOC		2.63	13	1.5	4.6 mg/l	13087 tonnes	yes
Orthoph.	*	1.38	13	1	3 µg/l	7 tonnes	yes
	**	1.62	–	–	– µg/l	8 tonnes	–
Total P	*	12	13	<1	48 µg/l	47 tonnes	yes
	**	12	–	–	– µg/l	48 tonnes	–
Nitrates		130	13	86	243 µg/l	687 tonnes	yes
Ammonia	*	17	13	<1	47 µg/l	99 tonnes	yes
	**	17	–	–	– µg/l	99 tonnes	–
Total N		221	13	105	325 µg/l	1119 tonnes	yes
SiO₂		1.55	13	0.56	2.36 mg/l	8328 tonnes	yes
Arsenic	*	0.10	13	<0.02	0.20 µg/l	0.4 tonnes	yes
	**	0.11	–	–	– µg/l	0.6 tonnes	–
Lead		0.30	13	0.03	1.80 µg/l	1.2 tonnes	yes
Cadmium	*	0.017	13	0.009	0.029 µg/l	0.09 tonnes	yes
	**	0.019	–	–	– µg/l	0.10 tonnes	–
Copper		0.35	13	0.197	0.55 µg/l	2 tonnes	yes
Total Cr-T	*	0.05	13	<0.02	0.25 µg/l	0.3 tonnes	no
	**	0.15	–	–	– µg/l	0.7 tonnes	–
Nickel	*	0.49	13	<0.03	0.86 µg/l	2.4 tonnes	yes
	**	0.49	–	–	– µg/l	2.4 tonnes	–
Zinc		3.28	13	0.7	7.60 µg/l	18 tonnes	yes
Mercury	*	2.8	13	<2	12 ng/l	10 kg	no
	**	5.5	–	–	– ng/l	25 kg	–
Lindane		0.64	4	0.32	0.94 ng/l	3 kg	yes

Measurements below detection limits are treated in two ways

* Detection limit = zero, ** Detection limit = limit

Table IV.VI Main riverine inputs 2001 (6) Orreelva

Total volume:	283 262 m³/d	Long term average flow (LTA):	335 000 m³/d
Minimum flow:	13 440 m³/d	LTA period:	1961 to 1990
Maximum flow:	962 640 m³/d		

		Mean	Number of meas- urements	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.		5.22	12	2.2	11.7 mg/l	698 tonnes	yes
TOC		6.50	12	5.7	8.30 mg/l	686 tonnes	yes
Orthoph.	*	5.25	12	1	15 µg/l	0.7 tonnes	yes
	**	5.42	–	–	– µg/l	1 tonnes	–
Total P		53	12	35	93 µg/l	6 tonnes	yes
Nitrates		763	12	4	1556 µg/l	99 tonnes	yes
Ammonia		32	12	2	124 µg/l	3 tonnes	yes
Total N		1314	12	508	2175 µg/l	155 tonnes	yes
SiO₂	*	1.94	12	<0.09	6.00 mg/l	184 tonnes	yes
	**	2.04	–	–	– mg/l	214 tonnes	–
Arsenic		0.25	12	0.17	0.36 µg/l	0.026 tonnes	yes
Lead	*	0.08	12	0.01	0.46 µg/l	0.018 tonnes	no
	**	0.09	–	–	– µg/l	0.019 tonnes	–
Cadmium	*	0.004	12	0.005	0.02 µg/l	0.0005 tonnes	no
	**	0.010	–	–	– µg/l	0.0011 tonnes	–
Copper		1.14	12	0.55	1.49 µg/l	0.12 tonnes	yes
Total Cr-T	*	0.29	12	<0.02	1.27 µg/l	0.02 tonnes	no
	**	0.40	–	–	– µg/l	0.03 tonnes	–
Nickel		1.04	12	0.28	1.75 µg/l	0.12 tonnes	yes
Zinc	*	1.44	12	0.09	3.20 µg/l	0.20 tonnes	yes
	**	1.54	–	–	– µg/l	0.20 tonnes	–
Mercury	*	1.5	12	2	6 ng/l	0.1 kg	no
	**	3.9	–	–	– ng/l	0.3 kg	–
Lindane		0.35	4	0.26	0.47 ng/l	0.040 kg	yes

Measurements below detection limits are treated in two ways

* Detection limit = zero, ** Detection limit = limit

Table IV.VII Main riverine inputs 2001 (7) Suldalslågen

Total volume: 3 775 674 m³/d **Long term average flow (LTA):** 7 420 000 m³/d
Minimum flow: 1 175 040 m³/d **LTA period:** 1961 to 1990
Maximum flow: 23 412 672 m³/d

		Mean	Number of meas- urements	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.	*	0.22	12	<0.06	1.4 mg/l	512 tonnes	no
	**	0.62	–	–	– mg/l	976 tonnes	–
TOC		1.25	12	0.5	2.5 mg/l	1891 tonnes	yes
Orthoph.	*	2.08	12	1	6 µg/l	3.0 tonnes	yes
	**	2.25	–	–	– µg/l	3.1 tonnes	–
Total P		13	12	1	36 µg/l	18.6 tonnes	yes
Nitrates		186	12	126	275 µg/l	222 tonnes	yes
Ammonia	*	6	12	2	19 µg/l	8.5 tonnes	yes
	**	6	–	–	– µg/l	8.8 tonnes	–
Total N		232	12	157	304 µg/l	286 tonnes	yes
SiO₂		1.04	12	0.34	1.37 mg/l	1259 tonnes	yes
Arsenic	*	0.04	12	<0.02	0.20 µg/l	0.061 tonnes	no
	**	0.06	–	–	– µg/l	0.081 tonnes	–
Lead	*	0.03	12	<0.01	0.14 µg/l	0.047 tonnes	no
	**	0.04	–	–	– µg/l	0.063 tonnes	–
Cadmium	*	0.004	12	0.005	0.02 µg/l	0.005 tonnes	no
	**	0.011	–	–	– µg/l	0.014 tonnes	–
Copper	*	0.17	12	0.02	0.39 µg/l	0.26 tonnes	yes
	**	0.19	–	–	– µg/l	0.27 tonnes	–
Total Cr-T	*	0.04	12	<0.02	0.20 µg/l	0.05 tonnes	no
	**	0.14	–	–	– µg/l	0.20 tonnes	–
Nickel	*	0.15	12	<0.03	0.30 µg/l	0.21 tonnes	yes
	**	0.18	–	–	– µg/l	0.26 tonnes	–
Zinc	*	1.59	12	<0.1	2.70 µg/l	2.1 tonnes	yes
	**	1.60	–	–	– µg/l	2.2 tonnes	–
Mercury	*	1.2	12	2	6 ng/l	2 kg	no
	**	4.0	–	–	– ng/l	5 kg	–
Lindane		0.38	4	0.27	0.47 ng/l	0.5 kg	yes

Measurements below detection limits are treated in two ways

* Detection limit = zero, ** Detection limit = limit

Table IV.VIII Main riverine inputs 2001 (8) Orkla

Total volume: 4 248 055 m³/d **Long term average flow (LTA):** 5 710 000 m³/d
Minimum flow: 1 470 826 m³/d **LTA period:** 1961 to 1990
Maximum flow: 33 039 850 m³/d

		Mean	Number of meas- urements	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.	*	1.10	12	0.6	3.7 mg/l	2062 tonnes	yes
	**	1.15	–	–	– mg/l	2113 tonnes	–
TOC		3.58	12	1.5	6.9 mg/l	5939 tonnes	yes
Orthoph.	*	2.25	12	1	6 µg/l	3.9 tonnes	yes
	**	2.50	–	–	– µg/l	4.2 tonnes	–
Total P		25.8	12	3	129 µg/l	37 tonnes	yes
Nitrates		224	12	99	384 µg/l	339 tonnes	yes
Ammonia		10	12	1	23 µg/l	16 tonnes	yes
Total N		344	12	235	525 µg/l	541 tonnes	yes
SiO₂		3.10	12	2.10	4.07 mg/l	4842 tonnes	yes
Arsenic		0.12	12	0.07	0.18 µg/l	0.19 tonnes	yes
Lead	*	0.04	12	<0.01	0.27 µg/l	0.05 tonnes	no
	**	0.05	–	–	– µg/l	0.06 tonnes	–
Cadmium		0.062	12	0.013	0.28 µg/l	0.09 tonnes	yes
Copper		5.72	12	2.15	8 µg/l	9 tonnes	yes
Total Cr-T	*	0.25	12	<0.02	0.63 µg/l	0.38 tonnes	yes
	**	0.27	–	–	– µg/l	0.40 tonnes	–
Nickel		0.81	12	0.42	1.50 µg/l	1.4 tonnes	yes
Zinc		16.68	12	5.3	24.5 µg/l	26 tonnes	yes
Mercury	*	2.5	12	2	24 ng/l	2 kg	no
	**	5.5	–	–	– ng/l	7 kg	–
Lindane		0.19	4	0.1	0.24 ng/l	0.29 kg	yes

Measurements below detection limits are treated in two ways

* Detection limit = zero, ** Detection limit = limit

Table IV.IX Main riverine inputs 2001 (9) Vefsna

Total volume: 13 454 339 m³/d **Long term average flow (LTA):** 15 655 000 m³/d
Minimum flow: 2 215 645 m³/d **LTA period:** 1961 to 1990
Maximum flow: 104 137 251 m³/d

		Mean	Number of meas- urements	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.	*	1.78	11	0.6	3.9 mg/l	10597 tonnes	yes
	**	1.89	–	–	– mg/l	10860 tonnes	–
TOC		1.93	11	0.7	3.4 mg/l	10452 tonnes	yes
Orthoph.	*	3.18	11	<1	16 µg/l	13 tonnes	yes
	**	3.27	–	–	– µg/l	13 tonnes	–
Total P		8	11	3	28 µg/l	42 tonnes	yes
Nitrates		91	11	16	205 µg/l	268 tonnes	yes
Ammonia	*	6	11	1	26 µg/l	17 tonnes	yes
	**	7	–	–	– µg/l	21 tonnes	–
Total N		188	11	79	282 µg/l	883 tonnes	yes
SiO₂		1.69	11	0.84	2.36 mg/l	6473 tonnes	yes
Arsenic	*	0.12	11	<0.02	0.21 µg/l	0.62 tonnes	yes
	**	0.13	–	–	– µg/l	0.62 tonnes	–
Lead	*	0.05	11	<0.01	0.18 µg/l	0.18 tonnes	yes
	**	0.05	–	–	– µg/l	0.19 tonnes	–
Cadmium	*	0.005	11	0.003	0.043 µg/l	0.017 tonnes	yes
	**	0.012	–	–	– µg/l	0.055 tonnes	–
Copper		0.43	11	0.24	0.62 µg/l	1.95 tonnes	yes
Total Cr-T	*	0.42	11	<0.02	3.19 µg/l	0.96 tonnes	yes
	**	0.49	–	–	– µg/l	1.47 tonnes	–
Nickel	*	0.26	11	<0.03	0.58 µg/l	1.28 tonnes	yes
	**	0.27	–	–	– µg/l	1.30 tonnes	–
Zinc	*	4.54	11	<0.1	37 µg/l	37.3 tonnes	yes
	**	4.55	–	–	– µg/l	37.4 tonnes	–
Mercury	*	3.0	11	<2	9 ng/l	20 kg	no
	**	5.0	–	–	– ng/l	27 kg	–
Lindane		0.12	4	0.02	0.18 ng/l	0.49 kg	yes

Measurements below detection limits are treated in two ways

* Detection limit = zero, ** Detection limit = limit

Table IV.X Main riverine inputs 2001 (10) Alta

Total volume: 7 173 334 m³/d **Long term average flow (LTA):** 7 495 000 m³/d
Minimum flow: 2 209 770 m³/d **LTA period:** 1961 to 1990
Maximum flow: 36 946 605 m³/d

		Mean	Number of meas- urements	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.	*	1.20	12	<0.06	9.5 mg/l	2903 tonnes	no
	**	1.41	–	–	– mg/l	3279 tonnes	–
TOC		3.65	12	2.2	9.4 mg/l	9942 tonnes	yes
Orthoph.		13.67	12	2	43 µg/l	30 tonnes	yes
Total P		24	12	7	85 µg/l	53 tonnes	yes
Nitrates		80	12	36	105 µg/l	193 tonnes	yes
Ammonia	*	13	12	<1	84 µg/l	23 tonnes	yes
	**	13	–	–	– µg/l	23 tonnes	–
Total N		221	12	156	584 µg/l	579 tonnes	yes
SiO₂		5.57	12	3.64	7.93 mg/l	12889 tonnes	yes
Arsenic		0.27	12	0.085	0.95 µg/l	0.63 tonnes	yes
Lead	*	0.03	12	<0.01	0.2 µg/l	0.05 tonnes	no
	**	0.04	–	–	– µg/l	0.07 tonnes	–
Cadmium	*	0.020	12	0.002	0.17 µg/l	0.03 tonnes	no
	**	0.024	–	–	– µg/l	0.04 tonnes	–
Copper	*	0.49	12	0.39	1.06 µg/l	1.28 tonnes	yes
	**	0.54	–	–	– µg/l	1.41 tonnes	–
Total Cr-T	*	0.39	12	0.2	0.86 µg/l	1.2 tonnes	yes
	**	0.43	–	–	– µg/l	1.3 tonnes	–
Nickel	*	0.34	12	<0.05	0.82 µg/l	1.0 tonnes	yes
	**	0.34	–	–	– µg/l	1.0 tonnes	–
Zinc	*	0.83	12	<0.10	6.3 µg/l	1.4 tonnes	no
	**	1.01	–	–	– µg/l	2.0 tonnes	–
Mercury	*	3.1	12	2	21 ng/l	13 kg	no
	**	5.8	–	–	– ng/l	20 kg	–
Lindane	*	0.10	4	<0.1	0.39 ng/l	0.42 kg	no
	**	0.17	–	–	– ng/l	0.58 kg	–

Measurements below detection limits are treated in two ways

* Detection limit = zero, ** Detection limit = limit

Appendix V. Input from the tributary rivers 2001

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 2001

**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.		3348	1543	2284	2855	1101	27366	tonnes	yes
TOC		10152	3371	668	3109	5261	65057	tonnes	yes
Orthoph.	*	3.1	8.1	1.1	0.2	3.7	3.8	tonnes	yes
	**	3.1	8.1	1.1	0.8	3.7	37.9		
Total P	*	32	24	7	22	11	205	tonnes	yes
	**	32	24	7	22	11	223		
Nitrates		329	371	88	237	195	2652	tonnes	yes
Ammonia		23	35	5	210	27	460	tonnes	yes
Total N		800	581	125	491	480	5146	tonnes	yes
Silicate SiO₂	*	3765	2015	970	2371	2622	15583	tonnes	yes
	**	3765	2015	970	2371	2622	15831		
Arsenic	*	0.26	0.20	0.09	1.9	0.12	2.3	tonnes	yes
	**	0.26	0.20	0.09	1.9	0.12	3.0		
Lead	*	0.14	0.12	0.006	0.0	0.09	6.5	tonnes	yes
	**	0.14	0.12	0.006	0.007	0.09	6.5		
Cadmium	*	0.017	0.011	0.002	0.002	0.028	0.58	tonnes	yes
	**	0.017	0.011	0.002	0.008	0.028	0.65		
Copper	*	0.93	1.10	0.19	3.83	0.44	6.76	tonnes	yes
	**	0.93	1.10	0.19	3.83	0.44	7.46		
Total Cr-T	*	0.65	0.63	0.45	2.18	0.38	0.22	tonnes	yes
	**	0.65	0.63	0.45	2.18	0.38	2.00		
Nickel	*	0.8	0.5	0.1	0.6	0.3	2.3	tonnes	yes
	**	0.8	0.5	0.1	0.6	0.3	4.7		
Zinc	*	0	1.06	0	1.3	3.2	76	tonnes	yes
	**	0.12	1.10	0.02	1.3	3.2	76		
Mercury	*	16	4	0	5	0	793	kg	yes
	**	18	7	1	7	6	812		

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 2001

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.	*	6870	47300	tonnes	yes
	**	7878	50679		
TOC		17664	34015	tonnes	yes
Orthoph.	*	27.8	23.6	tonnes	no
	**	32.7	46.9		
Total P		152	427	tonnes	yes
Nitrates		2125	4183	tonnes	yes
Ammonia	*	150	313	tonnes	yes
	**	150	313		
Total N		2912	6156	tonnes	yes
Silicate SiO₂		12209	28025	tonnes	yes
Arsenic	*	0.3	1.4	tonnes	no
	**	1.7	2.3		
Lead	*	1.5	1.7	tonnes	no
	**	1.8	2.0		
Cadmium	*	0.07	0.10	tonnes	no
	**	0.17	0.29		
Copper	*	3.6	11.2	tonnes	yes
	**	3.7	11.3		
Total Cr-T	*	0.2	2.1	tonnes	no
	**	1.6	5.7		
Nickel	*	1.7	3.8	tonnes	no
	**	3.4	4.9		
Zinc	*	15	60	tonnes	yes
	**	17	64		
Mercury	*	69	103	kg	no
	**	72	177		
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 2001**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.	*	120264	32443	tonnes	yes
	**	123093	43982		
TOC		144821	53695	tonnes	yes
Orthoph.	*	19	33	tonnes	no
	**	41	56		
Total P	*	486	266	tonnes	yes
	**	486	279		
Nitrates		5345	862	tonnes	yes
Ammonia		310	398	tonnes	yes
Total N		9324	4652	tonnes	yes
Silicate SiO₂		44335	35603	tonnes	yes
Arsenic	*	2.5	2.9	tonnes	no
	**	3.0	3.3		
Lead	*	0.99	0.48	tonnes	no
	**	1.20	0.81		
Cadmium	*	0.04	0	tonnes	no
	**	0.32	0.34		
Copper		32	16	tonnes	yes
Total Cr-T	*	5.1	1.2	tonnes	no
	**	8.4	6.9		
Nickel	*	16	8	tonnes	yes
	**	16	9		
Zinc	*	38	25	tonnes	yes
	**	42	30		
Mercury	*	200	54	kg	yes
	**	202	84	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 2001**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.	*	26218	tonnes	no
	**	28262		
TOC		95034	tonnes	yes
Orthoph.	*	50	tonnes	no
	**	58		
Total P	*	165	tonnes	yes
	**	166		
Nitrates	*	137	tonnes	yes
	**	139		
Ammonia		246	tonnes	yes
Total N		4427	tonnes	yes
Silicate SiO₂		76271	tonnes	yes
Arsenic	*	2.4	tonnes	no
	**	2.6		
Lead	*	0.45	tonnes	no
	**	0.77		
Cadmium	*	0.01	tonnes	no
	**	0.25		
Copper		22	tonnes	yes
Total Cr-T	*	8.0	tonnes	no
	**	9.4		
Nickel	*	57	tonnes	yes
	**	57		
Zinc	*	81	tonnes	yes
	**	82		
Mercury	*	108	kg	yes
	**	111		
Lindane				

Measurements below detection limits are treated in two ways:

* Detection limit = zero, ** Detection limit = limit

Appendix VI. Other inputs 2001

Table VI Nutrients from “Down Stream Areas of main and tributary rivers and rivers not monitored 2001. Direct runoff P and N

Table VI **Nutrients from “Down Stream Areas” of main and tributary rivers and rivers not monitored 2001. Direct runoff of P and N.**

Sub-areas:		Background tonnes	Agriculture Area tonnes	Sum tonnes	
1 Glomma	P	18,4	15,6	34,0	
	N	463.1	504.5	967.6	
	PO ₄ -P	3.7	4.7	8.4	
	NO ₃ -N	277.8	353.2	631.0	
	NH ₄ -N	23.2	35.3	58.5	
1 Inner Oslofjord	P	3.4	3.4	6.8	
	N	72.8	108.4	181.2	
	PO ₄ -P	0.7	1.0	1.7	
	NO ₃ -N	43.7	75.9	119.6	
	NH ₄ -N	3.6	7.6	11.2	
2 Drammenselva	P	1.4	2.5	3.9	
	N	64.0	95.3	159.2	
	PO ₄ -P	0.3	0.7	1.0	
	NO ₃ -N	38.4	66.7	105.1	
	NH ₄ -N	3.2	6.7	9.9	
3 Numedalslågen	P	4.9	18.1	22.9	
	N	184.7	578.0	762.8	
	PO ₄ -P	1.0	5.4	6.4	
	NO ₃ -N	110.8	404.6	515.5	
	NH ₄ -N	9.2	40.5	49.7	
4 Skienselva	P	6.8	2.7	9.5	
	N	331.3	102.4	433.7	
	PO ₄ -P	1.4	0.8	2.2	
	NO ₃ -N	198.8	71.7	270.5	
	NH ₄ -N	16.6	7.2	23.7	
5 Otra	P	7.0	3.9	11.0	
	N	391.8	129.6	521.4	
	PO ₄ -P	1.4	1.2	2.6	
	NO ₃ -N	235.1	90.7	325.8	
	NH ₄ -N	19.6	9.1	28.7	
6 Orreelva	P	22.8	47.5	70.4	
	N	1463.8	1394.7	2858.6	
	PO ₄ -P	4.6	14.3	18.8	
	NO ₃ -N	878.3	976.3	1854.6	
	NH ₄ -N	73.2	97.6	170.8	
7 Suldalslågen	P	58.0	69.1	127.2	
	N	5151.3	1359.0	6510.3	
	PO ₄ -P	11.6	20.7	32.3	
	NO ₃ -N	3090.8	951.3	4042.0	
	NH ₄ -N	257.6	95.1	352.7	
8 Orkla	P	142.1	153.4	295.5	
	N	3850.8	3626.9	7477.6	
	PO ₄ -P	28.4	46.0	74.4	
	NO ₃ -N	2310.5	2538.8	4849.3	
	NH ₄ -N	192.5	253.9	446.4	
9 Vefsna	P	83.6	39.4	123.0	
	N	1920.5	929.0	2849.5	
	PO ₄ -P	16.7	11.8	28.5	
	NO ₃ -N	1152.3	650.3	1802.6	
	NH ₄ -N	96.0	65.0	161.1	
10 Altaelva	P	86.1	2.1	88.2	
	N	1618.3	62.4	1680.7	
	PO ₄ -P	17.2	0.6	17.9	
	NO ₃ -N	971.0	43.7	1014.7	
	NH ₄ -N	80.9	4.4	85.3	
SUM	P		792	tonnes	
SUM	N		24403	tonnes	
SUM	PO₄-P		194	tonnes	
SUM	NO₃-N		15531	tonnes	
SUM	NH₄-N		1398	tonnes	

Appendix VII. Main rivers 1-10. Measured concentrations 2001

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.I Measured concentration 2001 – Watercourse: Glomma

Annual flow: 24365 10⁶ m³ **Min:** 307 m³/s
Drainage area: 41218 km² **Max:** 1690 m³/s

Date 2001	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
2000-12-28	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	0.57
2001-02-15	538	4.70	2.2	4.4	3	10	384	54	555	4.71	0.13	0.26	0.005	1.50	0.05	0.57	2.50	<5	
2001-03-06	384	4.70	2.0	3.5	<1	<2	350	39	1127	4.71	0.07	0.05	0.005	1.18	<0.02	0.50	3.00	<5	
2001-04-01	333	4.90	7.7	3.3	3	20	385	57	618	4.50	<0.2	0.10	0.020	1.30	<0.2	0.70	5.00	9	
2001-04-29	841	71.0*	60.5	5.5	6	45	524	76	803	5.57	0.30	0.62	0.026	2.60	0.85	1.54	6.15	<5	
2001-05-13	1280	3.43	9.1	5.8	2	21	225	17	521	4.71	<0.2	0.30	0.020	2.00	<0.2	0.90	8.00	<5	
2001-05-20	1555	3.28	7.0	5.3	3	36	217	22	402	4.50	0.16	0.09	0.010	2.47	0.31	0.70	3.88	<5	
2001-05-28	1259	3.34	5.4	4.3	5	24	229	16	457	4.07	<0.02	0.05	0.006	1.51	0.41	0.67	3.99	<5	
2001-06-04	1252	3.80	3.1	3.9	<1	44	228	10	443	3.64	0.14	0.23	0.016	1.57	0.47	0.81	2.40	<5	
2001-06-12	956	3.90	4.1	3.5	2	93	375	23	559	3.43	0.17	0.21	0.007	1.63	0.44	0.69	2.20	<5	
2001-06-17	794	3.80	3.6	3.4	4	14	235	23	398	3.64	0.23	0.04	0.005	0.99	<0.02	0.42	2.50	<5	0.49
2001-06-24	1101	3.94	3.4	3.1	6	21	206	13	422	3.43	0.11	<0.01	<0.01	0.86	0.36	0.32	<0.1	8	
2001-07-01	1178	3.82	2.9	3.5	3	23	209	23	361	3.21	0.12	0.20	<0.01	1.23	0.45	0.45	2.10	<5	
2001-07-24	973	3.99	3.3	3.5	1	48	205	12	347	1.99	0.11	1.60	<0.01	1.30	0.31	0.50	4.00	11	0.51
2001-08-26	854	4.08	2.8	4.1	3	22	180	15	366	2.14	0.13	0.08	<0.01	1.40	<0.2	0.50	0.95	2	
2001-09-24	768	4.70	4.4	5.5	3	38	261	17	501	3.00	0.14	0.04	<0.01	1.40	<0.2	0.52	3.30	47	0.52
2001-10-29	819	4.94	19.6	6.3	25	73	485	31	696	4.29	0.18	0.09	0.015	1.60	0.19	0.80	3.30	6	
2001-11-25	461	4.38	4.0	4.4	4	14	305	20	409	3.86	0.17	0.20	<0.01	1.40	<0.2	0.61	2.80	<2	
2002-01-06	388	4.80	1.2	3.2	2	37	369	36	483	3.86	0.14	0.21	<0.01	0.93	<0.2	0.60	2.80	19	
Min.:	333	3.28	1.20	3.1	< 1	<2	180	10	347	1.99	<0.02	<0.01	0.005	0.86	<0.02	0.32	<0.10	<2	0.49
Max.:	1555	7.10	60.5	6.3	25	93	524	76	1127	6.00	0.30	1.60	0.026	2.60	0.85	1.54	8.00	47	0.57
Aver.:	866	4.29	8.0	4.4	4.4	32	298	28	526	3.96	0.15	0.24	0.012	1.46	0.28	0.65	3.31	8	0.52
St.dev.:	348	0.86	13.3	1.1	5.3	22	100	18	187	1.02	0.06	0.36	0.006	0.48	0.19	0.26	1.76	10	0.03
Numb.:	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	4

* 7.1 is used for calculations.

Table VII.II Measured concentration 2001 – Watercourse: Drammenselva

Annual flow: 11980 10⁶ m³ **Min:** 117 m³/s
Drainage area: 17028 km² **Max:** 962 m³/s

Date 2001	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
2001-01-26	372	3.70	1.2	3.6	1	6	196	19	421	3.64	0.10	0.010	0.008	0.58	<0.02	0.37	2.57	<5	0.43
2001-02-22	308	4.20	<0.6	2.5	2	10	273	30	411	3.43	<0.02	0.030	0.015	0.95	0.24	<0.03	2.80	<5	
2001-03-27	292	3.70	0.9	2.7	3	9	268	24	390	3.21	0.13	0.010	0.009	0.90	1.17	0.56	3.03	<5	
2001-04-26	308	4.40	10.7	4.6	8	15	369	35	604	4.93	0.23	0.360	0.020	2.49	0.29	1.37	6.90	<5	
2001-05-03	356	3.70	3.9	4.1	2	8	293	28	519	3.86	0.20	0.070	0.014	1.24	0.36	0.72	3.50	<5	
2001-05-08	372	3.70	2.9	4.5	<1	7	289	13	486	3.21	0.23	0.020	0.010	0.88	0.30	0.59	3.50	<5	
2001-05-15	919	2.80	6.6	3.4	3	9	198	12	383	3.21	0.21	0.140	0.080	0.95	0.24	0.58	3.10	<5	
2001-05-21	962	3.00	3.7	3.4	1	14	220	13	372	3.21	0.51	0.080	0.007	0.96	0.22	0.40	2.70	<5	
2001-05-29	863	3.00	2.2	3.8	6	9	235	12	380	3.21	0.16	0.050	0.010	0.87	<0.02	0.42	3.42	<5	
2001-05-05	704	2.93	1.7	3.7	1	7.1	209	21	394	3.21	0.10	0.040	0.012	0.33	1.30	0.37	0.60	<5	
2001-06-12	542	3.20	1.4	3.5	1	17	208	27	395	3.43	<0.2	<0.1	<0.02	0.60	<0.2	0.50	3.00	<5	0.34
2001-06-18	345	3.20	1.9	3.3	4	9	190	36	387	3.43	0.13	0.050	0.010	0.72	<0.02	0.51	2.30	<5	
2001-06-25	489	2.58	2.4	3.3	3	13	146	18	324	3.21	<0.02	0.098	<0.01	0.71	0.22	0.30	1.80	<5	
2001-07-30	388	2.96	1.3	3.2	2	11	149	35	324	1.63	0.14	0.024	<0.01	0.78	<0.2	0.36	2.10	3	0.70
2001-08-27	202	4.61	1.3	3.9	3	42	143	38	380	1.44	0.18	0.051	0.011	1.30	<0.2	0.49	2.20	<2	
2001-09-24	404	3.30	1.9	4.1	1	9	178	25	349	2.14	0.14	0.030	0.010	0.84	<0.2	0.41	2.50	7	0.28
2001-10-29	393	3.36	0.8	3.8	2	19	228	28	283	3.00	0.13	0.100	0.013	1.10	0.086	0.51	3.00	4	
2001-11-22	292	3.40	1.3	3.3	7	18	245	37	344	2.79	0.13	0.044	0.011	1.10	<0.2	0.37	8.40	<2	
2001-12-17	260	3.70	3.8	3.7	3	13	276	45	437	3.00	0.14	0.068	0.010	0.76	0.23	0.58	2.60	4	
Min.:	202	2.58	<0.6	2.5	<1	6	143	12	283	1.44	<0.02	0.010	0.007	0.33	<0.02	<0.03	0.60	<2	0.28
Max.:	962	4.61	10.7	4.6	8	42	369	45	604	4.93	0.51	0.360	0.080	2.49	1.30	1.37	8.40	7	0.70
Aver.:	462	3.44	2.7	3.6	2.8	13	227	26	399	3.12	0.16	0.072	0.015	0.95	0.30	0.50	3.16	5	0.44
St.dev.:	230	0.55	2.4	0.5	2.1	8	58	10	74	0.77	0.10	0.078	0.016	0.44	0.34	0.26	1.74	1	0.19
Numb.:	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	4

Direct and riverine inputs to Norwegian coastal waters – 2001 OSPAR Commission

Table VII.III Measured concentration 2001 – Watercourse: Numedalslågen

Annual flow: 4479 10⁶ m³ Min: 54 m³/s
 Drainage area: 5513 km² Max: 455 m³/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)
2001	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
2001-01-26	119	2.80	5.1	2.7	2	12	266	38	347	4.07	0.09	0.060	0.011	0.41	<0.02	0.30	3.60	<5	0.28
2001-02-22	83	2.60	2.6	2.0	1	10	198	46	358	3.86	<0.02	0.090	0.012	0.55	0.04	<0.03	3.40	<5	
2001-03-27	81	3.30	2.6	2.2	4	8	231	40	380	4.07	0.09	<0.01	0.009	0.44	0.95	0.35	2.60	<5	
2001-04-26	194	3.60	45.4	5.3	8	71	539	51	876	7.50	0.39	1.090	0.035	1.99	0.69	1.02	10.20	<5	
2001-05-29	226	1.80	5.3	4.4	2	12	86	6	242	3.21	0.14	0.260	0.015	0.85	<0.02	0.35	3.63	<5	0.79
2001-06-24	116	1.86	2.4	3.0	<1	10	79	15	226	3.00	<0.02	0.060	<0.01	0.38	0.13	0.38	1.80	<5	
2001-07-29	76	2.48	1.4	4.0	60	136	111	17	259	1.65	0.18	0.077	0.012	0.80	<0.2	0.29	2.10	4	
2001-08-26	71	2.44	1.6	4.6	4	22	104	41	332	1.54	0.16	0.077	<0.01	0.73	0.22	0.38	1.90	<2	
2001-09-23	211	2.60	4.5	8.1	2	32	135	7	343	2.79	0.21	0.100	0.020	0.85	<0.2	0.39	4.20	4	0.17
2001-10-28	165	3.16	7.1	6.2	4	24	309	30	504	5.36	0.24	0.330	0.020	1.20	0.25	0.72	6.00	9	
2001-11-22	101	2.42	1.1	2.8	3	3	133	39	239	3.21	0.13	0.130	<0.01	0.57	<0.2	0.29	2.90	<2	
2001-12-17	143	3.50	1.8	3.6	4	31	207	47	349	3.64	0.16	0.220	0.020	0.72	<0.2	0.48	4.20	7	
Min.:	71	1.80	1.10	2.0	<1	3	79	6	226	1.54	<0.02	<0.01	0.009	0.38	<0.02	<0.03	1.80	<2	0.17
Max.:	226	3.60	45.4	8.1	60	136	539	51	876	7.50	0.39	1.090	0.035	1.99	0.95	1.02	10.2	9	0.79
Aver.:	132	2.71	6.7	4.1	7.9	31	200	31	371	3.66	0.15	0.209	0.015	0.79	0.26	0.42	3.88	5	0.36
St.dev.:	55	0.58	12.3	1.8	16.5	38	130	16	177	1.60	0.10	0.293	0.007	0.44	0.28	0.25	2.32	2	0.29
Numb.:	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	4

