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Switzerland's first update of the National Implementation Plan under the Stockholm Convention

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Authors

Andreas Häner, Karina Urmann
BMG Engineering AG, Ifangstrasse 11, 8952 Schlieren, Switzerland

Project group

Bettina Hitzfeld, Sarah Maillefer, Josef Tremp, Andreas Weber,
Federal Office for the Environment (FOEN), Berne

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Abbreviations

b.w.	body weight
BDEs	brominated diphenyl ethers
ChemO	Chemicals Ordinance
c-octaBDE	commercial octabromodiphenyl ether product
c-PCBs	coplanar polychlorinated biphenyls
c-pentaBDE	commercial pentabromodiphenyl ether product
CSO	Contaminated Sites Ordinance
dl-PCB	dioxin-like polychlorinated biphenyls
d.w.	dry weight
FIV	Ordinance on Contaminants and Ingredients in Food
FOEN	Federal Office for the Environment (until 2005: Swiss Agency for the Environment, Forests and Landscape (SAEFL))
FOPH	Federal Office of Public Health
HCB	hexachlorobenzene
HCH	hexachlorocyclohexane
I-TEQ	international toxicity equivalent concentration according to NATO-CCMS
NABEL	National Air Pollution Monitoring Network
NABO	National Soil Monitoring Network
NADUF	National River Monitoring and Survey Programme
NAQUA	National Groundwater Monitoring Programme
NATO-CCMS	Committee on the Challenges of Modern Society of the North Atlantic Treaty Organization
OAPC	Ordinance on Air Pollution Control
OBP	Ordinance on Biocidal Products
OCP	Organochlorine Pesticides
OPPP	Ordinance on Plant Protection Products
ORRChem	Chemical Risk Reduction Ordinance
PBDEs	polybrominated diphenyl ethers
PCBs	polychlorinated biphenyls
PCDDs	polychlorinated dibenzo-*para*-dioxins
PCDFs	polychlorinated dibenzofurans
PeCB	pentachlorobenzene
PFCs	perfluorinated chemicals

PFOS	perfluorooctanesulfonic acid, perfluorooctane sulfonates and related substances
POPs	persistent organic pollutants
PRTR	Pollutant Release and Transfer Register
REACH	Regulation (EC) No 1907/2006 concerning the Registration, Evaluation and Authorisation of Chemicals
TEF	toxicity equivalence factor
TEQ	toxicity equivalent concentration
TVA	Technical Ordinance on Waste

1 Introduction

The Conference of the Parties adopted amendments to the Stockholm Convention to include nine new persistent organic pollutants (POPs) at its meeting held in May 2009. On 26 August 2009, the amendments were communicated to all Parties. They entered into force one year later in 2010.

The following eight new POPs were included in Annex A (Elimination): the organochlorine pesticides alpha-, beta- and gamma-hexachlorocyclohexane (HCH) and Chlordecone and the industrial chemicals pentachlorobenzene, hexabromobiphenyl, hexabromo- and hepta-bromodiphenylether, tetrabromo- und pentabromodiphenyl ether. Pentachlorobenzene was additionally added in Annex C (Unintentional Production). Perfluorooctane sulfonic acid and its salts and perfluorooctane sulfonyl fluoride were added to Annex B (Restriction).

In 2006, Switzerland submitted a first national implementation plan (NIP) according to Article 7 of the Stockholm Convention. Due to the nine new POPs this update of the NIP has been compiled. At the same time an update on the initial POPs is provided with a focus on new information that has become available since 2005/2006. A consultation on the updated NIP has been held within the Swiss authorities that are concerned with the topic.

2 Country description

No relevant changes have occurred since the first Swiss NIP from 2006 [45]. Therefore, please refer to the first NIP for further information on this section.

3 Policy and legislation

A detailed description of the policy and of the institutional and regulatory framework with regard to the regulation of chemicals in general and POPs in particular is contained in the first Swiss NIP [45] in chapter 2.2. Since 2005 several updates of some of the relevant ordinances have been implemented or are planned to further regulate the POPs issue in general as well as the initial and new POPs. The most important changes, which are described here, concern the following regulations:

- Chemical Risk Reduction Ordinance (ORRChem, SR 814.81) [84]
- Chemicals Ordinance (ChemO, SR.813.11) [83]
- Ordinance on Biocidal Products (OBP, SR 813.12) [86]
- Ordinance on Plant Protection Products (OPPP, SR 916.161) [87]
- Ordinance on the Register relating to Pollutant Release and the Transfer of Waste and of Pollutants in Waste Water (PRTR – V, SR 814.017)) [88]
- Ordinance on Contaminants and Ingredients in Food (SR 817.021.23) [81]
- Ordinance on Construction Work (SR 832.311.141) [85]

3.1 Chemical Risk Reduction Ordinance (ORRChem)

In Switzerland bans and restrictions of POPs are regulated in the Ordinance on the Reduction of Risks relating to the Use of Certain Particularly Dangerous Substances, Preparations and Articles (ORRChem, SR 814.81). Since its entry into force in 2005, the ORRChem has been amended several times, adapting it to changes in the EU legislation [95] [96] and the Stockholm Convention. The first version of the ORRChem has already banned – or with respect to PCDDs/PCDFs limited – all initial POPs and some of the nine new POPs, namely Chlordecone, HCH and its isomers (with an exemption for Lindane in medicinal products), commercial pentaBDEs and octaBDEs, polybrominated biphenyls (hexabromobiphenyl).

Since 2005 the ORRChem has been amended with regard to POPs as summarized in Tab. 1 (a detailed description of the changes is given in [5]).

Tab. 1 Amendments of the ORRChem since 2005

Date of amendment	POPs concerned	Description
10.12.2010 Annex 1.1, 3	pentachlorobenzene	Ban of the substance without exemptions
10.12.2010 Annex 1.1, 3	hexachlorocyclohexane (all isomers including Lindane)	The exemption for the use of Lindane in medicinal products is removed.
10.12.2010 Annex 1.9	brominated flame retardants: commercial penta- and octa-bromodiphenyl ether (c-pentaBDE / c-octaBDE);	Addition of a ban of production to the existing ban of use.
10.12.2010 Annex 1.16	perfluoroctane sulfonates (PFOS)	General ban of PFOS including the definition of threshold values and some specific exemptions for uses were substitution is not (yet) possible. If PFOS are used according to the exemptions, yearly reporting to FOEN is required. For fire-fighting foams that were placed on the market before the ban, a transitional period applies for the use of existing stocks in stationary industrial installations (until 2018) and by professional fire fighters in cases of emergency (until 2014) with the obligation of yearly reporting to FOEN.
10.12.2010 Annex 2.14, 3	PCBs	Amendment that the inspection bodies specified in Article 26 paragraph 1 of the Ordinance of 7 November 2001 on Low-Voltage Electrical Installations (SR 734.27) [82] shall also check, whether pollutant (e.g. PCBs) - containing capacitors with a total weight in excess of 1 kg are being used.

The following changes are planned for the next amendment of the ORRChem that is due to enter into force on 1 December 2012 (see

Tab. 2) a detailed description of the changes is given in [4]). The changes adapt the ORR-Chem to the Stockholm Convention, the EU POP regulation and the REACH regulation.

Tab. 2 Planned changes for the next amendment of the ORRChem

Planned date of amendment	POPs concerned	Description
01.12.2012 Annex 1.9, 2 and 3	brominated flame retardants: commercial penta- and octabromodiphenyl ether (c-pentaBDE / c-octaBDE); congeners identified as POPs: tetraBDEs, pentaBDEs, hexaBDEs and heptaBDEs (summarized as PBDEs); additionally regulated: octaBDEs	Inclusion of the definition of the POP PBDEs: tetraBDEs, pentaBDEs, hexaBDEs and heptaBDEs; Ban of the production, placing on the market and use of the POP PBDEs and octaBDEs and all articles or preparations containing PBDEs above 0.001%.
01.12.2012 Annex 2.18	all brominated flame retardants (including DecaBDE, all POP PBDEs etc.)	A threshold value of 0.1% (by weight) for all PBDEs applies to those parts of electrical and electronic appliances that are treated with flame retardants.
01.12.2012 Annex 1.16	perfluoroctane sulfonates (PFOS)	Lowering of the limit value for PFOS in substances and mixtures from 0.005 to 0.001 % (by weight). Constriction of the existing exemptions for use of PFOS in mist suppressants for non-decorative hard chromium (VI) plating to closed systems, and for use of PFOS in hydraulic fluids to aviation; abrogation of the exemption for use of PFOS for medical devices.
01.12.2012 Annex 1.1 3 (b)	Endosulfan (inclusion in annex A of the Stockholm Convention by 27 October 2012)	The last authorizations of plant protection products containing Endosulfan expired in 2009, the deadline for the termination of use is in August 2013. The production, placing on the market and use of Endosulfan will be forbidden within the framework of the ORRChem. The planned date of entry into force is 1 September 2013..
01.12.2012 Annex 1.17	potential POPs / Annex XIV substances	Substances that are included in Annex XIV of the REACH regulation (substances subject to authorization) shall be banned unless an exemption as defined in the REACH regulation applies, an authorization has been granted in the EU or a specific exemption from the ban has been granted in Switzerland. For the latter an application, similar to an application for authorization in the EU has to be submitted. Products that contain authorized substances have to be labeled with the respective authorization number.

3.2 Chemicals Ordinance (ChemO)

The Ordinance of 18 May 2005 on Protection against Dangerous Substances and Preparations (Chemicals Ordinance, ChemO, SR.813.11) was amended on 14.01.2009 to include the PBT (persistent, bioaccumulative, toxic) and vPvB (very persistent, very bioaccumulative) properties in accordance with the EU REACH regulation. For the definition of these properties the ChemO refers to Annex XIII of the REACH regulation. Substances considered as PBT or vPvB are potential POPs, but are not automatically considered to be POPs as defined by the Stockholm Convention due to different criteria. Based on the ChemO, PBT and vPvB properties have to be evaluated when new substances (substances that were placed on the market after 1981) are notified. Furthermore, PBT and vPvB properties have to be considered for existing substances within the framework of industry's self-supervision according to Article 7. For substances identified as PBT or vPvB, or preparations containing them, many of the duties apply that were defined for substances classified as dangerous according to the ChemO or preparations containing them (e.g. compilation of a safety data sheets, notifications to the authorities).

With the planned amendment of the ChemO (end of 2012), the communication duties for substances of very high concern (which include PBT and vPvB substances) in articles defined in Article 33 of the REACH regulation will be introduced in Switzerland.

3.3 Ordinance on Biocidal Products (OBP)

The Swiss Ordinance on the Placing on the Market and Handling of Biocidal Products (SR 813.12) shall be revised based on the planned revision of the EU regulation on biocidal products [97].

According to the revised EU regulation that will enter into force on 1 September 2013, PBT and vPvB properties (as defined in REACH Annex XIII) represent an exclusion criterion for the approval of active substances (Article 5) unless certain criteria for exemptions are met. Active substances for which such exemptions are granted and those that meet two of the three PBT criteria are considered as candidates for substitution. Therefore, biocidal products that contain these substances are only approved if no alternatives are available for that specific type of product.

The Swiss Ordinance on Biocidal Products refers to the EU legislation for approved active substances. Thus, the assessment of PBT and vPvB properties required by the EU regulation for the approval of active substances will also apply for active substances used in Switzerland.

Biocidal products may only contain approved active substances. According to the revised EU regulation, the following further provisions shall apply:

- Authorizations for biocidal products shall not be granted if they have unacceptable effects on the environment having particular regard to contamination of surface waters (including estuarial and seawater), groundwater and drinking water, air and soil, taking into account locations distant from its use following long-range environmental transportation (Article 19).
- Biocidal products with PBT or vPvB properties shall not be sold to the general public unless certain conditions apply.
- For all substances of concern that are present in biocidal products, which includes substances fulfilling the PBT, vPvB according to REACH Annex XIII or the POP criteria according to the Stockholm Convention, but also all substances considered as dangerous according to the current EU or GHS classification system, a risk assessment has to be performed similar to the risk assessment of the active substance.

By implementing similar provisions for biocidal products in the framework of the Swiss Ordinance on Biocidal Products, a screening for PBT and vPvB properties and POP properties will be necessary for all ingredients in biocidal products to determine if they have to be considered as substances of concern and subsequently to perform a risk assessment. For the risk assessment of biocidal products, the determination of potential effects at other locations after long-range environmental transport will be necessary, also for the respective active substances. It is planned to implement the changes in the ordinance by the end of 2013.

3.4 Ordinance on Plant Protection Products (OPPP)

On 14 June 2011 the new EU regulation on plant protection products [94] entered into force. The Swiss Ordinance on Plant Protection Products (OPPP, SR 916.161) from 2005 was fully revised in order to reflect the changes in the EU regulation. The new version of the OPPP was published on 12 May 2010 (For further details on the revision see [11]).

For the criteria of approval of active substances, synergists and safeners, the OPPP refers to Annex II of the EU regulation. Approval for active substances, synergists and safeners for the use in plant protection products can only be given for substances that are neither considered PBT, vPvB in accordance with Annex XIII of the REACH regulation nor POPs in accordance with the Stockholm Convention, except for the criterion on *adverse effects* (Annex II of the EU regulation on plant protection products, 3.7). These criteria were newly included in the EU and in the Swiss regulation. In contrast to active substances in biocidal products, active substances, synergists and safeners in plant protection products have to be separately approved by the Swiss authorities, so that the above mentioned criteria will be directly applied in the evaluation process.

Plant protection products may only contain approved active substances, synergists and safeners and no co-formulants forbidden according to the ordinance. Authorizations for plant protection products shall furthermore not be granted if they have unacceptable effects on the environment having particular regard to contamination of surface waters (including estuarial and seawater), groundwater and drinking water, air and soil, taking into account locations distant from its use following long-range environmental transportation (Art. 4 para. 5 let. E PSMV, SR 916.161). .

The above mentioned provisions oblige the producer to investigate PBT, vPvB and POP properties of active substances, synergists and safeners. They thus prevent the release of substances with PBT, vPvB or POP properties in the environment.

In the light of the above mentioned criteria, none of the initial or new (as of 2012) POPs can be approved active substances to be used in plant protection products in Switzerland.

3.5 Ordinance on the Register relating to Pollutant Release and the Transfer of Waste and of Pollutants in Waste Water (PRTR-V)

Based on the Kiev Protocol to the Aarhus Convention (UNECE) from 21.5.2003 that was ratified by Switzerland in 2007, the Ordinance of 15 December 2006 on the Register relating to Pollutant Release and the Transfer of Waste and of Pollutants in Waste Water (PRTR – V, SR 814.017) entered into force on 1 March 2007 . The ordinance introduces the obligation to notify pollutant releases into air, water and soil and transfers into waste water above certain thresholds for certain industries. The 86 pollutants according to the UNECE Kiev Protocol are subject to notifications. This list includes all initial and new POPs apart from PFOS and hexabromobiphenyl. The latter is only included in the pollutant list of the EU. Some substances are grouped for notifications such as the brominated diphenylethers. Data from notifications for Switzerland are available starting from 2007 on the SwissPRTR platform (www.prtr.ch) and on the EU PRTR site (http://prtr.ec.europa.eu/).

3.6 Ordinance on Contaminants and Ingredients in Food (FIV)

The Ordinance on Contaminants and Ingredients in Food (FIV [81]) defines tolerance values or limit values in food for specific substances such as POPs. The ordinance originates from 1995 and was since then updated several times, latest in May 2012. The FIV contains only substances that require tolerance or limit values. They have to be of relevance concerning food quality. Substances that are not likely to be of relevance (since they are not detected in food in relevant concentrations or because they are not used at all) are not listed in the FIV. Values are listed for a range of POPs including all of the initial POPs with the exception of Mirex which was never listed (because of no relevance to food in Switzerland). Among the new POPs PBDEs, hexabromobiphenyl, PFOS and PeCB are not listed.

With the newest revision of the ordinance, provisions for PCBs, and PCDDs/PCDFs were adapted to Commission Regulation (EU) No 1259/2011 [40]. Specifically, the following adaptations were included in list 7 in the annex of the ordinance:

- Lower maximum concentration levels for the sum of dioxins (WHO- PCDDs/PCDFs -TEQ) and the sum of dioxins and dioxin-like PCBs (WHO- PCDDs/PCDFs -PCB-TEQ) in foodstuffs have been issued;
- In addition to dioxins and dioxin-like PCBs maximum concentration levels have been set as well for the sum of six indicator PCB congeners (sum of PCB28, PCB52, PCB101, PCB138, PCB153 and PCB180 (ICES – 6)) in foodstuffs;
- For the calculation of TEQ-concentrations the toxic equivalency factors (TEF-values) recommended by the WHO in 2005 have to be used instead of those from the WHO in 1998.

With these changes the level of protection for consumers from exposure to PCBs, and PCDDs/PCDFs has been increased.

Normally, before new substances are listed in the FIV and maximum concentration levels are derived, the Federal Office of Public Health (FOPH) initiates studies to determine levels of contaminants in drinking water, food, and biological samples (e.g. breast milk, blood).

Prior to a decision on the inclusion of the new POPs in the FIV, the FOPH has commissioned studies with respect to perfluorinated chemicals, PFCs incl. PFOS (see section 5.2.3) and PBDEs (see section 5.2.2). Low concentrations of these contaminants in drinking water and food were observed. Therefore there is currently no necessity to include PFOS and PBDEs in the FIV.

3.7 Ordinance on Construction Work

The Ordinance of 29 June 2005 on Security and Health Protection for Employees during -Construction Work (Ordinance on Construction Work, SR 832.311.141) was updated in July 2008. The newly introduced article 3 (1bis) states that based on the suspicion that substances particularly hazardous to human health such as asbestos or PCBs are present, the employer of potentially exposed workers has the obligation to investigate the hazards and associated risks and implement measures for risk reduction as required. Furthermore, if substances particularly hazardous to human health are found unexpectedly during construction work, work has to be stopped and the owner of the building has to be informed by the contractor.

