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Contamination of chicken eggs near the Mbeubeuss dumpsite in a suburb of Dakar, Senegal by dioxins, PCBs and hexachlorobenzene

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“Keep the Promise, Eliminate POPs!” Campaign Report

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Dakar - Prague (March - 31 - 2005)

Executive Summary

Free-range chicken eggs collected near the Mbeubeuss dumpsite in one of Dakar’s suburbs in Senegal showed very high levels of dioxins and elevated levels of PCBs. The dioxin levels in the eggs were more than 11 times higher than the existing European Union (EU) limit for these chemicals. The PCB levels in eggs were more than 1.7 times higher than the newly proposed EU limit for PCBs in eggs . To our knowledge, this study represents the first data about POPs in chicken eggs from Senegal.

The most obvious potential source of POPs releases at the site is chlorine-containing waste disposed at the Mbeubeuss dumpsite and uncontrolled burning of the chlorine-containing waste products such as commonly-found PVC plastics. The high levels of U-POPs represent a concern for wider contamination since the rubbish dump is located on one part of the Mbeubeuss lake bottom, parallel to the Atlantic coast.

The toxic substances measured in this study are slated for reduction and elimination by the Stockholm Convention which holds its first Conference of the Parties beginning 2 May 2005. Senegal is a Party to Convention since it ratified the Treaty in October 2003. The Convention mandates Parties to take specific actions aimed at eliminating these pollutants from the global environment. We view the Convention text as a promise to take the actions needed to protect the Senegalese and global public’s health and environment from the injuries that are caused by persistent organic pollutants, a promise that was agreed by representatives of the global community: governments, interested stakeholders, and representatives of civil society. We call upon Senegal’s governmental representatives and all stakeholders to honor the integrity of the Convention text and keep the promise of reduction and elimination of POPs.

Recommendations

1) More POPs monitoring in Senegal is needed;

2) More publicly accessible data about U-POPs releases from all potential sources in the region are needed to address them properly;

3) Stringent limits for U-POPs releases and levels in waste should be introduced into both national and international legislation.

4) Chlorinated materials and especially PVC-containing waste should not be burned and preferably other materials that do not contain chlorine should be substituted for products currently using PVC.

5) A comprehensive waste-management strategy needs to be implemented for Dakar to help prevent further threats to public health and the environment posed by the Mbeubeuss dumpsite.

Introduction

Persistent organic pollutants (POPs) harm human health and the environment. POPs are produced and released to the environment predominantly as a result of human activity. They are long lasting and can travel great distances on air and water currents. Some POPs are produced for use as pesticides, some for use as industrial chemicals, and others as unwanted byproducts of combustion or chemical processes that take place in the presence of chlorine compounds. Today, POPs are widely present as contaminants in the environment and food in all regions of the world. Humans everywhere carry a POPs body burden that contributes to disease and health problems.

The international community has responded to the POPs threat by adopting the Stockholm Convention in May 2001. The Convention entered into force in May 2004 and the first Conference of the Parties (COP1) will take place on 2 May 2005. Senegal ratified the Convention in October 2003.

The Stockholm Convention is intended to protect human health and the environment by reducing and eliminating POPs, starting with an initial list of twelve of the most notorious, the "dirty dozen." Among this list of POPs there are four substances that are produced unintentionally (U-POPs): polychlorinated biphenyls (PCBs), hexachlorobenzene (HCB), polychlorinated dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs) The last two groups are simply known as dioxins.

The International POPs Elimination Network (IPEN) asked whether free-range chicken eggs might contain U-POPs if collected near potential sources of U-POPs named by the Stockholm Convention. The surroundings of the Mbeubeuss dumpsite in the suburban zone of Dakar, Senegal was selected as a sampling site since open burning of PVC plastic and other chlorine-containing items are known to produce dioxins and furans. Chicken eggs were chosen for several reasons: they are a common food item; their fat content makes them appropriate for monitoring chemicals such as POPs that dissolve in fat; and eggs are a powerful symbol of new life. Free range hens can easily access and eat soil animals and therefore their eggs are a good tool for biomonitoring of environmental contamination by U-POPs. This study is part of a global monitoring of egg samples for U-POPs conducted by IPEN and reflects the first data about POPs in eggs ever reported in Senegal.

Materials and Methods

Please see Annex 1.

Results and Discussion

U-POPs in eggs sampled near the Mbeubeuss dumpsite the suburban zone of Dakar, Senegal

The results of the analysis of a pooled sample of 6 eggs collected within a 0.7 km distance from the Mbeubeuss dumpsite in suburban Dakar are summarized in Tables 1 and 2. Pooled sample fat content was measured at 11.3%.

The levels of dioxins found in sampled eggs from the Mbeubeuss dumpsite in Table 1 were more than eleven times higher than the EU dioxin limit for eggs. In addition, the samples exceeded the proposed EU limits for PCBs (in WHO-TEQs) by more than 1.7-fold. The total WHO-TEQ levels exceeded the EU limit for eggs by more than 7-fold.

Table 1: Measured levels of POPs in eggs sampled near the Mbeubeuss dumpsite in Senegal per gram of fat.

	Measured level	Limits	Action level
PCDD/Fs in WHO-TEQ (pg/g)	35.10	3.0[a]	2.0[b]
PCBs in WHO-TEQ (pg/g)	3.44	2.0[b]	1.5[b]
Total WHO-TEQ (pg/g)	38.53	5.0[b]	-
PCB (7 congeners) (ng/g)	29.17	200[c]	-
HCB (ng/g)	1.70	200 (10)[d]	-

Abbreviations: WHO, World Health Organization; TEQ, toxic equivalents; pg, picogram; g, gram; ng, nanogram.

[a] Limit set up in The European Union (EU) Council Regulation 2375/2001 established this threshold limit value for eggs and egg products. There is even more strict limit at level of 2.0 pg WHO-TEQ/g of fat for feedingstuff according to S.I. No. 363 of 2002 European Communities (Feedingstuffs) (Tolerances of Undesirable Substances and Products) (Amendment) Regulations, 2002.

[b] These proposed new limits are discussed in the document Presence of dioxins, furans and dioxin-like PCBs in food. SANCO/0072/2004.

[c] Limit used for example in the Czech Republic according to the law No. 53/2002 as well as in Poland and/or Turkey.

[d] EU limit according to Council Directive 86/363/EEC, level in brackets is proposed new general limit for pesticides residues (under which HCB is listed) according to the Proposal for a Regulation of the European Parliament and of the Council on maximum residue levels of pesticides in products of plant and animal origin, COM/2003/0117 final - COD 2003/0052.

Table 2 shows that the level of dioxins in eggs expressed as fresh weight exceeded the limit for commercial eggs in the USA by 2.5-fold. The US Food and Drug Administration estimates a lifetime excess cancer risk of one in 10,000 for eggs contaminated at 1 pg/g ITEQ. The samples collected near the Mbeubeuss waste dump in the suburbs of Dakar exceeded this cancer risk level.[a]

Table 2: Measured levels of POPs in eggs sampled near the Mbeubeuss dumpsite in Senegal per gram of egg fresh weight.

	Measured level	Limits	Action level
PCDD/Fs in WHO-TEQ pg/g	3.65	1[a]	-
PCBs in WHO-TEQ pg/g	0.36	-	-
Total WHO-TEQ pg/g	4.01	-	-
PCBs (7 congeners) in ng/g	3.03	-	-
HCB in ng/g	0.18	-	-

[a] U.S. Department of Agriculture Food Safety and Inspection Service [Memo 8 July 1997] Advisory to Owners and Custodians of Poultry, Livestock and Eggs. Washington, DC:U.S. Department of Agriculture, 1997. FSIS advised in this memo meat, poultry and egg product producers that products containing dioxins at levels of 1.0 ppt in I-TEQs or greater were adulterated. There is even more strict EU limit at level of 0.75 pg WHO-TEQ/g of eggs fresh weight for feeding stuff according to S.I. No. 363 of 2002 European Communities (Feedingstuffs) (Tolerances of Undesirable Substances and Products) (Amendment) Regulations, 2002.

To our knowledge, the measurements of U-POPs in this study represent the first data on U-POPs in chicken eggs ever reported in Senegal. The surprising high-levels of U-POPs observed in the egg samples support the need for further monitoring and longer-term changes to eliminate chlorinated

[a] Estimated using a cancer potency factor of 130 (mg/kg-day)-1 and rounding the risk to an order of magnitude for consumption of 3-4 eggs per week (30 g egg/day) contaminated at 1 ppt ITEQ

materials that serve as donors for dioxin formation in the dump. An additional unanticipated finding is that the current limits for dioxins and furans content in wastes proposed by the relevant documents and/or drafts associated with the Stockholm Convention permits these POPs to enter the environment. It is very important to cover this gap and introduce stricter rules for handling PCCD/Fs-containing wastes as well as PCDD/Fs releases into the environment.

Comparison with other studies of eggs

The dioxin levels observed in eggs in this study exceed background levels by almost 30-fold (0.2 - 1.2 pg WHO-TEQ/g of fat).

