

## LEVELS OF DIOXINS IN SOIL AND FRESHWATER FISH FROM NORTHERN NORWAY

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### Introduction

Few studies exist in the Norwegian Arctic where levels of dioxins (i.e. dioxins and furans) are investigated in environmental samples. This present study was a continuation of a previous project<sup>1</sup> analysing fresh water sediments nearby industrial and combustion sources in Troms county, North-Norway. The initial project revealed sediment levels that could indicate influence of local sources and the present study was conducted as a continuation project to investigate the levels of dioxins in soil samples nearby the lakes and to investigate if the levels of dioxins in fish from these waters exceeded the maximum levels of dioxins in fish muscle meat stipulated by the EU commission. In order to engage the local community, environmental science learning and teaching was done at high-school level at Finnfjord videregående skole. Through supervision and pre-prepared fish sampling protocol, the pupils were active participants in fishing, logging of fish physiological data and scientific correct filleting of fish.

With the political focus on the Norwegian Northern environments and evaluation of the influence of different environmental threats such as long range air transportation of pollutants, effects of climate change, oil-gas exploitation, shipping and fishing, this investigation is a relevant contribution to risk assessment of air-transported persistent organic pollutants.

### Material and Methods

**Soil:** Soil samples were collected 28<sup>th</sup> September, 2005 near the freshwater lakes Finnfjordvatn, Botnvatn and Abborvatn. A pre-cleaned sampling device with a diameter of 2 cm with 10 cm sampling depth was used. On the sampling site a square of 15 x 15 m was chosen constituting 15 single soil samples. Pooled soil samples were transferred to pre-cleaned and burned glass jars, stored in a freezer before for dioxin analysis.

**Fish:** Arctic char (*Salvelinus alpinus*), brown trout (*Salmo trutta*) and perch (*Perca fluviatilis*) were collected from the largest lake Finnfjordvatn, trout from Botnvatn and perch from Abborvatn. Pooled fillet samples of 5-10 fish were used for dioxin analysis and the samples were stored in freezer prior to analysis. All equipment for fish handling were pre-cleaned with acetone and hexane (99.99 % purity) before use.

### Analysis

Samples were spiked with <sup>13</sup>C-labelled 2,3,7,8-chloro substituted PCDD and PCDF congeners and Soxhlet extracted with warm toluene.

Most of the sample matrix was removed with multi column chromatography on different types of silica gel and on activated charcoal. A final treatment was done on sulphuric acid coated silica and aluminium oxide. Just before quantification, the sample was spiked with a recovery control standard.

The isomer identification and quantification was done with GC/MS. The separation of the PCDD and PCDF isomers was carried out on 30 m Rtx-2330 fused silica column. The quantification of all 2,3,7,8-chloro substituted congeners and the determination of the sum of all isomers with the same degree of chlorination were done by high resolution mass spectrometry (res>10000) using electron impact ionisation. Two masses were monitored for each isomer group. The added <sup>13</sup>C-labelled isomers were used as internal standard for each group. Additionally, the recovery of the added internal standard compounds were determined.