4 Enforcement

As described in the first NIP (chapter 2.2) the cantons play an important role in enforcement of the legal provisions laid out in the above mentioned ordinances and other legislation. This applies in particular for the enforcement of provisions concerning POPs. The enforcement activities include campaigns aimed at specifically checking if all legal provisions are followed for substances, mixtures, and articles. POPs are one of the groups of substances considered for such campaigns if occurrence in products is anticipated. Two campaigns coordinated at the national level were aimed at brominated flame retardants in articles [7] [68] (see chapter 5.2.2). A further focus is the enforcement of the elimination of PCBs. For this purpose information on the general procedure, identification, possible analysis and disposal of PCB-containing capacitors as well as a list of capacitors was published by chemsuisse, the cantonal enforcement authorities for chemicals' regulations [34][35][33][36] (see chapter 5.1.4).

5 Assessment of the POPs issue in Switzerland

5.1 Update for initial POPs

5.1.1 Aldrin, Dieldrin, Endrin (drins)

Occurrence and measures concerning these POP pesticides were already discussed in the first NIP (chapter 2.3.1). Residues of these compounds are still present in the environment despite being banned since 1986. In various soils with different use patterns a median value of 0.3 µg/kg d.w. (71 samples) was detected for the sum of Aldrin, Dieldrin and Endrin during a monitoring campaign in the Canton Basel-Land [8] (see chapter 5.5.4). The maximum detected concentration was 130 µg/kg d.w. Suspended solids from the river Rhine sampled at the ICPR monitoring station in Weil were analyzed for all three substances in 1995 – 1998 and 2008 – 2010, but none of the substances was detected (quantification limit 1 µg/kg d.w.) [127] (see chapter 5.5.3). Groundwater samples from the NAQUA National Groundwater Monitoring Programme were also analyzed for all three substances, but none of them was detected in 2005 to 2010 (see chapter 5.5.1). Based on these data, residues of Aldrin, Dieldrin and Endrin may still be present in soils in Switzerland while it can be assumed that they are not present (dissolved) in groundwater [132].

In a study on horticultural soils, Dieldrin was detected in concentrations up to 0.4 mg/kg [49]. As this concentration level is above the maximum level layed down in the FIV for Cucurbitaceae fruits (cucumbers, zucchini, and pumpkin), reduction of the uptake by these fruit was studied (see chapter 5.5.4).

Research was conducted on the photolytic transformation of Aldrin and Dieldrin and on their analytical detection in environmental samples [32] to better understand the abiotic transformation of these substances in the environment.

5.1.2 DDT

Occurrence and measures for elimination of DDT were already discussed in the first NIP (chapter 2.3.3). Residues of DDT and its metabolites are still present in the environment despite it being banned since 1986.

A median concentration of 3.9 µg/kg d.w. was detected for the sum of DDT, DDD and DDE during the monitoring campaign in Canton Basel-Land on different soils with different use patterns [8] (see section 5.5.4).The maximum concentration found was 7135 µg/kg d.w.

The study performed by Hilber *et al.* (2008 [49]) concerning organochlorine pesticides (OCP) residues in Swiss horticultural soil is summarized in section 5.5.4.

Between 1995 and 2010, 4,4'-DDT was detected in 58% of 362 samples of suspended solids (quantification limit of 1 µg/kg d.w.) from the river Rhine sampled at the ICPR monitoring station in Weil am Rhein.The median concentration was 1.2, the maximum concentration 66 µg/kg d.w. [127]. Metabolites of 4,4'-DDT were also detected. However, as the levels of DDT and its metabolites all met the quality criteria for the Rhine set by ICPR, sampling frequency will in the future be reduced to every 6 years (see section 5.5.3).

Groundwater samples from the NAQUA National Groundwater Monitoring were also analyzed for DDT and its metabolites. Except for one single detection of 2,4'-DDE at one monitoring site in 2005, none of the substances was detected in 2005 to 2010 (see section 5.5.1) [132].

DDT was detected in 1996 in twait shads (*Alosa fallax*) in Lago Maggiore in a study conducted by the cantonal laboratory of the Canton Ticino [99]. The contamination derived from indiscriminate industrial discharges by a factory into a creek in Italy. The elevated concentration in fish resulted in a ban for the catch of shads and chars. However, the ban has been repealed in 2007, since the contamination dropped below the limit values for DDT in fish [99].

Based on these data, residues of DDT and its' metabolites still can be detected in soils and sediments as well as in fish in Switzerland, while they should not be present (dissolved) in groundwater. This is in accordance with the expected distribution of DDT in the environment. Overall, sediment cores in lakes clearly indicate a continued decrease of DDT in the environment (e.g. [14]).

5.1.3 Hexachlorobenzene (HCB)

Occurrence and measures concerning hexachlorobenzene (HCB) were already discussed in the first NIP (chapter 2.3.4). Residues of HCB are still present in the environment despite it being banned since 1986.

During a monitoring campaign for organochlorine pesticides in Canton Basel-Land (see chapter 5.5.4) on different soils with different use patterns, a median value of 0.67 µg/kg d.w. of HCB (71 samples) was detected. The maximum detected concentration was 12 µg/kg d.w. All concentrations were well below the German guidance value of 4 mg/kg d.w. for HCB playgrounds .[8]

In a study commissioned by FOEN, suspended solids and the fine part of the bed sediment from ten different rivers in Switzerland, sampled in 1999 – 2000, were analyzed for different organic micropollutants and metals [90]. For HCB, a concentration range of 0.05 – 7.2 µg/kg d.w. (80 samples, median 0.35 µg/kg d.w.) was determined with no clear difference between suspended solids and bed sediment.

HCB concentrations in Rhine sediments from different studies from 1988 – 2004 ranged from 0 – 2500 µg/kg d.w. However, only few values were above the Dutch CTT (chemistry toxicity tests) threshold value of 20 µg/kg d.w. (above this value the deposition of excavated sediment in water bodies is forbidden) [63]. Between 1995 and 2010, HCB was furthermore detected in 90% of 362 samples of suspended solids (quantification limit of 1 µg/kg d.w.) from the river Rhine sampled at the ICPR monitoring station in Weil am Rhein. The median concentration was 3.8 µg/kg d.w., the maximum concentration was 103 µg/kg d.w.[127] (see also chapter 5.5.3). The exceptionally high concentration of 103 µg/kg d.w. was likely due to remobilization of contaminated sediment. Overall, concentrations in the Rhine were generally higher than in the other Swiss rivers. This is likely due to a previous production site of HCB on the German shore of the Rhine [63]. Nonetheless, HCB concentrations at the monitoring station in Weil are well below the quality criteria set by ICPR [61] (see also section 5.5.3).

In 2005 to 2010, HCB was regularly detected at one monitoring site of the NAQUA National Groundwater Monitoring. This monitoring site is situated in the immediate vicinity of a contaminated site. All other monitoring sites sampled did not show any HCB, i.e. this substance does not impact groundwater quality at a national level (see section 5.5.1) [132]

Effect compositions of firework contained in the past 5-15% hexachlorobenzene as chlorine donator for amplification of light effects. Today polyvinyl chloride, polyvinylidene chloride or chlorinated rubber are used for this purpose. Based on information from Denmark and Austria where recently HCB has been measured in firework, a market survey was conducted to investigate the presence of HCB, pentachlorobenzene (PeCB), and hexachlorocyclohexane (HCH) in 47 firework products on the Swiss market. The selected firework products comprised Roman candles (17%), rokets (20%), fountains (23%), batteries of mixed firework (23%) and bombs used by professional fireworkers (17%). The origin of the firework products was China (72%), Germany (19%), and Switzerland (4%). After careful delaboration of the firework items by specialists, the effect compositions have been analyzed for target substances. If firework items contained several effect compositions they were combined to one composite sample for analysis. Traces of HCB, i.e. concentrations between 4-41 mg/kg, have been detected in four effect compositions. PeCB and HCH was not detected in any of the analyzed firework products (the detection limit was 50 mg/kg). In addition to this market survey an air pollution measurement campaign was conducted on August 1, 2011 (August 1 is the Swiss national holiday), when firework is used extensively. Ambient air was collected by high-volume sampling at the NABEL station “Kaserne” in Zurich on July 24, August 1 and 2, and August 14. The air samples were analyzed for chlorobenzenes (tetra-, penta- and hexachlorobenzenes) and chlorophenols (tri-, tetra-, and pentachlorophenols). The concentration of HCB in the air was around 60 pg/m^3 on the days when no firework has been used. This concentration corresponds to background levels measured in Central Europe. Air concentrations of the other chlorobenzenes and chlorophenols were significantly lower. In the night between August 1 and 2, when fireworks have been extensively used, air concentrations up to 350 pg/m^3 for the sum of chlorobenzenes und 430 pg/m^3 for the sum of chlorophenols have been measured (3h sampling intervals). For HCB, the highest concentration was 300 pg/m^3. In summary it can be concluded that urban air concentrations of HCB and other chlorobenzenes and chlorophenols can be elevated by a factor of five during periods of extensive use of fireworks, compared to background concentrations in urban air [133].

5.1.4 Polychlorinated biphenyls (PCBs)

General

Polychlorinated biphenyls (PCBs) are listed both in Annex A (elimination) and Annex C (unintentional production) of the Stockholm Convention.

Where Annex A (elimination) is concerned, no specific exemptions are foreseen. The agreed measures for the elimination are described in Part II of Annex A of the Convention.

PCBs can also be unintentionally formed and released from thermal processes involving organic matter and chlorine as a result of incomplete combustion or chemical reactions. To prevent or reduce the release of PCBs best available techniques and best environmental practices have to be applied as defined in Part V of Annex C of the Convention.

According to the Convention PCBs means aromatic compounds formed in such a manner that the hydrogen atoms on the biphenyl molecule (two benzene rings bonded together by a single carbon-carbon bond) may be replaced by up to ten chlorine atoms. PCBs comprise 209 individual substances (congeners) of which about 130 have been identified in technical PCB-mixtures in various concentrations [135]. Coplanar PCBs are regarded as dioxin-like compounds [70] and listed in the Convention together with polychlorinated dibenzo-*p*-dioxins and dibenzofurans (PCDDs/PCDFs).

In addition to the POP properties, polychlorinated biphenyls (PCBs) have been shown to cause cancer in animals, as well as several serious, non-cancer health effects including developmental and reproductive toxicity, dermal toxicity, endocrine effects, hepatotoxicity, and the induction of diverse drug metabolizing enzymes. Studies on humans provide supportive evidence for the potential carcinogenic and non-carcinogenic effects of PCBs [134].

Legal framework and measures

With respect to PCBs Annex 2.14 ORRChem was amended on the 10 December 2010 as follows:

[1] The inspection bodies specified in Article 26 paragraph 1 of the Ordinance of 7 November 2001 [82] on Low-Voltage Electrical Installations shall also check, as part of the enforcement responsibilities assigned to them, whether pollutant-containing capacitors with a total weight in excess of 1 kg are being used.

[2] If the inspection bodies suspect or determine that such capacitors are being used, they shall notify the owner of the installation and the authority of the canton in whose territory the installation is located.

[3] If necessary, the authority notified in accordance with paragraph 2 shall order the decommissioning or replacement of the capacitors referred to in paragraph 1, and their disposal.

[4] The costs of the checking specified in paragraph 1 are to be borne by the owner of the installation.

The Federal Council has newly implemented the obligation to assess the hazard and the potential risks, if it has to be presumed that workers come in contact with substances of very high concern such as asbestos or PCBs during construction works (Bauarbeitenverordnung, BauAV [124], amendment of 2 July 2008, see chapter 3.7).

Specific provisions are defined for the handling of PCBs at contaminated sites and in waste (see subchapter "waste phase). Furthermore, several guidance documents for the assessment and safe handling of PCB-contaminated materials in buildings, facilities and equipments and for the disposal of PCB-containing waste (e.g. [24], [35]).

The ordinance on foreign substances and ingredients contains tolerance values for PCDDs/PCDFs and dl-PCBs in food that have been made more stringent with the last revision (see chapter 3.6).

Production, import, export and use

As mentioned in in the first Swiss NIP [45] PCBs were extensively used in Switzerland, though they were never produced by the Swiss chemical industry. Because of their distinguished chemical and physical properties PCBs were used from 1929 up to about 1990 as hydraulic fluids, lubricants, flame retardants and – in electro-technics – as isolation fluids in transformers and dielectric in capacitors [1].

The use of PCBs as softener in joint sealants and anti-corrosion coating products (i.e. open use) has been banned in Switzerland since 1972. A total ban of PCBs for all uses was released in 1986. For the decommissioning and the disposal of PCB-containing transformers and of PCB-containing capacitors with a total weight of 1 kg or above a transition period until 31 August 1998 was set [34].

It was estimated that in total about 6000 tons of PCBs were used in Switzerland [1].

There is no actual import, export or use of PCBs in Switzerland.

Remaining sources and emissions

Precise data concerning the amount of PCBs that are still present in Switzerland are not available, since no detailed information was collected for the total import and the total amount of PCBs used in buildings, electro-technical equipment and other products designed for a long-term use. Furthermore no information is available on the disposed amount of PCBs during all the years of use because in the statistics on hazardous waste disposal only data on the total weight of PCB-containing devices are collected. Based on the results of several studies by the cantons and the FOEN concerning PCBs in transformers and capacitors, anti-corrosion coatings of steel constructions (e.g. brigdes, fuel tanks, pylons of high voltage transmission lines) and joint sealants it could be estimated in 2008 that the total amount of PCBs still present in these uses amount to several hundred tons.

Former uses, where significant amounts of PCBs are still existing in Switzerland, comprise [1]:

- Capacitors in power factor correction units, in electric equipment and in ballasts of fluorescent lamps (estimated amounts: 100 – 450 tons);
- Joint sealants in buildings and in civil engineering (estimated amounts: 50 – 150 tons);

- Anti-corrosion coatings in penstock pipelines of hydro-electric power plants and of steel bridges, fuel depots and other large steel constructions (estimated amounts: 50 – 100 tons).

PCBs used as isolation fluids in transformers have been phased out and disposed of almost completely. It is estimated that only few tons are remaining in use. The amount of PCBs still present in old coats of paints and varnishes is not known [1].

Significant amounts are presumably present in some particular landfills and contaminated sites because of the disposal practice in the past [1] (see section 5.3 on contaminated sites). In the landfill "La Pila" 20 tons of PCBs are estimated to be present, which remain a source of PCBs for the river environment (see also environmental quality and monitoring data below in this section). Further tons of PCBs are suspected to have been disposed of at former landfills for industrial waste. These landfills are now in the progress of complete remediation.

Measurements in buildings that are equipped with PCB-containing elastic joint sealants showed ([66], see environmental quality and monitoring data) that PCBs in the µg/m^3 concentration range occur in indoor air. Anti-corrosion coatings represent an additional diffuse emission source of PCBs. However, PCBs in capacitors are not anticipated to be released provided that the capacitors are disposed of according to the legal provisions.

Emissions of PCBs have to be notified to the SwissPRTR register (see chapter 5.5.2) by certain industries if releases to air, soil or water above the threshold value of 0.1 kg/year are emitted. Releases were notified by steel works and ranged from 0.2 to 1.5 kg/year.

Short-term variability of PCBs in air and characterization of urban sources were measured and modeled for the city of Zurich [46]. Air samples were simultaneously collected in the city center and on a nearby hill. PCB concentrations in the city center were markedly higher than those on the hill, indicating that the city site is influenced by sources of PCBs [46].

Waste phase

PCB-containing waste can be generated from the above mentioned remaining sources of PCBs,.

Based on spot tests in buildings and in electric equipment it was estimated that from hundreds up to thousands of objects with PCBs might still be present. Therefore, prior to renovation or decommissioning of buildings or corrosion inhibiting coatings of large steel constructions clarifications about the presence of PCBs are required [1].

All PCB-containing operating transformers and large capacitors have to be decommissioned and professionally disposed of according to the requirements of the Ordinance on the Return, the Taking Back and the Disposal of Electrical and Electronic Appliances (ORDEA [89]). The decommissioning and disposal have to be notified to the authorities of the individual cantons according to the procedure layed down in the Ordinance on Movements of Special Waste (VeVa [123]).

Small PCB-containing capacitors present in ballasts of fluorescent lamps and in old electric appliances such as washing machines have to be professionally disposed of according to the requirements of the Ordinance on the Return, the Taking Back and the Disposal of Electrical and Electronic Appliances (ORDEA [89]) and the Ordinance on Movements of Special Waste (VeVa [123]).

In agreement with the European list of hazardous waste Switzerland has listed PCB-containing equipment in its list of hazardous waste [120] with the following waste codes:

- 16 02 09 [S] Transformers and capacitors containing PCBs
- 16 02 10 [S] Discarded equipment containing or contaminated by PCBs other than those mentioned in 16 02 09

The procedure for the disposal of PCB-containing equipment is described in detail in information material provided by the authorities of the individual cantons [35].

The disposal of PCB-containing joints is described in detail in the guidance document provided by the FOEN [24].

In 2011 the FOEN conducted a project to analyze the concentrations of POPs in Waste Electrical and Electronic Equipment (WEEE) and to determine the transfer of these substances into the various output streams (i.e. fractions of ferrous and non-ferrous metals, plastics, printed circuit boards, capacitors, and dust from exhaust cleaning devices) in a state-of-the-art WEEE recycling plant [47]. Calculated mean (worst-case) concentrations of PCBs were about 2 mg/kg in WEEE. This value is about a factor of 7 lower than the concentrations determined in a comparable study in 2003 (cited in [47]). The reduction is due to the fact that PCB containing capacitors have been widely eliminated [47].

