

DDT in Eggs

A Global Review

IPEN Pesticides Working Group

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Keep the Promise Eliminate POPs Report

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**IPEN POPs / Pesticides Working Group
Keep the Promise, Eliminate POPs**

Abstract

DDT is a persistent organic pollutant (POP) slated for global reduction and elimination under the Stockholm Convention. Like other POPs, DDT is highly persistent; bioaccumulates in the food chain; travels long distances; and displays a variety of adverse effects. Parties to the Convention are permitted to use DDT for disease vector control in accordance with World Health Organization (WHO) guidelines. Fifteen countries use DDT for disease vector control and an additional six countries have reserved the right to use DDT in the future. Currently, some DDT use does not comply with Convention obligations. DDT exposure also occurs due to its wide presence in obsolete stockpiles and wastes. Most of the DDT present in humans comes from foods such as meat, fish, and dairy products. In this study, IPEN collected eggs from free-range hens living close to selected hot spots in 18 countries and analysed them for DDT, including p,p'-DDT, o,p'-DDT, p,p'-DDE and p,p'-DDD. Results were compared to background levels and limits established by the European Union (EU) and USA. DDT levels in the eggs ranged from background levels to over 7,000 ng g⁻¹ fat; 14 times higher than the EU maximum residue limit. At two sites, the composite egg samples indicate a fresh load of DDT. The highest DDT levels were found in seven countries: Bulgaria, Czech Republic, India, Kenya, Mexico, Pakistan, and Tanzania. These sites include residential areas near obsolete pesticide stockpiles, pesticide storage facilities, and a DDT production facility. The results indicate the need to fully implement Stockholm Convention provisions on DDT and wastes, including development of action plans to implement suitable alternative control strategies; obligations for reporting; and remediation of contaminated sites using methods that destroy or irreversibly transform their POPs content.

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Introduction

The insecticide properties of dichlorodiphenyl-trichloroethane (DDT) were discovered in 1939 and since then, about 1.8 million tons of DDT have been produced all around the world (Dejonckheere, 1990). During the 1970s, industrial countries started to ban the use of DDT as a pesticide for agricultural use. Concentrations of DDT in the environment did not start to significantly decrease immediately after this ban due to the persistence of this compound, illegal usage of remaining stocks, old burdens and the import of some feed from developing countries, where the use of DDT was still allowed (Holoubek et al., 2003). In other regions of the world, DDT is still used.

DDT is listed under Annex B of the Stockholm Convention on Persistent Organic Pollutants (POPs), which means that it is globally recognised as a POP and that all production and use should be reduced and ultimately eliminated. Under the Convention's acceptable use exemption, Parties are obligated to only use or produce DDT under the following conditions: 1) DDT is used exclusively for disease vector control in accordance with World Health Organization (WHO) guidelines; 2) its use is locally safe and effective; and 3) affordable alternatives are not available (Annex B, Part II, paragraph 2). Parties must notify the Stockholm Secretariat and WHO that they wish to use DDT under these conditions and must report every three years on the amount used, conditions of use, and its relevance to the country's disease management strategy (Annex B, Part II, paragraph 3 and 4). Parties are also encouraged by the Convention to develop a mechanism that ensures DDT is only used for disease vector control and to implement suitable alternative control strategies (Annex B, Part II, paragraph 5 (a) and subparagraphs (i) and (ii)). Parties can also be granted a time-limited specific exemption to use DDT in the manufacture of dicofol in a non-closed system.¹ China and India have both

¹ Note that the Convention permits the use of DDT as a site-limited intermediate in closed-system production (for example in dicofol production). Brazil, China, and India have notified the

received exemptions for this specific use. In July 2008, China notified the Stockholm Convention Secretariat that it would not request an extension for its exemption, which was set to expire in May 2009. India has requested the Fourth Conference of the Parties to grant an extension for its exemption, which expires in 2011.

Current use of DDT occurs in the African and Asia-Pacific regions and does not always follow Stockholm Convention obligations. The Stockholm Convention Expert Group on DDT² estimates that 15 countries use DDT for disease vector control³ and an additional six countries have reserved the right to use DDT in the future.⁴ Five Parties use DDT but have not notified the Secretariat and WHO as required by the treaty.⁵ The Expert Group notes also that 80% - 90% of the global use of DDT for disease vector control occurs in India. Two countries export DDT⁶ and some exporting has not been in accordance with WHO guidelines and requirements. The Convention requires safe and effective use of DDT but the Expert Group notes examples of poor quality spray equipment and sparse coverage of targeted houses.

The Convention encourages implementation of alternative control strategies. In practice this has focused on insecticide treated nets (ITN) and indoor residual spraying (IRS) with alternative pesticides. The Expert Group notes that integrated vector management (IVM) needs to be promoted and that non-chemical methods have an essential role to play but have not

Secretariat that they are using DDT for this purpose.

² UNEP/POPS/COP.4/5

³ DPR Korea, Eritrea, Ethiopia, Gambia, India, Mauritius, Mozambique, Myanmar, Namibia, South Africa, Swaziland, Uganda, Yemen, Zambia, Zimbabwe

⁴ Botswana, China, Madagascar, Marshall Islands, Morocco, and Senegal

⁵ DPR Korea, Eritrea, Gambia, Namibia, and Zambia

⁶ India and China

received sufficient attention in current malaria control efforts.

Large amounts of DDT appear to be widely present in obsolete stockpiles and wastes. The DDT Expert Group notes that DDT stocks kept for malaria outbreaks could become obsolete wastes and that cradle-to-grave management of stocks should be part of any donor-funded IRS program that uses DDT. The Stockholm Convention requires cleanup and proper disposal of all POPs-containing wastes and stockpiles. This includes safe handling, collection, transport, and storage, along with a requirement that the POPs content be destroyed or irreversibly transformed so that it no longer exhibits POPs characteristics.

A detailed literature review of the environmental fate and toxicology of DDT is beyond the scope of this study. However, it should be mentioned that DDT is highly persistent in the environment and subject to long-range transport and thus found even in remote areas far from emission sources (Risebrough, 1990; De Voogt and Jansson, 1993). DDT is also very fat soluble, which promotes its bioaccumulation up the food chain (Morrison and Newell, 1999). Since the 1960s, eggshell thinning (Wiemeyer et al., 1988; Blus et al., 1997) and feminization of birds and reptiles (Anderson et al., 1982; Fry, 1995) have been associated with DDT. Despite significantly decreasing levels in wildlife (e.g. osprey eggs and prey in New Jersey, USA, see Clark et al., 2001), residues found in some biota samples still exceed the maximum permissible residue levels for DDT for food and feed, even in countries that have long ago ceased using it (e.g. peregrine falcon eggs sampled in Germany in recent years, see von der Trenck et al., 2006).

Effects of DDT on the nervous system have been observed in both humans and animals (Faroon et al., 2002). In the environment, DDT breaks down mainly to dichlorodiphenyl-dichloroethylene (DDE) (Hoh and Hites, 2004) and also dichlorodiphenyldichloroethane (DDD). Commercial products contain a small amount of these substances (Iwata et al., 1993). DDT, DDE, and DDD are all implicated in adverse health effects. DDE has been associated with anti-androgenic activity in men

(Kelce et al., 1995) and increased occurrence of breast cancer in women (Wolff et al., 1993; Cohn et al., 2007). Additionally, an increased risk of abortion, premature delivery and decreased fetal growth were associated with DDE in blood and placenta (Kamrin et al., 1994, Longnecker et al. 2001, and 2005). Human health impacts from DDT exposure due to IRS could include shortened duration of lactation and an increase in preterm birth, raising concerns about increases in infant mortality (Chen and Rogan, 2003). The United States Environmental Protection Agency (EPA) has classified DDT, DDE, and DDD under Group B2, probable human carcinogens. The International Agency for Research on Cancer (IARC) has also determined that DDT, DDE, and DDD are possibly carcinogenic to humans (Group 2B).

Humans are exposed to DDT mainly through ingestion (Faroon et al., 2002; Guo, 2004). It has been estimated that over 90% of the DDT stored body burden in the general population is derived from food, particularly fatty foods of animal origin, e.g. meat, fish and dairy products (WHO, 2004; WHO Regional Office for Europe, 2003). In many countries chicken eggs are among the most popular food items. In China, for example, daily consumption of chicken eggs is increasing (Wang, 2006). Although Tao et al. (2009) suggest that environmental levels of DDTs have decreased substantially over the past two decades in China, this does not mean that potential DDT contamination should not be a public health concern. Tao et al. (2009) estimated the exposure of Chinese children aged below 7 years to DDTs through chicken and egg consumption to be 140% of those through fish consumption (based on results obtained from a single chicken farm in Beijing and a single study on fish in the Guangdong province). Obviously, the contribution of chicken meat and eggs to the total exposure by DDTs should not be ignored.

Home-produced foodstuffs are generally not submitted to any compliance control, although private owners of free-range hens might consume large quantities of their own produced eggs. If this food item is contaminated, these individuals may have different exposure levels than what is

considered a "background" level (Stephens et al., 1995). Also, contaminant levels in the eggs from free-range hens are considered good indicators of the contamination of the environment in which the hens live (Chang et al., 1989).

A few years ago, IPEN collected eggs from free-range hens living close to selected hot spots in various countries and continents and analysed them for the presence of poly-brominated diphenyl ethers, lindane (hexachlorocyclohexane) (Blake, 2005), polychlorinated biphenyls, dioxins and hexachlorobenzene (DiGangi and Petrlik,

2005). Levels of DDTs in these eggs were also obtained and the results are evaluated and discussed in this study. Obviously, the character of a number of hotspots that were chosen does not lead to expectations of elevated levels of DDTs, as they were chosen on the basis of expectations of elevated levels of other POPs (as demonstrated by the above-mentioned studies). Nevertheless, the analysis of DDTs reveals interesting findings. The Czech IPEN partner organization Arnika conducted the occasional sampling of eggs at various Czech POPs hotspots and analysed them for DDTs, and these samples are included in this study.



Photo 1: Obsolete pesticide storage in Dures (Albania); part of the abandoned lindane production facility. Photo by Ladislav Kleger, 2006.

Materials and Methods

Sampling

For sampling in each country, IPEN participating organizations chose an area close to a potential or known POP source. One to sixteen eggs from one to eight chicken fancies were sampled from the chosen area, and sampling details recorded included: description of location, chicken feed, details about the range covered by the chickens, age of chickens, geographical coordinates of the sampling location and additional data. The hens from which the eggs were picked were all free-range, though occasionally (sometimes regularly) provided with homemade or purchased feed. All hens could easily access soil organisms. The sampling was done between June 2003 and April 2006, and one additional sampling in Albania was done in March 2009. The eggs were kept in cool conditions after sampling.

Eggs from the Czech locations Klatovy – Luby, Lysa nad Labem, Pseves and Liberec (sample B) were analysed raw. Eggs from outside the Czech Republic were boiled in the country of origin for 7 – 10 minutes in pure water and then transported by express services and personally by IPEN participating organizations to the laboratory at ambient temperature. This was done for two reasons: (1) conservation during transport, and, more especially, (2) restrictions imposed by the Czech State Veterinary Administration, which allowed only the import of boiled eggs due to the threat of bird influenza.

Sampling details are summarized in Table 1.

Analyses

In all samples, egg whites and yolk were analyzed. All eggs except the sample from Lysa nad Labem (Czech Republic, see below) were analysed by the Axys Varilab CZ laboratory (Vrane nad Vltavou, Czech Republic). The laboratory Axys Varilab is jointly owned by a Czech – Canadian company that is certified by the Institute for Technical Normalization, Metrology and Probations under the Ministry of Industry and Traffic of the Czech Republic, for analysis of POPs in air

emissions, environmental compartments, wastes, food and biological materials. Its services are widely used by industry as well as by Czech governmental institutions. In 1999, this laboratory worked on the study of POP levels in the ambient air of the Czech Republic upon request of the Ministry of the Environment of the Czech Republic. That study also included soil and blood tests.



