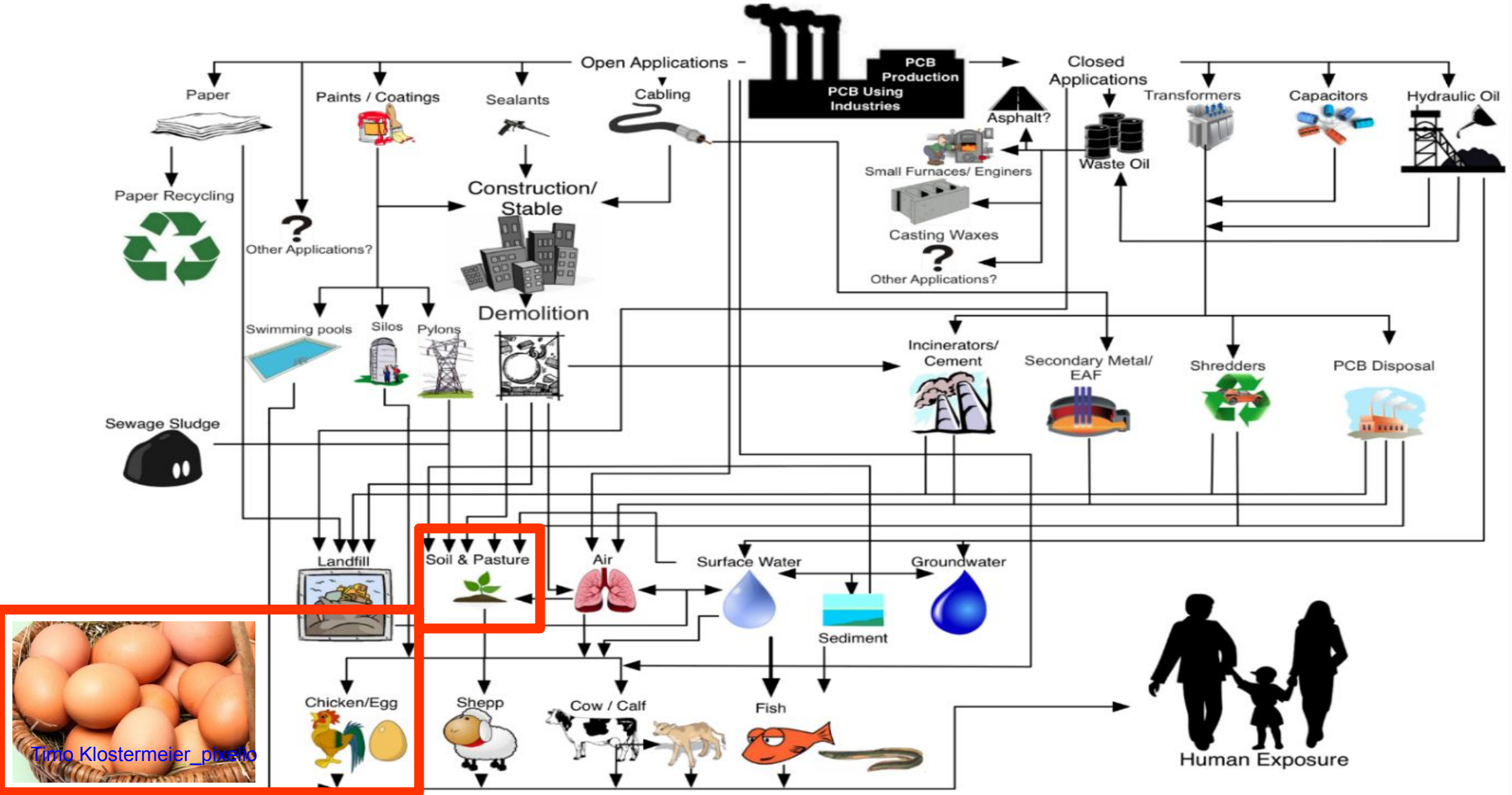
14th International HCH and Pesticides Forum

Monitoring PCBs in Eggs as Sensitive Indicators for Contaminated Sites from PCB Management Highlighting the Need for Stricter Control of PCB Waste

Roland Weber[1], Jindrich Petrlik[2,3], Lee Bell[2,4], Joe DiGangi[2], Gilbert Kuepouo[5], Yuyun Ismawati Drwiega[6], Peter Behnisch[7], Christine Herold[1]

[1]POPs Environmental Consulting, D-73527 Schwäbisch Gmünd, Germany; [2]International Pollutants Elimination Network (IPEN), Göteborg, Sweden; [3]Arnika – Toxics and Waste Programme, Prague, Czech Republic; [4]National Toxics Network (NTN), Perth, Australia; [5]Centre de Recherche et d'Education pour le Développement (CREPD), Yaoundé, Cameroon; [6]Nexus3 Foundation, Denpasar, Indonesia; [7]BioDetection Systems BV (BDS), The Netherlands.