Environmental quality and monitoring data

With respect to PCBs in joint sealants Kohler *et al.* (2005 [66]) published the following findings:

Joint sealants containing PCBs were discovered in October 2000 in various public buildings in Switzerland. Therefore, a comprehensive study was initiated by the FOEN. More than 1000 samples of joint sealants and up to 160 indoor air samples from concrete buildings erected between 1950 and 1980 were analyzed. 48% of the joint sealant samples contained PCBs. In 21% of the samples, PCB concentrations of 10 g/kg and more were detected, and concentrations of 100 g/kg of PCBs or more were found in 10% of the samples. This indicates that PCBs were widely used as plasticizers in joint sealants in Switzerland. In buildings constructed between 1966 and 1971, one-third of all joint sealants investigated contained more than 10 g/kg of PCBs. PCB concentrations exceeding the limit of 0.050 g/kg above which material is required to be treated as PCB bulk product waste were reached by 42% of the samples. The PCBs that could mostly be identified were Clophen A50, Aroclor 1248, and Aroclor 1254. In 26% of the cases, where joint sealants containing PCBs were present, clearly elevated PCB indoor air concentrations above 1 µg/m^3 could be measured. In 5% of the cases , levels were higher than 3 µg/m^3 [66]. On the basis of this work it was estimated that there are still 50-150 t of PCBs present in these materials,. They are distributed over many hundreds of buildings all over the country and represent a significant but frequently overlooked inventory of PCBs. They are acting as diffuse sources for PCBs [66].

Triggered by the finding that brown trout from a rural river system in western Switzerland are highly contaminated with dioxin-like PCBs (dl-PCBs), the Federal Office for the Environment (FOEN) together with the Federal Office for Public Health (FOPH) started a national project in 2008 to investigate the PCB- and PCDD/PCDF-contamination of wild fish in Swiss lakes and rivers [27][91].

The aim of the study was to identify current background concentrations of these highly toxic pollutants in different wild fish species and to determine the level of contamination of fish that are living in waters which have been polluted with PCBs emitted from point sources. The risk for human health and the environment from exposure to PCBs and PCDDs/PCDFs was assessed and the need for risk reduction measures identified. More than 1300 data sets from a period of around 20 years were collected and evaluated [27][91].

Background concentrations of dl-PCBs and PCDDs/PCDFs have been identified to be in the range of 0.5-4 pg WHO(98)-TEQ/g fresh weight (fw). Such concentrations have been determined in particular in fish from the rivers Doubs, Rhône (before the confluence with lake Geneva), Rhine (before the confluence with lake Constance), and Inn, as well as in fish that were caught in the lakes of the Swiss plateau, lake Lugano and alpine lakes. Concentration levels of dl-PCBs and PCDDs/PCDFs in the range of 4-12 pg WHO(98)-TEQ/g fw have been measured in fish from waters with elevated contamination from diffuse sources. Fish from waters that are polluted by PCB-emissions from point sources (i.e. a single identifiable localized source) showed concentrations of dl-PCBs and PCDDs/PCDFs above 8 pg WHO(98)-TEQ/g fw. The highest levels up to 97 pg WHO(98)-TEQ/g fw were found in brown trout from the river Saane close to the former landfill site "La Pila", where industrial waste from manufacturing of capacitors was dumped until 1974. Additional measurement campaigns showed that especially the sediments down-gradient of the former landfill site were highly contaminated [93]. Measurements in fish of 2007 showed concentrations up to 329 pg WHO(98)-TEQ/g fresh weight. Mean and median values were 81 and 57 pg WHO(98)-TEQ/g fresh weight, respectively.

High concentrations of dl-PCBs up to 60 pg WHO(98)-TEQ/g fw have also been determined in fish species of the River Rhine near Basel and in brown trout from the river Birs [27][91]. Passive samplers were successfully used to identify the PCB point source contaminating the river Birs. An industrial site recycling/melting PCB-contaminated scrap metal, cooled the process exhaust gases with water from the river, which after a simple cleaning step was discharged into the river [131].

Dated sediment cores provide a way to investigate the historical input of persistent organic pollutants into the environment and to identify possible sources of pollution [129].

Zennegg *et al.* (2007 [129]) described the historical record of PCB and PCDD/PCDF deposition at Greifensee, a lake of the Swiss plateau, between 1848 and 1999. The vertical distribution of PCDDs/PCDFs and PCBs was investigated in a sediment core from Greifensee to show the historical trends of PCDD/PCDF and PCB inputs between 1848 and 1999. Concentrations of PCBs and PCDDs/PCDFs significantly increased between 1930 and 1960. PCB and PCDD/PCDF concentrations were 5'700 ng/kg dry weight (d.w.) and 160 ng/kg d.w., respectively, in sediments originating from the late 1930s and reached a maximum of 130'000 ng/kg d.w. and 2'400 ng/kg d.w., respectively, in sediments from the early 1960s. Up to the mid 1980s, concentrations decreased to values in the range such as measured in the 1930s. The rapid decline of PCDD/PCDF and PCB concentrations in the sediment starting in the early 1960s reflects according to the authors the result of better emission control techniques in thermal processes and the improvement of waste water treatment in the catchment of Greifensee [129]. Sediment cores, therefore indicate the effectiveness of legislative action and implemented measures. Bogdal *et al.* (2008 [13]) assessed sediment cores in Lake Thun, a prealpine lake. The input in the lake can exclusively be attributed to atmospheric deposition. The highest concentrations of PCBs were observed in sediments deposited around the early 1970s. In more recent sediments of PCB concentrations are steadily decreasing with time [13]. As stated above, these findings therefore indicate decreasing PCB sources triggered by legislative action and implemented measures.

Suspended solids and the fine part of the bed sediment from ten different rivers in Switzerland sampled in 1999 - 2000 were analyzed for different organic micropollutants and metals [90]. For PCBs (sum of congeners PCB 28/31, PCB 52, PCB 101, PCB 118, PCB 138, PCB 153 and PCB 180) a concentration range of 0.35 – 58 µg kg^{-1} d.w. (median 7.9 µg kg-1 d.w., 80 samples) was determined. A similar concentration range of 0 – 78 µg kg^{-1} d.w. (sum of 6 - 9 PCB congeners) was determined in different studies for sediments of the Rhine or its tributaries [63]. Suspended solids from the ICPR monitoring station in Weil am Rhein contained similar concentrations (see chapter 5.5.3).

With respect to PCB concentrations in composts and digestates deriving from crude organic kitchen waste and green waste Brändli *et al.* (2007 [18]) presented an inventory of the pollutant situation in source-separated composts, digestates and presswater in Switzerland by analyzing more than 70 samples. PCB concentrations (sum of PCB 28, 52, 101, 118, 138, 153, 180) were significantly higher in urban (median: 30 µg/kg d.w., 52 samples) than in rural samples (median: 14 µg/kg d.w., 16 samples). These generally low concentrations could – according to the authors - be attributed to atmospheric deposition [18].

Desaules *et al.* (2008 [42]) gave an overview over surface soil concentrations (0-20 cm) in samples from 1995 – 1999 of the Swiss soil monitoring network (NABO) (see chapter 5.5.1) with more than 10 observation sites representing all major land use. PCB concentrations (as sum of 7 congeners according to the Institute for Reference Materials and Measurements, IRMM [23]) were clearly below any assessment value. Higher concentrations were observed at urban and viticulture sites. For PCBs, the general congener rank order was PCB no. 153 > 138 > 101 > 180. In a further investigation from 2002, PCB concentrations at 23 monitoring sites from NABO were very similar to the previous study [103] (see section 5.5.1).

Overall, mainly elevated concentrations in fish and sediment close to point sources currently give reason for concern while sediment cores indicate the effectiveness of measures already implemented.

Possible further need for monitoring and action required for risk reduction

The Federal Council considers the legislation and the available guidance documents for the safe handling of the existing PCB amounts in buildings, facilities and equipments and for the disposal of PCB-containing waste as sufficient [1].

However, a need for action has been identified by the federal authorities for the assessment of the presence of PCBs in buildings, electric facilities and in contaminated sites. The implementation of the legal requirements and the application of technical rules in construction, renovation and disposal practice have also to be enhanced [1].

Based on the 2010 status report on PCBs in fish and surface waters in Switzerland [27] the following actions are considered to be required for risk reduction [91]. The implementation of these actions is ongoing:

- Locally or regionally elevated levels of PCBs may occur in rivers as a result of emissions from point sources and requires measures to reduce exposure of humans and the environment. In order to support the enforcement authorities in the communities to identify point sources of PCBs near waterbodies, guidance for the planning and conducting of such investigations is currently developed. In addition, the FOEN has conducted a study on PCB point sources in Switzerland.

- In cases where concentrations of PCDDs/PCDFs and dl-PCBs exceed 8 pg WHO(98)-TEQ/g fw in fish, measures must be taken to protect consumers of contaminated fish. On January 15, 2009, the FOEN and FOPH published recommendations for limiting the population's exposure to PCDDs/PCDFs and dl-PCBs from consumption of fish. In addition, FOPH issued a directive on 19 May 2009 advising the food safety enforcement authorities how to monitor the compliance of marketed foodstuffs with the maximum concentrations and what measures to take in the event of these concentrations being exceeded [2]. Furthermore, the provisions of the Ordinance on Contaminants and Ingredients in Food (FIV) concerning PCDDs/PCDFs and dl-PCBs in food have been aligned with the 2011 amendment of the EU regulation ([40], see chapter 3.6).
- Passive samplers that were successfully used to identify PCBs emissions from point sources in rivers should be used for a broader monitoring. Furthermore passive sampling could be used to verify the effectiveness of remediations of PCB-contaminated sites.
- Further action is required to identify PCBs in buildings and electrical installations. Such PCB-containing materials and appliances have to be separated and safely disposed of.
- Top priority is to be accorded to investigations of PCB emissions from contaminated sites where large amounts of PCBs are found and the remediation of these sites shall be undertaken in accordance with approved regulatory procedures.

5.1.5 Polychlorinated dibenzo-*p*-dioxins and dibenzofurans (PCDDs/PCDFs)

General

Polychlorinated dibenzo-*p*-dioxins and dibenzofurans (PCDDs/PCDFs) are listed in Annex C (unintentional production) of the Stockholm Convention.

PCDDs/PCDFs as defined in the Convention text are tricyclic, aromatic compounds formed by two benzene rings connected by two oxygen atoms in polychlorinated dibenzo-*p*-dioxins and by one oxygen atom and one carbon-carbon bond in polychlorinated dibenzofurans and the hydrogen atoms of which may be replaced by up to eight chlorine atoms.

PCDDs/PCDFs are (or may be) unintentionally formed and released from thermal processes involving organic matter and chlorine as a result of incomplete combustion or chemical reactions. To prevent or reduce the release of PCDDs/PCDFs best available techniques and best environmental practices have to be applied as defined in Part V of Annex C of the Convention.

The toxicity of PCDDs/PCDFs is expressed using the concept of toxic equivalency which measures the relative dioxin-like toxic activity of congeners of PCDDs/PCDFs and coplanar PCBs in comparison to 2,3,7,8-tetrachlorodibenzo-p-dioxin. The toxic equivalent factor (TEF) values to be used for the purposes of the Convention shall be consistent with accepted international standards such as values defined by the World Health Organization (WHO; actual values from 2005 [70]). Concentrations are expressed in toxic equivalents (TEQ) Earlier TEF schemes have been proposed by the North Atlantic Treaty Organization – Committee on Challenges of modern Society (NATO/CCMS) in 1988 (International toxicity equivalency factor, I-TEFs) and by the World Health Organisation (WHO) in 1998 (WHO(98)-TEFs) [119].

Legal framework and measures

Based on the amendment of 14 November 2007 of the Ordinance on Fertilizers (Dünger-Verordnung, DüV [122]) the Annex 2.6 ORRChem was amended with respect to PCDDs/PCDFs as follows:

- For compost and digestates a guidance value of 20 ng I-TEQ per kilogram of dry matter applies.
- the FOEN carries out analyses of compost, digestates and pressing liquor in appropriate intervals to check its PCDD/PCDF-content. It publishes a summary of the results of its analyses and, beforehand, informs the cantonal authorities, the Federal Office for Agriculture FOAG and operators of the installations.
- In cases where guidance values are exceeded the cantonal authorities must determine the reason and ensure that the compost, digestates and pressing liquor are not applied to soil.

The Ordinance Relating to Impacts on the Soil (OIS, VBBo [121]) specifies soil standards for PCDDs/PCDFs. Although the main PCDD/PCDF pathway of exposure for humans, animals and plants may not pass via soil but rather via air (deposition), it was nevertheless considered necessary to introduce normative regulations for soil protection for precautionary and practical reasons. As already mentioned in the first NIP the OIS defines a guidance value of 5 ng I-TEQ/kg (or per liter, depending on humidity). A Trigger value for a specific exposure assessments was set at 20 ng I-TEQ/kg. Clean-up values were set at 100 ng I-TEQ/kg (children’s playgrounds or home and family gardening) and 1000 ng I-TEQ/kg (agriculture and horticulture) [121].

Emissions from incineration plants for municipal waste and/or hazardous waste shall not exceed the limit value for PCDDs/PCDFs of 0.1 ng I-TEQ/m^3 as layed down in the Ordinance on Air Pollution Control (OAPC [80]).

The Ordinance on Contaminants and Ingredients in Food (FIV [81]) was amended on 7 May 2012 aligning the maximum concentration levels for PCDDs/PCDFs, dl-PCBs and and non dioxin-like PCBs in foodstuffs with those in the EU as defined in Commission Regulation (EU) No 1259/2011 [39] (see section 3.6).

In October 2007 the FOEN published updated guidelines for the disposal of waste in cement plants [108]. For PCDDs/PCDFs no specific guidance value is defined. Waste containing PCDDs/PCDFs may be disposed of in cement plants provided that the procedure according to the Ordinance on Air Pollution Control, Appendix 2, subsection 719, and the rule of minimization of emissions has to be followed whenever substances such as PCBs, PCDDs/PCDFs or compounds of equivalent concern are suspected,:

OAPC, Appendix 2, subsection 719 (incineration of particularly hazardous waste)

[1] In cases where emissions may be particularly hazardous to the environment, the installation owner shall determine the emissions to be expected by means of preliminary tests with small amounts of waste and shall inform the authorities of the results before the waste is incinerated.

[2] Emissions are regarded as particularly hazardous to the environment if they are both highly toxic and persistent, such as polyhalogenated aromatic hydrocarbons.

Remaining sources and emissions

Emissions from municipal solid waste incineration (MSWI) were a major source for PCDD/PCDF pollution. However, due to the enforcement of the Ordinance on Air Pollution Control (OAPC [80]), the total PCDD/PCDF emissions from MSWI in Switzerland decreased from 365 g I-TEQ in 1980 to about 16 g I-TEQ in 1999. Concentrations in the off-gas of MSWI plants could be reduced by scrubbers from 30 ng I-TEQ/Nm^3 to 0.005 ng I-TEQ/Nm^3 or even <0.001 ng I-TEQ/Nm^3 [29]. According to OAPC [80] the emissions from MSWI and hazardous waste incineration shall not exceed the limit value for PCDDs/PCDFs of 0.1 ng I-TEQ/m^3.

Burning of municipal solid waste (MSW), urban waste wood (UWW) and other waste in stoves is a potential source of emissions of PCDDs/PCDFs and other toxic substances. Beside heavy metals found in ash and flue gas, organic substances such as polycyclic aromatic hydrocarbons (PAH) and PCDDs/PCDFs can be emitted in relevant concentrations [29]. It was estimated by FOEN that the uncontrolled burning of 1 kg MSW is polluting the environment to a comparable extent as if 10 tons of MSW are disposed of in a modern MSWI plant. It was estimated in 1999 that about 1 – 2% of the total amount of MSW are illegally burned by private households. About 27 – 30 g I-TEQ are emitted, which is twice the total amount emitted by all MSWI plants in Switzerland. In 2004 it was estimated that the percentage of PCDD/PCDF emissions from households has increased from 4 to 40% between 1980 and 2000 [29].

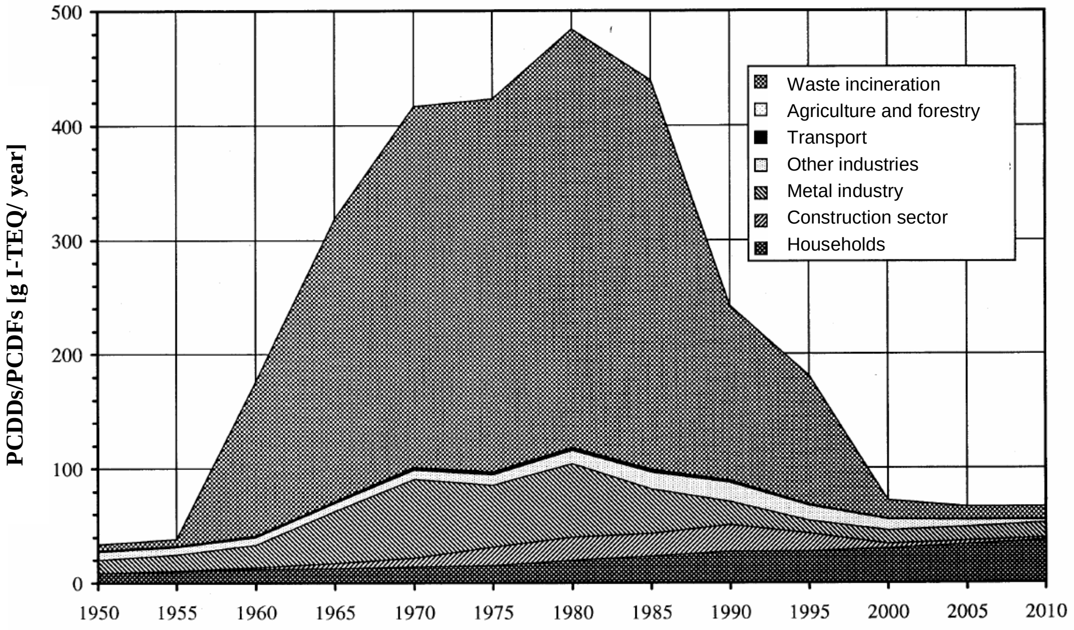

Fig. 1 PCDD/PCDF emissions in Switzerland from 1950 to 2010 [29]

Emissions from industries that are subject to notifications to the Swiss Pollutant Release and Transfer Register (see chapter 5.5.2) were all at or below the threshold value for notification of 0.001 kg/year for the sum of PCDDs/PCDFs since notifications started in 2007.