Photo 2: Eloor (India); Hindustan Insecticides Ltd (HIL) plant, the burnt down endosulfan production unit. Photo by Nityanand Jayaraman, 2004.

After being received by the laboratory, the boiled eggs were kept frozen until analysis. The egg shells were removed and the edible contents of 3 to 12⁷ eggs were homogenized. The numbers of eggs analyzed in the pooled

⁷ The number of eggs per pooled sample differed from place to place due to several factors: Czech veterinary restrictions on sending them to the laboratory, the need for extra eggs in case of laboratory problems, or for use in analysing other POPs as described in separate reports.

samples are in Table 1. 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 H₂SO₄, NaOH and AgNO₃. The extract was further purified and fractionated on an activated carbon column. The fraction containing OCPs was analyzed by HR GC-MS on Autospec Ultima NT.

The eggs from Liberec (Czech Republic) sample B were analysed twice to study the effect of boiling on DDT content in eggs. In the first analysis, a subsample of a raw mixture of egg white and yolk was analyzed. In the second test, the mixture was injected into a hollow egg shell, sealed and boiled in water for 10 minutes. The egg content was then analysed as boiled eggs.

The limit of determination (LOD) for samples analysed by Axys Varilab CZ is based on the lowest calibration point and varied between 0.1 to 0.5 ng g⁻¹ fat (Table 3). Recoveries for DDE ranged from 68 - 147 %, for DDT from 38 to 117 %.

The eggs from Lysa nad Labem (Czech Republic) were analysed by the laboratory at the Department of Food and Chemistry Analysis at the Institute of Chemical Technology (Prague, Czech Republic). The isolation of target compounds from egg samples was performed by Soxhlet extraction with *n*-hexane and dichloromethane as extraction solvent mixture. The clean-up of crude extracts was carried out by gel permeation chromatography. For identification of OCPs, a GC with two parallel capillary columns with different polarity of stationary phases (DB-5, DB-17) was used. Two parallel electron capture detectors were employed for detection. Identification of analytes was carried out by comparison of retention times in the sample chromatogram with analytes in standard. For quantification of target compounds, a multilevel calibration curve was used. No LOD values and recoveries were provided.

Photo 3: Indian Pesticides Limited near Lucknow (Uttar Pradesh, India): factory manufacturing lindane and chlorpyrifos. In the nearby village of Takia, chicken eggs were sampled for analysis on DDT. There is an obsolete pesticides stockpile in this picture. Photo by Toxics Link, 2004.



Table 1: Brief description of sampling locations, number of eggs analyzed, age and feed of hens and date of sampling.

Site	Country	Hot-spot	Eggs analyzed	Age of hens	Hen feed	Date of sampling
Elbasan I	Albania	Metallurgical complex	1 fancier / 1 egg	2 years	Occasionally provided with home feed supplements	Mar 2006
Elbasan II	Albania	Cement kiln	2 fanciers / 3 eggs	1 – 3 years	Occasionally provided with home feed supplements	Mar 2006
Porto Romano	Albania	Chemical plant – abandoned lindane production	2 fanciers / 3 eggs	2 – 3 years	Occasionally provided with home feed supplements	Mar 2006
Rubik - Paraspur	Albania	Abandoned copper smelter	2 fanciers / 4 eggs	1 – 3 years	Occasionally provided with home feed supplements	Mar 2009
Bolshoi Trostenech	Belarus	Mixed waste landfill site (fires)	2 fanciers / 6 eggs	1,5-2 years	Local hey, nettle, barley, bread	Jan 2005
Kovachevo	Bulgaria	Power plants, coal mines, industrial area, storage of obsolete pesticides	3 fanciers / 6 eggs	1 – 3 years	Local wheat, grains, barley, chickpeas, soy, special component to increase laying of eggs	Jan 2005
Klatovy – Luby A ⁺ , B ⁺	Czech Rep.	Abandoned pesticides stockpile	1 fancier / A 1 egg / B 12 eggs	NA	Occasionally provided with home feed supplements	Jun – Jul 2003
Liberec A, B, B ⁺	Czech Rep.	Municipal waste incinerator, secondary steel production	1 fancier / 3 eggs / 3 eggs / 3 eggs	2 years	Provided with mixture of cereals (bought feeding from local farm), wheat	Feb 2005
Lysa nad Labem ⁺	Czech Rep.	Hazardous waste incinerator	1 fancier / 1 egg	2-3 years	Regularly provided with bought grains	Feb 2004
Pseves ⁺	Czech Rep.	Vicinity of former pesticide stockpile	1 fancier / 6 eggs	2 years	Regularly provided with bought grains	Apr 2006
Usti nad Labem	Czech Rep.	Chlor-alkali plant producing different chlorine products	1 fancier / 6 eggs	1-2 years	Leftovers from school kitchen, wheat	Jan 2005
Helwan	Egypt	Metalurgy, cement kiln	1 fancier / 6 eggs	NA	Occasionally provided with local feed	Jan 2005
Eloor	India	Production of OCPs (including DDT)	6 fanciers / 6 eggs	8 months – 2,5 years	Occasionally provided with leftovers from kitchen (especially rice), feed from market	Feb 2005
Lucknow	India	Medical waste incinerator	1 fancier / 4 eggs	1-1,5 years	Home grain available	Jan 2005

Takia	India	Production of OCPs	3 fanciers / 6 eggs	1 year	Grains available	Jan 2005
Nairobi - Dandora	Kenya	Dumpsite (fires)	2 fanciers / 6 eggs	6 – 9 months	Provided with bought feed only up to 1 month of age	Dec 2004
Coatzacoalcos	Mexico	Petrochemical complex	1 fancier / 6 eggs	7 – 15 months	Regularly provided with locally grown maize	Jan 2005
Santos / Matola	Mozambique	Cement kiln burning waste, obsolete pesticides storage	3 fanciers / 6 eggs	NA	Occasionally fed by different feeding stuffs	Jan 2005
Peshawar	Pakistan	Abandoned municipal waste dumpsite	1 fancier / 3 eggs	3 years	Occasionally provided with kitchen leftovers	March 2005
Barangay Aguado	Philippines	Medical waste incinerator	3 fanciers / 6 eggs	1-2 years	Regularly given supplementary feed from local Sustamina Feeds Company, rice, corn, kitchen leftovers	Jan 2005
Gorbatovka	Russia	Chlorine chemical industry, hazardous waste incinerator	3 fanciers / 4 eggs	10 months – 6 years	Regularly provided with grain, unregularly with kitchen leftovers	Jan 2005
Igumnovo	Russia	Chlorine chemical industry, hazardous waste incinerator	2 fanciers / 4 eggs	3-6 years	Provided with grain once a day	Jan 2005
Malika	Senegal	Dumpsite (fires)	3 fanciers / 6 eggs	8-12 months	Regularly provided with kitchen leftovers, millet, grains, telluric organisms, one chicken fancier also used SEDIMA feed*	Jan 2005
Sangalkam	Senegal	Pesticides application area	4 fanciers / 8 eggs	1 - 2 years	SEDIMA feed*, grains, kitchen leftovers, cereals, telluric organisms, millet	Jan 2005
Koshov- Baksha / Valaliky	Slovakia	Municipal waste incinerator	5 fanciers / 6 eggs	1,5-3 years	Provided with home grown feed, dried grass, wheat, potatoes, corn, beet, tritikale (wheat and barley hybrid), food residues	Feb 2005
Vikuge	Tanzania	Obsolete pesticides storage	3 fanciers / 6 eggs	NA	Occasionally provided with home feed supplements	Jan 2005
Izmit	Turkey	Hazardous waste incinerator	4 fanciers / 6 eggs	4 months – 1 year	Regularly provided with home grown wheat, barley, oats, maize	Jan 2005
Mossville	USA	PVC and oil industries	2 fanciers / 6 eggs	3 years	Regularly provided with corn and commercial chicken feed	Jan 2005
Minas	Uruguay	Cement kilns, burning waste	4 fanciers / 8 eggs	2-3 years	Provided with maize once a day	Jan 2005

[†]Raw eggs

*SEDIMA is a chicken feed company. Food consists of an oil cake, cereals, fish meal, minerals, vitamins, oligoelements and additives.

NA – information not available

Results and Discussion

IPEN selected egg sampling sites near potential POP sources, some of them relevant for DDT. Many of these sites are located near residential living areas and rivers (see a detailed description of sampling sites in Annex 1). Levels of DDT and its metabolites measured in eggs are compared to “background“ concentrations, discussed in the context of the state of the environment in sampling areas (where information is available) and regulations creating threshold limit values for DDTs in chicken eggs.

In addition to DDT levels providing insight to emission sources of this chemical, the ratio of DDT to its breakdown products DDD and/or DDE can also serve as a guide to emission sources (Fu et al., 2003) and provide information on the history of its application. In general, higher DDT/DDE or DDT/(DDE+DDD) ratios indicate more recent usage, and 0.5 or 1.0 were often applied as arbitrary values of the ratio to distinguish between historical and recent applications. Despite several limitations (e.g. metabolism rates of p,p'-DDT and p,p'-DDE in soil differ greatly) the ratios provide a common approach to discussing DDT levels in various environmental compartments (see e.g. Tao et al., 2008). Therefore, the possibility of a fresh DDT load is investigated in this study, too. However, the suggestions should be taken with caution as DDT and DDE could be metabolized to a very different level in the hen organism.

The sum of DDTs (p,p'-DDT, o,p'-DDT, p,p'-DDE and p,p'-DDD) in the Liberec B sample was 21.0 ng g⁻¹ fat for boiled eggs and 21.3 ng g⁻¹ fat for raw eggs. This is considered to be a minor difference that points to the fact that boiling has no significant effect on DDTs content in eggs. This conclusion is supported by Nikonorow and Zimak (1975), who also did not find any effect on the content of DDT and its metabolites in eggs after boiling for 10 minutes. Given the fact that DDT and DDD are incinerated at 800 - 1600°C (Faroon et al., 2002), no effect from boiling is to be expected. Therefore, the discussion in the following text

does not differentiate between raw and boiled eggs.

Background levels of DDTs in eggs

In addition to long-range transport from areas where organochlorine pesticides (OCPs) are still in use, volatilisation from contaminated soils and water is another important source for their presence in the global atmosphere (Meijer et al., 2003). This creates an existing background level of OCPs in the environment, foods and humans, with no uncontaminated place to serve as a true control. To understand whether particular sites contain elevated levels of OCPs, it would be desirable to compare them with background levels. However, levels of OCPs may vary greatly even within a country, and extensive sampling to fully characterize and define control levels of OCPs in all the examined countries was beyond the scope of this study.

Eggs from free-range hens often exhibit a higher level of DDT contamination compared to eggs from poultry farms, as was the case demonstrated by a Belgian study. For example, in one study, pooled egg samples obtained from 22 private owners exhibited considerably higher contamination levels than egg samples from 19 commercial egg production farms (a mean concentration of the sum of DDT, DDE and DDD being 770.7 ng g⁻¹ yolk fat and 17.3 ng g⁻¹ yolk fat, respectively). It was postulated that environmental pollution is at the origin of the higher contamination of eggs from private owners (van Overmeire et al., 2006). Therefore, studies on levels of DDTs in eggs from hens held at poultry farms are mentioned in Table 2 to give a clue on “background“ levels of DDTs in chicken eggs.

Furusawa and Morita (2000) considered only egg yolk in their study, therefore their results cannot be used as a comparing “background“ level for results obtained by IPEN (as yolk and egg white together were analysed here). Tao et al. (2009) do not explicitly mention whether yolk only or egg white and yolk together were considered, but as these authors use the determined concentrations to estimate daily

intakes of DDTs via various food types, we suppose that whole eggs were analysed. Therefore, we use the results of Tao et al. (2009) as “background” concentrations to

compare levels of DDTs determined by IPEN in eggs of free-range hens at various sampling sites all around the world.

