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## Report


Number: C085/05


# Environmental Levels and Trends of 1,2-dichloroethane, vinyl chloride and chloroform in water, sediment and biota for the European and Arctic regions: literature study


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| Commissioned by: | Euro Chlor<br>Avenue E. van Nieuwenhuyse 4<br>Box 2<br>B-1160 Brussels<br>Belgium |
| Project number: | 3.46.12285.08 |
| Approved by: | Prof.Dr. J. de Boer<br>Head of Environment dept. |
| Signature: | _____ |
| Date: | 15 February 2006 |
| Number of copies: | 10 |
| Number of pages: | 36 |
| Number of tables: | 5 |
| Number of figures: | 5 |
| Number of annexes: | 14 |

# Table of Contents

# Summary

Data on concentrations of chloroform, 1,2-dichloroethane and vinyl chloride in European and Arctic waters, sediments and biota were collected from scientific literature and monitoring programmes for the period 1980–2005 and are presented in this report. Occurrence of chloroform and 1,2-dichloroethane in surface water is relatively well documented in the monitoring programmes and also in the literature. Extensive data sets or evaluation reports of monitoring results were obtained for 10 European countries – Belgium, Czech Republic, Denmark, Germany, Greece, Luxemburg, the Netherlands, Portugal, Slovakia and United Kingdom. Data for biota and sediments are available mainly from the literature and are rather limited. Significantly less data are available for vinyl chloride. Only few publications were found, and monitoring of this compound has been rather scarce. All data obtained are for surface water only.

The amount of the data collected and its quality were sufficient to identify time trends. Concentrations of chloroform, 1,2-dichloroethane and vinyl chloride in surface waters were found to decrease over the time period studied.

# 1. Introduction

One of the main scientific issues for Euro Chlor, the European association representing the chlor-alkali industry, is acquiring a greater understanding of chlorine, its derivatives and how they behave in the environment. During the past decades, this industry has significantly reduced its emissions to the environment, both to air and water. Emission data to support this have been collected since 1985 and are now published annually as part of the Euro Chlor 'Sustainable Development' programme.

It is important to Euro Chlor to investigate whether or not reduced emissions have led to decreasing concentrations in the environment (including biota). It is also important to know for which substances the emission reductions have not led to changes in environmental concentrations and which chemicals have not been detected at all. Furthermore, an overview of actual substance concentrations in the environment could improve prioritisation of future emission reduction actions and future impact assessment activities for remaining emissions. Therefore, Euro Chlor has commissioned a report from the Netherlands Institute for Fisheries Research concerning existing measured concentrations of chloroform, 1,2-dichloroethane and vinyl chloride in water, sediment and biota from European and Arctic regions. The project consisted of two phases: i) obtaining data for the target compounds from the scientific literature, and monitoring programmes and ii) evaluating, summarizing and reporting data collected in the first phase. The results of this project are presented in this report.

# 2. Objective

For the three chemicals, 1,2-dichloroethane, chloroform and vinyl chloride:

- To review and report measured data from monitoring programmes and scientific literature for the period 1980 – 2005, in water, sediment and biota for the European and Arctic region.
- To identify current levels or trends based on the environmental concentration data found.

# 3. Search strategy

Information on concentrations of 1,2-dichloroethane, chloroform and vinyl chloride in water, sediment and biota was obtained by means of an on-line literature search, databases search and personal contacts.

The literature search was performed using the ISI Web of Knowledge – Web of Science portal consisting of SCI-EXPANDED, SSCI and A&HCI databases, which covers references from peer-reviewed scientific journals for the time period 1945–2005. In Annex 1 the search criteria and the number of (relevant) hits are provided. Several synonyms of the chemical names of 1,2-dichloroethane, chloroform and vinyl chloride were considered. Despite the use of additional key words, such as *e.g.* matrix names, to reduce the number of hits, an extensive manual review of the articles was required because the target compounds are very common chemicals with a wide application range and appear frequently in abstracts.

1,2-Dichloroethane and chloroform were found to be on the List I, Dangerous substances, of the Directive 76/464/EEC on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community and their limit values in surface waters are set in the directive 86/280/EEC

on limit values and quality objectives for discharges of certain dangerous substances and it's amendments 90/415/EEC and 88/347/EEC. Therefore, water monitoring bodies of EU member states were identified in the Internet search and asked to provide their monitoring data for the period 1980–2005. In addition, various environmental agencies, marine and polar institutes were approached with the same request. All organizations and/or databases consulted are listed in Annex 2.

# 4. Search results

## 4.1. Literature

A number of publications have been found for each of the three target compounds and are listed in Annex 3. It shows that the highest number of publications is available for chloroform, followed by 1,2-dichloroethane, while for vinyl chloride only a few papers were found. Bibliographic information for each target compound was compiled into an electronic library (see Annex 4 for data file names) readable by EndNote software, which is an effective tool for publishing and managing bibliographies. The literature review reveals that most data are survey data reported for fresh water environment, while only limited data are available for biota and sediments. Data were compiled from the original publications into two MS Excel sheets, which are provided in electronic form (see Annex 4 for data file names and brief content description). One contains concentrations in surface waters (sea, estuaries, rivers and lakes), while the second one contains concentrations in biota and sediments. The concentrations compiled in the files are shown in Annexes 5-9. These data are mainly meant to report the analyte concentration in the specific matrix, at a specific place and time, but because of their inconsistency (*e.g.* limited data sets, different sampling locations) most of them are not really suitable for time trends. The only exception are two recent publications by Huybrechts *et al.,* 2004 and 2005, in which time trends in chloroform and 1,2-dichloroethane concentrations in the Scheldt estuary (the Netherlands/Belgium) are described. The papers by Martinez *et al.,* 2002 and Kostopoulou *et al.,* 2000 are also highly valuable, because they report levels in Portugal and Greece, for which it is usually difficult to obtain any monitoring data. More details about these four papers are given in Section 5.

## 4.2. Databases, monitoring programmes and personal contacts

The availability of the monitoring data from databases, monitoring programmes and personal contacts are indicated in Annex 2. Long term monitoring data for 8 countries – Belgium, Czech Republic, Denmark, Germany, Luxemburg, the Netherlands, Slovakia and United Kingdom – were obtained. For two countries – Poland and Sweden – limited survey data were received. A large database of monitoring and survey data for surface and estuarine waters, biota and sediments from UK was provided by Environmental Protection Agency. However, data were received just before the deadline and are therefore not discussed. Data from Nordic countries (Norway, Sweden, Finland, and Estonia) and the Arctic are limited. Institutions approached in this region, including Arctic Monitoring and Assessment Programme (AMAP), have no data available and responded that very limited measurements of these compounds had been performed. This is due to a

reduced production and usage of the target compounds in this region. Competent authorities do not consider these compounds to be a threat for the environment anymore.

Most of the data obtained are for surface waters and mainly for river water (Czech Republic, Denmark, Luxemburg, the Netherlands and Slovakia). Data from Germany are for estuarine and coastal waters of the North and Baltic Seas, while the data from Belgium are for surface waters (no distinguishing between estuaries and rivers). Monitoring data for sediments are available from Belgium and some surveys for sediments, silts and fish were obtained from Sweden and Poland.

The obtained data are reliable, were acquired over relatively long periods and are suitable for the construction of time trends. They were compiled into Excel sheets (see Annex 4 for the data file names) and if possible, formatted into a similar style. The only exceptions are data from UK, which are available as MS Access database. Since the large amount of data available (more than 200 pages), the Excel sheets are not printed. These data are available in electronic form only.

# 5. Data overview and analysis

## 5.1. Sea water

*Southern North Sea (Belgium/Netherlands/France)*

The occurrence of chloroform and 1,2-dichloroethane in the southern North Sea was studied in six campaigns from September 1994 to December 1995 (Dewulf *et al.*, 1998) and in six campaigns from April 1998 to October 2000 (Huybrechts *et al.*, 2005). Sampling sites for both studies are indicated in Annexes 10 and 11. The concentrations observed are summarized in Table 1.

*Table 1. Summary of chloroform and 1,2-dichloroethane concentrations (ng/l) in the southern North Sea.*

| Sampling period | n | $n_{censored}$ | Min | Max | Mean | Median | P25 | P75 |
|---|---|---|---|---|---|---|---|---|
| *$CHCl_3$* | | | | | | | | |
| 1994-1995 | 38 | – | – | – | 73 | – | 10 | 45 |
| 1994-1995 (Excl. site G) | 32 | – | – | – | – | – | – | 26 |
| 1998-2000 | 47 | 13 | <28 | 1900 | 130 | 26 | 12 | 130 |
| *1,2-DiChEt* | | | | | | | | |
| 1994-1995 | 38 | – | – | – | 21 | – | 4.9 | 16 |
| 1994-1995 (Excl. site G) | 32 | – | – | – | – | – | – | 8.9 |
| 1998-2000 | 47 | 36 | <16 | 110 | 7.8 | 3.2 | 1.4 | 7.9 |

n, number of measurements; $n_{censored}$, number of censored observations; Min, minimum value; Max, maximum value; P25, 25$^{th}$ percentile; P75, 75$^{th}$ percentile; –, not reported

In the earlier study, one sampling location was in the Scheldt estuary (sampling site G), and for this place significantly higher levels of priority compounds were reported. In order to study time trends in the southern North Sea only, the data for this sampling location were excluded and the median and quantiles were re-calculated. The results which are depicted in Fig. 1 show that levels of 1,2-dichloroethane are decreasing. On the other hand, an increase in chloroform concentrations was observed.

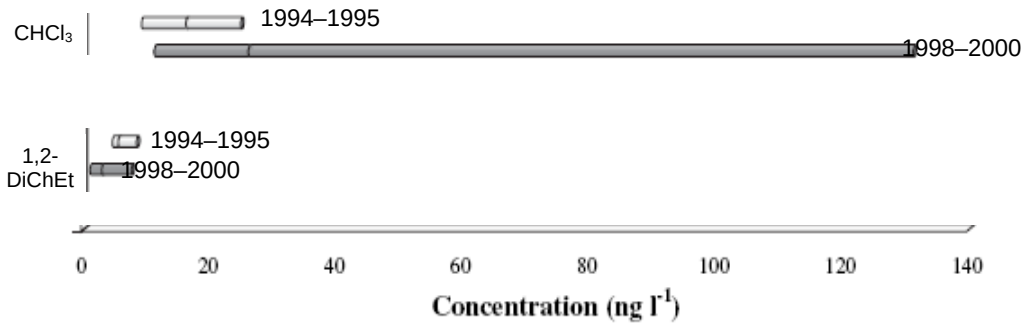


*Fig.1. P25 to P75 ranges and median levels (ng/l) of chloroform and 1,2-dichlororethane in the southern North Sea over the period 1994–1995 (n =32), and 1998–2000 (n =47). (Reproduced from* Huybrechts *et al.*, 2005).

As for the current levels, concentrations of $CHCl_3$ range from below detection limit values to 1900 ng/l. The predicted no-effect concentrations (PNEC) of 1000 ng/l defined by Euro Chlor (Zok *et al.*, 1998) was exceeded at two occasions. $CHCl_3$ levels were highly variable, as shown in Fig. 2, and very large fluctuations were found from one campaign to another. A similar degree of variability was also observed for 1,2-dichloroethane. Concentrations of 1,2-dichloroethane range from below detection limit to 110 ng/l. The occurrence of 1,2-dichloroethane was poorly defined owing to a high detection limit (16 ng/l) and a large number of censored measurements (77%).

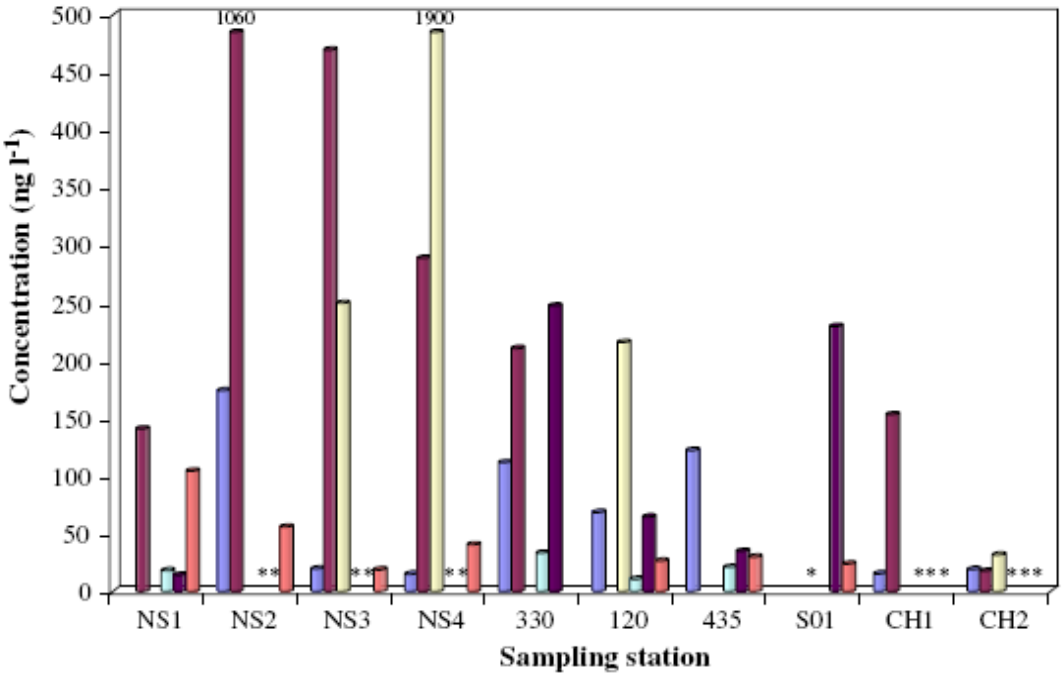


*Fig. 2. Concentrations (ng/l) of chloroform in the Southern Bight (NS1, NS2, NS3, NS4), the BCS (330, 120, 435), the mouth of the Scheldt estuary (S01) and the Channel (CH1, CH2) over the period 1998–2000. Non-detected (<28 ng/l) values are left blank; not-measured values are indicated with *; (blue) April 1998; (dark brown) September–October 1998; (yellow) June–July 1999; (turquoise) October 1999; (dark purple) March 2000; (orange) October 2000. (Reproduced from* Huybrechts *et al.*, 2005).

*North German and Baltic Sea*

Data for twelve sampling locations in the North Sea and two in the Baltic Sea for the period 1994 till 2004 were provided by the Bundesamt fuer Seeschifffahrt und Hydrographie, Hamburg, Germany. Sampling locations are shown in Annex 12. Chloroform concentrations were reported for all sampling locations, but

only in 5 locations was long term monitoring performed. Data of the most recent years (2003 and 2004) show that most reported concentrations are below the limit of quantification (LOQ), which was 4–50 ng/l. For some sampling locations and times, higher levels were reported but never exceed 200 ng/l. A typical time trend for one of the locations is shown in Fig. 3a. It is apparent that the highest reported $CHCl_3$ concentrations decrease with time. As for 1,2-dichloroethane, concentrations for both seas were always below the LOQ, which varied between 80 and 1000 ng/l. A typical time trend is shown in Fig. 3b. Vinyl chloride was measured only in two Baltic stations and only for the years 2002 and 2003. Reported concentrations were always below LOQ (500 ng/l).