Life cycle of PCBs - contamination of soils, food and human exposure



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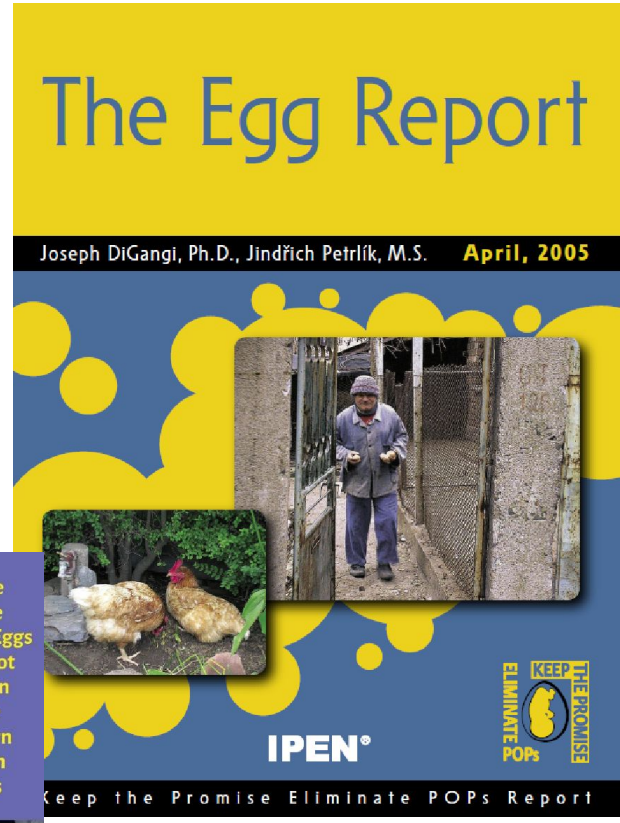
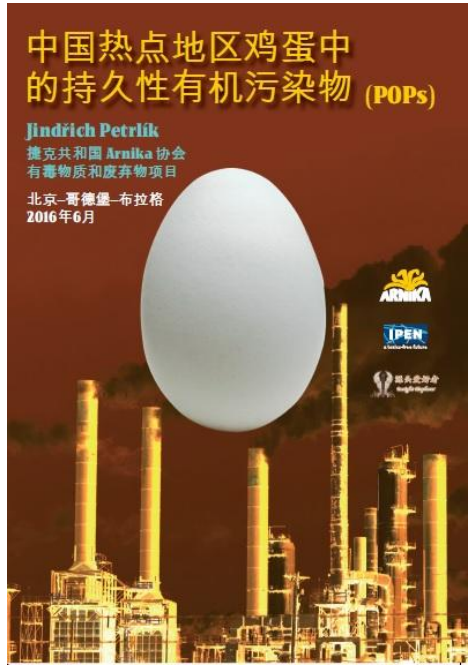
Weber et al. (2018) Environ Sci Pollut Res Int. 25(17), 16325-16343 https://doi.org/10.1007/s11356-018-1811-y

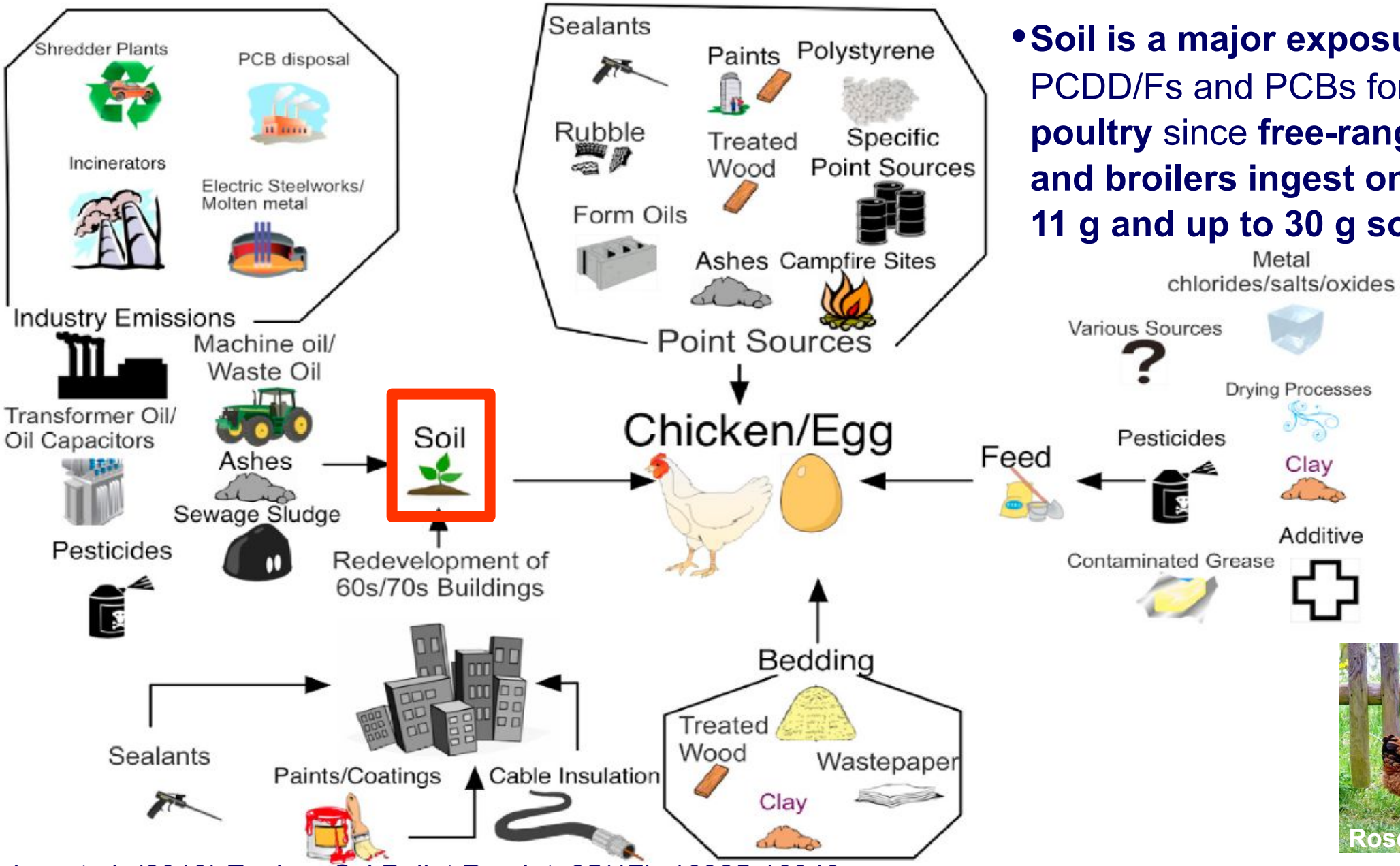
Eggs as exposure pathway of PCB & PCDD/F from contaminated soil

- Free-range eggs are sensitive indicators for PCB and PCDD/F contamination in soils and eggs & meat are an important exposure pathway from polluted soils to humans.
- Chickens and eggs are therefore ideal “active samplers” and indicator species for PCB and PCDD/F contaminated soils.
- Since the beginning of the Stockholm Convention the International Pollutants/POPs Elimination Network (IPEN) monitored eggs around priority dioxin/PCB sources listed in the Stockholm Convention (e.g. metal industries, shredder plants, e-waste recycling sites, waste incinerators, dumpsites and other open burning sites).