We compared the levels of PCDD/Fs measured in this study in eggs collected near the Mbeubeuss dumpsite with data from other studies that also used pooled samples and/or expressed mean levels from more egg samples measurements (Please see Annexes 2 and 3.) The data for eggs described in this report follow on the heels of a similar studies in Slovakia, Kenya, Czech Republic, Belarus, India (Uttar Pradesh) and Tanzania released since 21 March 2005.[1, 2, 3, 4, 5, 6] The dioxin levels in eggs in this study exceeded background levels by almost 30-fold (35.10 vs 0.2 - 1.2 pg WHO-TEQ/g of fat) and represent the highest levels observed so far in studies of POPs in eggs from three continents.

Higher levels of dioxins were found in eggs near an old waste incinerator in Maincy, France [7] and comparable levels in an area affected by a spread mixture of waste incineration residues in Newcastle, UK,[8] 42.47 pg WHO-TEQ/g and 31 pg WHO-TEQ/g respectively. This comparison adds Mbeubeuss to the most dioxin-contaminated sites in the world.

PCBs levels also exceeded background levels, though they are not as high as dioxins (see Annex 4). HCB levels in eggs slightly exceeded the background level, but were among the lowest observed in eggs studied by IPEN so far in this round (see Annex 6).

Concerning the balance between PCBs and PCDD/Fs contribution to the whole WHO-TEQ, PCDD/Fs have the highest majority among compared samples in Annex 5 reaching over 90% of the whole TEQ value in eggs.

Possible U-POPs sources

The very high levels of dioxins in free range chicken eggs in these samples provoke the question of their possible sources. There is most likely only one major potential source of PCDD/Fs releases: the Mbeubeuss dumpsite and the open burning of wastes at this dumpsite. However, the PCDD/Fs congener pattern observed in the eggs does not follow the pattern normally observed from combustion sources. In contrast to combustion sources, both 1,2,3,4,6,7,8 HpCDD and OCDD are quite prominent (see Table 3). In addition, a comparison of PCDD/Fs patterns (expressed in WHO-TEQs) in pooled eggs samples from two other studies of eggs collected near dumpsites shows a big difference in congener patterns with those observed from the samples collected near the Mbeubeuss dumpsite (see Annex 7). Finally, the burning of wastes from the dumpsite in private households could be an additional source of dioxins, but not likely a major one. Taken together, the data suggests that the large dioxin source at the Mbeubeuss dumpsite might be chlorine-containing chemicals present in the dumpsite. This calls for stricter rules for dioxins content in wastes under Stockholm Convention as well as at the national level in Senegal.

Table 3: Results of PCDD/Fs analysis in a pooled sample of eggs collected near the Mbeubeuss dumpsite in Senegal

PCDD/Fs congeners	WHO-TEF	Values in pg/g of fat in WHO-TEQ	Values in pg/g of fat
2,3,7,8 TeCDD	1	0.62	0.62
1,2,3,7,8 PeCDD	1	4.60	4.60
1,2,3,4,7,8 HxCDD	0.1	0.81	8.10
1,2,3,6,7,8 HxCDD	0.1	7.42	74.20
1,2,3,7,8,9 HxCDD	0.1	2.43	24.30
1,2,3,4,6,7,8 HpCDD	0.01	11.00	1,100.00
OCDD	0.0001	1.30	13,000.00
2,3,7,8 TeCDF	0.1	0.48	4.80
1,2,3,7,8 PeCDF	0.05	0.21	4.20
2,3,4,7,8 PeCDF	0.5	3.40	6.80
1,2,3,4,7,8 HxCDF	0.1	1.10	11.00
1,2,3,6,7,8 HxCDF	0.1	0.51	5.10
2,3,4,6,7,8 HxCDF	0.1	0.60	6.00
1,2,3,7,8,9 HxCDF	0.1	0.220	2.20
1,2,3,4,6,7,8 HpCDF	0.01	0.293	29.30
1,2,3,4,7,8,9 HpCDF	0.01	0.106	10.60
OCDF	0.0001	0.00577	57.70

The Mbeubeuss dumpsite

Physical and administrative description

Created in 1968 for the purpose of eliminating scraps and unused compost of the Bel-Air compost factory,, the Mbeubeuss rubbish dump with a surface area of 60 hectares, was in the beginning just a dump meant to raise the ground in order to create Malika road.[9]

The rubbish dump is located on one part of the Mbeubeuss lake bottom, parallel to the Atlantic coast and separated from the beach by a SW to NE dunal cord which is being re-forested. The rubbish dump now occupies nearly 25% of the lake surface area representing about 55 hectares.[10]

In November 1996, as part of the Senegalese government administrative reform instituting decentralization, Malika was set up as a district. It is located 22 kilometres North West of the centre of Dakar, in the southern part of Pikine department straddling Yeumbeul and Keur Massar.[11]

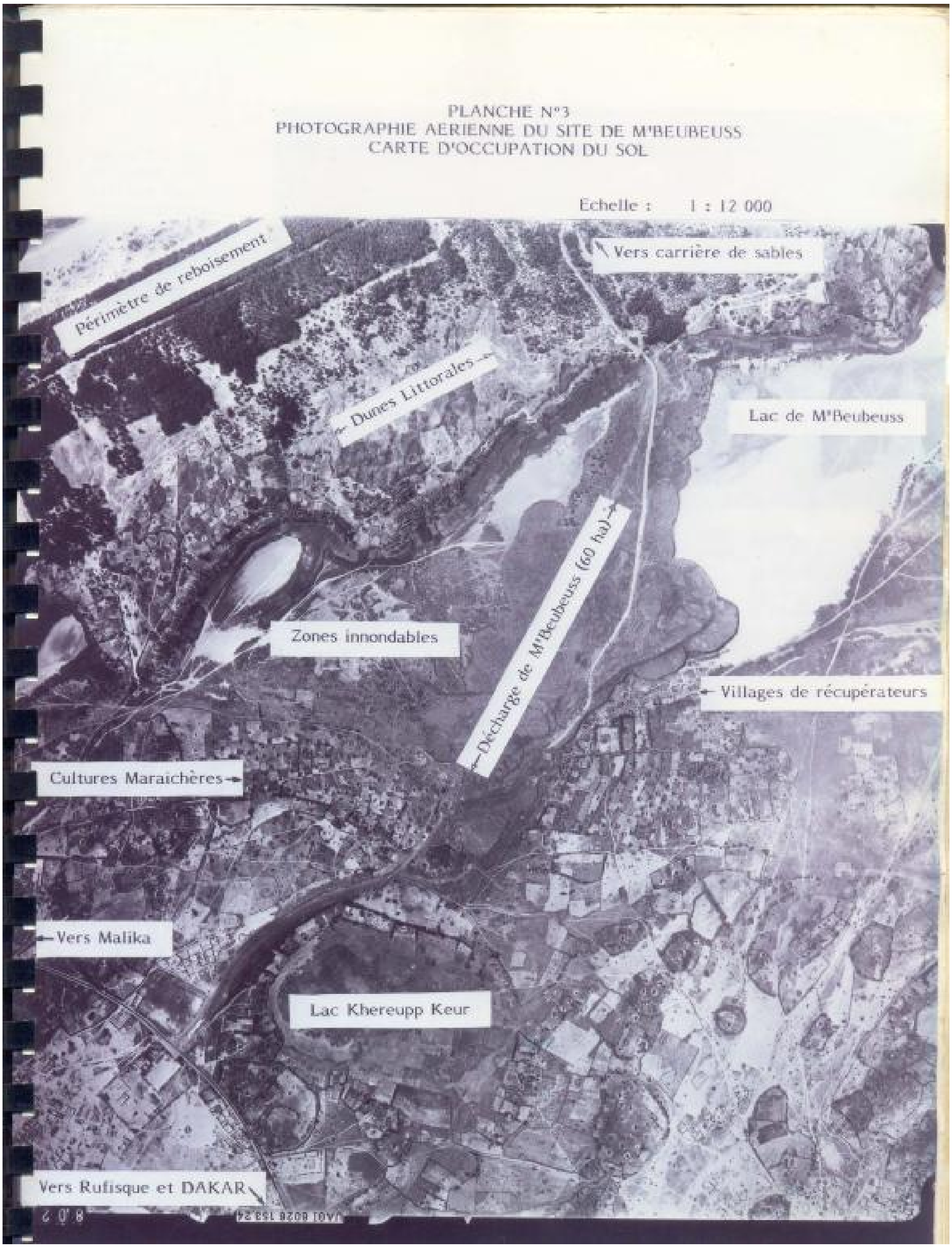
The site is hilly as we move toward the interior. An elevation of the shelf due to the rubbish that has been tipped there for decades is plainly noticeable. The dump has entirely changed the living environment.

Located on the slopes of the big Niayes of Dakar, Mbeubeuss marks the beginning of an area through a low pressure (inter-dunal depression, meaning between the coastal dunes and the continental ones) filled with fresh and salty water which extends with Tanma Lake.