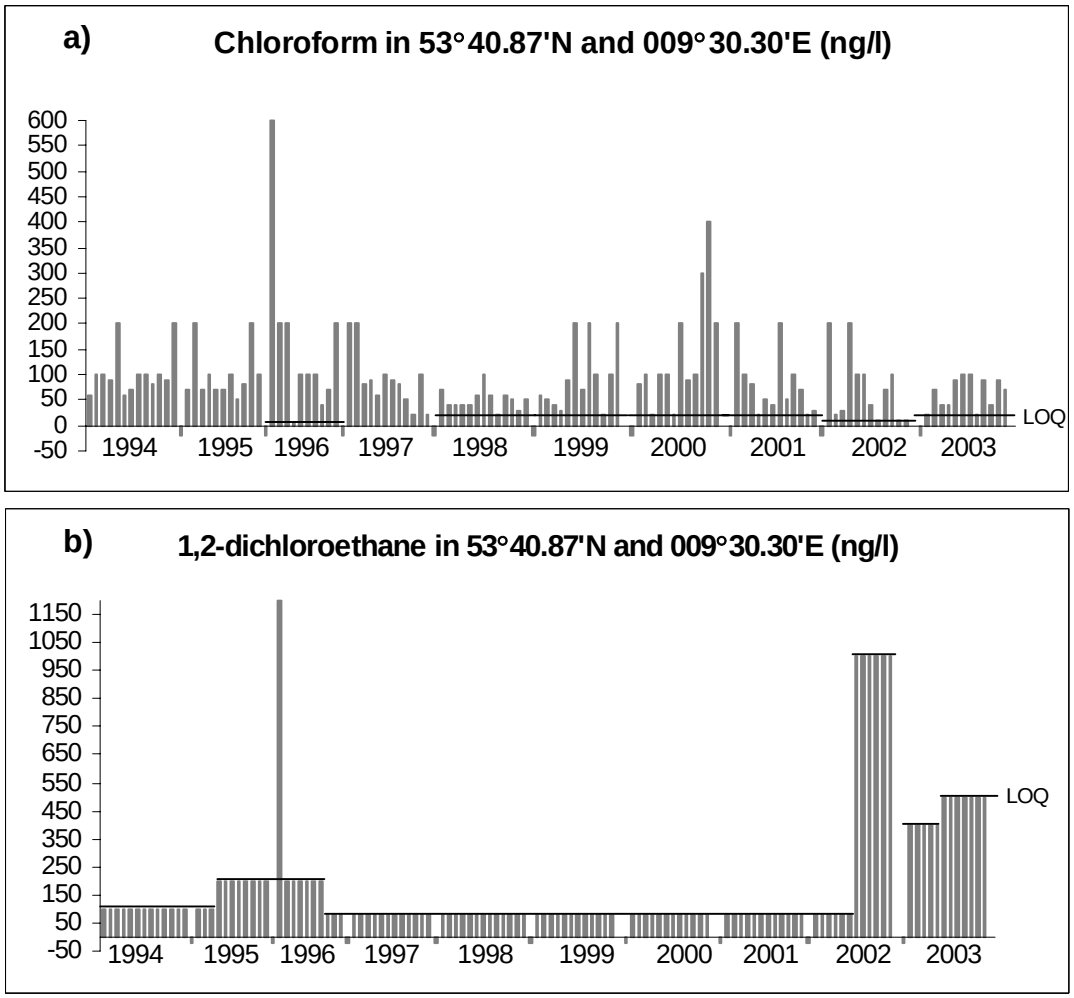


*Fig. 3. Time trends of chloroform and 1,2-dichloroethane concentrations(ng/l) in German North Sea over the period 1993 – 2003.*

When evaluation of the chloroform levels in sea is performed, one should keep in mind that chloroform is also produced naturally in the marine environment, particularly by macro and micro algae. Determination of chloroform in open-ocean waters has shown that concentrations in the range 1.6–1000 ng/l can be expected (McCulloch, 2003).

## 5.2. Estuarine waters

*Scheldt estuary (Belgium/Netherlands)*

The occurrence of chloroform and 1,2-dichloroethane in Scheldt estuary (Belgium/Netherlands) was studied in eight campaigns from March 1995 to January 1997 by Dewulf *et al.,* 1998b and in six campaigns from May 1998 to November 2000 by Huybrechts *et al.,* 2004. Sampling sites for both studies are indicated in Annexes 13 and 14 and the concentrations reported are summarized in Table 2.

*Table 2. Summary of chloroform and 1,2-dichloroethane concentrations (ng/l) in the Scheldt estuary.*

| Sampling period | n | $n_{censored}$ | Min | Max | Mean | Median | P25 | P75 |
|---|---|---|---|---|---|---|---|---|
| *$CHCl_3$* | | | | | | | | |
| 1995-1999 | 72 | – | – | – | 153.5 | – | 45.8 | 212.1 |
| 1998-2000 | 84 | – | <28.0 | 768 | 80.7 | 46.5 | 27.0 | 94.7 |
| *1,2-DiChEt* | | | | | | | | |
| 1995-1999 | 72 | – | – | – | 76.1 | – | 20.6 | 107.7 |
| 1998-2000 | 84 | – | <16.5 | 137 | 40.0 | 31.6 | 15.8 | 57.2 |

n, number of measurements; $n_{censored}$, number of censored observations; Min, minimum value; Max, maximum value; P25, 25$^{th}$ percentile; P75, 75$^{th}$ percentile; –, not reported

To assess whether current concentrations reflect the progress that has been made over the past two decades for reducing inputs to the marine environment, Huybrechts *et al.,* 2004 compared these two data sets. They used the non-parametric Mann-Kendall test to determine temporal trends at S01, S04, S07, S09, S12, S15 and S22 (n = 14 per station). Data reported as 'less than the detection limit' were assigned a common value equal to the detection limit. In the event that multiple detection limits were present in the data set, all non-detects were assigned the highest value.

Results are given in Table 3. Kendall's $\tau$ and its associated *P*-value were calculated. Only those significance levels with an upper bound $P \leq 0.05$ were considered to be indications that a significant monotonic trend exists. A strong negative correlation was reported for 1,2-dichloroethane at S07, S09, S12 and S15 (Annexes 13 and 14), which indicates that the occurrence of 1,2-dichloroethane in the Scheldt estuary was significantly reduced. Concentrations of chloroform were found to decrease in the upper estuary as statistically significant downward trends were detected at S12, S15 and S22 (Annexes 13 and 14).

*Table 3. Temporal variability (Kendall's $\tau$) of chloroform and 1,2-dichloroethane in the Scheldt estuary over the period 1995-2000.*

| Compound | S01 | S04 | S07 | S09 | S12 | S15 | S22 |
|---|---|---|---|---|---|---|---|
| $CHCl_3$ | 0.10 | -0.16 | -0.34 | -0.25 | **-0.43** | **-0.40** | **-0.58** |
| 1,2-DiChEt | -0.03 | -0.25 | **-0.46** | **-0.55** | **-0.45** | **-0.43** | 0.14 |

Significant trends ($P \leq 0.05$) are indicated in bold.

## 5.3. River and lake waters

*Portugal*

Martinez *et al.* (2002) reported a monitoring study of Portuguese surface waters for period April 1999 to May 2000. The study is based on the analyses of 644 samples, which corresponds to a 14 months survey of 46 sites and includes sea, estuarine, river water and industrial effluents. Table 4 summarizes the detection frequency of chloroform and 1,2-dichloroethane in the analysed samples.

*Table 4. Limit of detection (LOD), percentage and number of detected positive samples in Portuguese surface waters (644 samples analyzed).*

| Compound | LOD | Number of samples with concentrations | | | | Total # of samples | % of samples |
|---|---|---|---|---|---|---|---|
| | (ng/l) | <100 ng/l | >100 ng/l | >1000 ng/l | >10 000 ng/l | > 100 ng/l | > 100 ng/l |
| $CHCl_3$ | 30 | 23 | 231 | 86 | 3 | 320 | 49.7 |
| 1,2-DiChEt | 30 | 64 | 26 | 2 | 0 | 28 | 4.3 |

Chloroform was present in 49% of the samples analyzed, in 231 with values higher than 100 ng/l and in 89 with levels higher than 1 000 ng/l. Fig. 4 shows the mean concentration of chloroform in each sampling site throughout the 14 month of monitoring. The sites Ria Aveiro (site 15), Ponte Formoselha (17) and Dornelas do Zézere (27) had mean values of 1160, 1550 and 1650 ng/l, respectively, due to high contributions in June, October, November 1999 and February 2000, where more than 10 sites gave positive results. However, occasionally high levels of chloroform of 4000–20000 ng/l were distributed throughout Portugal due to spills or usage, corresponding mainly to the highly industrialized and urban area of the Lisbon estuary (Esteiro Seixal), in the agricultural Guadiana river basin (Monte da Vinha, Ardila Captacao, Pulo Lobo and Cais de Alcoutim) and in river waters close to paper industry effluents (Alb. Castelo de Bode and Dornelas do Zézere). In the majority of the sampling points the levels were between 100 and 500 ng/l, indicating widespread diffuse levels. This widespread distribution of chloroform makes it difficult to establish a unique source (agricultural/domestic or industrial) and indicates that contamination of chloroform is common in most water reservoirs.

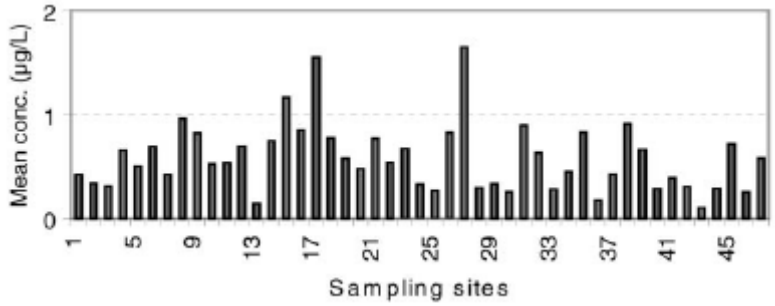


*Fig. 4. Mean concentration of chloroform (µg/l) in Portuguese surface waters for 47 sampling sites for the period April 1999 to May 2000. (Reproduced from Martinez et al., 2002)*

1,2-dichloroethane was sporadically found in samples collected in June at levels of between 100 and 700 ng/l, so it was always below the maximum permissible concentration set up by Directive 90/415/EEC. In many samples, this compound was detected slightly above the limit of detection.

*Belgium*

Monitoring data for year 1991 and then for period 1997-2005 were provided by Vlaamse Milieumaatschappij VMM, Erembodegem, Belgium. Chloroform levels of the last few years are somewhat lower compared with 1991 as can be easily read from the lower number of high values reported for recent years (see raw data in electronic database). Current levels of chloroform vary from below 0.041 µg/l up to 7 µg/l, but most of the data are below the LOQ, which is 0.041-0.37 µg/l.

The LOQ of 1,2-dichloroethane varied between 0.039-0.5 µg/l and most of the data reported were below this value. No trends were observed. The highest reported value in the last 3 years was 15 µg/l.

Vinyl chloride was monitored in 43 sampling locations during 1997-2000. From 550 measurements performed, no one exceeded the LOQ, which was 0.1-0.48 µg/l.

*Greece*

The occurrence of chloroform from June 1996 to June 1998 in rivers and lakes of Northern Greece (near Albania, Macedonia and Bulgaria) was reported by Kostopoulou *et al.* (2000). The concentrations of single measurements in rivers, were in the range <25–417 ng/l, and in the lakes <25–174 ng/l. The mean concentrations of the first and second year for each of the monitored rivers and lakes are shown in Table 5. Concentrations of chloroform in estuaries (always <25 ng/l) were found to be lower than in rivers. Kostopoulou et al. (2000) concluded that this would possibly be caused by activities in the neighbouring countries. The concentrations in rivers are slightly higher than those in lakes.

*Table 5. Mean concentrations of chloroform in the rivers and lakes of Northern Greece*

| River | Year | Mean (ng/l) | Lake | Year | Mean (ng/l) |
|---|---|---|---|---|---|
| Evros | 1995–1996 | <25 | Volvi | 1995–1996 | <25 |
| | 1996–1997 | <25 | | 1996–1997 | <25 |
| Nestos | 1995–1996 | <25 | Vistonoda | 1995–1996 | <25 |
| | 1996–1997 | <25 | | 1996–1997 | <25 |
| Strimonas | 1995–1996 | 251 | Vegorotida | 1995–1996 | <25 |
| | 1996–1997 | 51 | | 1996–1997 | <25 |
| Axios | 1995–1996 | 25 | L. Prespa | 1995–1996 | <25 |
| | 1996–1997 | <25 | | 1996–1997 | <25 |
| | | | S. Prespa | 1995–1996 | 15 |
| | | | | 1996–1997 | <25 |

*Denmark*

Monitoring data from Denmark were provided by National Environmental Research Institute, Silkeborg, Denmark. Chloroform was monitored at 7 sampling stations for the period 1995-2004 and 1,2-dichloroethane was monitored at 5 sampling stations for the period 1999-2003. As for chloroform, most of the data are below the LOQ (0.02-0.1 ug/l). In very few cases higher concentrations were measured, but never exceeded 0.58 ug/l. Concentrations of 1,2-dichloroethane were practically invariably below the LOQ, which was 0.05-0.1 ug/l.

*Luxemburg*

Data from 7 sampling locations in Luxemburg for years 2002, 2003 and 2005 were provided by Administration de la Gestion de l'Eau, Luxembourg, Luxemburg. Concentrations of chloroform are usually below the LOQ, which is 0.5-2.5 ug/l. In very few instances, concentrations up to 11 ug/l were reported. Reported concentrations for 1,2-dichloroethane are invariably below the LOQ, which is 5-20 ug/l.

*The Netherlands*

Data for 23 sampling locations in the Netherlands were obtained from database published by the Ministerie van Verkeer en Waterstaat on the web page www.waterbase.nl. Time trends at selected sampling stations in Fig. 5 clearly show that levels of chloroform and 1,2-dichloroethane have decreased significantly over the last 25 years. The current levels vary between 0.01 and 0.43 ug/l for chloroform and <0.05 and 3.7 ug/l for 1,2-dichloroethane.