Table VII.IV Measured concentration 2001 – Watercourse: Skienselva

Annual flow: 10284 10⁶ m³ Min: 133 m³/s
 Drainage area: 10348 km² Max: 763 m³/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)
2001	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
2001-01-26	305	2.10	1.0	2.8	2	5	209	13	281	2.79	0.080	0.009	0.012	0.24	<0.02	0.28	2.94	<5	
2001-02-22	300	2.10	<0.6	2.6	1	5	185	11	292	2.79	<0.02	<0.01	0.017	0.52	<0.02	<0.03	2.60	<5	
2001-03-27	270	2.00	0.6	2.4	3	4	199	13	272	2.57	0.090	<0.01	0.019	0.74	0.59	0.24	2.96	<5	0.53
2001-04-26	390	2.10	4.0	2.7	2	8	202	26	391	3.00	0.210	0.120	0.020	1.15	<0.02	0.37	4.62	5	
2001-05-29	538	1.90	0.9	2.6	1	6	178	5	294	2.57	0.090	0.020	0.012	0.45	<0.02	0.25	2.67	<5	
2001-06-24	341	1.80	3.7	2.4	<1	14	147	7	264	2.57	<0.02	0.030	<0.01	0.34	0.17	0.24	<0.1	42	0.45
2001-07-29	133	1.73	0.6	2.5	2	11	121	16	222	1.31	0.084	0.021	0.014	0.56	<0.2	0.16	2.20	6	
2001-08-26	224	1.71	0.7	2.7	2	11	116	15	238	1.03	0.094	0.025	0.010	0.55	<0.2	0.26	2.10	<2	0.70
2001-09-23	283	1.80	1.0	2.7	1	19	125	14	250	1.59	0.088	<0.02	0.017	0.37	<0.2	0.20	2.10	5	
2001-10-28	408	1.87	0.8	3.1	3	12	170	14	251	2.36	0.120	0.110	0.016	0.53	0.086	0.38	2.90	86	0.35
2001-11-22	300	1.98	0.6	2.4	33	86	213	24	243	2.14	0.120	0.068	0.016	0.76	<0.2	0.21	3.30	<2	
2001-12-17	249	2.40	0.7	3.0	2	246	202	18	293	2.36	0.110	0.065	0.019	0.50	<0.2	0.33	3.00	<2	
Min.:	133	1.71	<0.6	2.4	<1	4	116	5	222	1.03	<0.02	0.009	0.010	0.24	<0.02	<0.03	<0.1	<2	0.35
Max.:	538	2.40	4.0	3.1	33	246	213	26	391	3.00	0.210	0.120	0.020	1.15	0.59	0.38	4.62	86	0.70
Aver.:	312	1.96	1.3	2.7	4.4	36	172	15	274	2.26	0.094	0.042	0.015	0.56	0.16	0.25	2.62	14	0.51
St.dev.:	102	0.20	1.2	0.2	9.0	70	36	6	44	0.63	0.049	0.039	0.004	0.24	0.16	0.10	1.04	25	0.15
Numb.:	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	4

Table VII.V Measured concentration 2001 – Watercourse: Otra

Annual flow: 4889 10⁶ m³ **Min:** 53 m³/s
Drainage area: 3730 km² **Max:** 632 m³/s

Date 2001	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
2001-01-02	202	1.40	0.7	2.5	2	3	121	10	194	1.65	<0.2	0.08	<0.02	0.25	<0.2	0.40	4.20	<5	0.94
2001-01-30	208	1.80	<0.6	2.6	<1	5	200	47	325	2.36	0.140	0.28	0.029	0.36	0.250	0.36	4.58	<5	
2001-02-27	182	1.40	<0.6	2.1	1	5	133	18	239	1.99	<0.02	0.10	0.009	0.25	<0.02	<0.03	2.40	<5	
2001-03-26	170	1.40	<0.06	1.5	2	5	137	10	198	1.78	0.080	0.06	0.016	0.24	0.030	0.38	2.60	<5	
2001-04-24	213	1.50	0.9	1.9	<1	<1	147	25	232	1.76	0.060	0.15	0.017	0.31	<0.02	0.59	4.20	<5	
2001-05-29	123	1.40	0.7	2.2	2	21	110	10	199	1.63	0.074	0.15	0.016	0.29	0.190	0.34	0.70	<5	0.87
2001-06-26	56	1.39	0.8	1.9	<1	17	99	<1	184	1.26	0.096	0.03	0.011	0.20	0.084	0.29	0.80	7	
2001-07-25	67	1.38	0.6	2.9	1	7	91	9	275	0.75	0.130	1.80	0.023	0.40	<0.2	0.72	2.60	10	0.42
2001-08-27	106	1.40	0.9	3.2	3	48	91	20	242	0.56	0.150	0.26	0.016	0.49	<0.2	0.83	3.50	4	
2001-09-24	59	1.40	0.8	2.7	1	13	86	8	105	0.96	0.120	0.12	0.016	0.43	<0.2	0.41	3.60	4	0.32
2001-10-29	213	1.63	0.9	4.6	2	12	117	20	230	1.95	0.180	0.42	0.027	0.55	0.094	0.86	7.60	<2	
2001-11-27	189	2.77	0.6	2.9	2	10	117	21	202	1.56	0.094	0.17	0.022	0.34	<0.2	0.40	2.70	<2	
2001-12-17	189	1.50	0.9	3.2	2	7	243	27	247	1.89	0.120	0.32	0.022	0.38	<0.2	0.80	3.20	12	
Min.:	56	1.38	<0.1	1.5	<1	<1	86	<1	105	0.56	<0.02	0.03	0.009	0.20	<0.02	<0.03	0.70	<2	0.32
Max.:	213	2.77	0.9	4.6	3	48	243	47	325	2.36	0.200	1.80	0.029	0.55	0.250	0.86	7.60	12	0.94
Aver.:	152	1.57	0.7	2.6	1.6	12	130	17	221	1.55	0.113	0.30	0.019	0.35	0.145	0.49	3.28	5	0.64
St.dev.:	61	0.38	0.2	0.8	0.7	12	45	12	52	0.52	0.049	0.46	0.006	0.10	0.083	0.25	1.76	3	0.31
Numb.:	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	4

Table VII.VI Measured concentration 2001 – Watercourse: Orreelva

Annual flow: 103 10⁶ m³ Min: 0.2 m³/s
 Drainage area: 105 km² Max: 11.1 m³/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)
2001	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
2001-01-23	2.3	17.0	2.2	5.7	15	56	1539	124	2098	6.00	0.23	0.11	0.010	1.37	0.68	1.75	3.20	<5	0.26
2001-02-20	3.7	17.0	2.8	6.7	13	54	1464	104	2175	5.36	0.30	<0.1	<0.02	1.30	<0.2	1.20	3.00	<5	
2001-03-26	1.3	1.7	4.6	6.1	8	46	1556	21	2046	3.21	0.18	0.01	0.009	1.49	0.87	1.29	2.48	<5	
2001-04-23	1.3	18.0	6.4	6.5	2	43	771	26	1592	<0.09	0.24	0.12	0.008	1.31	<0.02	1.20	1.60	<5	
2001-05-21	0.9	18.6	3.4	5.7	1	36	311	21	816	0.30	0.20	0.02	0.005	1.30	0.58	1.06	0.09	6	0.33
2001-06-26	1.2	19.6	2.6	5.7	<1	35	4	20	508	0.51	0.27	<0.01	<0.01	1.08	1.27	0.99	<0.1	<5	
2001-07-23	1.2	19.4	3.9	7.8	<1	73	295	26	634	1.39	0.33	<0.02	<0.01	0.76	<0.2	0.28	<0.5	3	0.32
2001-08-27	1.6	19.2	6.7	8.3	3	49	11	2	694	1.89	0.36	0.03	<0.01	0.55	<0.2	0.59	<0.5	2	
2001-09-25	1.8	17.7	5.5	5.8	2	55	68	4	587	1.67	0.22	<0.02	<0.01	0.78	<0.2	0.58	0.95	4	0.47
2001-10-22	4.1	16.9	6.6	5.7	5	45	957	5	1516	1.35	0.22	<0.01	<0.01	1.10	0.13	1.10	1.10	3	
2001-11-19	5.9	17.0	6.2	6.9	7	55	1130	25	1555	1.59	0.17	0.20	<0.01	1.30	<0.2	0.99	2.60	<2	
2001-12-11	9.2	17.8	11.7	7.1	7	93	1051	10	1550	<1.07	0.31	0.46	0.011	1.30	<0.2	1.40	2.30	<2	
Min.:	0.9	1.7	2.2	5.70	<1	35	4	2	508	<0.09	0.17	0.01	0.005	0.55	<0.02	0.28	0.09	<2	0.26
Max.:	9.2	19.6	11.7	8.30	15	93	1556	124	2175	6.00	0.36	0.46	0.020	1.49	1.27	1.75	3.20	6	0.47
Aver.:	2.9	16.7	5.2	6.50	5.4	53	763	32	1314	2.04	0.25	0.09	0.010	1.14	0.40	1.04	1.54	4	0.35
St.dev.:	2.5	4.8	2.6	0.89	4.8	16	605	39	632	1.89	0.06	0.13	0.003	0.29	0.37	0.40	1.14	1	0.09
Numb.:	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	4

Table VII.VII Measured concentration 2001 – Watercourse: Suldalslågen

Annual flow: 1378 10⁶ m³ Min: 14 m³/s
 Drainage area: 1457 km² Max: 271 m³/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)
2001	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
2001-01-29	17	1.80	<0.6	0.5	<1	1	239	4	242	1.37	<0.2	<0.1	<0.02	<0.2	<0.2	<0.2	2.00	<5	0.34
2001-02-26	16	1.90	<0.6	0.9	1	3	226	2	273	1.20	<0.02	<0.01	<0.01	0.13	<0.02	<0.03	1.20	<5	
2001-03-26	14	1.80	<0.06	0.8	1	4	214	3	262	1.03	0.050	<0.01	0.011	0.13	0.07	0.15	1.77	<5	
2001-04-30	20	2.00	<0.6	2.1	1	1	186	19	294	1.20	0.060	0.050	0.010	0.39	0.13	0.30	2.20	<5	
2001-05-28	54	1.50	0.6	1.3	6	9	155	6	218	0.94	<0.02	<0.01	0.005	0.02	0.16	0.13	1.74	<5	0.47
2001-06-25	49	1.46	<0.6	0.6	<1	14	151	4	191	0.96	<0.02	<0.01	<0.01	<0.02	0.04	0.12	<0.1	<5	
2001-07-31	77	1.38	0.6	1.3	2	18	126	17	217	0.64	0.063	<0.02	<0.01	0.20	<0.2	<0.16	1.10	2	
2001-08-27	76	1.36	<0.6	1.5	2	8	141	2	194	0.34	0.067	0.051	<0.01	0.24	<0.2	0.19	1.30	<2	
2001-09-24	62	1.30	<0.6	0.8	1	7	131	<2	157	0.69	0.061	<0.02	<0.01	0.20	<0.2	0.15	1.60	3	0.27
2001-10-29	78	1.76	1.4	2.5	2	21	154	5	166	1.37	0.076	0.140	0.011	0.37	0.069	0.29	2.70	3	
2001-11-27	27	1.98	<0.6	1.5	4	36	237	5	260	1.35	<0.05	0.029	0.010	0.23	<0.2	0.26	1.80	<2	
2001-12-17	15	2.00	<0.6	1.2	5	30	275	6	304	1.37	0.059	0.047	<0.01	0.13	<0.2	0.21	1.70	6	
Min.:	14	1.30	<0.06	0.5	<1	1	126	<2	157	0.34	<0.02	<0.01	0.005	<0.02	<0.02	<0.03	<0.1	<2	0.27
Max.:	78	2.00	1.4	2.5	6	36	275	19	304	1.37	0.200	0.140	0.020	0.39	0.20	0.30	2.70	6	0.47
Aver.:	42	1.69	0.6	1.3	2.3	12.7	186	6	232	1.04	0.062	0.041	0.011	0.19	0.14	0.18	1.60	4	0.38
St.dev.:	26	0.27	0.3	0.6	1.8	11.5	50	6	49	0.34	0.048	0.041	0.003	0.11	0.07	0.08	0.65	1	0.09
Numb.:	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	4

Table VII.VIII Measured concentration 2001 – Watercourse: Orkla

Annual flow: 1551 10⁶ m³ Min: 17.0 m³/s
 Drainage area: 2872 km² Max: 382.4 m³/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)
2001	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
2001-01-31	40	6.00	1.2	1.8	<1	3	141	23	265	3.21	0.070	<0.01	0.013	2.15	0.20	0.55	6.1	<5	
2001-02-27	28	8.30	<0.6	1.8	1	4	268	19	360	4.07	0.100	0.270	0.280	6.45	0.63	0.87	24.5	<5	
2001-03-23	37	8.70	0.7	1.5	3	4	293	1	333	4.07	0.100	<0.01	0.067	6.37	<0.02	0.76	24.1	<5	0.20
2001-04-30	67	6.30	3.7	6.9	6	6	270	23	525	3.21	0.160	0.020	0.033	6.29	0.47	1.50	18.4	<5	
2001-05-30	68	4.60	1.5	4.4	2	12	99	1	268	2.79	0.110	<0.01	0.041	5.57	<0.02	0.75	18.2	<5	
2001-06-30	30	5.95	0.6	1.9	<2	23	130	2	279	2.10	0.094	0.080	0.026	3.37	0.48	0.54	8.6	<5	0.24
2001-07-26	28	11.60	0.7	4.5	1	46	319	15	484	2.57	0.150	0.031	0.065	8.20	0.24	0.75	24.0	<2	
2001-08-30	32	6.80	0.9	5.9	4	129	145	9	277	2.36	0.180	0.028	0.047	6.20	0.25	0.92	5.3	2	0.10
2001-09-30	25	7.80	0.7	3.0	3	3	253	1	342	2.79	0.096	<0.02	0.035	4.80	<0.2	0.42	14.0	24	
2001-10-30	34	6.13	0.8	4.8	2	39	181	5	235	3.43	0.120	0.014	0.041	5.80	0.17	0.83	17.0	4	0.20
2001-11-29	42	7.90	1.2	3.0	2	8	384	7	438	3.43	0.130	0.028	0.052	7.30	0.29	0.96	21.0	<2	
2001-12-17	78	6.80	1.2	3.5	3	33	209	10	326	3.21	0.110	0.035	0.047	6.10	0.25	0.92	19.0	<2	
Min.:	25	4.60	0.6	1.5	<1	3	99	1	235	2.10	0.070	<0.01	0.013	2.15	<0.02	0.42	5.3	<2	0.10
Max.:	78	11.60	3.7	6.9	6	129	384	23	525	4.07	0.180	0.270	0.280	8.20	0.63	1.50	24.5	24	0.24
Aver.:	42	7.24	1.1	3.6	2.5	26	224	10	344	3.10	0.118	0.046	0.062	5.72	0.27	0.81	16.7	6	0.19
St.dev.:	18	1.80	0.9	1.7	1.4	36	87	8	93	0.62	0.032	0.073	0.070	1.64	0.18	0.27	6.8	6	0.06
Numb.:	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	4

Table VII.IX Measured concentration 2001 – Watercourse: Vefsna

Annual flow: 4911 10⁶ m³ Min: 26 m³/s
 Drainage area: 4113 km² Max: 1205 m³/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)
2001	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
2001-01-11	27	8.64	1.4	0.8	2	5	140	9	190	2.08	0.200	0.020	<0.02	0.54	0.50	0.23	4.70	7	
2001-02-27	77	7.80	<0.6	1.6	1	6	123	3	216	2.14	<0.02	<0.01	<0.01	0.30	0.09	<0.03	0.20	<5	
2001-03-29	41	8.50	3.4	1.0	2	7	121	14	186	2.14	0.160	0.180	0.003	0.45	3.19	0.53	1.31	<5	0.11
2001-04-25	65	7.50	3.9	3.4	16	28	87	26	215	2.01	0.150	0.110	0.005	0.62	<0.02	0.58	1.00	<5	
2001-05-22	226	4.70	1.3	1.6	<1	6	48	<1	154	1.44	0.140	0.020	0.003	0.47	0.34	0.31	0.94	6	
2001-06-26	276	2.99	1.4	0.7	1	13	35	<1	79	1.07	0.104	0.030	<0.01	0.24	0.34	0.21	<0.1	<5	0.17
2001-07-31	434	3.21	3.1	2.5	3	5	24	<2	282	0.84	0.096	0.041	<0.01	0.31	<0.2	0.22	0.67	4	
2001-08-29	324	4.17	3.5	3.3	3	13	16	7	105	1.11	0.210	0.031	<0.01	0.51	<0.2	0.33	37.0	9	0.02
2001-10-01	78	6.90	<0.6	1.8	2	3	104	1	227	1.52	0.110	<0.02	<0.01	0.38	<0.2	<0.05	0.70	2	
2001-11-05	117	7.53	1.0	2.6	3	3	101	4	174	1.84	0.099	0.063	0.043	0.60	0.14	0.47	3.00	5	
2001-12-03	73	8.97	0.6	1.9	2	3	205	6	245	2.36	0.092	0.026	<0.01	0.31	<0.2	<0.05	0.43	<2	0.18
Min.:	27	2.99	0.6	0.7	<1	3	16	<1	79	0.84	<0.02	<0.01	0.003	0.24	<0.02	<0.03	<0.1	<2	0.02
Max.:	434	8.97	3.9	3.4	16	28	205	26	282	2.36	0.210	0.180	0.043	0.62	3.19	0.58	37.0	9	0.18
Aver.:	158	6.45	1.9	1.9	3.3	8.4	91	6.7	188	1.69	0.126	0.050	0.012	0.43	0.49	0.27	4.55	5	0.12
St.dev.:	135	2.24	1.3	0.9	4.3	7.4	57	7.6	59	0.52	0.054	0.051	0.011	0.13	0.90	0.19	10.8	2	0.07
Numb.:	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	4

Table VII.X Measured concentration 2001 – Watercourse: Alta

Annual flow: 2618 10⁶ m³ **Min:** 25.6 m³/s
Drainage area: 7367 km² **Max:** 427.6 m³/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)
2001	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
2001-01-08	26	10.90	0.5	2.8	6	8	72	8	163	7.07	0.250	<0.01	0.004	0.49	0.45	0.28	0.96	9	
2001-02-03	27	13.00	<0.6	3.0	6	11	101	12	180	7.93	0.170	0.200	0.170	0.52	0.29	0.30	0.67	<5	
2001-03-04	27	13.40	<0.6	2.2	12	12	98	10	189	7.93	0.180	<0.01	0.003	0.39	0.34	0.16	0.40	<5	
2001-03-30	27	14.00	<0.06	2.2	6	7	86	6	178	4.29	0.200	0.020	0.025	0.49	0.32	0.24	0.67	<5	<0.10
2001-05-01	36	8.80	9.5	9.4	43	85	71	84	584	5.36	0.250	<0.01	0.002	1.06	0.68	0.82	0.92	<5	
2001-05-30	121	7.93	0.9	4.4	2	11	56	4	217	4.07	0.136	<0.01	<0.01	0.50	0.86	0.37	<0.1	<5	
2001-07-02	90	6.04	1.1	4.1	2	12	36	2	193	3.64	0.085	<0.01	0.004	0.41	0.53	0.24	<0.1	<5	0.39
2001-08-04	145	9.56	1.1	3.8	4	11	79	3	258	4.29	0.230	<0.02	<0.01	0.64	0.63	0.65	<0.5	21	
2001-09-05	71	19.10	<0.6	3.3	22	26	80	<1	156	4.50	0.360	0.059	<0.01	<0.5	<0.2	0.18	<0.5	2	
2001-10-02	66	22.50	0.8	3.0	26	26	87	5	185	5.36	0.210	0.025	<0.01	0.53	<0.2	<0.05	<0.5	2	<0.10
2001-11-03	44	22.20	<0.6	2.6	22	23	89	11	165	5.36	0.260	0.031	0.026	0.49	0.42	0.71	6.30	3	
2001-11-30	36	14.90	0.5	3.0	13	51	105	10	187	7.07	0.950	<0.02	<0.01	0.42	0.20	0.11	<0.5	<2	<0.10
Min.:	26	6.04	<0.06	2.20	2	7.0	36	<1	156	3.64	0.085	<0.01	<0.002	0.39	<0.20	<0.05	<0.10	<2	<0.1
Max.:	145	22.50	9.5	9.4	43	85	105	84	584	7.93	0.950	0.200	0.170	1.06	0.86	0.82	6.30	21	0.39
Aver.:	60	13.53	1.4	3.7	14	24	80	13	221	5.57	0.273	0.035	0.024	0.54	0.43	0.34	1.01	6	0.17
St.dev.:	40	5.41	2.6	1.9	12	23	20	23	117	1.54	0.224	0.054	0.047	0.18	0.21	0.25	1.69	5	0.15
Numb.:	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	4

Appendix VIII. Tributary Rivers. Measured concentrations 2001

Table VIII. Tributary Rivers, Measured Concentrations 2001

County		Watercourse	Drainage area Outlet km ²	Precip. 2001 (% of normal)	Runoff (outlet)		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	Parameter									
					Normal 1930-60 10 ⁶ m ³ /år	2001								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
Østfold (1.)	001	Tista.	1588	111%	721	798	4.63	2	8.6	3	23	346	20	699	4.29	0.2	0.12	0.02	1.08	0.54	0.58	<0.1	20
	003	Iddefjord Mosselva. Mossesundet	690	113%	316	357	7.16	4.9	9.2	2	38	149	21	678	0.96	0.29	0.12	0.004	0.18	0.62	0.92	<0.1	<5
Oslo og Akers- hus (1.)	004	Hølenelva.	137	104%	60	63	30.5	3.5	10	10	56	1123	41	1737	1.05	0.62	<0.01	0.015	2.11	1.19	3.6	<0.1	<5
	005	Drøbaksundet Ø	52	104%	21	22	21.2	2.6	5.9	34	52	1224	18	1587	2.14	0.38	<0.01	0.008	1.64	1.09	1.1	<0.1	64
	006	Årungenelva. Indre Oslofjord	86	112%	38	43	15.6	2	7.2	2	92	698	31	1126	3.86	0.2	<0.01	0.003	1.45	0.99	1.73	<0.1	43
	007	Gjersjøelva. Indre Oslofjord	42	111%	17	19	27.7	1.6	4.6	31	49	778	31	1066	6.00	0.3	0.04	0.018	2	1.07	1.18	0.2	<5
	008	Ljanselva. Indre Oslofjord	75	111%	31	34	30	6.5	6.3	63	117	953	252	1746	7.71	0.44	0.38	0.035	4.79	1.29	1.01	7.3	29
	009	Loelva/Alna. Indre Oslofjord	227	111%	125	139	4.73	1.9	4.2	7	18	201	62	398	3.86	0.26	0.75	0.041	1.62	0.44	0.34	5.4	<5
	010	Akerselva. Indre Oslofjord	23	111%	11	12	26	3.4	5	100	143	2272	215	2939	6.43	0.46	0.11	0.021	7.13	1.06	1.04	4.2	<5
	011	Frognerelva. Indre Oslofjord	178	111%	94	105	6.87	1.8	4.6	7	18	171	36	386	2.79	0.14	<0.01	0.005	0.78	0.52	0.14	<0.1	<5
	012	Sandvikselva. Indre Oslofjord	223	113%	129	146	19.8	1.9	3.8	6	18	523	24	752	1.54	0.22	<0.01	0.008	1.08	0.7	0.22	<0.1	<5
	013	Åroselva. Indre Oslofjord	113	116%	61	70	15.3	2.2	4.5	1	23	652	44	957	3.21	0.43	<0.01	0.01	1.62	2.75	0.47	<0.1	<5
Buske- rud (2.)	014	Lierelva. Drammensfjord Ø	309	119%	181	216	13.9	10.6	3.1	5	34	409	23	579	4.50	0.42	0.03	0.011	0.89	2.07	0.66	<0.1	<5
Vestfold (3.)	016	Sandeelva.	193	114%	103	118	658	6.4	3.9	2	58	248	50	494	2.79	0.57	<0.01	0.019	3.03	12.7	0.35	1.3	9.6
	017	Sandebukta	363	116%	171	197	2500	9.3	4.6	<1	47	440	1012	1135	1.31	9.47	<0.01	<0.01	17.2	3.28	2.8	<0.1	19
	019	Aulielva. Tønsbergfjord Farriselva. Larvikfjord	491	113%	334	378	3.01	0.7	4.6	<1	16	320	12	551	4.71	<0.02	<0.01	<0.01	0.2	0.1	0.08	2.9	<5

County		Watercourse	Drainage area Outlet km ²	Precip. 2001 (% of normal)	Runoff (outlet)		Parameter																
					Normal 1930-60 10 ⁶ m ³ /år	2001	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
Tele- mark (4.)	021	Tokkeelva. Kragero	1238	117%	1042	1224	2.01	0.9	4.3	3	9	159	22	392	2.14	0.1	0.07	0.023	0.36	0.31	0.24	2.6	<5
Aust- Agder (5.)	022	Gjerstadelva. Sønedeidfjord	419	115%	357	410	1.85	0.8	3.9	3	9	143	30	405	1.24	0.19	0.15	0.025	0.41	0.24	0.21	2.1	5
	023	Vegårdselva. Sandnesfjord	457	114%	422	482	2.54	1.3	4.3	3	9	98	18	325	0.24	0.17	0.07	0.016	0.41	0.26	0.21	1.2	53
	024	Nidelva. Arendal	4025	112%	3783	4218	1.45	0.7	2.5	<2	<2	135	10	222	1.52	0.1	0.11	0.04	0.81	<0.02	0.2	7.1	130
Vest- Agder (5.)	025	Tovdalselva. Topdalsfjord	1856	105%	1984	2085	1.94	1	3.5	<2	<2	93	15	237	0.39	0.11	0.13	0.03	0.24	<0.02	0.27	2.8	25
	027	Søgneelva. Flekkerøy	204	112%	244	275	6.03	1.1	4.6	4	7	497	58	795	1.37	0.18	0.47	0.06	0.57	<0.02	0.61	5	21
	028	Mandalselva. Mannefjord	1809	107%	2624	2801	1.6	1	3.2	<2	<2	175	22	276	0.77	0.08	0.26	0.03	0.21	<0.02	0.18	2.19	44
	029	Audna. Sniksfjord	450	107%	639	684	3	3	6.4	<2	26	195	18	458	1.31	0.3	0.7	0.06	0.4	<0.2	<0.3	7	12
	030	Lygna. Lyngdalsfjord	664	105%	1005	1056	2.1	4.5	5.3	<2	25	160	46	357	1.05	0.2	1.3	0.1	0.6	<0.2	<0.3	5	<5
	031	Kvina. Fedafjord	1445	105%	2625	2757	2.3	2.9	6.2	<2	46	127	37	370	<0.09	0.3	0.7	0.03	0.3	<0.2	<0.3	4	<5
	032	Sira. Åna-Sira	1916	97%	3589	3471	1.5	1	1.8	<2	7	145	36	199	0.92	<0.2	0.3	<0.02	<0.2	<0.2	<0.3	3	8
Roga- land (6.)	033	Sokndalselva. Sogndalsstrand	294	102%	474	483	4.2	1.3	2.4	4	82	253	28	367	1.41	<0.2	0.4	0.04	0.5	<0.2	2.4	5	10
	034	Hellelandselva. Egersund	241	102%	437	446	3.7	1.3	3.4	3	18	523	26	708	1.54	<0.2	0.4	0.03	0.5	<0.2	0.4	5	13
	035	Bjerkreimselva. Egersund	705	102%	1727	1761	3.3	0.9	1.8	3	18	321	26	403	1.46	<0.2	0.3	0.02	0.2	<0.2	<0.3	3	11
	036	Håelva. Håtangen	165	117%	244	286	8.7	4.8	5.8	12	51	878	49	1277	2.36	0.7	0.2	<0.02	0.9	0.2	0.4	4	12
	038	Figgjo. Solavika	229	117%	361	423	10.2	2.2	4.1	13	33	726	66	1034	2.79	0.2	0.4	<0.02	1.2	0.3	0.4	3	11
	039	Ims-Lutsivasdraget Høgsfjord Boknafj.	127	95%	140	132	72.2	1.4	3.2	<2	13	458	29	671	0.43	<0.2	<0.1	<0.02	0.7	0.2	0.4	2	8
	040	Oltedalselva. Høgs- fjord Boknafj.	102	95%	225	213	3.7	0.9	1.8	<2	17	278	17	362	2.14	<0.2	<0.1	<0.02	0.4	<0.2	<0.3	3	<5

County		Watercourse	Drainage area Outlet km ²	Precip. 2001 (% of normal)	Runoff (outlet)		Parameter																
					Normal 1930-60 10 ⁶ m ³ /år	2001	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
(7.)	041	Dirdalselva. Høgsfjord Boknafjord	158	95%	414	391	1.7	0.7	2.3	<2	14	201	4	287	1.37	<0.2	0.3	<0.02	0.3	<0.2	<0.3	2	9
	042	Frafjordelva. Frافjord Boknafjord	178	95%	530	501	1.4	0.7	1.9	<2	18	126	9	167	0.92	<0.2	0.3	<0.02	<0.2	<0.2	<0.3	1	10
	043	Espedalselva. Høgsfjord Boknafj.	138	95%	392	370	2.1	<0.6	1.3	<2	5	199	7	221	2.08	<0.2	<0.1	<0.02	<0.2	<0.2	<0.3	<1.0	<5
	044	Lyseelva. Lysefjord Boknafjord	182	96%	425	409	1.4	<0.6	2.6	<2	6	23	5	91	1.48	<0.2	0.2	<0.02	0.3	<0.2	<0.3	<1.0	6
	045	Årdalselva. Årdalsfjord Boknafjord	519	97%	1332	1288	2.15	0.6	1.6	8	13	153	9	214	1.37	<0.2	<0.1	<0.02	1	<0.2	<0.3	<1.0	10
	046	Førreelva. Jøsen-fjord Boknafjord	163	61%	441	269	1.89	<0.6	1.7	<1	2	110	2	156	2.14	<0.2	<0.1	<0.02	0.3	<0.2	<0.3	<1.0	10
	047	Ulla. Jøsenfjord Boknafjord	393	61%	1034	631	2.02	<0.6	2.7	<1	5	119	11	171	1.89	<0.2	<0.1	<0.02	0.3	<0.2	<0.3	1	5
	049	Saudaelva. Saudafjord Boknafjord	353	83%	946	785	2.71	0.6	1.5	<1	7	669	6	716	2.14	<0.2	<0.1	0.05	1.4	<0.2	<0.3	19	10
	050	Åbøelva. Saudafjord Boknafjord	82	83%	220	182	0.98	0.6	0.9	<1	2	104	1	109	0.81	<0.2	<0.1	<0.02	0.3	<0.2	<0.3	2	8
	051	Vikedalselva. Vindafjord Boknafj.	118	87%	298	259	2.14	0.8	1.9	<1	9	211	2	242	0.84	0.3	0.1	<0.02	0.4	<0.2	<0.3	2	9
Hordaland (7.)	052	Etneelva. Etnefjord Bømlafjord	252	87%	388	337	2.05	<0.6	1.2	<1	3	241	2	244	0.86	<0.2	<0.1	<0.02	0.4	<0.2	<0.3	2	9
	053	Opo. Sørfjord Hardangerfjord	482	89%	1205	1069	1.02	3.4	0.7	<1	72	110	6	116	1.05	<0.2	0.6	<0.02	0.4	<0.2	<0.3	3	10
	054	Tysso. Sørfjord Hardangerfjord	388	89%	970	860	2.15	<0.6	0.7	6	9	170	6	170	1.37	0.14	0.04	0.017	0.51	0.74	0.51	2.6	<5
	055	Kinso. Sørfjord Hardangerfjord	281	91%	408	370	1.84	<0.6	0.4	5	48	50	14	71	0.32	0.11	0.05	0.003	0.12	0.39	0.1	0.3	<5
	056	Veig. Eidfjord Hardangerfjord	496	104%	654	680	2.33	0.6	0.6	4	4	38	12	52	1.37	0.09	<0.01	0.007	0.14	0.32	0.29	0.4	<5
	057	Bjoreia. Eidfjord Hardangerfjord	592	108%	485	526	1.69	0.7	1.7	3	17	76	6	86	1.01	0.09	0.06	0.008	0.28	0.23	0.51	0.9	<5
	058	Sima. Eidfjord Hardangerfjord	145	104%	316	329	1.96	<0.6	1	2	4	94	3	94	2.14	0.05	0.02	0.003	0.13	0.19	0.18	0.5	<5
	059	Austdøla. Osafjord Eidfjord	131	104%	308	321	0.73	<0.6	0.4	2	17	56	<1	60	0.75	0.06	0.03	0.004	0.17	0.15	0.06	1.1	<5
	060	Norddøla. Osafjord Eidfjord	40	104%	94	98	4.32	<0.6	0.3	1	1	99	2	135	1.61	0.09	<0.01	0.002	0.05	0.33	0.08	0.2	<5
	061	Tysseelva. Fusafjord	240	97%	643	626	1.31	0.7	1.2	2	2	94	6	205	0.56	0.13	0.18	0.01	0.37	0.1	0.17	1.2	<5