Between market gardening, unseasonable farming, coco nut harvest and urban periphery aviculture, Mbeubeuss is a domain where we can notice different economic activities. However, its development area is heavily reduced by the progression of the rubbish dump.

The different soils observed in the rubbish dump are characterized by very high permeability and consequently are incapable of constituting the bottom of a rubbish dump. As a result, during the rainy season materials from the dump infiltrate the ground and transfer pollution toward the subsoil. To make matters worse, one part of the dump bottom lies in the groundwater.

Picture 1: Aerial photograph of the dumpsite area. (**Source :** Republic of Senegal/Ministry of Tourism and the Protection of the environment/The environmental department (1990): Study of the impacts of Mbeubeuss rubbish.)



Dumpsite history and detailed description of the hot spot

Mbeubeuss, the dried lake, has ultimately replaced the former rubbish dump of Hann since 1971, despite the fact that no assessment study of the site capacity for the operation of a rubbish dump has ever been done. On a daily basis, the dump receives over 1,000 tons of solid household rubbish plus the waste from about 30 industries, liquid waste and septic tank collection. The Mbeubeuss remains one of the biggest threats to the environment of Dakar.[12]

The dump receives 75% of the household waste (representing 2,600 m^3/day), one-third of the hospital waste (which represents 42 m^3/jday) and also industrial waste (5,000 m^3/month) from Dakar.[13] It is noteworthy that these figures date back to 1990 with a population of 1,650,000 inhabitants living in Dakar whereas the city currently hosts nearly 3,000,000 inhabitants. So, the actual amounts are much larger even if we only consider household rubbish.

As shown in the chart in Annex 8, the household wastes are composed, in their majority, of organic matters and sand. Nevertheless, it is important to note that household waste also includes large quantities of cardboard plastic, and textiles, the burning of which can create dioxins.

Hospital wastes are composed of surgery waste, obstetrical, gynaecological, laboratory, bandage, needles, plasters, expired products, one-way use objects, hotels rubbish, restaurant, administration, garden etc.

The industrial wastes disposed at Mbeubeuss come from the following activity sectors: parachemistry (insecticides, herbicides, explosive products, paints etc), metallurgy, textile, chemistry, petro-chemistry, farm-produce, paper-cardboard, printing works, management and servicing of cars. Wastes dumped at Mbeubeuss also include different chemical solvents, oils, salts etc. A more detailed description of Mbeubeuss can be found in a hot spot report prepared by PAN Africa.[14]

It is often noticed that the dump is on fire, but the reasons are unknown. However, due to the methanization of waste (with an important content of oxidizible scraps), we notice, on a daily basis, emission of smoke at the dump level as shown on the Photo 1 in Annex 9. So far, there has not been any characterization or study of the smoke emanating from the waste stocks.

The impact study carried out by the Environmental department of the VERITAS office of Dakar shows that:[15]

- The water used by market gardeners set up near the rubbish dump is polluted by organic matter; in particular, hydrocarbons and heavy metals and consequently, public health is threatened due to the consumption of polluted vegetables and fruits;

- The fresh water from the groundwater would be polluted within a wide radius (about 30 kilometres) with a high risk rate for some populations whose main drinking source still remains the water from the wells.

- The lake is actually the terminal area of waters which flow through the rubbish dump.

- Areas located at the hydraulic upstream of the rubbish dump show some water of fresh quality, though we can not exclude the possibilities of pollution by diffuse waste, indeed by the rubbish dump itself.

Mbeubeuss dumpsite lesson

In the early 1990's, African cities and especially capitals showed unbearable realities: the sprawling of the urban area, urban districts marked by piling up of rubbish and a particularly dirty living environment. Among these problems stemming from urbanization, that of the pressure of rubbish is one of the biggest weaknesses of our civilization. In Dakar, the management of rubbish remains a puzzle for authorities. Many structures have been set up one by one without responding effectively to the social demand.

The prominence taken by rubbish and the growth pace of cities introduces an important sector of economic activities, the sector of urban rubbish. At Malika, the Mbeubeuss rubbish dump is a new centre of activities and urban employment. So, besides trade and horticultural activities, the recuperation and recycling sector is being developed, which is a kind of treatment of rubbish embodying not only a protection effect of an environment whose balance is threatened, but also a source of employment and new resources from things that are thrown away. This activity should be supported with a better managed protection of the health of people working in that sector which is not the case at the Mbeubeuss dumpsite.

U-POPs and the Stockholm Convention

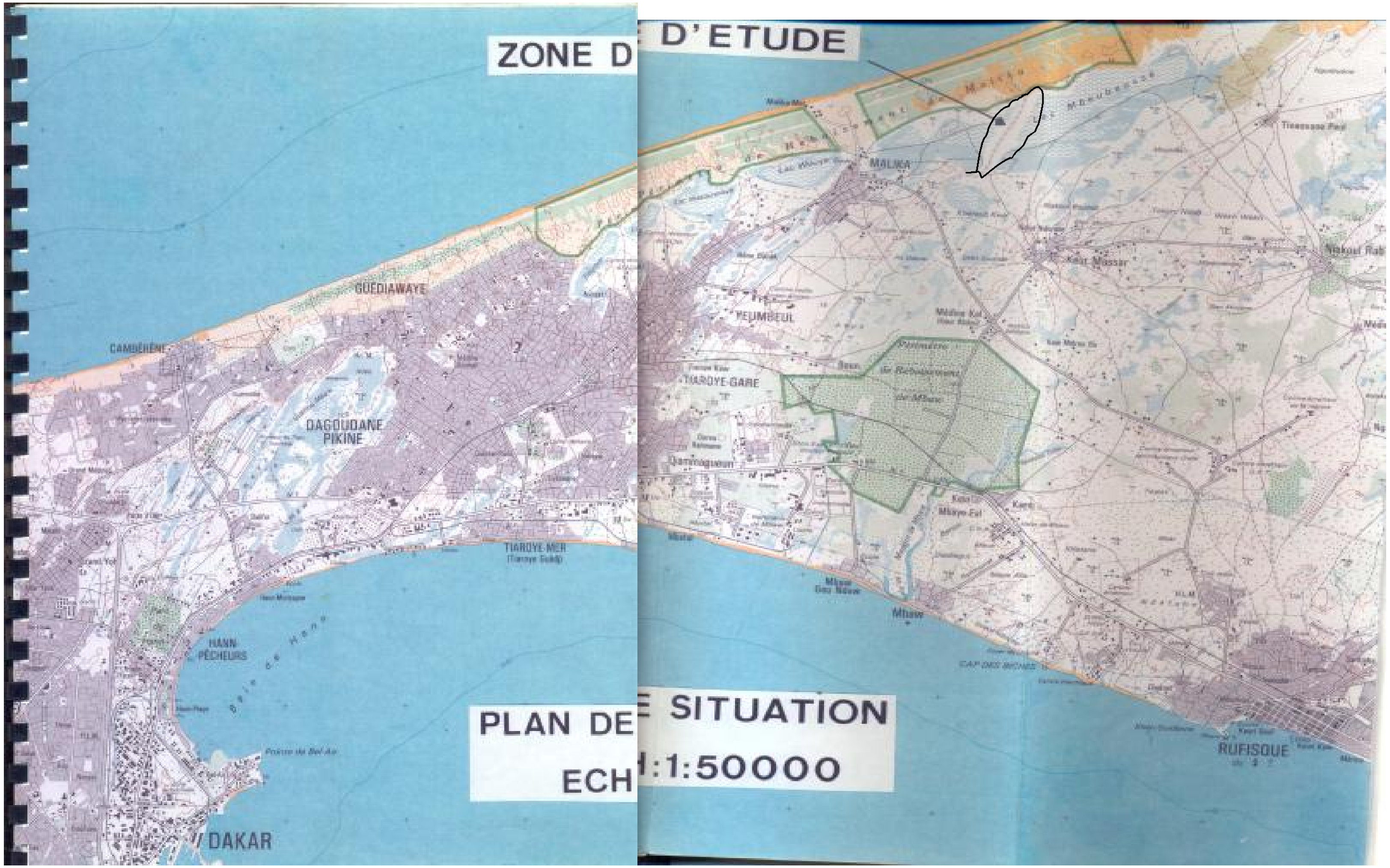
The U-POPs measured in this study are slated for reduction and elimination by the Stockholm Convention which holds its first Conference of the Parties in May 2005. Senegal is a Party to Convention since it ratified the Treaty in October 2003.

The Convention mandates Parties to take specific actions aimed at eliminating these pollutants from the global environment. Parties are to require the use of substitute or modified materials, products and processes to prevent the formation and release of U-POPs.[b] Parties are also required to promote the use of best available techniques (BAT) for new facilities or for substantially modified facilities in certain source categories (especially those identified in Part II of Annex C).[c] In addition, Parties are to promote both BAT and best environmental practices (BEP) for all new and existing significant source categories,[d] with special emphasis on those identified in Parts II and III. As part of its national implementation plan (NIP), each Party is required to prepare an inventory of its significant sources of U-POPs, including release estimates.[e] These NIP inventories will, in part, define activities for countries that will be eligible for international aid to implement their NIP. Therefore it is important that the inventory guidelines are accurate and not misleading.