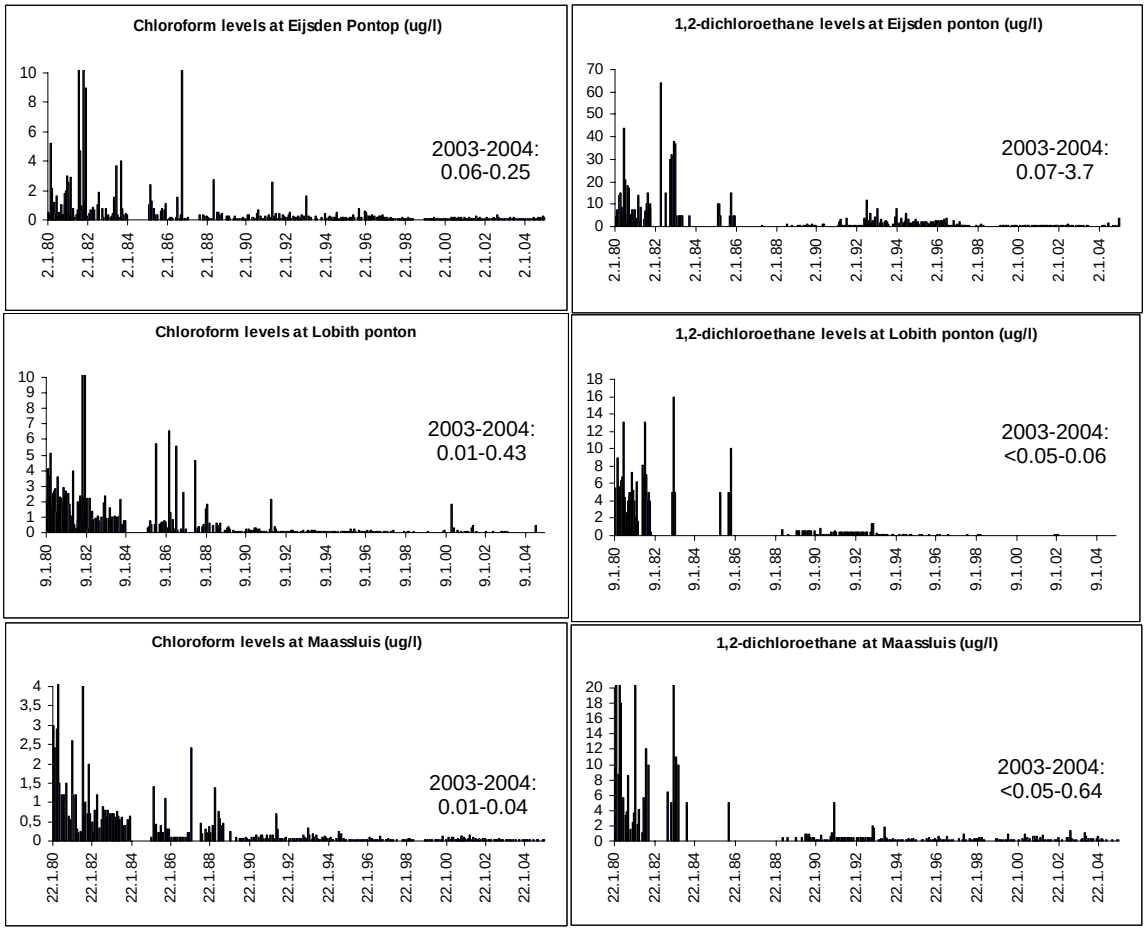


*Fig. 5. Time trends of chloroform and 1,2-dichloroethane concentration (µg/l) in river waters of the Netherlands.*

*Slovakia and Czech Republic*

Monitoring data from Slovakia were provided by Slovak hydrometeorological institute, Bratislava, Slovakia and data from Czech Republic were obtained from the database published by Czech hydrometeorological institute on the web page www.chmu.cz. Data for chloroform and 1,2-dichloroethane are available from both countries for the period 1991-2005. Data from Slovakia are not reliable, because for some data points an error in units was found (ug/l instead of ng/l). Data from Czech Republic shows decreases in concentrations over the last 15 years. as was observed in the Netherlands. The latest surveys in Slovakia show that the current levels for chloroform, 1,2-dichloroethane and vinyl chloride in most of the sampling station are below the LOQs, which are 0.5-1.8 ug/l, 0.7 ug/l and 0.1 ug/l, respectively. Only in the stations located close to chemical factories, elevated values were reported: for chloroform up to 18 ug/l and for 1,2-dichloroethane up to 11.4 ug/l. Vinyl chloride was not detected at any of the stations.

## 5.4. Biota

Concentrations of chloroform and 1,2-dichlorethane in biota are summarized in Annexes 8 and 9. Some of the data is discussed in the following:

*Belgium*

Twenty eels caught in Flanders (Belgium) were analysed for chloroform and 1,2-dichloroethane by Roose *et al.* (2003). Chloroform was detected in 15 samples, and 1,2-dichloroethane in 9 samples. Concentrations of chloroform varied between 3.9 and 96 ng/g ww and of 1,2-dichloroethane between 1.4 and 4.9 ng/g ww. The same substances were analysed in whiting and dab caught in the Belgian continental shelf (Roose and Brinkman, 1998). The mean concentration of chloroform was 198 ng/g ww in whiting and 14.3 ng/g ww in dab. In another study, Roose and Brinkman (2000) analysed chloroform and 1,2-dichlroethane in two species of vertebrates and four species of invertebrates from sampling stations in the southern North Sea. The chloroform concentrations were 0.4-5.4 ng/g, those of 1,2-dichloroethane 0.3-0.9 ng/g.

*Sweden*

Chloroform and 1,2-dichloroethane concentrations were determined in fish of the two largest lakes in Sweden (Vänern and Vättern) by the Swedish Environmental Protection Agency. Concentrations were reported for 8 fishes. The assessment was based on the analysis of 8 fish samples. Chloroform concentrations varied between <0.05 and 0.26 mg/kg dw with mean of 0.14 mg/kg dw. Concentrations for 1,2-dichloroethane were below LOQ (0.05 mg/kg dw).

# 6. Conclusions

Chloroform, 1,2-dichloroethane and vinyl chloride concentrations in surface waters have decreased significantly over the last 25 years. The most pronounced decrease is observed for vinyl chloride, for which levels currently do not exceed the limit of quantifications. One should, however, remember that for this compound the least data are available. The decrease of 1,2-dichloroethane was identified by the statistical evaluation of marine and estuarine waters and can be observed also for river waters. The majority of the current concentrations are below or close to limit of quantification and elevated values are reported almost exclusively for the locations which are close to chemical factories. Current chloroform levels are significantly lower compared to 25 years ago. However, the decrease in the last years is less pronounced as compared to the two other investigated compounds.

# Annexes: 1-14

**Annex 1.** Literature search criteria and number of hits

- General search

| Key words used | No. of hits | No. of relevant hits |
|---|---|---|
| chlorinated volatile organic compounds | 56 | 1 (for chloroform) |

- 1,2-dichloroethane (synonyms: ethylene dichloride (EDC), 1,2-ethylene chloride, 1,2-ethylidene dichloride)

| Key words used | No. of hits | No. of relevant hits |
|---|---|---|
| 1,2-dichloroethane | 2 837 | not reviewed |
| 1,2-dichloroethane monitoring | 0 | 0 |
| 1,2-dichloroethane and monitoring | 22 | 4 |
| 1,2-dichloroethane and distribution | 146 | 1 |
| 1,2-dichloroethane and concentration | 349 | 1 |
| 1,2-dichloroethane and trend | 2 | 0 |
| 1,2-dichloroethane and water | 734 | 5 |
| 1,2-dichloroethane and biota | 1 | 1 |
| 1,2-dichloroethane and sediment | 6 | 0 |
| 1,2-dichloroethane and fish | 14 | 2 |
| 1,2-dichloroethane and mussel | 0 | 0 |
| 1,2-dichloroethane and environment* | 77 | 5 |
| ethylene dichloride | 181 | 2 |
| 1,2-ethylene dichloride | 0 | 0 |
| 1,2-ethylidene dichloride | 0 | 0 |

- chloroform (synonyms: trichloromethane, 1,1,1-trichloromethane)

| Key words used | No. of hits | No. of relevant hits |
|---|---|---|
| Chloroform | 18 426 | not reviewed |
| Chloroform monitoring | 0 | 0 |
| Chloroform and monitoring | 281 | 12 |
| Chloroform and distribution | 783 | not reviewed |
| Chloroform and concentration | 2 291 | not reviewed |
| Chloroform and concentration and distribution | 164 | 4 |
| Chloroform and level* | 1 592 | not reviewed |
| Chloroform and level* and environment* | 133 | 2 |
| Chloroform and trend* | 192 | 3 |
| Chloroform and water | 3 690 | not reviewed |
| Chloroform and biota | 12 | 3 |
| Chloroform and sediment* | 169 | 4 |
| Chloroform and fish | 123 | 2 |
| Chloroform and mussel | 12 | 0 |
| Chloroform and environment* | 666 | not reviewed |
| Trichloromethane | 375 | 12 |
| 1,1,1-trichloromethane | 5 | 0 |

- vinyl chloride (synonyms: chloroethene, chloroethylene, ethylene monochloride)

| Key words used | No. of hits | No. of relevant hits |
|---|---|---|
| Vinyl chloride | 7 263 | not reviewed |
| Vinyl chloride monitoring | 3 | 0 (all in room air) |
| Vinyl chloride and monitoring | 153 | 0 |
| Vinyl chloride and distribution | 339 | 1 |
| Vinyl chloride and concentration | 928 | not reviewed |
| Vinyl chloride and concentration and distribution | 46 | 0 (all kinetics) |

| | | |
|---|---|---|
| Vinyl chloride and level* and environment* | 67 | 0 |
| Vinyl chloride and trend* | 80 | 0 |
| Vinyl chloride and water | 547 | not reviewed |
| Vinyl chloride and biota | 0 | 0 |
| Vinyl chloride and sediment* | 85 | 2 |
| Vinyl chloride and fish | 15 | 1 |
| Vinyl chloride and mussel | 1 | 0 |
| Vinyl chloride and environment* | 322 | 0 |

## **Annex 2.** Consulted databases, personal contacts and data availability

| Country | Institute / Organization | Webpage/Database | Compound and matrix | Number of sites | Year of sampling |
|---|---|---|---|---|---|
| Belgium | VMM - flemish environmental agency | www.vmm.be | 1,2-dichloroethane in surface water | 105 | 1991-2005 |
| | | | chloroform in surface water | 105 | 1991-2005 |
| | | | vinyl chloride in surface water | 43 | 1997-2000 |
| | | | 1,2-dichloroethane in river sediment | 485 | 1999,2000,2002-2004 |
| | | | chloroform in river sediment | 485 | 1999,2000,2002-2004 |
| | | | vinyl chloride in river sediment | 14 | 1999,2000,2002-2004 |
| Czech Republic | Czech hydrometeorological institute | www.chmu.cz | 1,2-dichloroethane in river water | 80 | 1991-2005 |
| | | | chloroform in river water | 80 | 1991-2005 |
| Denmark | National Environmental Research Institute | www.dmu.dk | 1,2-dichloroethane in river water | 5 | 1999-2003 |
| | | | chloroform in river water | 7 | 1995-2004 |
| Germany | German Oceanographic Data Centre | www.bsh.de | 1,2-dichloroethane in estuarine and coastal waters of North Sea | 12 | 1994-2003 |
| | | | chloroform in estuarine and coastal waters of North Sea | 12 | 1994-2004 |
| | | | 1,2-dichloroethane in estuarine and coastal waters of Baltic Sea | 2 | 2002-2003 |
| | | | chloroform in estuarine and coastal waters of Baltic Sea | 2 | 2002-2003 |
| | | | vinyl chloride in estuarine and coastal waters of Baltic Sea | 2 | 2002-2003 |
| Luxemburg | Administration de la Gestion de l'Eau | www.waasser.lu | 1,2-dichloroethane in river water | 7 | 2002,2003,2005 |
| | | | chloroform in river water | 7 | 2002,2003,2005 |
| Netherlands | RIKZ/RIZA | www.waterstat.nl or | 1,2-dichloroethane in surface water | 23 | 1980-2004 |
| | | www.waterbase.nl | chloroform in surface water | 23 | 1980-2004 |
| Poland | Voivodship Inspectorate for Environmental Protection in Krakow | | 1,2-dichloroethane in surface water (survey) | 1 | 2003 |
| | | | 1,2-dichloroethane in sediment (survey) | 2 | 2003 |
| Slovakia | Slovak hydrometeorological institute | www.shmu.sk | 1,2-dichloroethane in river water | 41 | 1992-2003 |
| | | | chloroform in river water | 41 | 1992-2004 |
| | | | vinyl chloride in river water (survey) | 40 | 2004 |
| | | | 1,2-dichloroethane in river water (survey) | 25 | 2002/2003, 2004 |
| | | | chloroform in river water (survey) | 25 | 2002/2003, 2005 |
| Sweden | Swedish Environmental Protection Agency | www.internat.naturvardsverket.se | 1,2-dichloroethane in sediment (survey) | 34 | 2002 |
| | | | chloroform in sediment (survey) | 34 | 2002 |
| | | | 1,2-dichloroethane in silt (survey) | 2 | 2002 |
| | | | chloroform in silt (survey) | 2 | 2002 |
| | | | vinyl chloride in sediment (survey) | 15 | 2004 |
| | | | 1,2-dichloroethane in fish (survey) | 1 | 2002 |
| | | | chloroform in fish (survey) | 1 | 2002 |
| UK | Environmental Protection Agency | www.environment-agency.gov.uk | Huge set of data; not reviewed due to the late delivery | | |
| Belgium | DPE - division de la police l'environnement | | no reply | | |
| Estonia | Tallin University of Technology | www.ttu.ee | they were not analysed in marine neither fresh waters of Estonia | | |
| Finland | Finnish Environment Institute, State of Finlands surface waters | www.environment.fi | they do not have such data | | |
| | Finnish Institute of Marine Research | www.fimr.fi | no reply | | |
| France | Agricultural and environmental engineering research (CEMAGREF) | www.cemagref.fr | no reply | | |
| | IFREMER | www.ifremer.fr | no reply | | |
| Germany | Umwelt Bundes Ambt | www.umweltprobenbank.de | no data available in on-line database | | |
| Hungary | | www.kwm.hu | no reply | | |
| Ireland | EPA Regional Inspectorate | www.epa.ie | no reply | | |
| Italy | CNR-IRSA Water Research Institute | www.irsa.cnr.it | no reply | | |
| Norway | Norwegian Institute for Water Research (NIVA) | www.niva.no | they do not have such data | | |
| | Norwegian Pollution Control Authority | www.environment.no/www.sft.no | they do not have such data | | |
| | Norwegian Polar Institute | www.npolar.no | no reply | | |
| Polar region | Arctic Monitoring and assesment programme (AMAP) | www.amap.no | they do not have such data | | |
| Spain | Spanish Institute of Oceanography (IEO) | | no reply | | |
| Sweden | Swedish Environmental Research Institute | www.ivl.se/miljo/db/intro.asp | they do not have such data | | |
| | Institutionen för miljöanalys SLU | http://info1.ma.slu.se/ | they do not have such data | | |
| UK | Centre for Ecology and Hydrology | www.ceh.ac.uk | they do not have such data | | |
| | CEFAS | www.cefas.co.uk | CEFAS does not monitor any of the compounds (not included in national marine monitoring programme) | | |
| | Scotisch Environmental Protection Agency | www.sepa.org.uk/spri/index.htm | They reported that they are below LOQs and there is very little emission. No data available | | |

## **Annex 3.** List of publications

### Chloroform


Abrahamsson, K., *et al.* (1989). "Halocarbon concentration in Askerofjorden related to the water exchange and inputs from the petrochemicals site at Stenungssund" *Vatten* 45, 3-8.

Aucott, M. L., *et al.* (1999). "Anthropogenic emissions of trichloromethane (chloroform, CHCl3) and chlorodifluoromethane (HCFC-22): Reactive Chlorine Emissions Inventory" *Journal of Geophysical Research-Atmospheres* 104, 8405-8415.

Ballschmiter, K. (2003). "Pattern and sources of naturally produced organohalogens in the marine environment: biogenic formation of organohalogens" *Chemosphere* 52, 313-324.

Bianchi, A. P. & Varney, M. S. (1998). "Volatile organic compounds in the surface waters of a British estuary. Part 1. Occurence, distribution and variation" *Water Research* 32, 352-370.

Bianchi, A. P., *et al.* (1991). "Analysis of volatile organic compounds in estuarine sediments using dynamic headspace and gas chromatography-mass spectrometry " *Journal Of Chromatography A* 542, 413-450.