Major exposure pathways of PCBs and PCDD/Fs for chicken/eggs



- **Soil is a major exposure pathway** for PCDD/Fs and PCBs for **free range poultry** since **free-range laying hens and broilers ingest on average about 11 g and up to 30 g soil per day.**

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Global egg study – Outcome of IPEN & Science for PCDD/Fs & PCBs

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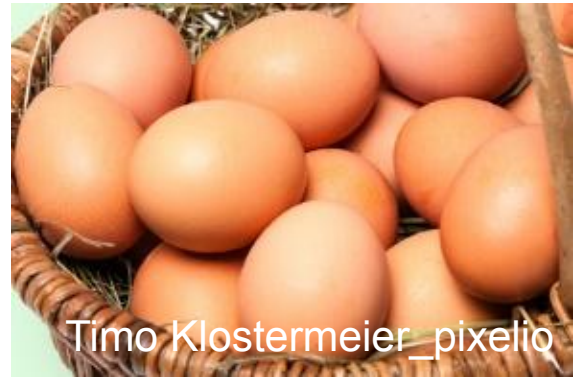


Monitoring dioxins and PCBs in eggs as sensitive indicators for environmental pollution and global contaminated sites and recommendations for reducing and controlling releases and exposure

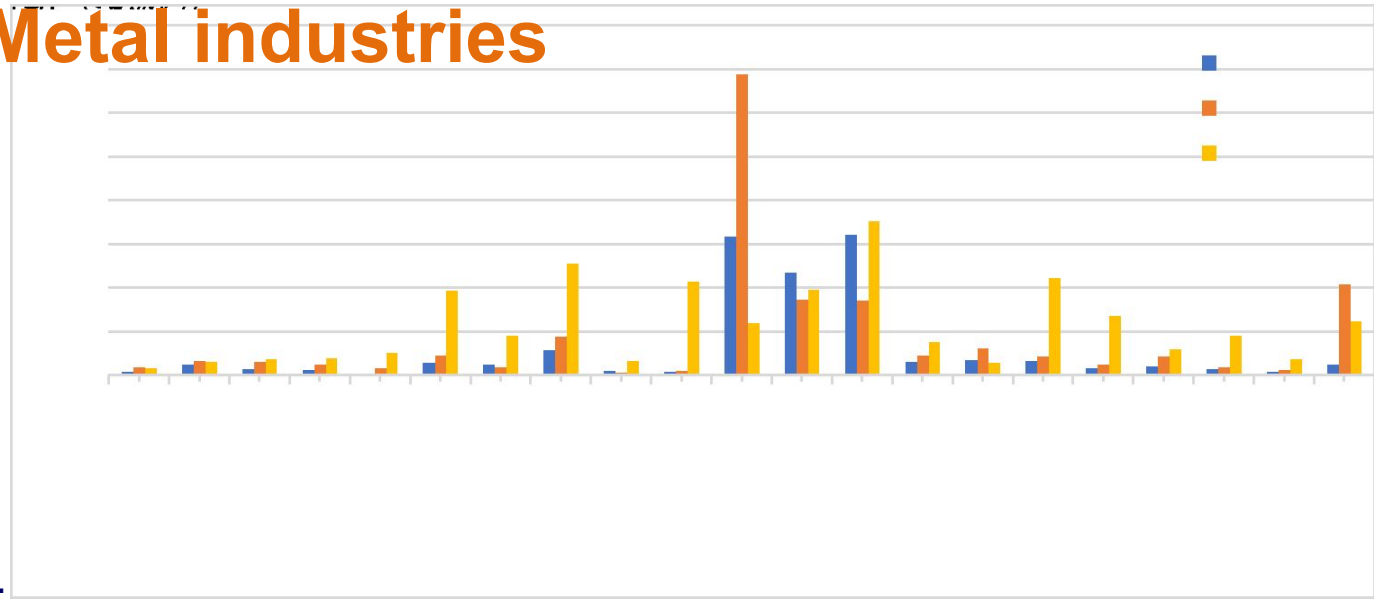
Jindrich Petrlik [a, b], Lee Bell [a, c], Joe DiGangi [a], Serge Molly Allo'o Allo'o [d], Gilbert Kuepouo [e], Griffins Ochieng Ochola [f], Valeriya Grechko [b, g], Nikola Jelinek [b], Jitka Strakova [a, b], Martin Skalsky [h], Yuyun Ismawati Drwiega [i], Jonathan N. Hogarh [j], Eric Akortia [k], Sam Adu-Kumi [l], Akarapon Teebthaisong [m], Maria Carcamo [n], Bjorn Beeler [a], Peter Behnisch [o], Claudia Baitinger [p], Christine Herold [q], Roland Weber [q, *]