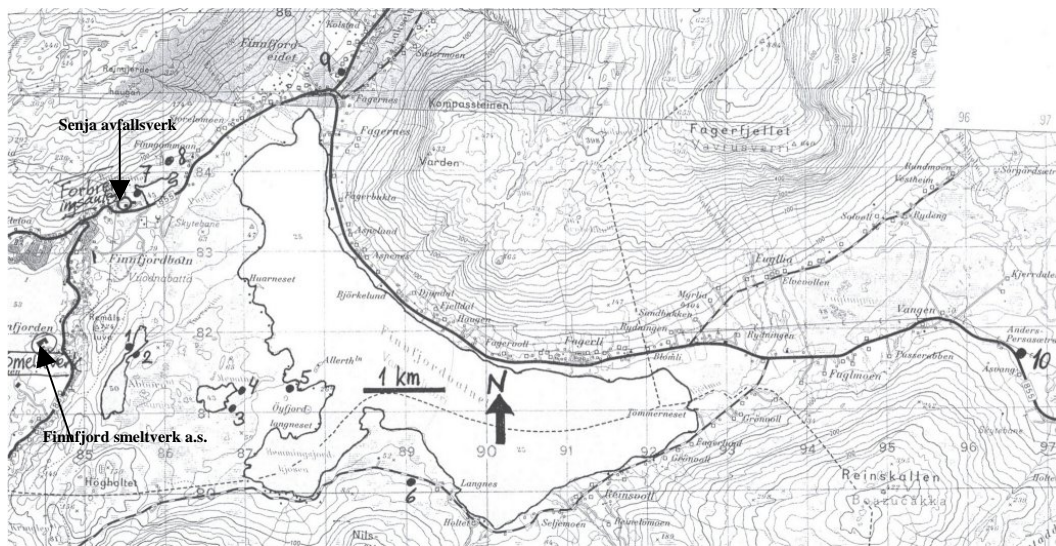


Figure 1: Map showing sampling sites 1-10 for soil samples and the lakes Abbortvatn (sampling site 1 and 2), Finnjordsvatn (sampling site 5 and 6), Botnvatn (sampling site 7 and 8) and two other stations; station 9 (Botnvatn2kmE) located 2 km north-east of Botnvatn and reference station 10 (Ref. Soil) located 12 km east of Botnvatn. Sampling sites 3 and 4 near Mevatn were not used for analysis due to the lack of fish samples from these stations. The location of the industries Finnjords Smelteverk a.s. and Senja avfallsverk are given with arrows.