Campillo, N., *et al.* (2004). "Determination of volatile halogenated organic compounds in soils by purge-and-trap capillary gas chromatography with atomic emission detection" *Talanta* 64, 584-589.

Christof, O., *et al.* (2002). "Volatile organic compounds in European estuaries" *Biogeochemistry* 59, 143-160.

Class, T. & Ballschmitter, K. (1986). "Chemistry of organic traces in air VI: Distribution of chlorinated C1-C4 hydrocarbons in air over the Northern and Southern Atlantic Ocean" *Chemosphere* 15, 413-427.

Comba, M. E., *et al.* (1994). "Volatile Halocarbons As Tracers Of Pulp-Mill Effluent Plumes" *Environmental Toxicology And Chemistry* 13, 1065-1074.

Dawes, V. J. & Waldock, M. J. (1994). "Measurement Of Volatile Organic-Compounds At Uk National Monitoring Plan Stations" *Marine Pollution Bulletin* 28, 291-298.

Dewulf, J., *et al.* (1998b). "Volatile organic compounds in the Scheldt estuary along the trajectory Antwerp-Vlissingen: Concentration profiles, modelling and estimation of emissions into the atmosphere" *Water Research* 32, 2941-2950.

Dewulf, J., *et al.* (1998). "Air/Water Exchange Dynamics of 13 Volatile Chlorinated C1- and C2-Hydrocarbons in the Southern North sea and the Scheldt Estuary" *Environmental Science & Technology* 32, 903-911.

Gotz, R., *et al.* (1998). "Organic trace compounds in the water of the river elbe near Hamburg Part I" *Chemosphere* 36, 2085-2101.

Harper, D. J., *et al.* (1992). "Concentrations Of Hexachlorobenzene, Trichlorobenzenes And Chloroform In The Waters Of The Forth Estuary, Scotland" *Marine Pollution Bulletin* 24, 244-249.

Hurst, D. F., *et al.* (1998). "Recent trends in the variability of halogenated trace gases over the United States" *Journal Of Geophysical Research-Atmospheres* 103, 25299-25306.

Huybrechts, T., *et al.* (2003). "State-of-the-art of gas chromatography-based methods for analysis of anthropogenic volatile organic compounds in estuarine waters, illustrated with the river Scheldt as an example" *Journal Of Chromatography A* 1000, 283-297.

Huybrechts, T., *et al.* (2004). "Spatial and temporal variability of priority volatile organic compounds in the Scheldt estuary" *Water Research* 38, 3241-3250.

Huybrechts, T., *et al.* (2005). "Priority volatile organic compounds in surface waters of the southern North Sea" *Environmental Pollution* 133, 255-264.

Khalil, M. A. K., *et al.* (1983). "Atmospheric chloroform (CHCl3): ocean air exchange and global mass balance" *Tellus* 35B, 266-274.

Kleiman, G. & Prinn, R. G. (2000). "Measurement and deduction of emissions of trichloroethene, tetrachloroethene, and trichloromethane (chloroform) in the northeastern United States and southeastern Canada" *Journal of Geophysical Research-Atmospheres* 105, 28875-28893.

Kostopoulou, M. N., *et al.* (2000). "Volatile organic compounds in the surface waters of Northern Greece" *Chemosphere* 40, 527-532.

Martinez, E., *et al.* (2002). "Patterns and levels of halogenated volatile compounds in Portuguese surface waters" *Journal Of Environmental Monitoring* 4, 253-257.

McCulloch, A. (2003). "Chloroform in the environment: occurrence, sources, sinks and effects" *Chemosphere* 50, 1291-1308.

Miermans, C. J. H., *et al.* (2000). "Analysis of volatile organic compounds, using the purge and trap injector coupled to a gas chromatograph/ion-trap mass spectrometer: Review of the results in Dutch surface water of the Rhine, Meuse, Northern Delta and Westerscheldt, over the period 1992-1997" *Chemosphere* 40, 39-48.

Plumacher, J. & Renner, I. (1993). "Determination Of Volatile Chlorinated Hydrocarbons And Trichloroacetic-Acid In Conifer Needles By Headspace Gas-Chromatography" *Fresenius Journal Of Analytical Chemistry* 347, 129-135.

Rogers, H. R., *et al.* (1992). "Sources and fate of organic contaminants in the Mersey Estuary: Volatile organohalogen compounds" *Marine Pollution Bulletin* 24, 82-91.

Roose, P. & Brinkman, U. A. T. (1998). "Determination of volatile organic compounds in marine biota" *Journal of Chromatography A* 799, 233-248.

Roose, P. & Brinkman, U. A. T. (2000). "Volatile organic compounds in various marine organisms from the southern North Sea" *Marine Pollution Bulletin* 40, 1167-1177.

Roose, P., *et al.* (2001). "Measurement of volatile organic compounds in sediments of the Scheldt estuary and the southern north sea" *Water Research* 35, 1478-1488.

Roose, P., *et al.* (2003). "Determination of VOCs in yellow eel from various inland water bodies in Flanders (Belgium)" *Journal of Environmental Monitoring* 5, 876-884.

Sauer Jr., T. C. (1991). "Volatile organic compounds in open ocean and coastal surface waters" *Org. Geochem.* 3, 91-101.

van Zoest, R. & van Eck, G. T. M. (1991). "Occurence and behaviour of several groups of organic micropollutants in the Scheldt estuary" *Science Of The Total Environment* 103, 57-71.

Vroblesky, D. A., *et al.* (1991). "Mapping Zones Of Contaminated Groundwater Discharge Using Creek-Bottom-Sediment Vapor Samplers, Aberdeen-Proving-Ground, Maryland" *Ground Water* 29, 7-12.

Zok, S., *et al.* (1998). "Euro Chlor risk assessment for the marine environment OSPARCOM region: North sea - Chloroform" *Environmental Monitoring and Assessment* 53, 401-424.

## 1,2-dichloroethane

Bianchi, A. P., *et al.* (1991). "Analysis of volatile organic compounds in estuarine sediments using dynamic headspace and gas chromatography-mass spectrometry " *Journal of Chromatography A* 542, 413-450.

Bruggemann, R., *et al.* (1991). "Behavior Assessment Of A Volatile Chemical In The Rhine River" *Environmental Toxicology And Chemistry* 10, 1097-1103.

Christof, O., *et al.* (2002). "Volatile organic compounds in European estuaries" *Biogeochemistry* 59, 143-160.

Dawes, V. J. & Waldock, M. J. (1994). "Measurement Of Volatile Organic-Compounds At Uk National Monitoring Plan Stations" *Marine Pollution Bulletin* 28, 291-298.

de Rooij, C., *et al.* (1998). "Euro Chlor risk assessment for the marine environment OSPARCOM region: North sea - 1,2-dichloroethane" *Environmental Monitoring and Assessment* 53, 425-445.

Dewulf, J., *et al.* (1998b). "Volatile organic compounds in the Scheldt estuary along the trajectory Antwerp-Vlissingen: Concentration profiles, modelling and estimation of emissions into the atmosphere" *Water Research* 32, 2941-2950.

Dewulf, J., *et al.* (1998). "Air/Water Exchange Dynamics of 13 Volatile Chlorinated C1- and C2-Hydrocarbons in the Southern North sea and the Scheldt Estuary" *Environmental Science & Technology* 32, 903-911.

Freiriagandara, M. J., *et al.* (1992). "Occurrence Of Halogenated Hydrocarbons In The Water-Supply Of Different Cities Of Galicia (Spain)" *Environmental Technology* 13, 437-447.

Gotz, R., *et al.* (1998). "Organic trace compounds in the water of the river elbe near Hamburg Part I" *Chemosphere* 36, 2085-2101.

Hughes, K., *et al.* (1994). "1,2-Dichloroethane - Evaluation Of Risks To Health From Environmental Exposure In Canada" *Environmental Carcinogenesis & Ecotoxicology Reviews-Part C Of Journal Of Environmental Science And Health* 12, 293-303.

Huybrechts, T., *et al.* (2003). "State-of-the-art of gas chromatography-based methods for analysis of anthropogenic volatile organic compounds in estuarine waters, illustrated with the river Scheldt as an example" *Journal of Chromatography A* 1000, 283-297.

Huybrechts, T., *et al.* (2004). "Spatial and temporal variability of priority volatile organic compounds in the Scheldt estuary" *Water Research* 38, 3241-3250.

Huybrechts, T., *et al.* (2005). "Priority volatile organic compounds in surface waters of the southern North Sea" *Environmental Pollution* 133, 255-264.

Lee, M. D., *et al.* (1999). "Investigation and remediation of a 1,2-dichloroethane spill part II: Documentation of natural attenuation" *Ground Water Monitoring and Remediation* 19, 82-88.

Martinez, E., *et al.* (2002). "Patterns and levels of halogenated volatile compounds in Portuguese surface waters" *Journal of Environmental Monitoring* 4, 253-257.

Miermans, C. J. H., *et al.* (2000). "Analysis of volatile organic compounds, using the purge and trap injector coupled to a gas chromatograph/ion-trap mass spectrometer: Review of the results in Dutch surface water of the Rhine, Meuse, Northern Delta and Westerscheldt, over the period 1992-1997" *Chemosphere* 40, 39-48.

Roose, P. & Brinkman, U. A. T. (2000). "Volatile organic compounds in various marine organisms from the southern North Sea" *Marine Pollution Bulletin* 40, 1167-1177.

Roose, P., *et al.* (2001). "Measurement of volatile organic compounds in sediments of the Scheldt estuary and the southern north sea" *Water Research* 35, 1478-1488.

Roose, P., *et al.* (2003). "Determination of VOCs in yellow eel from various inland water bodies in Flanders (Belgium)" *Journal of Environmental Monitoring* 5, 876-884.

Sehayek, L., *et al.* (1999). "Investigation and remediation of a 1,2-dichloroethane spill part I: Short and long-term remediation strategies" *Ground Water Monitoring and Remediation* 19, 71-81.

van de Meent, D., *et al.* (1986). "Organic micropollutants in Dutch coastal waters" *Water Sci. Technol.* 18, 73-81.

Zuccato, E., *et al.* (1980). "Glc-Determination of Ethylene Dichloride (Edc) In Biological Samples" *Analytical Letters Part B-Clinical And Biochemical Analysis* 13, 363-370.

## Vinyl Chloride

de Rooij, C., *et al.* (2004). "Vinyl chloride marine risk assessment with special reference to the OSPARCOM region: North Sea" *Environmental Monitoring and Assessment* 00, 1-11.

Malle, K. G. (1984). "Priority list of 129 dangerous substances (occurrence in the Rhine, toxicology, open questions)" *Z. Wasser Forsch.* 17, 75.

Wittsiepe, J. (1990). "Occurrence of vinyl chloride and other halogenated C1- and C2-hydrocarbons in German surface water" *Organohalogen Compounds* 4, 425-434.

Yamamoto, K., *et al.* (2001). "Contamination of vinyl chloride in shallow urban rivers in Osaka, Japan" *Water Research* 35, 561-566.

## **Annex 4.** List of electronic files

Bibliographic libraries (EndNote software):

- Chloroform.enl bibliographic data regarding chloroform occurrence
- 1,2-dichloroethane.enl bibliographic data regarding 1,2-dichloroethane occurrence
- Vinyl Chloride.enl bibliographic data regarding Vinyl Chloride occurrence

Literature data overviews (MS Excel):

- Literature data for CHCl3, 1,2-DiChEt and vinyl chloride in surface waters.xls
- Literature data for CHCl3, 1,2-DiChEt and vinyl chloride in biota and sediments.xls

Monitoring and survey data files obtained (MS Excel and MS Access):

- Belgium_monitoring data for CHCl3, 12-DiChEt and VC in surface waters and sediments.xls
- Czech Republic_monitoring data for CHCl3 and 12-DiChEt in river waters.xls
- Denmark_monitoring data for CHCl3 and 12-DiChEt in river waters.xls
- Germany_monitoring data for CHCl3, 12-DiChEt and VC in estuarine and coastal waters of North and Baltic Sea.xls
- Luxemburg_monitoring data for CHCl3 and 12-DiChEt in river waters.xls
- Netherlands_monitoring data for CHCl3 and 12-DiChEt in river and canal waters.xls
- Poland_survey data for 12-DiChEt in reservoir water and sediment.xls
- Sweden_survey data for CHCl3 and 12-DiChEt in fish.xls
- Sweden_survey data for CHCl3 and 12-DiChEt in sediments and slits.xls
- Sweden_survey data for VC in sediments.xls
- Slovakia_monitoring data for CHCl3 and 12-DiChEt in river waters.xls
- Slovakia_survey data for CHCl3, 12-DiChEt and VC in river waters.xls
- Slovakia_survey data for CHCl3 in river waters.xls
- Slovakia_survey data for 12-DiChEt in river waters.xls
- UK_monitoring and survey data.mdb