Table 2: Mean concentrations of DDTs in chicken eggs at two poultry farms (expressed as ng g⁻¹ fat). Σ DDTs refers to the sum of p,p'-DDT, o,p'-DDT, p,p'-DDE and p,p'-DDD

Site	o,p'-DDE	p,p'-DDE	o,p'-DDD	p,p'-DDD	o,p'-DDT	p,p'-DDT	Σ DDTs
Osaka, Japan ¹⁺	NA	69	NA	ND	ND	37	
Beijing, China ²	0.17	15.0	0.67	8.97	0.75	4.97	29.69

¹Furusawa and Morita, 2000, ⁺only egg yolk considered

²Tao et al., 2009

NA – not analysed, ND – not detected

Limits for DDTs in eggs

The EU maximum residue limit (MRL) for the sum of DDTs (expressed as the sum of p,p'-DDT, o,p'-DDT, p,p'-DDE and p,p'-DDD) in eggs with a fat content higher than 10% is set to 500 ng g⁻¹ of egg fat⁸. The MRL is the maximum permitted concentration of the residue of a pesticide in or on foodstuffs for humans or animals, and means the upper legal level of a concentration for a pesticide residue based on good agricultural practice and the lowest consumer exposure necessary to protect vulnerable consumers (EU, 2005).

In the USA, the regulation of pesticide residues in food and feed is governed by the Federal Food, Drug, and Cosmetic Act. The action level set to 500 ng g⁻¹ of egg fat is for DDT, DDE and DDD individually or in combination. However, in adding amounts of DDT, DDE and DDD, any of the three found below 200 ng g⁻¹ is not counted. Food or feed found to contain an unavoidable pesticide residue at a level that is at or greater than an action level is subject to US Food and Drug Administration enforcement action (FDA, 2009).

⁸ For a fat content lower than 10%, MRL are expressed for fresh eggs and set to a value 10 times lower. There are only two cases in this study when eggs have a fat content slightly below 10%, and these are duplicated by samples from the same site with a fat content higher than 10%. To keep things well-arranged, only the limit value of 500 ng g⁻¹ fat is applied to discuss the findings at IPEN sampling sites.

Levels of DDTs in eggs from 17 countries

Table 3 lists concentrations of individual species and the sum of DDTs in eggs sampled by IPEN. Graphs at Pictures 1 and 2 show the sum of DDTs in egg samples from different sites, and p,p'-DDT / p,p'-DDE balance respectively. As noted previously, the character of a number of hotspots chosen does not lead to expectations of elevated levels of DDTs, but was chosen due to expectations of elevated levels of other POPs as demonstrated by Blake (2005) and DiGangi and Petrlik (2005). Nevertheless, the analysis of DDT residues also revealed interesting findings. It is obvious that, for a confirmation of the findings presented here, much more detailed studies based on broader sampling of various environmental matrices would be needed. This was beyond the scope of this study. However, the results suggest possible sources of DDTs and the level of influence of selected DDTs hotspots on their vicinities. For a detailed description of the sampling sites, please see Annex 1.

The lowest concentration was observed in the sample from Minas (Uruguay), a locality 2 km distance from two cement kilns burning fuel oil and rice peel. Burning of waste was also reported in this area, although no hotspot nor extensive use of DDTs was mentioned. As this sample consists of eggs provided by four different fanciers and exhibits a concentration of about only a third of the chosen background level of 30 ng g⁻¹ (Table 2), it can be concluded

that these hens do not indicate a local contamination by DDTs at all.

In general, the lowest concentrations of DDTs in the composite egg samples in this study were approximately the same as the chosen background level of 30 ng g⁻¹ fat. Samples from Bolshoi Trostenech (Belarus), Liberec (Czech Republic), Helwan (Egypt), Takia (India), Malika (Senegal), Izmit (Turkey) and Mossville (USA) ranged from 20.9 to 35.5 ng g⁻¹ fat for the sum of DDTs. No possible DDT sources in the vicinity of these sampling sites were reported by local IPEN participating organizations. In Malika, eggs were collected within a 0.7 km distance from the Mbeubeuss dumpsite in suburban Dakar, at sites exposed to prevalent winds from the dumpsite. Insecticides were among the wastes reported to be dumped there, but the level of DDTs in eggs provided by three local fanciers is below the chosen background level. However, Manirakiza et al. (2003) suggested a recent use of DDT in this locality. Interestingly, the p,p'-DDT / p,p'-DDE ratio in eggs at Malika is among the lowest from all samples investigated and thus does not indicate a problematic burden of fresh DDTs in eggs from the three sampled households. Also, the hens there were young and sometimes provided with commercial feed, lowering the probability of DDT accumulation in their tissue. The Takia site has two organochlorine pesticides factories (Indian Pesticides Limited) manufacturing lindane and chlorpyrifos. The eggs were collected from the northeastern area, 1.5 km distance from the pesticides factory in the direction of the prevailing wind flow. Again, the low concentrations of DDTs in eggs provided by 3 fanciers do not indicate a local burden by DDTs from this factory or any other significant source.

Samples with DDTs content above the background level but still in the same order of magnitude came from Usti nad Labem (Czech Republic), Dandora (Kenya) and Elbasan II (Albania), and were 43.9 ng g⁻¹, 83.2 ng g⁻¹ and 64.3 ng g⁻¹ fat, respectively. All three sites were not reported to be close to any DDTs hot spot. The relatively low concentration of DDTs measured at the Dandora dumpsite, together with a very low p,p'-DDT / p,p'-DDE ratio (0.18), suggest the absence of a major source

of fresh DDT. However, the hens from which the eggs came were young, which lowers the probability of DDT accumulation in their tissue. The Dandora site was also subject to passive air sampling in the first half of 2008. The concentrations measured were ten times higher than at the background sampling site at Mt. Kenya; however, they were still significantly lower than concentrations at other polluted sites in Kenya (e.g. Kitengela). The p,p'-DDT / p,p'-DDE ratio values ranged from 0.56 to 2.8 (for six consecutive samples) (Klanova et al., 2008), which, according to this study, indicates fresh as well as slightly degraded DDT sources at this site. The sample from Elbasan II (near a cement kiln) has a very low p,p'-DDT / p,p'-DDE ratio (0.13) too, which, together with the only slightly elevated DDTs concentration (in comparison to background levels), could suggest the absence of a significant source of fresh DDT.

The composite egg sample obtained from 3 households in Barangay Aguado (Philippines), 0.5 km distance from a medical waste incinerator, exhibited quite a low concentration of DDTs (133.9 ng g⁻¹ fat), which was 4.5 times higher than the selected background level and well below the MRL for DDTs in eggs set by the EU as well as the action level set by the FDA. Interestingly, the p,p'-DDT / p,p'-DDE ratio was 1.15, which is higher than all the other samples presented here except Klatovy-Luby (Czech Republic), and could indicate a moderate, but fresh, load of DDT. There was no significant source of DDT reported at this site, therefore it can be speculated that there was pesticide use in the households or a moderate contamination of the supplementary chicken feed.

A similar level of DDTs was found in egg samples from Pseves (Czech Republic), Lucknow (India), Sangalkam (Senegal) and Rubik - Paraspur (Albania) (187.1, 189.7, 177.5 and 157.6 ng g⁻¹ fat, respectively). In Pseves, eggs were sampled in the vicinity of a former pesticide storage unit. The sampling site in Lucknow is 25 km from an organochlorine pesticide factory. In Sangalkam, eggs were sampled in an agricultural area characterised by an uncontrolled use of pesticides of various types. The sampling site in Rubik - Paraspur is a

rather industrialized area with mining and copper smelters. Although all the four determined concentrations are well below the MRL for DDTs in eggs set by the EU as well as the action level set by the FDA, they are five to six times higher than the background level of 30 ng g⁻¹ fat selected in this study. The finding from Sangalkam (eggs provided by 4 fanciers) illustrates the probable influence of the uncontrolled use of pesticides on levels of DDTs in local biota samples. The possible source of DDTs in the egg sample (provided by 1 fancier) from Pseves could be the former pesticide storage unit. The Czech State Phytosanitary Administration argues that pesticides have been stored according to established regulations (MU Kopidlno, 2006), but neighbours have observed worsening conditions. The possible source of DDTs in Lucknow remains an open question, as there was no information available on the possibility of DDT production or storage in the pesticide factory farther away, or DDT usage in the sampling area. It should be noted that eggs were provided by only 1 fancier there, and thus the determined level could also have resulted from former use of DDT in this one household and not be indicative of the contamination in the broader area of Lucknow. There is also a lack of information about potential use or a potential contamination source by DDT in Rubik – Paraspur. The p,p'-DDT / p,p'-DDE ratio in all four pooled egg samples could point to an old burden of DDTs.

The eggs from Elbasan I and Porto Romano (two remaining sites in Albania) exhibited DDTs concentrations of 204.9 and 263 ng g⁻¹ fat, respectively. Both concentrations are well below the MRL for DDTs in eggs set by the EU as well as the action level set by the FDA; however, they are 6.5 and 9 times higher than the selected background level of 30 ng g⁻¹ fat. The site at Porto Romano is in the neighborhood of a former pesticides production facility also known as Durres. Lindane (gamma – HCH) was the major pesticide produced in the abandoned factory. Some DDT packed in barrels and bottles has been reported to have been stored in the past in an Albanian Ministry of Health storehouse in the Durres district, probably in the former pesticide plant (Selfo et al., 2006). However, mud was sampled inside one of the storage

buildings in the plant and levels of DDT and its metabolites were found to be low (Kleger et al. 2006).

Composite egg samples from Igumnovo and Gorbatovka (Russia) exhibited DDT concentrations of 138.7 and 214.6 ng g⁻¹ fat, respectively. Both concentrations are well below the MRL for DDTs in eggs set by the EU as well as the action level set by the FDA. However, they are 4.5 and 7 times higher than the background level of 30 ng g⁻¹ fat. Both villages are situated a few kilometres distance from the Korund Company plant, which produced the pesticides lindane and DDT from 1948 to 1980. As eggs were sampled from 5 fanciers in two different villages, it can be proposed that they reflect the influence of former DDT production in the factory vicinity. The p,p'-DDT / p,p'-DDE ratio values were almost the same (0.24 and 0.25, respectively), pointing to the same level of degradation of DDT and/or presence of technical DDT mixture (containing a higher amount of impurities, e.g. DDE).

The eggs from Santos (Mozambique) were collected at 3 different sites close to a cement kiln and within a radius of 2.3 km of an obsolete pesticide storage site. The whole storage place was seriously flooded in 2000. The pesticides stored were reported to include DDT. The DDTs level in the composite egg sample obtained from 3 fanciers was 238.1 ng g⁻¹ fat, which is well below the MRL for DDTs in eggs set by the EU as well as the action level set by the FDA, but about 8 times higher than the selected background concentration. Indoor spraying with DDT was reintroduced into Mozambique for malaria control in 2005, and it is increasingly becoming the main insecticide used for malaria vector control in Mozambique (Coleman et al., 2008). However, the p,p'-DDT / p,p'-DDE ratio of 0.30 and only slightly elevated DDTs levels rather indicate the influence of an old and distant DDT source, probably the obsolete pesticide storage site.

The composite egg sample obtained from 5 fanciers from the villages Kokshov-Baksha and Valaliky (Slovakia) exhibited a concentration of DDTs more than 13 times higher than the selected background level and

come closer to the MRL for DDTs in eggs set by the EU as well as the action level set by the FDA (397.1 ng g⁻¹ fat). Czechoslovakia banned DDT for agricultural use in 1974 (Holoubek et al., 2003). Considering this, the very low p,p'-DDT / p,p'-DDE ratio of 0.16 probably indicates an old burden. It can be speculated that this results from extensive use of DDT in the area in the past, as this sampling site is not close to any reported DDT hot spot. Although the measured value is below the MRL set by the EU, a possibility of extensive consumption of self-produced eggs should be taken into account and discussed with the hen owners to avoid a possible health risk.