Annual emissions of PCDDs/PCDFs to air are regularly estimated by the FOEN. The most important emissions from 2004 – 2010 are compiled in Fig. 2.

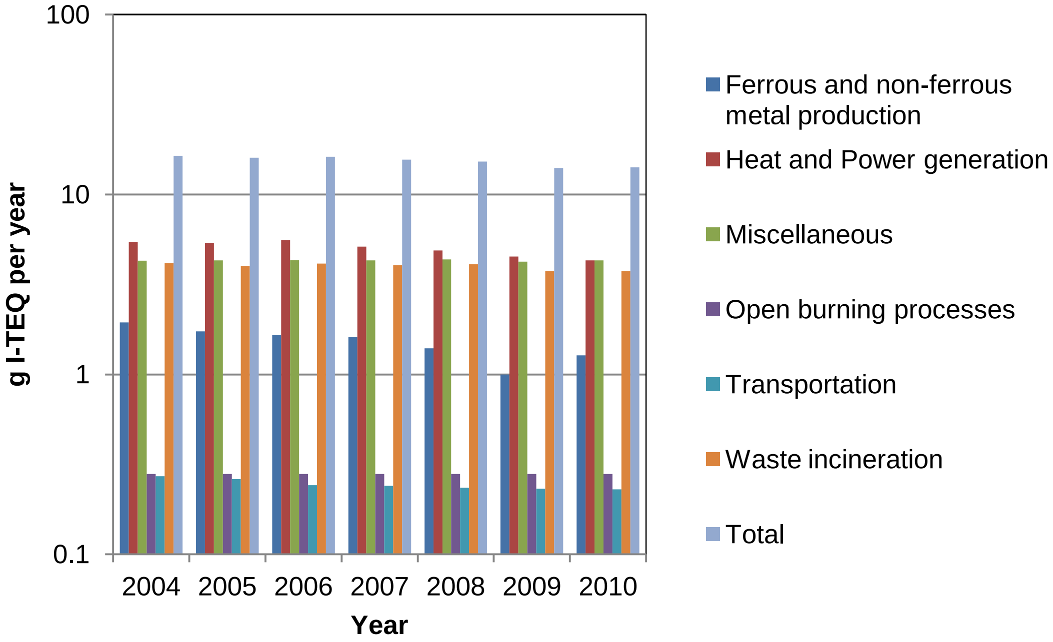

Fig. 2 PCDD/PCDF emissions in Switzerland from 2004 – 2010

Waste phase

The Technical Ordinance on Waste (TVA [109]) does not contain any specific reference to PCDDs/PCDFs. However, the general requirements with respect to the incineration and the landfilling of waste can adequately be adapted to PCDD/PCDF containing waste [28] (see also section 5.4)

Hazardous waste contaminated with PCDDs/PCDFs shall not be deposited in landfills. It is disposed of in hight-temperature incineration plants.

Whereas emissions of PCDDs/PCDFs from MSWI nowadays are very low, the fly ash resulting from off-gas scrubbing is contaminated with PCDDs/PCDFs formed during incineration. About 60'000 tons are yearly produced in Switzerland. MSWI fly ash contains up to 5 µg I-TEQ/kg. According to the Technical Ordinance on Waste (TVA [109]) conditioned MSWI fly ash can be disposed of in landfills for MSWI slag. However, the EU has recently set a limit value of 1 µg I-TEQ/kg. If Switzerland would also adapt this limit value, a disposal of MSWI fly ash on landfills would only be possible after a pre-treatment of the fly ash. A pilot study for pretreatment of MSWI fly ash has been carried out. It has been demonstrated that PCDDs/PCDFs contents in MSWI fly ash can be reduced to 0.5 µg I-TEQ/kg and that the EU limit value for PCDDs/PCDFs for fly ash to be disposed of in surface landfills can be fulfilled after treatment by acidic washing and flotation with charcoal [25].

Environmental quality and monitoring data

Recycling of PCB polluted scrap steel as secondary raw material in smelting processes has proved to be a source for PCDD/PCDF emissions. Analyses in the surroundings of foundries have shown that this is a relevant source for these contaminants. Therefore it is required to remove PCB-containing coatings before the meltdown. Modern furnaces such electric arc furnaces in foundries significantly reduce emissions. The FOEN initiated a pilot study in order to verify how efficiently PCBs and PCDDs/PCDFs are eliminated during the melting and the subsequent off-gas cleaning processes [26]. In the first two series of measurements a mean PCB elimination of 99.5% by thermal decomposition and adsorption to activated lignite coke, which is injected into the raw off-gas stream after the termal combustion unit, was observed.

Soils are sinks for PCDDs/PCDFs. The contamination is primarily caused by long-range atmospheric transport followed by wet and dry deposition of particulate matter and aerosols. PCDDs/PCDFs are primarily formed in waste incineration and other industrial thermal processes. Since PCDDs/PCDFs are lipophilic, they adsorb preferentially to the organic carbon fraction of soils, and due to the low mobility and high persistence, they accumulate in soils [103]. In 2005, data on PCBs and PCDDs/PCDFs in topsoil samples from 23 monitoring sites from the National Soil Monitoring Network NABO, including the organic top layer (see section 5.5.1), sampled between March and July 2002), were published [103]. Total PCDD/PCDF concentrations were between 72 and 703 ng/kg which corresponds to 1.1 to 11 ng I-TEQ/kg. In 19 samples PCDD/PCDF levels were below the guidance value of 5 ng I-TEQ/kg set by the Swiss ordinance relating to impacts on the soil (OIS) while concentrations in the remaining samples (4 sites) were below the trigger value (20 ng I-TEQ/kg) (see also section 5.5.1.

Brändli *et al.* (2007 [19]) presented a comprehensive study of organic pollutants in compost and digestate. Among other components the 17 PCDD/PCDF congeners and 12 congeners of dioxin-like polychlorinated biphenyls (dl-PCBs) according to WHO were analyzed. The median concentrations of the sum of 17 PCDDs/PCDFs and 12 dl-PCBs were 3.2 ng I-TEQ/kg d.w. and 3.0 ng WHO-TEQ/kg d.w., respectively. These values are below the guideline value of 20 ng I-TEQ/kg dry matter of compost and digestates as defined in Annex 2.6 ORRChem.

Zennegg *et al.* (2007 [129]) described the historical record of PCB and PCDD/PCDF deposition between 1848 and 1999 to Greifensee, a lake of the Swiss plateau.. The vertical distribution of PCDDs/PCDFs and PCBs was investigated in a sediment core from Greifensee to show the historical trends of PCDD/PCDF and PCB inputs between 1848 and 1999. The results of this study for PCDDs/PCDFs are presented in the PCB chapter (see section 5.1.4).

Within the framework of IGKB (see chapter 5.5.3), a study on surface sediments in Lake Constance was conducted in 2003 - 2006 [58]. For PCDDs/PCDFs values of ca. 2 – 9 I-TEQ/kg d.w. with one core showing values between 15 – 20 were found in surface sediments (dating from the early 90s to 2005). Concentrations of PCDDs/PCDFs had peaked in the 1970s with values up to ca. 35 I-TEQ/kg d.w.

Triggered by the finding that brown trout from a rural river system in western Switzerland are highly contaminated with dioxin-like PCBs (dl-PCBs), the Federal Office for the Environment (FOEN) together with the Federal Office for Public Health (FOPH) started a national project in 2008 to investigate the PCB and PCDD/PCDF contamination of wild fish in Swiss lakes and rivers [27] [91]. The aim of the study was to identify current background concentrations of these highly toxic pollutants in different wild fish species and to determine the level of contamination of fish that are living in waters which have been polluted with PCBs emitted from point sources. The risk for human health and the environment from exposure to PCBs and PCDDs/PCDFs was assessed and the need for risk reduction measures identified. More than

1300 data sets from a period of around 20 years were collected and evaluated [27][91]. The results of this study are presented in the PCB chapter (see section 5.1.4).

In a national campaign in the years 2005 – 2006 58 samples of cow's milk, directly sampled from farms, were analyzed for PCDDs/PCDFs and PBDEs (see section 5.2.2) [65]. In three samples from the Canton Basel-Stadt PCDD/PCDF concentrations of 0.51, 0.47 and 0.38 pg WHO-TEQ/g milk fat were measured. The mean of all 58 samples analyzed in the campaign was 0.43 pg WHO(98)-TEQ/g milk fat. The FOPH concluded that the measured concentrations are of no concern for human health [65].

According to the FOPH the total daily intake of PCDDs/PCDFs and dl-PCBs of the Swiss population is estimated to be 1.75 pg WHO(98)TEQ/kg b.w. [21]. This value lies within the range of the mean intake in Europe. PCDD/PCDF residues in milk, eggs, pork and poultry are below the maximum concentration levels layed down in the FIV. For beef and veal the maximum concentration values for PCDDs/PCDFs are met. However, for the sum of PCDDs/PCDFs and dl-PCBs the maximum concentration level is exceeded. It is recommended by the FOPH that a balanced diet including fruit and vegetables should be consumed. Too much food or food with high fat content and an unbalanced diet should be avoided [20].

In 2011 the FOPH reported on PCDD/PCDF residues in vegetable oils and fats sampled on the Swiss market [22]. The raw material for the 58 products tested came from Switzerland (8 samples) or from abroad (50 samples). 32 of the 58 products were produced from the raw material in Switzerland. In 51 samples (88%) the concentrations of all PCDD/PCDF congeners were below the quantification limit; in 42 samples (72%) the concentrations of all dl-PCBs congeners were below the quantification limit; and in 39 samples (67%) the concentrations of all PCDD/PCDF and all dl-PCB congeners were below the quantification limit. The FOPH summarized that in all 58 samples of vegetable oils and fats the residues were far below the Swiss and EU limit values of 0.75 pg/g WHO(98)-TEQ for PCDDs/PCDFs and 1.5 pg/g WHO(98)-TEQ for the sum of PCDDs/PCDFs and c-PCBs; even mostly below the quantification limit [22].

Switzerland is participating in the WHO/UNEP biomonitoring of human milk for POPs (see also section 5.5.4).

Possible further need for monitoring and action required for risk reduction

An inclusion of PCDD/PCDF measurements in the NABO monitoring network would give a better understanding of levels of these compounds different soils with different land uses.

5.2 The nine new POPs

5.2.1 Organochlorine compounds / pesticides

General

- Chlordecone

  Chlordecone was mainly used as an agricultural pesticide. It was first produced in 1951 and introduced commercially in 1958. No use or production of the chemical is currently reported worldwide. [128].

In addition to the POP properties, Chlordecone is very toxic to aquatic organisms and classified as a possible human carcinogen [114].

- Alpha-, beta- and gamma-hexachlorocyclohexane (HCH)

  Lindane (gamma-HCH) has been used as a broad-spectrum insecticide e.g. in agriculture, for wood treatment and in both veterinary and human applications. A few countries are still known to produce Lindane today. Alpha-HCH and beta-HCH are produced as unintentional by-products of Lindane in large amounts (6-10 times more by-products than Lindane), but the use of commercial mixtures of HCH as insecticides was phased out years ago worldwide and only the use of the purified Lindane remains [117].

  In addition to POP properties, Alpha-HCH and beta-HCH are classified as potential carcinogens [115][116].

- Pentachlorobenzene (PeCB)

  PeCB was used in in a range of products. PeCB might still currently be used in some countries as a chemical intermediate. Furthermore, PeCB is produced unintentionally during combustion, thermal and industrial processes and is present as impurities in products (e.g. solvents or pesticides) [128].

  PeCB is moderately toxic to humans, but very toxic to aquatic organisms [118].

Production, import, export and use

Between 1935 and 1965, Lindane was produced at one site (Maag site, Dielsdorf) in Switzerland including burial of waste near the production building. The site had been successfully cleaned up by 1996 including the removal of 100 t of pure HCH (see chapter 5.3).

None of the above listed substances is currently intentionally produced, imported or used in Switzerland.

Legal framework and measures

All organochlorine pesticides among the new POPs are banned in the ORRChem (see chapter 3.1). .

Chlordecone had been banned since 1986 in the framework of the Ordinance on -Environmentally Hazardous Substances (“Verordnung über umweltgefährdende Stoffe”, SR 814.013). This ban was transferred to the ORRChem in 2005.

Alpha-HCH, beta-HCH and Lindane had already been banned since 1972 in the Ordinance on Banned Toxic Substances (“Verordnung über verbotene giftige Stoffe”, SR 813.39) with the exemption for certain uses of Lindane as a pesticide and in medicinal products. In 2005, the ban was transferred to the ORRChem and the exemptions for the use of Lindane were reduced to medicinal products. With the revision of 2010, the exemption for the use of Lindane in medicinal products was removed from the ORRChem.

The use and production of PeCB was banned in the ORRChem in 2010.

Remaining sources and emissions

The ban of use of medicinal products containing Lindane entered into force on 1 August 2011. At the end of 2008, 5 medicinal products (two for human, three for veterinary use) containing Lindane were still on the Swiss market. By the end of 2010, the products for human use were already withdrawn by the producers [5].

PeCB has not been manufactured or used in Switzerland previous to the ban in 2010. In Europe, it had mainly been used as an intermediate for the production of pentachloronitrobenzene. Therefore, no sources or emissions from recent use are present in Switzerland. However, PeCB can be formed unintentionally during combustion, thermal and industrial processes.

Lindane has been produced at one site in Switzerland, which has been successfully remediated. Therefore, the main potential source for the HCH isomers has been removed (see chapter 5.3).

In the creek Lörzbach, near the French border, slightly elevated concentrations of HCHs (in the ng/l range) were detected due to a landfill across the border. However, this constituted only a local problem and based on the analysis of the cantonal authorities, water quality criteria were met [9].

Waste phase

Waste containing Lindane may still occur in small amounts due to medicinal products that have not yet been disposed of. However, safe disposal through incineration is ensured by the general rules for disposal of medicinal products.

Environmental quality and monitoring data

Lindane, alpha-HCH, beta HCH

During an organochlorine pesticides monitoring campaign in the Canton Basel-Land HCH-isomers were analyzed in different soils with different use patterns [8] (see chapter 5.5.4). For the sum of all HCH congeners a median value of 0.3 µg/kg d.w. (71 samples) was detected. The maximum detected concentration was 3.4 µg/kg d.w. Concentrations of HCH-isomers were low in comparison to other organochlorine pesticides.

Groundwater samples from the NAQUA National Groundwater Monitoring network have been regularly analyzed for the three HCH isomers. None of these substances derogated the groundwater quality. (see also chapter 5.5.1)

HCH isomers were also detected in water samples from the river Rhine at the ICPR monitoring station in Weil am Rhein from 1995 – 1999 (alpha- and beta-HCH) and 1995 – 2010 (Lindane). Among 556 samples analyzed for the three isomers, only two samples in 1995 showed concentrations of 0.01 and 0.003 µg/l (quantification limit 0.002 µg/l) of Lindane. In almost 90% of samples of suspended solids Lindane was below the quantification limit of 1 or 0.5 (starting from 2007) µg/kg d.w. The maximum concentration was 10 µg/kg d.w. No samples contained Lindane above the quantification limit between 2007 and 2010. Concentrations of alpha-HCH (46%) and beta-HCH (13%) were found more often, with maximum values of 86 µg/kg d.w. and 43 µg/kg d.w., respectively. Alpha-HCH was only measured until 2006, beta-HCH until 1999 as concentrations consistently met the quality criteria for the Rhine defined by ICPR so that regular measurements were not considered necessary any more [127] (see also chapter 5.5.3).

Pentachlorobenzene

Pentachlorobenzene (PeCB) was analyzed in water samples from the river Rhine at the ICPR monitoring station in Weil am Rhein in 1995, but was not detected above the quantification limit of 0.002 µg/l. In contrast, PeCB was found in 60% of samples of suspended solids, with a median concentration of 1.1 µg/kg d.w. (limit of quantification of 1 or 0.5 (starting from 2007) µg/kg d.w.) and a maximum concentration of 17.5 µg/kg d.w. [127] (see also chapter 5.5.3).

Possible further need for monitoring

Due to strict water quality criteria for Lindane (0.002 µg/l) for the Rhine [62], this substance will remain in the regular monitoring programme at the ICPR station in Weil am Rhein [59].

A focus on HCH isomers within the soil monitoring network NABO, which so far does not include these substances, does not appear necessary due to comparatively low values found in the Canton Basel-Land. However, grab sample measurements would give a better understanding of remaining levels in soils..