The Stockholm Convention on POPs is historic. It is the first global, legally binding instrument whose aim is to protect human health and the environment by controlling production, use and disposal of toxic chemicals. We view the Convention text as a promise to take the actions needed to protect Senegalese and global public's health and environment from the injuries that are caused by persistent organic pollutants, a promise that was agreed by representatives of the global community: governments, interested stakeholders, and representatives of civil society. We call upon Senegal governmental representatives and all stakeholders to honor the integrity of the Convention text and keep the promise of reduction and elimination of POPs.

[b] Article 5, paragraph (c)
[c] Article 5, paragraph (d)
[d] Article 5, paragraphs (d) & (e)
[e] Article 5, paragraph (a), subparagraph (i)

Map: Map of Dakar capitol city of Senegal with a localisation of the garbage waste site. Source: République du Sénégal / Ministere du Tourisme et de la Protection de l'Environnement / Direction de l'Environnement 1990.[16]



Annex 1. Materials and Methods

Sampling

For sampling in Senegal we have chosen the Mbeubeuss dumpsite near Dakar. The eggs were collected from a site called Malika, which is 0.7 km from the dumpsite's edge. The hens from which the eggs were picked were all free-range of age between 8 - 12 months although regularly provided with home food supplements - leftovers from the kitchen and in the case of one chicken fancier also with foods from SEDIMA (a chicken food company). Chickens can easily access soil organisms and they roam an area between 500 - 1000 square meters.

Sampling was done by members of PAN Africa on 24 January 2005. Three chicken fanciers supplied a total of 10 eggs from their free range chickens. The eggs were kept in cool conditions after sampling and then were boiled by PAN Africa in Senegal for 7 - 10 minutes in pure water and transported to the laboratory at ambient temperature.

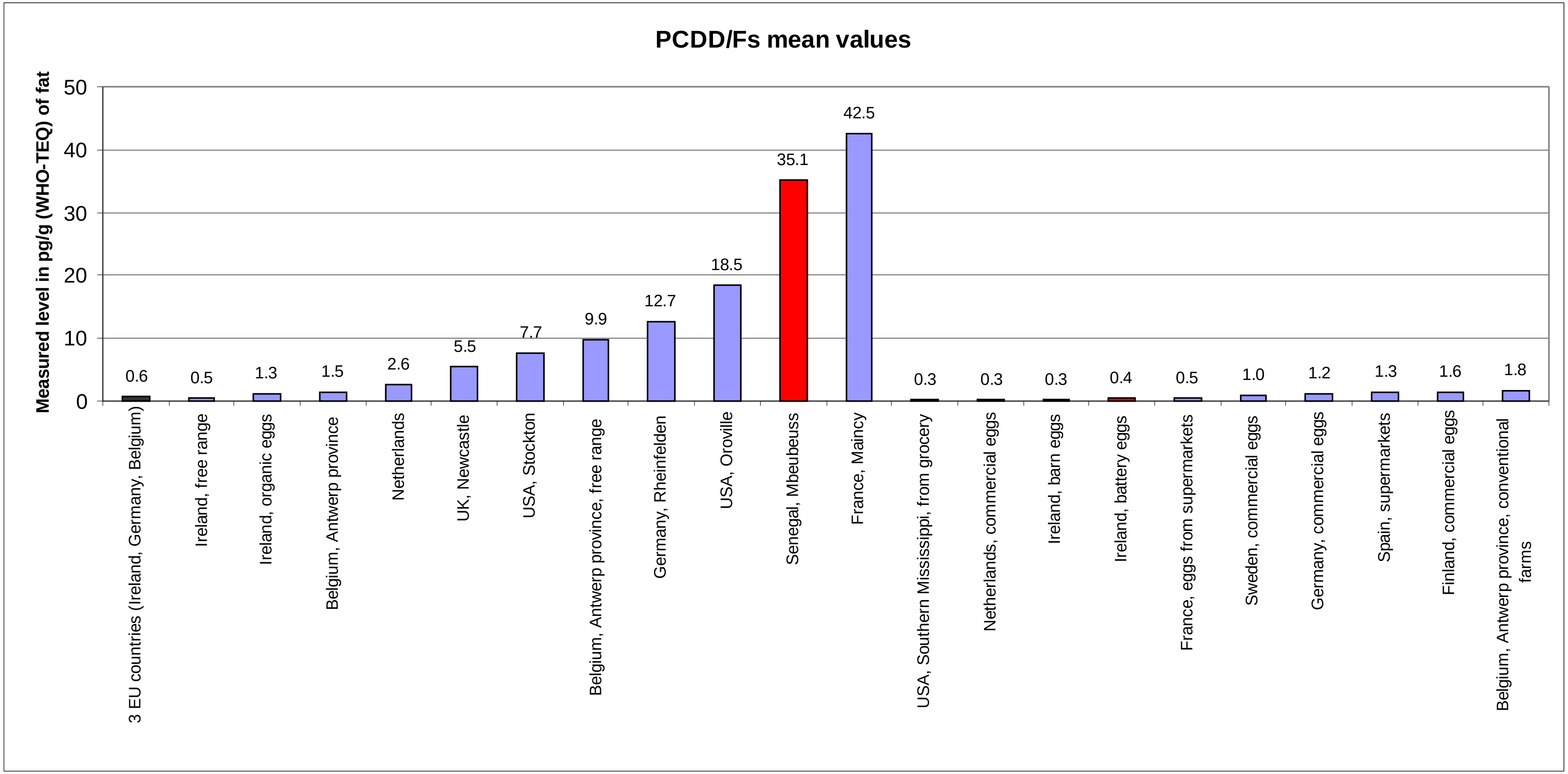
Analysis

After being received by the laboratory, the eggs were kept frozen until analysis. The egg shells were removed and the edible contents of 6 eggs were homogenised. A 30 g sub-sample was dried with anhydrous sodium sulphate, spiked by internal standards and extracted by toluene in a Soxhlet apparatus. A small portion of the extract was used for gravimetric determination of fat. The remaining portion of the extract was cleaned on a silica gel column impregnated with H_2SO4, NaOH and $AgNO_3$. The extract was further purified and fractionated on an activated carbon column. The fraction containing PCDD/Fs, PCBs and HCB was analysed by HR GC-MS on Autospec Ultima NT.

Analysis for PCDD/Fs, PCBs and HCB was done in the Czech Republic in laboratory Axys Varilab. Laboratory Axys Varilab, which provided the analysis is certified laboratory by the Institute for technical normalization, metrology and probations under Ministry of Industry and Traffic of the Czech Republic for analysis of POPs in air emissions, environmental compartments, wastes, food and biological materials.[a] Its services are widely used by industry as well as by Czech governmental institutions. In 1999, this laboratory worked out the study about POPs levels in ambient air of the Czech Republic on request of the Ministry of the Environment of the Czech Republic including also soils and blood tests.

Annex 2: Mean values found within different groups of eggs from different parts of world