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Sogn og Fjord- dane (7.)	062	Oselva.	109	103%	315	323	3.16	1.1	3.2	<1	15	173	14	301	1.01	0.17	0.42	0.008	0.9	0.26	0.42	1.5	<5
	063	Fusafjord																					
	063	Bergsdalse. Veafjord	198	103%	500	515	1.56	0.7	1.6	<1	19	100	17	191	0.96	0.11	0.22	0.006	0.51	0.14	0.22	1	<5
	064	Herdlafj.																					
	064	Vosso. Veafjord	1492	104%	2738	2842	0.9	0.7	0.7	<1	7	77	11	163	0.77	0.06	<0.01	0.002	0.15	0.05	<0.01	0.46	<5
	065	Sørfjord																					
	065	Ekso.	414	94%	1125	1057	1.05	0.9	1.4	<1	6	61	9	163	0.60	0.05	0.09	0.006	0.2	0.06	0.09	0.55	5
	066	Osterfjord																					
	066	Modalselva.	385	96%	1159	1111	0.98	<0.6	0.8	<1	6	123	4	175	0.88	0.05	0.09	0.005	0.15	0.22	0.5	1.6	<5
	066	Osterfjord																					
	067	Nærøyelva. Aur-	290	97%	544	528	1.21	0.7	0.6	<1	46	69	7	125	2.36	0.03	<0.01	0.002	0.16	0.04	0.07	0.4	<5
	068	landsfjord Sognefj.																					
	068	Flåmselva. Aurlands-	280	97%	463	449	1.2	<0.6	0.3	<1	6	84	5	90	0.69	0.04	<0.01	0.004	0.1	0.04	0.18	0.4	<5
	069	fjord Sognefj.																					
	069	Aurlandv. Aurlands-	800	97%	1226	1189	1.08	0.7	1	<1	18	87	7	109	0.94	0.03	0.02	0.002	0.6	0.04	0.14	0.5	<5
	070	fjord Sognefjord																					
	070	Erdalselva. Lærdals-	138	97%	131	127	0.8	<0.6	0.3	<1	5	12	3	50	1.07	0.05	<0.01	0.001	0.09	<0.02	0.04	0.06	<5
	071	fjord Sognefj.																					
	071	Lærdalsv. Lærdals-	1184	119%	1120	1333	1.63	0.8	0.6	<1	17	53	4	111	1.54	0.03	<0.01	0.001	0.34	0.04	0.11	0.39	<5
	072	fjord Sognefjord																					
	072	Årdalselva. Årdals-	989	100%	1400	1407	0.88	1.2	0.7	<1	7	90	17	231	1.18	<0.05	<0.02	<0.01	0.78	<0.2	0.16	1.6	<2
	073	fjord Sognefjord																					
	073	Fortunelva. Luster-	508	100%	817	821	0.73	2.3	0.7	<1	6	101	16	151	0.71	<0.05	0.05	<0.01	0.37	<0.2	0.13	<1.5	(6)*
	074	fjord Sognefjord																					
	074	Mørkriselva. Luster-	282	100%	486	489	0.9	3.1	0.6	<1	6	110	6	469	0.47	<0.05	0.02	<0.01	0.23	<0.2	0.14	1.6	8
	075	fjord Sognefjord																					
	075	Jostedøla. Lusterfjord	865	101%	1855	1869	0.82	10.8	0.5	2	25	172	7	203	0.58	<0.05	<0.02	<0.01	0.07	<0.2	<0.05	<0.5	6
	076	Sognefjord																					
	076	Årøyelva. Sognefjord	449	101%	1093	1101	1.5	1.1	0.7	<1	18	243	9	309	0.90	0.05	<0.02	<0.01	0.19	<0.2	<0.05	0.88	4
	077	Sogndalselva Sogn-	175	99%	365	361	0.84	0.6	0.8	<1	7	122	7	219	0.41	<0.05	0.14	<0.01	0.23	<0.2	0.06	42	(8)*
	078	dalsfjord. Sognefj.																					
	078	Gaular. Dalsfjord	627	97%	1568	1528	1.29	0.8	1.9	<1	13	216	7	306	0.51	0.06	0.03	<0.01	0.24	<0.2	0.11	1.5	2
	079	Bufjord																					
	079	Jølstra.	714	97%	1673	1629	1.68	<0.6	1.6	<1	8	135	17	221	0.58	0.05	0.02	<0.01	0.25	<0.2	0.11	2.1	(6)*
	080	Førdefjord																					
	080	Nausta.	277	97%	714	695	1.22	0.8	2.4	4	13	96	21	132	0.41	0.07	0.04	<0.01	0.25	<0.2	0.1	1.5	6
	080	Førdefjord																					

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Møre og Roms- dal (8.)	081	Oselva. Høydalsfjord	287	106%	712	756	1.96	1	3.8	<1	9	31	21	132	0.26	0.09	0.06	<0.01	0.38	<0.2	0.22	2.4	(12)*
	082	Hopselva. Hyefjord Nordfjord S	73	108%	173	186	0.94	0.8	1.2	<1	6	73	13	83	0.26	0.07	0.07	<0.01	0.15	<0.2	0.08	1	12
	083	Gjengedalselva. Hyefjord Nordfjord S	170	100%	402	400	1.04	0.7	2.1	1	9	168	9	158	0.54	0.07	0.05	<0.01	0.24	<0.2	0.12	1.4	10
	084	Breimselva. Gloppen- fjord Nordfjord S	636	101%	1364	1374	1.47	1.2	1.1	2	8	167	17	206	0.79	<0.05	<0.02	<0.01	0.21	<0.2	0.06	0.84	4
	085	Oldenelva. Indre Nordfjord	226	105%	500	525	1.37	1.4	0.6	<1	8	115	9	214	0.86	<0.05	<0.02	<0.01	<0.05	<0.2	<0.05	0.8	13
	086	Loenelva. Indre Nordfjord	261	105%	535	562	1.31	2.4	0.9	<1	11	207	7	191	0.96	<0.05	0.02	<0.01	0.19	<0.2	<0.05	<0.5	<2
	087	Stryneelva. Indre Nordfjord	531	99%	1008	997	1.65	1.7	0.7	<1	7	88	17	214	0.81	<0.05	<0.02	<0.01	1.8	<0.2	<0.05	<0.5	(<5)*
	088	Hornindalselva. Nordfjord N	428	103%	784	807	2.12	0.8	1.3	<1	10	185	7	190	1.01	<0.05	0.03	<0.01	0.26	<0.2	0.23	<0.5	(<5)*
	089	Ørstaelva. Ørsta fjord	160	110%	353	387	2.82	0.8	1.7	<1	13	188	10	271	1.26	<0.05	<0.02	<0.01	0.29	<0.2	0.28	0.96	3
	090	Valldøla. Nordalfjord Storfjord	359	78%	679	532	1.24	0.6	0.6	<1	9	29	6	56	0.92	<0.05	<0.02	<0.01	0.19	<0.2	<0.05	1.2	<2
	091	Rauma. Romsdals- fjord Moldefjord	1202	101%	1243	1260	1.51	<0.6	0.6	<1	10	57	6	58	1.37	<0.05	<0.02	<0.01	0.12	<0.2	<0.05	<0.5	3
	092	Isa. Isfjord Moldefjord	175	101%	315	317	1.45	0.6	0.5	2	10	52	6	52	1.35	<0.05	0.02	<0.01	0.19	<0.2	<0.05	<0.5	<2
	093	Eira. Eresfjord Moldefjord	1119	114%	1228	1403	2.31	<0.6	0.7	1	12	119	4	167	1.52	<0.05	<0.02	<0.01	0.24	<0.2	<0.05	<0.5	4
	094	Littlelalselva. Sunnalsfjord	359	108%	464	500	2.51	1	0.6	1	13	122	5	181	2.57	<0.05	<0.02	<0.01	0.22	0.2	<0.05	<0.5	5
	095	Driva. Sunnalsfjord Tingvollfjord	2487	117%	2188	2554	2.28	1.4	1.3	<1	16	41	6	106	1.78	<0.05	0.03	<0.01	0.48	<0.2	<0.05	<0.5	5
	096	Ulvåa. Ålvundfjord	199	117%	358	419	2.26	0.7	1.9	<1	16	238	7	409	2.14	<0.05	0.03	<0.01	0.76	<0.2	0.15	1.1	3
	097	Toåa. Todalsfjord	251	117%	463	542	1.21	<0.6	1.8	<1	14	17	3	214	0.94	<0.05	0.07	<0.01	0.36	<0.2	<0.05	0.74	5
	098	Surna. Surnadalsfjord	1200	111%	1816	2022	2.74	0.8	3.4	<1	17	89	11	172	1.03	<0.05	0.02	<0.01	0.59	<0.2	0.36	<0.5	5
	099	Bøvra. Hamnesfjord Halsafjord	243	105%	421	441	2.44	0.8	3.9	<1	20	43	4	188	0.92	<0.05	0.03	<0.01	0.38	<0.2	0.28	<0.5	3

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Sør-Trøndelag (8.)	101	Børselva. Gaulosen Trondheimsfjord.	110	123%	104	128	12.9	6.9	5.9	6	39	601	13	860	1.84	0.2	0.02	<0.01	1.4	0.37	1.4	0.6	7
	102	Vigda. Gaulosen Trondheimsfjord.	150	123%	142	174	14.3	45	4.2	3	49	459	9	657	1.89	0.21	<0.02	<0.01	1.2	0.36	0.1	<0.5	8
	103	Gaula. Gaulosen Trondheimsfjord.	3659	108%	3046	3302	3.96	6.2	5.2	<1	25	62	5	205	1.95	0.08	0.04	<0.01	1.9	0.25	1.4	2.4	5
	104	Nidelva. Trondheimsfjord	3110	133%	3482	4631	3.57	3.4	3.9	<1	24	91	10	209	1.37	0.1	<0.02	<0.01	0.8	<0.2	0.78	0.91	7
	105	Homla. Stjørdalsfjord Trondheimsfjord	157	106%	149	157	5.8	1.1	9.1	1	25	64	25	304	1.52	0.42	0.03	<0.01	1	0.32	0.58	0.79	9
Nord-Trøndelag (8.)	106	Stjørdalselva. Stjørdalsfj. Trondheimsfj.	2117	119%	2570	3046	3.44	3.5	5.3	<1	3	209	8	344	1.05	0.13	0.06	0.012	2.9	0.34	0.65	3.8	8
	107	Gråelva. Stjørdalsfjord Trondheimsfj.	93	120%	73	88	13.5	10.5	7.7	6	21	1200	16	2600	2.36	0.3	0.06	0.01	1.5	0.65	0.56	0.86	8
	108	Verdalsvassdraget. Trondheimsfjord.	1472	118%	1857	2189	5.56	4.8	5.6	3	12	268	14	390	1.22	0.18	0.05	<0.01	1.2	0.36	0.61	0.88	10
	109	Figga/Leksdalselva. Trondheimsfjord	1080	106%	1376	1461	6.26	13.7	8.1	2	19	662	10	814	1.41	0.17	0.07	<0.01	1.1	0.39	0.55	0.6	9
	110	Snåsavassdraget. Trondheimsfjord	1095	117%	1376	1608	4.27	1.1	4.3	<1	2	191	15	290	0.90	0.09	<0.02	<0.01	0.57	0.23	0.34	0.83	9
	111	Årgårdselva. Namsfjord	1110	121%	1376	1664	4.44	6.9	16	2	23	559	33	880	1.78	0.14	0.08	<0.01	0.96	0.42	0.41	1.6	8
Nordland (9.)	112	Namsen. Namsfjord Ø	1124	109%	1376	1506	3.38	8.4	7.6	1	13	80	9	279	1.22	0.12	0.07	<0.01	0.94	0.36	0.56	1.9	4
	113	Salsvatnelva. Follafjord	1154	110%	1374	1511	4.46	<0.6	2.6	<1	1	54	5	132	0.90	<0.05	0.03	<0.01	0.25	<0.2	0.13	1.4	8
	114	Åbjøra. Bindalsfjord S	526	111%	1330	1479	2.23	0.9	3.3	<1	86	41	6	139	0.64	0.07	0.06	<0.01	0.34	<0.2	0.15	0.83	3
	116	Skjerva. Vefsenfjord S	104	104%	135	141	11.2	1.8	3.9	4	12	194	27	351	1.69	0.19	0.05	<0.01	0.71	0.4	0.43	0.84	7
	117	Fusta. Vefsenfjord N	544	104%	1088	1135	3.03	2.2	2.6	1	4	44	31	201	0.54	0.91	0.03	<0.01	0.41	<0.2	0.24	0.71	3
	118	Drevja. Vefsenfjord N	177	104%	363	379	5.25	4.1	2	1	5	34	11	136	0.47	0.11	0.03	<0.01	0.38	0.21	0.11	<0.5	3
	119	Røssåga. Sørfjord	2092	129%	2995	3855	4.76	3.8	2	<1	2	30	7	148	0.51	0.08	0.03	<0.01	0.43	0.22	0.36	2.5	3
	120	Bjerka. Sørfjord	385	97%	673	649	5.12	0.9	2.8	1	43	36	12	149	0.66	0.07	<0.02	<0.01	0.67	0.26	0.48	0.78	5

County		Watercourse	Drainage area Outlet km ²	Precip. 2001 (% of normal)	Runoff (outlet)		Parameter																
					Normal 1930-60 10 ⁶ m ³ /år	2001	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
Troms (9.)	121	Dalselva. Ranafjord N	211	97%	263	254	3.21	0.8	2.8	1	2	10	10	130	0.64	<0.05	0.02	<0.01	0.57	<0.2	0.52	0.72	2
	122	Ranavassdraget. Ranafjord N	3847	112%	5447	6077	5	<0.6	1.3	2	4	19	18	131	0.79	0.06	<0.02	<0.01	0.55	<0.2	0.11	0.74	2
	123	Fykanåga. Glomfjord	297	94%	971	915	3.41	<0.6	0.6	<1	2	56	19	139	0.39	<0.05	<0.02	<0.01	0.18	<0.2	0.11	0.55	4
	124	Beiarelva. Beiarfjord Nordfjord	1064	103%	1513	1551	2.93	2.8	1.2	3	4	16	11	109	0.99	0.07	0.03	<0.01	0.29	<0.2	0.27	<0.5	<2
	125	Saltdalsvassdraget. Saltdalsfjord S	1544	119%	1563	1855	3.07	2.4	1.6	<1	5	17	7	134	1.39	0.11	0.03	<0.01	0.4	<0.2	0.49	0.72	<2
	126	Sulitjelmavassdraget. Saltdalsfjord S	1028	116%	1426	1649	2.43	<0.6	1.4	<1	22	10	15	108	0.64	0.08	<0.02	<0.01	1.1	<0.2	0.21	0.98	4
	127	Kobbelva. Leirfjord Sørfolda N	405	105%	854	897	1.75	<0.6	0.7	<1	<2	25	11	123	0.71	<0.05	0.03	<0.01	0.13	<0.2	0.11	1.1	3
	128	Skjoma. Ofotfjord S	845	111%	967	1078	1.63	<0.6	2.6	<1	2	7	13	136	1.74	0.11	0.03	<0.01	0.4	<0.2	0.15	0.83	<2
	129	Spanselva. Astafjord Vågsfjord	142	128%	224	286	9.19	<0.6	1.2	<2	<2	15	5	108	0.86	<0.05	<0.02	<0.01	0.41	<0.2	<0.05	<0.5	<2
	130	Salangselva. Astafjord Vågsfjord	539	113%	695	783	8.05	<0.6	1	<2	<2	29	8	114	0.62	<0.05	0.04	<0.01	0.29	<0.2	<0.05	0.99	4
	131	Rossfjordelva. Malangen	196	137%	244	333	7.03	0.7	2	3	3	5	8	152	0.43	<0.05	<0.02	<0.01	0.33	<0.2	0.05	<0.5	<2
	132	Målselva. Måls- elvfjord Malangen	3239	116%	2932	3390	6.44	<0.6	1.3	<2	<2	27	14	139	1.50	<0.05	<0.02	<0.01	0.34	<0.2	<0.05	<0.5	<2
	133	Barduelva. Målselv- fjorden Malangen	2906	116%	2594	2999	7.71	<0.6	1.1	2	2	22	10	149	1.11	0.05	0.02	<0.01	0.38	<0.2	<0.05	<0.5	<2
	134	Nordkjoselva. Balsfjord	191	124%	167	207	4.4	<0.6	1.1	<2	<2	13	5	115	1.63	0.09	<0.02	<0.01	0.4	<0.2	0.1	0.71	<2
	135	Signaldalselva. Lyngen V	473	138%	413	570	3.65	0.7	1.4	3	6	7	8	124	1.52	0.08	<0.02	<0.01	0.42	<0.2	0.13	<0.5	<2
	136	Skibotnelva. Lyngen	770	151%	437	662	3.34	<0.6	1.6	<2	<2	23	5	131	1.50	<0.05	0.02	<0.01	0.52	<0.2	1	0.86	<2
	137	Kåfjordelva. Lyngen Ø	358	128%	226	289	5.42	<0.6	0.9	<2	<2	153	8	224	2.36	0.1	<0.02	<0.01	0.95	<0.2	0.52	1.2	<2
	138	Reisa. Reisafjord	2702	159%	1363	2162	3.81	0.9	1.6	2	2	22	3	142	2.79	0.07	<0.02	<0.01	0.67	<0.2	0.96	0.6	<2

County		Watercourse	Drainage area Outlet km ²	Precip. 2001 (% of normal)	Runoff (outlet)		Parameter																
					Normal 1930-60 10 ⁶ m ³ /år	2001	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
Finn- mark (10.)	139	Mattiselva. Kåfjord Altafjord	325	158%	272	429	3.71	<0.6	2.7	2	2	14	4	160	1.37	0.12	0.02	<0.01	0.79	<0.2	0.3	0.74	5
	141	Tverrelva. Altafjord	234	158%	111	176	4.27	1	4.5	3	6	40	7	244	2.14	0.11	0.02	<0.01	0.78	0.28	0.37	0.72	<2
	142	Repparfjordvass- draget. Repparfjord	1090	128%	859	1099	3.35	0.6	3.7	<2	3	7	14	156	1.16	0.07	<0.02	<0.01	2.3	0.27	0.3	0.53	3
	143	Stabburselva. Indre Porsangen V	1108	128%	639	818	3.11	<0.6	2.7	2	3	10	15	123	2.01	0.05	<0.02	<0.01	0.53	<0.2	0.17	1.1	5
	144	Lakselva. Indre Porsangen S	1533	128%	769	983	5.25	5.9	2.8	2	11	13	8	149	1.99	<0.05	<0.02	<0.01	0.62	<0.2	0.37	<0.5	3
	145	Børselva.Indre Porsangen Ø	883	158%	830	1315	4.65	1	1	<2	3	5	11	90	3.00	<0.05	<0.02	<0.01	0.2	<0.2	0.24	0.96	8
	146	Mattusjåkka. Indre Laksefjord V	101	138%	73	100	6.04	0.6	1.3	<2	<2	97	10	107	1.20	0.06	0.41	0.037	0.45	4.8	0.87	4.7	6
	147	Storelva. Indre Laksefjord V	690	138%	477	657	3.6	<0.6	0.7	<2	4	21	4	101	2.57	<0.05	<0.02	<0.01	0.1	<0.2	0.26	1.1	5
	148	Soussjåkka. Indre Laksefjord V	92	138%	73	101	5.7	<0.6	1.3	<2	<2	26	5	96	3.00	<0.05	<0.02	<0.01	0.17	<0.2	0.15	0.95	14
	149	Adamselva. Indre Laksefjord Ø	705	138%	442	610	5.51	<0.6	1.6	<2	6	2	4	103	2.36	<0.05	<0.02	<0.01	0.26	<0.2	0.1	0.92	20
	150	Tanavassdraget. Tanafjord S	16389	133%	5944	7897	3.48	1.4	5.3	3	9	3	10	225	4.50	0.06	<0.02	<0.01	0.65	0.31	0.42	8.5	6
	151	Vesterelva. Syltefjord	469	154%	512	790	5.66	<0.6	0.8	3	21	7	9	99	2.14	0.21	<0.02	<0.01	0.11	<0.2	<0.05	<0.5	2
	152	Vestre Jakobselva. Ytre.Varangerfjord	627	141%	358	503	10.5	0.6	2.8	3	9	2	7	129	3.86	0.07	<0.02	<0.01	0.21	0.2	0.13	<0.5	6
	153	Passvikelva. Bøkfjord Varangerfjord	18404	141%	5398	7588	3.62	0.7	4.2	2	5	4	10	190	2.79	0.19	0.05	<0.01	1.5	0.52	6.6	1	2
	154	Neiden. Munkfjord Varangerfjord	2960	128%	915	1168	2.63	1.2	4.1	2	5	<2	17	205	1.84	0.06	<0.02	<0.01	0.49	<0.2	0.22	0.62	<2
	155	Grense Jakobselv. Varangerfjord	234	127%	133	169	4.13	0.8	2.9	2	3	3	6	162	2.79	0.18	0.34	0.032	2.3	4.2	8.1	4.5	<2

Appendix IX. Tributary Rivers. Annual Load 2001

Table IX. Tributary Rivers. Annual Load 2001

County	Watercourse	S.P.M. tonnes	TOC tonnes	PO ₄ -P tonnes	Tot-P tonnes	NO ₃ -N tonnes	NH ₄ -N tonnes	Tot-N tonnes	Parameter								
									SiO ₂ tonnes	As kg	Pb kg	Cd kg	Cu kg	Cr kg	Ni kg	Zn kg	Hg kg
Østfold (1.)	001 Tista. Iddefjord	1596	6863	2.39	18.35	276	16.0	558	3420	160	96	16.0	862	431	463	< 80	16
	003 Mosselva. Mossesundet	1752	3289	0.71	13.58	53	7.5	242	345	104	43	1.4	64	222	329	< 36	< 1.8
Oslo og Akershus (1.)	004 Hølenelva. Drøbaksundet Ø	221	631	0.63	3.54	71	2.6	110	66	39	< 0.6	0.9	133	75	227	< 6	< 0.3
	005 Årungelva. Indre Oslofjord	58	131	0.76	1.16	27	0.4	35	48	8	< 0.2	0.2	36	24	24	< 2	1.42
	006 Gjersjøelva. Indre Oslofjord	85	306	0.09	3.91	30	1.3	48	164	9	< 0.4	0.1	62	42	74	< 4	1.83
	007 Ljanselva. Indre Oslofjord	31	88	0.59	0.94	15	0.6	20	115	6	1	0.3	38	20	23	4	< 0.1
	008 Loelva/Alna. Indre Oslofjord	222	215	2.15	4.00	33	8.6	60	264	15	13	1.2	164	44	35	250	0.99
	009 Akerselva. Indre Oslofjord	265	585	0.98	2.51	28	8.6	55	538	36	105	5.7	226	61	47	753	< 0.7
	010 Frognerelva. Indre Oslofjord	41	61	1.21	1.73	27	2.6	36	78	6	1	0.3	86	13	13	51	< 0.1
	011 Lysakerelva. Indre Oslofjord	189	483	0.73	1.89	18	3.8	40	292	15	< 1	0.5	82	55	15	< 10	< 0.5
	012 Sandvikselva. I. Oslofjord	277	555	0.88	2.63	76	3.5	110	225	32	< 1	1.2	158	102	32	< 15	< 0.7
	013 Åroselva. Indre Oslofjord	154	316	0.07	1.61	46	3.1	67	226	30	< 0.7	0.7	114	193	33	< 7	< 0.4
Buske- rud (2.)	014 Lierelva. Drammensfjord Ø	2284	668	1.08	7.33	88	5.0	125	970	91	6	2.4	191	446	142	< 22	< 1.1
Vestfold (3.)	016 Sandeelva. Sandebukta	755	460	0.24	6.84	29	5.9	58	329	67	< 1	2.2	357	1498	41	153	1.13
	017 Aulielva. Tønsbergfjord	1835	908	< 0.2	9.27	87	200	224	258	1868	< 2	< 2.0	3393	647	552	< 20	3.75
	019 Farriselva. Larvikfjord	265	1741	< 0.4	6.06	121	4.5	209	1784	< 8	< 4	< 3.8	76	38	29	1098	< 1.9
Tele- mark (4.)	021 Tokkeelva. Kragerø	1101	5261	3.67	11.01	195	26.9	480	2622	122	86	28.1	440	379	294	3181	< 6.1
Aust- Agder (5.)	022 Gjerstadelva. Søndeledfjord	328	1599	1.23	3.69	59	12.3	166	509	78	61	10.2	168	98	86	861	2.05
	023 Vegårdselva. Sandnesfjord	626	2072	1.45	4.34	47	8.7	157	114	82	34	7.7	198	125	101	578	25.5
	024 Nidelva. Arendal	2952	10544	< 8.4	< 8.4	569	42.2	936	6417	422	464	169	3416	< 84	844	29945	548
Vest- Agder (5.)	025 Tovdalselva. Topdalsfjord	2085	7297	< 4.2	< 4.2	194	31.3	494	804	229	271	62.5	500	< 42	563	5838	52
	027 Søgneelva. Flekkerøy	302	1264	1.10	1.92	137	15.9	218	377	49	129	16.5	157	< 5	168	1374	5.77
	028 Mandalselva. Mannefjord	2801	8964	< 5.6	< 5.6	490	61.6	773	2161	224	728	84	588	< 56	504	6135	123
	029 Audna. Sniksfjord	2053	4379	< 1.4	17.79	133	12.3	313	894	205	479	41.1	274	< 137	< 205	4789	8.21
	030 Lygna. Lyngdalsfjord	4751	5596	< 2.1	26.40	169	48.6	377	1109	211	1373	105.6	633	< 211	< 317	5279	< 5.3
	031 Kvina. Fedafjord	7996	17095	< 5.5	126.83	350	102.0	1020	< 248	827	1930	82.7	827	< 551	< 827	11029	< 13.8
	032 Sira. Åna-Sira	3471	6248	< 6.9	24.30	503	125.0	691	3198	< 694	1041	< 69.4	< 694	< 694	< 1041	10414	27.8

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 (6.)	033 Sokndalselva. Sogndalsstrand	628	1160	1.93	39.64	122	13.5	177	684	< 97	193	19.3	242	< 97	1160	2417	4.83
	034 Hellelandselva. Egersund	580	1516	1.34	8.03	233	11.6	316	688	< 89	178	13.4	223	< 89	178	2229	5.8
	035 Bjerkreimselva. Egersund	1585	3170	5.28	31.70	565	45.8	710	2566	< 352	528	35.2	352	< 352	< 528	5283	19.4
	036 Håelva. Håtangen	1372	1658	3.43	14.58	251	14.0	365	674	200	57	< 5.7	257	57	114	1144	3.43
	038 Figgjo. Solavika	931	1734	5.50	13.96	307	27.9	437	1178	85	169	< 8.5	508	127	169	1269	4.65
	039 Ims-Lutsi. Høgsfjord Boknafjord	185	423	< 0.3	1.72	61	3.8	89	57	< 26	< 13	< 2.6	93	26	53	264	1.06
	040 Oltedalselva Høgsfjord Boknafj.	192	383	< 0.4	3.62	59	3.6	77	456	< 43	< 21	< 4.3	85	< 43	< 64	639	< 1.1
	041 Dirdalselva Høgsfjord Boknafj.	274	900	< 0.8	5.48	79	1.6	112	536	< 78	117	< 7.8	117	< 78	< 117	782	3.52
	042 Fraffjordelva. Fraffjord Boknafj.	351	952	< 1.0	9.02	63	4.5	84	462	< 100	150	< 10.0	< 100	< 100	< 150	501	5.01
	043 Espedalselva. Høgsfj. Boknafj.	< 222	482	< 0.7	1.85	74	2.6	82	770	< 74	< 37	< 7.4	< 74	< 74	< 111	< 370	< 1.9
	044 Lyseelva. Lysefjord Boknafjord	< 245	1064	< 0.8	2.45	9	2.0	37	605	< 82	82	< 8.2	123	< 82	< 123	< 409	2.45
	045 Årdalselva. Årdalsfjord Boknafj.	773	2060	10.30	16.74	197	11.6	276	1766	< 258	< 129	< 25.8	1288	< 258	< 386	< 1288	12.9
	046 Førreelva. Jøsenfjord Boknafj.	< 162	458	< 0.3	0.54	30	0.5	42	577	< 54	< 27	< 5.4	81	< 54	< 81	< 269	2.69
	047 Ulla. Jøsenfjord Boknafjord	< 379	1704	< 0.6	3.16	75	6.9	108	1190	< 126	< 63	< 12.6	189	< 126	< 189	631	3.16
	049 Saudaelva. Saudafjord Boknafj.	471	1178	< 0.8	5.50	525	4.7	562	1683	< 157	< 79	39.3	1099	< 157	< 236	14921	7.85
(7.)	050 Åbøelva. Saudafjord Boknafj.	109	164	< 0.2	0.36	19	0.2	20	149	< 36	< 18	< 3.6	55	< 36	< 55	365	1.46
	051 Vikedalselva. Boknafjord	207	492	< 0.3	2.33	55	0.5	63	216	78	26	< 5.2	104	< 52	< 78	518	2.33
Horda- land (7.)	052 Etneelva. Etnefjord Bømlafjord	< 202	405	< 0.3	1.01	81	0.7	82	289	< 67	< 34	< 6.7	135	< 67	< 101	675	3.04
	053 Opo. Sørfjord Hardangerfjord	3633	748	< 1.1	76.94	118	6.4	124	1122	< 214	641	< 21.4	427	< 214	< 321	3206	10.7
	054 Tysso. Sørfjord Hardangerfjord	< 516	602	5.16	7.74	146	5.2	146	1180	120	34	14.6	439	637	439	2236	< 4.3
	055 Kinso. Sørfjord Hardangerfjord	< 222	148	1.85	17.77	19	5.2	26	119	41	19	1.1	44	144	37	111	< 1.9
	056 Veig. Eidfjord Hardangerfjord	408	408	2.72	2.72	26	8.2	35	933	61	< 7	4.8	95	218	197	272	< 3.4
	057 Bjoreia. Eidfjord Hardangerfjord	368	895	1.58	8.95	40	3.2	45	530	47	32	4.2	147	121	268	474	< 2.6
	058 Sima. Eidfjord Hardangerfjord	< 198	329	0.66	1.32	31	1.0	31	706	16	7	1.0	43	63	59	165	< 1.6
	059 Austdøla. Osafjord Eidfjord	< 192	128	0.64	5.45	18	< 0.3	19	241	19	10	1.3	55	48	19	353	< 1.6
	060 Norddøla. Osafjord Eidfjord	< 59	29	0.10	0.10	10	0.2	13	157	9	< 1	0.2	5	32	8	20	< 0.5
	061 Tysseelva. Fusafjord	438	751	1.25	1.25	59	3.8	128	349	81	113	6.3	231	63	106	751	< 3.1
	062 Oselva. Fusafjord	356	1035	< 0.3	4.85	56	4.5	97	326	55	136	2.6	291	84	136	485	< 1.6
	063 Bergsdalse. Veafjord Herdlafj.	360	824	< 0.5	9.78	51	8.8	98	497	57	113	3.1	263	72	113	515	< 2.6
	064 Vosso. Veafjord Sørfjord	1989	1989	< 2.8	19.89	219	31.3	463	2192	171	< 28	5.7	426	142	< 28	1307	< 14.2
	065 Ekso. Osterfjord	951	1480	< 1.1	6.34	64	9.5	172	634	53	95	6.3	211	63	95	581	5.28
	066 Modalselva. Osterfjord	< 667	889	< 1.1	6.67	137	4.4	194	976	56	100	5.6	167	244	555	1777	< 5.6