A number of eggs with a content of DDTs exceeding the MRL set by the EU, as well as the action level set by the FDA, were sampled in the vicinity of known DDT hot spots. The limit values are slightly exceeded in Kovachevo (Bulgaria), with 546.9 ng g⁻¹ fat in eggs provided by 3 fanciers living close to an obsolete pesticides stockpile that has not been managed for years. The higher p,p'-DDT / p,p'-DDE ratio of 0.71 indicates a fresher load of DDT; however, a certain level of degradation can be assumed.

Eggs from Klatovy-Luby A and B (Czech Republic) with 1782 ng g⁻¹ fat and 2321 ng g⁻¹ fat, respectively, exceeded the MRL set by the EU and action level set by the FDA by 3.5 and 4.5 times, respectively. These two samples also exhibited strikingly high p,p'-DDT / p,p'-DDE ratios (46.5 and 23.1 respectively), indicating that DDT did not undergo degradation at all at this site. The fancier who provided the eggs lives right next to a building complex used for various pesticide storage and preparation in the past. A risk analysis based on broad sampling of various environmental matrices was conducted for the building and its close vicinity and long-term monitoring and cleanup was recommended (Musil et al., 2008). The fancier stopped breeding hens, too.

A concentration of 1677.6 ng g⁻¹ fat was found in the composite sample of eggs provided by 6 fanciers living in Eloor (India) up to 0.5 km from the Hindustan Insecticides Limited (HIL) factory that produces organochlorine pesticides including DDT. The concentration exceeds the MRL set by the EU and action level set by the

FDA by more than 3 times and the p,p'-DDT / p,p'-DDE ratio of 0.60 could indicate a fresher load of DDT.

The composite sample of eggs obtained from 1 fancier in Peshawar (Pakistan) was obtained from a settlement 250 meters from a municipal and hospital waste dumpsite. Although a known DDT hotspot at this site has not been reported, the DDTs concentration of 2329.3 ng g⁻¹ fat exceeds the MRL set by the EU and action level set by the FDA by 4.5 times. A survey of a district in the North West Frontier Province of Pakistan revealed the availability of smuggled DDT pesticide formulations in the open market under the brand names Methyl, Dusting Powder and 785, containing 15, 5 – 15 and 100 % DDT, respectively (ul Hadi, 2005). The p,p'-DDT / p,p'-DDE ratio in eggs was very low (0.16), thus pointing to an old DDT load. Also, the contamination of the considered household (e.g. spraying of DDT in the hen house) and chicken range by a pesticide formulation with low DDT content cannot be excluded.

Eggs provided by 1 fancier from Coatzacoalcos (Mexico) also exhibited a high concentration of 2191.8 ng g⁻¹ fat, exceeding the MRL set by the EU and action level set by the FDA by 4 times. Despite the restrictions on DDT use in antimalaria campaigns in Mexico, the use of DDT in the 1990s was higher here than in other Latin American countries (Lopez-Carrillo et al., 1996). Eggs were sampled within 2 km from the petrochemical complex Pajaritos and no known significant DDT source was reported by the local IPEN partner organization. It should be stressed that eggs from only 1 fancier were sampled and the possibility of a high DDT contamination of the considered household (e.g. spraying of DDT in the hen house) cannot be excluded.

The eggs sampled in Lysa nad Labem (Czech Republic) were taken 3-4 km from a POPs waste stockpile in Milovice and had a high concentration of DDT (3338.7 ng g⁻¹ fat), exceeding the MRL set by the EU and the action level set by the FDA by 6.5 times. In Milovice and Lysa nad Labem, elevated levels of DDT and its metabolites were found in soils at two of seven sampled sites (Vacha et al., 2003). The considered hen was 2-3 years old

and had been living at the sampling site for several years, thus was considered suitable for indicating local pollution. However, only one egg from one hen was sampled. Therefore, questions on the source of DDTs are left open; it could either be the former pesticide storage site, burning of the waste from the storage site at the waste incinerator in Lysa nad Labem, or the local DDT burden at the sampling site.

The highest content of DDTs determined in eggs in this study was found in Vikuge (Tanzania). A current intensive use of DDT in agriculture in Tanzania was reported, despite a ban on this chemical for agricultural use (Kishimba et al., 2004). However, the strikingly high level of 7041 ng g⁻¹ fat (exceeding the MRL set by the EU and action level set by the FDA by 14 times) found in the composite sample of eggs from 3 fanciers living in the Vikuge village is most probably to be attributed to the local DDT hotspot. At the sampling site, villagers complained about the pungent smell of DDT in the dry season. The old storage site at the Vikuge farm has been described as a highly contaminated site (Kishimba et al., 2004). The levels of DDT in topsoil were found to be up to 282 g kg⁻¹ for DDT. The total pesticide content (together with lindane and pendimethalin) in soil was found to be almost 40%. In water samples from the storage site, higher concentrations of p,p'-DDT than of its metabolites were found. Of the DDT metabolites, p,p'-DDD showed higher concentration than p,p'-DDE, indicating

Limitations of the study

This study of DDTs in free range chicken eggs provides a snap shot of levels of DDTs from many localities around the world. Pooled samples provide a broader view of DDTs content than a single egg sample, but the view is still limited by a single pooled sample per locality. Financial constraints prohibited more sampling to ascertain levels of DDTs in other parts of each country. These constraints are also the reason for the absence of blanks, which should usually be run parallel to assure analytical quality control.

The IPEN sampling was conducted during a single short time period. In some countries the winter season may have affected the range that chickens covered and/or egg laying behavior

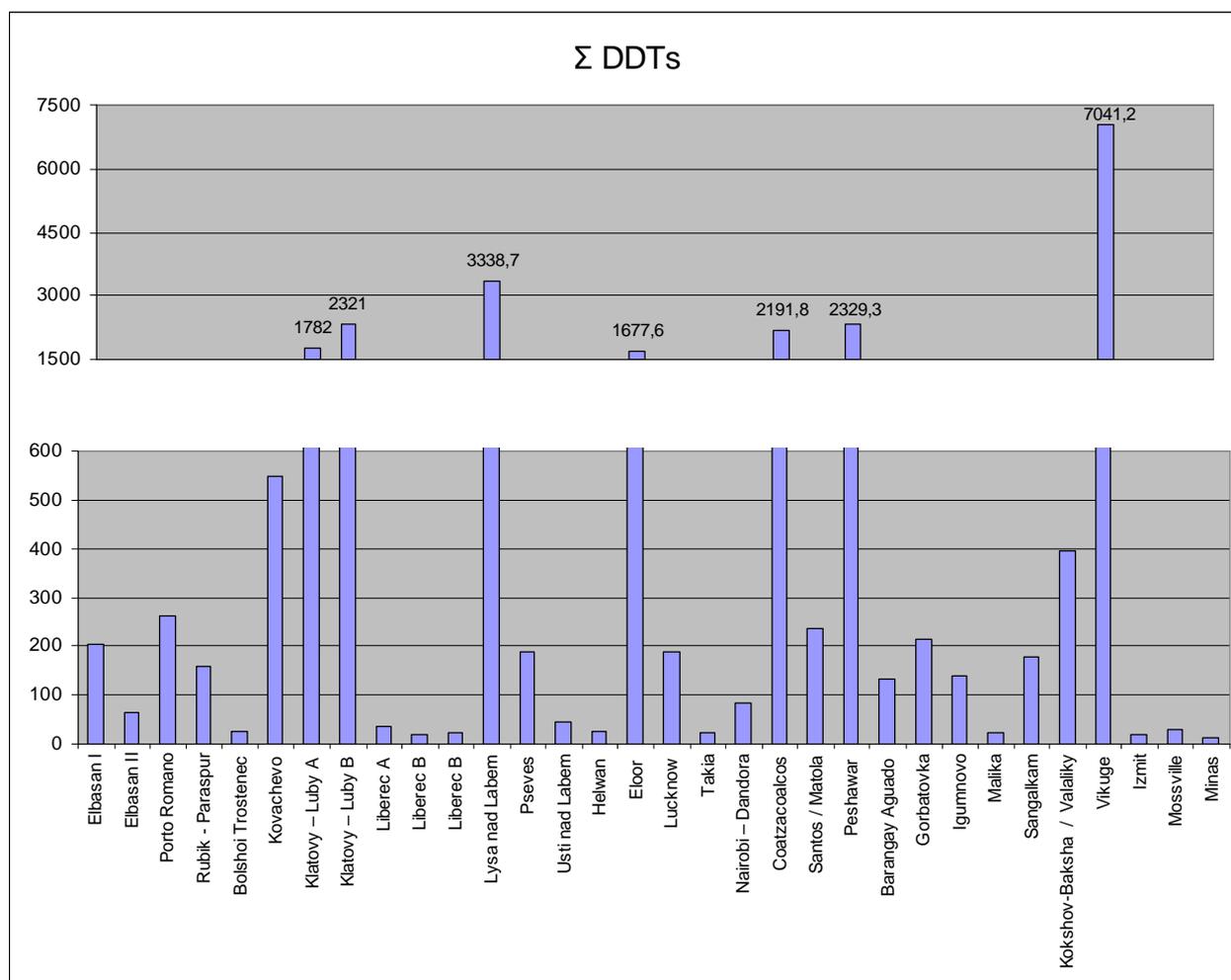
the presence of DDD (rothane or TDE). The levels of DDT detected in drinking water (well water) exceeded the WHO and EU limits for drinking water by several times (Kishimba et al., 2004). Also, concentrations of DDT residues in grasses and sedges from the vicinity of Vikuge were far above the Australian extraneous maximum residue limit in primary animal feedstuffs. Even at 6 km distance north of the hot spot, DDT concentrations in leaves of giant sedges (*Cyperus exaltatus*) were still two times higher than the mentioned Australian limit (Marco and Kishimba, 2005). Also, the concentrations of DDT in cassava roots sampled at a distance of 4 km north of the site were found to be three times greater than the corresponding FAO/WHO limit (Marco and Kishimba, 2006). All the mentioned studies suggested an input of non-degraded DDT. However, the p,p'-DDT / p,p'-DDE ratio of 0.33 in the composite eggs sample obtained by IPEN suggests degradation of DDT and/or storage of technical DDT rather than fresh DDT input. It can be speculated that metabolism of DDT in the hen is a possible reason for this discrepancy. All these findings indicate potential high risk and concerns for livestock and public health and point to the urgent need of remediation. A Global Environment Facility (GEF)-United Nations Environment Programme (UNEP) project proposal, "Bioremediation of POPs Impacted Soils in Eastern Africa", ear-marking Vikuge as a demonstration site, has been submitted (Kishimba et al., 2004).

and fat content. Because this study provides some of the first information about DDTs in eggs in a number of countries, there was little data available for comparison. Additionally, little information was available on the origin of hens, which means that some of the sampled eggs could have been laid by hens recently purchased and thus not suitable for indicating local pollution. However, this possible effect was significantly reduced by using pooled samples often composed of eggs from hens owned by two or more fanciers.

Table 3: Concentration of individual species and the sum of DDTs in pooled egg samples (ng.g⁻¹ fat) with respective fat content. Underlined concentrations of Σ DDTs⁺⁺ exceed the selected background level of 30 ng.g⁻¹ fat, concentrations highlighted in grey exceed the MRL for DDTs in eggs set by the EU as well as the action level set by the FDA (500 ng.g⁻¹ fat).