**Annex 5.** Levels of chloroform in surface waters reported in scientific literature for period 1980-2005

| Country/Sea | Area/Location | Year | Matrices | n | Mean | Median | Min | Max | Conc | Units | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | Meuse, Tailfer | 1992 | River and lake water | | | | | 200 | | ng/l | McCulloch (2003), Zok et al (1998) |
| Belgium/Netherlands | Scheldt estuary | 1998 | Estuarine water | 15 | | | 6,2 | 360 | | ng/l | Christof et al (2002), Huybrechts et al (2003) |
| Belgium/Netherlands | Scheldt estuary | 1998 | Estuarine water | 14 | | | 5,4 | 2900 | | ng/l | Christof et al (2002), Huybrechts et al (2003) |
| Belgium/Netherlands | Scheldt estuary | 1994 | Estuarine water | 2 | | | 44 | 48 | | ng/l | Dewulf et al (1998) |
| Belgium/Netherlands | Scheldt estuary | 1995-1997 | Estuarine water | 72 | 153,5 | | 7,4 | 1300 | | ng/l | Dewulf et al (1998b) |
| Belgium/Netherlands | Scheldt estuary | 1998-2000 | Estuarine water | 84 | 80,7 | 46,5 | <28 | 768 | | ng/l | Huybrechts et al (2004) |
| Belgium/Netherlands | Scheldt estuary | 1992-1997 | Estuarine water | 13 | | | | 6800 | | ng/l | Miermans et al (2000) |
| Canada | Great Lakes | 1980 | River and lake water | | | | 18 | 830 | | ng/l | McCulloch (2003) |
| Eastern Pacific | | 1970s | Open ocean water | | | | | 15 | | ng/l | McCulloch (2003) |
| Europe | European rivers | 1980-1995 | River and lake water | | | 500 | | | | ng/l | McCulloch (2003) |
| France | Loire estuary | 1998 | Estuarine water | 14 | | | 2 | 36 | | ng/l | Christof et al (2002), Huybrechts et al (2003) |
| France | Seine River (Poses, Honfleur) | 1995 | River and lake water | | | | <1000 | | | ng/l | Zok et al (1998) |
| Germany | Bodensee | 1984-1990 | River and lake water | | | | 10 | 29 | | ng/l | Zok et al (1998) |
| Germany | Bodensee, Lindau | 1983 | River and lake water | | 100 | | | | | ng/l | Zok et al (1998) |
| Germany | Bodensee, Uberlingen | 1983 | River and lake water | | | | | | <50 | ng/l | Zok et al (1998) |
| Germany | Donau, Bofinger Halde | 1989 | River and lake water | | | | | | <1017 | ng/l | Zok et al (1998) |
| Germany | Donau, Jochenstein | 1989 | River and lake water | | 908 | | | | | ng/l | Zok et al (1998) |
| Germany | Elbe | 1988 | River and lake water | | 940 | | | 2700 | | ng/l | Zok et al (1998) |
| Germany | Elbe mouth, St Margarethen | 1993 | Estuarine and coastal water | | | | <10 | 90 | | ng/l | McCulloch (2003), Zok et al (1998) |
| Germany | Elbe, Geesthacht | 1981 | River and lake water | | 594 | | | | | ng/l | Zok et al (1998) |
| Germany | Elbe, Hamburg Hafen | 1983-1985 | River and lake water | | 1540 | | | | | ng/l | Zok et al (1998) |
| Germany | Elbe, Scharhoern | 1981 | River and lake water | | 168 | | | | | ng/l | Zok et al (1998) |
| Germany | Elbe, Schnackenburg | 1990 | River and lake water | | 595 | | | | | ng/l | Zok et al (1998) |
| Germany | Elbe, Seemannshoft | 1992-1993 | River and lake water | 20 | | 102 | 23 | 354 | | ng/l | Gotz et al (1998) |
| Germany | Elbe, Wedel | 1981 | River and lake water | | 450 | | | | | ng/l | Zok et al (1998) |
| Germany | Elbe, Zollenspieker | 1992-1993 | River and lake water | 20 | | 123 | 27 | 445 | | ng/l | Gotz et al (1998) |
| Germany | Ems | 1991 | River and lake water | | 60 | | | | | ng/l | Zok et al (1998) |
| Germany | Emscher | 1986 | River and lake water | | | | | 100 | | ng/l | Zok et al (1998) |
| Germany | Main, Hessen | 1985-89 | River and lake water | | 3800 | | | 12000 | | ng/l | Zok et al (1998) |
| Germany | Main, Kahl am Main | 1989 | River and lake water | | 3170 | | | | | ng/l | Zok et al (1998) |
| Germany | North Sea | 1983 | Estuarine and coastal water | | | | 560 | 3800 | | ng/l | McCulloch (2003), Zok et al (1998) |
| Germany | Ostsee | 1983 | Estuarine and coastal water | | | | 60 | 170 | | ng/l | McCulloch (2003), Zok et al (1998) |
| Germany | Rein, Wiesbaden | 1994 | River and lake water | | | | | 400 | | ng/l | Zok et al (1998) |
| Germany | Rhine, Bad-Honnef | 1986 | River and lake water | | | | | 400 | | ng/l | Zok et al (1998) |
| Germany | Rhine, Bimmen | 1991 | River and lake water | | 150 | | | | | ng/l | Zok et al (1998) |
| Germany | Rhine, Constanz-Emmerich profile | 1983 | River and lake water | | 2000 | | | | | ng/l | Zok et al (1998) |
| Germany | Rhine, Dusseldorf | 1991 | River and lake water | | 230 | | | | | ng/l | Zok et al (1998) |
| Germany | Rhine, Hessen | 1985-1989 | River and lake water | | 2600 | | | 9000 | | ng/l | Zok et al (1998) |
| Germany | Rhine, Karlsruhe | 1991 | River and lake water | | 100 | | | | | ng/l | Zok et al (1998) |
| Germany | Rhine, Koblenz | 1991 | River and lake water | | 400 | | | | | ng/l | Zok et al (1998) |
| Germany | Rhine, Koln | 1994 | River and lake water | | | | | 390 | | ng/l | Zok et al (1998) |
| Germany | Rhine, Worms | 1991 | River and lake water | | 1170 | | | | | ng/l | Zok et al (1998) |
| Germany | Ruhr | 1986 | River and lake water | | | | | 100 | | ng/l | Zok et al (1998) |
| Germany | Ruhr, Duisburg bis Wildshaven | 1984 | River and lake water | | | | 150 | 15000 | | ng/l | Zok et al (1998) |
| Germany | Sieg | 1986 | River and lake water | | | | | | <100 | ng/l | Zok et al (1998) |
| Germany | Unterelbe, Schahoern | 1981-1982 | Estuarine and coastal water | | 40 | | | | | ng/l | Zok et al (1998) |
| Germany | Weser mouth, Bremerhaven | 1993 | Estuarine and coastal water | | | | <20 | 200 | | ng/l | McCulloch (2003), Zok et al (1998) |
| Germany | Wupper | 1986 | River and lake water | | | | | 400 | | ng/l | Zok et al (1998) |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Germany | | 1986-1990 | River and lake water | | | | <100 | 3800 | | ng/l | Zok et al (1998) |
| Greece | Axios estuary (Aegean Sea) | 1996-1998 | Estuarine water | | <25 | | | | | ng/l | Kostopoulou et al (2000) |
| Greece | Axios river | 1995-1996 | River and lake water | | 25 | | | | | ng/l | Kostopoulou et al (2000) |
| Greece | Axios river | 1996-1997 | River and lake water | | <25 | | | | | ng/l | Kostopoulou et al (2000) |
| Greece | Evros estuary (Aegean sea) | 1996-1998 | Estuarine water | | <25 | | | | | ng/l | Kostopoulou et al (2000) |
| Greece | Evros river | 1995-1996 | River and lake water | | <25 | | | | | ng/l | Kostopoulou et al (2000) |
| Greece | Evros river | 1996-1997 | River and lake water | | <25 | | | | | ng/l | Kostopoulou et al (2000) |
| Greece | L. Prespa (lake) | 1995-1996 | River and lake water | | <25 | | | | | ng/l | Kostopoulou et al (2000) |
| Greece | L. Prespa (lake) | 1996-1997 | River and lake water | | <25 | | <25 | 174 | | ng/l | Kostopoulou et al (2000) |
| Greece | Nestos estuary (Aegean Sea) | 1996-1998 | Estuarine water | | <25 | | | | | ng/l | Kostopoulou et al (2000) |
| Greece | Nestos river | 1995-1996 | River and lake water | | <25 | | | | | ng/l | Kostopoulou et al (2000) |
| Greece | Nestos river | 1996-1997 | River and lake water | | <25 | | | | | ng/l | Kostopoulou et al (2000) |
| Greece | S. Prespa (lake) | 1995-1996 | River and lake water | | 15 | | | | | ng/l | Kostopoulou et al (2000) |
| Greece | S. Prespa (lake) | 1996-1997 | River and lake water | | <25 | | | | | ng/l | Kostopoulou et al (2000) |
| Greece | Strimonas estuary (Aegean Sea) | 1996-1998 | Estuarine water | | <25 | | | | | ng/l | Kostopoulou et al (2000) |
| Greece | Strimonas river | 1995-1996 | River and lake water | | 251 | | <25 | 417 | | ng/l | Kostopoulou et al (2000) |
| Greece | Strimonas river | 1996-1997 | River and lake water | | 51 | | | | | ng/l | Kostopoulou et al (2000) |
| Greece | Vegoritida (lake) | 1995-1996 | River and lake water | | <25 | | | | | ng/l | Kostopoulou et al (2000) |
| Greece | Vegoritida (lake) | 1996-1997 | River and lake water | | <25 | | | | | ng/l | Kostopoulou et al (2000) |
| Greece | Vistonida (lake) | 1995-1996 | River and lake water | | <25 | | | | | ng/l | Kostopoulou et al (2000) |
| Greece | Vistonida (lake) | 1996-1997 | River and lake water | | <25 | | | | | ng/l | Kostopoulou et al (2000) |
| Greece | Volvi (lake) | 1995-1996 | River and lake water | | <25 | | | | | ng/l | Kostopoulou et al (2000) |
| Greece | Volvi (lake) | 1996-1997 | River and lake water | | <25 | | | | | ng/l | Kostopoulou et al (2000) |
| Gulf of Mexico | | 1990 | Open ocean water | | | | 40 | 200 | | ng/l | Sauer (1991) |
| Indian Ocean | Lohifushi, Maldive Islands | 1986 | surface water from the coral reef | | | | | | 4 | ng/l | Ballschmiter (2003) |
| Indian Ocean | Lohifushi, Maldive Islands | 1986 | surface water from the coral reef | | | | | | 10 | ng/l | Ballschmiter (2003) |
| Indian Ocean | Maldive Islands | 1986 | Open ocean water | | | | | | 1,5 | ng/l | Ballschmiter (2003) |
| Netherlands | Ijsselmeer, Andijk | 1990-1991 | River and lake water | | | | | | <100 | ng/l | Zok et al (1998) |
| Netherlands | Meuse | 1992-1997 | River and lake water | | | | | | 1600 | ng/l | Miermans et al (2000) |
| Netherlands | Meuse, Eijsden | 1992 | River and lake water | | 900 | | | | | ng/l | Zok et al (1998) |
| Netherlands | Meuse, Keizersveer | 1992 | River and lake water | | 70 | | | | | ng/l | Zok et al (1998) |
| Netherlands | Northern Delta Area | 1992-1997 | River and lake water | | | | | | 300 | ng/l | Miermans et al (2000) |
| Netherlands | Rhine | 1993 - 1995 | Estuarine and coastal water | | | | 5 | 91 | | ng/l | McCulloch (2003), Zok et al (1998) |
| Netherlands | Rhine | 1992-1997 | River and lake water | | | | | | 300 | ng/l | Miermans et al (2000) |
| Netherlands | Rhine estuary | 1997 | Estuarine water | 15 | | | 14 | 100 | | ng/l | Christof et al (2002), Huybrechts et al (2003) |
| Netherlands | Rhine, Hagestein | 1991 | River and lake water | | 300 | | | | | ng/l | Zok et al (1998) |
| Netherlands | Rhine, Lobith | 1991 | River and lake water | | 200 | | | | | ng/l | Zok et al (1998) |
| Netherlands | Schelde/Maas | 1993 | Estuarine and coastal water | | | | <60 | 150 | | ng/l | Zok et al (1998) |
| Netherlands | Scheldt | 1993 | Estuarine and coastal water | | | | | 150 | | ng/l | McCulloch (2003) and Zok et al (1998) |
| Netherlands | Scheldt | 1980s | Estuarine and coastal water | | | | 10 | 5190 | | ng/l | van Zoest and van Eck(1991) |
| Netherlands | | 1990-1992 | River and lake water | | | | <10 | 900 | | ng/l | McCulloch (2003) |
| North Atlantic | 31°N, 14°W | 1985 | Open ocean water | | | | 1,6 | 7 | 1,6 | ng/l | Class and Ballschmiter (1986), McCulloch (2003 |
| North Atlantic and | | 1980s | Open ocean water | | | | 330 | 1090 | | ng/l | Khalil et al (1983) |
| North Atlantic near | 25°N, 18°W | 1985 | Open ocean water | | | | | | 1,6 | ng/l | Ballschmiter (2003) |
| North East Atlantic | | 1972 | Open ocean water | | | | | 8 | | ng/l | McCulloch (2003) |
| North Sea | southern North Sea | 1994-1995 | Estuarine and coastal water | 38 | 72,86 | | | | | ng/l | Dewulf et al (1998) |
| North Sea | southern North Sea | 1998-2000 | Estuarine and coastal water | 47 | 130 | 26 | <28 | 1900 | | ng/l | Huybrechts et al (2005) |
| Portugal | Entire country | 1999-2000 | Surface waters | 644 | 1100 | | <30 | 16.000 | | ng/l | Martinez et al (2002) |
| Sweden | Stenungsund | 1988 | Estuarine and coastal water | | | | 5,4 | 15 | | ng/l | Abrahamsson et al (1989), Zok et al (1998) |
| Switzerland | Rhine, Basel | ca. 1982 | River and lake water | | 1190 | | | | | ng/l | Zok et al (1998) |
| Switzerland | typical lake | ca. 1984 | River and lake water | | | | | | <10 | ng/l | Zok et al (1998) |
| Switzerland | typical river | 1981-1983 | River and lake water | | 62 | | | 1000 | | ng/l | Zok et al (1998) |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| Switzerland | | 1982-1984 | River and lake water | | | | <10 | 1190 | | ng/l | McCulloch (2003) |
| UK | Bristol Channel | 1992 | Estuarine and coastal water | | | | | | <10 | ng/l | Dawes and Waldock (1994) |
| UK | Ditton Brook | 1987-1989 | River and lake water | | 500 | 400 | | | | ng/l | Rogers et al (1992) |
| UK | Falmouth | 1992 | Estuarine and coastal water | | | | | | <10 | ng/l | Dawes and Waldock (1994) |
| UK | Firth of Forth | 1992 | Estuarine and coastal water | | | | | | <10 | ng/l | Dawes and Waldock (1994) |
| UK | Forth estuary, Scotland | 1987-1990 | Estuarine and coastal water | | | | | | <500 | ng/l | Harper et al (1992) |
| UK | Howley Weir | 1987-1989 | River and lake water | | 600 | 700 | | | | ng/l | Rogers et al (1992) |
| UK | Humber | 1992 | Estuarine and coastal water | | | | <10 | 16,2 | | ng/l | Dawes and Waldock (1994) |
| UK | Liverpool | 1992 | Estuarine and coastal water | | | | 28,3 | 88,9 | | ng/l | Dawes and Waldock (1994) |
| UK | Liverpool Bay | 1970s | Estuarine and coastal water | | | | | | <1000 | ng/l | McCulloch (2003) |
| UK | Manchester Ship Canal | 1987-1989 | River and lake water | | 32500 | 13100 | | | | ng/l | Rogers et al (1992) |
| UK | Mersey | 1987-1990 | Estuarine and coastal water | | | | 2200 | 70000 | | ng/l | Rogers et al (1992) |
| UK | Moray Forth | 1992 | Estuarine and coastal water | | | | | | <10 | ng/l | Dawes and Waldock (1994) |
| UK | North Minch | 1992 | Estuarine and coastal water | | | | | | <10 | ng/l | Dawes and Waldock (1994) |
| UK | Poole Harbour | 1992 | Estuarine and coastal water | | | | <10 | 54 | | ng/l | Dawes and Waldock (1994) |
| UK | Queens Channel | 1992 | Estuarine and coastal water | | | | | | <10 | ng/l | Dawes and Waldock (1994) |
| UK | River Gowy | 1987-1989 | River and lake water | | 1800 | 700 | | | | ng/l | Rogers et al (1992) |
| UK | Southampton Water | 1987-1988 | Estuarine water | 52 | 3624 | 3140 | 904 | 11145 | | ng/l | Bianchi et al (1998) |
| UK | Southampton Water | 1995 | Estuarine water | 52 | 5200 | 4125 | 850 | 14610 | | ng/l | Bianchi et al (1998) |
| UK | Southampton Water | 1992 | Estuarine and coastal water | | | | <10 | 242 | | ng/l | Dawes and Waldock (1994) |
| UK | Southampton Water - Solent | pre 1990 | Estuarine and coastal water | | | | 10 | 7502 | | ng/l | Bianchi et al (1991), McCulloch (2003) |
| UK | Swansea Bay | 1992 | Estuarine and coastal water | | | | | | <10 | ng/l | Dawes and Waldock (1994) |
| UK | Tees | 1992 | Estuarine and coastal water | | | | <10 | 11500 | | ng/l | Dawes and Waldock (1994) |
| UK | Thames estuary | 1999 | Estuarine water | 15 | | | 2 | 120 | | ng/l | Christof et al (2002), Huybrechts et al (2003) |
| UK | Tweed | 1992 | Estuarine and coastal water | | | | | | <10 | ng/l | Dawes and Waldock (1994) |
| UK | Tyne | 1992 | Estuarine and coastal water | | | | <10 | 239 | | ng/l | Dawes and Waldock (1994), McCulloch (2003) |
| UK | Wear | 1992 | Estuarine and coastal water | | | | <10 | 199 | | ng/l | Dawes and Waldock (1994) |
| UK | | 1993 | River and lake water | | | | <1000 | >2000 | | ng/l | Zok et al (1998) |
| USA | Ohio | 1970s | River and lake water | | | | 4 | 2100 | | ng/l | McCulloch (2003) |