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. Aurlandsfj. Sognefj	370	317	< 0.5	24.30	36	3.7	66	1245	16	< 5	1.1	85	21	37	211	< 2.6
	068 Flåmselva. Aurlandsfj. Sognefj.	< 269	135	< 0.4	2.69	38	2.2	40	308	18	< 4	1.8	45	18	81	179	< 2.2
	069 Aurlandelva. Aurlandsfj. Sognefj	832	1189	< 1.2	21.40	103	8.3	130	1121	36	24	2.4	713	48	166	595	< 5.9
	070 Erdalselva. Lærdalsfj. Sognefj.	< 76	38	< 0.1	0.63	2	0.4	6	136	6	< 1	0.1	11	< 3	5	8	< 0.6
	071 Lærdalselva. Lærdalsfj. Sognefj	1066	800	< 1.3	22.66	71	5.3	148	2056	40	< 13	1.3	453	53	147	520	< 6.7
	072 Årdalselva. Årdalsfjord Sognefj.	1688	985	< 1.4	9.85	127	23.9	325	1658	< 70	< 28	< 14.1	1097	< 281	225	2251	< 2.8
	073 Fortunelva. Lusterfj. Sognefj.	1888	575	< 0.8	4.93	83	13.1	124	580	< 41	44	< 8.2	304	< 164	107	< 1231	4.93
	074 Mørkriselva. Lusterfj. Sognefj.	1515	293	< 0.5	2.93	54	2.9	229	230	< 24	10	< 4.9	112	< 98	68	782	3.91
	075 Jostedøla. Lusterfjord Sognefj.	20184	934	3.74	46.72	321	13.1	379	1081	< 93	< 37	< 18.7	123	< 374	< 93	< 934	11
	076 Årøyelva. Sogndalsfj. Sognefj.	1211	771	< 1.1	19.82	268	9.9	340	991	56	< 22	< 11.0	209	< 220	< 55	969	4.4
	077 Sogndalselva Sognd.fj. Sognefj	216	288	< 0.4	2.52	44	2.5	79	147	< 18	50	< 3.6	83	< 72	21	15145	2.88
	078 Gaular. Dalsfjord Bufjord	1223	2904	< 1.5	19.87	330	10.7	468	786	93	46	< 15.3	367	< 306	168	2292	3.06
	079 Jølstra. Førdefjord	< 978	2607	< 1.6	13.03	220	27.7	360	943	83	34	< 16.3	407	< 326	179	3422	9.78
	080 Nausta. Førdefjord	556	1668	2.78	9.04	67	14.6	92	283	51	29	< 7.0	174	< 139	70	1043	4.17
	081 Oselva. Høydsalfjord	756	2875	< 0.8	6.81	23	15.9	100	195	65	46	< 7.6	287	< 151	166	1816	9.08
	082 Hopselva. Hyefjord Nordfjord S	149	224	< 0.2	1.12	14	2.4	15	48	13	13	< 1.9	28	< 37	15	186	2.24
	083 Gjengedalselva. Hyefj. Nordfj.S	280	841	0.40	3.60	67	3.6	63	215	28	21	< 4.0	96	< 80	48	561	4
	084 Breimselva. Gloppenfj. Nordfj.S	1649	1511	2.75	10.99	229	23.4	283	1089	< 69	< 27	< 13.7	289	< 275	77	1154	5.5
	085 Oldenelva. Indre Nordfjord	735	315	< 0.5	4.20	60	4.7	112	450	< 26	< 10	< 5.2	< 26	< 105	< 26	420	6.82
	086 Loenelva. Indre Nordfjord	1348	506	< 0.6	6.18	116	3.9	107	542	< 28	12	< 5.6	107	< 112	< 28	< 281	< 1.1
	087 Stryneelva. Indre Nordfjord	1694	698	< 1.0	6.98	88	16.9	213	811	< 50	< 20	< 10.0	1794	< 199	< 50	< 498	< 5.0
	088 Hornindalselva. Nordfjord N	646	1049	< 0.8	8.07	149	5.7	153	813	< 40	27	< 8.1	210	< 161	186	< 404	< 4.0
Møre og Romsdal (8.)	089 Ørstaelva. Ørsta fjord	309	658	< 0.4	5.03	73	3.9	105	489	< 19	< 8	< 3.9	112	< 77	108	371	1.16
	090 Valldøla. Nordalfjord Storfjord	319	319	< 0.5	4.79	15	3.2	30	490	< 27	< 11	< 5.3	101	< 106	< 27	639	< 1.1
	091 Rauma. Romsdalsfjord Moldefj.	< 756	756	< 1.3	12.60	72	7.6	73	1728	< 63	< 25	< 12.6	151	< 252	< 63	< 630	3.78
	092 Isa. Isfjord Moldefjord	190	158	0.63	3.17	16	1.9	16	428	< 16	7	< 3.2	60	< 63	< 16	< 158	< 0.6
	093 Eira. Eresfjord Moldefjord	< 842	982	1.40	16.83	167	5.6	234	2134	< 70	< 28	< 14.0	337	< 281	< 70	< 701	5.61
	094 Littledalselva Sunndalsfjord	500	300	0.50	6.50	61	2.5	91	1286	< 25	< 10	< 5.0	110	100	< 25	< 250	2.5
	095 Driva. Sunndalsfjord Tingvollfj.	3575	3320	< 2.6	40.86	105	15.3	271	4542	< 128	79	< 25.5	1226	< 511	< 128	< 1277	12.8
	096 Ulvåa. Ålvundfjord	293	796	< 0.4	6.70	100	2.9	171	897	< 21	11	< 4.2	318	< 84	63	461	1.26
	097 Toåa. Todalsfjord	< 325	976	< 0.5	7.59	9	1.6	116	511	< 27	35	< 5.4	195	< 108	< 27	401	2.71
	098 Surna. Surnadalsfjord	1617	6874	< 2.0	34.37	180	22.2	348	2079	< 101	46	< 20.2	1193	< 404	728	< 1011	10.1
	099 Bøvra. Hamnesfjord Halsafjord	353	1720	< 0.4	8.82	19	1.8	83	406	< 22	11	< 4.4	168	< 88	123	< 221	1.32

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 Trondheimsfj.	880	753	0.77	4.97	77	1.7	110	235	26	3	< 1.3	179	47	179	77	0.89
	102 Vigda. Gaulosen Trondheimsfj.	7827	731	0.52	8.52	80	1.6	114	328	37	< 3	< 1.7	209	63	17	< 87	1.39
	103 Gaula. Gaulosen Trondheimsfj.	20470	17168	< 3.3	82.54	205	16.5	677	6438	248	129	< 33.0	6273	825	4622	7924	16.5
	104 Nidelva. Trondheimsfjord	15747	18062	< 4.6	111.15	421	46.3	968	6352	459	< 93	< 46.3	3705	< 926	3612	4215	32.4
	105 Homla. Stjørdalsfj. Trondheimsfj.	173	1428	0.16	3.92	10	3.9	48	239	66	5	< 1.6	157	50	91	124	1.41
Nord-Trøndelag (8.)	106 Stjørdalselva. Stjørdalsfj.Tr.h.fj.	10661	16144	< 3.0	9.14	637	24.4	1048	3198	396	171	36.6	8833	1036	1980	11575	24.4
	107 Gråelva. Stjørdalsfj.Trondh.fj.	925	679	0.53	1.85	106	1.4	229	208	26	5	0.88	132	57	49	76	0.71
	108 Verdalsvassdrag. Trondheimsfj	10509	12261	6.57	26.27	587	30.7	854	2674	394	107	< 21.9	2627	788	1336	1927	21.9
	109 Figga/Leksdalselva. Trondh.fj	20018	11836	2.92	27.76	967	14.6	1189	2067	248	104	< 14.6	1607	570	804	877	13.2
	110 Snåsavassdrag. Trondheimsfj	1769	6914	< 1.6	3.22	307	24.1	466	1447	140	< 32	< 16.1	917	370	547	1335	14.5
	111 Årgårdselva. Namsfjord	11478	26617	3.33	38.26	930	54.9	1464	2959	233	136	< 16.6	1597	699	682	2662	13.3
	112 Namsen. Namsfjord Ø	12648	11444	1.51	19.57	120	13.6	420	1839	181	98	< 15.1	1415	542	843	2861	6.02
	113 Salsvatnelva. Follaifjord	< 907	3928	< 1.5	1.51	82	7.6	199	1360	< 76	39	< 15.1	378	< 302	196	2115	12.1
Nordland (9.)	114 Åbjøra. Bindalsfjord S	1331	4880	< 1.5	127.17	61	8.9	206	951	102	86	< 14.8	503	< 296	222	1227	4.44
	116 Skjerva. Vefsenfjord S	254	551	0.57	1.70	27	3.8	50	239	27	7	< 1.4	100	57	61	119	0.99
	117 Fusta. Vefsenfjord N	2497	2951	1.13	4.54	50	35.2	228	608	1033	28	< 11.3	465	< 227	272	806	3.4
	118 Drevja. Vefsenfjord N	1552	757	0.38	1.89	13	4.2	51	178	42	10	< 3.8	144	79	42	< 189	1.14
	119 Røssåga. Sørfjord	14649	7710	< 3.9	7.71	116	27.0	571	1983	320	96	< 38.5	1658	848	1388	9637	12
	120 Bjerka. Sørfjord	584	1818	0.65	27.92	23	7.8	97	431	43	< 13	< 6.5	435	169	312	506	3.25
	121 Dalselva. Ranafjord N	203	710	0.25	0.51	3	0.5	33	163	< 13	6	< 2.5	145	< 51	132	183	0.51
	122 Ranavassdraget. Ranafjord N	< 3646	7900	12.15	24.31	115	109	796	4818	377	< 122	< 60.8	3342	< 1215	668	4497	12
	123 Fykanåga. Glomfjord	< 549	549	< 0.9	1.83	51	17.4	127	353	< 46	< 18	< 9.1	165	< 183	101	503	3.66
	124 Beiarelva. Beiarfjord Nordfjord	4344	1862	4.65	6.21	25	17.1	169	1529	112	39	< 15.5	450	< 310	419	< 776	< 3.1
	125 Saltdalsvassdrag. Saltdalsfj. S	4452	2968	< 1.9	9.27	32	13.0	249	2584	204	46	< 18.5	742	< 371	909	1336	< 3.7
	126 Sulitjelmavassdrag. Saltdalsfj.	< 989	2308	< 1.6	36.27	16	24.7	178	1060	124	< 33	< 16.5	1813	< 330	346	1616	6.59
	127 Kobbe. Leirfjord Sørfolda N	< 538	628	< 0.9	< 1.8	22	9.9	110	634	< 45	24	< 9.0	117	< 179	99	987	2.69
	128 Skjoma. Ofotfjord S	< 647	2802	< 1.1	2.16	8	14.0	147	1871	119	29	< 10.8	431	< 216	162	895	< 2.2

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
Troms (9.)	129 Spanselva. Astafjord Vågsfjord	< 171	343	< 0.6	< 0.6	4	1.4	31	245	< 14	< 6	< 2.9	117	< 57	< 14	< 143	< 0.6
	130 Salangselva. Astafjord Vågsfj.	< 470	783	< 1.6	< 1.6	23	6.3	89	486	< 39	28	< 7.8	227	< 157	< 39	775	3.13
	131 Rossfjordelva. Malangen	233	667	1.00	1.00	2	2.7	51	143	< 17	< 7	< 3.3	110	< 67	17	< 167	< 0.7
	132 Målselva. Målselv fj. Malangen	< 2034	4407	< 6.8	< 6.8	92	47.5	471	5085	< 170	< 68	< 33.9	1153	< 678	< 170	< 1695	< 7
	133 Barduelva. Målselva	< 1800	3299	6.00	6.00	66	30.0	447	3342	150	63	< 30.0	1140	< 600	< 150	< 1500	< 6
	134 Nordkjøselva. Balsfjord	< 124	228	< 0.4	< 0.4	3	1.0	24	338	18	< 4	< 2.1	83	< 41	21	147	< 0.4
	135 Signaldalselva. Lyngen V	399	797	1.71	3.42	4	4.6	71	867	46	< 11	< 5.7	239	< 114	74	< 285	< 1.1
	136 Skibotnelva. Lyngen	< 397	1059	< 1.3	< 1.3	15	3.3	87	993	< 33	14	< 6.6	344	< 132	662	569	< 1.3
	137 Kåfjordelva. Lyngen Ø	< 173	260	< 0.6	< 0.6	44	2.3	65	680	28	< 6	< 2.9	274	< 58	150	346	< 0.6
	138 Reisa. Reisafjord	1946	3459	4.32	4.32	48	6.5	307	6022	153	< 43	< 21.6	1448	< 432	2075	1297	< 4.3
Finn- mark (10.)	139 Mattiselva. Kåfjord Altafjord	< 258	1159	0.86	0.86	6	1.7	69	589	52	10	< 4.3	339	< 86	129	318	2.15
	141 Tverrelva. Altafjord	176	792	0.53	1.06	7	1.2	43	377	19	4	< 1.8	137	49	65	127	< 0.4
	142 Repparfjordvasdraget. Repparfj	660	4068	< 2.2	3.30	8	15.4	172	1272	74	< 22	< 11.0	2529	297	330	583	3.3
	143 Stabburselva. I. Porsangen V	< 491	2209	1.64	2.45	8	12.3	101	1648	43	< 16	< 8.2	434	< 164	139	900	4.09
	144 Lakselva. I. Porsangen S	5802	2754	1.97	10.82	13	7.9	147	1960	< 49	< 20	< 9.8	610	< 197	364	< 492	2.95
	145 Børselva. I. Porsangen Ø	1315	1315	< 2.6	3.94	7	14.5	118	3945	< 66	< 26	< 13.1	263	< 263	316	1262	10.5
	146 Mattusjåkka. I. Laksefjord V	60	130	< 0.2	< 0.2	10	1.0	11	120	6	41	3.70	45	481	87	471	0.6
	147 Storelva. I. Laksefjord V	< 394	460	< 1.3	2.63	14	2.6	66	1690	< 33	< 13	< 6.6	62	< 131	171	723	3.29
	148 Soussjåkka. I.. Laksefjord V	< 61	132	< 0.2	< 0.2	3	0.5	10	304	< 5	< 2	< 1.0	17	< 20	15	96	1.42
	149 Adamselva. I. Laksefjord Ø	< 366	976	< 1.2	3.66	1	2.4	63	1438	< 31	< 12	< 6.1	159	< 122	61	561	12.2
	150 Tanavassdraget. Tanafjord S	11055	41852	23.69	71.07	24	79.0	1777	35535	505	< 158	< 79.0	5133	2448	3317	67122	47
	151 Vesterelva. Syltefjord	< 474	632	2.37	16.60	6	7.1	78	1694	166	< 16	< 7.9	87	< 158	< 40	< 395	1.58
	152 V. Jakobselva .Y.Varangerfjord	302	1409	1.51	4.53	1	3.5	65	1941	33	< 10	< 5.0	106	101	65	< 252	3.02
	153 Passvikelva. Bøkfj. Varangerfj.	5311	31868	15.18	37.94	30	75.9	1442	21137	1442	341	< 75.9	11382	3946	50079	7588	15.2
	154 Neiden. Munkfjord Varangerfj.	1401	4788	2.34	5.84	< 2	19.9	239	2152	74	< 23	< 11.7	572	< 234	257	724	< 2.3
	155 Grense Jakobselva. Varangerfj.	135	490	0.34	0.51	1	1.0	27	471	30	57	5.4	389	710	1369	761	< 0.3

Appendix X. Tributary Rivers. "Mean" Load 2001

Table X. Tributary Rivers, "Mean" Load 2001

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. Iddefjord	1442	6202	2.16	16.59	250	14.4	504	3091	144	87	14.4	779	389	418	< 72	14.4
	003 Mosselva. Mossesundet	1546	2903	0.63	11.99	47	6.6	214	304	92	38	1.3	57	196	290	< 32	< 1.6
Oslo og Akershus (1.)	004 Hølenelva. Drøbaksundet Ø	212	605	0.60	3.39	68	2.5	105	64	38	< 0.6	0.9	128	72	218	< 6	< 0.3
	005 Årungenelva. Indre Oslofjord	55	126	0.72	1.11	26	0.4	34	46	8	< 0.2	0.2	35	23	23	< 2	1.4
	006 Gjersjøelva. Indre Oslofjord	76	273	0.08	3.49	27	1.2	43	146	8	< 0.4	0.1	55	38	66	< 4	1.6
	007 Ljanselva. Indre Oslofjord	28	79	0.53	0.84	13	0.5	18	103	5	1	0.3	34	18	20	3	< 0.1
	008 Loelva/Alna. Indre Oslofjord	200	194	1.94	3.60	29	7.7	54	237	14	12	1.1	147	40	31	224	0.9
	009 Akerselva. Indre Oslofjord	238	526	0.88	2.25	25	7.8	50	483	33	94	5.1	203	55	43	676	< 0.6
	010 Frognerelva. Indre Oslofjord	37	54	1.09	1.56	25	2.3	32	70	5	1	0.2	78	12	11	46	< 0.1
	011 Lysakerelva. Indre Oslofjord	170	434	0.66	1.70	16	3.4	36	263	13	< 0.9	0.5	74	49	13	< 9	< 0.5
	012 Sandvikselva. I. Oslofjord	246	492	0.78	2.33	68	3.1	97	200	28	< 1.3	1.0	140	91	28	< 13	< 0.6
	013 Åroselva. Indre Oslofjord	133	273	0.06	1.39	39	2.7	58	195	26	< 0.6	0.6	98	167	28	< 6	< 0.3
Buske- rud (2.)	014 Lierelva. Drammensfjord Ø	1921	562	0.91	6.16	74	4.2	105	816	76	5	2.0	161	375	119	< 18	< 0.9
Vestfold (3.)	016 Sandeelva. Sandebukta	662	404	0.21	6.00	26	5.2	51	288	59	< 1	2.0	314	1314	36	135	1.0
	017 Aulielva. Tønsbergfjord	1586	785	< 0.2	8.02	75	173	194	223	1615	< 2	< 1.7	2934	559	478	< 17	3.2
	019 Farriselva. Larvikfjord	234	1539	< 0.3	5.35	107	4.0	184	1577	< 7	< 3	< 3.3	67	33	25	970	< 1.7
Telemark (4.)	021 Tokkeelva. Kragerø	938	4482	3.13	9.38	166	22.9	409	2234	104	73	24.0	375	323	250	2710	< 5.2
Aust- Agder (5.)	022 Gjerstadelva. Søndeledfjord	285	1391	1.07	3.21	51	10.7	144	443	68	54	8.9	146	86	75	749	1.8
	023 Vegårdselva. Sandnesfjord	549	1816	1.27	3.80	41	7.6	137	100	72	30	6.8	173	110	89	507	22.4
	024 Nidelva. Arendal	2648	9456	< 7.6	< 7.6	511	37.8	840	5755	378	416	151	3064	< 76	757	26856	491.7
Vest- Agder (5.)	025 Tovdalselva. Topdalsfjord	1984	6945	< 4.0	< 4.0	185	29.8	470	765	218	258	59.5	476	< 40	536	5556	49.6
	027 Søgneelva. Flekkerøy	269	1125	0.98	1.71	122	14.2	194	335	44	115	14.7	139	< 5	149	1222	5.1
	028 Mandalselva. Mannefjord	2624	8398	< 5.2	< 5.2	459	57.7	724	2024	210	682	79	551	< 52	472	5747	115.5
	029 Audna. Sniksfjord	1916	4087	< 1.3	16.60	125	11.5	292	835	192	447	38.3	255	< 128	< 192	4470	7.7
	030 Lygna. Lyngdalsfjord	4523	5327	< 2.0	25.13	161	46.2	359	1055	201	1307	100.5	603	< 201	< 302	5026	< 5.0
	031 Kvina. Fedafjord	7612	16274	< 5.2	120.74	333	97.1	971	< 236	787	1837	78	787	< 525	< 787	10499	< 13.1
	032 Sira. Åna-Sira	3589	6460	< 7.2	25.12	520	129	714	3307	< 718	1077	< 71	< 717	< 718	< 1077	10767	28.7

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 (6.)	033 Sokndalselva. Sogndalsstrand	616	1137	1.90	38.85	120	13.3	174	670	< 95	190	19.0	237	< 95	1137	2369	4.7
	034 Hellelandselva. Egersund	568	1486	1.31	7.87	229	11.4	309	674	< 87	175	13.1	219	< 87	175	2185	5.7
	035 Bjerkreimselva. Egersund	1555	3109	5.18	31.09	555	44.9	696	2517	< 345	518	34.5	345	< 345	< 518	5182	19.0
	036 Håelva. Håtangen	1171	1415	2.93	12.45	214	12.0	312	575	171	49	< 4.9	220	49	98	976	2.9
	038 Figgjo. Solavika	794	1480	4.69	11.92	262	23.8	373	1006	72	144	< 7.2	433	108	144	1083	4.0
	039 Ims-Lutsi. Høgsfjord Boknafjord	196	447	< 0.3	1.82	64	4.1	94	60	< 28	< 14	< 2.8	98	28	56	280	1.1
	040 Oltedalselva Høgsfjord Boknafj.	203	405	< 0.5	3.83	63	3.8	82	483	< 45	< 23	< 4.5	90	< 45	< 68	676	< 1.1
	041 Dirdalselva Høgsfjord Boknafj.	289	951	< 0.8	5.79	83	1.7	119	567	< 83	124	< 8.3	124	< 83	< 124	827	3.7
	042 Frafjordelva. Frafjord Boknafj.	371	1007	< 1.1	9.54	67	4.8	88	488	< 106	159	< 10.6	< 106	< 106	< 159	530	5.3
	043 Espedalselva. Høgsfj. Boknafj.	< 235	509	< 0.8	1.96	78	2.7	87	814	< 78	< 39	< 7.8	< 78.3	< 78	< 118	< 392	< 2.0
	044 Lyseelva. Lysefjord Boknafjord	< 255	1104	< 0.8	2.55	10	2.1	39	628	< 85	85	< 8.5	127	< 85	< 127	< 425	2.5
	045 Årdalselva. Årdalsfjord Boknafj.	799	2132	10.66	17.32	204	12.0	285	1827	< 266	< 133	< 26.6	1332	< 266	< 400	< 1332	13.3
	046 Førreelva. Jøsenfjord Boknafj.	< 265	750	< 0.4	0.88	49	0.9	69	945	< 88	< 44	< 8.8	132	< 88	< 132	< 441	4.4
	047 Ulla. Jøsenfjord Boknafjord	< 620	2791	< 1.0	5.17	123	11.4	177	1949	< 207	< 103	< 20.7	310	< 207	< 310	1034	5.2
	049 Saudaelva. Saudafjord Boknafj.	568	1419	< 0.9	6.62	633	5.7	678	2028	< 189	< 95	47.3	1325	< 189	< 284	17979	9.5
(7.)	050 Åbøelva. Saudafjord Boknafj.	132	198	< 0.2	0.44	23	0.2	24	179	< 44	< 22	< 4.4	66	< 44	< 66	440	1.8
	051 Vikedalselva. Boknafjord	238	566	< 0.3	2.68	63	0.6	72	249	89	30	< 6.0	119	< 60	< 89	595	2.7
Horda- land (7.)	052 Etneelva. Etnefjord Bømlafjord	< 233	465	< 0.4	1.16	93	0.8	95	332	< 78	< 39	< 7.8	155	< 78	< 116	776	3.5
	053 Opo. Sørfjord Hardangerfjord	4098	844	< 1.2	86.79	133	7.2	140	1266	< 241	723	< 24.1	482	< 241	< 362	3616	12.1
	054 Tysso. Sørfjord Hardangerfjord	< 582	679	5.82	8.73	165	5.8	165	1331	136	39	16.5	495	718	495	2523	< 4.9
	055 Kinso. Sørfjord Hardangerfjord	< 245	163	2.04	19.57	20	5.7	29	131	45	20	1.2	49	159	41	122	< 2.0
	056 Veig. Eidfjord Hardangerfjord	392	392	2.62	2.62	25	7.8	34	897	59	< 7	4.6	92	209	190	262	< 3.3
	057 Bjoreia. Eidfjord Hardangerfjord	340	825	1.46	8.25	37	2.9	42	489	44	29	3.9	136	112	248	437	< 2.4
	058 Sima. Eidfjord Hardangerfjord	< 190	316	0.63	1.27	30	0.9	30	678	16	6	0.9	41	60	57	158	< 1.6
	059 Austdøla. Osafjord Eidfjord	< 185	123	0.62	5.24	17	< 0.3	18	231	18	9	1.2	52	46	18	339	< 1.5
	060 Norddøla. Osafjord Eidfjord	< 56	28	0.09	0.09	9	0.2	13	151	8	< 1	0.2	5	31	8	19	< 0.5
	061 Tysseelva. Fusafjord	450	772	1.29	1.29	60	3.9	132	358	84	116	6.4	238	64	109	772	< 3.2
	062 Oselva. Fusafjord	347	1009	< 0.3	4.73	55	4.4	95	317	54	132	2.5	284	82	132	473	< 1.6
	063 Bergsdalse. Veafjord Herdlafj.	350	799	< 0.5	9.49	50	8.5	95	482	55	110	3.0	255	70	110	500	< 2.5
	064 Vosso. Veafjord Sørfjord	1917	1917	< 2.7	19.17	211	30.1	446	2112	164	< 27	5.5	411	137	< 27	1260	< 13.7
	065 Ekso. Osterfjord	1013	1576	< 1.1	6.75	69	10.1	183	675	56	101	6.8	225	68	101	619	5.6
	066 Modalselva. Osterfjord	< 696	928	< 1.2	6.96	143	4.6	203	1019	58	104	5.8	174	255	580	1855	< 5.8

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. Aurlandsfj. Sognefj	381	326	< 0.5	25.03	38	3.8	68	1283	16	< 5	1.1	87	22	38	218	< 2.7
	068 Flåmselva. Aurlandsfj. Sognefj.	< 278	139	< 0.5	2.78	39	2.3	42	317	19	< 5	1.9	46	19	83	185	< 2.3
	069 Aurlandelva..Aurlandsfj.Sognefj	858	1226	< 1.2	22.07	107	8.6	134	1156	37	25	2.5	736	49	172	613	< 6.1
	070 Erdalselva. Lærdalsfj. Sognefj.	< 78	39	< 0.1	0.65	2	0.4	7	140	7	< 1	0.1	12	< 3	5	8	< 0.7
	071 Lærdalselva. Lærdalsfj.Sognefj	896	672	< 1.1	19.04	59	4.5	124	1728	34	< 11	1.1	381	45	123	437	< 5.6
	072 Årdalselva. Årdalsfjord Sognefj.	1680	980	< 1.4	9.80	126	23.8	323	1650	< 70	< 28	< 14.0	1092	< 280	224	2241	< 2.8
	073 Fortunelva. Lusterfj. Sognefj.	1879	572	< 0.8	4.90	83	13.1	123	578	< 41	43	< 8.2	302	< 163	106	< 1226	4.9
	074 Mørkriselva. Lusterfj. Sognefj.	1508	292	< 0.5	2.92	54	2.9	228	229	< 24	10	< 4.9	112	< 97	68	778	3.9
	075 Jostedøla. Lusterfjord Sognefj.	20033	927	3.71	46.37	319	13.0	377	1073	< 93	< 37	< 18.5	122	< 371	< 93	< 927	11.1
	076 Årøyelva. Sogndalsfj. Sognefj.	1202	765	< 1.1	19.68	266	9.8	338	984	56	< 22	< 10.9	208	< 219	< 55	962	4.4
	077 Sogndalselva Sognd.fj. Sognefj	219	292	< 0.4	2.55	45	2.6	80	149	< 18	51	< 3.6	84	< 73	21	15321	2.9
	078 Gaular. Dalsfjord Bufjord	1254	2979	< 1.6	20.38	339	11.0	480	806	96	47	< 15.7	376	< 314	172	2352	3.1
	079 Jølstra. Førdefjord	<1004	2677	< 1.7	13.38	226	28.4	370	968	85	35	< 16.7	418	< 335	184	3513	10.0
	080 Nausta. Førdefjord	571	1713	2.85	9.28	69	15.0	94	291	52	30	< 7.1	178	< 143	71	1071	4.3
	081 Oselva. Høydsalfjord	712	2707	< 0.7	6.41	22	15.0	94	183	61	43	< 7.1	271	< 142	157	1710	8.5
	082 Hopselva. Hyefjord Nordfjord S	138	207	< 0.2	1.04	13	2.2	14	44	12	12	< 1.7	26	< 35	14	173	2.1
	083 Gjengedalselva. Hyefj. Nordfj.S	281	844	0.40	3.62	68	3.6	64	215	28	21	< 4.0	97	< 80	48	563	4.0
	084 Breimselva. Gloppenfj. Nordfj.S	1637	1500	2.73	10.91	228	23.2	281	1081	< 68	< 27	< 13.6	286	< 273	76	1146	5.5
	085 Oldenelva. Indre Nordfjord	699	300	< 0.5	4.00	57	4.5	107	428	< 25	< 10	< 5.0	< 25.0	< 100	< 25	400	6.5
	086 Loenelva. Indre Nordfjord	1284	482	< 0.5	5.89	111	3.7	102	516	< 27	11	< 5.4	102	< 107	< 27	< 268	< 1.1
	087 Stryneelva. Indre Nordfjord	1714	706	< 1.0	7.06	89	17.1	216	821	< 50	< 20	< 10.1	1815	< 202	< 50	< 504	< 5.0
	088 Hornindalselva. Nordfjord N	627	1019	< 0.8	7.84	145	5.5	149	790	< 39	26	< 7.8	204	< 157	180	< 392	< 3.9
Møre og Romsdal (8.)	089 Ørstaelva. Ørsta fjord	283	600	< 0.4	4.59	66	3.5	96	447	< 18	< 7	< 3.5	102	< 71	99	339	1.1
	090 Valldøla. Nordalfjord Storfjord	408	408	< 0.7	6.11	20	4.1	38	626	< 34	< 14	< 6.8	129	< 136	< 34	815	< 1.4
	091 Rauma. Romsdalsfjord Moldefj.	< 746	746	< 1.2	12.43	71	7.5	72	1705	< 62	< 25	< 12.4	149	< 249	< 62	< 622	3.7
	092 Isa. Isfjord Moldefjord	189	157	0.63	3.15	16	1.9	16	425	< 16	7	< 3.1	60	< 63	< 16	< 157	< 0.6
	093 Eira. Eresfjord Moldefjord	< 737	860	1.23	14.74	146	4.9	205	1868	< 61	< 25	< 12.3	295	< 246	< 61	< 614	4.9
	094 Littledalselva Sunndalsfjord	464	279	0.46	6.03	57	2.3	84	1194	< 23	< 9	< 4.6	102	93	< 23	< 232	2.3
	095 Driva.Sunndalsfjord Tingvollfj.	3063	2845	< 2.2	35.01	90	13.1	232	3892	< 109	68	< 21.9	1050	< 438	< 109	< 1094	10.9
	096 Ulvåa. Ålvundfjord	250	680	< 0.4	5.72	85	2.5	146	767	< 18	9	< 3.6	272	< 72	54	393	1.1
	097 Toåa. Todalsfjord	< 278	834	< 0.5	6.48	8	1.4	99	437	< 23	30	< 4.6	167	< 93	< 23	343	2.3
	098 Surna. Surnadalsfjord	1453	6176	< 1.8	30.88	162	20.0	312	1868	< 91	42	< 18.2	1072	< 363	654	< 908	9.1
	099 Bøvra. Hamnesfjord Halsafjord	337	1644	< 0.4	8.43	18	1.7	79	388	< 21	11	< 4.2	160	< 84	118	< 211	1.3

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 Trondheimsfj.	718	614	0.62	4.06	63	1.4	89	192	21	2	< 1.0	146	39	146	62	0.7
	102 Vigda. Gaulosen Trondheimsfj.	6386	596	0.43	6.95	65	1.3	93	268	30	< 3	< 1.4	170	51	13	< 71	1.1
	103 Gaula. Gaulosen Trondheimsfj.	18887	15841	< 3.0	76.16	189	15.2	624	5940	228	119	< 30.5	5788	762	4265	7311	15.2
	104 Nidelva. Trondheimsfjord	11838	13579	< 3.5	83.56	317	34.8	728	4775	345	< 70	< 34.8	2785	< 696	2716	3168	24.4
	105 Homla. Stjørdalsfj. Trondheimsfj.	163	1352	0.15	3.71	10	3.7	45	226	62	5	< 1.5	149	48	86	117	1.3
Nord-Trøndelag (8.)	106 Stjørdalselva. Stjørdalsfj.Tr.h.fj.	8996	13623	< 2.6	7.71	537	20.6	884	2699	334	144	30.8	7454	874	1671	9767	20.6
	107 Gråelva. Stjørdalsfj.Trondh.fj.	770	565	0.44	1.54	88	1.2	191	173	22	4	0.73	110	48	41	63	0.6
	108 Verdalsvassdrag. Trondheimsfj	8913	10398	5.57	22.28	498	26.0	724	2268	334	91	< 18.6	2228	668	1133	1634	18.6
	109 Figga/Leksdalselva. Trondh.fj	18849	11145	2.75	26.14	911	13.8	1120	1946	234	98	< 13.8	1513	537	757	826	12.4
	110 Snåsavassdrag. Trondheimsfj	1514	5918	< 1.4	2.75	263	20.6	399	1239	120	< 28	< 13.8	785	317	468	1142	12.4
	111 Årgårdselva. Namsfjord	9497	22023	2.75	31.66	769	45.4	1211	2448	193	113	< 13.8	1321	578	564	2202	11.0
	112 Namsen. Namsfjord Ø	11558	10457	1.38	17.89	110	12.4	384	1681	165	89	< 13.8	1293	495	771	2614	5.5
	113 Salsvatnelva. Folla fjord	< 824	3571	< 1.4	1.37	74	6.9	181	1236	< 69	36	< 13.7	343	< 275	179	1923	11.0
Nordland (9.)	114 Åbjøra. Bindalsfjord S	1197	4390	< 1.3	114.41	55	8.0	185	855	92	77	< 13.3	452	< 266	200	1104	4.0
	116 Skjerva. Vefsenfjord S	244	528	0.54	1.63	26	3.7	48	229	26	7	< 1.4	96	54	58	114	0.9
	117 Fusta. Vefsenfjord N	2393	2828	1.09	4.35	48	33.7	219	583	990	27	< 10.9	446	< 218	261	772	3.3
	118 Drevja. Vefsenfjord N	1488	726	0.36	1.81	12	4.0	49	171	40	9	< 3.6	138	76	40	< 181	1.1
	119 Røssåga. Sørfjord	11382	5990	< 3.0	5.99	90	21.0	443	1540	249	75	< 30.0	1288	659	1078	7488	9.0
	120 Bjerka. Sørfjord	605	1883	0.67	28.92	24	8.1	100	447	45	< 13	< 6.7	451	175	323	525	3.4
	121 Dalselva. Ranafjord N	210	736	0.26	0.53	3	0.5	34	169	< 13	6	< 2.6	150	< 53	137	189	0.5
	122 Ranavassdraget. Ranafjord N	< 3268	7081	10.89	21.79	103	98.1	714	4319	338	< 109	< 54.5	2996	< 1089	599	4031	10.9
	123 Fykanåga. Glomfjord	< 583	583	< 1.0	1.94	54	18.5	135	375	< 49	< 19	< 9.7	175	< 194	107	534	3.9
	124 Beiarelva. Beiarfjord Nordfjord	4237	1816	4.54	6.05	24	16.6	165	1492	109	38	< 15.1	439	< 303	409	< 757	< 3.0
	125 Saltdalsvassdrag. Saltdalsfj. S	3751	2501	< 1.6	7.81	27	10.9	209	2177	172	39	< 15.6	625	< 313	766	1125	< 3.1
	126 Sulitjelmavassdrag. Saltdalsfj.	< 856	1997	< 1.4	31.38	14	21.4	154	917	107	< 29	< 14.3	1569	< 285	300	1398	5.7
	127 Kobbe. Leirfjord Sørfolda N	< 513	598	< 0.9	< 1.7	21	9.4	105	604	< 43	23	< 8.5	111	< 171	94	940	2.6
	128 Skjoma. Ofotfjord S	< 580	2515	< 1.0	1.93	7	12.6	132	1679	106	26	< 9.7	387	< 193	145	803	< 1.9