Site	Country	o,p'-DDE	p,p'-DDE	o,p'-DDD	p,p'-DDD	o,p'-DDT	p,p'-DDT	p,p'-DDT / p,p'-DDE	Σ DDTs ⁺⁺	Fat content (%)
Elbasan I**	Albania	ND	150	< LOD	0.44	1.8	52.7	0.35	<u>204.9</u>	14.8
Elbasan II**	Albania	ND	56.4	ND	< LOD	0.65	7.2	0.13	<u>64.3</u>	13.9
Porto Romano**	Albania	ND	220	ND	1.6	1.5	39.9	0.18	<u>263</u>	15.0
Rubik - Paraspur*****	Albania	ND	120	0.019	4.5	2.2	30.9	0.26	<u>157.6</u>	13.6
Bolshoi Trostenech*	Belarus	< LOD	20.3	< LOD	0.3	0.42	5.3	0.26	26.3	12.0
Kovachevo*	Bulgaria	0.21	310	ND	8.6	8.3	220	0.71	<u>546.9</u>	12.1
Klatovy – Luby A ⁺	Czech Rep.	0.95	16.8	NA	961	21.1	782	46.5	<u>1782</u>	9.5
Klatovy – Luby B ⁺	Czech Rep.	2.55	42.7	NA	1252	38.5	985	23.1	<u>2321</u>	11.0
Liberec A*	Czech Rep.	< LOD	23.2	< LOD	1.1	0.47	10.7	0.46	<u>35.5</u>	11.4
Liberec B**	Czech Rep.	< LOD	12.1	ND	0.23	0.61	8.1	0.67	21.0	9.7
Liberec B***	Czech Rep.	< LOD	12.8	< LOD	0.34	0.37	7.8	0.61	21.3	10.1
Lysa nad Labem ⁺	Czech Rep.	1.4	2748.9	9.1	39.8	12.8	537.2	0.20	<u>3338.7</u>	16.4
Pseves***	Czech Rep.	ND	150	ND	0.58	0.69	35.8	0.24	<u>187.1</u>	10.7
Usti nad Labem*	Czech Rep.	< LOD	30.9	< LOD	0.66	0.73	11.6	0.38	<u>43.9</u>	11.3
Helwan*	Egypt	< LOD	17.5	< LOD	0.54	0.47	7.3	0.42	25.8	14.0
Eloor*	India	0.54	1000	0.14	69.5	8.1	600	0.60	<u>1677.6</u>	13.1
Lucknow*	India	< LOD	150	< LOD	3.7	1.5	34.5	0.23	<u>189.7</u>	12.5
Takia****	India	< LOD	16.9	ND	< LOD	0.65	6.5	0.38	24.1	12.1
Nairobi – Dandora*	Kenya	ND	69.3	< LOD	0.84	0.41	12.6	0.18	<u>83.2</u>	11.5
Coatzacoalcos*	Mexico	0.64	1600	ND	100	11.8	480	0.30	<u>2191.8</u>	11.8
Santos / Matola*	Mozambique	ND	180	ND	3.8	1.0	53.3	0.30	<u>238.1</u>	12.5
Peshawar*	Pakistan	ND	2000	ND	2.3	7.0	320	0.16	<u>2329.3</u>	13.3
Barangay Aguado*	Philippines	ND	60	ND	3.5	1.2	69.2	1.15	<u>133.9</u>	12.5
Gorbatovka*	Russian Fed.	< LOD	170	< LOD	1.5	0.68	42.4	0.25	<u>214.6</u>	12.9
Igumnovo**	Russian Fed.	9.9	110	< LOD	1.3	0.83	26.6	0.24	<u>138.7</u>	10.9
Malika**	Senegal	ND	19	ND	0.29	0.47	3.2	0.17	23.0	10.4
Sangalkam***	Senegal	< LOD	150	< LOD	1.6	1.3	24.6	0.16	<u>177.5</u>	11.0
Kokshov-Baksha / Valaliky*	Slovakia	< LOD	340	< LOD	2.8	0.51	53.8	0.16	<u>397.1</u>	12.2
Vikuge*	Tanzania	0.41	5200	< LOD	110	31.2	1700	0.33	<u>7041.2</u>	13.8
Izmit*	Turkey	ND	16.6	ND	0.13	0.25	3.9	0.23	20.9	13.8
Mossville*	USA	< LOD	17.7	< LOD	0.59	0.3	10.3	0.58	28.9	12.4
Minas**	Uruguay	< LOD	9.0	< LOD	0.22	0.3	3.0	0.33	12.52	10.7

⁺Raw eggs, ⁺⁺ Σ DDTs refers to the sum of p,p'-DDT, o,p'-DDT, p,p'-DDE and p,p'-DDD; *LOD = 0.1 ng.g⁻¹ fat, **LOD = 0.2 ng.g⁻¹ fat, ***LOD = 0.5 ng.g⁻¹ fat, ****LOD = 0.4 ng.g⁻¹ fat, *****LOD = 0.01 ng.g⁻¹; NA – not analysed, ND – not detected



Picture 1: Graph of sum of DDTs levels measured in pooled egg samples collected at different sites in 18 countries on 4 continents in ng.g⁻¹.

Conclusions

Home-produced foodstuffs are generally not submitted to any compliance control, although they are consumed in large quantities by their producers in many regions of the world. The consumption of home-produced eggs can pose a risk of adverse effects due to both the often elevated contamination of the eggs as well as a possibly unusually high consumption rate. This study found some elevated and a number of unusually high concentrations of DDT and its metabolites in several pooled egg samples from around the world, some of them significantly exceeding internationally accepted MRLs. This stresses the short-term necessity of informing private owners of possible pollution sources in their

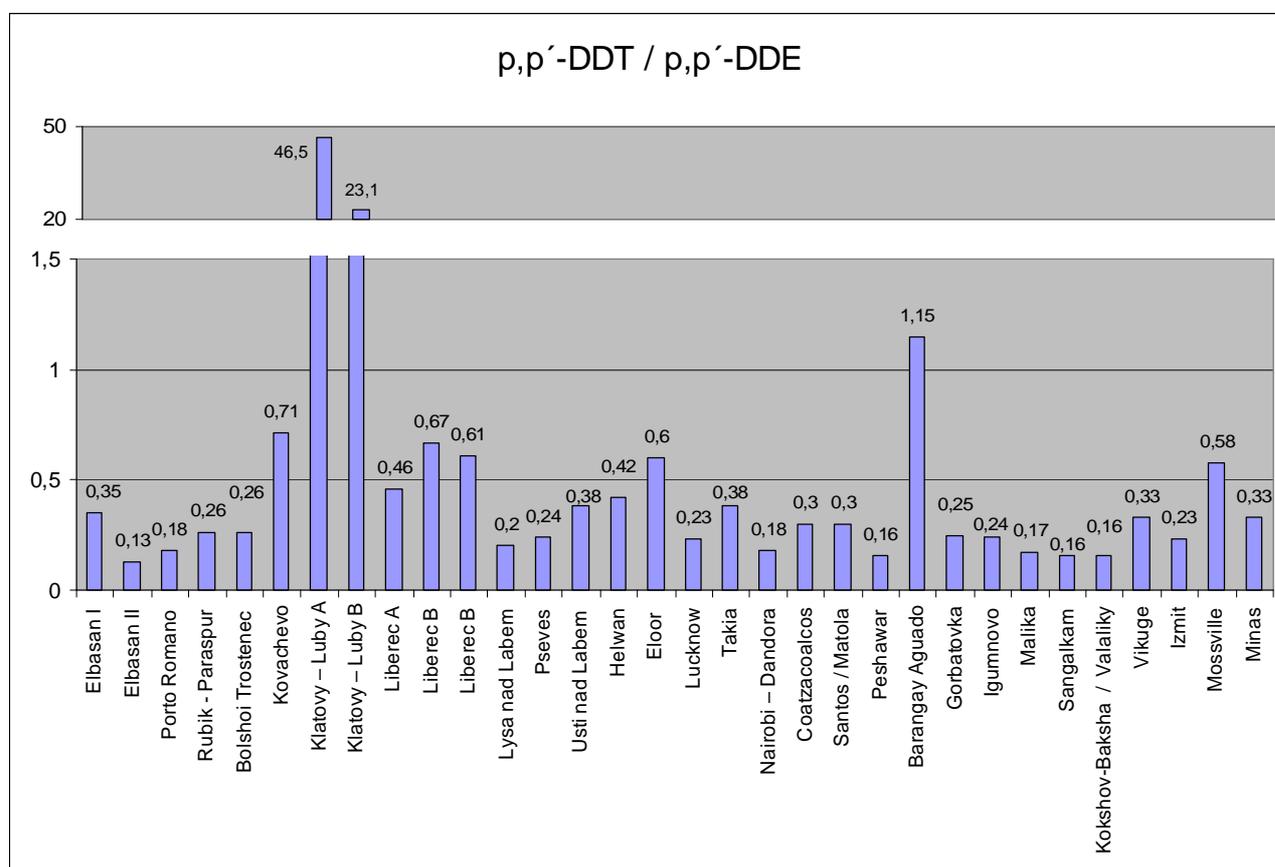
neighbourhoods and, more generally, the need for publicly available information on DDT and its metabolites in food, humans and the environment. Such a need is also recognised by the European Union: “...it should also be recognised that few consumers are aware of the risks arising from pesticides. It would be valuable to fully explain such risks to the public.” (EU, 2005). In the long-term, the results of this study underline the need for suitable alternative control strategies for disease vectors so that the Stockholm Convention’s goal of reduction and ultimate elimination of DDT can be achieved.

Contaminant levels in the eggs from free-range hens are considered good indicators of the contamination of the environment in which the

hens live (Chang et al., 1989). This study proposes a relationship between several hot spots of DDTs in various parts of the world and elevated levels in eggs laid by free-range hens living in their vicinities. At two sites, the composite egg samples indicate a fresh load of DDT. Although a confirmation of the findings based on broader sampling of various environmental matrices would be needed, the worldwide egg sampling campaign conducted by IPEN illustrates the urgent need for remediation of several highly polluted sites, some of them included in this study.

Countries in Africa, Asia and Latin America with more recent exposure to DDT and DDE have higher levels in human tissue than in Europe and the USA (Jaga and Dharmani,

2003). However, even in Europe, where DDT has not been used for two or more decades and levels of p,p'-DDE in blood have shown a sharp decline in recent years (Lackmann, 2005), a risk for human health (due especially to imported cereals and foods of animal origin) cannot be excluded (Galassi et al., 2008). This stresses the need for global action on a further reduction of DDT emissions to the environment, as elevated levels of DDTs in several regions contribute to human (and animal) exposure to DDTs even in cleaner regions in two obvious ways: (1) long-range transport contributing to background levels in regions far from sources, and (2) import of food and feed produced in regions with a higher burden of DDT.



Picture 2: Graph shows the balance between p,p'-DDT and p,p'-DDE metabolites in egg samples from different sites. In general, higher DDT/DDE or DDT/(DDE+DDD) ratios indicate more recent usage, and 0.5 or 1.0 were often applied as arbitrary values of the ratio to distinguish between historical and recent applications.

Recommendations

As a result of these findings, which indicate the widespread contamination of chicken eggs by DDT, even long after use in that area has ceased, IPEN offers the following recommendations:

1. The Stockholm Convention provisions on DDT should be fully implemented as soon as possible. These obligations include: 1) strictly confining DDT use to disease vector control in a safe and effective way when affordable alternatives are not available, and 2) reporting on the amount used, conditions of use, and its relevance to the country's disease management strategy. Parties not in conformity with these obligations should be strongly encouraged to immediately come into compliance.
2. Parties using DDT should develop action plans to implement suitable alternative control strategies. Implementation of the provisions, and the spirit, of the Stockholm Convention with regard to the use of DDT for the control of disease vectors is a necessity. DDT is listed under Annex B with an exemption for this use "*when locally safe, effective and affordable alternatives are not available*" [emphasis added]. Such alternatives have been developed, have undergone trials, and have been successfully implemented in a number of areas in the world, eliminating the usage of DDT. Yet despite this, the use of DDT for disease vector control is actually increasing.
3. The WHO and the Stockholm Convention Secretariat should continue to strengthen the capacity of countries to report on the production and use of DDT.
4. A multi-stakeholder, global partnership should be established to develop and deploy alternative products, methods, and strategies to DDT, including Integrated Vector and Disease Management programmes to combat malaria, drawing on successful programmes that have not relied on DDT.
5. No further specific exemptions should be granted for the continued use of DDT as an intermediate in the production of dicofol. Only one country has indicated it wishes to continue such use, and it has failed to justify its need for this exemption. Organochlorine manufacturing is a significant cause of 'hotspot' environmental contamination, as evidenced by the IPEN egg monitoring studies.
6. There is an urgent need for remediation of a number of highly polluted sites, and the Conference of the Parties should strengthen the capacity of countries to eliminate stockpiles and remediate them. This should be performed under Convention guidelines using an updated definition of low POPs content that is more protective of human health and the environment and Convention objectives.