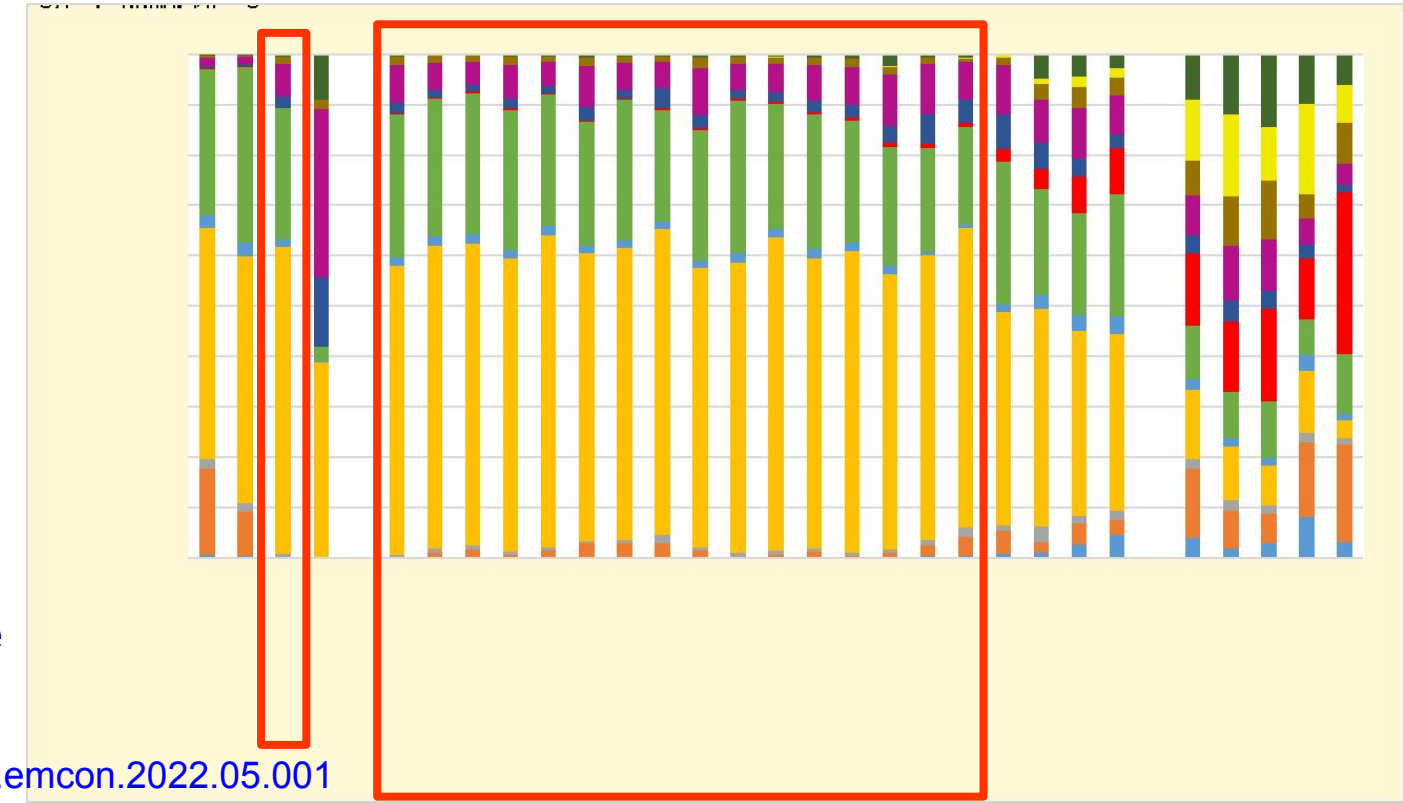
Petrlik et al. (2022) Emerg. Contam. 8, 254-279 https://doi.org/10.1016/j.emcon.2022.05.001

- Data on PCB & PCDD/F contaminated eggs were assessed from 20 years monitoring of IPEN & science literature.
- IPEN monitored 113 chicken flocks at potential PCDD/F- and PCB-contaminated sites and **88% of the pooled egg samples were above the EU maximum limits** for PCDD/Fs (2.5 pg PCDD/F-TEQ/g fat) or the sum of PCDD/Fs and dioxin-like PCBs (5 pg PCDD/F-PCB-TEQ/g fat).
- **Children consuming just one egg exceed the FAO/WHO TDI (based on 70 pg TEQ/kg month) and the EU tolerable weekly intake (TWI). This indicates that close to 90% of areas around these industrial emitters and**

IPEN global egg study – Metal industries

- IPEN monitored 21 pooled chicken eggs around secondary metal smelters or steel industry in 7 countries (Armenia, Bosnia and Herzegovina, Egypt, Indonesia, Kazakhstan, Thailand, and Ukraine).
- **All chicken flocks exceeded the EU regulatory limit** with a **high mean TEQ (26.0 pg TEQ/g fat).** This indicates that all areas around these metal industries were unfit for free-range chicken farming.
- **At 15 of the 21 sites commercial PCBs** were the **main TEQ contributor** (mainly Arochlor 1254).
- **This demonstrates that over the last 40 years PCBs have entered metal smelters on metal scrap** with associated **pollution of surrounding soils** and chicken/eggs with exposure to humans.
- **This highlights that the management of metals from PCB containing transformers, capacitors & other PCB contaminated metals need a better control and better cleaning of metal parts** before they enter e.g. copper or aluminum smelters!!





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IPEN global egg study – Shredder facilities

- High releases of PCBs have been detected from metal shredder plants with associated PCB contamination in the surrounding areas. Source are mainly small capacitors in washing machines, other electronics and cars. Also some cars produced in the 1970s and 1980s contained PCB as brake fluid.
- In the IPEN global egg monitoring studies, pooled eggs from 6 chicken flocks around shredders and recycling plants were analysed from 3 countries (Belarus, Mexico and Czech Republic (4)). The PCDD/F-PCB-TEQ of the pooled egg samples ranged from 5.8 to 31.9 pg TEQ/g and therefore all chicken flocks exceeded the EU regulatory limit. This indicates that the areas around the three investigated shredder/recycling sites were unfit for free-range chicken.
- The pooled egg from Belarus was sampled near a large car shredder plant in a small town (Gatovo) approx. 10 km south from Minsk and had TEQ levels of 15.6 pg TEQ/g fat with **73% contribution from dl-PCBs**.
- Also the chicken eggs close to an e-waste shredder plant and recycling workshops in Mexico (Guadalajara) were impacted with 6.8 pg TEQ/g fat with a **contribution of 36% TEQ from PCB**.
- IPEN also sampled eggs in Pitarne village (Czech Republic) near a recycling plant for cables wires and other PVC products that uses shredding to produce PVC roofing materials. Pooled egg samples from 4 flocks were sampled in the surrounding area. All samples were above the EU maximum limit for eggs and ranged from 5.8 to 31.9 ng TEQ/g fat. **PCBs contributed between 52 to 79% which could possibly stem from PCBs formerly used as plastic additives in cables**.