5.2.2 Brominated flame retardants

General

Annex A (Elimination) of the Stockholm Convention contains the following entries of brominated biphenyls and brominated diphenyl ethers that have been used as flame retardants:

- Hexabromobiphenyl (CAS No: 36355-01-8),
- “Hexabromodiphenyl ether and heptabromodiphenyl ether” which means according to Annex A of the Convention: 2,2’,4,4’,5,5’-hexabromodiphenyl ether (BDE-153, CAS No: 68631-49-2), 2,2’,4,4’,5,6’-hexabromodiphenyl ether (BDE-154, CAS No: 207122-15-4), 2,2’,3,3’,4,5’,6-heptabromodiphenyl ether (BDE-175, CAS No: 446255-22-7), 2,2’,3,4,4’,5’,6-heptabromodiphenyl ether (BDE-183, CAS No: 207122-16-5) and other hexa- and heptabromodiphenyl ethers present in commercial octabromodiphenyl ether.
- “Tetrabromodiphenyl ether and pentabromodiphenyl ether” which means according to Annex A of the Convention: 2,2’,4,4’-tetrabromodiphenyl ether (BDE-47, CAS No: 5436-43-1) and 2,2’,4,4’,5-pentabromodiphenyl ether (BDE-99, CAS No: 60348-60-9) and other tetra- and pentabromodiphenyl ethers present in commercial pentabromodiphenyl ether.

Hereafter, commercial pentabromodiphenyl ether products will be referred to as c-pentaBDE, commercial octabromodiphenyl ether products will be referred to as c-octaBDE. commercial PBDEs referred to in different studies have a variable composition of different congeners.

For hexabromobiphenyl no specific exemptions are allowed, while for the polybromodiphenyl ethers (PBDEs) specific exemptions for recycling of articles containing these substances are possible, provided that the provisions in part IV and V of Annex A are fulfilled. Switzerland has not registered any specific exemptions for these substances.

In addition to the POP properties, hexabromobiphenyl is a potential human carcinogen and an endocrine disruptor [113]. PentaBDEs are considered as endocrine disruptors [72].

Legal framework and measures

Production, import, placing on the market and use of PBBs have already been banned in the Ordinance on Environmentally Hazardous Substances ("Verordnung über umweltgefährdende Stoffe", SR 814.013) in 1987.

From the 1990s Switzerland contributed to an OECD programme to investigate and reduce the risk of brominated flame retardants [74]. Based on this programme, a voluntary industry commitment was negotiated with the industry to introduce risk management measures for PBDEs and to stop production, import and export of polybrominated biphenyls (PBBs) (cited in [68]).

The use of the POP PBDEs was banned in the first version of the ORRChem in 2005 (see chapter 3.1). In the 2010 revision, a ban of production was added to the ban of use as a precautionary measure. Provisions for PBBs were transferred from the Ordinance on Environmentally Hazardous Substances to the ORRChem in 2005.

Currently it is thus prohibited to produce, place on the market or use c-octaBDE, c-pentaBDEs and mixtures that contain more than 0.1% by weight of each of these substances. Furthermore, it is prohibited to place new articles on the market, if their parts treated with flame retardants contain more than 0.1% by weight of c-octaBDE or c-pentaBDE. Similar provisions apply for hexabromobiphenyl.

With the 2012 revision of the ORRChem the existing provisions are planned to be amended as follows:

- Substances, preparations and new articles may not be produced, placed on the market or used if they contain tetraBDEs, pentaBDEs, hexaBDEs, heptaBDEs or octaBDEs above 0.001% by weight for each substance.
- For articles and preparations partially or fully manufactured from recycled materials a threshold value of 0.1% by weight for each substance applies.

The only exemptions apply for analysis and research purposes.

As is already the case today, a threshold value of 0.1% applies for the sum of polybrominated diphenyl ethers and the sum of polybrominated biphenyls respectively in homogenous materials treated with flame retardants in electrical and electronic appliances. This includes decabromodiphenylether.

Production, import, export and use

c-octaBDE and c-pentaBDE are not produced and have not been produced in Switzerland [74]. Import of the substances ceased in 2005 with the ban in the ORRChem. In the EU the production was stopped in 1997 /1998 [5]. Use of hexabromobiphenyl already ceased with the ban in 1988 - 1989.

The flame retardants were used mainly in polymeric materials in a wide range of applications such as electrical and electronic equipment, textiles, vehicles and construction materials. The substances are still in use for this purpose in existing products that have not yet been disposed of.

Remaining sources and emissions

In the Swiss National Research Programme “Endocrine Disruptors”, brominated flame retardants were one target substance group [110]. Within this programme a substance flow analysis for the pentaBDEs was published in 2008 using a dynamic model [72]. According to this study, the use of pentaBDEs in Switzerland reached a maximum of 14 tonnes per year in the beginning of the 1990s with the main use in the construction sector, but was assumed to be negligible from 2006 onwards due to the ban implemented in the ORRChem. For the year 2000 the stock of pentaBDEs in use was estimated to be 55 tonnes (corresponding to 140 tonnes c-pentaBDE) most of which is stored in buildings which will only be released in many years when buildings are replaced or renovated. Stocks in other applications (electrical and electronic equipment, transport, textiles / furniture) were simulated to have decreased to almost zero by 2010. In this study, the stocks of c-pentaBDEs in landfills were estimated to be comparatively low with a total of 5 – 6 tonnes (corresponding to approximately 12 – 15 tonnes c-pentaBDE) due to the Swiss waste management strategy of incinerating combustible waste. Emissions of c-pentaBDEs to the environment were estimated to have decreased from a maximum of 2.5 kg per year in the mid 1990s to below 1 kg per year by 2010 due to the implemented ban and risk management measures. Remaining emissions, mainly from stocks in construction material and landfills are predicted to decrease only slowly due to the long lifecycle of the construction materials.

Previously, in 2003, a substance flow analysis on brominated flame retardants for Switzerland has been published by SAEFL (today FOEN) covering, among others, c-octaBDEs and c-pentaBDEs [74].The above stated data from the 2008 study refined the estimates from this earlier study for pentaBDEs as better data and a better model were available. For c-octaBDEs, it can be concluded based on the 2003 and 2008 studies that the estimated stocks of 680 tonnes of c-octaBDE in use in the late 1990s have decreased significantly due to the ban. The fact that c-octaBDE was mainly used in electrical and electronic appliances and textiles and upholstery in vehicles, which are products with a relatively short life cycle has presumably contributed to the decrease. It can be assumed that a large proportion (about 90%) of waste containing c-octaBDE was incinerated [74]. Nonetheless, similar to pentaBDEs, a certain stock of c-octaBDE is contained in landfills, which was estimated in the 2003 study to be about 160 t.

To verify whether or not the ban of the POP brominated flame retardants is respected by industry, several market surveillance campaigns were conducted. As the substances were already in the focus before the ban, data from older market surveys are also available.

In 2000, a first national survey on brominated flame retardants was conducted with the participation of 12 cantons [68]. 486 plastic components potentially treated with these substances from 366 articles from a wide range of applications (electrical and electronic appliances, vehicles, construction material) that were available on the Swiss market were analyzed for brominated flame retardants. C-pentaBDE was not detected in any of the samples while 0.4 – 3% c-octaBDE was found in ca. 1% of the samples.

In 2008, a second national survey was conducted on the occurrence of brominated flame retardants in plastic articles including polybrominated biphenyls (PBBs), pentabromodiphenyl ether (c-pentaBDE), and octabromodiphenyl ether (c-octaBDE). The authorities of 18 cantons participated in the survey. 1907 components originating from 1359 articles available on the Swiss market for a wide range of applications including electrical and electronic appliances and building materials were analyzed. C-pentaBDE and PBBs were not detected in any of the samples, while only 2 samples contained c-octaBDE above the current limit of 0.1% [7] In a similar campaign in the Canton Basel-Stadt neither c-pentaBDE nor c-octaBDE was detected [64].

In the conducted surveys, the aim was to verify compliance with the threshold value of 0.1% that was in force at that time. Due to the detection limit applied at the time, retrospective conclusions cannot be drawn on compliance with the lower threshold value of 0.001%, that is planned to enter into force for new articles by the end of 2012. However, current detection limits are low enough [47] to verify compliance with the new threshold in future campaigns.

Based on the results of above described market surveillance campaigns it can be concluded that the bans of c-pentaBDEs, c-octaBDEs and PBBs are generally respected and new products available on the market, are, and were already in 2000, no significant source of the POP PBDEs and PBBs anymore. However, flame-retarded products that have been placed on the market before 2000 and are still in use may be a source of emissions of PBDEs. Therefore, it is important to determine the PBDE contents of waste to subsequently decide if materials may be reused (if the 0.1% threshold value for POP PBDEs in recycled materials can be met) or have to be disposed of by incineration.

In 2003, a substance flow analysis study on brominated flame retardants in a Swiss recycling plant for waste electrical and electronic equipment (WEEE) was conducted by FOEN (at the time: Swiss Agency for the Environment Forests and Landscape (SAEFL)), and the Agency for Environmental Protection and Energy of the Canton Basel-Land (AUE) [71]. C-pentaBDE concentrations of 10 - 50 mg/kg (mean value 34 mg/kg) were determined in different output fractions of the WEEE recycling process and 10 - 8000 mg/kg (mean value 530 mg/kg) of c-octaBDE with high concentrations in plastic TV/PC housings and TV rear covers [73] [71].

In 2011 the FOEN conducted another substance flow analysis in the same WEEE recycling plant as in 2003 [47].The mean concentration values for c-pentaBDE (2.4 mg/kg) and c-octaBDE (123 mg/kg) in WEEE significantly decreased in comparison to the 2003 study, confirming that the regulatory measures were effective. However, the data also showed that a certain stock, especially of c-octaBDE is still present in older products. Note that the limit of detection (LOD) for the individual BDE congeners was 5 mg/kg and half the detection limit was assumed for analyses results below the LOD.

Results from a study for European recycling plants performed by the Swiss Federal Laboratories for Materials Science and Technology (EMPA) commissioned by the European Association of Electrical and Electronic Waste Take Back Systems (WEEE Forum) [125] were in general accordance with the studies for Switzerland.

From the studies it was concluded that a strict quality management is required for WEEE recycling operations to be able to dispose of materials that contain PBDEs and other regulated substances and to meet the requirements for recycled materials and for electric and electronic equipment [125].

To conclude, products such as electrical and electronic equipment as well as textiles, upholstery, vehicles still constitute a source of the POP PBDEs in Switzerland which has to be adequately considered during recycling processes. However, this stock has already significantly decreased since the ban of the POP PBDEs in 2005. It was estimated that POP PBDEs in Switzerland will occur during the recycling process for another 10 years [78]. Longer-term stocks of POP PBDEs are landfills and construction materials that require appropriate management and disposal.

Waste phase

As indicated above, waste containing POP PBDEs may be generated during the disposal of PBDE-containing articles that are still in use or the destruction and renovation of buildings. A further source could be contaminated site restoration (see chapter 5.3). For details on the treatment of PBDE-containing waste see chapter 5.4

Environmental quality and monitoring data

Sediment cores are a useful tool to retrace environmental emissions of lipophilic substances and to monitor the effectiveness of risk reduction measures.

In a sediment core, sampled in lake Greifensee near Zurich, brominated flame retardants were analyzed, among other substances. The results showed a large increase of c-pentaBDE and c-octaBDE from the early 1980s until 1995. Concentrations leveled off in the mid 1990s to about 1.6 ng/g d.w. (dry weight) and remained constant till 2000 [67].

Sediment cores sampled in 2005 from a prealpine lake, Lake Thun, were similarly analyzed for c-pentaBDE, c-octaBDE and decaBDE [14]. Similar to lake Greifensee, concentrations of c-pentaBDE and c-octaBDE leveled off in one core in recent times while in two cores concentrations still increased. However, only one core was sampled in the year of the ban of these substances. Due to the continued presence of the POP PBDEs in products a delay may be expected until the effect of the ban is reflected in a decrease of concentrations in sediment cores. New sediment core samples could be used in the future to verify this.

For decaBDE, which is still in use, an increase in concentrations was generally observed in both lake sediments.

In a further study on Lake Thun, the following environmental concentrations in different compartments were determined [15]: Measured concentrations of individual PBDEs in air were 26–406 pg/m^3. The pattern of PBDEs in air was dominated by the lower-brominated homologues (tetra- > penta- > deca-BDE). Lake and river water concentrations of PBDE congeners were 17–78 pg/l. As expected for lipophilic substances, sediment concentrations were higher than water concentrations, with higher concentrations for tetra-, penta- and hepta-BDEs (up to 0.2 ng/g d.w.) and lower concentrations for hexa- and tri-BDEs (below 0.1 ng/g d.w.). This confirms sediments as the main sink for PBDEs in a lake system, but also shows that PBDEs can be detected in other compartments.

Between 2007 and 2010, several PBDE congeners (tri- to hexa-BDEs) were detected in 21% of 336 samples of suspended solids (quantification limit of 0.3 – 0.8 µg kg^{-1} d.w.) from the river Rhine sampled at the ICPR monitoring station in Weil am Rhein. The median concentration for individual congeners was <0.6 µg kg^{-1} d.w., the maximum concentration for an individual congener was 2.1 µg kg^{-1} d.w. [127] (see also chapter 5.6.3).

Beside sediments, lipophilic POPs are mainly expected in soils or in organisms in the upper end of the food chain such as carnivorous fish.

Brändli *et al.* (2007 [19]) presented an inventory of the pollutant situation in source-separated composts, digestates and presswater in Switzerland by analyzing 18 samples. The concentration of the sum of PBDEs was with 10 µg/kg d.w., 18 samples) relatively low. DecaBDE was the most important congener (mean 7.3 µg/kg d.w., 18 samples). The authors concluded that the input of PBDEs to soils via compost was low in comparison to other inputs to soils [19].

A comparison of concentrations of pentaBDEs in sewage sludge between 1993 and 2002 showed a decrease by 50% [10] reflecting the decrease in use even before the ban of penta-BDEs.

Due to bioaccumulation in fish, lipophilic POPs may be of concern for consumers in fish and fish oil products. Several POPs, among them POP PBDEs were analyzed in 2006 in a range of fish oil products available on the Swiss market. Fish oil products contained PBDEs in concentrations around two magnitudes lower than those detected in wild and farmed fish from Switzerland (36 to 165 ng/g lipids and 12 to 24 ng/g lipids, respectively, results cited in [130]) in 2003. Fish in rivers with a large input from wastewater treatment plants were found to contain concentrations up to 1000 ng pentaBDEs/g lipids [10].

In a national campaign in the years 2005 – 2006, 58 samples of cow's milk, directly sampled from farms, were analyzed for PCDDs/PCDFs/c-PCBs [65] (see sections 5.1.4 and 5.1.5). In three samples from the Canton Basel-Stadt PBDEs concentrations of 1120, 470 and 540 ng/kg milk fat were measured. The mean of all 58 samples analyzed in the campaign was 340 ng/kg milk fat. The FOPH concluded that the measured concentrations of PBDEs are – based on the present knowledge – of no concern for human health [65].

The FOPH funded a project by Trudel *et al.* (2011 [111]), where the authors evaluated the exposure of the Irish population to PBDEs in food. Consideration of parameter uncertainty and variability for risk assessment were assessed. The authors concluded that that there is no significant risk for human health through intake of food contaminated with the present low levels of PBDEs [111].

Possible further need for monitoring and research

Despite the observed decrease in concentrations of POP PBDEs in WEEE further monitoring of recycled materials is recommended to control the distribution of POP PBDEs in recycled materials. Furthermore, concentrations should be monitored in selected environmental compartments and / or fish in around 5 to 10 years to confirm expected decreases in concentrations due to regulatory measures and elimination of stocks.

Based on OECD and EU risk assessments as well as work in the framework of the Swiss National Research Programme "Endocrine Disruptors" that included brominated flame retardants as one target substance group, requirements for further research were identified [54]. Research work commissioned by FOEN is planned to compile an updated mass balance for PBDEs among other substances (see also chapter 0). Based on this work potential further measures will be identified.

5.2.3 Perfluorooctane sulfonic acid (PFOS), and perfluorooctane sulfonyl fluoride

General

Perfluorooctane sulfonic acid (PFOS) (CAS No: 1763-23-1), its salts and perfluorooctane sulfonyl fluoride (CAS No: 307-35-7)[1] are listed in Annex B (Restriction) of the Stockholm

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[1] In the following this full entry in the Stockholm Convention shall be referred to as „PFOS".

Convention with the possibility for specific exemptions and acceptable purposes. Examples of listed salts are mentioned with their CAS numbers. Switzerland has notified the use of PFOS for metal plating (hard metal plating and decorative plating) as specific exemptions in the register of specific exemptions of the Stockholm Convention. Additionally, PFOS are still used for some of the acceptable purposes listed in the Stockholm Convention which have also been registered.

PFOS bind to proteins in the blood and the liver rather than to partition into fatty tissues like other POPs [128] . In contrast to other classical POPs, PFOS are primarily emitted to water which is also the most important medium for their transport. Water is the major reservoir of PFOS in the environment. [69]

Legal framework and measures

PFOS have been banned in Switzerland in the ORRChem since 10.12.2010 (see chapter 3.1) with some exemptions corresponding to acceptable purposes and specific exemptions as defined in the Stockholm Convention. With the amendment planned for December 2012, the regulation in the ORRChem will further improve the level of protection of health and environment with regard to PFOS. The following uses are currently exempted (Annex 1.16, 3 ORRChem as of 1 August 2011):

a. photoresistant or anti-reflective coatings for photolithography processes;

b. photographic coatings applied to films, papers, or printing plates;

c. mist suppressants for non-decorative hard chromium (VI) plating and wetting agents for use in controlled electroplating systems where the amount of PFOS released into the environment is minimised;

d. hydraulic fluids for aviation;

e. medical devices, and components thereof, where the amount of PFOS released during the manufacturing process and during the disposal of process solutions is minimised.