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. Astafjord Vågsfjord	< 134	269	< 0.4	< 0.4	3	1.1	24	192	< 11	< 4	< 2.2	92	< 45	< 11	< 112	< 0.4
	130 Salangselva. Astafjord Vågsfj.	< 417	695	< 1.4	< 1.4	20	5.6	79	432	< 35	25	< 7.0	202	< 139	< 35	688	2.8
	131 Rossfjordelva. Malangen	171	488	0.73	0.73	1.2	2.0	37	105	< 12	< 5	< 2.4	81	< 49	12	< 122	< 0.5
	132 Målselva. Målselv fj. Malangen	< 1759	3811	< 5.9	< 5.9	79	41.0	407	4397	< 147	< 59	< 29.3	997	< 586	< 147	< 1466	< 6
	133 Barduelva. Målselva	< 1556	2853	5.19	5.19	57	25.9	386	2890	130	54	< 25.9	986	< 519	< 130	< 1297	< 5
	134 Nordkjøselva. Balsfjord	< 100	184	< 0.3	< 0.3	2	0.8	19	272	15	< 3	< 1.7	67	< 33	17	118	< 0.3
	135 Signaldalselva. Lyngen V	289	578	1.24	2.48	3	3.3	51	629	33	< 8	< 4.1	174	< 83	54	< 207	< 0.8
	136 Skibotnelva. Lyngen	< 262	699	< 0.9	< 0.9	10	2.2	57	656	< 22	9	< 4.4	227	< 87	437	376	< 0.9
	137 Kåfjordelva. Lyngen Ø	< 135	203	< 0.5	< 0.5	35	1.8	51	532	22	< 5	< 2.3	215	< 45	117	271	< 0.5
	138 Reisa. Reisafjord	1227	2181	2.73	2.73	30	4.1	194	3798	97	< 27	< 13.6	913	< 273	1309	818	< 2.7
Finn- mark (10.)	139 Mattiselva. Kåfjord Altafjord	< 163	733	0.54	0.54	4	1.1	43	372	33	7	< 2.7	215	< 54	81	201	1.4
	141 Tverrelva. Altafjord	111	501	0.33	0.67	4	0.8	27	239	12	3	< 1.1	87	31	41	80	< 0.2
	142 Repparfjordvasdraget. Repparfj	516	3180	< 1.7	2.58	6	12.0	134	994	58	< 17	< 8.6	1977	232	258	455	2.6
	143 Stabburselva. I. Porsangen V	< 384	1726	1.28	1.92	6	9.6	79	1288	34	< 13	< 6.4	339	< 128	109	703	3.2
	144 Lakselva. I. Porsangen S	4535	2152	1.54	8.46	10	6.1	115	1532	< 38	< 15	< 7.7	477	< 154	284	< 384	2.3
	145 Børselva. I. Porsangen Ø	830	830	< 1.7	2.49	4	9.1	75	2489	< 41	< 17	< 8.3	166	< 166	199	797	6.6
	146 Mattusjåkka. I. Laksefjord V	44	94	< 0.1	< 0.1	7	0.7	8	87	5	30	2.69	33	349	63	341	0.4
	147 Storelva. I. Laksefjord V	< 286	334	< 1.0	1.91	10	1.9	48	1225	< 24	< 10	< 4.8	45	< 95	124	524	2.4
	148 Soussjåkka. I.. Laksefjord V	< 44	95	< 0.1	< 0.1	2	0.4	7	220	< 4	< 1	< 0.7	12	< 15	11	70	1.0
	149 Adamselva. I. Laksefjord Ø	< 265	708	< 0.9	2.65	0.9	1.8	46	1043	< 22	< 9	< 4.4	115	< 88	44	407	8.8
	150 Tanavassdraget. Tanafjord S	8321	31502	17.83	53.49	18	59.4	1337	26747	380	< 119	< 59.4	3863	1843	2496	50521	35.7
	151 Vesterelva. Syltefjord	< 307	409	1.54	10.75	4	4.6	51	1097	107	< 10	< 5.1	56	< 102	< 26	< 256	1.0
	152 V. Jakobselva .Y.Varangerfjord	215	1002	1.07	3.22	0.7	2.5	46	1380	24	< 7	< 3.6	75	72	47	< 179	2.1
	153 Passvikelva. Bøkfj. Varangerfj.	3778	22670	10.80	26.99	22	54.0	1026	15036	1026	243	< 54.0	8096	2807	35624	5398	10.8
	154 Neiden. Munkfjord Varangerfj.	1098	3751	1.83	4.57	< 2	15.6	188	1686	58	< 18	< 9.1	448	< 183	201	567	< 1.8
	155 Grense Jakobselva. Varangerfj.	106	385	0.27	0.40	0.4	0.8	22	370	24	45	4.3	306	558	1076	598	< 0.3

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 runoff 1961-1990, main river, 1931-1960, tributary rivers)

		Area runoff	Fish farming	Direct dis- charges	Tributary inputs	Main river- ine inputs	Grand total
S.P.M.	*	-	-	702 491	240 993	258 956	1 202 4409 tonnes
	**	-	-	702 491	260 113	262 230	1 224 833
TOC		-	-	249	375 435	220 555	596 239 tonnes
Orthoph.	*	194	709	535	150	265	1 853 tonnes
	**	194	709	535	257	270	1 965
Total P	*	792	3 937	1 150	1 650	1 475	9 004 tonnes
	**	792	3 937	1 150	1 678	1 477	9 034
Nitrates	*	15 531	-	53	15 522	13 095	44 201 tonnes
	**	15 531	-	53	15 524	13 095	44 203
Ammonia	*	1 398	6 007	8 346	1 966	1 229	18 946 tonnes
	**	1 398	6 007	8 346	1 967	1 235	18 953
Total N		24 403	18 772	14 668	31 548	22 930	112 321 tonnes
Silicate SiO₂	*	-	-	-	190 490	184 967	375 457 tonnes
	**	-	-	-	190 726	185 012	375 738
Arsenic	*	-	-	0.9	12	8	21 tonnes
	**	-	-	0.9	17	8	26
Lead	*	-	-	10	11	9	30 tonnes
	**	-	-	10	13	9	32
Cadmium	*	-	-	0.5	0.8	0.7	2.0 tonnes
	**	-	-	0.5	1.9	0.9	3.3
Copper	*	-	-	26	84	66	176 tonnes
	**	-	-	26	85	66	177
Total Cr-T	*	-	-	3.9	18	11	33 tonnes
	**	-	-	3.9	33	15	52
Nickel	*	-	-	21	70	30	121 tonnes
	**	-	-	21	77	30	128
Zinc	*	-	-	62	270	244	576 tonnes
	**	-	-	62	285	245	592
Mercury	*	-	-	49	1 221	340	1 610 kg
	**	-	-	49	1 357	500	1 906
Lindane	*	-	-	-	-	26	26 kg
	**	-	-	-	-	26	26

Measurements below detection limits are treated in two ways

*Detection limit = zero, ** Detection limit = limit

Table XI.I Mean total discharges to the Skagerrak Region

(Mean runoff 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 Fish farm- runoff	ing	Direct dis- charges	Tributary inputs	Main river- ine inputs	Grand total
S.P.M.	*			3 321	35 724	238 190	277 235 tonnes
	**			3 321	35 724	239 607	278 652
TOC				21	81 210	184 712	265 943 tonnes
Orthoph.	*	22	0.1	83	18	207	330 tonnes
	**	22	0.1	83	51	211	367
Total P	*	88	0	228	281	1 270	1 867 tonnes
	**	88	0	228	298	1 272	1 886
Nitrates		1 967	-	21	3 588	11 458	17 034 tonnes
Ammonia	*	182	1	3 442	703	1 140	5 468 tonnes
	**	182	1	3 442	703	1 141	5 469
Total N		3 026	2	5 639	7 035	19 662	35 364 tonnes
Silicate SiO₂	*			-	24 959	154 783	179 742 tonnes
	**			-	25 195	154 783	179 978
Arsenic	*			0.2	4	6	10 tonnes
	**			0.2	5	6	11
Lead	*			0.9	7	8	16 tonnes
	**			0.9	7	8	16
Cadmium	*			0.07	0.6	0.5	1.2 tonnes
	**			0.07	0.7	0.7	1.5
Copper	*			13	12	50	75 tonnes
	**			13	13	50	76
Total Cr-T	*			1.6	4	8	14 tonnes
	**			1.6	6	11	19
Nickel	*			2.2	4	25	31 tonnes
	**			2.2	7	25	34
Zinc	*			13	76	157	246 tonnes
	**			13	76	157	246
Mercury	*			23	745	296	1 064 kg
	**			23	775	427	1 225
Lindane				-	-	24	24 kg

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 runoff 1961-1990, main river, 1931-1960, tributary rivers)

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

		Area runoff	Fish farm- ing	Direct dis- charges	Tributary inputs	Main river- ine inputs	Grand total
S.P.M.	*			66 791	53 984	2 257	123 032 tonnes
	**			66 791	58 904	3 354	129 049
TOC				148	53 109	5 501	58 758 tonnes
Orthoph.	*	51	303	178	51	8	591 tonnes
	**	51	303	178	80	8	620
Total P		198	1683	379	588	54	2 902 tonnes
Nitrates		5 897	-	16	6 455	674	13 042 tonnes
Ammonia	*	524	2564	2 347	462	25	5 922 tonnes
	**	524	2564	2 347	463	26	5 924
Total N		9 369	8013	4 608	9 210	910	32 110 tonnes
Silicate SiO₂	*			-	41 560	3 253	44 813 tonnes
	**			-	41 560	3 298	44 858
Arsenic	*			0.2	1.6	0.2	2.0 tonnes
	**			0.2	4.2	0.2	4.6
Lead	*			5.5	3	0.1	9 tonnes
	**			5.5	4	0.2	10
Cadmium	*			0.3	0.2	0.01	0.5 tonnes
	**			0.3	0.5	0.03	0.9
Copper	*			5.1	15	0.8	21 tonnes
	**			5.1	15	0.8	21
Total Cr-T	*			1.3	2	0.1	3 tonnes
	**			1.3	8	0.5	10
Nickel	*			16	5	0.7	22 tonnes
	**			16	9	0.8	26
Zinc	*			35	80	5	120 tonnes
	**			35	85	5	125
Mercury	*			14	178	4	196 kg
	**			14	255	12	281
Lindane				-	-	1.3	1.3 kg

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 runoff 1961-1990, main river, 1931-1960, tributary rivers)

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

		Area runoff	Fish farm- ing	Direct dis- charges	Tributary inputs	Main riv- erine in- puts	Grand total
S.P.M.	*			400 223	131 732	15 659	547 614 tonnes
	**			400 223	144 481	16 050	560 754
TOC				80	171 043	20 584	191 707 tonnes
Orthoph.	*	103	353	254	45	21	776 tonnes
	**	103	353	254	83	22	815
Total P	*	419	1962	508	659	100	3 648 tonnes
	**	419	1962	508	670	100	3 659
Nitrates		6 652	-	15	5 381	774	12 822 tonnes
Ammonia	*	607	3000	2 363	620	41	6 631 tonnes
	**	607	3000	2 363	620	46	6 636
Total N		10 327	9375	4 160	12 053	1 790	37 705 tonnes
Silicate SiO₂				-	68 165	14 279	82 444 tonnes
Arsenic	*			0.6	4.7	1.0	6.3 tonnes
	**			0.6	5.5	1.0	7.1
Lead	*			3.7	1.3	0.3	5.3 tonnes
	**			3.7	1.7	0.3	5.7
Cadmium	*			0.07	0.03	0.13	0.2 tonnes
	**			0.07	0.57	0.18	0.8
Copper				8	41	14.1	63 tonnes
Total Cr-T	*			0.9	5	2	8 tonnes
	**			0.9	13	2	16
Nickel	*			2.3	20	3	25 tonnes
	**			2.3	21	3	26
Zinc	*			12	54	80	146 tonnes
	**			12	62	80	154
Mercury	*			10.5	219	27	257 kg
	**			10.5	247	42	300
Lindane				-	-	1	1 kg

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 runoff 1961-1990, main river, 1931-1960, tributary rivers)

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

		Area runoff	Fish farm- ing	Direct dis- charges	Tributary inputs	Main river- ine inputs	Grand total	
S.P.M.	*			232 156	19 554	3 394	255 104	tonnes
	**			232 156	21 003	3 394	256 553	
TOC				-	70 073	9 759	79 832	tonnes
Orthoph.	*	18	53	20	37	29	157	tonnes
	**	18	53	20	43	29	163	
Total P	*	88	292	35	121	52	588	tonnes
	**	88	292	35	121	52	588	
Nitrates	*	1 015	-	1	99	189	1 304	tonnes
	**	1 015	-	1	101	189	1 306	
Ammonia	*	85	442	194	180	22	923	tonnes
	**	85	442	194	180	23	924	
Total N		1 681	1382	260	3 250	568	7 141	tonnes
Silicate SiO₂				-	55 806	12 651	68 457	tonnes
Arsenic	*			-	1.8	0.6	2.4	tonnes
	**			-	1.9	0.6	2.5	
Lead	*			0.05	0.33	0.05	0.43	tonnes
	**			0.05	0.56	0.07	0.68	
Cadmium	*			0.0003	0.01	0.02	0.03	tonnes
	**			0.0003	0.18	0.04	0.22	
Copper	*			0.69	16.3	1.3	18.3	tonnes
	**			0.69	16.3	1.4	18.4	
Total Cr-T	*			0.08	5.9	1.2	7.2	tonnes
	**			0.08	6.9	1.3	8.3	
Nickel	*			0.083	40.7	0.9	41.7	tonnes
	**			0.083	40.7	1.0	41.7	
Zinc	*			1.0	60.7	1.4	63.1	tonnes
	**			1.0	61.5	2.0	64.5	
Mercury	*			1.2	78	13	92	kg
	**			1.2	81	19	101	
Lindane	*			-	-	0.4	0.4	kg
	**			-	-	0.6	0.6	

Measurements below detection limits are treated in two ways

*Detection limit = zero, ** Detection limit = limit

Appendix XII. Fish farming effluents to convention water 2001

Table XII	Fish farming effluents from down stream areas of mainland Norway to convention waters (2001)
Table XII.I	Fish farming effluents to the Skagerrak region (2001)
Table XII.II	Fish farming effluents to the Remaining North Sea region(2001)
Table XII.III	Fish farming effluents to the Norwegian Sea region (2001)
Table XII.IV	Fish farming effluents to the Barents Sea region (2001)

**Table XII Fish Farming Effluents from down stream areas of
mainland Norway to convention waters (2001)**

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	0.3	
	N	1.5	
	PO4-P	0.1	
	NH4-N	0.5	
5 Otra	P	0.0	
	N	0.1	
	PO4-P	0.0	
	NH4-N	0.0	
6 Orreelva	P	203.5	
	N	966.0	
	PO4-P	36.6	
	NH4-N	309.1	
7 Suldalslågen	P	1479.6	
	N	7047.0	
	PO4-P	266.3	
	NH4-N	2255.0	
8 Orkla	P	742.2	
	N	3532.2	
	PO4-P	133.6	
	NH4-N	1130.3	
9 Vefsna	P	1219.9	
	N	5843.1	
	PO4-P	219.6	
	NH4-N	1869.8	
10 Altaelva	P	292.0	
	N	1381.6	
	PO4-P	52.6	
	NH4-N	442.1	
SUM	P	3937	tonnes
SUM	N	18772	tonnes
SUM	PO4-P	709	tonnes
SUM	NH4-N	6007	tonnes

Appendix XIII. Mean Concentrations and loads from 1990 to 2001. 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.

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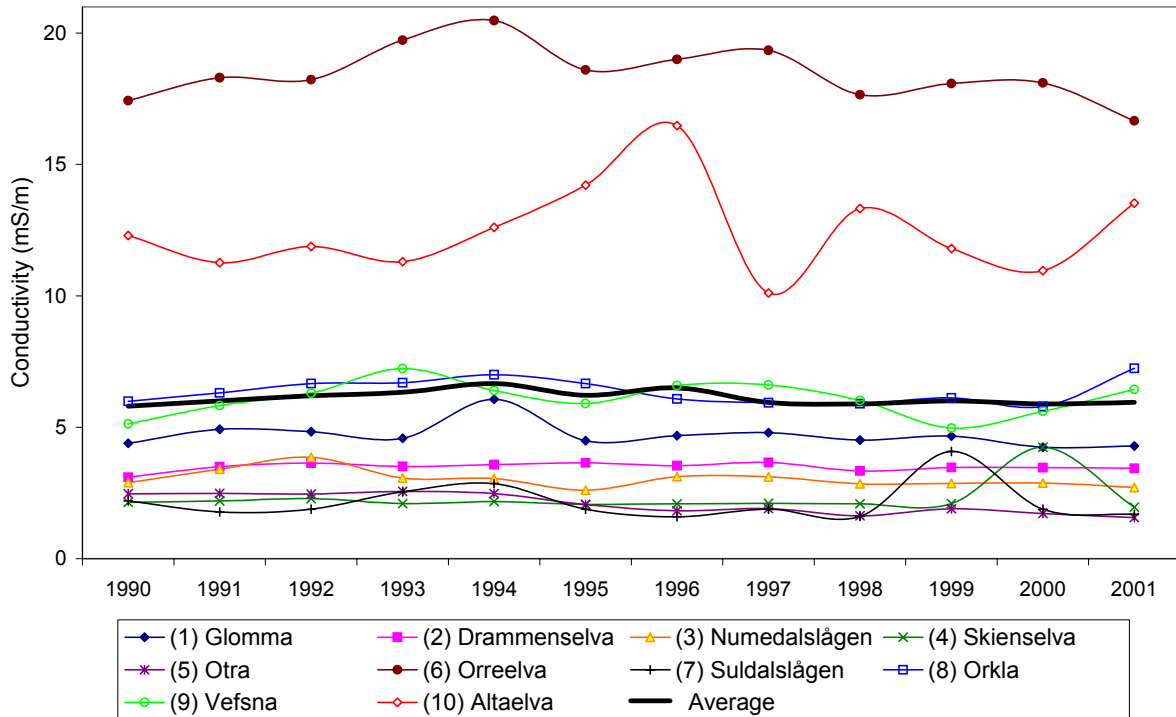


Figure XIII.I Specific conductivity in main rivers.
Mean value from 1990 to 2001 (mS/m).

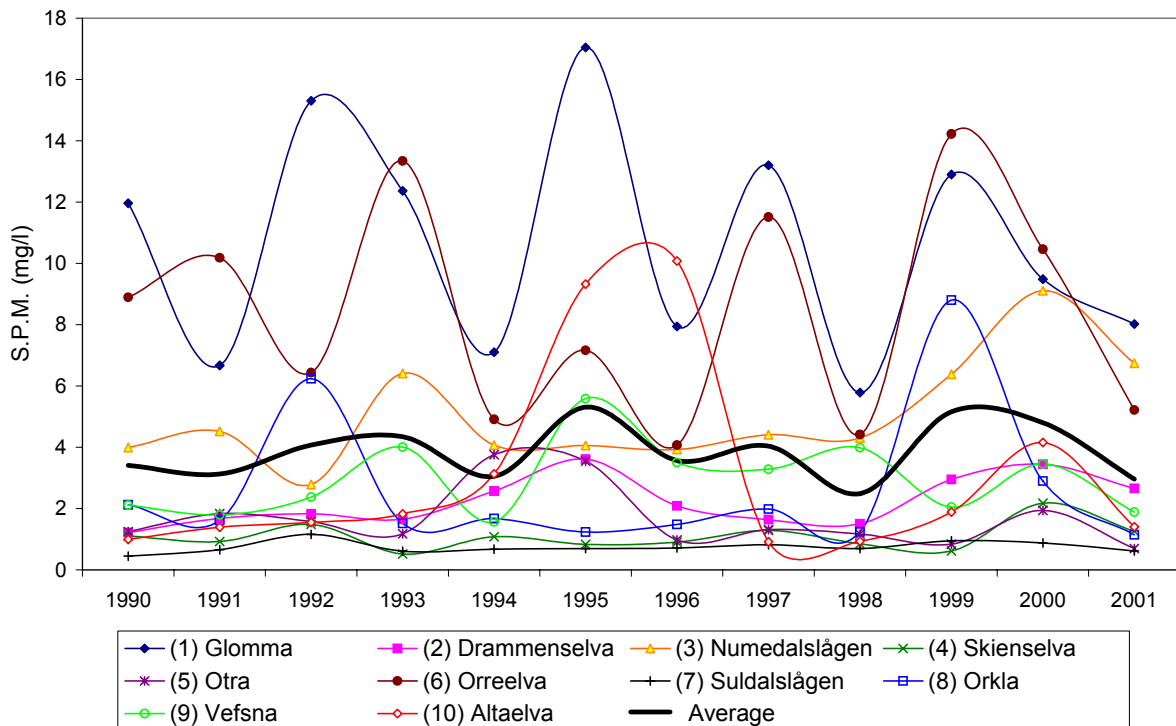


Figure XIII.II Suspended particulate matter (S.P.M.) concentration in main rivers.
Mean value from 1990 to 2001 (mg/l).

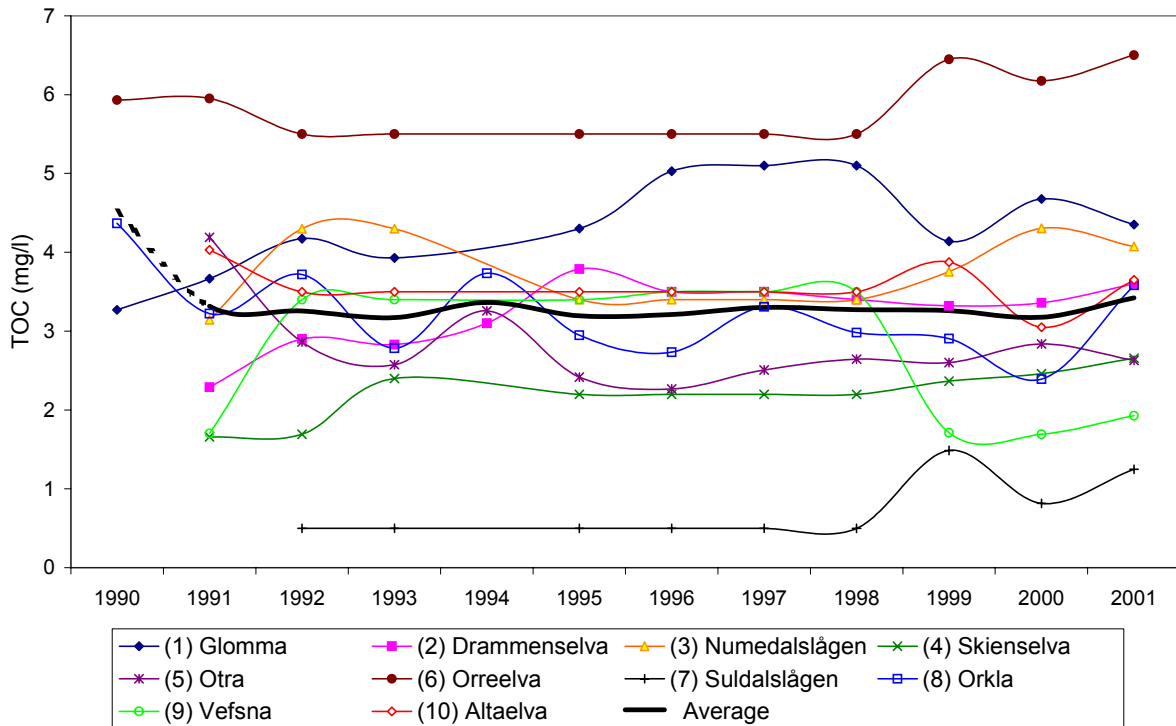


Figure XIII.III Total organic carbon (TOC) concentration in main rivers.
Mean value from 1990 to 2001 (mg/l).

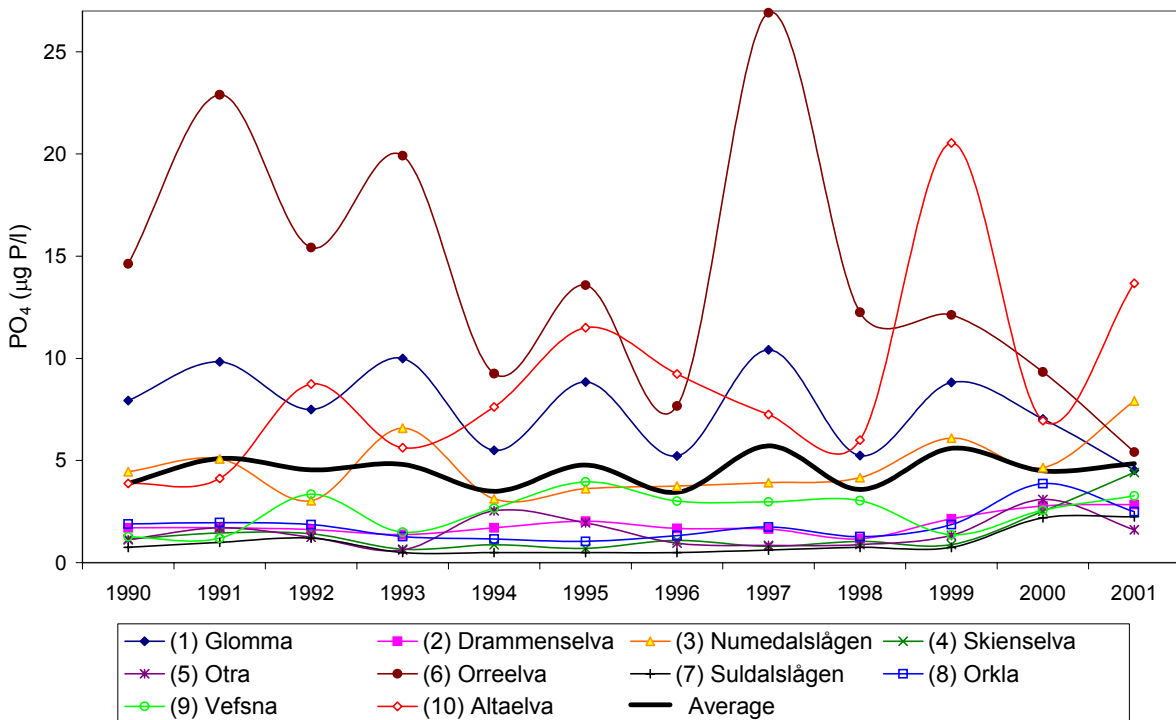


Figure XIII.IV Orthophosphate (PO_4) concentration in main rivers.
Mean value from 1990 to 2001 ($\mu\text{g/l}$).

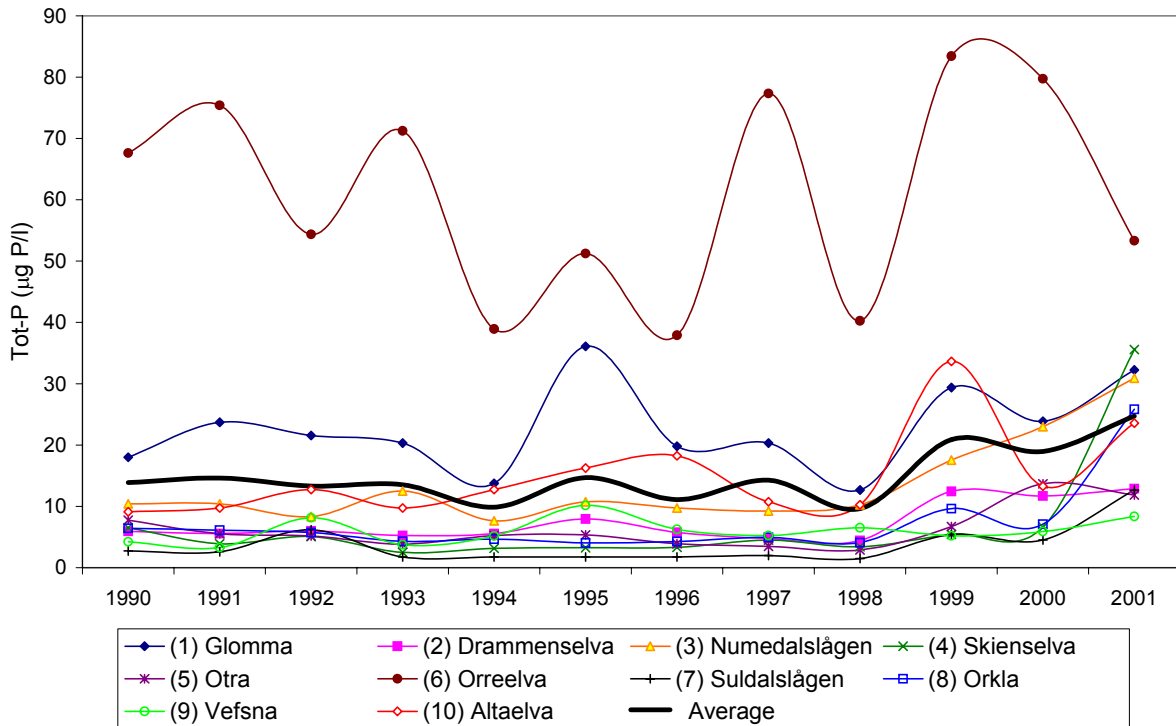


Figure XIII.V Total phosphorus (Tot-P) concentration in main rivers.
Mean value from 1990 to 2001 ($\mu\text{g/l}$).

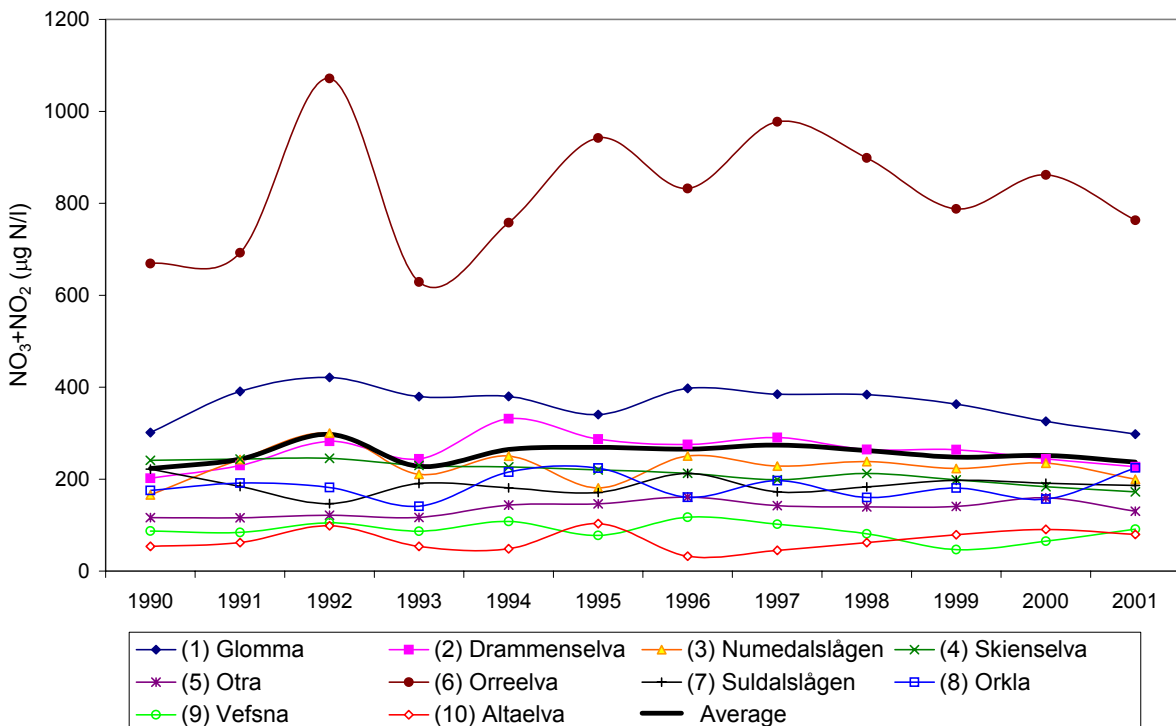


Figure XIII.VI Nitrate and nitrite ($\text{NO}_2 + \text{NO}_3$) concentration in main rivers.
Mean value from 1990 to 2001 ($\mu\text{g/l}$).