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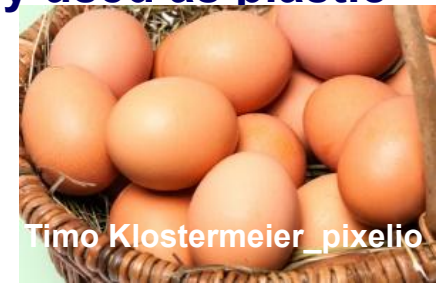

IPEN global egg study – E-waste recycling sites

- IPEN monitored 7 pooled eggs from chicken flocks at e-waste sites in 5 countries (Ghana, Kenya, Indonesia, Philippines, Thailand). The PCDD/F-PCB-TEQs were between 20.4 to 856 pg TEQ/g and therefore **all eggs exceeded the EU regulatory limit**. The **mean TEQ was 308.4 pg TEQ/g fat** and by far the highest mean/median TEQ of all source categories.
- Eggs at the Ngara e-waste dismantling market in Kenya were contaminated with **567.4 and 519.6 pg TEQ/g fat with 97.8 and 96.6% TEQ contribution from dl-PCB which are the highest dl-PCB levels ever measured in free-range eggs**.
- With 855.8 pg TEQ/g fat in eggs from the e-waste site in Agbogbloshie (Ghana) where e-waste plastic parts/cables is frequently burned. The major TEQ contribution came from PCDD/Fs (661 pg TEQ/g fat) but also dl-PCBs were high (194.8 pg PCB-TEQ/g fat)
- This highlights that **e-waste sites in developing countries can be PCB hotspots** with associated exposure and stresses that PCB equipment need a better management there.

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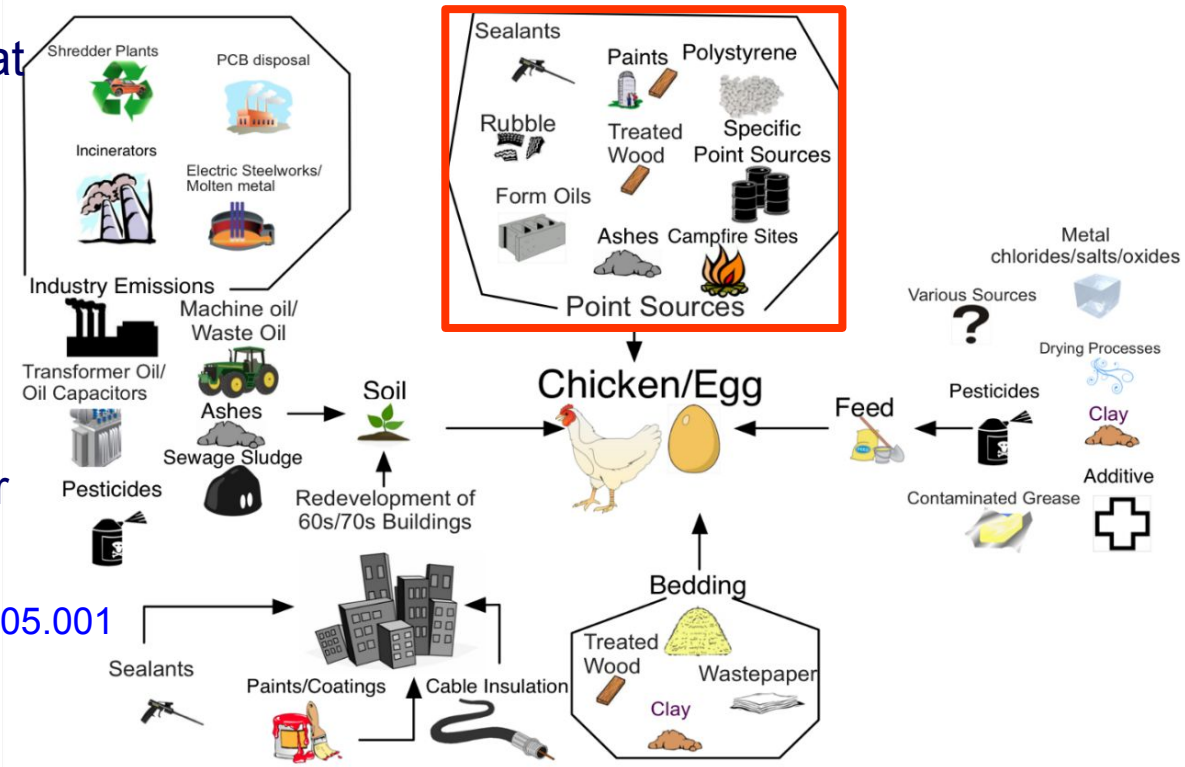
PCB point sources at farms

- The 5th highest dl-PCB-contaminated egg (150.4 PCB-TEQ pg/g fat) was sampled by IPEN at a small farm in a pristine mountain area in Kazakhstan – intended as reference background site but obviously heavily impacted by a PCB point source on the farm.
- For the 9th HC-PCB egg (78.8 pg PCB-TEQ/g) the PCB point source on a farm in the Netherlands could be determined as PCB paints on the asbestos roof (Hogenboom et al. 2014).
- Similarly the 7th HC-PCB egg (86.15 pg PCB-TEQ/g) on a farm in Belgium without a particular industry close by was most likely contaminated by such a PCB point source, since the measured feed and soil were low in PCBs (van Overmeire et al. 2009).
- A range of further cases with contaminated eggs but also meat and milk from farms with PCB paints on walls, silos and asbestos roofs have been documented in industrial countries as important point sources (Weber et al. 2018).
- This highlights that PCB paints can be relevant PCB sources on farms and that within a national PCB inventory of the Stockholm Convention the assessment of past use of PCB paints and sealants is needed to understand the relevance for a particular country (Weber et al. 2018).