The use in fire-fighting foams that were placed on the market before 1 August 2011 is allowed until 30 November 2014 for fire-fighting by professional fire-fighters in cases of emergency and until 30 November 2018 for stationary fire safety installations in industrial facilities and fuel depots.

For all users of exemptions reporting to FOEN is required. The exemptions as they are currently listed in the ORRChem are based on information from the Swiss industry on existing essential uses of these substances due to lack of alternatives.

With the amendment planned for December 2012, the exemptions will be further limited by adding a requirement for closed loop systems for non-decorative hard chromium (VI) plating and limiting the exemption for wetting agents for use in controlled electroplating systems until 31. August 2015. The exemption for use in medical devices will be removed as the exemption is not needed any more in Switzerland.

The acceptable levels of PFOS will be:

- 0.001% for substances and preparations (lowered from the currently valid 0.005%)
- 0.1% for new articles (already valid since 2010)
- 1 $\mu g/m^2$ for coated materials (already valid since 2010)

Thus, with the amendments of the ORRChem in 2012 a further step will be made towards totally ceasing use of PFOS.

Production, import, export and use

PFOS are both intentionally produced and an unintended degradation product of related anthropogenic chemicals. Currently, PFOS are still produced in several countries [128]. In 2001 the globally most important producer of PFOS terminated production which lead to a reduction of use in the EU by about 98% in 2004 in comparison with 2000 [5].

Based on an OECD survey from 2000, there was no noteworthy production of PFOS in Switzerland and there is no production today [31]. The total volume used in Switzerland therefore originates from imports. Based on the Rotterdam Convention Export Notification, in 2010 and 2011 respectively 100 kg of PFOS were imported into Switzerland for the purpose of chromium plating. The estimates for 2012 amounted to 600 kg. Apart from imports, stocks of PFOS are still present in particular as fire-fighting foams. In 2005, estimates for stocks of PFOS in fire-fighting foams amounted to a total of approximately 15 - 18 t [5].

By the end of April 2012, the reports of the amounts of PFOS used for exempted purposes and stocks of PFOS containing fire-fighting foams for 2011 were received by FOEN. These are the first reports based on the provisions introduced in the ORRChem in 2010 to fulfill the reporting requirements related to the use of specific exemptions or acceptable purpose. Based on a first evaluation of these data and a voluntary survey of the Association of Fire-fighting Inspectorates (VKF), 1000 t of PFOS-containing fire-fighting foams and thus roughly 10 t of PFOS are still stored in Switzerland. The difference to the estimates from 2005 may be due to notifications that are still missing and stocks that have been disposed of recently.

Remaining sources and emissions

For the year 2007, a substance flow analysis for Switzerland was performed for PFOS and other perfluorinated surfactants [31] in order to identify remaining sources and to be able to define further measures to reduce emissions. The results are based on a system model with the input based on the best available data for Switzerland. The following most important results were obtained for remaining sources and emissions. Due to remaining data gaps, the obtained values are associated with relatively high uncertainties [31]:

- In 2007, approximately 300 kg of PFOS were used in products in the application areas of metal plating, photography and photolithography and semiconductors. The entire amount was imported. Additionally, there is an estimated stock of 12’000 – 15’000 kg in aqueous film-forming foams (AFFF) for fire-fighting purposes. In contrast, the stock of PFOS in the service life of goods, mainly originating from historical uses of PFOS, was simulated to be significantly smaller and accounting for 300 kg.
- The most relevant (ultimate) emission source determined was wastewater treatment plants. Other important emission sources identified are the application of products containing PFOS and landfills. The simulated best guess emissions in 2007 were 0.8 kg/year to the atmosphere, 480 kg/year to the hydrosphere and 29 kg/year to soil. According to the model, precursors of PFOS contribute to emissions to the hydrosphere, however to an unknown extent. Despite uncertainties, it was concluded from the study that there was a decrease in the emissions of PFOS to the environment caused by both the phase-out by the largest global producer in 2001 and changes in the waste management (see below).

In order to evaluate the levels of long-chain PFCs in sewage sludge and to identify potential sources two studies were performed in Switzerland. In 2008 sewage sludge from 20 municipal WWTPs in the region of Zurich was analysed [106]. For total perfluoralkyl carboxylates (PFCAs), the concentrations ranged from 14 to 50 µg/kg dry matter. Concentrations of perfluorooctane sulfonic acid (PFOS) ranged from 15 to 600 µg/kg dry matter. In three WWTPs, the PFOS levels were six to nine times higher than the average values measured in the other plants. In the year 2011, in a Swiss wide survey 46 WWTPs with potential emitters in the catchment were selected in order to identify point sources [107]. In each WTTP two or three sewage samples were collected at intervals of 1-3 months. For some WWTPs the emission levels were constant, at others the levels varied significantly indicating intermittent discharges of PFOS. Concentrations of PFOS occurred up to 2’400 µg/kg dry matter (Total PFAS 2’500 µg/kg). Total PFCAs occurred at levels up to 230 µg/kg dry matter. In most cases where high levels of PFOS (>100 µg/kg) occurred, chromium electroplating and surface finishing industries are located in the catchment of the WWTP. However, the presence of chromium plating industries did not always contribute to higher PFOS concentrations in the sewage sludge. Hence, depending on the use of PFOS in specific processes and disposal pathways of process baths the contribution to emissions into the environment can vary significantly. PFOS emissions were also observed where production sites using aqueous firefighting foams (AFFF) and training grounds of fire brigades were present in the catchment.

Based on the data gaps identified in the substance flow analysis, further studies were conducted to better identify point and diffuse sources of PFOS and other perfluoroalkyl substances. Based on a survey in Swiss rivers [75], the estimated total emission to the aquatic environment was 100 kg/year in 2009. The load of PFOS in rivers correlated with the load of Acesulfame, a substance used as calorie-free artificial sweetener which is a marker for - domestic waste water. Thus, wide dispersive use in various products and/or industrial applications appears to be a significant source of PFOS. On the other hand, maximum concentrations and loads have been found near suspected point sources [56] [75] [106] [107], which indicated that point sources contribute to the total load and cause local maximum concentration. In the absence of industrial activities, diffuse inputs from outdoor use, wet and dry deposition have been shown to contribute to the total load in a river that flows through a village with 10'000 inhabitants, for which the total input was rather low [76]. Overall, there appears to be a trend of decreasing concentrations and mass loads, which reflects the replacement of PFOS in consumer products and the limitation of professional use to exempted uses.

Due to the legal provisions for fire-fighting foams in the ORRChem, the largest stock of PFOS will be eliminated by 2018. Based on an analysis in the UK, the replacement until 2018 is a realistic scenario considering common rates of replacement of fire-fighting foams [5].

Currently, a study is being conducted in how far relevant stocks of PFOS may be present at contaminated sites (see chapter 5.3).

Waste phase

Waste containing PFOS is currently still generated due to the following activities:

- Disposal of remaining stocks of fire-fighting foams
- Disposal due to uses for exempted purposes
- Disposal of goods mainly originating from historical uses of PFOS

- Disposal of waste material during the clean-up of contaminated sites (see chapter 5.3, relevance not yet known)

Model calculations for Switzerland [31] indicated that the main stock of goods containing PFOS and thus the main source of waste was fire-fighting foams and that the main ultimate emission source was wastewater treatment plants. As over the past two decades, fractions of sewage sludge applied to soil and dumped in landfills have decreased drastically, incineration plants have become important sinks for PFOS, eliminating remaining stocks of these substances. For the general approach to treat POP-containing waste see chapter 5.4.

Environmental quality and monitoring data

Surface and groundwater

Based on the current estimated emissions of PFOS due to the continued, even though limited, use of PFOS and remaining stocks, environmental concentrations for different compartments were simulated [31]. The predicted "best guess" concentration of 9 ng/l (range between 1 – 60 ng/l) corresponds well with PFOS concentrations in Swiss surface waters measured in 2009 in 44 locations, that ranged from ca. 0.03 – 100 ng/l with a median of 3.8 ng/l and concentrations above 10 ng/l only in some exceptional cases [75]. The detected concentrations in groundwater in the 2007/2008 NAQUA pilot study (see chapter 5.5.4) were in a similar range with the higher detected values of 10 – 50 ng/l often corresponding to similar concentrations in adjacent rivers determined at measuring locations of the NADUF network in 2007 (see chapter 5.5.4). Measured concentrations in the Rhine (8 – 13 ng/l) and in Lake Constance (up to 40 ng/l) were similar while one value in a tributary of Lake Constance (400 ng/l) was exceptionally high (see chapter 5.5.3).

In the study on diffuse sources of PFOS [77] and the NAQUA pilot study on PFOS in groundwater [76], it was concluded that the detected concentrations neither constrained the use of groundwater as drinking water resource [76] nor were they of direct ecotoxicological concern [77]. However, due to extensive bioaccumulation, it was concluded that higher organisms such as water birds may still be at risk [77].

The Food Control Authority of Geneva reported on the estimation of perfluorinated compounds, PFCs (incl. PFOS), in various food products as they might be a significant route of human exposure [104]. An analytical method has been developed and validated for fishery products for the screening of 25 perfluoroalkyl chemicals at concentrations down to about 10 µg/kg. The study included analyses of about 200 samples covering all common food types from the Swiss market. Amongst primary food, 52 fish samples from Swiss lakes were analyzed, among which 25% showed certain levels for PFOS with concentrations ranging from 16 – 74 µg/kg. Moreover, a monitoring of the exposure of PFCs via fish samples over ten years was realized by analyzing old lyophilized samples. The analysis revealed that the residual levels of PFOS did not increase during the last decade. It was concluded that the average consumption of fish deriving from Swiss lakes presents no health concerns for the Swiss population [104].

Furthermore, the Food Control Authority of Geneva evaluated, whether PFCs could migrate from packaging materials into food. All samples were free of significant concentrations of PFCs demonstrating that migration from packaging is a minor route of exposure for PFCs in Switzerland [104].

In 2010, the Dutch National Institute for Public Health and the Environment (RIVM) has derived scientific Environmental Risk Limits (ERLs) for PFOS as a proposal for water quality standards [79]. The derived maximum permissible concentration (MCP) for the most sensitive route of uptake which in this case was the consumption of fish by humans was 0.65 ng/L for freshwater. The derived MCP for surface water intended for drinking water was 0.53 µg/l.

Based on these values, even though they do not represent legally adopted standards, and on the PFOS monitoring data, it can also be concluded that the use of groundwater as a drinking water resource is not impacted. In contrast, PFOS concentrations in fish contribute more to the overall exposure of consumers. However, the RIVM concluded that, based on EU monitoring values of PFOS in water, which were similar to Swiss values, the risks to the average fish consumer were low due to sufficient safety margins applied in the derivation of the MCP values.

Continued efforts to eliminate sources of PFOS are expected to reduce environmental concentrations and thus potential risk to consumers.

The Panel on Contaminants in the Food Chain (CONTAM) of the European Food Safety Authority (EFSA) established a tolerable daily intake TDI for PFOS of 150 ng/kg bodyweight per day. The CONTAM Panel noted that the indicative dietary exposure of 60 ng/kg bodyweight per day is below the TDI of 150 ng/kg bodyweight but that the highest exposed people within the general population might slightly exceed this TDI [44].

Soil and sediment

PFOS mainly partition into water. Therefore, low concentrations of PFOS were estimated for sediments (0.07 ng/g wet weight) and soils (0.009 ng/g wet weight) [31].

For PFOS concentrations in sewage sludge see studies in the subchapter “remaining sources and emissions”.

Brändli *et al.* (2007 [19]) presented a comprehensive study of organic pollutants in compost and digestate.The median concentration of the sum of 21 perfluorinated alkyl substances (including perfluorinated sulfonates) was 6.3 µg/kg d.w. (3.4 – 35 µg/kg d.w.).

Possible further need for monitoring

In order to monitor the effect of emission reduction measures of PFOS, PFOS concentrations in ground- and surface waters should be measured at regular intervals within the NAQUA and NADUF monitoring networks as water is the major reservoir of PFOS in the environment.

Furthermore, continuation of monitoring of PFOS concentrations in fish is advisable as consumption of fish by humans is the most relevant route of human exposure and detected concentrations in surface waters may exceed derived maximum permissible concentrations in water with regard to PFOS-uptake via fish consumption.

5.3 Contaminated sites and POPs

Register

The investigation, classification and remediation of contaminated sites is regulated in the CSO (Contaminated Sites Ordinance). The CSO obliges the cantons to compile a register on all polluted sites in their territory. These registers have been completed by all cantons. Nationwide about 50'000 sites have been identified and 5-10% thereof need to be remediated.

Procedure

The characterization of a site includes the determination of the relevant contaminants, an estimation for the amounts of these contaminants at the site as well as an evaluation of the mobilization potential of these contaminants and an exposure assessment for groundwater, surface waters and soil. These evaluations provide the basis for a risk assessment identifying environmental risks. Contaminated materials must only be removed from a site if a risk is identified.

Regulated POPs

PCBs are the only substances of the POP list for which the CSO defines numerical groundwater quality criteria. For non-regulated compounds the FOEN has defined a procedure for the derivation of toxicity-based groundwater quality criteria ensuring an adequate assessment of all relevant contaminants.

Funding of investigation and remediation

The VASA fund ensures the funding of remediations of contaminated sites. For more information see http://www.bafu.admin.ch/vasa/index.html?lang=de.

Major chemical waste sites

The first NIP report of 2006 mentioned two relevant waste disposal sites (Bonfol and Koelliken) where 100 to 350 kilotons of chemical waste had been deposited. The remediation of both sites is ongoing. POPs are of minor relevance for remediation at both sites and all chemical waste will completely be removed and treated according to the Swiss legislation.

Relevant POPs

PCBs

PCBs are the most relevant POPs at polluted sites. PCBs are frequently found at polluted sites, but mostly at minor concentrations. Consequently, the investigation of a polluted site routinely includes the analysis of PCBs as a standard parameter.

Between 1952 and 1975 PCB containing waste from a local transformer producer were deposited in the landfill "la Pila" directly adjacent to the river Saane (Canton Fribourg). Between 2004 and 2008 this site has been investigated according to the CSO. Due to the emissions of PCBs to the river the river water and fish have been contaminated. In 2007 fishery was prohibited because the maximum concentration levels for the sum of PCDDs/PCDFs and dl-PCBs layed down in the FIV were exceeded. In 2010 the remediation of the site has been started. For information on the site see http://www.fr.ch/pila/de/pub/index.cfm.

As a consequence of the fish contamination in the river Saane the FOEN initiated a nationwide study on PCBs and PCDDs/PCDFs in fish and surface waters [27][91]. As a result fishery in two additional rivers (Birs, Canton Jura; Canal des Mangettes, Canton Valais) has been prohibited. In both cases the sources have been identified.

In addition to these clarifications, the FOEN has conducted a survey on PCB point sources in Switzerland which have been registered by cantonal authorities [51]. In this study 23 main point sources exhibiting PCBs in relevant amounts have been identified. 55% of these sites have already been remediated, 45% have been investigated and adequate measures have been defined.

Hexachlorocyclohexanes (alpha-, beta-, gamma- and delta-HCH)

Between 1935 and 1965 Lindane was produced at the Maag site in Dielsdorf including burial of waste near the production buildings. This site has already been remediated in 1996 (removal of about 100 tons of HCHs). The groundwater downstream of this site has periodically been monitored since the remediation. According to the monitoring results no further measures are necessary.

DDT and metabolites

No sites with substantial DDT/DDD/DDE pollutions are known in Switzerland. In the context of a construction project at a chemical site small underground volumes polluted with DDT and DDE have been found. The origin of this contamination is unknown, but DDT had never been produced at that site. The polluted material was recently disposed of according to the Swiss legislation.

PFOS

This compound has not yet been considered in the context of polluted sites. A study initiated by the FOEN will clarify the relevance of PFOA and PFOS at polluted sites including landfills.

Hexabromobiphenyl and polybrominated diphenyl ethers

These compounds were used in a broad range of consumer’s products as flame retardants (electric and electronic devices, textiles in vehicles, construction materials such as PE films). By direct deposition of such products in landfills or by deposition of incineration slag substantial amounts have to be expected in landfills. Hexabromobiphenyls and polybrominated diphenyl ethers have not systematically been monitored in landfills.

Further studies on POPs in the context of polluted sites

In the context of the elaboration of a factsheet for micropollutants by the FOEN the emissions of PCBs, PCDDs/PCDFs, PBDEs, Lindane, and DDT into surface waters have been estimated.

Tab. 3 Relevant regulation on contaminated sites and waste management

Ordinance	SR-No.	Content	POPs with numerical quality criteria
Contaminated Sites			
Contaminated Sites Ordinance CSO	814.680	Investigation, classification and remediation of contaminated sites	PCBs
VASA	814.681	This ordinance ensures the funding of the investigation, surveillance and remediation of polluted sites	-
Waste			
TVA	814.600	Classification, disposal and treatment of waste; threshold values for waste that is adequate for disposal on landfills	PCBs
VBBo	814.12	Observation, surveillance and assessment of the chemical, biological and physical pollution of fertile soils	PCBs, PCDDs/PCDFs
VaB	VU-4812-D	Guidance for the re-use of excavated fertile soil	DDT, DDD, DDE, Aldrin, Dieldrin, Endrin, ∑HCH, Chlordan, PCDDs/PCDFs, PCBs
VeVA	814.610	National and international transfer of hazardous waste. The ordinance ensures the transfer of hazardous waste to authorized enterprises and environmentally sound treatment of waste	-
LVA	814.610.1	Amendment to VeVA: List and categorization of hazardous waste	PCB-containing waste (no numerical criteria)

5.4 POP waste and its management

The relevant regulations on waste management are listed in Tab. 3. The Technical - Ordinance on Waste (TVA [109]) regulates the requirements for waste treatment and landfills. Furthermore requirements for the location and construction construction of landfills are defined in this ordinance aiming at reducing emissions to air, surface- and groundwater as much as possible.