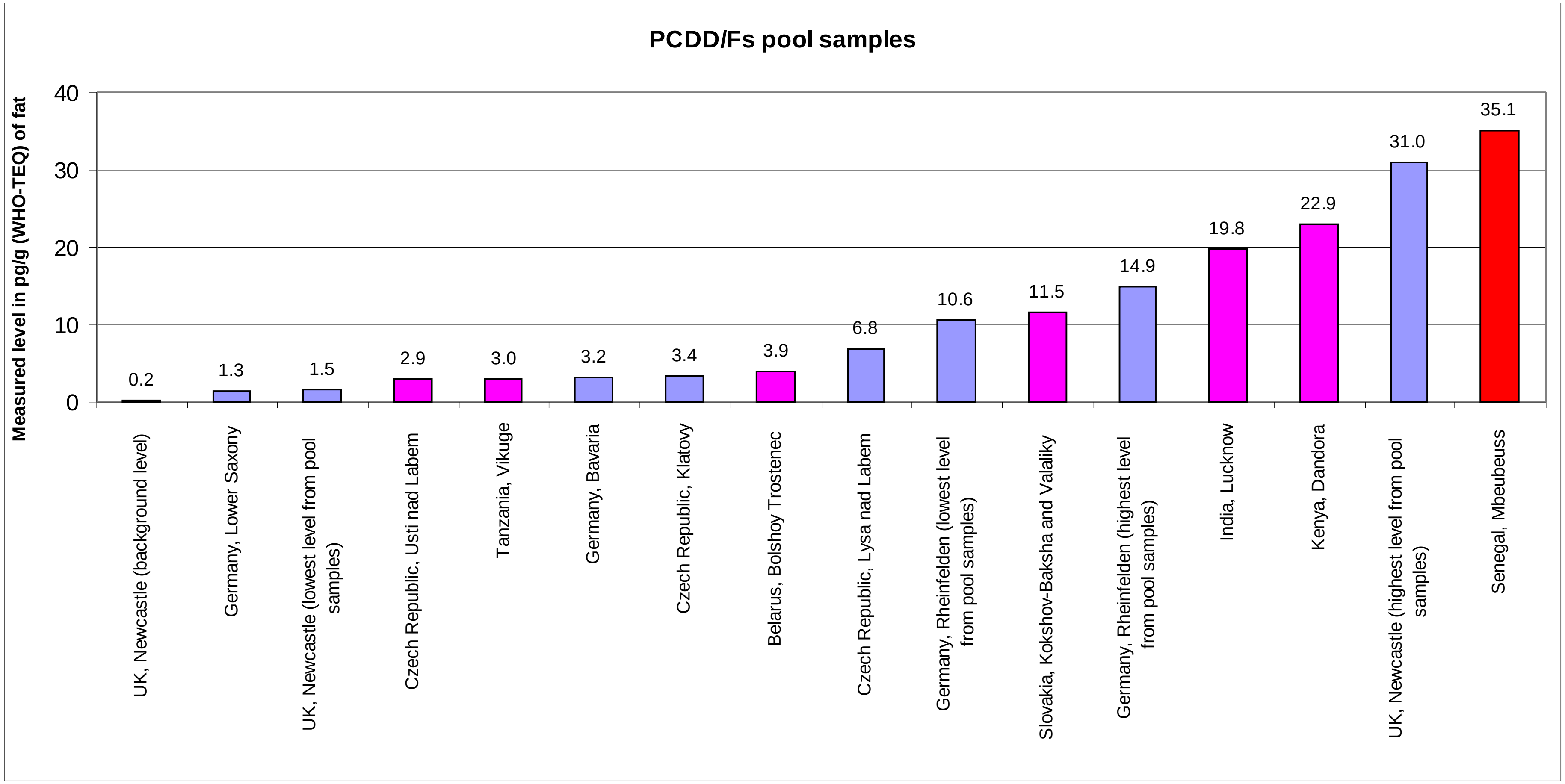
Country/locality	Year	Group	Measured level in pg/g (WHO-TEQ) of fat	Source of information
3 EU countries (Ireland, Germany, Belgium)	1997-2003	both	0.63	DG SANCO 2004
Ireland, free range	2002-2005	free range	0.47	Pratt, I. et al. 2004, FSAI 2004
Ireland, organic eggs	2002-2005	free range	1.30	Pratt, I. et al. 2004, FSAI 2004
Belgium, Antwerp province	2004	free range	1.50	Pussemeier, L. et al. 2004
Netherlands	2004	free range	2.60	SAFO 2004
UK, Newcastle	2002	free range	5.50	Pless-Mulloli, T. et al. 2003b
USA, Stockton	1994	free range	7.69	Harnly, M. E. et al. 2000
Belgium, Antwerp province, free range	2004	free range	9.90	Pussemeier, L. et al. 2004
Germany, Rheinfelden	1996	free range	12.70	Malisch, R. et al. 1996
USA, Oroville	1994	free range	18.46	Harnly, M. E. et al. 2000
Senegal, Mbeubeuss	2005	free range	35.10	Axys Varilab 2005
France, Maincy	2004	free range	42.47	Pirard, C. et al. 2004
USA, Southern Mississippi, from grocery	1994	not free range	0.29	Fiedler, H. et al. 1997
Netherlands, commercial eggs	2004	not free range	0.30	Anonymus 2004
Ireland, barn eggs	2002-2005	not free range	0.31	Pratt, I. et al. 2004, FSAI 2004
Ireland, battery eggs	2002-2005	not free range	0.36	Pratt, I. et al. 2004, FSAI 2004
France, eggs from supermarkets	1995-99	not free range	0.46	SCOOP Task 2000
Sweden, commercial eggs	1995-99	not free range	1.03	SCOOP Task 2000
Germany, commercial eggs	1995-99	not free range	1.16	SCOOP Task 2000
Spain, supermarkets	1996	not free range	1.34	Domingo et al. 1999
Finland, commercial eggs	1990-94	not free range	1.55	SCOOP Task 2000
Belgium, Antwerp province, conventional farms	2004	not free range	1.75	Pussemeier, L. et al. 2004



PCDD/Fs mean values
Measured level in pg/g (WHO-TEQ) of fat
0
10
20
30
40
50
0.6
0.5
1.3
1.5
2.6
5.5
7.7
9.9
12.7
18.5
35.1
42.5
0.3
0.3
0.3
0.4
0.5
1.0
1.2
1.3
1.6
1.8
3 EU countries (Ireland, Germany, Belgium)
Ireland, free range
Ireland, organic eggs
Belgium, Antwerp province
Netherlands
UK, Newcastle
USA, Stockton
Belgium, Antwerp province, free range
Germany, Rheinfelden
USA, Oroville
Senegal, Mbeubeuss
France, Maincy
USA, Southern Mississippi, from grocery
Netherlands, commercial eggs
Ireland, barn eggs
Ireland, battery eggs
France, eggs from supermarkets
Sweden, commercial eggs
Germany, commercial eggs
Spain, supermarkets
Finland, commercial eggs
Belgium, Antwerp province, conventional farms

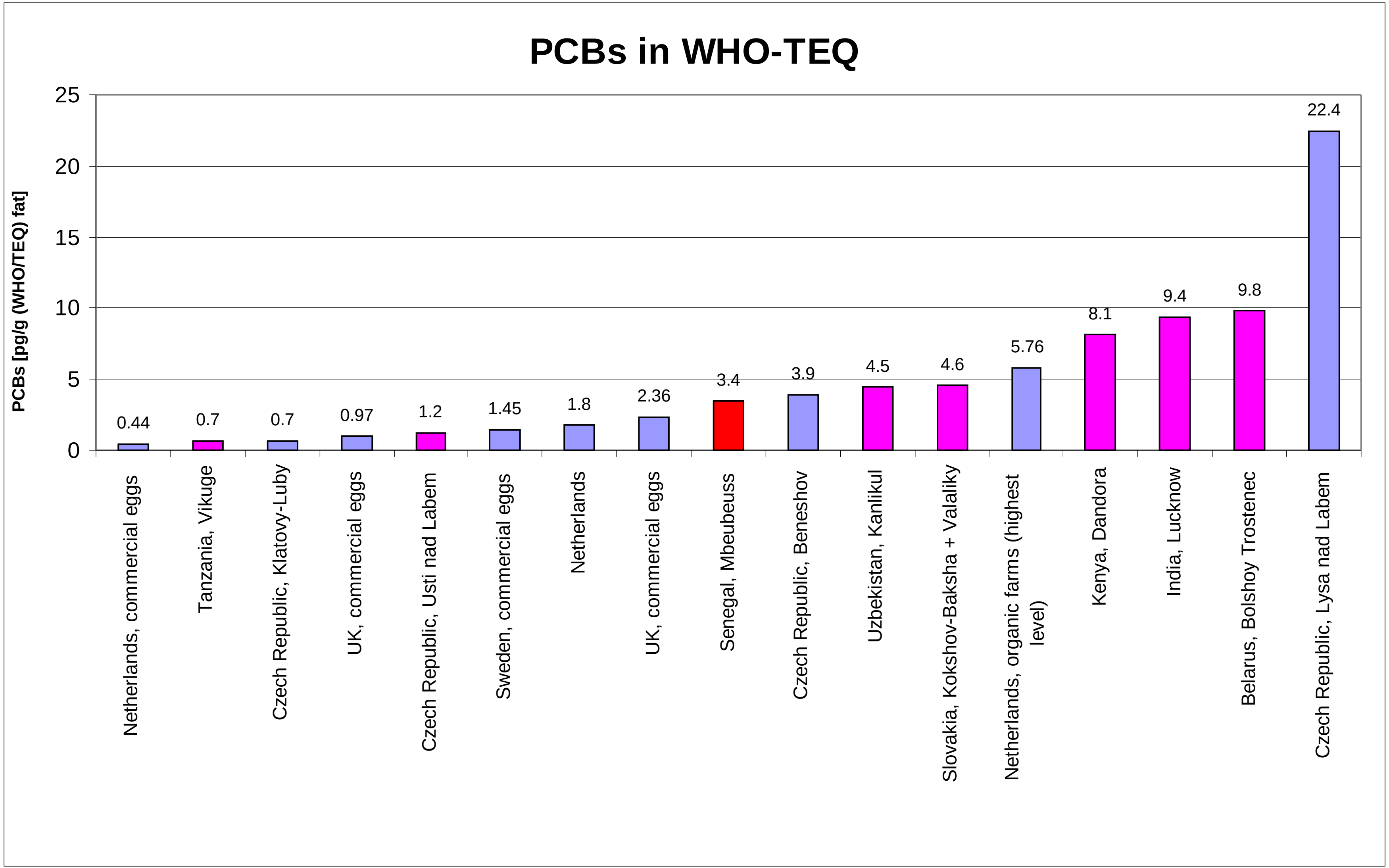
Annex 3: Levels of dioxins (PCDD/Fs) in different pool samples from different parts of world