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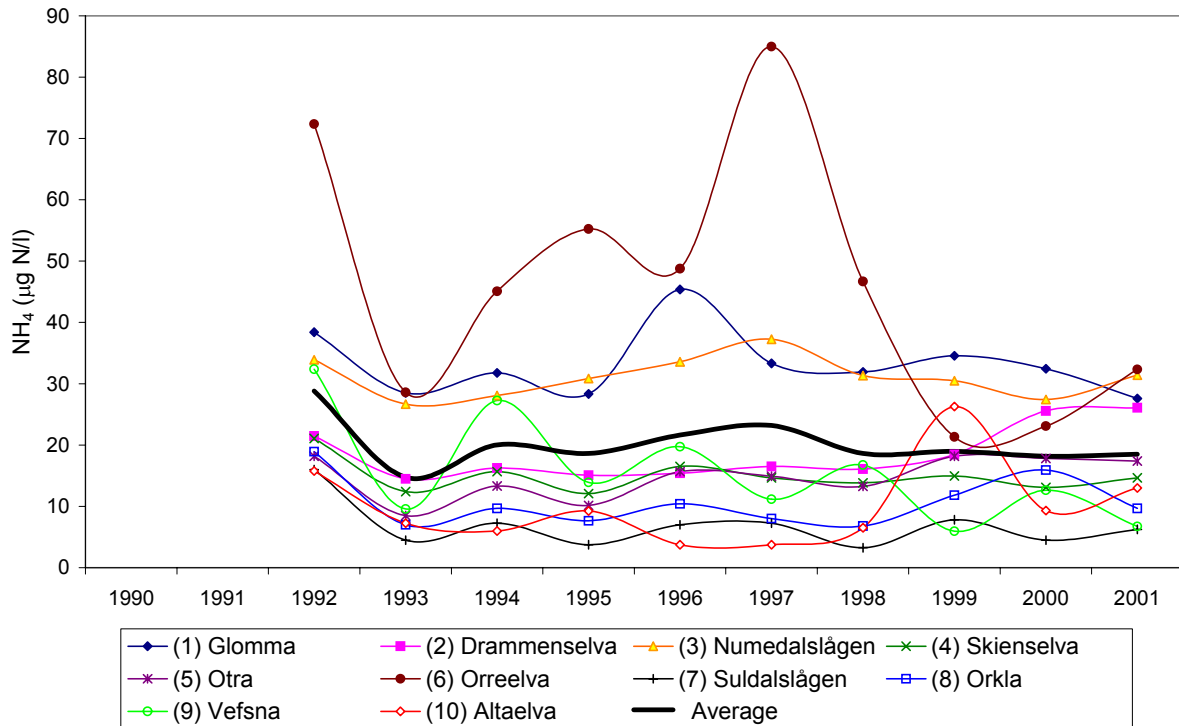


Figure XIII.VII Ammonia (NH_4) concentration in main rivers.
Mean value from 1990 to 2001 ($\mu\text{g/l}$).

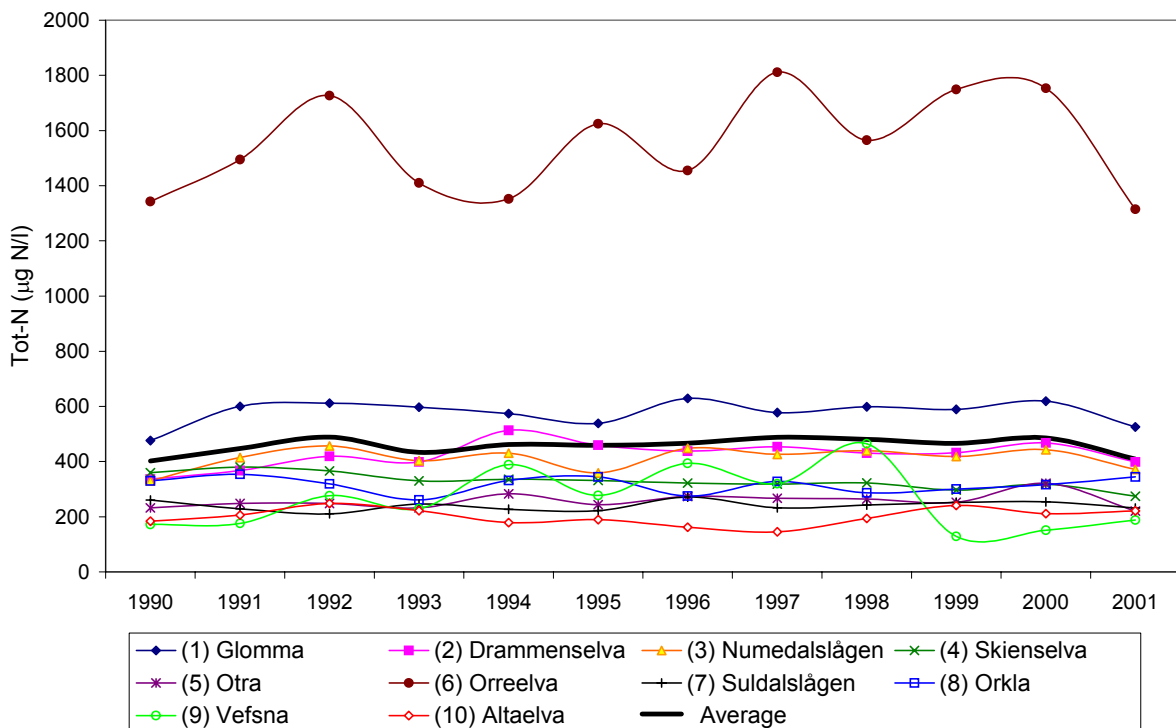


Figure XIII.VIII Total nitrogen (Tot-N) concentration in main rivers.
Mean value from 1990 to 2001 ($\mu\text{g/l}$).

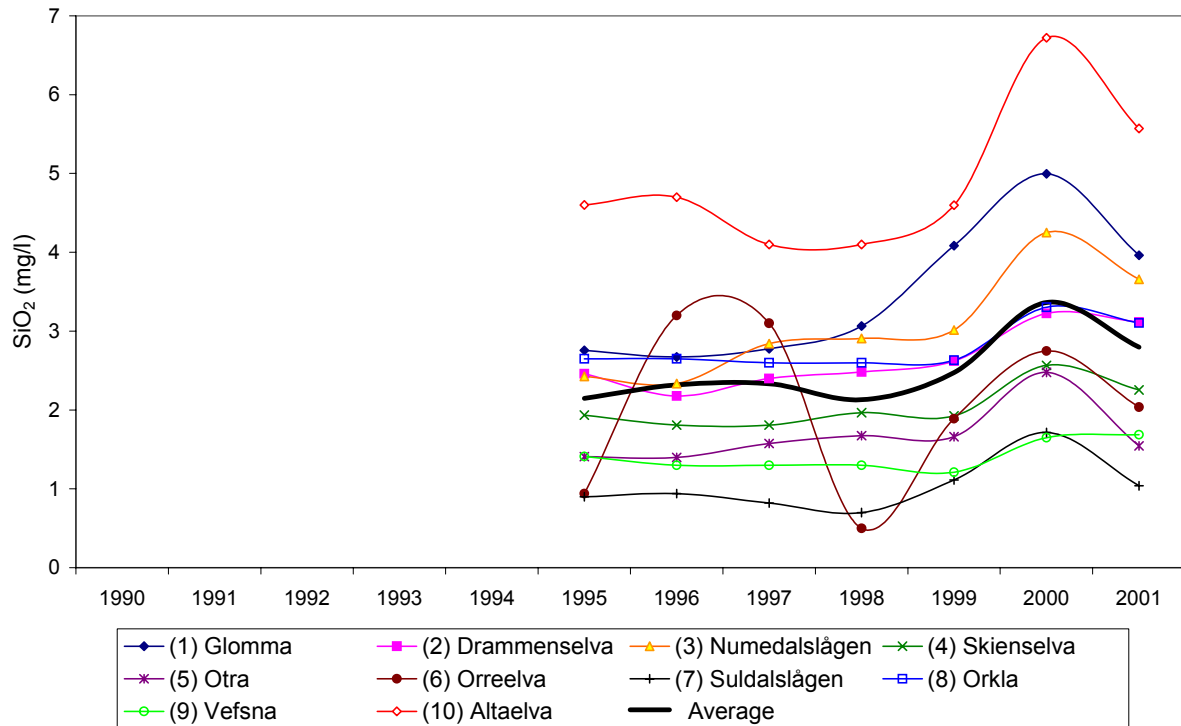


Figure XIII.IX Silicate (SiO_2) concentration in main rivers.
Mean value from 1990 to 2001 (mg/l).

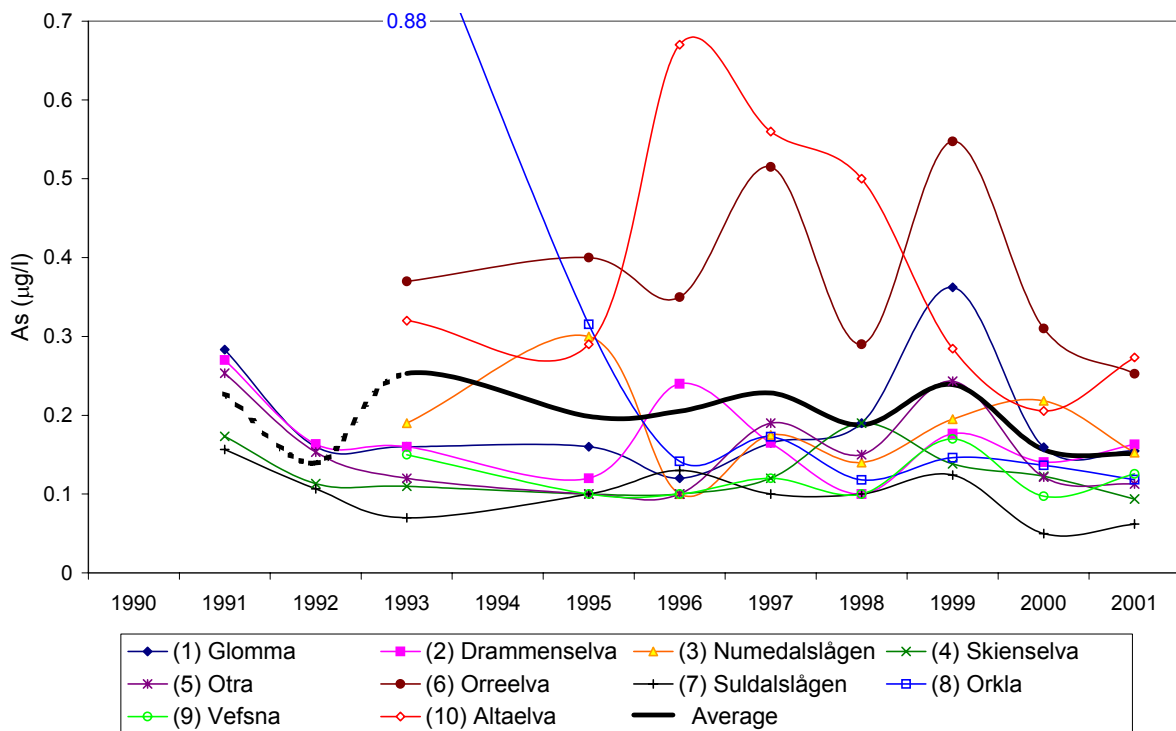


Figure XIII.X Arsenic (As) concentration in main rivers.
Mean value from 1990 to 2001 ($\mu\text{g/l}$).

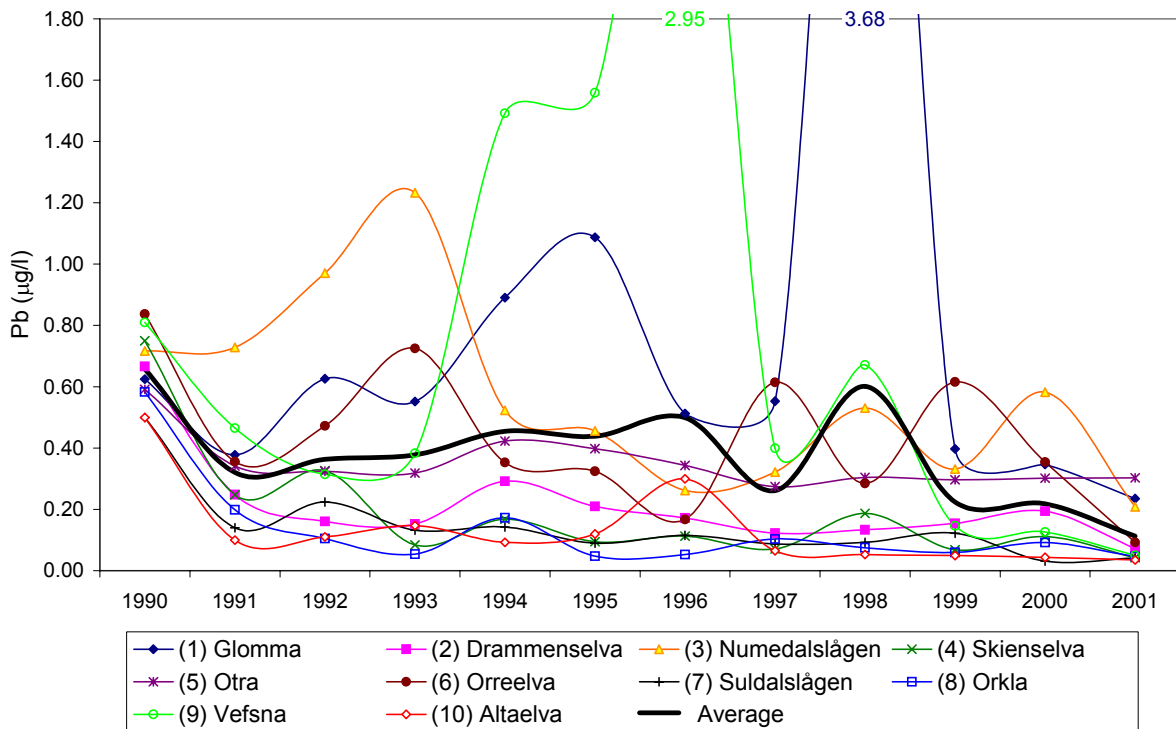


Figure XIII.XI Lead (Pb) concentration in main rivers.

Mean value from 1990 to 2001 ($\mu\text{g/l}$).

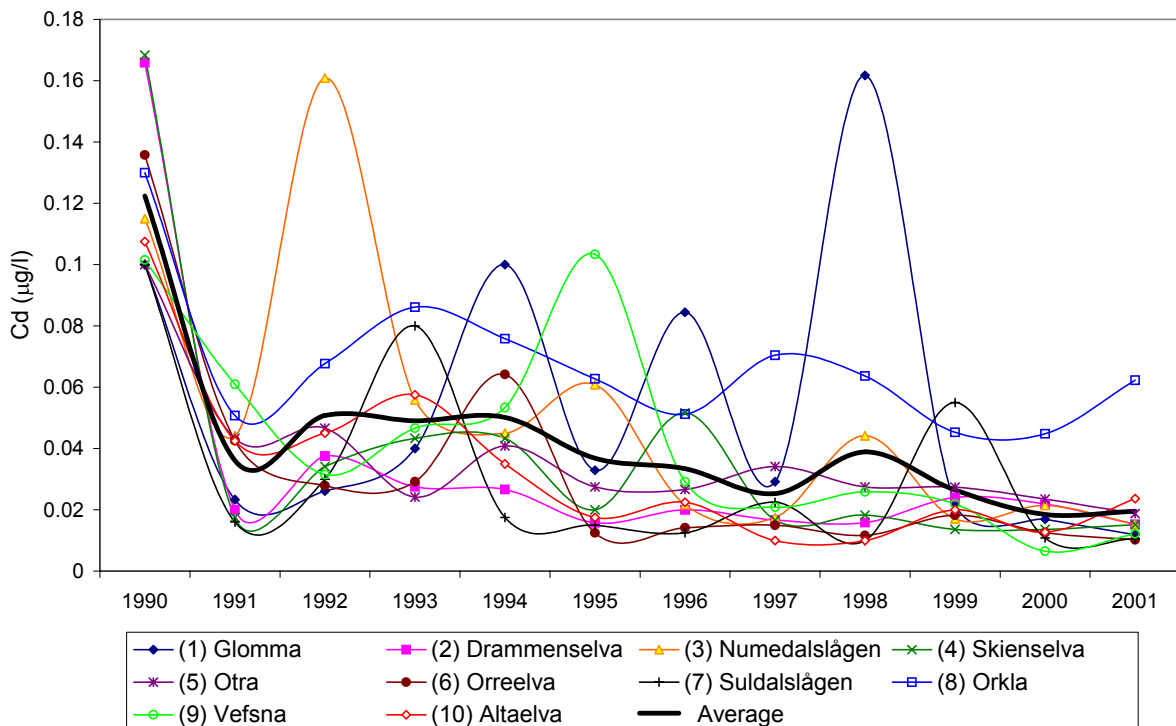


Figure XIII.XII Cadmium (Cd) concentration in main rivers.

Mean value from 1990 to 2001 ($\mu\text{g/l}$).

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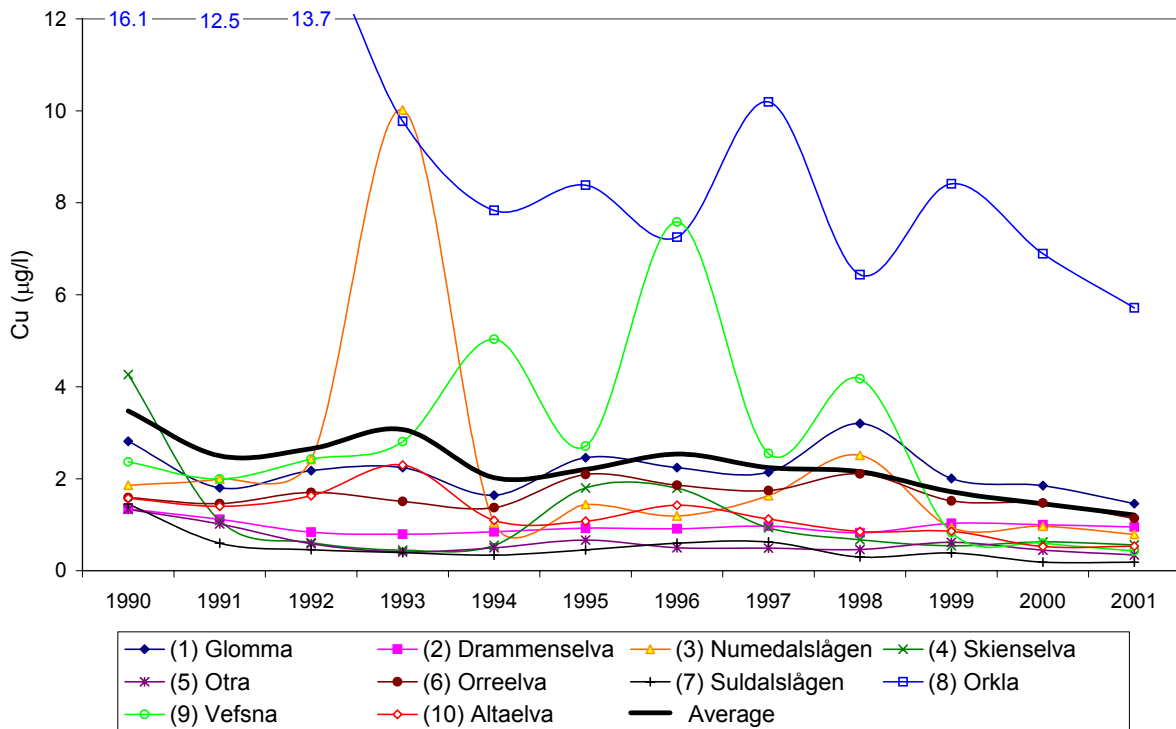


Figure XIII.XIII Copper (Cu) concentration in main rivers.

Mean value from 1990 to 2001 ($\mu\text{g/l}$).

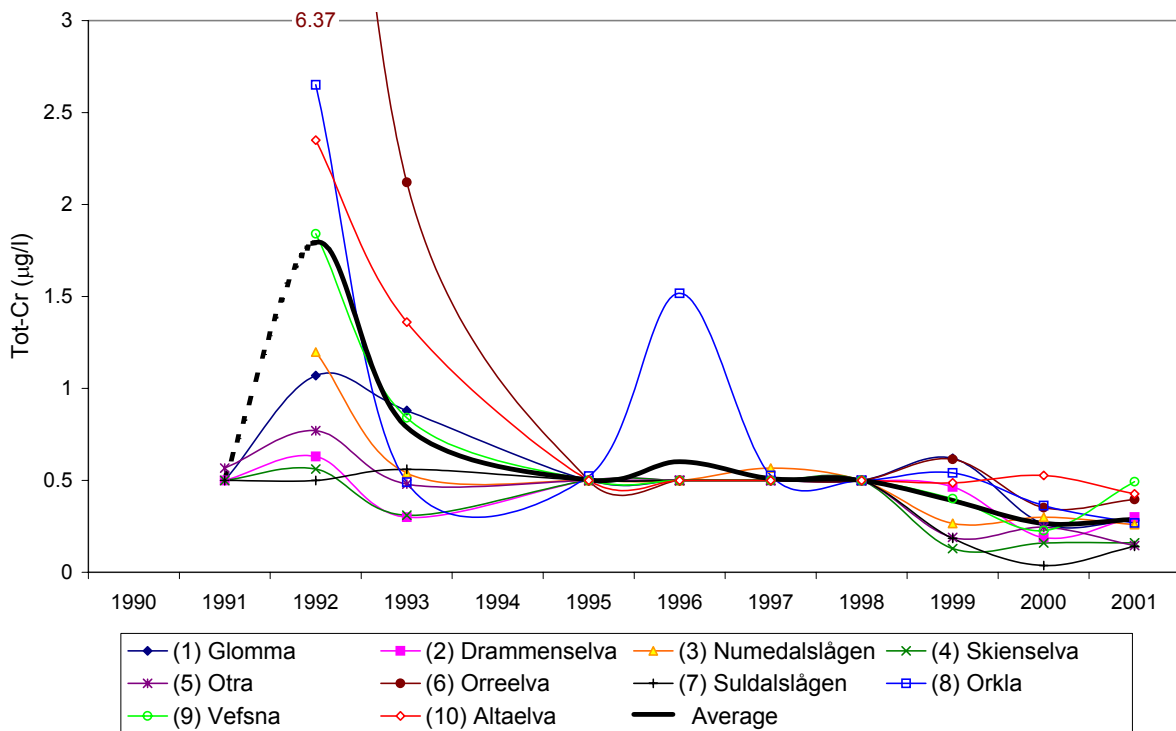


Figure XIII.XIV Total chromium (Tot-Cr) concentration in main rivers.

Mean value from 1990 to 2001 ($\mu\text{g/l}$). Since 1999 a lower limit of detection has been reported.

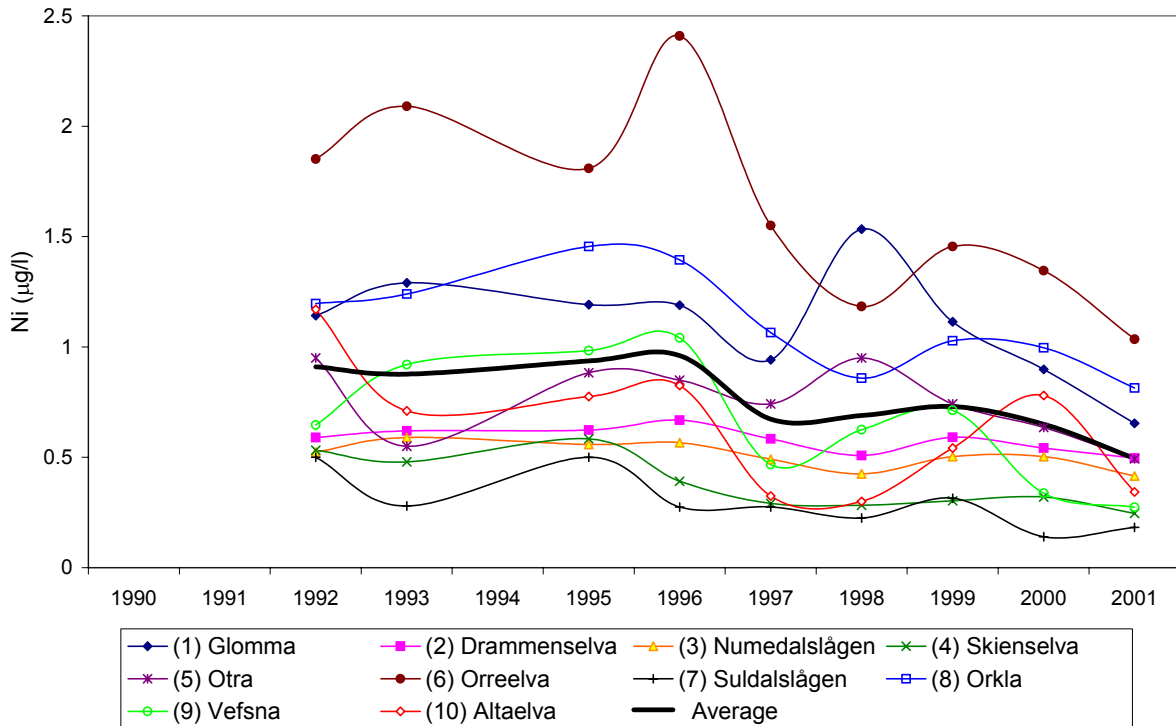


Figure XIII.XV Nickel (Ni) concentration in main rivers.
Mean value from 1990 to 2001 ($\mu\text{g/l}$).

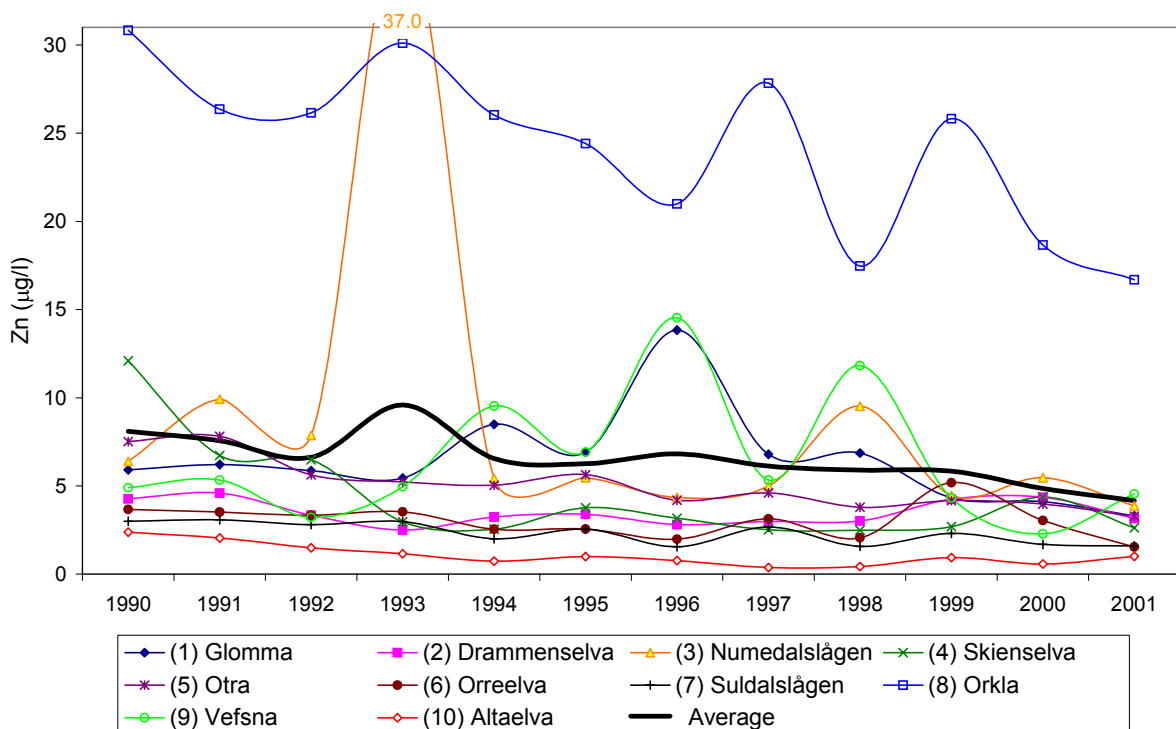


Figure XIII.XVI Zinc (Zn) concentration in main rivers.
Mean value from 1990 to 2001 ($\mu\text{g/l}$).

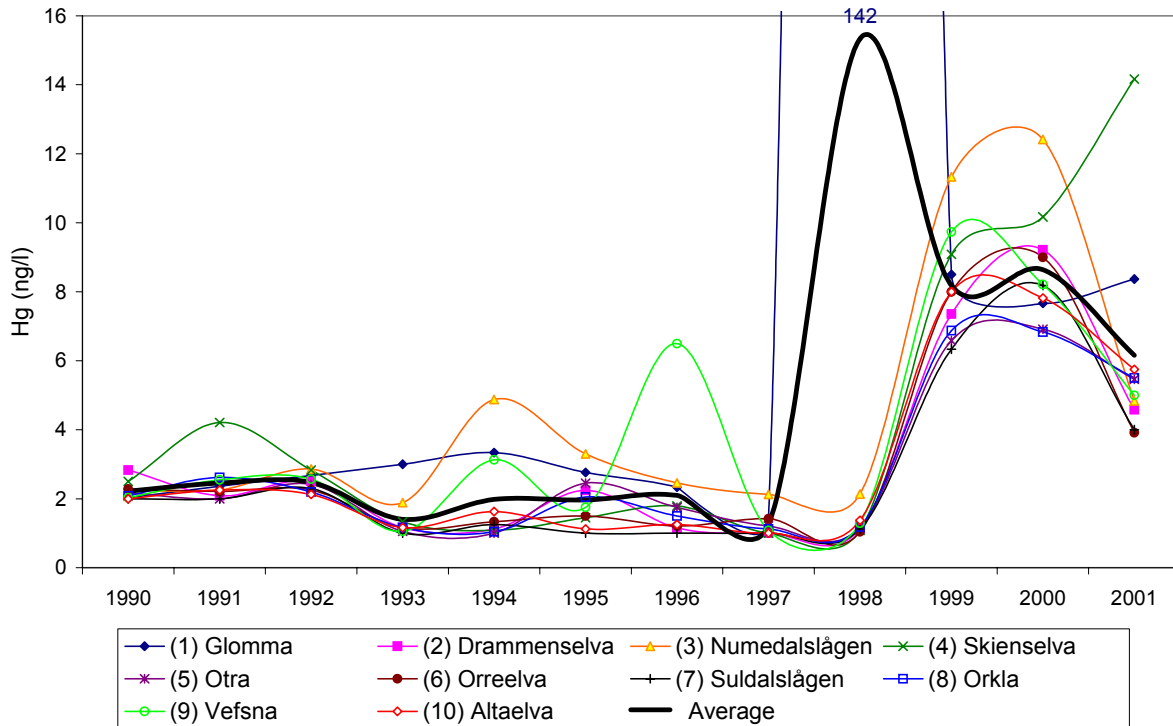


Figure XIII.XVII Mercury (Hg) concentration in main rivers.
Mean value from 1990 to 2001 (ng/l). Since 1999 a new analytical method is used.