**Annex 6.** Levels of 1,2-dichloroethane in surface waters reported in scientific literature for period 1980-2005

| Country/Sea | Area/Location | Year | Matrices | n | Mean | Median | Min | Max | Conc | Units | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | Meuse, Tailfer | 1993 | River and lake water | | 200 | | | | | ng/l | de Rooij et al (1998) |
| Belgium | Schelde, Doel | 1992 | River and lake water | | <200 | | | | | ng/l | de Rooij et al (1998) |
| Belgium | Schelde, Doel | 1993 | River and lake water | | <85 | | | 200 | | ng/l | de Rooij et al (1998) |
| Belgium/Netherlands | Scheldt estuary | 1998 | Estuary water | 15 | | | 0,1 | 150 | | ng/l | Christof et al (2002), Huybrechts (2003) |
| Belgium/Netherlands | Scheldt estuary | 1998 | Estuary water | 14 | | | 0,5 | 91 | | ng/l | Christof et al (2002), Huybrechts (2003) |
| Belgium/Netherlands | Scheldt estuary | 1994 | Estuary water | 2 | | | 30 | 40 | | ng/l | Dewulf et al (1998) |
| Belgium/Netherlands | Scheldt estuary | 1995-1997 | Estuary water | 72 | 76,1 | | 3 | 370 | | ng/l | Dewulf et al (1998b) |
| Belgium/Netherlands | Scheldt estuary | 1998-2000 | Estuary water | 84 | 40 | 31,6 | <16,5 | 137 | | ng/l | Huybrechts et al (2004) |
| Belgium/Netherlands | Scheldt estuary | 1992-1997 | Estuary water | 13 | | | | | 900 | ng/l | Miermans et al (2000) |
| France | Loire estuary | 1998 | Estuary water | 14 | | | 1,5 | 28 | | ng/l | Christof et al (2002), Huybrechts (2003) |
| France | Seine estuary | 1995 | Estuarine and coastal water | | <1000 | | | | | ng/l | de Rooij et al (1998) |
| France | Seine river | 1995 | River and lake water | | <2000 | | | | | ng/l | de Rooij et al (1998) |
| Germany | Elbe estuary | 1993 | Estuarine and coastal water | | <1000 | | | | | ng/l | de Rooij et al (1998) |
| Germany | Elbe, Schnackenburg | 1981-1982 | River and lake water | | <150 | | | 2100 | | ng/l | de Rooij et al (1998) |
| Germany | Elbe, Seemannshoft | 1992-1993 | River and lake water | 12 | | 117 | 33 | 973 | | ng/l | Gotz et al (1998) |
| Germany | Elbe, Zollenspieker | 1992-1993 | River and lake water | 12 | | 80 | 31 | 1270 | | ng/l | Gotz et al (1998) |
| Germany | Emscher | 1988-1991 | River and lake water | | 5600 | | | | | ng/l | de Rooij et al (1998) |
| Germany | Rhine | 1990 | River and lake water | | <5000 | | | | | ng/l | de Rooij et al (1998) |
| Germany | Rhine, D/NL border | 1990 | River and lake water | | | | <100 | 570 | | ng/l | de Rooij et al (1998) |
| Germany | Rhine, D/NL border | 1993 | River and lake water | | 500 | | | | | ng/l | de Rooij et al (1998) |
| Germany | Ruhr, km 124-46 | 1983-1986 | River and lake water | | 30 | | | 100 | | ng/l | de Rooij et al (1998) |
| Germany | Sieg, Wupper, Erft, Ruhr, Lippe | 1987 | River and lake water | | <5000 | | | | | ng/l | de Rooij et al (1998) |
| Germany | Weser estuary | 1993 | Estuarine and coastal water | | <1000 | | | | | ng/l | de Rooij et al (1998) |
| Netherlands | Ijsselmeer/Andijk | 1991 | River and lake water | | <2000 | | | | | ng/l | de Rooij et al (1998) |
| Netherlands | Ijsselmeer/Maas | 1990-1991 | River and lake water | | | | | 2000 | | ng/l | de Rooij et al (1998) |
| Netherlands | Lekwater, Hagestein | 1991 | River and lake water | | <100 | | | | | ng/l | de Rooij et al (1998) |
| Netherlands | Meuse | 1992-1997 | River and lake water | | | | | | 8200 | ng/l | Miermans et al (2000) |
| Netherlands | Meuse, Eijsden | 1992 | River and lake water | | <2000 | | | | | ng/l | de Rooij et al (1998) |
| Netherlands | Meuse, Eijsden | 1993 | River and lake water | | 1000 | | | | | ng/l | de Rooij et al (1998) |
| Netherlands | Meuse, Keizersveer | 1993 | River and lake water | | <2000 | | | | | ng/l | de Rooij et al (1998) |
| Netherlands | North sea coasts, 9 sites | 1983-1984 | Estuarine and coastal water | | 50 | | | | | ng/l | van de Meent et al (1986) |
| Netherlands | North sea, open sea | 1983-1984 | Estuarine and coastal water | | <5 | | | | | ng/l | van de Meent et al (1986) |
| Netherlands | Northern Delta Area | 1992-1997 | River and lake water | | | | | | 9500 | ng/l | Miermans et al (2000) |
| Netherlands | Rhine | 1992-1997 | River and lake water | | | | | | 300 | ng/l | Miermans et al (2000) |
| Netherlands | Rhine | 1983 | River and lake water | | 200 | | | | | ng/l | van de Meent et al (1986) |
| Netherlands | Rhine estuary | 1997 | Estuary water | 15 | | | 0,9 | 100 | | ng/l | Christof et al (2002), Huybrechts (2003) |
| Netherlands | Rhine estuary | 1983-1984 | Estuarine and coastal water | | | | | 647 | | ng/l | van de Meent et al (1986) |
| Netherlands | Rhine, Lobith | 1991 | River and lake water | | 300 | | | | | ng/l | de Rooij et al (1998) |
| North Sea | southern North Sea | 1998-2000 | Sea water | 38 | 21,01 | | | | | ng/l | Dewulf et al (1998) |
| North Sea | southern North Sea | 1998-2000 | Sea water | 47 | 7,8 | 3,2 | <16 | 110 | | ng/l | Huybrechts et al (2005) |
| Portugal | Entire country | 1999-2000 | Surface waters | 644 | ca. 100 | | <30 | ca. 1500 | | ng/l | Martinez et al (2002) |
| UK | 10 estuaries | 1986-1987 | Estuarine and coastal water | | <100 | | | | | ng/l | de Rooij et al (1998) |
| UK | Bristol Channel | 1992 | Estuarine and coastal water | | | | | | <25 | ng/l | Dawes and Waldock (1994) |
| UK | Falmouth | 1992 | Estuarine and coastal water | | | | | | <25 | ng/l | Dawes and Waldock (1994) |
| UK | Firth of Forth | 1992 | Estuarine and coastal water | | | | | | <25 | ng/l | Dawes and Waldock (1994) |
| UK | Humber | 1992 | Estuarine and coastal water | | | | | | <25 | ng/l | Dawes and Waldock (1994) |
| UK | Liverpool | 1992 | Estuarine and coastal water | | | | <25 | 33,4 | | ng/l | Dawes and Waldock (1994) |
| UK | Mersey estuary | 1993 | Estuarine and coastal water | | | | <10 | 1100 | | ng/l | de Rooij et al (1998) |

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|---|---|---|---|---|---|---|---|---|---|---|
| UK | Moray Forth | 1992 | Estuarine and coastal water | | | | | <25 | ng/l | Dawes and Waldock (1994) |
| UK | North Minch | 1992 | Estuarine and coastal water | | | | | <25 | ng/l | Dawes and Waldock (1994) |
| UK | Poole Harbour | 1992 | Estuarine and coastal water | | | | | <25 | ng/l | Dawes and Waldock (1994) |
| UK | Queens Channel | 1992 | Estuarine and coastal water | | | | | <25 | ng/l | Dawes and Waldock (1994) |
| UK | Rivers estuaries (Tweed, Blyth, | 1993 | Estuarine and coastal water | | | | 30 | typ <10 | ng/l | de Rooij et al (1998) |
| UK | Southampton Water | 1992 | Estuarine and coastal water | | | | | <10 | ng/l | Dawes and Waldock (1994) |
| UK | Southampton water - Solent estuary | pre 1990 | Estuarine and coastal water | | | 15 | 955 | | ng/l | Bianchi et al (1991) |
| UK | Swansea Bay | 1992 | Estuarine and coastal water | | | | | <25 | ng/l | Dawes and Waldock (1994) |
| UK | Tees | 1992 | Estuarine and coastal water | | | 720 | 4020 | | ng/l | Dawes and Waldock (1994) |
| UK | Tees | 1995 | Estuarine and coastal water | | 1300 | 100 | 6400 | | ng/l | de Rooij et al (1998) |
| UK | Thames estuary | 1999 | Estuary water | 15 | | 1,1 | 7 | | ng/l | Christof et al (2002), Huybrechts (2003) |
| UK | Tweed | 1992 | Estuarine and coastal water | | | | | <25 | ng/l | Dawes and Waldock (1994) |
| UK | Tyne | 1992 | Estuarine and coastal water | | | | | <25 | ng/l | Dawes and Waldock (1994) |
| UK | Wear | 1992 | Estuarine and coastal water | | | | | <25 | ng/l | Dawes and Waldock (1994) |

**Annex 7.** Levels of vinyl chloride in surface waters reported in scientific literature for period 1980-2005

| Country/Sea | Area/Location | Year | Matrices | n | Mean | Median | Min | Max | Conc | Units | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Germany | Lippe | 1989 | River and lake water | 54 | | | <10 | 400 | | ng/l | Wittsiepe (1990) |
| Germany | Main | 1990 | River and lake water | 22 | <4 | | | 8 | | ng/l | Wittsiepe (1990) |
| Germany | Rhine | 1990 | River and lake water | 78 | | | <10 | 31 | | ng/l | Wittsiepe (1990) |
| Germany | Rhine, D/Nl border | 1982 | River and lake water | | <200 | | | | | ng/l | Malle (1984), de Rooij et al (2004) |
| Germany | Ruhr | 1990 | River and lake water | 60 | | | 0.4 | 60 | | ng/l | Wittsiepe (1990) |
| Germany | Saale | 1990 | River and lake water | 4 | | | | 69000 | | ng/l | Wittsiepe (1990) |
| Germany | Wupper | 1989 | River and lake water | 36 | | | | 69 | | ng/l | Wittsiepe (1990) |
| Japan | Taishogawa and Hiranogawa rivers | 1995-1997 | River and lake water | 106 | 3350 | 1790 | <640 | 55600 | | ng/l | Yamamoto et al (2001) |
| UK | Tees estuary | 1993 | Estuarine and coastal water | | | | <100 | 150 | | ng/l | de Rooij et al (2004) |
| USA | San Francisco Bay | 1987 | Estuarine and coastal water | | <300 | | | | | ng/l | de Rooij et al (2004) |