Photo 4: Stocks of obsolete pesticides in Vikuge (Tanzania) in a new storage facility in 2004. Photo by Agenda.

ANNEX 1

Detailed description of sampling sites

Elbasan, Albania

Hot spot: Elbasan is a historic city approximately 40 km southeast from Tirana that has been subject to industrialisation in the last decades. At the western part of the city, a metallurgical complex (Elbasan I sampling site) as well as a cement kiln (Elbasan II sampling site) was built. The metallurgical complex was in full operation between 1977 and 1990. Since 1990, all of the processes have been closed, except a scrap steel smelter. The smelter emits particles CO, SO₂ and iron dust. The main environmental problem today is caused by a hydro-tailing sediment site containing tailings and dust from a former coke production process (UNEP 2000). There is also a cement kiln next to the metallurgical complex, which is very close to a residential area. There are a number of industrial waste dumpsites containing metallurgy waste within this industrialized area.



Photo 5: Sampling site in front of metallurgical complex in Elbasan, Albania. March 2006. Photo by Hana Kuncova.

Sampling sites: The egg from the Elbasan I site was sampled at the eastern part of the industrialized area in front of the entrance to the metallurgical complex (see Photo xx). Location Elbasan II is on the opposite edge of the industrialized area in the residential part next to the cement kiln. While the egg from Elbasan I was sampled directly from the public “park” in front of the facility, at Elbasan II the

eggs were sampled from two fanciers living close to the cement kiln.

Porto Romano (Durrës), Albania

Hot spot: Until 1990, the former chemical plant in Durrës produced sodium dichromate, for leather tanning, and pesticides, such as lindane (gamma-HCH, 6-10 tonnes per year) and thiram. Since both productions have been closed, the plant’s buildings have been totally destroyed. Houses of families living in this area were built using contaminated bricks from the old lindane production buildings 20 meters away. As a result, the people living there are in a heavily contaminated zone. The families keep domestic animals that feed inside the plant area. A 6-meter deep well is located inside the plant and is being used to obtain water for animals and vegetables irrigation. UNEP analyses showed extremely high levels of technical HCH mixtures in the plant area and in storage facilities located two kilometers away. UNEP sampling identified tetra-, penta-, hexa- and hepta-chlorinated cyclohexanes. Hexachlorinated isomers were found to be dominant (UNEP 2000). Additionally, mud was sampled inside one of the storage buildings containing barrels with obsolete chemicals, but levels of DDT and metabolites were low (Kleger et al. 2006).

Sampling site: Eggs were collected from families (probably the same ones as in the above-mentioned UNEP report) living near the contaminated area of the abandoned chemical factory.

Rubik – Paraspur, Albania

Hot spot: Rubik is a mining town (2500 inhabitants) in the mountainous Mirditë District, Lezhë County, northwest Albania, about 10 km east of the regional capital city of Lezhë and about 90km north of Albania’s capital Tirana. Rubik is located on the River Fani, approximately 10 km north of its confluence with the River Matit which provides drinking water to local inhabitants. After more than 60 years, a copper plant stopped production in 1998. During its more

productive years, it generated approximately 30,000 tons of mineral residues annually, which were deposited in the surrounding area. Experiences with similar plants as well as analyses of soil and water from this particular area indicate a high potential of contamination by toxic compounds that poses risks both to health and the environment.

Sampling site: The eggs were sampled from two fanciers living in the Paraspur village located above the old copper smelter on the western bank of the river. The village is located on a slope and was affected by copper smelter emissions in the past.

Village of Bolshoi Trostenec, Belarus

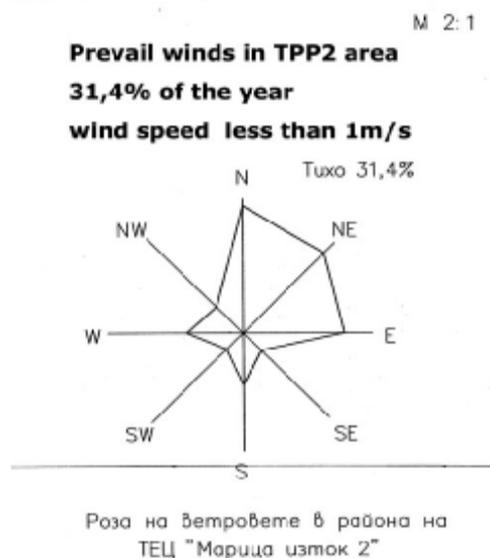
Hot spot: The Trostenec landfill site is located 5 km outside Minsk in the south-east direction, and situated in the Minsk Hills in the territory between the river Svisloch and its left tributary, the river Trostyanka. The distance between the landfill and the nearest open water reservoir (storage pond Stayki) is 3 km. The distance between the landfill and the nearest underground water source (water scoop Drazhnya) is 2.5 km. The direction of the underground drainage from the landfill is south-east to the Trostyanka river. The landfill does not have waterproofing protection. The only so-called “nature-protection“ construction is the bypass drain across the western and southern boards. The basis of the landfill is sand and gravel. The landfill site has operated since 1958. It is the oldest and largest landfill in the Minsk area and fires occur frequently in the summer. Each year, more than 880 000 m³ of wastes are disposed here. This mainly consists of household waste, but also includes some waste from the Minsk waste processing plant, industrial waste from the varnish-and-paint industry, pharmaceutical industry waste, building waste, and other types of waste. A considerable part of the waste stream is plastic waste. In addition, about 20 years ago, the bottom ash from the Minsk incinerator was disposed here (the incinerator was closed at the beginning of the 1990s). From the waste amount disposed in the landfill, more than 100 toxic substances get into the environment.

Sampling site: The Trostyanka River flows across the village Bolshoi Trostenec, which was the locality for eggs sampling. The

distance between the landfill and the village is 0.5-1 km in the northwest direction.

Village of Kovachevo, Bulgaria

Hot spot: The thermal power plants (TTP) Maritza East 2 and 3 are located close to the village of Kovachevo. The main water source for the industrial needs of Maritza East 2 is the Ovtcharitza River, flowing southwest. A possible pollution pathway is waste water, contaminated with used industrial oils, containing PCBs. A major source of dust emissions is the temporary deposition site, to which fly and bottom ash from the power plant are transported by water. After drying, the ashes are transported to a permanent deposition site.



Picture 3: Prevailing winds for the surrounding of Kovachevo and the area of Maritza East 2 (Energoprojekt, 2004).

Also found in the area are the brown coal mines Troyanovo1, Troyanovo North and Troyanovo 3 (providing 80% of the country's coal) and Brikel (producing electricity and briquettes) (Energoprojekt, 2004). There is also an abandoned obsolete pesticides stockpile at the northeast edge of the village of Kovachevo. There are about 20 pierced and rusty 20 litre tanks outside the building. The site has not been managed for many years. A waste landfill with frequent open burning is located on the eastern edge of the town of

Radnevo, relatively close to Kovachevo (15 - 20 km). Another potential source of pollution could be the Agrobiochim chemical plant located 7 km east from Stara Zagora, which was shut down a few years ago but previously produced caprolactam, nylon 6, MMA and PMMA, ammonia, nitric acid, ammonium nitrate, ammonium sulphate, urea and plant protection agents (Chem Systems, 2001).

Sampling site: The village of Kovachevo is located in a valley of a hilly plain. The village is located 2 km southwest from Maritza East TPP 2 and 8 km from TPP 3, and is just next to an open coal mine. The village of Kovachevo's water supply for industrial and household purposes comes from three drilling points. The abandoned pesticides stockpile is at the northeast edge of Kovachevo.

Klatovy – Luby, Czech Republic



Photo 6: Former pesticides storage facility in Klatovy-Luby (Czech Republic) - highly contaminated by DDT and other pesticides including lindane. Photo by Tomas Fertek, 2006.

Hot spot: The hot spot consists of a building complex with a built-up yard formerly used by Agrochemický podnik Klatovy for storage of various pesticides and parking of spray adapters. The area is drained by the Drnový brook, flowing in the distance at about 200 m. Several wells are situated in the close vicinity. A risk analysis was conducted for the building and its close vicinity and long-term monitoring and cleanup was recommended (Musil et al., 2008).

Sampling site: Eggs were sampled in a neighbourhood very close to the abandoned pesticide stockpile.

Liberec, Czech Republic

Hot spot: Municipal waste incinerator. The municipal waste incinerator (MWI) in Liberec has operated since 1999. The capacity of the incinerator, which is almost fully utilised, is 96,000 tons of municipal solid waste per annum. It is a mass burn incinerator with single chamber and after-burner furnace. Until 2003 the incinerator was equipped with filters to reduce dust, sulphur dioxide and oxides of nitrogen emissions. Activated carbon injection was used between 2002-2003 in an attempt to reduce PCDD/Fs emissions, but this was only partly effective. Since 2003, GORE-TEX Remedia catalytic filter bags have been used to further reduce dioxin emissions into the air. Other potential sources of POPs releases in the city include: a metallurgical plant for secondary steel production in the northwestern part of the city, a heating station burning heavy oil adjacent to the MWI, a hospital waste incinerator to the north of the MWI, the crematorium, the car production plant Peguform, and domestic heating systems.

Sampling site: Located inside the town of Liberec in an urban area (former village settlement, now part of the town), very close to the municipal waste incinerator, in the direction of prevailing winds. The sampling site was chosen according to a pollution dispersion study (Smetana 2005) and is located 200 m southeast of the incinerator.

Lysa nad Labem, Czech Republic



Photo 7: Is this really safe storage for hazardous waste? Barrels outside of the waste incinerator building in Lysa nad Labem. Photo by Mlady svet journal, 2000.

Hot spot: The hazardous waste stockpile near Milovice was located in a former military battle site and became contaminated as a result

of the abandoned construction of a hazardous waste incinerator. The original owner filled it with tons of hazardous waste containing polychlorinated biphenyls, dioxins, and DDT. The hazardous waste stockpile was situated in the open air on the edge of the forest north of Milovice, elevation 205 metres, 6,5 kilometres in a beeline from the Elbe River and 2 kilometres from Mlynarice brook, which enters the Elbe under Lysa nad Labem. Later, the wastes containing DDT were burnt in the Lysá nad Labem hazardous waste incinerator (Marcanikova et al., 2006).

Sampling site: Egg sampled was 3-4 km distance from Milovice.