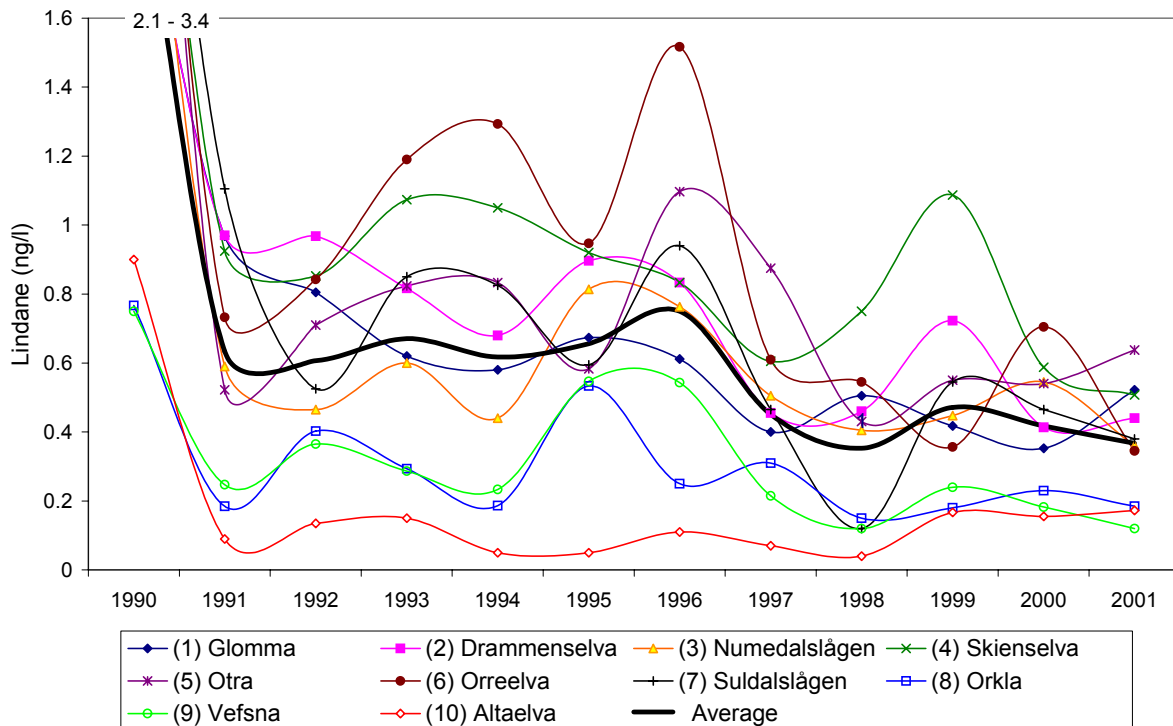


Figure XIII.XVIII Lindane concentration in main rivers
Mean value from 1990 to 2001 (ng/l).

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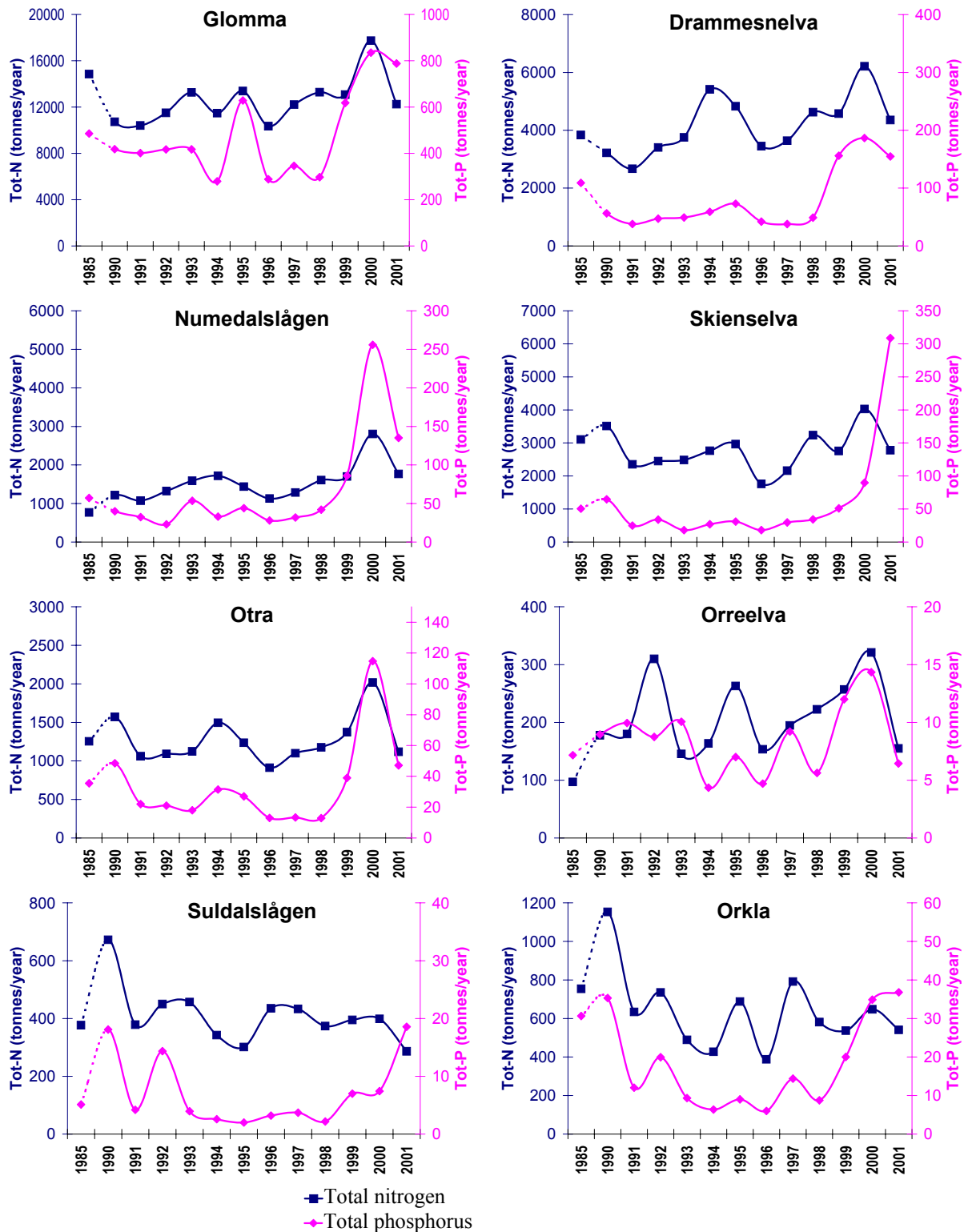


Figure XIX.XIX Total nitrogen (Tot-N) and total phosphorus (Tot-P), load in main rivers. Calculated load for 1985, 1990-2001 (tonnes/years). (Fig. continues on the next page.)

Direct and riverine inputs to Norwegian coastal waters – 2001. OSPAR Commision

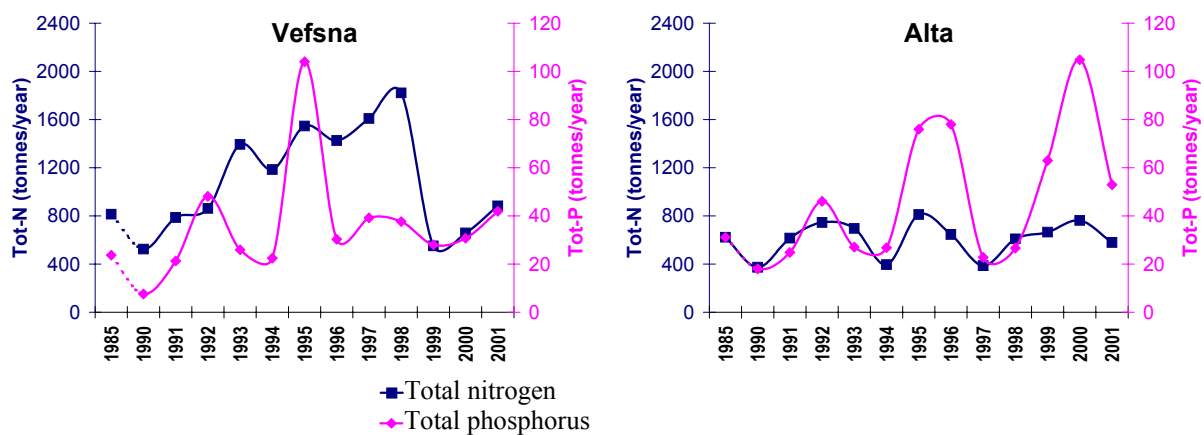


Fig. XIX.XIX (continue from previous page)

Appendix XIV. Comparison of sampling methods used for monitoring trace metals and organic pollutants in rivers

1. Background

There is a continuous development of new methods and improvement of existing methods for monitoring substances causing harmful effects in the aquatic environment. This development is driven by the appearance of better understanding of environmental effects, new equipment, new technology and new materials. A critical factor in the result of more sophisticated programmes is the sampling method. The use of more refined sampling methods could enhance the outcome of monitoring programmes. The implementation of the EU Water Framework Directive (EU 2000) also put focus on national monitoring programmes for fresh water and coastal marine water. The following three types of monitoring programmes for surface water are requested:

1. Surveillance monitoring: regular overall monitoring of water quality. Quantitative methods with a high degree of quality assurance.
2. Operational monitoring: designed to establish the status of the water bodies, which have been identified as possibly failing to meet the environmental objectives. Quantitative methods with a high degree of quality assurance.
3. Investigative monitoring: will be carried out where surveillance monitoring indicated that quality objectives for a water body are not likely to be achieved and operational monitoring has not already been established. Semi-quantitative methods (screening) can be used.

Development of differentiated sampling methods will also be important to OSPAR, since there will be an overlap in the monitoring activities of OSPAR and those required in the Water Framework Directive. The overlap includes both the monitoring of input from rivers and monitoring in main coastal waters.

Aquateam was engaged by the Norwegian Pollution Control Authority (SFT) to compare sampling methods used for river surveillance monitoring of trace metals and organic micropollutants. This project was carried out in connection with the River Input Project (RID). A separate report (Weideborg, 2002) from this project is available. The conclusions and the literature list from this report are included here.

The objective of this project has been to identify the methods for future monitoring of low concentration levels of pollutants in rivers. It is difficult to obtain a good estimate of load of pollutants in the rivers when several substances are present in lower concentrations than the detection limits. Some of these substances are, in spite of the very low concentrations measured in the water phase, very important since they are chronic toxic and persistent and likely to accumulate in organisms and in the food chain. Methods used for measurement of loads to the coast area are prioritised, but also methods for following-up trends in the environment are described.

There is a lack of appropriate methods for monitoring low levels of pollutants in rivers. All normally applied methods have advantages and disadvantages, e.g.:

- Spot sampling (grab sampling) will not catch short temporal variations or peaks in contaminant concentrations.

- Continuous monitoring systems require a high degree of operation, and are relatively expensive to keep operating.
- Robust chemical/technical on-line methods for monitoring low levels of metals and organic micropollutants are not yet 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 surveillance programs. No organisms have, however, been found to satisfy the requirements of quantification of environmental pollution with regard to variation in site and time. Concentrations of metals in aquatic mosses are not easy to calibrate with natural water concentrations, because of the plant's natural growth phases and influences from other ions. Mussels are known to reduce the filtration rate when heavy pollutants are passing by.

Different methods can be used (or designed) for different purposes. Some methods are relevant for monitoring substances dissolved in water, and some are more relevant for surface-active substances binding to particles. This report includes a short comparison of methods regarding their suitability for covering different needs, present application areas, uncertainty, necessary education/skills of the sampling personnel, labour need, material costs, power requirement, maintenance requirement, etc.

The following sampling methods are included: spot/grab sampling, composite sampling – automatic sampling, on-line monitoring, passive sampling, sampling of particles (particle trapping and flow centrifugation), surface microlayer sampling, sediment sampling, biomonitoring (accumulation in aquatic mosses and mussels), biomarkers, biological community studies (bottom fauna and periphyton) and bioassays (ecotoxicological testing of the water).

The passive sampling methods and spot sampling have been investigated in the RID project, while for the other methods information is from a literature search, which has been carried out.

2. Comparison of sampling methods

A comparison of the different sampling methods is shown in the table 15.1.

Table 15.1. Comparison of sampling methods used for monitoring trace metals and organic pollutants in rivers.

Method	Application area	Uncertainty	Experience with the method	Educated sampling persons necessary	Costs, requirements	Advantages/disadvantages
Spot sampling	S, O, I Quantitative sampling. All substances in water phase and particulate phase.	High uncertainty when used for river monitoring. High sampling frequency is required.	Used in a lot of water quality studies and monitoring programmes, especially in small water bodies.	No, but require trained personnel.	Low material costs. Personnel costs depending on sampling frequency. Analytical costs may be high.	Easy method/large uncertainty. Only snapshot of the water quality. No accumulation of substances/ not suitable for low water concentrations.
Composite sampling	S, O, I Quantitative sampling. All parameters in water phase and particulate phase. Measurement of water quality over a time period.	Lower uncertainty than spot sampling.	Normally used at municipal or industrial wastewater treatment plants for process monitoring and discharge control. Limited experience with river composite sampling in Norway.	No, but require trained personnel.	Higher costs (construction and operation) than spot sampling. Possible lower analytical costs due to long sampling intervals requiring fewer sampling than spot sampling.	No accumulation of substances/ not suitable for low water concentrations. Average concentrations will be measured. To obtain reliable operation, a permanent building and systematic operational programme are essential.
On-line monitoring	S, O, I Quantitative measurement. Only parameters in water phase.	Low uncertainty	Little experience with low concentrations.	No, but require trained personnel. Calibration with laboratory analyses necessary.	High material costs. Requires power. Careful operation and maintenance of the electrodes are necessary.	No accumulation of substances/ not suitable for low water concentrations. The peaks will be caught.
Passive sampling	S, O, I Measurement of water quality over a time period. Application for quantitative/semi quantitative measurements developed. Accumulating substances in water phase.	Higher certainty for lower concentrations.	Experience with many types of devices.	No, but require trained personnel for analytical work and interpretation of results.	Low material and personnel costs.	Accumulated amounts of concentration measured. Suitable for low water concentrations.

Direct and riverine inputs to Norwegian coastal waters – 2001. OSPAR Commision

Method	Application area	Uncertainty	Experience with the method	Educated sampling persons necessary	Costs, requirements	Advantages/disadvantages
Sampling of particles with flow centrifugation and sediment tanks	S, O, I Only parameters in particle phase. Supplement to other methods Quantitative or qualitative measurement.	High uncertainty. Sedimentation tanks more uncertain than flow centrifugation.	Experience with many types of devices (sediment tanks, and flow centrifuges).	Yes, require trained personnel.	Flow centrifuge: Very high material costs, high personnel costs. Require power. Sedimentation tank: low costs.	No accumulation of substances/ only suitable for particle bound substances.
Surface microlayer sampling	S Qualitative monitoring Supplement to other methods. Accumulating substances in surface microlayer Cannot be used for estimation of loads.	High uncertainty.	Little experience (but interesting methods) FoU-projects.	Yes, require trained personnel.	Low material costs. Some devices require power.	Only substances accumulated in the surface layer is measured. Problems to get large enough sampling volumes.
Sediment sampling	S I Qualitative monitoring Supplement to other methods. Only parameters in sediment phase measured. Cannot be used for estimation of loads.	High uncertainty.	Used in a lot of monitoring programmes in addition to water and biota sampling.	Yes, require trained personnel.	Low material and personnel costs depending on sampling frequency and method. Diving expensive Analytical costs may be high.	Only suitable for sediment bound substances.
Biomonitoring – accumulation in organisms	S, I Qualitative/ Semi-quantitative monitoring. Measurement of water quality over a time period. Accumulating substances in water phase	Higher certainty for lower concentrations.	Used in some water monitoring programmes FoU projects.	Yes, require trained personnel.	Low material and personnel costs.	Accumulated amounts of concentration measured. Suitable for low water concentrations. Standardisation of living organisms not easy.
Bio-markers	S, O, I Supplement to other methods. Cannot be used alone for estimation of loads.	High certainty for evaluation of conditions in water bodies.	Used in a lot of monitoring programmes in addition to water and sediment sampling.	Depending on the method. Normally are biologists or chemists required.	Depending on the method. Normally low material and high personnel costs.	Problems with interpretation of results.

Method	Application area	Uncertainty	Experience with the method	Educated sampling persons necessary	Costs, requirements	Advantages/disadvantages
Biological studies	S Supplement to other methods. Cannot be used for estimation of loads.	High certainty for evaluation of conditions in water bodies.	Used in a lot of monitoring programmes in addition to water and sediment sampling.	Yes, require biologists.	Low material and high personnel costs.	Problems with interpretation of results.
Bioassays	I Supplement to other methods. Can only be used for polluted discharges. Cannot be used for estimation of loads.	High certainty.	Used for monitoring of polluted discharges.	Yes, require biologists/ecotoxicologists.	Low material and high personnel costs.	Problems with interpretation of results.

S = Surveillance monitoring, O = Operational monitoring, I = Investigative monitoring

3. Conclusion regarding RID Project

Many of these parameters occur in so low concentrations in the rivers that the relevance of the analytical parameter is strongly dependent of appropriate sampling methods. The easiest and probably most appropriate sampling methods for chemical analyses in the RID project are water sampling, passive sampling, and a simplified arrangement for particle sampling. The water sampling may include spot sampling or composite sampling of relatively small water volumes (1-2 litres). Sampling of large water volumes (e.g. 2-10 litres) for extraction or evaporation is difficult to handle in the Norwegian part of the project.

Using a combination of different methods is valuable for river monitoring. In the RID project, where estimation of loads to the coastal area is the purpose, the existing spot sampling programme will continue. A combination of spot sampling and use of passive sampler will be investigated in 2002-2004 in River Glomma in the EU project: "Standard Aquatic Monitoring of Priority Pollutants by Passive Sampling (STAMPS)" within the EU's 5th framework program (Energy, Environment and Sustainable Development). In this project, Aquateam is responsible for field-testing and suggesting modification for the methodology in rivers, with focus on Norwegian conditions (low temperature, low concentrations of pollutants, low salinity, acidified and with high concentrations of humic substances).

In connection with the EU project (passive samplers) and the ordinary RID project (spot sampling, small volumes) a simplified arrangement for particle sampling in should be tried out from 2003.

Biomarkers like vitellogenin and EROD should also be tried out in the RID project, e.g. in co-operation with the JAMP project.

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Appendix XV. Estimation of uncertainty in calculated riverine input to Norwegian coastal water. Statistical evaluation of data from 1999-2001.

Introduction

Riverine inputs of nutrients, suspended matter, TOC, selected heavy metals and lindane have been calculated for 10 rivers in Norway for the years 1990-2001. Concentrations have been measured at least monthly for all parameters except lindane. Lindane concentration has been measured 4 times a year. Annual load has been determined on the basis of these results and the daily monitored flow measured by the Norwegian Water Resources and Energy Administration. Yearly variation of load has been calculated based on calculated monthly average measured concentrations and average monthly measured flow. Trend analyses have been made, and for some rivers a significant trend in yearly loading has been observed for some parameters. These trends can be caused by:

- Climatic changes influencing erosion
- Changes in input of industrial discharges due to improved pollution control, increased or decreased industrial activity and/or change in industrial activities in the catchment area.
- Changes in input of municipal discharge, related to change in wastewater treatment or due to increased overflow.
- Change in agricultural practice or vegetation in agricultural areas.
- Changes in human activity in the catchment area.

A statistical analysis of the variation of annual load of nutrients and pollutants has been performed to get a better understanding of which factor(s) has (have) the greatest influence on the observed variations. Observed variations could, however, also be due to sampling and/or measurement uncertainties and therefore not be real variations in the rivers loads. To get a better understanding of the statistical relevance of the observed trends, a statistical analysis has been performed using the riverine project monitoring data from the year 1999-2001 for the 10 main rivers, from which most information is available.

Definition of Statistical Terms and Methods Use

Statistical Terms

There are a few terms, which are used through the whole document, and which need to be understood from the beginning (Høyland, 1988; ISO, 1995; Rensvik, 1985; Hovind, 1986).

For the 10 main rivers,

- $\bar{x}$ or $\bar{y}$ = the sample mean of a dataset of different parameters or the average of a series of samples: (arithmetic mean of all measured data)
$$\bar{x} = \sum x_{1-n} / n$$
- n = number of samples in the dataset
- x_{1-n} = single measurements from no. 1 to no. n
- σ^2 = known (true) variance of x or y (measured spread around $\bar{x}$ or $\bar{y}$)
- S^2 = calculated variance = $\sigma^2 + \sigma_1^2$, where σ_1^2 = unknown variance
- $\sqrt{S^2}$ = standard deviation of a sample mean (or average), often called standard error (s.e.), is used when an estimate of the standard error is needed.

- A normal distribution is bell-shaped and symmetric around x or y, and the area under the curve is the probability that values of x or y will be within the stated limits. When using the 95% confidence limits, the 2.5% lowest and 2.5% highest tails of the normal distribution curve is left out, and $\text{Uncertainty} = 1.96 \frac{\sigma}{\sqrt{n}}$. When calculating confidence limit for a set of data it is important that the data do not contain any systematic errors, only random errors. Systematic errors include trends or seasonal variations.
- Calculation of errors in a combined measurement: $S = \sqrt{\sigma_1^2 + \sigma_2^2 + \sigma_3^2}$ where σ_1 is analytical error, σ_2 is sampling error, σ_3 is water flow errors. When the error represent different number of samples; $S/n = \sqrt{\sigma_1^2 / n_1^2 + \sigma_2^2 / n_2^2 + \sigma_3^2 / n_3^2}$

Analytical uncertainty

All statistical analysis must take into account the uncertainty of the analysis as well as the statistical uncertainties related to sampling. The analytical uncertainty depends on the method of analysis and the measured concentration.

The measured concentration in the rivers is sometimes lower than the laboratories' accredited analytical detection limit. Normally the value is then reported as below the detection limit. OSPAR (1998) requires, however, that analytical methods should be chosen, which gives at least 70% of positive findings (i.e. above the detection limit). For some of the main rivers included in the Norwegian RID project (RID = Riverine and Direct Input to Norwegian Coastal Waters), the measured concentration of some parameters included in the survey are so low, that no standard analytical method have accredited detection limits, which can meet the requirements of OSPAR. For these parameters and rivers the measured concentration is reported even if it is below accredited detection limit. This increases the analytical uncertainty. When evaluating the analytical uncertainty, the distinction between the accredited detection limit and the reported detection limit has therefore been made as defined below:

Accredited detection limit

- The concentration range upon, which the laboratory method is accredited for
- Separate limits are given for each analytical method
- Uncertainty in measured concentrations above the accredited detection limit is normally in the range of 10-20%

Reported detection limit

- The lowest concentration, the laboratory is reporting
- Separate limits exist for the individual analytical methods
- Less or equal to the accredited detection limit
- Uncertainties in measured concentrations below the accredited and above the reported detection limit is normally in the range of 30-50%

For all parameters included in the Norwegian RID project, the accredited detection limits and normal uncertainties (i.e. uncertainties for concentrations above accredited detection limit) are summarised in Table 2, Chapter 3.

When reported concentrations are below the reported detection limit, two calculation methods of average loading have been applied: one assuming that the concentration is zero (footnote: limit=0),

and the other assuming that the concentration is equal to the reported detection limit (footnote: limit=limit).

Calculation of uncertainties in measurements

To determine the uncertainty in measurements for each river, the average concentration or mean has been calculated for each parameter. For some parameters, one or two high values can give an unrealistic high average or mean concentration, an average value has therefore also been calculated ignoring the 10% highest and the 10% lowest values. This latter calculation has been performed for all parameters except for lindane, where only ten reported concentrations were available, making this calculation impossible.

By assuming a normal distribution of the measured concentrations, the average statistical uncertainty has been calculated (95% confidence limit) using the formula:

$$\text{Uncertainty} = 1.96 \frac{\sigma}{\sqrt{n}}$$

This calculation assumes normal distribution of all the parameters, which is not always the case, see discussion in chapter 2.5.

σ = standard deviation

n = number of measurements

1.96 = area under the normal distribution curve including the 95% confidence level.

This formula gives the statistical uncertainty of measured data. To get the total uncertainty, it needs to include the laboratory uncertainty. The reported variance is the sum of these two variances.

To determine the 95% confidence interval of the average concentration the following calculations are made:

$$95\% \text{ lower limit} = \text{Average}_{(\text{limit} = 0)} - \text{Uncertainty}_{(\text{limit} = 0)}$$

$$95\% \text{ higher limit} = \text{Average}_{(\text{limit} = \text{limit})} + \text{Uncertainty}_{(\text{limit} = \text{limit})}$$

In some cases the calculated 95 % lower limit is a negative number. The reported lower limit is then reported equal to zero.

Uncertainties on calculated total load

The higher and lower limit calculated as described in Chapter 2.3., give the 95 % confidence limit of the average (or mean) concentration. The major concern of the OSPAR monitoring project is the calculated total load of the measured parameters. Total load is calculated according to the following formula.

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

where

C_i = measured concentration in sample i

Q_i = corresponding flow for sample i

Q_r = mean flow rate for each sampling period

n = number of samples taken in the sampling period

When 12 or less measurements are performed per year, annual load is calculated directly with the formula over using each measured concentration. When the measurement frequency is increased during periods of high flow, monthly loads are calculated and the 12 monthly loads are summed. As load is basically calculated as the product of the concentration and the water flow, the total error needs to take into account also the errors in water flow, according to the formulae: $S/n = \sqrt{\sigma_1 / n_1^2 + \sigma_2 / n_2^2 + \sigma_3 / n_3^2}$

No information was available on uncertainties on water flow. An estimation of importance of the calculated uncertainties has been performed on the basis of the uncertainties in sampling and analytical methods.

Limitations

Distribution of the measurements

Calculation of statistical uncertainty from available monitored data assumes a normal distribution of the measurements. The same assumption of normal distribution is made by the Paris Commission when it gives the formula for calculating riverine load where load is calculated as an arithmetic average corrected only for flow variations. The measured concentrations in rivers are however not normally distributed. The assumption of normal distribution of data assumes that all errors are independent (random) and not dependent (i.e. seasonal variation).

The low measured concentration (< accredited detection limit) of some parameters often changes the distribution pattern for the majority of measurements near zero, and if one or a few measurements are significantly higher than the others, this can significantly increase the uncertainty of the data. If a set of data contains one or a few high values, this will have a high influence on the calculated average (mean). This is seen in Table 2 showing the comparison of the average of all data, the average where highest and lowest values are ignored as well as the median value (median is calculated removing the highest and the lowest value until only one or two values are left. If two values are left, the average of these equals the median, and if only one value is left, this is the median). Figure 1 illustrates typical cases where the measured concentrations are not normally distributed.

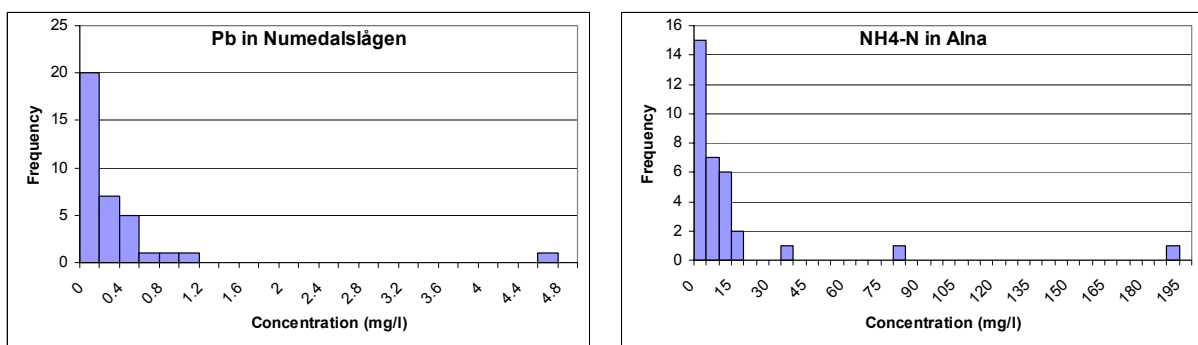


Figure 1. Examples of measurements where distribution is not normal; including distribution of the measurements for lead in Numedalslågen and ammonia in Alna, for the period 1999-2001.

Detection limit

For some parameters, more than 50% of the measurements are below the accredited detection limit. In these cases the mean is equal or less than the accredited detection limit.

In these cases it can in some cases be difficult to conclude whether there is a real increase or decrease of the mean. Similarly, for parameters where < 70% of measured concentrations (>30%) are below the reported detection limit it is difficult to perform a statistical analysis because of the large difference between calculated mean (average) when concentrations measured below detection limit is set equal to 0 (limit=0) or to the detection limit (limit = limit).

Arsenic, lead, cadmium, chromium and mercury are the compounds found in the lowest measured concentration in comparison to accredited or reported detection limits. Table 1 summarises information for all parameters where statistical relevant data analysis has been difficult to perform because of the low measured concentrations.

Table 1. A summary of analytical parameters (river by river) where the measured concentration is low compared to the laboratory accredited or reported detection limits.

River	> 30% of measured values are < laboratory reported detection limit	> 50% of measured values are < laboratory accredited detection
Glomma	Cd,	Cd, Hg
Drammenselva	Hg	As, Pb, Cd, Hg
Numedalslågen		As, Cd
Skienelva	Hg, Cr	PO ₄ -P, As, Pb, Cd, Cr, Ni
Otra	Hg	PO ₄ -P, As, Cr, Hg
Orreelva	Cd, Hg,	Cd, Hg
Suldalslågen	SPM, Pb, Cd, Cr, Hg	SPM, TOC, PO ₄ -P, NH ₄ , As, Pb, Cd, Cr, Ni, Hg
Orkla	PO ₄ -P, Hg	As, Pb, Hg, lindane
Vefsna	Cd, Hg	PO ₄ -P, NH ₄ , As, Pb, Cd, lindane
Alta	SPM, Pb, Cd, Zn, Hg, lindane	SPM, Pb, Cd, Ni, Hg, lindane

Correlations between sets of data

The Pearson's product moment relation coefficient R is an index reflecting the degree of linear relationship between two sets of data. When the two sets of data are represented by n different measured concentrations of parameter x and n different of parameter y, the Pearson's R coefficient is calculated by:

$$R = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}}$$

The R² value can be used to estimate the part of the variance in y that can be caused by the variance in x. A statistically significant correlation (R² > 0.8) usually indicates that variation in the two parameters have a common cause. In the evaluation of potential correlation between parameters, a potential correlation has been assumed if R² > 0.6.

Results and discussion

General results

Table 2 summarises statistical results from the statistical analysis performed for all data analysed, as well as the uncertainty of reported measurements for each individual analytical parameter included in the RID project.

Table 2. Statistical results for all laboratory data analysed for the 10 main rivers included in the RID project for the year 1999-2001, as well as measurement uncertainties.

Analytical parameter		Analytical limitations		Statistical information for the ten main rivers in the period 1999-2000								
				No of measurements (n)			Min. conc.	Max. conc.	Standard deviation $\sqrt{\sigma^2}$	Average (mean) conc		Median conc.
		Accred-ited De-tection Limit	Measur-ement Uncer-tainty	Total	> Reported detect. limit	> Accred-ited de-lect. limit				Nor-mal ¹⁾	High /low value ignored ²⁾	
Cond (mS/m)	* **	0	5%	402	402	402	1.3	28.2	5.29 5.29	5.73 5.73	4.6 4.6	3.69
SPM (mg/l)	* **	0.5	20%	402	327	311	0.06	109	9.61 9.65	4.32 4.42	2.29 2.36	1.4
TOC (mg/l)	* **	1	10%	403	392	378	0.5	10.9	1.77 1.81	3.27 3.30	3.11 3.11	2.9
PO4-P (µg/l)	* **	1.8	10%	400	332	247	0.46	177	10.8 10.8	4.61 4.83	2.72 2.94	2
Tot-P (µg/l)	* **	3	10%	401	368	340	1	246	31.6 31.8	20.9 21.1	13.9 14.0	10
NO3-N (µg/l)	* **	10	10%	403	402	400	4	2180	286 286	245 245	188 188	181
NH4-N (µg/l)	* **	5	10%	400	371	314	1	194	18.7 18.9	19.0 19.3	16.4 16.5	15
Tot-N (µg/l)	* **	0	10%	403	403	403	60	3640	482 482	452 451	347 347	324
SiO2 (mg/l)	* **	0.09	10%	403	394	394	0.09	15.64	1.82 1.85	2.83 2.89	2.61 2.66	2.57
As (µg/l)	* **	0.2	12% ³⁾	403	354	101	0.01	2.51	0.20 0.21	0.17 0.18	0.14 0.15	0.15
Pb (µg/l)	* **	0.1	10% ³⁾	403	339	174	0.005	4.65	0.37 0.37	0.19 0.19	0.12 0.12	0.1
Cd (µg/l)	* **	0.02	10%	403	299	92	0.001	0.4	0.03 0.03	0.02 0.02	0.01 0.02	0.014
Cu (µg/l)	* **	0.2	10% ³⁾	403	391	375	0.007	17	1.99 1.99	1.36 1.37	0.92 0.92	0.78
Cr (µg/l)	* **	0.2	10% ³⁾	402	288	192	0.008	3.7	0.39 0.4	0.28 0.31	0.21 0.25	0.2
Ni (µg/l)	* **	0.3	10% ³⁾	403	385	295	0.02	4.67	0.53 0.53	0.62 0.63	0.54 0.55	0.5
Zn (µg/l)	* **	0.1	10% ³⁾	403	381	378	0.04	52	6.88 6.89	4.60 4.62	3.04 3.04	2.8
Hg (ng/l)	* **	5	15%	403	239	200	2	86	6.53 7.69	5.83 7.72	4.61 6.65	5
γ-HCH (ng/l)	* **	0.2	20%	116	100	86	0.02	1.34	0.29 0.31	0.40 0.42	0.37 0.38	0.34

Average values are calculated ¹⁾ for all values (standard average) and ²⁾ by ignoring the 10% highest and the 10% lowest values. Average and standard deviation calculations are performed on two ways:

* Calculated when values report < detection limit is set equal to 0

** Calculated when values report < detection limit is set equal to detection limit

³⁾ In 2002, the laboratory gave a higher uncertainty estimation (15-20%), based on results from the last round-robin test for the actual parameters.