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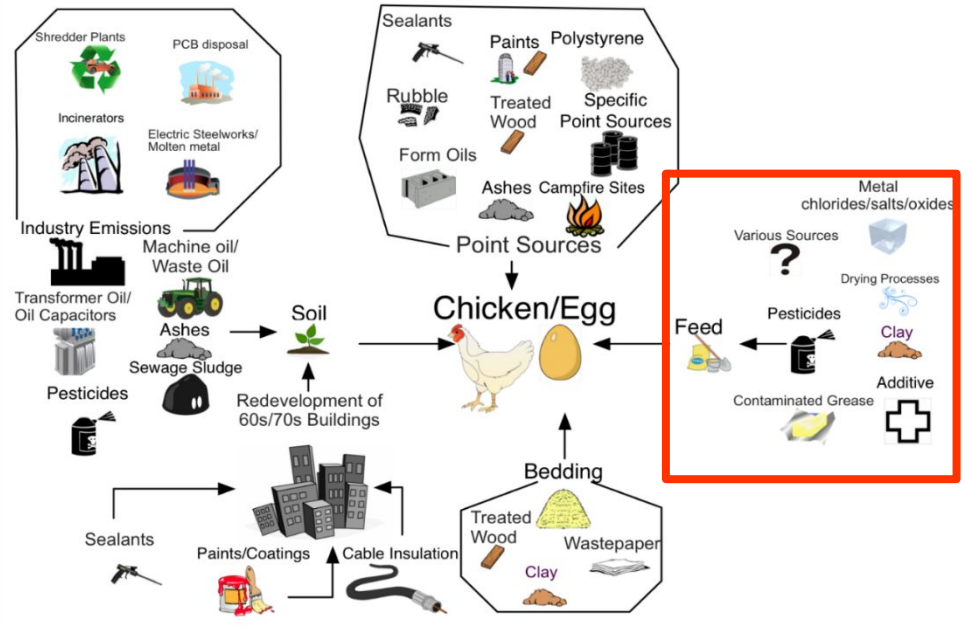
Weber et al. (2018) Environ Sci Eur. 30:42. https://rdcu.be/bax79

PCB Challenges in Material Cycles: Waste oils
Challenges in industrial countries – Feed & Food scandals

- The 3rd highest dl-PCB-contaminated egg (211 pg PCB-TEQ/g fat; HC-PCB#3) stems from the PCB feed incident in Belgium. In 1999 feed and food of thousands of farms in Belgium were contaminated with PCBs, because 25-50 kg PCB oils were not managed appropriately but were collected by the same companies which managed food fat and were mixed with 107 t fat for animal feed.
- Chicken eggs, meat from chicken, pork and beef were found in Belgium hundred times above today's EU food limits.
- 446 poultry farms, 746 pig and 393 cattle farms impacted.
- 20,000 t poultry, 6,000 t pork, 400 t beef, million eggs (incinerated)
- **1 billion US$ direct costs** for Belgium food production.
- **This highlights the risk of mismanaged PCB for feed and food for the population of a country and beyond!**

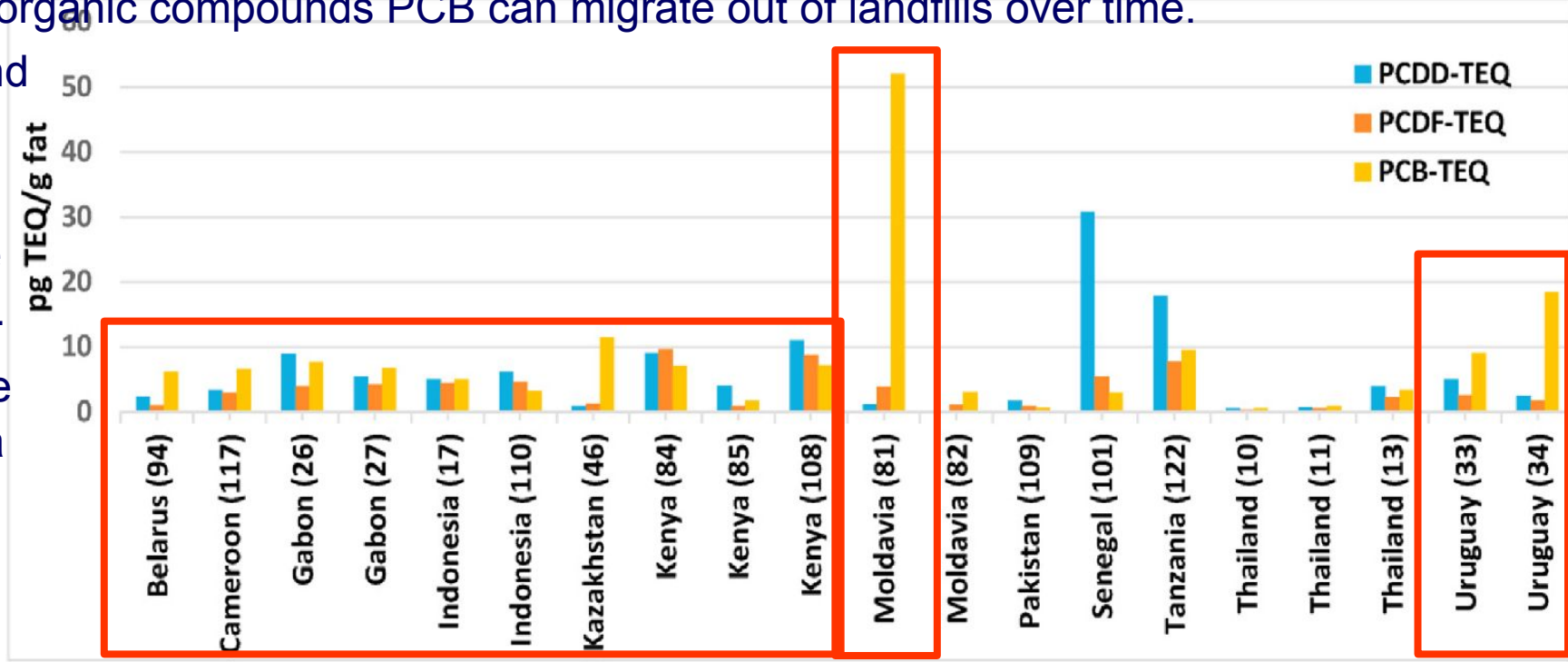
Fiedler et al. (2000) Study on behalf of the EU Commission,

Material Cycle Management: In the EU it is meanwhile prohibited that industrial waste oils and waste food fats are managed within the same company!