Country/locality	Year	Group	Number of eggs/measured samples	Measured level in pg/g (WHO-TEQ) of fat	Source of information
UK, Newcastle (background level)	2000	free range	3/1 pooled	0.20	Pless-Mulloli, T. et al. 2001
Germany, Lower Saxony	1998	free range	60/6 pools	1.28	SCOOP Task 2000
UK, Newcastle (lowest level from pool samples)	2000	free range	3/1 pooled	1.50	Pless-Mulloli, T. et al. 2001
Czech Republic, Usti nad Labem	2005	free range	6/1 pooled	2.90	Axys Varilab 2005
Tanzania, Vikuge	2005	free range	6/1 pooled	3.03	Axys Varilab 2005
Germany, Bavaria	1992	free range	370/37 pools	3.20	SCOOP Task 2000
Czech Republic, Klatovy	2003	free range	12	3.40	Beranek, M. et al. 2003
Belarus, Bolshoi Trostenec	2005	free range	6/1 pooled	3.91	Axys Varilab 2005
Czech Republic, Lysa nad Labem	2004	free range	4	6.80	Petrlik, J. 2005
Germany, Rheinfelden (lowest level from pool samples)	1996	free range	-	10.60	Malisch, R. et al. 1996
Slovakia, Kokshov-Baksha and Valaliky	2005	free range	6/1 pooled	11.52	Axys Varilab 2005
Germany, Rheinfelden (highest level from pool samples)	1996	free range	-	14.90	Malisch, R. et al. 1996
India, Lucknow	2005	free range	4/1 pooled	19.80	Axys Varilab 2005
Kenya, Dandora	2004	free range	6/1 pooled	22.92	Axys Varilab 2005
UK, Newcastle (highest level from pool samples)	2000	free range	3/1 pooled	31.00	Pless-Mulloli, T. et al. 2001
Senegal, Mbeubeuss	2005	free range		35.10	Axys Varilab 2005


PCDD/Fs pool samples
Measured level in pg/g (WHO-TEQ) of fat
40
30
20
10
0
0.2
1.3
1.5
2.9
3.0
3.2
3.4
3.9
6.8
10.6
11.5
14.9
19.8
22.9
31.0
35.1
UK, Newcastle (background level)
Germany, Lower Saxony
UK, Newcastle (lowest level from pool samples)
Czech Republic, Usti nad Labem
Tanzania, Vikuge
Germany, Bavaria
Czech Republic, Klatovy
Belarus, Bolshoy Trostenec
Czech Republic, Lysa nad Labem
Germany, Rheinfelden (lowest level from pool samples)
Slovakia, Kokshov-Baksha and Valaliky
Germany, Rheinfelden (highest level from pool samples)
India, Lucknow
Kenya, Dandora
UK, Newcastle (highest level from pool samples)
Senegal, Mbeubeuss

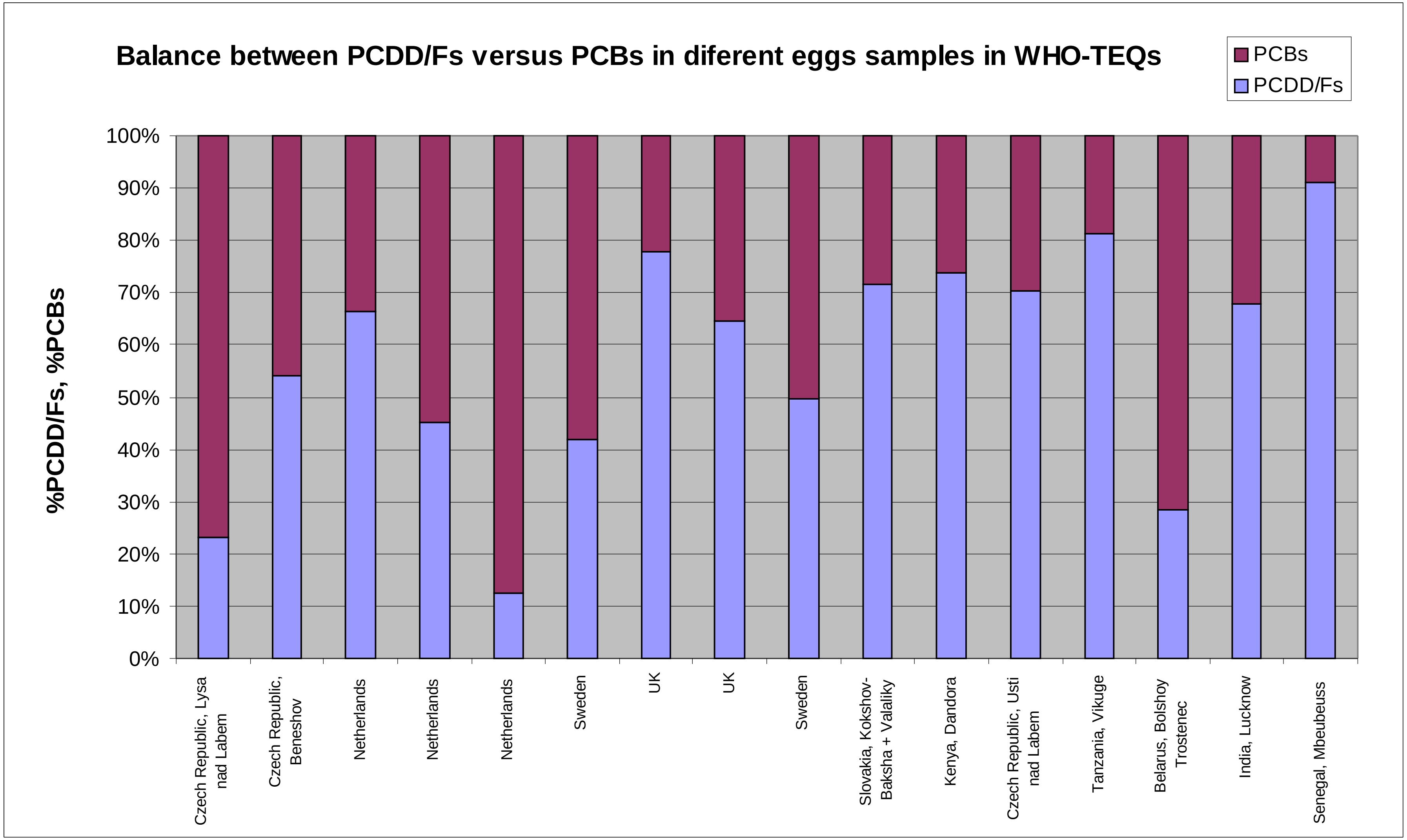
Annex 4: Levels of PCBs in WHO-TEQ in different chicken eggs samples from different parts of world

Country/locality	Year	Group	Number of measured samples	Specification	Measured level in pg/g (WHO-TEQ) of fat	Source of information
Netherlands, commercial eggs	1999	not free range	100/2 pools	pool, nonortho-PCBs	0.44	SCOOP Task 2000
Tanzania, Vikuge	2005	free range	6/1 pool	pool	0.70	Axys Varilab 2005
Czech Republic, Klatovy-Luby	2003	free range	free range	individual	0.70	Beranek, M. et al. 2003
UK, commercial eggs	1992	not free range	24/1 pool	pool	0.97	SCOOP Task 2000
Czech Republic, Usti nad Labem	2005	free range	6/1 pool	pool	1.20	Axys Varilab 2005
Sweden, commercial eggs	1999	not free range	32/4 pools	pool	1.45	SCOOP Task 2000
Netherlands	1990	mixed	8/2 pools	pool, nonortho-PCBs	1.80	SCOOP Task 2000
UK, commercial eggs	1982	not free range	24/1 pool	pool	2.36	SCOOP Task 2000
Senegal, Mbeubeuss	2005	free range		pool	3.40	Axys Varilab 2005
Czech Republic, Beneshov	2004	free range	4	pool	3.90	Axys Varilab 2004
Uzbekistan, Kanlikul	2001	free range	-	individual	4.50	Muntean, N. et al. 2003
Slovakia, Kokshov-Baksha + Valaliky	2005	free range	6/1 pool	pool	4.60	Axys Varilab 2005
Netherlands, organic farms (highest level)	2002	free range	6	pool	5.76	Traag, W. et al. 2002
Kenya, Dandora	2004	free range	6/1 pool	pool	8.10	Axys Varilab 2005
India, Lucknow	2005	free range	4/1 pooled	pool	9.40	Axys Varilab 2005
Belarus, Bolshoi Trostenec	2005	free range	6/1 pool	pool	9.80	Axys Varilab 2005
Czech Republic, Lysa nad Labem	2004	free range	4	pool	22.40	Petrlik, J. 2005