Uncertainties in calculated average concentration

To illustrate the uncertainties in average calculated concentrations, all the measured concentrations of Pb for all main rivers have been statistical evaluated for the time period 1999-2001. Figure 2 present the average (mean) as well as the median of reported concentrations for lead (Pb) and includes calculated uncertainties for each main river for the time period 1999-2001. All calculations are done assuming values below reported detection limit = 0, but the change in mean concentration is also illustrated by including mean value when assuming limit = limit. Figure 2 b (Pb) illustrate the same information including only the analytical uncertainty of each dataset. The analytical uncertainty is low compared to the total uncertainty, but for lead (Pb) in rivers where the concentrations are below the accredited detection limit, it can have a significant influence. For the data reported below the accredited detection limit, an analytical uncertainty of 50% has been assumed for both parameters.

The measured lead concentrations are generally low. For Suldalslågen and Alta more than 30% of the measurements are below the reported detection limit. For these two rivers as well as for four other rivers (Drammenselva, Skienselva, Orkla and Vefsna) more than 50% of the measurements are below the accredited detection limit. The analytical uncertainty accounts for a larger fraction of the total uncertainty than for many other rivers. For River Alta, the measured concentrations are so low that the 95% confidence interval of the average concentration is below the accredited detection limit for all three years investigated.

Comparison of the calculated median and average (mean) of lead (Figure 2) shows that the median is always lower than the average, except for Skienselva in year 1999, where all the measured concentrations were below 0.1 ($\mu\text{gPb/l}$), the accredited detection limit.

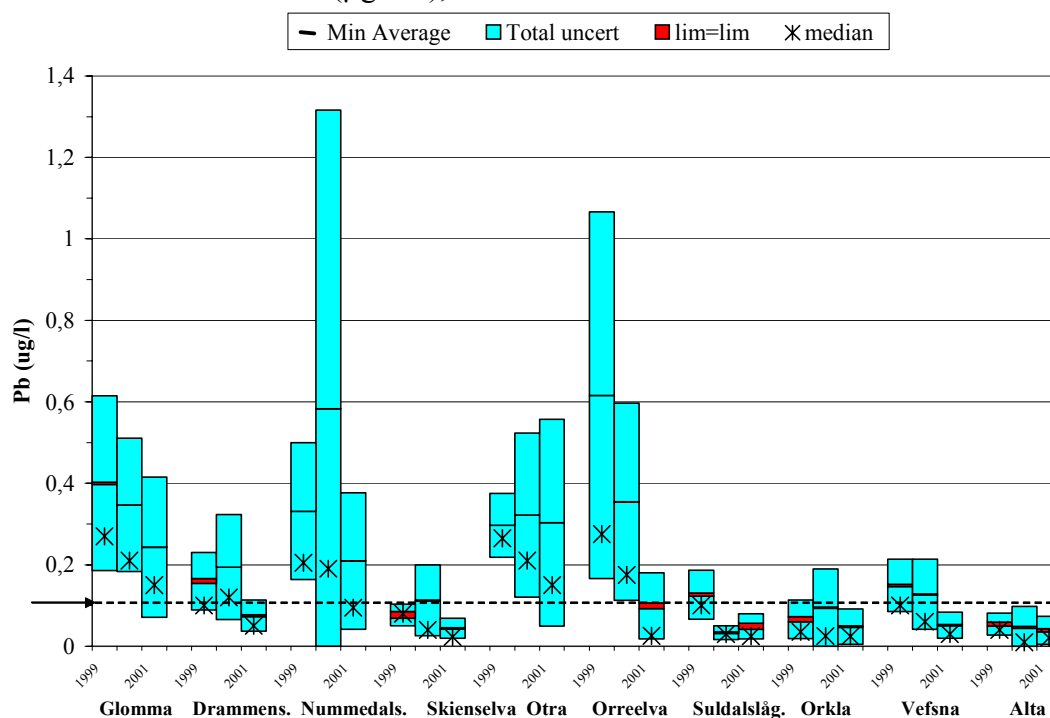


Figure 2 a. Uncertainty and variation of the yearly average of measured lead (Pb) concentration in the main rivers for the period 1999-2001. The accredited detection limit is 0.1 $\mu\text{g/l}$.

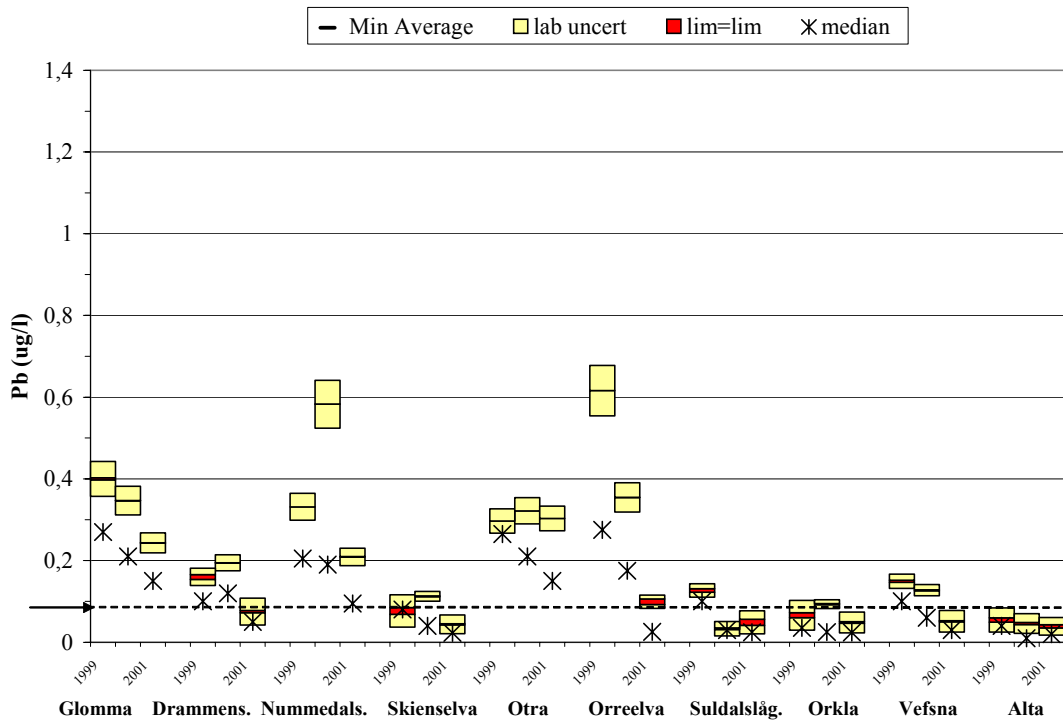


Figure 2 b. Analytical uncertainty and variation of the yearly average of measured lead (Pb) concentration in the main rivers for the period 1999-2001. The accredited detection limit is $0.1 \mu\text{g/l}$.

Detection limit

Due to the low measured concentrations compared to the analytical detection limits, reliable conclusions on trends can hardly be made for the parameters and rivers listed in Table 1. Especially for the metals arsenic, cadmium, lead and mercury there is a conflict between the need to report low discharges and the available detection limits for these analytical methods. The difference in the averages calculated for measured concentrations below the reported detection limit, when these are set equal to the limit (limit = limit) or zero (limit = 0) can lead to such high uncertainty in analytical data, that these in some cases can be larger than the eventual trend. Trends reflect in these cases rather the uncertainty in the analytical methods than a real change in loads.

Seasonal variations

Average measured concentrations for each month over the years 1999-2001 has been calculated for each river and the seasonal variation has been presented graphically. Figure 3 shows the seasonal variation in measured silicate concentrations. Silicate concentration is a good indication of erosion. Most rivers show high silicate concentration in spring and autumn and a minimum in summer, but the date of the maximum concentration vary with the climatic and local runoff situation. Almost no seasonal variation is, however, observed for Orkla and Suldalslågen (Figure 3). Most parameters are showing seasonal variations. Arsenic and copper seem to have less seasonal variation throughout the year for most rivers.

The pattern of the seasonal variations shows that differences in measured values are not only due to statistical variations. If episodes of high discharges are noticed every year at the same time, it is important to find how representative a monthly measurement is for this episode. Currently, the two rivers with the highest flow, Glomma and Drammenselva are monitored weekly in May to July.

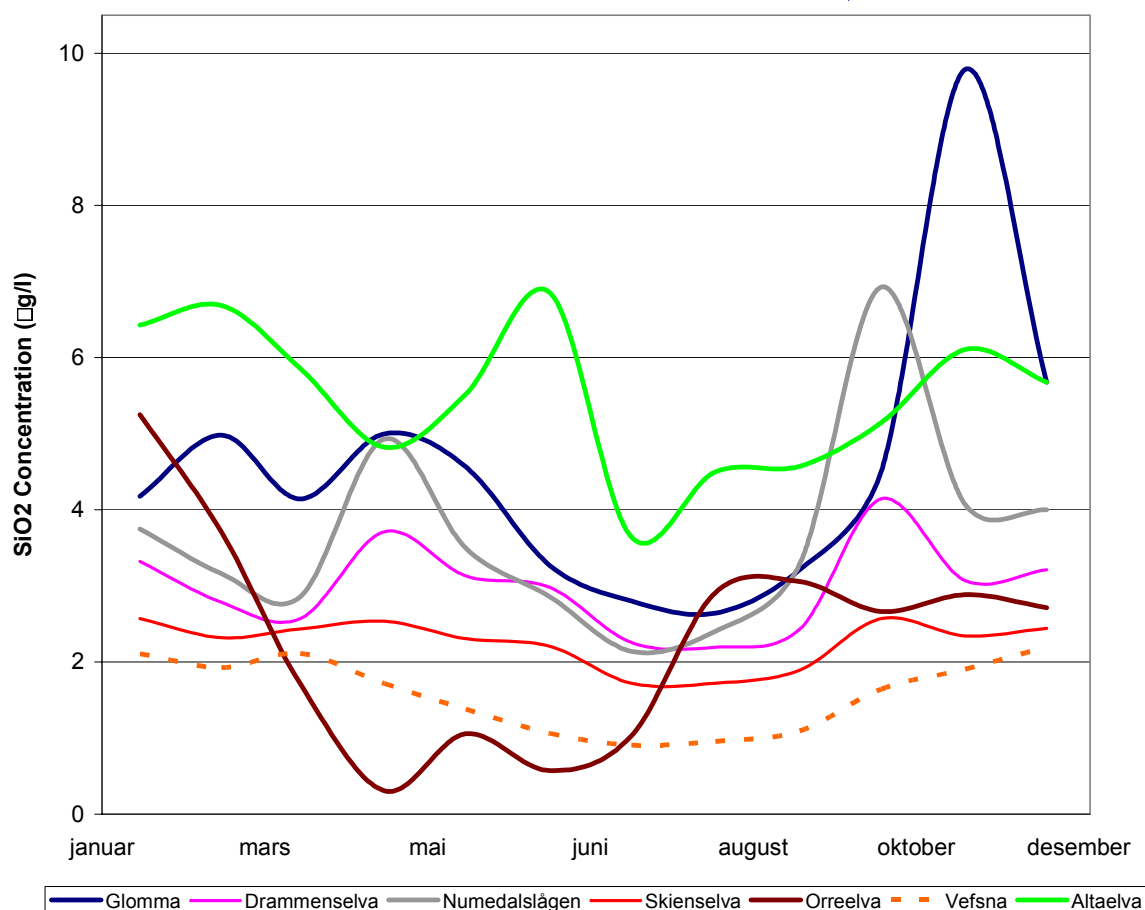


Figure 3 Silicate (SiO_2) concentrations in Main Rivers. Monthly variation has been calculated as average of measured data for the years 1999-2001.

Figure 3 shows average silicate concentration variations over the years 1999-2001 for some selected rivers. Vefsna and Skienselva show no clear seasonal variation, while Numedalslågen, Drammenselva and Glomma clearly illustrate the seasonal variation by a clear high concentration in spring and autumn. Orreelva shows a different pattern with the highest concentration in January and down to 1:5 of this concentration in May-June. Altaelva also shows a seasonal variation, but the high spring concentration occurs in the beginning of June due to the late appearance of spring. The figures showing seasonal variation add information about the watershed and runoff situation of each river and are important input to the uncertainty discussions of each compound. High concentration of particulate matter is likely to increase the concentration of particulate bound compounds. For rivers with wetland or boggy ground in the watershed, high runoff situations can also lead to increasing concentration of organics, and possibility of increasingly concentrations of complex bound compounds, such as seen in the correlation analysis for Altaelva.

Correlation between different sets of data

Focus has been to study the correlation between surface runoff (flow), suspended particulate matter (SPM) or silicate (SiO_2) to metals and nutrients. The degree of correlation is estimated by R^2 for each individual river. Since the average concentration, discharge patterns, anthropogenic activities, etc. vary for each parameter from river to river, this type of correlation has only been relevant to study for each individual river. The parameters indicating a possible correlation are summarised in Table 3. The calculated R^2 values indicate that for some of the rivers, groups of parameters are well related. For Numedalslågen runoff (flow) and SPM correlate well with Zn and Cu, and a possible

correlation is seen with most of the other metals (except Hg and Cr). Seasonal variation is also significant for this river, with a maximum in spring and in autumn. This indicates that erosion probably is the principal factor governing inorganic discharges from Numedalslågen. For river Alta correlations are found between TOC and most of the nutrients (except for nitrate which has a low and stable concentration). This suggests that organic discharges during summer are of major importance in Alta. For the other rivers few, if any, significant linear correlation is found between the parameters. The seasonal variations influencing inorganic erosion or seasonal variation influencing organic discharge can be important also in these rivers, but the many different sources of discharges make the pattern more complicated to explain.

Table 3. Analytical parameters indicating possible linear correlation between runoff (flow)/suspended particulate matter (SPM)/silicate (SiO₂)/Total organic carbon (TOC) and metals/nutrients. Calculated correlation coefficient (R^2) given in parenthesis.

River	Significant correlation ($R^2 > 0.8$)	Possible correlation ($R^2 > 0.6$)
Glomma	SPM – Ni (0.86)	SPM – Tot-P (0.66) SPM – Pb (0.61) SPM – Cr (0.61)
Drammenselva	SPM – Pb (0.85)	none
Numedalslågen	SPM - Cu (0.80) SPM – Zn (0.81)	SPM – SiO ₂ (0.71) Runoff - SPM (0.63) SPM – As (0.65) SPM – Pb (0.74) SPM – Cd (0.73) SPM – Cr (0.65) SPM – Ni (0.67)
Skienelva	none	Runoff – SPM (0.72) SPM - Pb (0.73)
Otra		Runoff – SPM (0.65) Runoff – Pb (0.67) Runoff – Cr (0.72) SPM – PO ₄ (0.74) SPM – Cr (0.77)
Orreelva	SPM – Pb (0.92)	SPM–Tot-P (0.66)
Suldalslågen	none	Runoff–NO ₃ (0.66)
Orkla	Runoff – PO ₄ (0.84)	Runoff –TOC (0.62) Runoff – Cr (0.70) Runoff – Ni (0.70)
Vefsna	None	none
Alta	Runoff – SPM(0.89) TOC – Tot-N(0.81)	Runoff – Pb (0.75) Runoff - Cr (0.64) SPM - Cr (0.79) TOC – PO ₄ (0.62) TOC–Tot-P(0.71)

Uncertainty in load calculations

Metal and nutrient concentrations often follow a seasonal variation. When this variation is following the same pattern as the seasonal variation of runoff, the variation in load ($C_i \bullet Q_i$) will be proportionally higher than the variation in measured concentration. This means a higher standard deviation and a higher statistical uncertainty.

The influence of a high measured concentration on the total load depends on the flow rate in the river at the date of sampling. A relatively high daily flow rate on a sampling day gives the measured

concentrations of this day a relatively high weight. In year 2000 one sample for Alta (02.06.2000) was given more weight than the sum of all other samples since the runoff to the river on this day was at the maximum this the year (Figure 4).

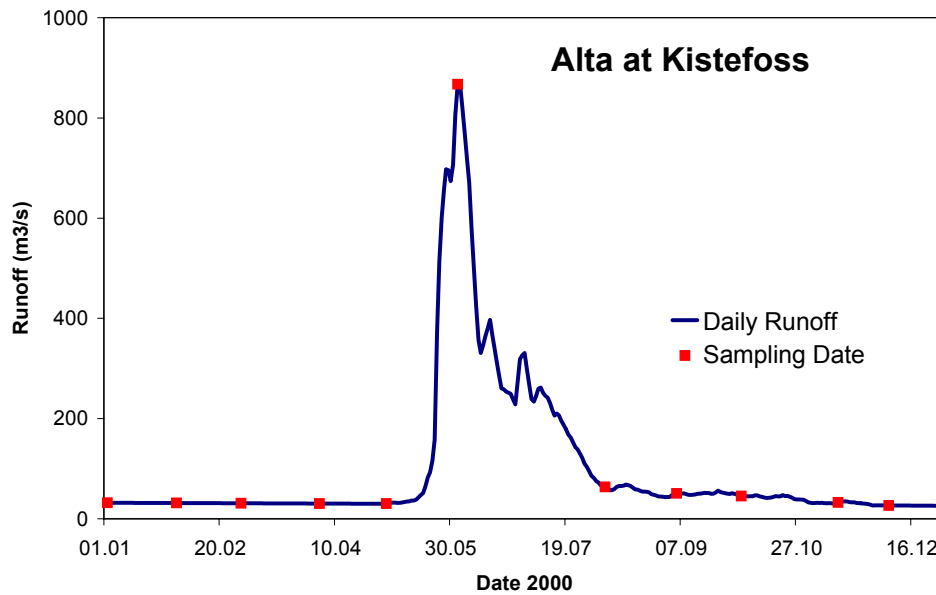


Figure 4. Seasonal change of daily runoff (m^3/s) on the sampling dates for river Alta in 2000.

The same variation observed in average concentration for two different rivers can have a significant different impact on the total discharge (load) dependent on the surface runoff. Table 4 shows that river Glomma accounts for more than 1/3 of the total flow, while river Orreelva accounts only for 0.2%. A moderate uncertainty in measured concentration in river Glomma has a much higher impact on the uncertainty in calculated total load than uncertainties in measured concentrations in river Orreelva. Most emphasis should therefore be used to reduce the uncertainties of measured concentrations of the rivers with the highest flow rates; i.e. river Glomma, Drammenselva and Skienselva.

Table 4. The catchments area and long term average flow (LTA 1961-90) of the Main rivers.

River	Catchments area (at outlet)		LTA, 1961-90 (at outlet)	
	km^2	%	$1000 \text{ m}^3/\text{day}$	%
Glomma	41 918	44%	61 350	35%
Drammenselva	17 034	18%	28 850	17%
Numedalslågen	5 577	5.9%	10 200	5.9%
Skienselva	10 772	11%	23 535	14%
Otra	3 738	3.9%	12 870	7.4%
Orreelva	105	0.11%	335	0.19%
Orkla	3 053	3.2%	5 710	3.3%
Vefsna	4 122	4.3%	15 655	9.0%
Suldalslågen	1 457	1.5%	7 420	4.3%
Alta	7 373	7.7%	7 495	4.3%
Sum of 10 main rivers	95 149	100%	173 420	100%

Measured phosphorus concentration in Glomma is in the same range as the average of the ten main rivers. Glomma represents ~50% of total phosphorus load. On the other hand the high phosphorus concentration in Orreelva is only representing 1% of the total load for the ten rivers, and the influence on the total load is therefore negligible.

Table 5 is showing the consequences of runoff variations. For river Alta, in year 2000, the sampling day corresponded with the day of the highest flow (see Figure 5) also corresponded with the day of the highest measured Tot-P concentration (38 µg/l). In spite of the fact that year 2000 was the year with the lowest measured average phosphorus concentration, the phosphorus load for this year is almost twice as high as for the two other years. The consequence of the highest phosphorus concentrations corresponding to the highest loads is visible also for other rivers; see Glomma, Drammenselva, Numedalslågen and Skienselva during the flooding in year 2000. These figures are given in bold in Table 5.

Table 5. Average yearly concentration and total yearly load for phosphorus (Tot-P), for the 10 main river in 1999- 2001. The high phosphorus load due to the flooding in year 2000 are illustrated with bold numbers.

River	Average Phosphorus Concentration µg P/l			Total Phosphorus Load tonnes/year		
	1999	2000	2001	1999	2000	2001
Glomma	29.4	23.9	32.3	618	835	788
Drammenselva	12.4	11.7	12.9	156	187	155
Numedalslågen	17.6	23.0	30.9	86	256	135
Skienselva	5.5	6.7	35.6	51	90	309
Otra	6.7	13.7	11.8	39	115	48
Orreelva	83.4	79.8	53.3	12	14	6
Suldalslågen	5.4	4.5	12.7	7	7	19
Orkla	9.6	7.1	25.8	20	35	37
Vefsna	5.2	5.9	8.4	28	31	42
Alta	33.6	13.3	23.6	63	105	53
All 10 Main Rivers	20.9	18.9	24.7	1080	1674	1591

Trend analysis

Medians of the measured parameters are usually lower than averages, as illustrated graphically for Pb in Figure 2 and Table 2. If measurements were normally distributed, calculated averages and medians would have the same probability to be the lowest or the highest value. The uncertainty calculations presented in this report have assumed normal distribution and can therefore only be considered to be a rough estimate of the real 95% confidence interval of the average (mean). For any parameter with a seasonal variation, the assumption of normal distribution is not valid. The 95% high confidence limit of the average is in some cases caused by a few extreme high values. The average calculated concentration can when used for trend analysis be in the high range. Cadmium in Vefsna: a parameter which demonstrated a significant trend of reduced loads for the period 1990-2001 (Figure 5-6) was chosen as an example for comparison of 1) the influence of using median and average, 2) trends dependent on starting year for trend analysis, and 3) using limit = limit or limit = 0 for data below detection limit, was selected for examining trends of development for the period 1990-2001.

Figures 5-6 present background data and result of trend analysis using yearly median and average calculated cadmium concentration in Vefsna. A downward trend (89%) was detected for the cadmium load in Vefsna (Weideborg *et al*, 2002) with the Trend-Y-Tector (Table 6). The same downward trend is seen for the average concentration (Table 6). For median_{limit=limit} the downward trend is lower and no significant trend is seen for the median_{limit=0}. In 1990, the reported detection limit for cadmium was high: 0.1 µg/l and in Vefsna 19 of 20 measurements were below this detection limit (Table 6). If 1990 data are ignored and trend analysis is performed for 1991-2001, the results are as reported in Figure 6.

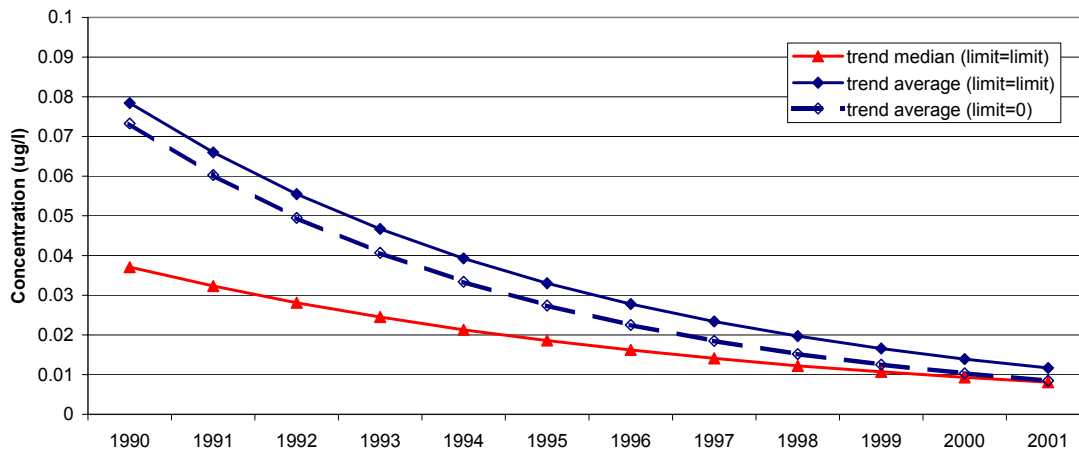


Figure 5. Calculated trends for development of cadmium in Vefsna (1990-2001) using yearly median and average calculated concentrations. Median and average are calculated using data below reported detection limit =limit and 0.

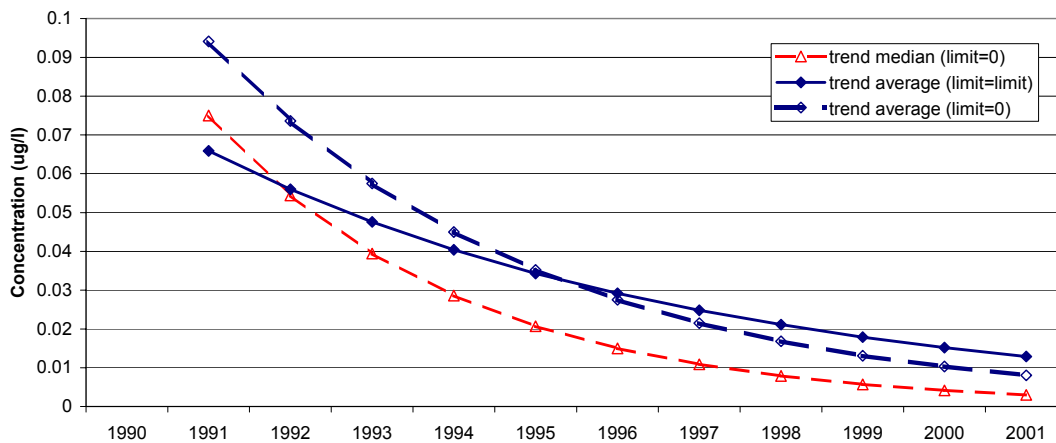


Figure 6. Calculated trends for development of cadmium in Vefsna (1991-2001) using yearly median and average calculated concentrations. Median and average are calculated using data below reported detection limit =limit and 0.

Table 6. Significant downwards trends detected by the Trend-Y-Tector for yearly average and median cadmium concentration in Vefsna for the periods 1990-2001 and 1991-2001.

Trends for year	Average (limit=limit)	Average (limit=0)	Median (limit=limit)	Median (limit=0)
1990-2001	85%	88%	78%	no significant trend
1991-2001	96%	80%	no significant trend	91%

The cadmium example for Vefsna has demonstrated how important the following aspects have been for the conclusions of a trend analysis:

- 1) Using measured concentrations below reported detection limit,

- 2) Using the average or the median to represent the dataset, and
- 3) The year of start of the trend analysis.

Conclusions and recommendations

Statistical evaluation of the monitoring data included in the Riverine Input project for the time period 1999- 2001, has been performed. The statistical analysis, and trend analysis of data for the period 1990-2001 addresses a number of questions of relevance for future monitoring and reporting programmes for this project:

- **Low concentrations (below detection limits)**

The measured concentration in the rivers is sometimes lower than the laboratories' accredited analytical detection limit. Normally the value is then reported as below the detection limit. PARCOM (1988) requires, however, that analytical methods should be chosen, which gives at least 70% of positive findings (i.e. above the detection limit). For some of the main rivers included in the Norwegian RID project (RID = Riverine and Direct Input to Norwegian Coastal Waters), the concentration of some parameters included in the survey are so low, that no standard analytical method have accredited detection limits, which can meet the requirements of PARCOM. For these parameters and rivers, the measured concentration is reported even if it is below accredited detection limit. This increases the analytical uncertainty from 10-20 % to 30-50 % depending on analytical parameter. For rivers with the highest loading, alternative sampling methods allowing for analysing higher concentrations for the most important rivers and parameters is needed. For some parameters, more than 50% of the measurements are below the accredited detection limit. In these cases the mean is equal or below the accredited detection limit. Arsenic, lead, cadmium, chromium and mercury are the compounds found in the lowest measured concentration in comparison to accredited or reported detection limits. Due to the low measured concentrations compared to the analytical detection limits, reliable conclusions on trends can hardly be made for these parameters and rivers. Especially for the metals arsenic, cadmium, lead and mercury there is a conflict between the need to report low discharges and the available detection limit. The difference in the averages calculated for measured concentrations below the reported detection limit, when these are set equal to the limit (limit = limit) or zero (limit = 0) can lead to such high uncertainty in analytical data, that these in some cases are larger than the eventual trend. Trends reflect in these cases rather the uncertainty in the analytical methods than a real change in loads. This was especially important for the starting year of the trend analysis (1990). By changing the starting year to 1991, the trend analysis makes significant improvement for the parameters in question.

- **The measurements are not normally distributed**

Calculation of statistical uncertainty assumes a normal distribution of the measurements. The assumption of normal distribution is also made by the Paris Commission when it gives the formula for calculating riverine load. Load is calculated as the arithmetic average corrected for flow variations. The concentration values measured in rivers is however not normally distributed. Seasonal variations are illustrating this clearly for several parameters. For rivers where one or two measured concentrations significantly can change the average, it should be considered if the analysis should be performed on the basis of the mean ignoring the extreme value.

- **Seasonal variations**

Most rivers show seasonal variation in measured silicate concentrations, high silicate concentration in spring and autumn and a minimum in summer, but the date of the maximum concentration vary with the local climatic and local runoff situation. Silicate is a good indication of erosion. Almost no seasonal variation is, however, observed for Orkla and Suldalslågen. Most parameters are showing seasonal variations. Arsenic and copper seem to have less seasonal variation throughout the year for most rivers. The pattern of the seasonal variations shows that differences in measured values are not only due to statistical variations. If episodes of high discharges are noticed every year at the same time, it is important to find how representative a monthly measurement is for this episode. Currently, the two rivers with the highest flow, Glomma and Drammenselva are monitored weekly from May to July.

For Numedalslågen almost all metals (except chromium and mercury) correlate well with silicate, particulate matters and runoff. Seasonal variation is also significant for this river, with a maximum silicate concentration in spring and in autumn. This indicates that erosion probably is the principal factor governing inorganic discharges from Numedalslågen. For river Alta correlations are found between TOC and most of the nutrients (except for nitrate which has a low and stable concentration). This suggests that organic discharges during summer are of major importance for Alta. For the other rivers few, if any, significant linear correlation is found between the parameters. The seasonal variations influencing inorganic erosion or seasonal variation influencing organic discharge can be important also in these rivers, but the many different sources of discharges make the pattern more complicated to explain.

- **Trend analyses**

The cadmium example for Vefsna illustrates the importance of 1) treatment of values below reported detection limit, 2) including all extreme values to represent the dataset of the mean, and 3) the year of start for the trend analysis, on the conclusions of the trend analysis.

Medians of the measured parameters are usually lower than averages. Loads are currently calculated using the average method. Another method for load calculation, using the mean but ignoring the extreme concentrations, should be considered when used for trend detection. If measurements were normally distributed, calculated averages and medians would have the same probability to be the lowest or the highest value.

- **Calculation of loads**

A moderate uncertainty in measured concentration of river Glomma influences the uncertainty in calculated total load much more than the higher uncertainties in measured concentrations in river Orreelva. The same variation observed in average concentration of two different rivers can result in a significant different influence in total discharge (load) if the surface runoff is different. The influence of a high measured concentration on the total load depends on the flow rate in the river at the date of sampling. A relatively high daily flow rate on a sampling day gives the measured concentrations of this day a relatively high weight. Phosphorus concentration in Glomma is in the same range as the average of the ten main rivers. Glomma represents, however, ~50% of total phosphorus load. On the other hand the high phosphorus concentration in Orreelva is only representing 1% of the total load for the ten rivers, and the influence on the total load is therefore negligible. Most emphasis should therefore be used to reduce the uncertainties of measured concentrations of the rivers with the highest flow rates; i.e. river Glomma, Drammenselva and Skienselva.

The following recommendations have been made:

- Alternative sampling methods should be evaluated for main rivers where critical parameters are found in extreme low concentrations (below detection limit).
- New sampling frequencies should be evaluated, especially for rivers with large seasonal variations, and which significantly influence on the total load.
- In calculation of load, single extreme concentrations might need to be ignored, unless they are part of the seasonal variation. In these cases, a higher frequency of sampling should be considered.
- More attention should be paid on the frequency of monitoring and improving of the sampling methods for high flow rivers, which account for the highest load (Glomma, Drammenselva and Skienselva).
- Trend analysis requires careful consideration of uncertainty figures, starting year and single extreme values.

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