**Annex 8.** Levels of chloroform in biota and sediments reported in scientific literature for period 1980-2005

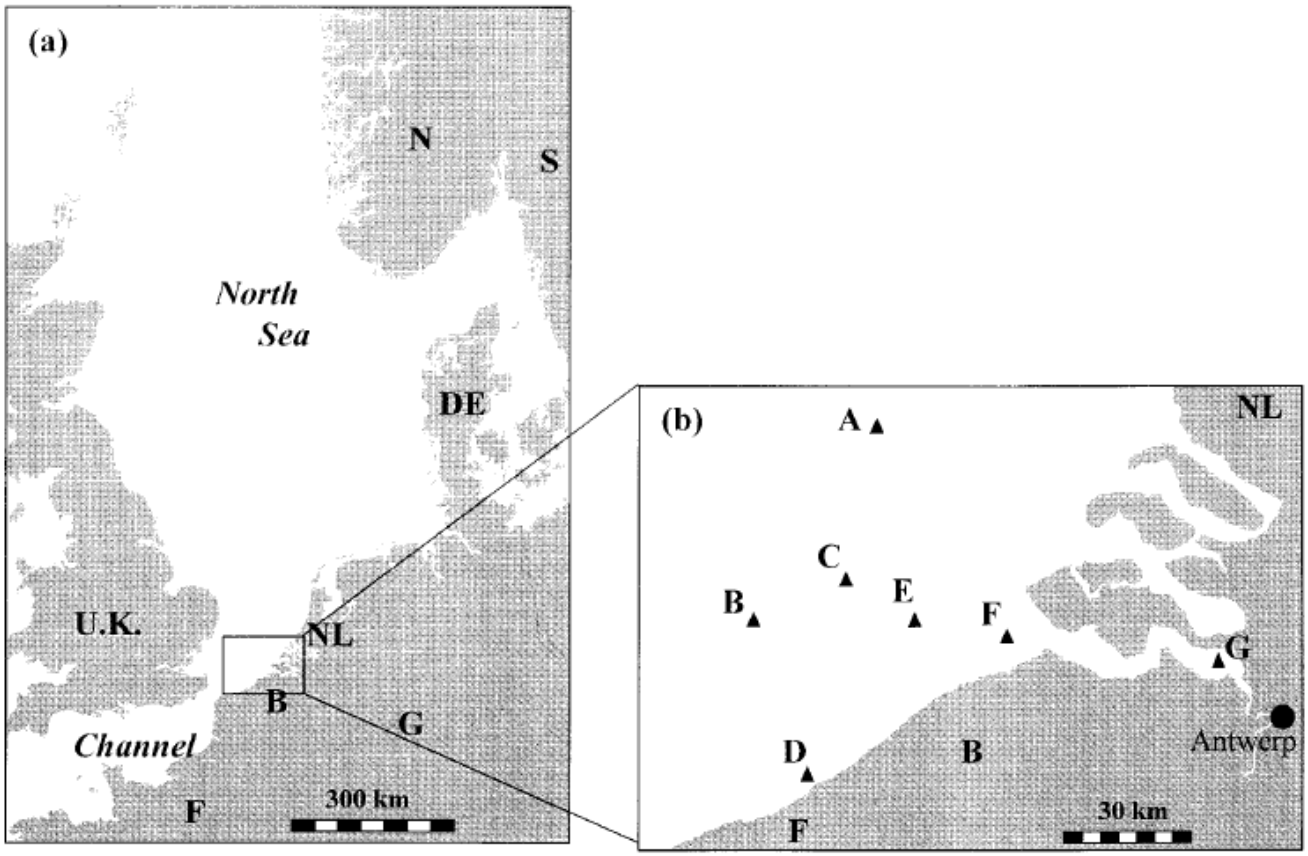
| Country | Area/Location | Year | Matrices | Species | Tissue | n | Mean | Median | Min | Max | Conc | Units | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | A, Poppel | | Fish | eel | muscle | | | | | | 1 | ng/g ww | **Roose et al (2003)** |
| Belgium | Albertkanaal, Langerlo | | Fish | eel | muscle | | | | | | 9,4 | ng/g ww | **Roose et al (2003)** |
| Belgium | Albertskanaal, Langerlo | | Fish | eel | muscle | | | | | | 7,4 | ng/g ww | **Roose et al (2003)** |
| Belgium | Darse, Vilvoorde | | Fish | eel | muscle | | | | | | 13 | ng/g ww | **Roose et al (2003)** |
| Belgium | Grensmaas, Molensteen | | Fish | eel | muscle | | | | | | 2,9 | ng/g ww | **Roose et al (2003)** |
| Belgium | Grensmaas, Molensteen | | Fish | eel | muscle | | | | | | 11 | ng/g ww | **Roose et al (2003)** |
| Belgium | Groot Zuunbekken, St.-Pieters-Leeuw | | Fish | eel | muscle | | | | | | 96 | ng/g ww | **Roose et al (2003)** |
| Belgium | Kanaal Beverloo, Leopoldsburg | | Fish | eel | muscle | | | | | | 23 | ng/g ww | **Roose et al (2003)** |
| Belgium | Kanaal Bochelt-Herentals, Blekerheide | | Fish | eel | muscle | | | | | | <dl | ng/g ww | **Roose et al (2003)** |
| Belgium | Kanaal Bochelt-, Sluis Herentals | | Fish | eel | muscle | | | | | | 16 | ng/g ww | **Roose et al (2003)** |
| Belgium | Kanaal van Leuven to the Dijle, Tildonk | | Fish | eel | muscle | | | | | | 17 | ng/g ww | **Roose et al (2003)** |
| Belgium | Kanaal van Leuven to the Dijle, Tildonk | | Fish | eel | muscle | | | | | | 30 | ng/g ww | **Roose et al (2003)** |
| Belgium | Leie, Menen | | Fish | eel | muscle | | | | | | 15 | ng/g ww | **Roose et al (2003)** |
| Belgium | Oude Leie Ooigem | | Fish | eel | muscle | | | | | | 3,9 | ng/g ww | **Roose et al (2003)** |
| Belgium | Oude Leie Wevelgem | | Fish | eel | muscle | | | | | | <dl | ng/g ww | **Roose et al (2003)** |
| Belgium | Pond at Rijksdomein, Hofstade | | Fish | eel | muscle | | | | | | <dl | ng/g ww | **Roose et al (2003)** |
| Belgium | Putten van Niel, Niel | | Fish | eel | muscle | | | | | | 10 | ng/g ww | **Roose et al (2003)** |
| Belgium | Scheldt estuary, st S01 | 1997-1998 | Sediment | | | | | | | | <90 | pg/g ww | **Roose et al (2001)** |
| Belgium | Scheldt estuary, st S04 | 1997-1998 | Sediment | | | | | | | | <90 | pg/g ww | **Roose et al (2001)** |
| Belgium | Scheldt estuary, st S07 | 1997-1998 | Sediment | | | | | | | | <90 | pg/g ww | **Roose et al (2001)** |
| Belgium | Scheldt estuary, st S09 | 1997-1998 | Sediment | | | | | | | | <90 | pg/g ww | **Roose et al (2001)** |
| Belgium | Scheldt estuary, st S12 | 1997-1998 | Sediment | | | | | | | | <90 | pg/g ww | **Roose et al (2001)** |
| Belgium | Scheldt estuary, st S15 | 1997-1998 | Sediment | | | | | | | | <90 | pg/g ww | **Roose et al (2001)** |
| Belgium | Scheldt estuary, st S18 | 1997-1998 | Sediment | | | | | | | | <90 | pg/g ww | **Roose et al (2001)** |
| Belgium | Scheldt estuary, st S22 | 1997-1998 | Sediment | | | | | | | | <90 | pg/g ww | **Roose et al (2001)** |
| Belgium | Warmbeek, Achel | | Fish | eel | muscle | | | | | | <dl | ng/g ww | **Roose et al (2003)** |
| Belgium | Witte Nete, Dessel | | Fish | eel | muscle | | | | | | <dl | ng/g ww | **Roose et al (2003)** |
| Belgium | Zandwinningsput, Weerde | | Fish | eel | muscle | | | | | | 9,7 | ng/g ww | **Roose et al (2003)** |
| Germany | Berlin | 1990-1991 | pine needle | | | | | | 20 | 17000 | | ng/kg ww | **Plumacher and Renner (1993)** |
| Ireland | Irish sea | pre 1994 | scallop | Pecten maximus | gill | | | | | | 1040 | ng/g dw | **McCulloch (2003)** |
| Ireland | Irish sea | pre 1994 | Fish | cod (gadus morhua) | muscle | | | | | | 168 | ng/g dw | **McCulloch (2003)** |
| Ireland | Irish sea | pre 1994 | Fish | dogfish (scylliorhinus canicula) | muscle | | | | | | 649 | ng/g dw | **McCulloch (2003)** |
| Ireland | Irish sea | pre 1994 | Fish | coalfish (pollachius birens) | liver | | | | | | 851 | ng/g dw | **McCulloch (2003)** |
| Ireland | Irish sea | pre 1994 | Fish | conger eel (conger conger) | gill | | | | | | 50 | ng/g dw | **McCulloch (2003)** |
| Ireland | Irish sea | pre 1994 | Fish | dogfish (scylliorhinus canicula) | gill | | | | | | 755 | ng/g dw | **McCulloch (2003)** |
| Ireland | Irish sea | pre 1994 | Fish | cod (gadus morhua) | | | | | | | 7 | ng/g dw | **McCulloch (2003)** |
| Ireland | Irish sea | pre 1994 | Fish | dogfish (scylliorhinus canicula) | | | | | | | 544 | ng/g dw | **McCulloch (2003)** |
| Ireland | Irish sea | pre 1994 | bird | shag (phalacrocerax aristotelis) | eggs | | | | | | 0.7 | ng/g | **McCulloch (2003)** |
| Ireland | Irish sea | pre 1994 | bird | guillemot (Uria aalge) | eggs | | | | | | 65 | ng/g | **McCulloch (2003)** |
| North Sea | North Sea, Belgian continental shelf | pre 1998 | Fish | Dab (Limanda limanda) | muscle | 17 | 14,3 | 1,9 | | | | ng/g ww | **Roose and Brinkman (1998)** |
| North Sea | North Sea, Belgian continental shelf | pre 1998 | Fish | Dab (Limanda limanda) | liver | 20 | 2,45 | 0,76 | | | | ng/g ww | **Roose and Brinkman (1998)** |
| North Sea | North Sea, Belgian continental shelf | pre 1998 | Fish | Whiting (Merlangius merlangus) | muscle | 10 | 198 | 41,7 | | | | ng/g ww | **Roose and Brinkman (1998)** |
| North Sea | North Sea, Belgian continental shelf | pre 1998 | Fish | Whiting (Merlangius merlangus) | liver | 11 | 4,66 | 3,66 | | | | ng/g ww | **Roose and Brinkman (1998)** |
| North Sea | North Sea, continental shelf, st 435 | 1997-1998 | Sediment | | | | | | | | 100 | pg/g ww | **Roose et al (2001)** |
| North Sea | North Sea, continental shelf, st 800 | 1997-1998 | Sediment | | | | | | | | <90 | pg/g ww | **Roose et al (2001)** |
| North Sea | | 2000 | Benthos | Brown shrimp (Crangon crangon) | whole | | | | | | 1100 | pg/g ww | **Roose and Brinkman (2000)** |
| North Sea | | 2000 | Benthos | Bivalve mollusc (Mactra stultorum) | whole | | | | | | 700 | pg/g ww | **Roose and Brinkman (2000)** |
| North Sea | | 2000 | Benthos | Bivalve mollusc (Mya truncata) | whole | | | | | | 400 | pg/g ww | **Roose and Brinkman (2000)** |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North Sea | | 2000 | Benthos | Bivalve mollusc (Spisula sp.) | whole | | | | | 2600 | pg/g ww | **Roose and Brinkman (2000)** |
| North Sea | | 2000 | Benthos | Dab (Limanda limanda) | liver | | | | | 3200 | pg/g ww | **Roose and Brinkman (2000)** |
| North Sea | | 2000 | Benthos | Dab (Limanda limanda) | muscle tissue | | | | | 5400 | pg/g ww | **Roose and Brinkman (2000)** |
| North Sea | | 2000 | Benthos | Whiting (Merlangius merlangus) | liver | | | | | 2800 | pg/g ww | **Roose and Brinkman (2000)** |
| North Sea | | 2000 | Benthos | Whiting (Merlangius merlangus) | muscle tissue | | | | | 2000 | pg/g ww | **Roose and Brinkman (2000)** |
| Spain | | pre 2004 | soil 1 | | | 3 | 0.04 | | | | ug/g | **Campilo et al (2004)** |
| Spain | | pre 2004 | soil 2 | | | 3 | 0.13 | | | | ug/g | **Campilo et al (2004)** |
| Spain | | pre 2004 | soil 3 | | | 3 | 0.16 | | | | ug/g | **Campilo et al (2004)** |
| Spain | | pre 2004 | soil 4 | | | 3 | 0.11 | | | | ug/g | **Campilo et al (2004)** |
| Spain | | pre 2004 | soil 5 | | | 3 | 1.10 | | | | ug/g | **Campilo et al (2004)** |
| Spain | | pre 2004 | soil 6 | | | 3 | 0.14 | | | | ug/g | **Campilo et al (2004)** |
| UK | Firth of Forth | pre 1994 | crustacea | shore crab (Carcinus maenas) | | | | | | 15 | ng/g ww | **McCulloch (2003)** |
| UK | Firth of Forth | pre 1994 | crustacea | cancer pagurus | | | | | | 180 | ng/g ww | **McCulloch (2003)** |
| UK | Liverpool Bay | 1970s | plankton | | | | | | | 0.02 | ng/g | **McCulloch (2003)** |
| UK | Liverpool Bay | pre 1994 | Fish | flounder (platycthys flesus) | liver | | | | | 6 | ng/g ww | **McCulloch (2003)** |
| UK | Merseyside | pre 1994 | | common shrews (sorex araneus) | | | | 41 | 66 | | ng/g ww | **McCulloch (2003)** |
| UK | Merseyside | pre 1994 | bird | moorhen (Gallinula chloropus) | liver | | | | | 1.3 | ng/g | **McCulloch (2003)** |
| UK | Merseyside | pre 1994 | bird | kittiwake (Rissa tridactyla) | liver | | | | | 17.3 | ng/g | **McCulloch (2003)** |
| UK | Southampton estuary | pre 1990 | Sediment | | | | | 97 | 22940 | | pg/g | **Bianchi et al (1991)** |
| UK | Thames estuary | pre 1994 | mussels | Mythilus edulis | | | | | | 3 | ng/g ww | **McCulloch (2003)** |
| UK | Thames estuary | pre 1994 | oysters | Ostrea edulis | | | | | | 3 | ng/g ww | **McCulloch (2003)** |
| UK | Thames estuary | pre 1994 | Fish | spurdog (squalus acanthias) | flesh | | | | | 110 | ng/g ww | **McCulloch (2003)** |
| | Farne Islands | pre 1994 | Fish | grey seals (halichoerus grypus) | blubber | | | | | 7.6 and 22 | ng/g ww | **McCulloch (2003)** |
| | Torbay | pre 1994 | plankton | | | | | | | 5 | ng/g | **McCulloch (2003)** |
| | Torbay | pre 1994 | Fish | sprat (clupea sprattus) | flesh | | | | | 5 | ng/g ww | **McCulloch (2003)** |
| | Torbay | pre 1994 | fish | mackerel (Scomber scombrus) | flesh | | | | | 5 | ng/g ww | **McCulloch (2003)** |

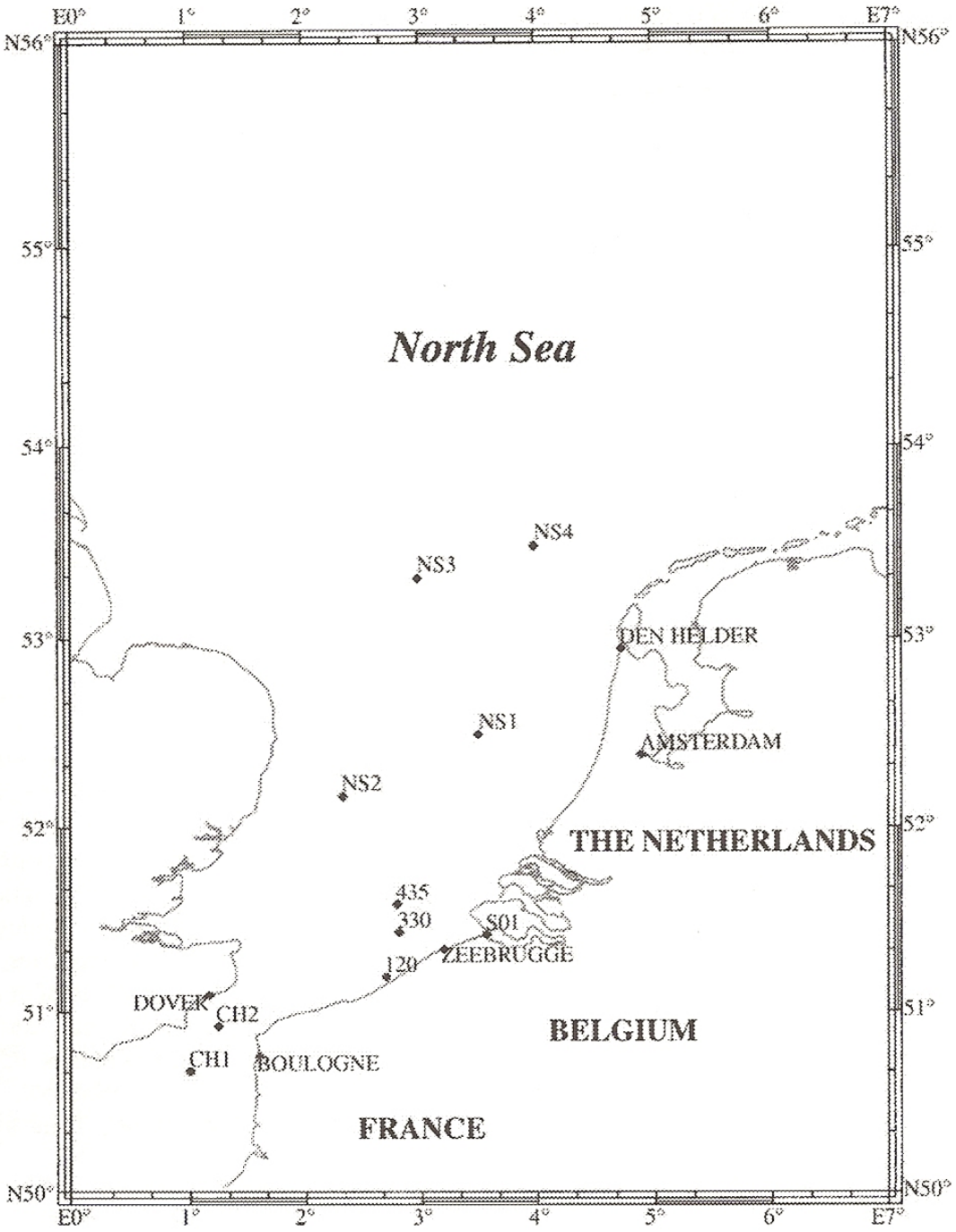
**Annex 9.** Levels of 1,2-dichloroethane in biota and sediments reported in scientific literature for period 1980-2005