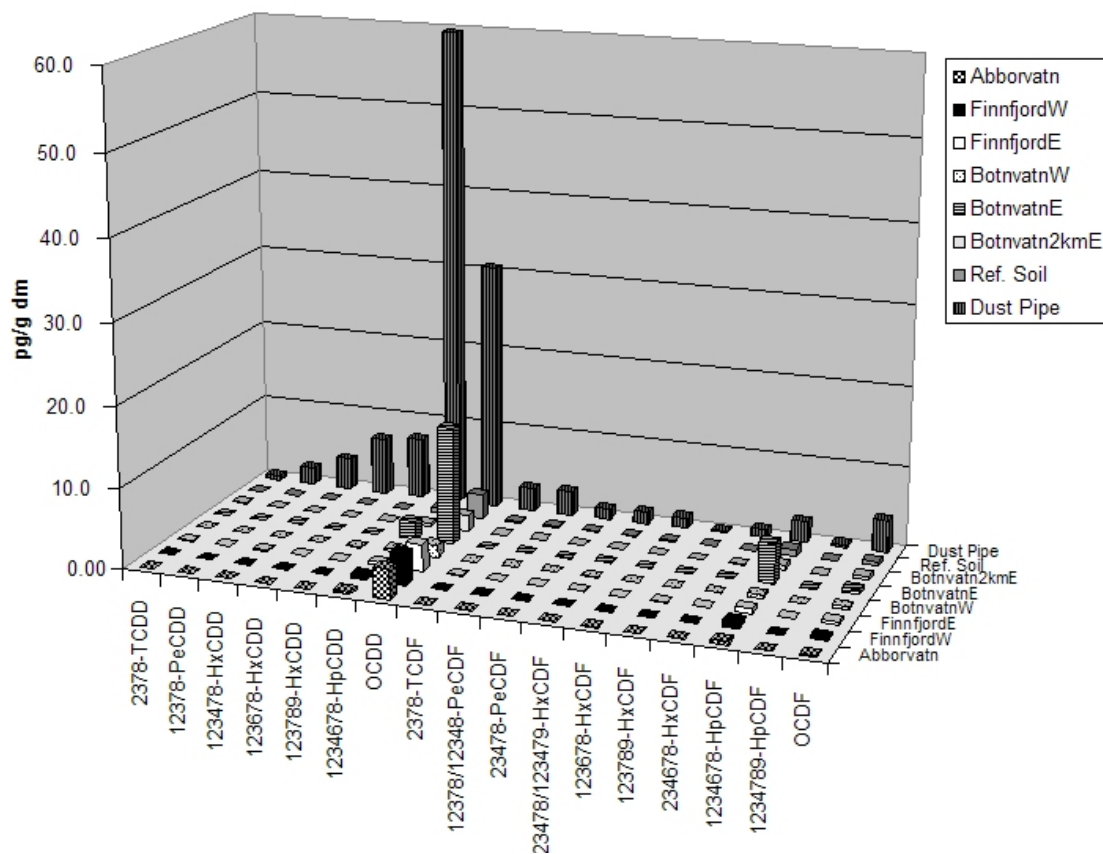


Figure 2: Dry matter congener concentrations (pg/g dm) and patterns in soil samples and one dust filter sample (Dust pipe) from Finnjords smelteverk a.s. Abbortvatn (sampling sites (St.) 1 and 2), FinnjordsW (St. 5), FinnjordsE (St. 6), BotnvatnW (St. 7), BotnvatnE (St. 8), Botnvatn2kmE (St. 9), Ref. Soil (St. 10) and Dust Pipe from Finnjords smelteverk a.s.

**Results and Discussion**

There have not been any air emission measurements of dioxins at Finnfjord smeltverk a.s. A filter bag containing dust was therefore collected for dioxin analysis from the main pipe at Finnfjord a.s. A relevant problem is that this filter sample not necessarily represents the dioxin composition in the filtered air emissions since low weight compounds may break through while heavier ones adsorb to the filter. The lower chlorinated dioxins emitted to air may therefore be underestimated from the filter composition. Hepta- and octachlorinated dioxins were the dominating congeners in the dust from the filter and OCDD dominated the soil samples with values from 1.55 to 14.6 pg/g dry matter (dm). This congener is also the most dominating one in the previous analysis of the 4 sediments<sup>1</sup>, although with much higher absolute values. Comparing soil and sediment samples on the basis of toxicity equivalent per organic matter (ignition loss), both the soil sample from Finnfjordvatn East St. 6 and the sediment sample from Finnfjordvatn show the highest Sum PCDD/PCDF pg TE (WHO)/g IG values of 43.9 and 110.1, respectively. Both the soil from Finnfjord East St. 6 and the sediment had low content of organic matter given by ignition loss.

Table 1: Sum Dioxins/Furans in sediment samples, Troms county<sup>1</sup>

Sediment samples	SumPCDD/PCDF pg TE (WHO)/g dm	% Ignition lost (IG)	SumPCDD/PCDF pg TE (WHO)/g IG
Abborvatn	19.6	32.2	62.1
Finnfjordvatn	12.2	10.9	110.1
Botnvatn	13.9	40.7	34.4
Mevatn	10.1	49.9	20.0

Table 2: Sum Dioxins/Furans in soil samples, Troms county

Soil samples	Sum PCDD/PCDF pg TE (WHO)/g dm	% Ignition lost (IG)	Sum PCDD/PCDF pg TE (WHO)/g IG
Abborvatn St. 1 and 2	0.06	0.48	12.5
Finnfjordvatn West St. 5	0.09	0.98	9.2
Finnfjordvatn East St. 6	0.18	0.41	43.9
Botnvatn West St. 7	0.10	6.20	1.6
Botnvatn East St. 8	0.16	10.08	1.6
Botnvatn 2 km north-east St. 9	0.10	1.90	5.3
Reference station, 12 km east of Botnvatn St. 10	0.13	5.06	2.6
Finnfjord A.S. dust	6.80		

The respective dioxin congeners in all fish samples had low values in the range of 0.01 pg/g ww to 0.45 pg/g ww. A study of dioxins in freshwater fish from Sørvaranger near industrial areas<sup>2</sup> revealed relatively higher values with maximum level of 6.72 pg/g ww (congener 2378-TCDF). The soil from Botnvatn East St. 8 and the pooled trout sample from Botnvatn had the highest dioxin concentrations with OCDD concentration of 14.8 pg/g dm and 2378-TCDF of 0.48 pg/g ww, respectively. The soil from this station had the highest percentage ignition loss compared to the other soil types and the trout had relatively high extractable organic matter. This sampling site is located approximately in the north-east direction of the industry which is estimated to give one of highest loads to the ground based upon meteorological data and dispersion calculations<sup>3</sup>.