Pseves, Czech Republic

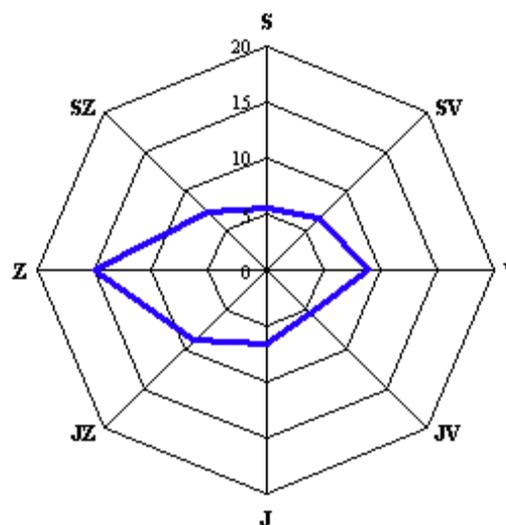
Hot spot: Former pesticide storage located in the village Pseves in the northeastern part of Bohemia, 1,5 km northeast from Kopidlno town. This storage was used before 1990 and destroyed by a new owner between the years 2000 and 2007. According to a control in 2000, there were approximately 2 tonnes of pesticides left, including 2,4-D, gamacid (HCH), MCP, triazine pesticides, mancozeb and some others still present in the storage. DDT was not listed on the list of stored pesticides. No detectable levels of pesticides residues were observed in an underground water sample taken at the same time as the eggs. LOD for DDT and metabolites was 0,005 µg/l (Ecochem 2006).

Sampling site: Eggs sampled were from a close neighbourhood of the former pesticide storage.

Usti nad Labem, Czech Republic

Hot spot: The most obvious potential source of POP releases at the site is the chlorine chemical plant Spolchemie, which still produces HCB as a by-product of chlorinated solvents manufacturing. Spolchemie is focused on: production of inorganic compounds, inorganic specialties production, resin production, and organic dye-stuff production. Its products include carbon tetrachloride, perchloroethylene, trichloroethylene and chlorinated benzenes. There is also an area of obsolete production buildings highly contaminated by POPs in Spolchemie, which could be a significant source of POP contamination. Other sources of POPs could be

contaminated sites and/or waste incineration inside the chemical plant, as well as in the neighbouring town of Trmice (Fara et al., 1999).



Picture 4: Prevailing winds determined for the area of Spolchemie by the dispersion study Kombinovaný způsob výroby epichlorhydrinu (CHMU, 2004).

Sampling site: Sampling place is located 2 - 3 km from Spolchemie in an urban living zone, a locality with panel houses called Skrivanek, in an elementary school area. The school was built 20 years ago; since that time there has been no manipulation of the soil.

Helwan area, Egypt

Hot spot: Helwan is one of the biggest industrial areas in Egypt and is located in the extreme south of the Cairo governorate at the River Nile. Helwan is also one of the great residential areas related to the Cairo governorate from the south at borders between Cairo and Giza governorates. The metallurgy facility in Helwan is the largest steel mill in Egypt. Additionally, cement kilns are found here that do not burn waste, but are planning to do so in the future. There is also a coke plant operating in this area. More potential POP sources located in the area include nonferrous metals production and open burning of waste. Besides cement production and metallurgy, the most important industries in Helwan are coal, chemical industries including fertilizers, coal-tar phenols and benzol, thermal, iron and steel, hammered, vehicle and bus industries, asbestos

pipe, and starch and glucose industries. A number of the factories mentioned are not connected to the sewage network and discharge their effluents directly to the river, to agricultural drains or to lagoons in the desert. The food processing industry in the area discharges effluents with high concentration of organic biodegradable materials including plant oil (El Danaf, 2000).

Sampling site: The nearest potential POP sources to the sampling site are primarily steel production, a cement kiln and a coke plant. The sampling was conducted at a 1 km distance from the metallurgy facility and 4 km from the coke plant. Eggs were collected in an area receiving wind from the direction of the steel mill and cement kilns.

Eloor area of Kerala, India

Hot spot: The Eloor-Edayar region, about 20 km from where the river meets the Arabian Sea, is the industrial hub of Kochi (the commercial capital of Kerala), and is home to Kerala's largest industrial cluster, the Udyogamandal Industrial Estate. There are about 250 industries including the Fertilizers and Chemicals Travancore Ltd. (FACT), Hindustan Insecticides Ltd (HIL), and Indian Rare Earths Ltd. They manufacture a range of chemicals: petrochemical products, pesticides, rare-earth elements, rubber processing chemicals, fertilisers, zinc/chrome products and leather products. Many of these industries are 50 years old and employ highly polluting technologies. The industries take large amounts of fresh water from the Periyar River and in turn discharge concentrated toxic effluents after little treatment. The most obvious source of POPs is the Hindustan Insecticides Limited (HIL) factory producing organochlorine pesticides. It was incorporated in 1954 for the Malaria Eradication Programme of the Government of India. The factory manufactures DDT, endosulfan, dicofol and mancozeb. To manage the Plant's effluents and emissions, the following are provided by the factory: The Plant has a Centralized Effluent Treatment Plant commissioned in 1982. Between 1954 and 1982 the effluents were released untreated. The quantity of effluent discharged from the ETP is 1024 KL / day. This is the quantity the factory is authorized to discharge, with the authorized capacity of

production. However, the Centralised ETP has the capacity to handle 600 m³ per day of effluents only. Moreover, on many days of the year the production of pesticides has been more than the established capacity. For example, in 2003-04, there were days in which the production of DDT reached 5.5 metric tons, when the installed capacity was only 3.73 metric tons per day. There are several facilities within the factory that discharge and/or can discharge chlorinated chemicals emissions into the air. These include the waste incinerator (6000 m³/h flow of flue gases), HCl System and Endosulfan production unit (80 m³/h) and Vent - Alcohol Chlorination in DDT (250 m/h) Emissions (Jayaraman 2005). The HIL factory discharges its liquid effluents to the open natural creek - the Kuzhikandam Thodu. This creek also flows through another factory - the Merchem Company Limited - which also releases its effluents out into the creek. This company produces mercaptan-based chemicals for the rubber processing industry as well as some fungicides, such as thiram and ziram.

Sampling site: The eggs were collected from the Kuzhikandam Thodu creek and its surrounding area in Eloor, 100 – 500 m from the hot spot in various directions (west, southwest, south, northwest). The sampling sites are located in marsh lands.

Lucknow, India

Hot spot: There are six medical waste incinerators operating in the city of Lucknow, including the Queen Mary's Hospital - Lucknow medical waste incinerator. This medical incinerator works for 3-4 hours a day and was established in 1999. Others are (1) the Nagar Nigam biomedical waste incinerator where the waste is collected from ten private and two government hospitals in the city, (2) the Balrampur Hospital which receives waste from eighteen hospitals in the city as well as the in-house waste generated in the hospital, (3) the Fatima Hospital, that caters to the waste generated in-house only, (4) the Sanjay Gandhi Post Graduate Institute of Medical Research, which incinerates the waste generated in-house, and (5) the Earaz Medical College which receives in-house waste only. A pesticides factory is located near about 25 km from the city station in the Chinhat Industrial Area. Near the organochlorine pesticides manufacturing unit, brick kilns and ceramic

and pottery manufacturing units have combustions of coal and wood charcoal. In addition, there is a small scale PVC recycling unit.

Sampling site: The eggs were collected from one chicken fancier living 0.5 km from the incinerator. Sampling was conducted in a slum settlement towards the east of the incinerator since the wind flow is directed from the northwest towards the east.

Village of Takia, India

Hot spot: The site has two organochlorine pesticides factories (Indian Pesticides Limited) manufacturing lindane and chlorpyrifos. Five to six brick kilns and one PVC recycling unit are also operating in the area.

Sampling site: The eggs were collected from the northeastern area 1.5 km from the pesticides factory where the wind carries the waste gases. A very characteristic lingering odor of gammexene at the egg sampling location was realized. The site is located 0.5 km from the brick kilns and PVC recycling unit.

Dandora (Nairobi), Kenya

Hot spot: The Dandora dumpsite is located in the Eastlands suburb of Nairobi. It is the biggest dumpsite in Kenya, where a large proportion of Nairobi's waste is disposed. This waste comprises industrial, medical and municipal waste, much of which is burned on site. Passing below the dumpsite is the Nairobi River, which eventually drains to the Indian Ocean. The soils are usually well-drained to moderately drained. Rain can also wash POP contaminated ash into the Nairobi River.

Sampling site: The eggs were collected from two sites bordering the Dandora dump. One was from the western border of the dump, within the Dandora estate, and the other from the northern border, within the Ngomongo slum. The hens do not feed directly from the dump, but live at the edge where ash from the dump is easily deposited.

Coatzacoalcos, Mexico

Hot spot: The incinerators I and II of the Petrochemical Complex Pajaritos started to run in 1995. The incinerator I was out of business for some time due to technical problems. The incinerator II was stopped in 2003. Incinerator

I was established to burn hexachloride residues from the production process of tetrachloride carbon and perchloroethylene. Incinerator II burnt liquid residues from the plants for chlorinated derivatives and acetaldehyde.

Sampling site: A map of pollutant dispersion based on a Gauss model considering meteorological information and estimates of atmospheric releases of hydrocarbons from the petrochemical complex was consulted to find a relevant sampling site. The chosen location is of a rural character located in a former grazing area. The distance from Incinerator II is less than 2 km.

Matola (Maputo), Mozambique

Hot spot: From 1998 until the beginning of 2002, during the Danida Mozambican obsolete pesticides removal project, the pesticides were stored at the Boror Warehouse, which is now an obsolete pesticide storage site. The whole storage place was seriously flooded in the year 2000. The pesticides stored include 42 tonnes of aluminum phosphine, azinphos methyl, brodifacoum, captafol, carbofuran, cholorfenvinphos, coumatetralyl, demeton-S-methyl, dichlorvos, difenacoum, fenamiphos, flocoumafen, furathiocarb, hydrogen cyanide, isofenphos, methyl bromide, monocrotophos and parathion, 54 tonnes of methoxyethyl mercury chloride, aldrin, camphechlor, DDT, endrin, ethidimuron, lindane, monocrotofos, nitralin and also other pesticides such as atrazine, endosulfan and paraquat (information obtained from EIA). Further sources of pollution up to a radius of 20 km are the cement kiln Cimentos de Moçambique – Cimpor aluminum smelter Mozal, tire factory Mabor, plant for the maintenance, repairing and filling of transformers Tecnel – ABB, leather processing industry, paint factory, waste incineration in a pen factory, cleaning agents production, and local heating using coal or wood as the main energy resource. It is also a highly populated area where the open burning of waste is a common practice.

Sampling site: The eggs were collected at 3 different sites within 0.7 - 2.5 km from the cement kiln Santos and within a radius of 2.3 km of the Boror Warehouse. Close to sampling spot 3 is also a waste dumpsite.

Peshawar, Pakistan

Hot spot: The most obvious potential pollution source is an abandoned dumpsite for municipal and hospital waste close to Charsadda road on the edge of Peshawar. Open burning of waste was observed here and also residual ashes from medical waste incinerators in Peshawar were dumped here. It is an open site where waste was dumped without any pre-treatment, ground insulation or cover. Peshawar and Charsadda have rainfall with a reported annual precipitation of 403.83 millimeters both in the winter and summer. This can lead to leaking of different toxic substances from the site into both underground and surface waters.



Photo 8: Sampling of eggs at the dumpsite near Peshawar. Photo by SDPI, 2005.

Sampling site: The eggs were collected in a settlement 250 meters from the dump site.

Barangay Aguado, Philippines

Hot spot: The Integrated Waste Management Inc. (IWMI) in Barangay Aguado operates a single-batch starved-air incinerator for medical waste. The IWMI incinerator is a pyrolytic waste oxidizer from Canada-based EcoWaste Solutions Inc., with a capacity of 10 tons/day. Apart from treating biomedical waste coming from client hospitals in Metro Manila, the IWMI incinerator also accepts and burns illegal drugs such as amphetamines seized from drug syndicates. Environmental groups are concerned about the IWMI incineration, which emits toxic gases while violating the

Philippine Clean Air Act. Barangay Aguado also hosts a small steel factory and a company producing poultry feeds, which are potential sources of pollutants as well. There are also industrial sites in the neighboring municipalities of Carmona, Dasmariñas, General Trias and other towns.

Sampling site: Eggs were collected in households within 0.5 km northeast of the medical waste incinerator.