| Country | Area/Location | Year | Matrices | Species | Tissue | n | Mean | Median | Min | Max | Conc | Units | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | A, Poppel | | Fish | eel | muscle | | | | | | <dl | ng/g ww | Roose et al (2003) |
| Belgium | Albertkanaal, Langerlo | | Fish | eel | muscle | | | | | | 1,8 | ng/g ww | Roose et al (2003) |
| Belgium | Albertskanaal, Langerlo | | Fish | eel | muscle | | | | | | 2,4 | ng/g ww | Roose et al (2003) |
| Belgium | Darse, Vilvoorde | | Fish | eel | muscle | | | | | | 2 | ng/g ww | Roose et al (2003) |
| Belgium | Grensmaas, Molensteen | | Fish | eel | muscle | | | | | | <dl | ng/g ww | Roose et al (2003) |
| Belgium | Grensmaas, Molensteen | | Fish | eel | muscle | | | | | | 3,3 | ng/g ww | Roose et al (2003) |
| Belgium | Groot Zuunbekken, St.-Pieters-Leeuw | | Fish | eel | muscle | | | | | | <dl | ng/g ww | Roose et al (2003) |
| Belgium | Kanaal Beverloo, Leopoldsburg | | Fish | eel | muscle | | | | | | <dl | ng/g ww | Roose et al (2003) |
| Belgium | Kanaal Bochelt-Herentals, Blekerheide | | Fish | eel | muscle | | | | | | 4,9 | ng/g ww | Roose et al (2003) |
| Belgium | Kanaal Bochelt-Herentals, Sluis Herentals | | Fish | eel | muscle | | | | | | 2 | ng/g ww | Roose et al (2003) |
| Belgium | Kanaal van Leuven to the Dijle, Tildonk | | Fish | eel | muscle | | | | | | <dl | ng/g ww | Roose et al (2003) |
| Belgium | Kanaal van Leuven to the Dijle, Tildonk | | Fish | eel | muscle | | | | | | <dl | ng/g ww | Roose et al (2003) |
| Belgium | Leie, Menen | | Fish | eel | muscle | | | | | | <dl | ng/g ww | Roose et al (2003) |
| Belgium | Oude Leie Ooigem | | Fish | eel | muscle | | | | | | <dl | ng/g ww | Roose et al (2003) |
| Belgium | Oude Leie Wevelgem | | Fish | eel | muscle | | | | | | <dl | ng/g ww | Roose et al (2003) |
| Belgium | Pond at Rijksdomein, Hofstade | | Fish | eel | muscle | | | | | | 2,5 | ng/g ww | Roose et al (2003) |
| Belgium | Putten van Niel, Niel | | Fish | eel | muscle | | | | | | 1,4 | ng/g ww | Roose et al (2003) |
| Belgium | Scheldt estuary, st S01 | 1997-1998 | Sediment | | | | | <20 | | | | pg/g ww | Roose et al (2001) |
| Belgium | Scheldt estuary, st S04 | 1997-1998 | Sediment | | | | | <20 | | | | pg/g ww | Roose et al (2001) |
| Belgium | Scheldt estuary, st S07 | 1997-1998 | Sediment | | | | | <20 | | | | pg/g ww | Roose et al (2001) |
| Belgium | Scheldt estuary, st S09 | 1997-1998 | Sediment | | | | | <20 | | | | pg/g ww | Roose et al (2001) |
| Belgium | Scheldt estuary, st S12 | 1997-1998 | Sediment | | | | | <20 | | | | pg/g ww | Roose et al (2001) |
| Belgium | Scheldt estuary, st S15 | 1997-1998 | Sediment | | | | | <20 | | | | pg/g ww | Roose et al (2001) |
| Belgium | Scheldt estuary, st S18 | 1997-1998 | Sediment | | | | | <20 | | | | pg/g ww | Roose et al (2001) |
| Belgium | Scheldt estuary, st S22 | 1997-1998 | Sediment | | | | | <20 | | | | pg/g ww | Roose et al (2001) |
| Belgium | Warmbeek, Achel | | Fish | eel | muscle | | | | | | <dl | ng/g ww | Roose et al (2003) |
| Belgium | Witte Nete, Dessel | | Fish | eel | muscle | | | | | | <dl | ng/g ww | Roose et al (2003) |
| Belgium | Zandwinningsput, Weerde | | Fish | eel | muscle | | | | | | 3,5 | ng/g ww | Roose et al (2003) |
| Denmark | Baltic sea | late 1980s | Sediment | | | | | | 70 | 10000 | | pg/g | de Rooj et al (1998) |
| North Sea | North Sea, continental shelf, st 435 | 1997-1998 | Sediment | | | | | <20 | | | | pg/g ww | Roose et al (2001) |
| North Sea | North Sea, continental shelf, st 800 | 1997-1998 | Sediment | | | | | <20 | | | | pg/g ww | Roose et al (2001) |
| North Sea | | 2000 | Benthos | Brown shrimp (Crangon crangon) | whole | | 300 | | | | | pg/g ww | Roose and Brinkman (2000) |
| North Sea | | 2000 | Benthos | Bivalve mollusc (Mactra stultorum) | whole | | 900 | | | | | pg/g ww | Roose and Brinkman (2000) |
| North Sea | | 2000 | Benthos | Bivalve mollusc (Mya truncata) | whole | | 300 | | | | | pg/g ww | Roose and Brinkman (2000) |
| North Sea | | 2000 | Benthos | Bivalve mollusc (Spisula sp.) | whole | | 400 | | | | | pg/g ww | Roose and Brinkman (2000) |
| North Sea | | 2000 | Benthos | Dab (Limanda limanda) | liver | | 900 | | | | | pg/g ww | Roose and Brinkman (2000) |
| North Sea | | 2000 | Benthos | Dab (Limanda limanda) | muscle tissue | | 300 | | | | | pg/g ww | Roose and Brinkman (2000) |
| North Sea | | 2000 | Benthos | Whiting (Merlangius merlangus) | liver | | 550 | | | | | pg/g ww | Roose and Brinkman (2000) |
| North Sea | | 2000 | Benthos | Whiting (Merlangius merlangus) | muscle tissue | | 500 | | | | | pg/g ww | Roose and Brinkman (2000) |
| UK | Southampton estuary | pre 1990 | Sediment | | | | | | 70 | 11045 | | pg/g | Bianchi et al (1991) |

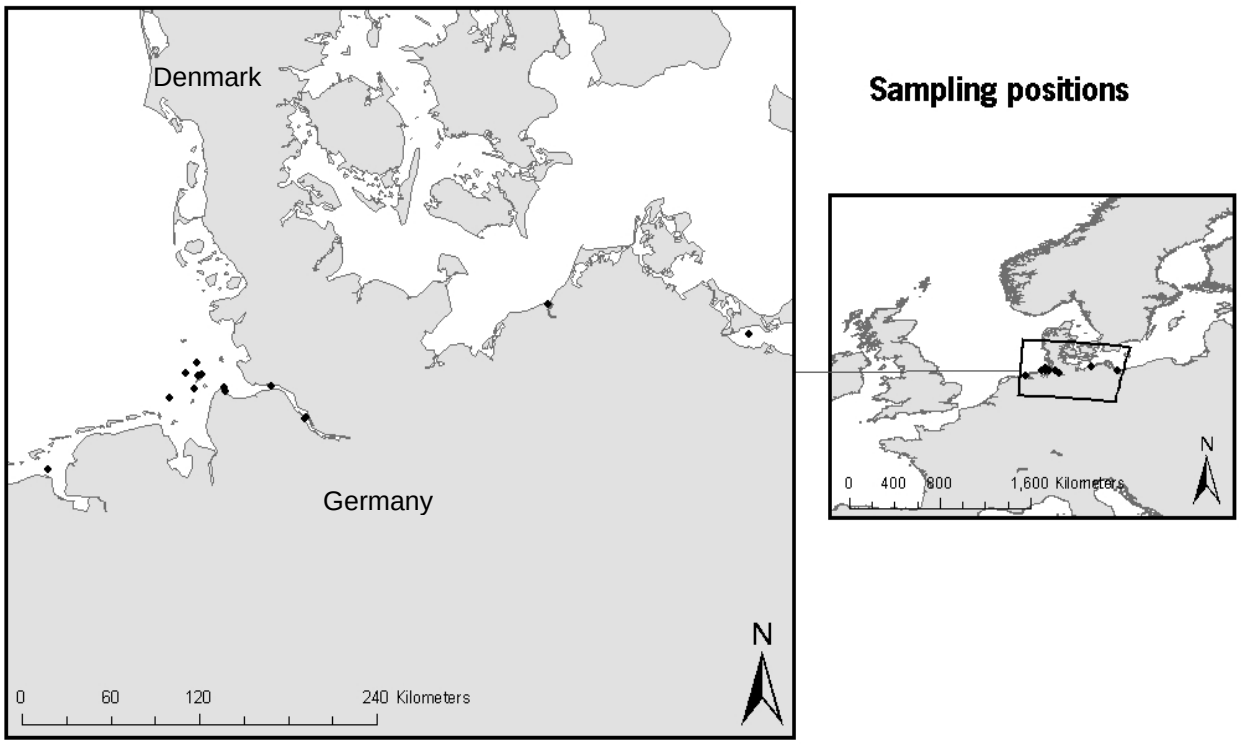
**Annex 10.** Sampling locations for the chloroform and 1,2-dichloroethane determination in the southern North Sea (Netherlands/Belgium/France) and Scheldt estuary (Netherlands/Belgium) for the period 1994-1995: A (51°50.83'N; 2°52.00'E), B (51°28.83'N; 2°27.00'E), C (51°34.84'N; 2°47.42'E), D (51°11.10'N; 2°42.07'E), E (51°28.27'N; 3°03.48'E), F (51°25.90'N; 3°17.80'E) and G (51°21.90'N; 4°13.50'E)



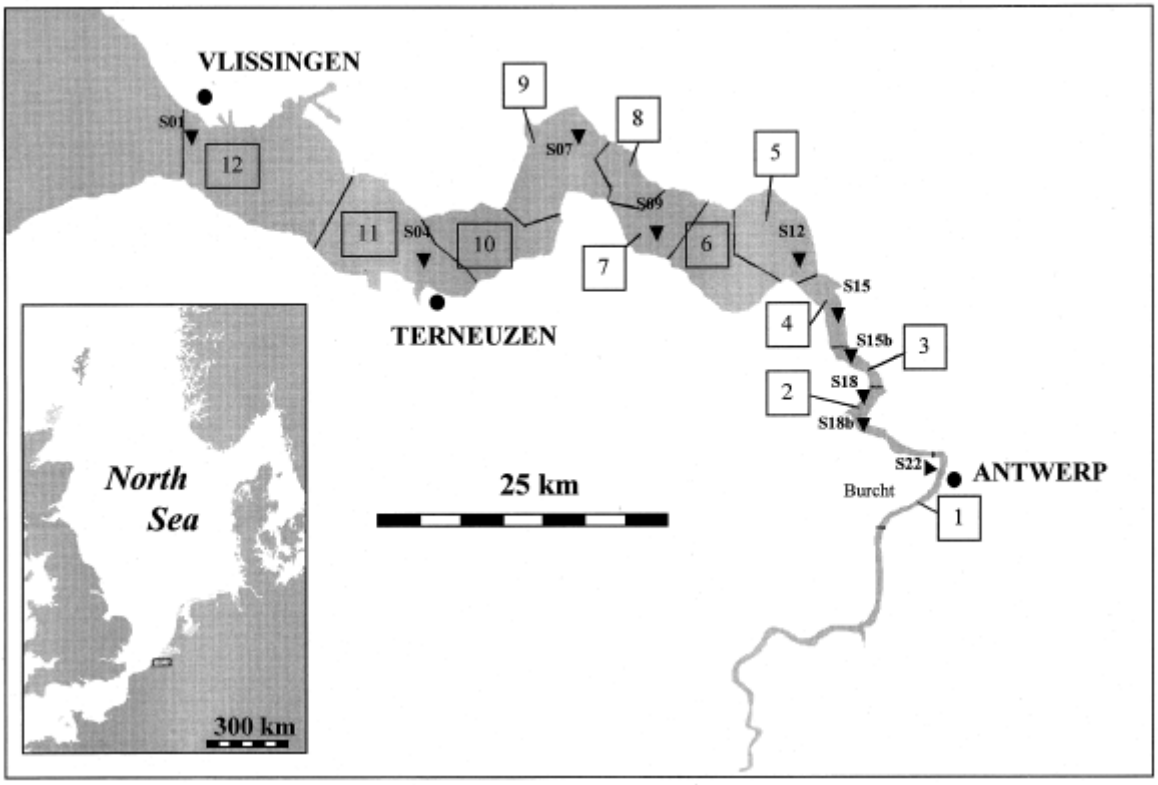
**Annex 11.** Sampling locations for the chloroform and 1,2-dichloroethane determination in the southern North Sea (Netherlands/Belgium/Fance) for the period 1998-2000: NS1 (52°30.21'N, 3°30.21'E); NS2 (52°9.13'N, 2°20.45'E); NS3 (53°17.51'N, 2°57.20'E); NS4 (53°23.25'N, 3°39.26'E); 330 (51°35.02'N, 2°47.48'E); 120 (51°18.45'N, 2°54.34'E); 435 (51°34.36'N, 2°49.23'E); S01 (51°24.75'N, 3°34.00'E); CH1 (50°42.32'N, 1°18.18'E); CH2 (50°55.02'N, 1°14.49'E).



**Annex 12.** Sampling locations for the chloroform, 1,2-dichloroethane and vinyl chloride determination in coastal waters of the German part of the North Sea and Baltic Sea.



**Annex 13.** Sampling locations for the chloroform and 1,2-dichloroethane determination along the Scheldt estuary (Netherlands/Belgium) for the period 1995-1997: S01 (51°25.00'N, 3°34.20'E); S04 (51°20.70'N, 3°49.50'E); S07 (51°26.20'N, 4°00.00'E); S09 (51°22.20'N, 4°04.70'E); S12 (51°21.90'N, 4°13.50'E); S15 (51°18.80'N, 4°16.40'E); S15b (51°17.35'N, 4°19.34'E); S18 (51°16.00'N, 4°18.00'E); S18b (51°15.29'N, 4°19.05'E); S22 (51°13.13'N, 4°23.50'E). Additionally, the compartmentalization of the estuary (Soetaert and Herman, 1995) is represented: compartments are numbered from 1 (at Antwerp) to 12 (at Vlissingen).



**Annex 14.** Sampling locations for the chloroform and 1,2-dichloroethane determination along the Scheldt estuary (Netherlands/Belgium) for the period 1998-2000: S01 (51°24.75'N, 3°34.00'E); S04 (51°20.90'N, 3°49.60'E); S07 (51°26.35'N, 4°1.00'E); S07b (51°25.25'N, 4°2.50'E); S09 (51°22.30'N, 4°5.00'E); S10 (51°23.95'N, 4°12.00'E); S12 (51°20.85'N, 4°15.80'E); S15 (51°18.10'N, 4°17.30'E); S15b (51°17.07'N, 4°19.19'E); S18b (51°15.10'N, 4°19.50'E); S22 (51°13.30'N, 4°23.50'E); S24 (51°10.50'N, 4°19.65'E); S26 (51°7.50'N, 4°18.50'E); S27 (51°7.00'N, 4°14.30'E). - - - densely populated and highly industrialized region.