The most dominating congener in 4 out of 5 pooled fish samples was 2378-TCDF. The soil and sediment samples are dominated by higher chlorinated congeners and fish samples with lower chlorinated ones, most probably due to bioavailability and uptake mechanisms in fish and that higher chlorinated congeners have higher susceptibility to adsorb to particles in soil and sediment. None of the fish samples exceeded the maximum level of 4 pg TE/g ww in fish muscle set by the EU commission and national authorities. The highest concentration in this study was 0.24 pg TE/g ww (Table 3). In comparison, 3.56 pg TE/g ww was detected in whitefish muscle

## Natural halogenated and chiral compounds

from Sørvaranger.<sup>2</sup> This study reveals that fish from freshwaters near Finnfjord Smelteverk a.s. and Senja Avfallsverk, are not highly influenced by high dioxin levels and are safe to eat.

Table 3: Sum Dioxins/Furans in fish samples from fresh water lakes, Troms County.

Fish samples	Sum PCDD/PCDF pg TE (WHO)/g ww	% Lipid content	Sum PCDD/PCDF pg TE (WHO)/g lw
Abborvatn Perch	0.12	0.42	28.6
Finnfjordvatn Char	0.14	1.63	8.6
Finnfjordvatn Trout	0.08	0.98	8.2
Finnfjordvatn Perch	0.10	0.57	17.5
Botnvatn Trout	0.24	1.06	22.6

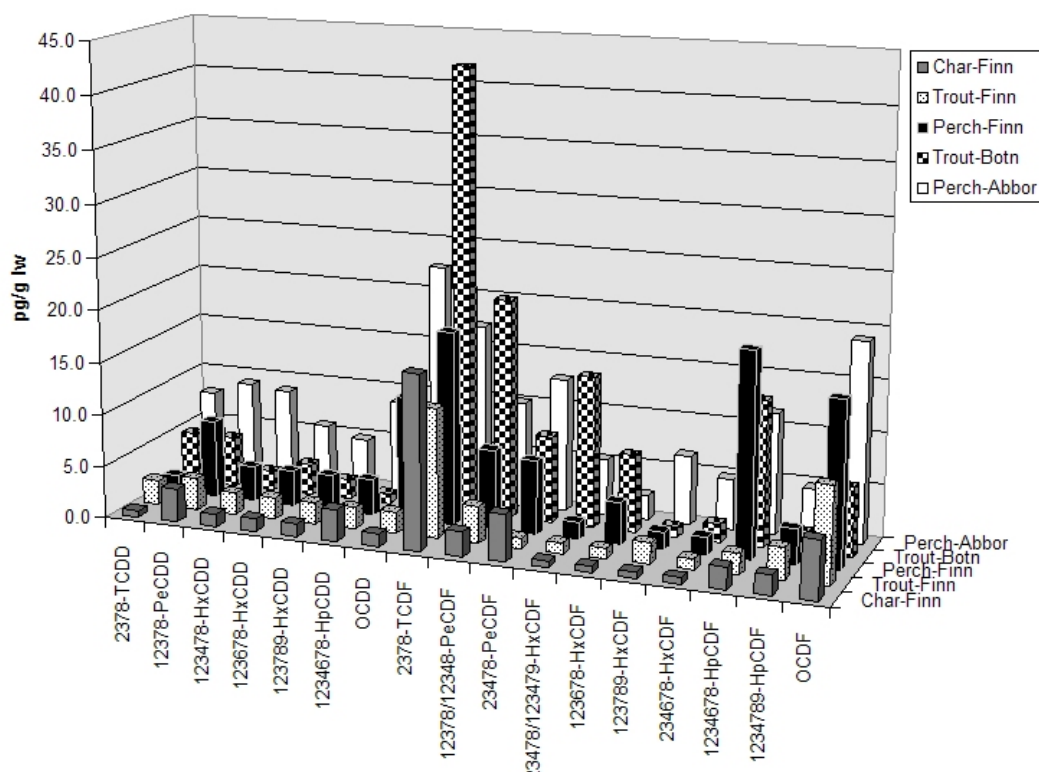


Figure 3: Lipid normalised dioxin concentrations (pg/g lw) for pooled samples of Char in Finn fjordvatn (Char-Finn), Trout in Finn fjordvatn (Trout-Finn), Perch in Finn fjordvatn (Perch-Finn), Trout in Botnvatn (Trout-Botn) and Perch in Abborvatn (Perch-Abbor).

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