Vilages of Igumnovo and Gorbatovka, Dzerzhinsk region, Russia

Hot spot: There are several places in the near surroundings of Gorbatovka with hazardous waste landfills, where both solid and liquid wastes were dumped. Some of them are still in use. In the settling pond called by local residents the “Black Hole”, phenol containing effluents are disposed of. The deep burial site for industrial wastewater from simazine production dumps over 2 million m³ of wastewater. Another landfill contains salts of heavy metals, electroplating and plastic waste. Now, it is covered by a clay layer. The municipal waste landfill located 1.5 - 2 km northwest of Gorbatovka accumulates solid waste from Dzerzhinsk and Nizhniy Novgorod. It has been operating since 1993. According to local inhabitants, ignition of municipal waste is observed every week.

Igumnovo is located south of the major chemical production facilities with associated sludge settlers, pits, waste dumps and wastewater channels along the groundwater flow from the north (from the industrial zone) to the south towards the Oka river. At a distance of 2.5 - 3 km to the northwest from the village, Kaprolaktam (a chlor alkali plant) is located. The plant has been operating since 1939, and was the oldest facility of its type in the former USSR. It includes also an industrial waste incinerator. In addition, a PVC production facility is also located there and has been operating since 1970. According to monitoring data of the Hydrometeorological Committee of the USSR, excessive levels of vinyl chloride were identified even at longer distances from the source. In some settlements vinyl chloride levels exceeded maximum acceptable levels by 20- to 40-fold. At an approximate distance of 4 km to the northwest of the village, the Korund Company pesticide

plant is located. From 1948 to 1980, the plant produced HCH and DDT.



Photo 9: “Black Hole” with chemical waste near Gorbatovka, Russia. Photo by Eco-SPES, 2004.

Sampling site: Local meteorological conditions support the hypothesis that the chlorine chemical industry and its waste dumpsites can be considered a pollution source for Gorbatovka and Igumnovo. Gorbatovka is located 2.5 – 3.5 km south of the Eastern Industrial Zone of Dzerzhinsk. Igumnovo is located 2.5 – 3 km distance south of major chemical production facilities.

District of Malika, Dakar, Senegal

Hot spot: The Mbeubeuss dumpsite and the open burning of wastes is the major pollution source. Soils in the rubbish dump are characterized by very high permeability. As a result, leakage can be observed during the rainy season. Also, one part of the bottom of the dump lies in the groundwater zone. On a daily basis, the dump receives over 1,000 tons of solid household waste, medical waste and waste from about 30 industry facilities. The Mbeubeuss dumpsite remains one of the biggest threats to the environment of Dakar (République du Sénégal, 1990). Household wastes are composed, in their majority, of organic matters and sand, and also include large quantities of cardboard, plastic and textiles. Hospital wastes are composed of surgery, obstetrical, gynecological, and laboratory waste, bandages, needles, plasters, expired products, one-way use objects, and hotels, restaurant, administration, and garden rubbish, etc. The industrial wastes disposed at Mbeubeuss come from the following activity sectors: parachemistry (insecticides, herbicides, explosive products, paints, etc), metallurgy, textile, chemistry, petrochemistry,

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 Pesticide Action Network (PAN) Africa (Badji and Diouf, 2005).

Sampling site: Eggs were collected within 0.7 km of the Mbeubeuss dumpsite in suburban Dakar. The sampling sites are located southeast and exposed to prevalent winds from the dumpsite.

Village of Sangalkam, Senegal

Hot spot: The sampling site is in a country-leading vegetable growing area located in the suburbs of Dakar in the Niayes area, and is characterized by an uncontrolled use of pesticides. Previous studies found lindane-contaminated groundwater that is used for irrigation and sometimes drinking. Besides market gardening, fruit arboriculture has begun developing in the area and the return of some crops grown during the rainy season (such as peanut, bean, and corn) is currently noticed (PAN, 2000). The Niayes area is characterized by its vulnerability, due both to the porosity of its substratum (exclusively composed of quaternary sands), and the shallowness of its groundwater (Cisse et al., 2004). Most of the small producers in this area are supplied with pesticides by street resellers who sell pesticides that are often expired (from outdated stocks) and/or imported illegally from nearby countries. These products are often without labels and/or different from those they are declared to be. The trade liberalization and the state disengagement in the agricultural sector have favoured an illegal trade of pesticides that gets supplied from nearby countries (e.g. Guinea-Bissau, Guinea-Conakry, The Gambia, Mali), the SODIFITSEX (spinning and textile industry), the DPV and other agro-industrial units. Prices in this informal market are lower and enable to partly lift the financial constraint related to the use of pesticides (Cisse et al., 2004). Moreover, some surveys conducted with market gardeners in the area have shown an intensification of treatments (PAN Africa 2004).

Sampling site: Sampling was conducted 1.5 km from the hot spot in the northern direction. The hens drink water from local wells.

Villages Valaliky and Kokshov-Baksha, Slovakia

Hot spot: The municipal waste incinerator in Koshice, the steelworks VSZ Koshice (southwestern from Valaliky) and the heating plant at Krasna nad Hornadom (north of the village) are considered to be main sources of pollution. In addition, local heating and possible open burning can be considered as potential POP sources in both villages, although most households in the villages do not use brown coal and/or wood for heating. The Koshice municipal waste incinerator began operating in the early 1990s. Since its beginnings, emissions were reduced only by an electrostatic precipitator of solid particles. Other air pollution control devices were not installed until recently. Approximately 70% of the prevailing winds blow southwards from Koshice. A serious fire lasting for 30 hours burst out on 2 June, 2004 at lunch time in the municipal waste incinerator. This fire could have led to greater amounts of releases of toxic substances.

Sampling site: The two villages Valaliky (in its parts called Bernatovce and Buzice) and Kokshov – Baksha are 1 and 2 km from the Koshice municipal waste incinerator, respectively, in the northeast direction.

Vikuge, Tanzania

Hot spot: The Vikuge obsolete pesticides stockpile is located about 35 miles (56 km) northeast of Dar es Salaam City. Between 1974 – 1976, the Sisal State Farm, under the Ministry of Agriculture, developed the land into a Research Center for growing seeds for food crops; later it became a hay farm. In 1986, the Government of Tanzania received various pesticides as a donation from the Government of Greece. It was noticed that the Government of Tanzania did not expect such a large amount of pesticides, and as a result, no preparation was made to receive the consignment. About 600 Mt stock received at the Vikuge site was stored under a shed measuring about 50 x 50 m. An estimated 200 Mt remained at the site. In the beginning of the 1990s the shed collapsed and the pesticides were exposed to direct sunlight, rain and other meteorological influences (Marco and Kishimba, 2007). The bags started leaking and contaminating the soils and ground water. In

1996, with the assistance of the Government of Sweden (SIDA), a new storage facility was built 20 m from the original site. Under the supervision of the NEMC (National Environment Management Council), the Government of Tanzania repackaged the pesticides in bags. The old site still has a strong odor of DDT along with the remains of dead insects and pieces of pesticide containers in a largely barren area with no vegetation. Villagers complained of the pungent smell of DDT, especially in the dry season and accompanied with wind.

Sampling site: Sampling was done south from the Vikuge village from three different fanciers in the surrounding area of wells contaminated by DDT. Two sampled farms were also close to a school.

Izmit, Turkey

Hot spot: The Izmit Waste and Residue Treatment, Incineration and Recycling Co. Inc. (Izaydas) was founded in 1996 by the Greater Izmit Municipality, within the scope of the Izmit Integrated Environment Project. The company was formed to operate the Clinical and Hazardous Waste Incinerator and the Industrial and Domestic Wastewater Treatment Plant. Both the incinerator, which has an annual capacity of 35,000 tons, and the landfill are located 2 km from the Solaklar village and 10 km from the city of Izmit. The landfill has a capacity of 790,000 m³ of industrial and 3,125,000 m³ of household waste (IGCM, 1994). Hazardous wastes incinerated included outdated herbicides and other pesticides, cosmetic and pharmaceutical wastes, refinery waste and wastes from oil and coal processing plants, used lubricants and oil residues, soil and dust contaminated with oil, solvents and paints, resins, glues and pastes, plastic and rubber products (including polyester and PVC products), used tires and wastes from plastic production and chlorinated residues of plastic products. Although it was planned to begin operation in August 1997, the Turkish Ministry of Environment refused to grant an operating permit on the basis of test burns, arguing that the plant had some technical deficiencies that would lead to emissions of toxic chemicals, especially dioxins and furans. According to information from the construction company, the plant was designed to meet German emission standards from 1986. At the same

time, the area within which the industrial wastes and toxic ash from the incinerator would be landfilled did not meet the standards of Hazardous Waste Control Regulations of the Ministry. The plant operated illegally, without any permit, until an action by Greenpeace Mediterranean in the late 1990's led to an order from the Ministry of Environment to the Kocaeli Governship to stop the transportation of all hazardous wastes to Izaydas and their incineration on site. The company running the incinerator continued to burn waste, despite the fact that the temporary permit had long expired. However, the company was able to get its permit from the Ministry in 2002 after conducting a few upgrades to cover the demands of the Ministry. Its permit for operation was renewed in 2004.

Sampling site: The samples were taken from two villages (Solaklar and Durhasan) 2 km downwind (northeast) of the hazardous waste incinerator in Izmit. There is no river or any other water source nearby these villages.

Mossville, USA

Hot spot: At least 14 industrial facilities manufacture, process, store and discharge toxic substances near Mossville, including hazardous waste incineration units (sometimes burning chlorine-containing materials) and several chlor alkali and VCM plants that are at the beginning of the production chain for PVC plastic. Recent US EPA Toxic Release Inventory reports show that the vinyl manufacturers, Georgia Gulf and PPG Industries, the Lyndell petrochemical facility, the Conoco Phillips oil refinery, and the coal-fired Entergy power plant are all sources of dioxins to the Mossville community (Costner, 2000).

Sampling site: Eggs were collected 1 mile from the PVC factory and oil industry area. The site is located northwest of the chemical industry area.

Minas, Uruguay

Hot spot: Two different cement kilns are located within the studied area: the ANCAP cement plant (Administración Nacional de Combustibles, Alcohol y Portland), a state owned company, located 5 km from the urban zone of the city of Minas, and the CUCSA cement plant (Compania Uruguaya de Cemento Sociedad Anonima), a private

company with investors from Spain. The ANCAP cement factory located in Minas initiated operations in 1954. In 2003, this plant produced 120,000 tons of clinker (ANCAP, 2002). The ANCAP cement kiln burns fuel oil and rice peel. The combustion of rice peel does not generate solid residue and the fraction of inorganic matter is incorporated into the clinker. The combustion of fuel oils produces significant pollution by carbon dioxide, nitrogen oxide, sulphur dioxide and potentially other polluting species, but their ambient levels are not being monitored. The La Plata stream passes 20-50 meters from the cement plants and runs into another stream, the San Francisco, which serves as a source of drinking water to the population of Minas and the adjacent area. Another potential source of pollution in the area could be the open burning of waste.

Sampling site: Eggs were collected within 2 km of the cement kilns ANCAP and CUSCA.

Abbreviations

DDD – Dichlorodiphenyldichloroethane
DDE – Dichlorodiphenyldichloroethylene
DDT – Dichlorodiphenyltrichloroethane
DDTs – Sum of DDD, DDE and DDT
EIA – Environmental Impact Assessment
EPA – US Environmental Protection Agency
EU – European Union
FDA – US Food and Drug Administration
GC – Gas chromatography
HCH – Hexachlorocyclohexane
IRS – indoor residual spraying
ITN – insecticide treated nets
IVM – integrated vector management
IARC – International Agency for Research on Cancer
MRL – Maximum residue limit
MWI – Municipal waste incinerator
HCB – Hexachlorobenzene
HR GC-MS – High resolution gas chromatography mass spectrometry
LOD – Limit of determination
OCPs – Organochlorine pesticides
POPs – Persistent organic pollutants
WHO – World Health Organization

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