The Technical Ordinance on Waste (TVA [109]) does not contain any specific reference to POPs. However, the requirements with respect to incineration and landfilling of waste apply to POPs containing waste (see also [28]):

- There is an obligation to incinerate all combustible waste. The cantons shall ensure that municipal waste, sewage sludge, combustible fractions of construction waste and other combustible waste - as far as it cannot be recycled and re-used - are incinerated in -

MSWI, high-temperature incineration facilities for hazardous waste or special incineratin facilities dedicated to certain categories of special waste (e.g. sewage sludge).

- Special waste must not be disposed of in landfills for inert waste or in bioactive landfills as specified in the TVA. However, after pre-treatment, special waste such as contaminated soil material or polluted construction waste may be disposed of in landfills
- Fly ash from MSWI may only be disposed of in landfills after conditioning with cement or acid treatment to eliminate soluble substances, provided that the criteria according to the TVA on maximum leaching of contaminants are fulfilled in leaching tests.

Waste such as contaminated natural underground materials (e.g., excavated at polluted sites), deconstruction materials or MSWI slag and fly ash resulting from off-gas scrubbing can be landfilled if the criteria of the TVA are fulfilled. The PCDD/PCDF load of fly ash resulting from off-gas scrubbing is addressed in the chapter PCDDs/PCDFs (see chapter 5.1.5).

The TVA defines physical and chemical quality requirements for waste disposal in landfills. Among the POP list only numerical quality criteria for PCBs are defined. Waste exhibiting PCB-concentrations above 10 mg/kg is not allowed to be deposited in landfills. For contaminants that are not regulated in the TVA the FOEN defines a procedure to determine numerical quality criteria that take into account the toxicity as well as the mobility of the contaminant in the waste matrix. This ensures an accurate handling of waste that is contaminated with non-regulated compounds.

The construction requirements for various types of landfills are stringently defined in the TVA. As an example landfills containing dioxin-contaminated incineration slags are only located in areas without exploitable groundwater sources. In addition, geological barriers are required.

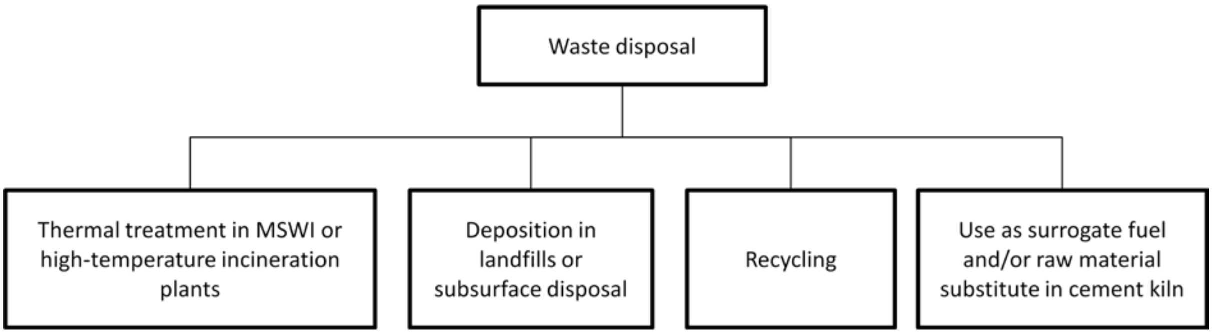

Fig. 3 Waste treatment in Switzerland

The Swiss legislation defines specific guideline values for excavated soils (VaB). Because of the application of organochlorine pesticides in agriculture in the past, soil might be contaminated with such pesticides. Therefore, several pesticides of the POP list are regulated in the VaB (see Tab. 3).

According to ORRChem Annex 2.6, sewage sludge may not be placed on the market or used as fertilizer. The transitional period for specific exemptions from the ban ended in 2006. Thus, emissions of POPs, that may be present in sewage sludge, to soils is prevented.

Hazardous waste

A list and categorization of hazardous waste is defined in the LVA (see Table 1). Only for PCBs specific waste codes exists. Amounts of PCB-containing waste have been presented in the latest national report pursuant to Article 15 of the Stockholm Convention. Other POP containing waste (such as fire-fighting foams with PFOS or plastics containing PBDEs) are generally categorized as hazardous waste. The FOEN issues instructions which waste code has to be used for POP containing waste and which technology must be used for the disposal of hazardous waste (see Table 1). POP containing combustible waste may only be disposed of in MSWI if it contains a) less than 50 ppm of halogenated organic compounds as listed in Annex 1.1 of the ORRChem (which comprises some of the POPs) and b) less than 1 % (by weight of halogen) of organic halogen compounds. As all POPs contain halogens, the latter provision is applicable to all POPs.

5.5 Monitoring

5.5.1 Swiss continuous monitoring programmes

At the national level, monitoring of a range of parameters in different environmental compartments is conducted in the framework of the following monitoring programmes that were already discussed in the first NIP (chapter 2.3.10):

- National Soil Monitoring Network (NABO)
- National Groundwater Quality Monitoring Network (NAQUA)
- National Air Pollution Monitoring Network (NABEL)
- National River Monitoring and Survey Programme (NADUF)

In the framework of the NABO, NAQUA and NADUF programmes the occurrence of some of the POPs in soil, rivers and groundwater has been assessed, partly within specific monitoring campaigns, see chapter 5.5.4:

NABO

The National Soil Monitoring Network (NABO) was started in 1984. The network comprises 105 observation sites which can be broken down by land-use type as follows:

- 50% in agricultural areas,
- 30% in forests,
- 20% on extensively managed land (Alpine pastures, etc.),
- 2 sites located in urban parks

In terms of vegetation, land use, management, air quality and soil type, the sites are representative of conditions typically found in Switzerland.

Temporal trends for heavy metals have been measured in five years intervals while organic pollutants are not yet included in the standard observation programme. However, PCBs and PCDDs/PCDFs were analyzed in specific campaigns.

In samples from all 105 monitoring sites originating from 1995 – 1999, PCB concentrations were assessed [59] [43]. Surface soil concentrations (0-20 cm) of PCBs ranged from 0.5 – 12 µg/kg and were thus clearly below any assessment value (see chapter 5.1.4). In contrast, concentrations in 357 samples of cantonal campaigns from 1990 – 1996 ranged from 0.1 – 602 µg/kg which was explained by the fact that these campaigns focused on potentially contaminated locations [43]. It was concluded that PCB concentrations in soil are not of concern apart from specific situations such as contaminated sites.

In 2005, further data on PCBs and PCDDs/PCDFs of 23 monitoring sites from the NABO network (samples from topsoil including the organic top layer were taken between March and July 2002) were published [103]. Total PCB concentrations (i.e. sum of 7 congeners IUPAC no. 28, 52, 101, 118, 138, 153, and 180) ranged from 1.1 to 12 µg/kg dry soil. Therefore, PCB concentrations were very similar to the previous study and clearly below the guidance value of 100 µg/kg or the lower Dutch target value of 20 µg/kg dry soil. Total PCDD/PCDF concentrations were between 72 and 703 ng/kg which corresponds to 1.1 to 11 ng I-TEQ/kg. In 19 samples PCDD/PCDF levels were below the guidance value of 5 ng I-TEQ/kg set by the Swiss Ordinance relating to Impacts on the Soil (OIS) while concentrations in the remaining samples (4 sites) were below the trigger value (20 ng I-TEQ/kg).

Currently, it is planned to assess the feasibility of including organic pollutants in the standard observation programme of NABO.

NAQUA

Implementation of the groundwater quality network was started in 1997, the monitoring network was fully implemented by 2002 with approximately 550 groundwater monitoring sites. Within NAQUA yearly standard measurement programmes as well as specific studies are performed. A first report on data from the years 2002 and 2003 was published in 2004 [30], a second report on the measuring campaigns from 2004 – 2006 was published in 2009 [3] (recent data are available at http://www.bafu.admin.ch/grundwasser/index.html?lang=en).

POPs were not a main focus in these measuring campaigns. However the regularly analysed target substance group of the plant protection products includes several POPs. From 2005 to 2010, up to 250 monitoring sites in several cantons were analyzed per year for the following POPs that had been used as plant protection products: Aldrin, Dieldrin, Endrin, alpha- and beta-HCH, Lindane, DDT and metabolites, Heptachlor, hexachlorbenzene. None of the substances apart from hexachlorobenzene was repeatedly detected. HCB was (repeatedly) detected at only one single monitoring site located near a contaminated site. Concentration ranged between of 0.03 – 0.07 µg/l ([3] p. 112, 114). From 2005 to 2010, one single detection of Lindane and 2,4-DDE was recorded, whereas the other substances were not detected at all [132].

Overall, only in exceptional cases plant protection product POPs were detected within NAQUA and all measured values were below the general limit value of 0.1 µg/l for individual organic pesticides according to the Water Protection Ordinance (WPO) [48].

5.5.2 SwissPRTR

Transfers in waste water, releases in air or water from certain industries above defined capacity thresholds have to be notified to the Swiss Pollutant Release and Transfer Register (SwissPRTR) implemented by FOEN according to the PRTR-V (see chapter 3.5). For 2007 to 2010, 200 – 230 facilities notified releases and transfers for some of the 86 pollutants subject to notifications. Among the POPs, only for PCB and PCDD/PCDF notifications were submitted for the years 2007 – 2010. For PCDDs/PCDFs all notifications were at or below the threshold value for notification of 0.001 kg/year, while for PCBs the notifications were above the threshold value of 0.1 kg/a. For the other POPs, apart from PFOS and hexabromodiphenyl ethers, which are not contained in the list, no releases or transfers above the threshold values occurred from facilities subject to notification. The data are compiled by industry, who is responsible for the quality of the data.

5.5.3 International continuous monitoring programs

Several commissions are dealing with rivers and lakes at the Swiss national borders.

<u>International Commission for the Protection of the Rhine (ICPR)</u>

For the benefit of the Rhine and of all of its tributaries the members of the International Commission for the Protection of the Rhine (ICPR) Switzerland, France, Germany, Luxemburg, Netherlands and the European Commission successfully co-operate with Austria, Liechtenstein, the Belgian region of Wallonia and Italy. Focal points of work are sustainable development of the Rhine, its alluvial areas and the good state of all waters in the watershed.

Within the framework of the international Commission for the Protection of the Rhine [127], a monitoring station is operated jointly with the German state of Baden-Württemberg in Weil am Rhein [52]. A number of initial and new POPs are included in the frequent analysis of water and suspended solids.

Apart from the above mentioned POPs Aldrin, Dieldrin, Endrin, Heptachlor, Mirex and Trans-Chlordane were measured in suspended solids in one up to six years. None of the substances was detected above the quantification limit of 1 µg/kg d.w. Further measurements were not considered necessary

PeCB was analyzed in water samples in 1995 but was not detected above the quantification limit of 0.002 µg/l.

ICPR published an evaluation of the data from 1990 – 2006 and 1990 - 2008 to compare them with the ICPR quality criteria for the Rhine which were defined with respect to drinking water quality and ecosystem function, among others. Combined concentrations in water and suspended solids are considered for the comparison [61][62]. Only for some of the POPs quality criteria are defined. For the substances Aldrin, Dieldrin, Endrin, DDT and its metabolites, alpha-HCH, beta-HCH and HCB concentrations were all at least 50% below the threshold value. Concentrations of Lindane and different PCB congeners were below or around the threshold value. Generally, concentrations measured in Weil am Rhein were considerably lower than those measured at other monitoring stations further downstream in Germany or the Netherlands.

In 2009, a sediment management plan for the Rhine was compiled by ICPR. No areas in Switzerland or near the Swiss border were classified as areas of concern or risk areas [60]. This is in accordance with a study commissioned by FOEN on the state of Rhine sediments in Switzerland [63].

Measurements at the ICPR monitoring stations were continued since 2010, however data for the following years are not yet available. The substances to be measured were revised in 2011 to adapt the monitoring programme to current knowledge [59].

The following substances always met the quality criteria for all stations along the Rhine. Therefore, measurements of these substances will only be performed every six years: Aldrin, Dieldrin, Endrin,alpha-HCH, beta-HCH, DDT and its metabolites.

Part of the current regular monitoring programme are:

- Brominated diphenylethers
- HCB
- PCBs
- Lindane

For PeCB an inclusion in the programme is evaluated. The reason why it was not included in the list in 2011 was an insufficient limit of quantification.

Tab. 4 Overview of monitoring data for several POPs in water and suspended solids from the station in Weil am Rhein

Pollutant	**Median**	**Max.**	**Limit of -quantification (LOQ)**	**Number of samples**	**% above LOQ**	**Sampling period**
Water measurements						
Lindane (µg/l)	<0.002	0.01	0.002	350	0.6	1995 - 2010
PFOS (ng/l)[2]	10.1	13	not reported	4	100	2010
Particle measurements (µg kg^{-1} d.w.)						
PBDEs[1]	<0.6	2.1	0.3 – 0.8	336	21	2007 - 2010
Alpha-HCH	<1	86	1	281	44	1995 - 2006
Beta-HCH	<1	43	1 / 10	101	13	1995 - 1999
Lindane	<1	10	1 / 0.5	311	12	1995 - 2010
HCB	3.8	103	1	362	90	1995 - 2010
PeCB	1.1	17.5	1 / 0.5	286	60	1995 - 1996 2000 - 2010
4,4'-DDT[3]	1.2	66	1	362	58	1995 - 2010
PCBs[4]	1.7	20	1	2533	66	1995 - 2010

[1] Six congeners from tri- to hexaBDEs, values for the individual congeners were evaluated.

[2] Measurements were also performed in 2008 and 2009, but the limit of quantification was too high (10 ng/l) and thus PFOS were not detected.

[3] Data for metabolites are not shown.

[4] Seven PCB congeners (28, 52, 101, 118, 138, 153, 180), values the for individual congeners were evaluated.

International Commission for the Protection of Lake Geneva (CIPEL)

The main role of CIPEL, an official Franco-Swiss organisation, is to survey the evolution of the water quality of Lake Geneva and its tributaries. It issues recommendations to Swiss and French governments, encouraging them to take measures to combat the sources of pollution; it contributes towards the coordination of water policy for the Lake Geneva basin and promotes public awareness of the importance of water protection.

In the framework of the CIPEL action plan for 2001 – 2010 [37], concentrations of PCBs, PBDEs and PFOS were measured in fish. Based on the results, the placing on the market of one species of fish above a certain size was prohibited. Based on the new action plan for 2011 – 2020 [38], efforts to evaluate and reduce the effects of micropollutants will be continued.

International Commission for the protection of Lake Constance (IGKB - Internationale Gewässerschutzkommission für den Bodensee)

The main role of IGKB, an official German-Austrian-Swiss organisation, is to make a joint effort to improve water quality of Lake Constance and its tributaries.

In a campaign to monitor water quality in 2008, PFOS were detected in the water phase at average concentrations of 7 ng/l. The maximum concentration was 40 ng/l. In the following year, water samples from tributaries of Lake Constance were analyzed. Highest PFOS concentrations were found in Swiss tributaries in the river Steinach (up to 400 ng/l) [57].

Also within the framework of IGKB, a study on surface sediments in Lake Constance was conducted in 2003 - 2006 [58]. Organochlorine POPs such as HCB, alpha-HCH, beta-HCH, Lindane and DDT and its metabolites were not found any more in surface sediments (quantification limit 2 µg/kg d.w.) while these substances had their peak concentrations in the 1960s – 1970s as shown by analyses in sediment cores. PCBs (sum of 6 congeners) were found in concentrations ranging from 1 – 11 µg/kg d.w. with two samples above the OSPAR trigger value of 10 µg/kg d.w. Concentrations had decreased on average to 6% of the maximum concentrations in sediment cores. For PCDD/PCDF values of about 2 – 9 TEQ/kg d.w. with one core showing values between 15 – 20 were found in surface sediments (dating from the early 90s to 2005). Concentrations of PCDDs/PCDFs had peaked in the 1970s with values up to ca. 35 TEQ/kg d.w. Results on organochlorine compounds, PCBs and PCDDs/PCDFs underline the successful reduction of emissions of these compounds. Only for PBDEs, sediment cores showed increasing concentrations towards the sediment surface.

International Commission for the protection of the Italian-Swiss waters (CIPAIS – Commissione Internazionale per la Protezione delle Acque Italo-Svizzere)

The Italian-Swiss organisation CIPAIS is concerned with the quality of the Italian-Swiss waters [53]. For example, studies were performed on the presence and effects of DDT in Lago Maggiore (see also chapter 5.1.2).

5.5.4 Specific monitoring campaigns

Human milk survey

In 2008/2009 Switzerland participated in the fifth round of the joint Stockholm Convention Secretariat / World Health Organization human milk survey [112]. The results showed that in Switzerland levels of POPs in human milk are similar to those in other European countries.

None of the results indicated a reason for concern with respect to breast feeding. Comparison with data on PCBs and PCDDs/PCDFs in human milk in 2002 showed a reduction by about 50% indicating that efforts in the reduction of exposure to these POPs were successful.[6]

POPAlp

The EU program on the Monitoring Network in the Alpine Region for POPs (POPAlp, previously MONARPOP), initiated in 2000, has already been discussed in the first NIP. The programme focuses on understanding POP contamination in the Alps and has led to a range of scientific publications [126]. Despite interest from Switzerland to continue the programme, it has currently been discontinued.

Pilot studies in the NAQUA and NADUF monitoring

Within the framework of the NAQUA National Groundwater Monitoring, a pilot study was conducted in 2007/2008 to determine levels of PFOS and other perfluorinated compounds in groundwater in Switzerland [98]. These compounds are so far not included in the standard monitoring programme. Two to three samples from 49 monitoring sites were analyzed for PFOS. PFOS was detected at 17 monitoring sites, 11 times below 10 ng/l and 6 times above 10 ng/l. From the NAQUA pilot study, it was concluded that neither the detected concentrations of PFOS nor of other perfluorated compounds constrain the use of groundwater as drinking water resource.