IPEN Global Egg Study – landfills & dump sites (n=20)

- More than 50% of PCBs were not adequately managed and were disposed in landfills and dump sites in the past (Breivik et al. 2007). As semivolatile organic compounds PCB can migrate out of landfills over time.
- 16 of 20 pooled eggs sampled around landfills and dump sites were above the EU limit.
- In 12 of the 20 sites PCB-TEQ alone exceeded the EU TEQ-limit for eggs.
- The highest contaminated eggs were sampled around a landfill in Moldova with >50 pg TEQ/g fat from dl-PCB.
- Also the eggs sampled around a landfill in Kazakhstan had more than 10 pg TEQ dl-PCB/g fat contamination.



- Also in landfills in Belarus, Cameroon, Gabon and Uruguay the TEQ contribution of PCBs was higher than the contribution of PCDD/PCDF.
- The high impact of PCB contamination in eggs around landfills and dump sites highlights that landfilling of PCB results in release and contamination of the surrounding with the very persistent and semivolatile PCBs.
- PCBs should not be disposed to landfills and dump sites since they evaporate over time and contaminated the surroundings.

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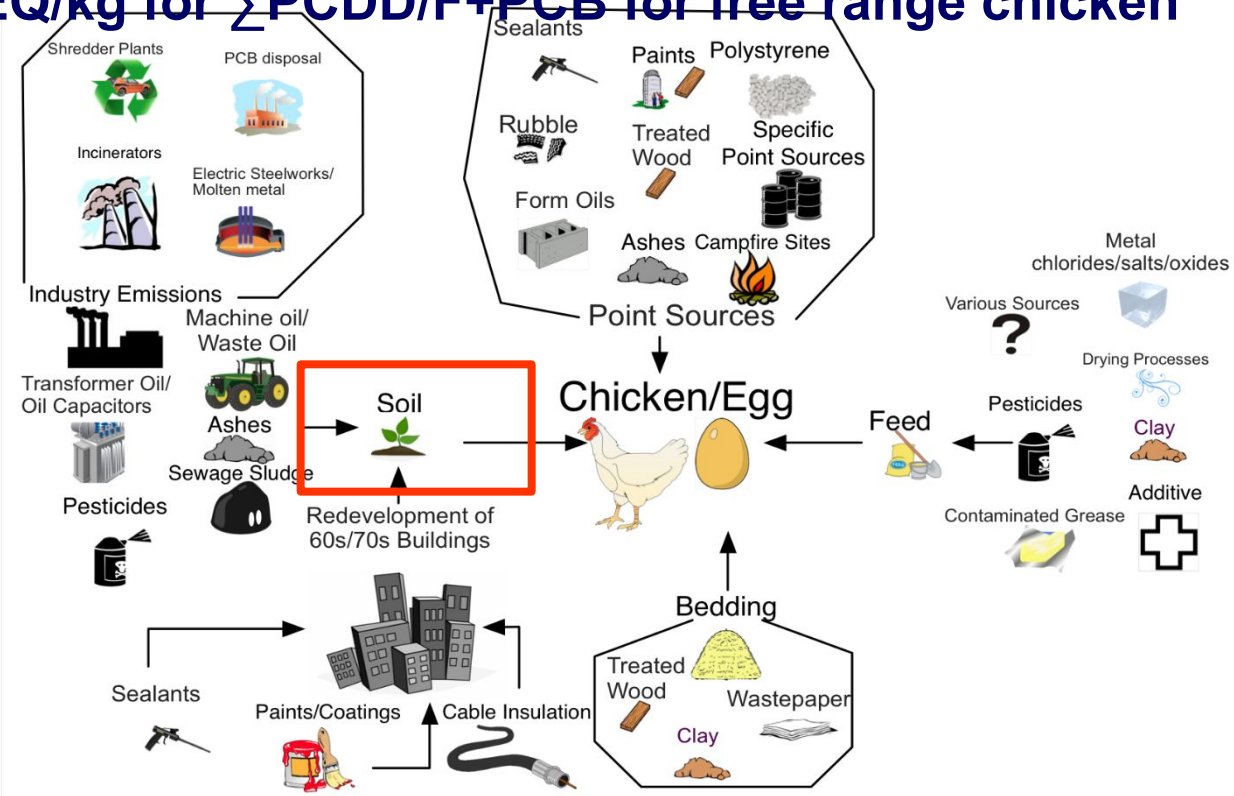
Problematic PCDD/F and PCB levels in soil for chicken egg and meat production

What are critical soil levels for impacting an egg above regulatory limit?

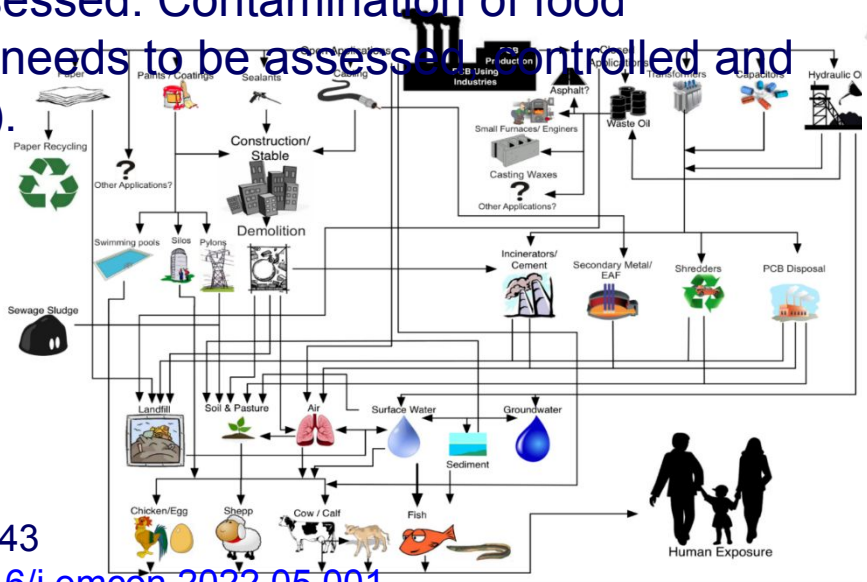
- With a total uptake of 25 pg (50 pg) TEQ/day a chicken reaches the current EU-limit of 2.5 pg (5 pg) for PCDD/F (sum PCDD/F-PCB) TEQ/g fat in egg.
- Free range chicken which spend a lot of time outdoor have a soil uptake of approx. 11-31 g soil/day.
- With a carry over of approx. 50% for TEQ-relevant PCB & PCDD/F the problematic levels in soils to reach EU limit for eggs (and meat) are approx. **3 to 7 ng TEQ/kg for ∑PCDD/F+PCB for free range chicken**
- These problematic soil levels are extremely low and are exceeded in many areas of industrial emissions and can also be exceeded in cities or residential areas (e.g. from open PCB uses, areas with PCB containing buildings, ashes, pesticides, open burning or deposition) (Weber et al. 2018, 2019).