PCBs in WHO-TEQ
PCBs [pg/g (WHO/TEQ) fat]
25
20
15
10
5
0
0.44
0.7
0.7
0.97
1.2
1.45
1.8
2.36
3.4
3.9
4.5
4.6
5.76
8.1
9.4
9.8
22.4
Netherlands, commercial eggs
Tanzania, Vikuge
Czech Republic, Klatovy-Luby
UK, commercial eggs
Czech Republic, Usti nad Labem
Sweden, commercial eggs
Netherlands
UK, commercial eggs
Senegal, Mbeubeuss
Czech Republic, Beneshov
Uzbekistan, Kanlikul
Slovakia, Kokshov-Baksha + Valaliky
Netherlands, organic farms (highest level)
Kenya, Dandora
India, Lucknow
Belarus, Bolshoy Trostenec
Czech Republic, Lysa nad Labem

Annex 5: Balance between PCDD/Fs versus PCBs in diferent eggs samples in WHO-TEQs

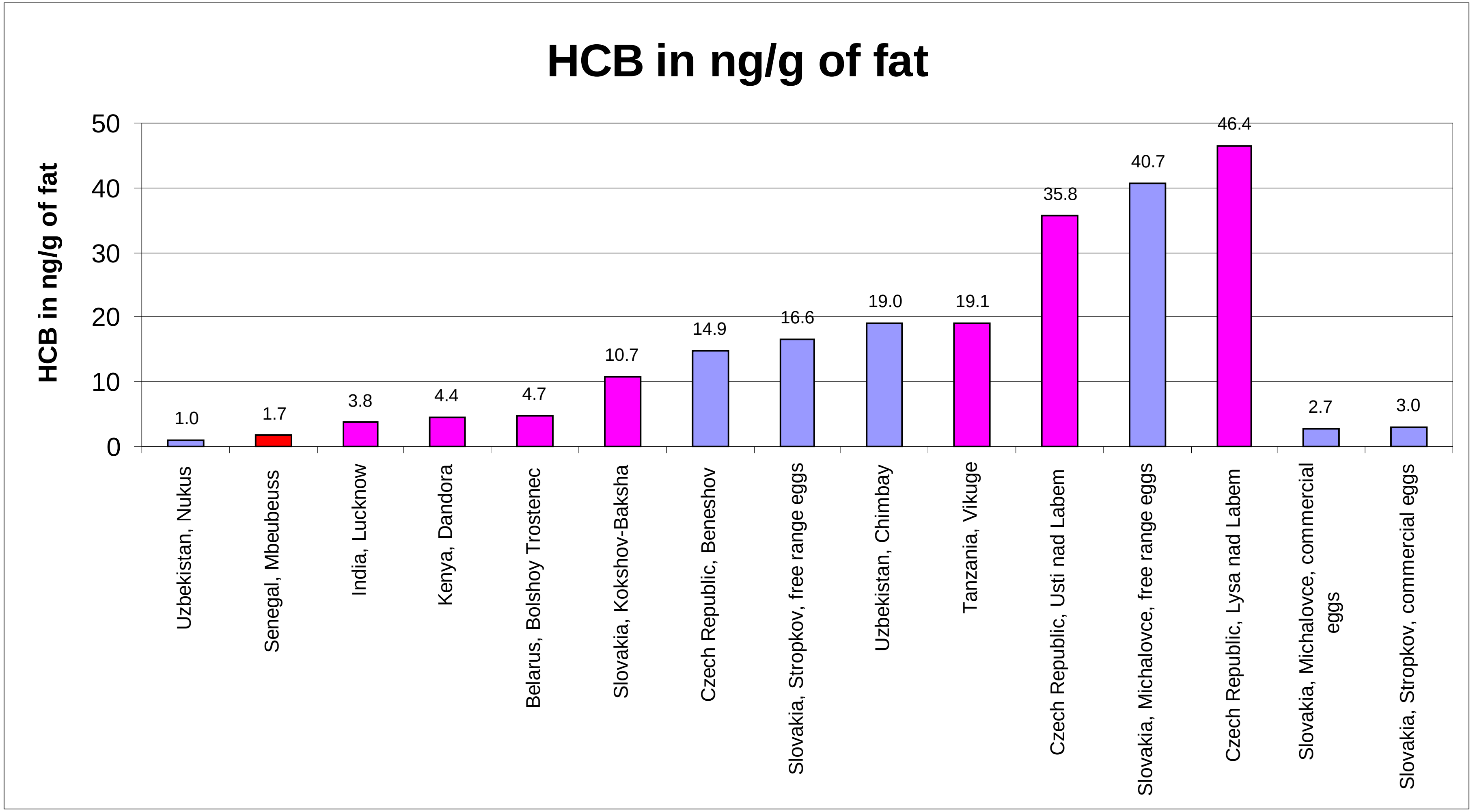
Country/locality	Year	Group	PCDD/Fs	PCBs	Total WHO-TEQ	Source of information
Czech Republic, Lysa nad Labem	2004	free range	6.80	22.40	29.20	Petrlik, J. 2005
Czech Republic, Beneshov	2004	free range	4.60	3.90	8.50	Axys Varilab 2004
Netherlands	2002	free range	3.01	1.52	4.53	Traag, W. et al. 2002
Netherlands	2002	free range	4.74	5.76	10.50	Traag, W. et al. 2002
Netherlands	2002	free range	0.70	4.89	5.59	Traag, W. et al. 2002
Sweden	1993	mixed	1.31	1.82	3.13	SCOOP Task 2000
UK	1982	not free range	8.25	2.36	10.61	SCOOP Task 2000
UK	1992	not free range	1.77	0.97	2.74	SCOOP Task 2000
Sweden	1999	not free range	1.43	1.45	2.48	SCOOP Task 2000
Slovakia, Kokshov-Baksha + Valaliky	2005	free range	11.52	4.60	16.12	Axys Varilab 2005
Kenya, Dandora	2004	free range	22.92	8.10	31.02	Axys Varilab 2005
Czech Republic, Usti nad Labem	2005	free range	2.90	1.22	4.12	Axys Varilab 2005
Tanzania, Vikuge	2005	free range	3.03	0.70	3.73	Axys Varilab 2005
Belarus, Bolshoi Trostenec	2005	free range	3.91	9.83	13.74	Axys Varilab 2005
India, Lucknow	2005	free range	19.80	9.40	29.20	Axys Varilab 2005
Senegal, Mbeubeuss	2005	free range	35.10	3.44	38.54	Axys Varilab 2005



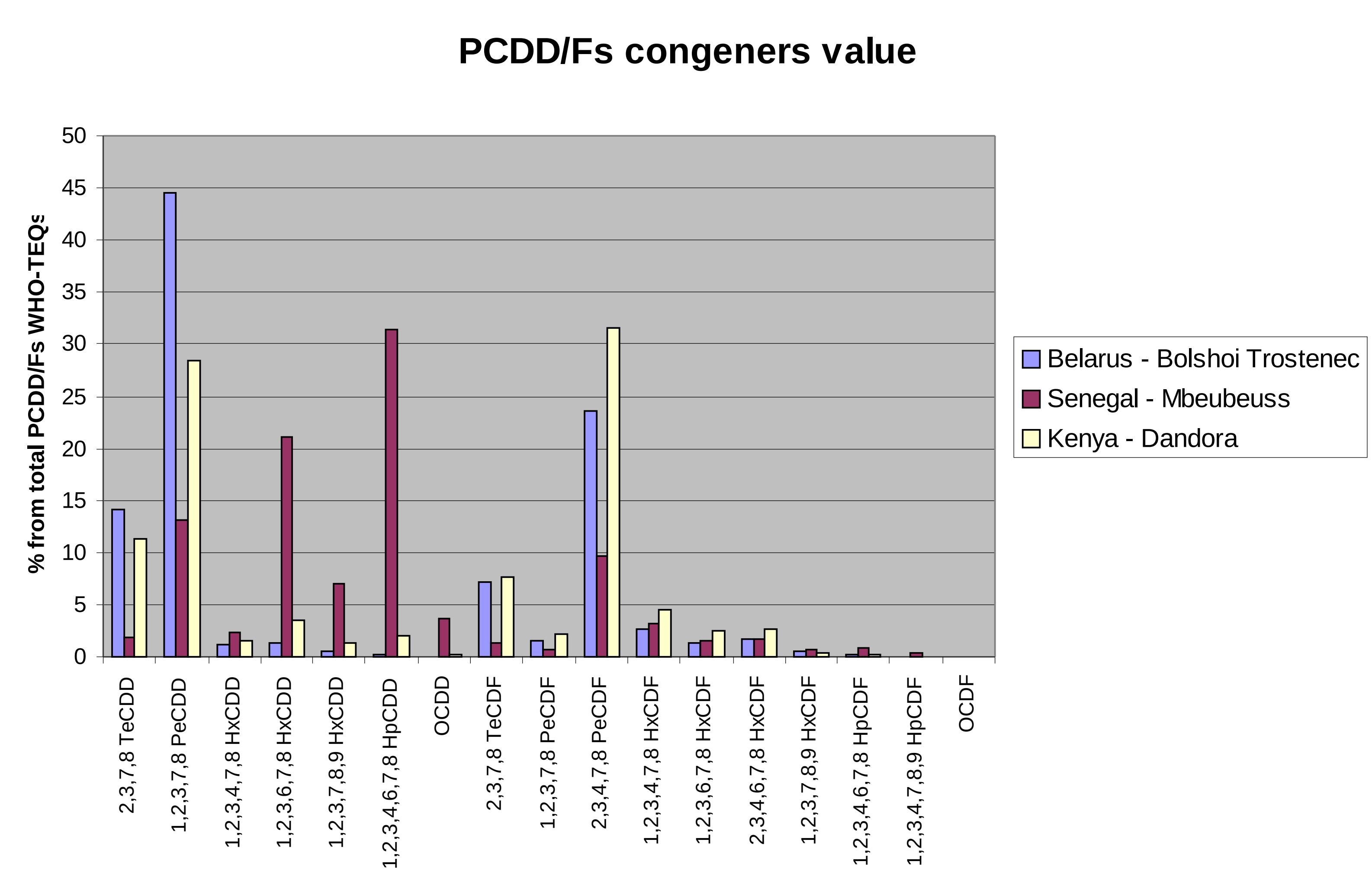
Balance between PCDD/Fs versus PCBs in diferent eggs samples in WHO-TEQs
PCBs
PCDD/Fs
%PCDD/Fs, %PCBs
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Czech Republic, Lysa nad Labem
Czech Republic, Beneshov
Netherlands
Netherlands
Netherlands
Sweden
UK
UK
Sweden
Slovakia, Kokshov-Baksha + Valaliky
Kenya, Dandora
Czech Republic, Usti nad Labem
Tanzania, Vikuge
Belarus, Bolshoy Trostenec
India, Lucknow
Senegal, Mbeubeuss