In 2007, Switzerland participated in an EU Wide Monitoring Survey of Polar Persistent Pollutants in European River Waters [69] which included monitoring of PFOS. For this survey water sampled at locations of the NADUF network were analyzed. The detected PFOS concentrations in the range of 10 – 50 ng/l in the rivers Glatt, Birs, Thur, Reuss, Limmat and Aare were similar to those measured in groundwater.

Analysis of soils for organochlorine pesticides

Monitoring of soils in the Canton Basel-Land

Triggered by some residues detected in vegetables, soils in the Canton Basel-Land were analyzed for organochlorine pesticides [8]. 71 samples dating from 2001 to 2009 and from different soils with different use patterns were analyzed for Aldrin, alpha-HCH, beta-HCH, DDT and metabolites, Dieldrin, Endrin, Heptachlor, hexachlorbenzene and Lindane and some further organochlorine pesticides. All substances were detected in some samples. Highest values were detected in allotment gardens followed by vineyards. From the study it was concluded that no health risk resulted from the consumption of vegetables grown in allotment gardens. Only for pumpkins, it was recommended as a precaution that it should be considered not to grow this vegetable due to its high uptake of organochlorine pesticides. Furthermore, it was recommended that children under four years should only play on ground that is well covered by grass to avoid pollutant ingestion together with soil.

Analysis of horticultural soils

Hilber *et al.* (2008 [49]) conducted a study on organochlorine pesticides (OCP) residues in Swiss horticultural soil. Two surveys in 2002 and 2005 were performed to assess the levels of OCP in 41 Swiss horticultural fields under organic and conventional production and corresponding *Cucurbitaceae* fruits (cucumbers, zucchini, and pumpkin). The analyses revealed that the production practice had no influence on the contamination or level of OCP in soil. OCP-loads per field ranged from <0.01 - 1.3 mg/kg dry soil and pentachloroaniline (2.1 mg/kg), p,p'-DDT (0.5 mg/kg), and p,p'-DDE and Dieldrin (0.4 mg/kg) were the pesticides that were mostly detected in the soils. It is interesting to note that OCP are still found although they were applied about 40 years ago [49]. The monitoring was accompanied by a study on methods to minimize uptake of Dieldrin by cumumbers [50].

Environmental concentrations of POPs are determined in different compartments to assess remaining exposure of humans and the environment to these compounds and to monitor the success of continuous reduction of exposure. Beyond the assessment of exposure, research efforts are undertaken to further understand the environmental fate of POPs. Alpine regions in Switzerland can serve to assess distribution processes that are not directly linked to local anthropogenic sources.

In a study in 2003, fish from remote alpine lakes were analyzed for PCBs, PCDDs/PCDFs, PBDEs and other POPs. Concentrations of PCBs, PCDDs/PCDFs, and PBDEs were in the same range as in fish from the major lakes situated in the Swiss plateau, indicating mainly atmospheric input of these persistent compounds [101].

In the years 2006-2010, a range of experimental and modelling studies on glacial and non-glacial lakes in the Swiss alps (Lake Oberaar, Lake Stein, Lake Engstlen) were conducted [102][17][12]. The studies confirmed the hypothesis that melting glaciers are a secondary source for POPs in alpine lakes. Some of the detected concentrations in lake sediment were higher than those at the time of use of these compounds. Due to low water solubility, the impact of the released POPs is expected to be mainly local. No significant effects on the alpine lakes as water resources are expected [16]. The behavior of POPs in a glacial environment is currently being investigated in a project funded by the Swiss National Science Foundation (Accelerated release of persistent organic pollutants (POPs) from Alpine glaciers).

DecaBDE has been shown to be susceptible to reductive debromination in the environment with subsequent formation of POP BDEs [41]. However, open questions remain regarding the role of debrominaton.

Higher congeners such as decaBDE and nonaBDE may be precursors to tetraBDEs, pentaBDEs, hexaBDEs, or heptaBDEs as PBDEs can be subject to debromination [128]. Therefore, decaBDE may be a source for the POP PBDEs [72]. In the national survey from 2008 [7], some samples still contained decaBDE which is currently only prohibited in electrical and electronic appliances.

However, in the substance flow analysis from 2008, it was estimated that due to the modern waste management system implemented in Switzerland, emissions of decaBDE to the environment through recycling, incineration and application of sewage sludge to soil are 10 times lower today than if no measures had been taken [72]. Thus, important emission reduction measures for decaBDE have already been implemented.

5.5.5 Further need for monitoring

Monitoring is important to control the effectiveness of the efforts to recuce exposure to POPs. Due to the global distribution of POPs, monitoring should be performed on a national and international level.

In Switzerland continued monitoring work should focus on:

- Continuation and strengthening of the national monitoring programmes like NABO, NADUF and NAQUA with the inclusion of further POPs in the standard monitoring programme, e.g. PFOS in NAQUA.
- Continuation of the monitoring of international waters such as the Rhine within the framework of international commissions. A continuation of the monitoring station in Weil am Rhein.
- Further participation in Stockholm Convention / WHO surveys such as the human milk survey.

Specifically, the following points should be considered with regard to the national monitoring programmes:

Most of the POPs partition preferentially to the solid phase and partially elevated levels of organochlorine pesticides in soils have been found during a cantonal study [44]. Therefore, POPs should be included in the NABO monitoring programme. PFOS behave differently because they partition primarily into water and to interfaces between different phases. Therefore, focus in the NADUF and NAQUA monitoring programmes should be on PFOS, while for other POPs such as PBDEs pilot studies should be conducted to evaluate if an inclusion in the programme is meaningful.

Few concentrations of air measurements of POPs are available. However, for example a study on PBDEs has shown that POPs may be present at detectable levels in the atmosphere in Switzerland [77]. Therefore, an inclusion of POPs in the NABEL air monitoring programme should be considered.

As the main route of human exposure to POPs, due to their persistent and bioaccumulative properties, is fish consumption, continued efforts to monitor fish is advisable.

5.6 Details of a relevant system for the assessment and listing of new chemicals

The Chemicals Ordinance and the Ordinance on Plant Protection Products provide the legal basis for the assessment of PBT, vPvB or POP properties of new substances.

Based on the Chemicals Ordinance (ChemO), PBT and vPvB properties have to be evaluated when new substances (substances that were placed on the market after 1981) are notified, which is similar to a REACH registration (see chapter 3.2). The duty for notification applies for new substances that are produced above 1 tonne per year.

Furthermore, approval for active substances, synergists and safeners for the use in plant protection products can only be given for substances that are neither considered PBT, vPvB in accordance with Annex XIII of the REACH regulation nor POPs in accordance with the Stockholm Convention, except for the criterion on *adverse effects* (Annex II of the EU regulation on plant protection products, 3.7) (see chapter 3.4).

5.7 Details on any relevant system for the assessment and regulation of chemicals already in the market

Even though Switzerland has not fully adopted all provisions of the REACH regulation for the assessment of substances already in the market, PBT and vPvB properties have to be considered for by manufacturers and importers of chemicals within the obligation of self--supervision according to Article 7 of the Chemicals Ordinance (see chapter 3.2).

Furthermore, Switzerland participates in the OECD Co-operative Chemicals Assessment Programme [55] that was established based on the previous High Production Volume (HPV) Chemicals Programme. The focus of the programme is to agree OECD-wide on hazard assessments of chemicals. The scope of the programme includes not only HPV chemicals, but also non-HPV, new and existing industrial chemicals. For the substances sponsored by Switzerland see http://webnet.oecd.org/hpv/ui/SponsoredChemicals.aspx.

5.8 Conclusions regarding the obligations

The production and use of all POPs are banned in Switzerland apart from uses under specific exemptions and acceptable purposes for PFOS. Most of the POPs have already been banned in Switzerland even before the inclusion of the substance in the Stockholm Convention; the remainder were regulated with the 2010 revision of the Ordinance on Chemical Risk Reduction (ORRChem). The exemptions for use of PFOS will be further restrained with the next revision of the ORRChem. Furthermore, appropriate measures to reduce production of Annex C POPs are implemented.

The only relevant remaining sources for Annex A POPs are products that are still in use (e.g. in old buildings) and have not yet been disposed of, as well as landfills and contaminated sites. Stringent criteria are defined for disposal of waste in landfills. POP containing waste is usually disposed of by incineration. All potential contaminated sites in Switzerland have been assessed and, if necessary, remediation has been performed or is planned.

Monitoring and research work on a national and international level to assess the presence of POPs in the environment and to understand their distribution and effects has led to increased knowledge on POPs. Work in this area is ongoing.

The public is informed about the POPs issues and related activities in a number of ways. Various reports have been published by the authorities including monitoring and research reports. Furthermore, data on current emissions by certain industries are contained in the Swiss Pollutant Release and Transfer Register (SwissPRTR) which is publicly available.

Therefore, Switzerland fulfills all obligations of the Stockholm Convention. Specifically, obligations regarding the reduction and elimination of releases from intentional production and use, from unintentional production and from stockpiles and waste are fulfilled. Furthermore, the public is appropriately informed and research and monitoring efforts are ongoing.

6 National action plan

An important instrument of the Stockholm Convention to achieve its goals is the obligation for parties to develop a national action plan (NAP) and subsequently implement it as part of its implementation plan. (See article 5, (a)).

Switzerland's first national implementation plan, submitted in 2005 (accessible on http://chm.pops.int/ by selecting >«IMPLEMENTATION» >«NIPs» >«NIP Submissions» >«Transmission of the first NIP»), includes a national action plan for the 12 initial POPs. It described measures already taken as well as planned measures. Many of the planned measures have meanwhile been implemented and are described in chapter 5 of the updated NIP.

As nine new POPs have been added to the Convention by the fourth meeting of the Conference of the Parties (COP4), the decision was taken to update and expand the first NAP with the latest insight into the 12 initial POPs and a description of the action regarding the nine new POPs. The updated NAP covers the period 2005 to 2012.

6.1 Legislation

Already in 2010 Switzerland has implemented bans and restrictions for the production and use for the 9 new POPs in the Chemical Risk Reduction Ordinance (ORRChem) in order to comply with the Stockholm Convention (see table 1, chapter 3.1). Only for the use of PFOS exemptions are granted by the ORRChem. In line with the national legislation, in 2011 specific exemptions and acceptable purposes have been registered only for the use of PFOS. Since Switzerland doesn't produce PFOS no exemption is needed for this category.

Currently Switzerland is preparing an adaptation of ORRChem to the EU Regulation No 850/2004 as amended by the Commission Regulation No 757/2010 (see table 2). It can be considered as a first step of Switzerland's final goal to eliminate all remaining uses of PFOS and other POPs, and to strengthen its legislation with regard to substances with POP characteristics.

With this amendment Switzerland aims at eliminating the registered specific exemptions and keep only the acceptable purposes. By 2015 the PFOS specific exemptions are no longer needed since the use of PFOS as wetting agent in controlled electroplating systems will be banned by 31.8.2015, the only allowed use of PFOS in the domain of electroplating will be as mist suppressant for non-decorative hard chromium(VI) plating in closed systems as mentioned in the registered acceptable purpose.

A draft amendment of the ORRChem and the Chemicals Ordinance (ChemO) in the domain of industrial chemicals and chemicals and articles used by the general public shall ensure that substances with POP characteristics listed in annex XIV of the REACH regulation are banned unless exemptions have been granted by the EU or Swiss authorities.

The Swiss Ordinance on Plant Protection Products (OPPP) has been revised and the authorization process for new active substances now includes precautionary measures that will strongly help the elimination of substances that have POP characteristics (see 3.4).

Similarly to the OPPP the Swiss Ordinance on the Placing on the Market and Handling of Biocidal Products is intended to be revised: e.g. new active ingredients that are being assessed and turn out to have PBT or vPvB properties as defined in REACH Annex XIII shall not be authorized (see 3.3).

6.2 Enforcement

In addition to the enforcement activities that have already been implemented earlier and described in the first NIP in subchapters 2.2.5 and 3.4, Switzerland is taking further action to enforce the regulatory obligations and phase-out of POPs. These efforts comprise in particular:

- the development and validation of state-of-the-art analytical techniques to be applied by cantonal enforcement authorities for market surveys of POPs in articles and for legal compliance investigations;
- the planning and conducting of market surveys by cantonal enforcement authorities to control whether or not existing bans and restrictions of POPs in preparations and articles are respected by market actors;
- conducting of controls by cantonal enforcement authorities whether or not the legal requirements regarding banned uses of POPs, notification obligations for allowed uses, and required practices for the safe disposal of POPs containing materials are respected by responsible actors;
- developing an inventory of existing stocks of PFOS containing fire-fighting foams by the FOEN based on notifications and analytical determination of the PFOS-content in foam products;
- the enforcement of notification obligations for the use of PFOS and PFOS containing preparations and ensure that the products are used in accordance with the registered specific exemptions and acceptable purposes reflected in the ORRChem;
- completion of the phase-out of PCB containing capacitors in low-voltage electrical installations through systematic controls of these installations by inspectors;
- the development of a guidance report for identification of PCB-contaminated sites based on historical information and inventories of the cantons.

6.3 Research and Development

Within the research networks among the Federal Institutes of Technology ETH Zurich and EPFL, the federal research institutes PSI, WSL, Empa and Eawag, the universities and universities of applied sciences various research projects on initial and new POPs issues are ongoing or in preparation. Some of these project are mentioned hereafter as examples:

Emissions, fate, and mass balance of POPs in Switzerland:
Primary emissions of regulated POPs have certainly decreased in Switzerland and other industrialized countries. However, the ongoing presence of POPs in former applications and continuing emissions represent major knowledge gaps. Current primary emissions of POPs, remaining reservoirs in former POP-applications, the relevance of secondary sources compared to primary sources, mass fluxes between environmental reservoirs and amounts stored in these reservoirs (air, soil, water), as well as the relevance of recently discovered POP-sources (for instance melting glaciers), are issues which will be investigated within this project in 2012-2014. Data on reservoirs, emissions, transport and environmental fate of selected POPs and candidate POPs (PCBs, polybrominated diphenylethers, hexabromocyclododecane, short-chain chlorinated paraffins) will be collected and a multicompartment model is developed and applied to calculate fluxes, distribution between environmental compartments and mass balances.

Pilot study on the behaviour of PCBs and PCDDs/PCDFs in a ferrous metal scrap smelter:

PCB containing anticorrosive coatings of steel construction can be a source of contamination of the environment with PCBs and PCDDs/PCDFs during decomposition, and recycling operations of such steel constructions. The first step which consists of grit cleaning or removing of PCB containing coatings with other abrasive methods can cause significant exposure of workers with PCBs and PCDDs/PCDFs as well as environmental pollution with these POPs. As an option the critical operation of removing PCB-containing coatings is skipped and PCB-contaminated steel scrap is used in a pilot study directly as raw material for the production of high-quality structural and reinforcing steels in an electric shaft furnace, which is equipped with state-of-the-art flue-gas cleaning technology. Concentrations of PCBs in the coating of the steel scrap and PCBs and PCDDs/PCDFs in the clean off-gas and in the residues of the flue-gas cleaning system will be analyzed and the elimination rate of PCBs as well as emissions of PCBs and PCDDs/PCDFs will be determined and compared with emissions when non-contaminated scrap is processed.

Early recognition of POPs and POP-like substances:
Hazardous properties, exposure and risk potential of POPs have been identified in the past after these chemicals have been already manufactured and used for decades and the POPs were distributed globally. It is widely accepted that early identification of POPs and POPs-like properties of chemicals would be beneficial and is a useful measure of precaution. The project is aimed at developing a concept to identify chemical substances which are expected to have properties as POPs, PBTs or vPvB and could be of concern because relevant exposure of humans and environment is anticipated based on volumes and types of uses of the particular substances. The concept will be based on four modules: (1) a comprehensive database of substances (CAS numbers, names, structural information), (2) compilation of physical-chemical property data and hazard information and (3) modeling of environmental behavior and (4) drawing-up of a spot sampling and analytical screening design for the determination of selected priority substances in environmental compartments.

6.4 Monitoring

Switzerland is currently evaluating to include some of the POPs in the parameters lists of existing monitoring networks NABEL, NAQUA, NADUF and NABO.

Depending on the properties of the new POPs and their behavior in the environment the consideration of their inclusion in monitoring programs occurs in a targeted way:

Possible inclusion of:

- PFOS in the water monitoring NAQUA and NADUF
- Relevant organochlorine POPs in soil monitoring NABO
- PBDEs in air monitoring NABEL
- Relevant POPs such as BDEs, PFOS in fish measurements campaigns

Concentrations and mass flows of PCBs, PBDEs, and hexabromocyclododecane in electrical and electronic scrap have been determined in two pilot studies in 2003 and 2011 in order to evaluate the effectiveness of legislative measures and the national waste management policy and to monitor the changes of contamination of waste electric and electronic scrap over time.

It has been recognized that guidance is needed for sampling, samples preparation and analysis of PCBs in the aqueous phase and in sediments of river systems. Based on the outcome of sampling campaigns in three rivers using sediment samples and polymethyldisiloxane passive samplers a report is currently in preparation which presents the results of the PCB and PCDD/PCDF analyses, describes the methods that have been used and provides recommendations for future investigations. The report will support the cantons to identify sources of contamination of PCBs in river systems from contaminated sites.

As already mentioned in earlier chapters (5.5.3, 5.5.4) Switzerland is involved in several international chemicals monitoring programs including POPs, participations in further monitoring programs or campaigns are considered.

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