Weber et al. (2018) Environ Sci Eur. 30:42. https://rdcu.be/bax79 ;
Weber, Bell et al. (2019) Environ Pollut. 249, 703-715.

Conclusions

- The large PCB (and PCDD/F) contamination along the life cycle of PCB including production, use and end of life treatment demonstrates that an overall assessment of PCB-contaminated sites along the life-cycle of PCBs is needed (Weber et al. 2018).
- The large pollution detected at metal smelters, e-waste recycling sites, shredder plants, and around landfills/dump sites highlights that an overall improvement of PCB management in end-of-life is urgently needed in developing and emerging economies and that care is needed when increasing now the PCB management pressure to meet the 2025 PCB phase-out and 2028 final PCB elimination goal of the Stockholm Convention (https://wedocs.unep.org/bitstream/handle/20.500.11822/20786/PCB%20Brochure%20(2017).pdf?sequence=1).
- In addition, human exposure from the related PCB-contaminated sites and soils from past (and ongoing) PCB-releases need to be assessed. Contamination of food produced on such sites like eggs, milk and meat needs to be assessed, controlled and eliminated (Weber et al. 2018; Petrlik et al. 2022).
- Please note, the WHO working group is currently assessing toxic equivalency factors (TEF) of PCBs and might update.



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Policy recommendations to improve POPs management

3.4.1 Overall conclusion on egg and soil contamination and related human exposure
3 4.2 Preliminary conclusions on time trends
3.4.3 Stop transgressing the global boundary for “Novel Entities”

Recommendations on waste management

3 4.4 **Recommendation to improve management of POPs wastes and tracking of pollution in the POPs life cycle**
3.4.5 **Recommendation of improved management of plastics and e-waste** and stop of thermal treatment in non-BAT facilities by effective implementation of conventions

Recommendations on inventory of emission sources and contaminated sites

3.4.6 Systematic inventory of sites and potential contamination around emission sources within the inventory activities of Stockholm Convention
3.4.7 Systematic monitoring of human exposure from contaminated sites to reduce and minimize exposure
3.4.8 Capacity building for monitoring in developing countries including bioassay

Recommendations on legislative limits

3.4.9 **Recommendation on re-evaluation of soil limit values**
3.4.10 **Recommendation for industrial emissions and for low POPs limits** in particular for fertilizer and other soil amendments (approx. 10 ng TEQ/kg)
3.4.11 Recommendation for unintentional trace content limits for pesticides/chemicals

Addressing farmers and consumer needs

3 4.12 **Measures to control exposure**
3.4.13 **Compensation of farmers and consumers by applying PPP**

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14th International HCH and Pesticides Forum

THANK YOU FOR YOUR ATTENTION

Dr. Roland Weber
POPs Environmental Consulting
Roland.Weber10@web.de

Dr. Jindrich Petrlik
Arnika and IPEN
jindrich.petrlik@arnika.org

PLASTIC WASTE FLOODING INDONESIA LEADS TO TOXIC CHEMICAL CONTAMINATION OF THE FOOD CHAIN

December 2019

NEXUS3 ARNIKA ecoton IPEN for a toxics-free future

Persistent Organic Pollutants (POPs) in Eggs: Report from Africa

AUTHORS:
Jindřich Petrlík – Sam Adu-Kumi – Jonathan Hogarh – Eric Akortia – Gilbert Kuepouo – Peter Behnisch – Lee Bell – Joseph DiGangi

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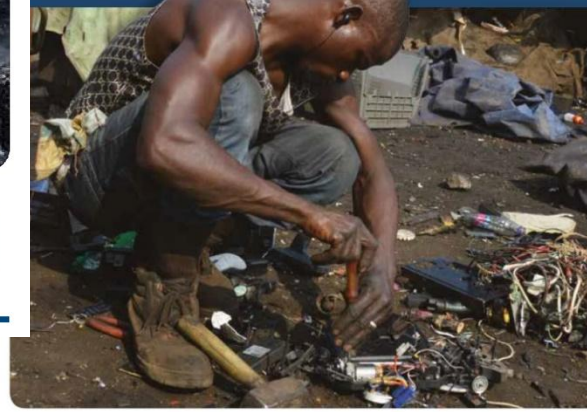

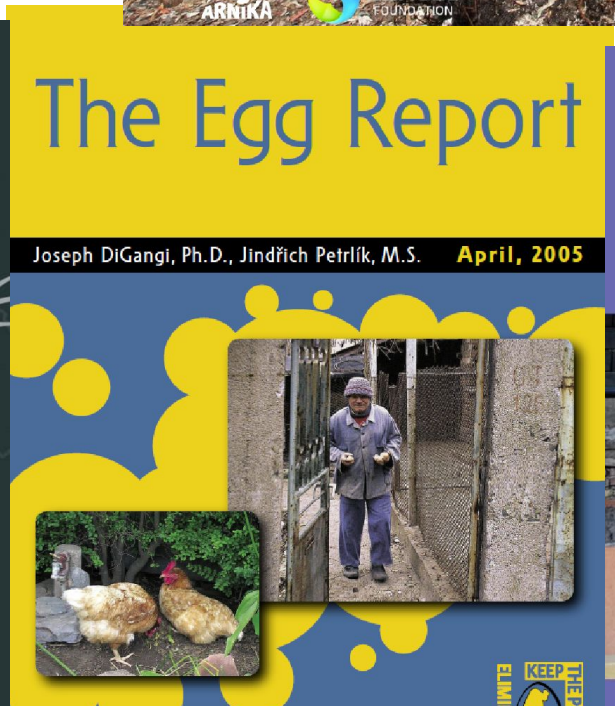

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