Annex 6: Levels of HCB in ng/g of fat in different chicken eggs samples from different parts of world

Country	Date/year	Specification	Number of measured samples	Measured level in ng/g of fat	Source of information
Uzbekistan, Nukus	2001	free range	-	1.0	Muntean, N. et al. 2003
Senegal, Mbeubeuss	2005	free range		1.7	Axys Varilab 2005
India, Lucknow	2005	free range	4/1 pooled	3.8	Axys Varilab 2005
Kenya, Dandora	2004	free range	6/1 pool	4.4	Axys Varilab 2005
Belarus, Bolshoi Trostenec	2005	free range	6/1 pool	4.7	Axys Varilab 2005
Slovakia, Kokshov-Baksha	2005	free range	6/1 pool	10.7	Axys Varilab 2005
Czech Republic, Beneshov	2004	free range	4/1 pool	14.9	Axys Varilab 2004
Slovakia, Stropkov, free range eggs	before 1999	free range	1	16.6	Kocan, A. et al. 1999
Uzbekistan, Chimbay	2001	free range	-	19.0	Muntean, N. et al. 2003
Tanzania, Vikuge	2005	free range	6/1 pool	19.1	Axys Varilab 2005
Czech Republic, Usti nad Labem	2005	free range	6/1 pool	35.8	Axys Varilab 2005
Slovakia, Michalovce, free range eggs	before 1999	free range	1	40.7	Kocan, A. et al. 1999
Czech Republic, Lysa nad Labem	2004	free range	1	46.4	VSCHT 2005
Slovakia, Michalovce, commercial eggs	before 1999	not free range	1	2.7	Kocan, A. et al. 1999
Slovakia, Stropkov, commercial eggs	before 1999	not free range	1	3.0	Kocan, A. et al. 1999


HCB in ng/g of fat
HCB in ng/g of fat
0
10
20
30
40
50
1.0
1.7
3.8
4.4
4.7
10.7
14.9
16.6
19.0
19.1
35.8
40.7
46.4
2.7
3.0
Uzbekistan, Nukus
Senegal, Mbeubeuss
India, Lucknow
Kenya, Dandora
Belarus, Bolshoy Trostenec
Slovakia, Kokshov-Baksha
Czech Republic, Beneshov
Slovakia, Stropkov, free range eggs
Uzbekistan, Chimbay
Tanzania, Vikuge
Czech Republic, Usti nad Labem
Slovakia, Michalovce, free range eggs
Czech Republic, Lysa nad Labem
Slovakia, Michalovce, commercial eggs
Slovakia, Stropkov, commercial eggs

Annex 7: Comparison of PCDD/Fs patterns between pooled eggs samples from localities close to different dumpsites



Annex 8: Composition of household waste disposed at Mbeubeuss rubbish dumpsite in %

Categories	Department of Dakar					Department of Pikine			Department of Rufisque
	Plateau	Liberte II	Dieupeul	Médina	Grand dakar	Dagoudane	Thiaroye	Diamaguen	
Organic waste	58.9	58.4	54.9	43.6	47.3	34.5	42.8	34.5	35.2
Textiles	2.4	4.2	3.5	8.6	3.7	3.9	4.1	2.3	6.1
Cardboard	23.1	6.8	6	10.2	7.1	5.4	6.2	4.2	6.1
Ferrous metals	3.9	4.1	4.3	4.9	3.3	2.7	1.6	1.5	3.1
Non ferrous metals	0	0	0	0	0	0	0	0	0
Plastics	5.2	3.9	2.6	6.6	3.5	3.5	3.5	2.4	4.4
Glass	0.9	1.1	1.1	0.7	2.4	1.4	1.3	0.5	0.9
Ceranic stones	0.5	3.6	2.2	1.8	3.3	3.8	1.8	3.3	2
remainder	0.6	4.1	3	4.4	1.8	6.5	6.6	8.8	9.8
Thin and losses	4.5	11.8	22.4	19.2	27.4	38.3	32.1	42.5	32.4
Total	100	100	100	100	100	100	100	100	100

Sources : Republic of Senegal/Ministry of Tourism and the Protection of the environment/The environmental department (1990): Study of the impacts of Mbeubeuss rubbish

Annex 7: Photos

Photo 1: The rubbish dump of Mbeubeuss in the background hidden by a thick cloud of smoke emanating from the dump. Source: République du Sénégal / Ministere du Tourisme et de la Protection de l'Environnement / Direction de l'Environnement 1990.[17]

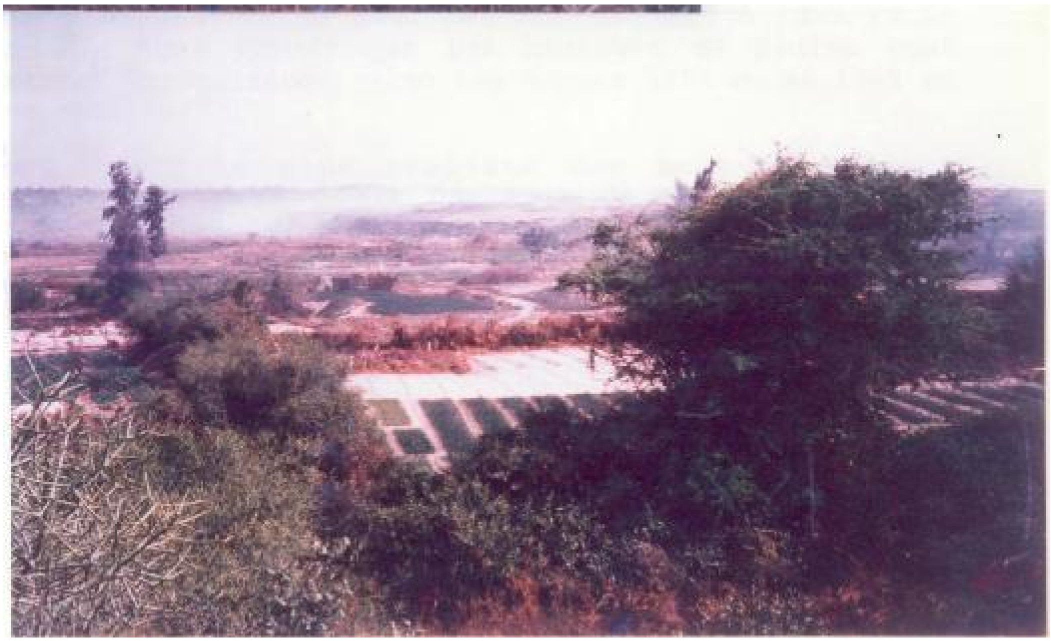


Photo 2: Huge quantities of plastic disposed at the Mbeubeuss dumpsite. Photo by: PAN Africa.

Photo 3: Black substance leak from the waste dumped at the landfill. Photo by: PAN Africa.

Photo 4: Sampling place. Chicken foraging at the chicken walk - in Malika site, 0.7 km far from dumpsite edge. Photo by: PAN Africa.

Photo 5: Market garden growing near the garbage dump. Photo by: PAN Africa.

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