Necessity for Establishment of POPs/PTS Inventories for Landfills & Contaminated Sites for an Evaluation of Mobilisation Risk by Climate Change

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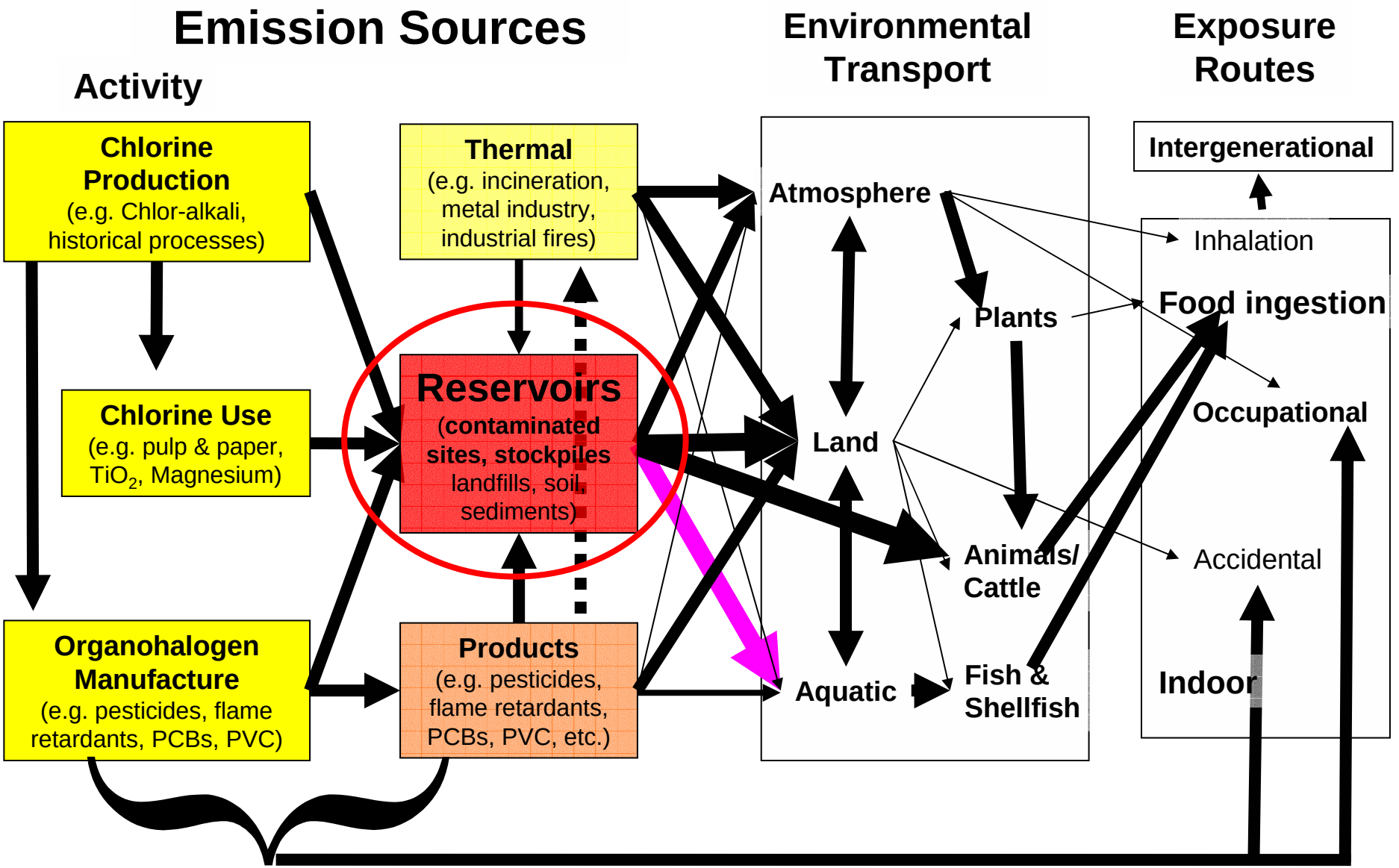
Spolana - Flooding as Remediation Argument

Life-Cycle of uPOPs/POPs



Weber et al. “POPs and Landfills - A Review” Waste Manag & Research 29 (1) 107-121 (2011)

Lindane and HCH Production
Deposits of alpha/beta-HCH POPs

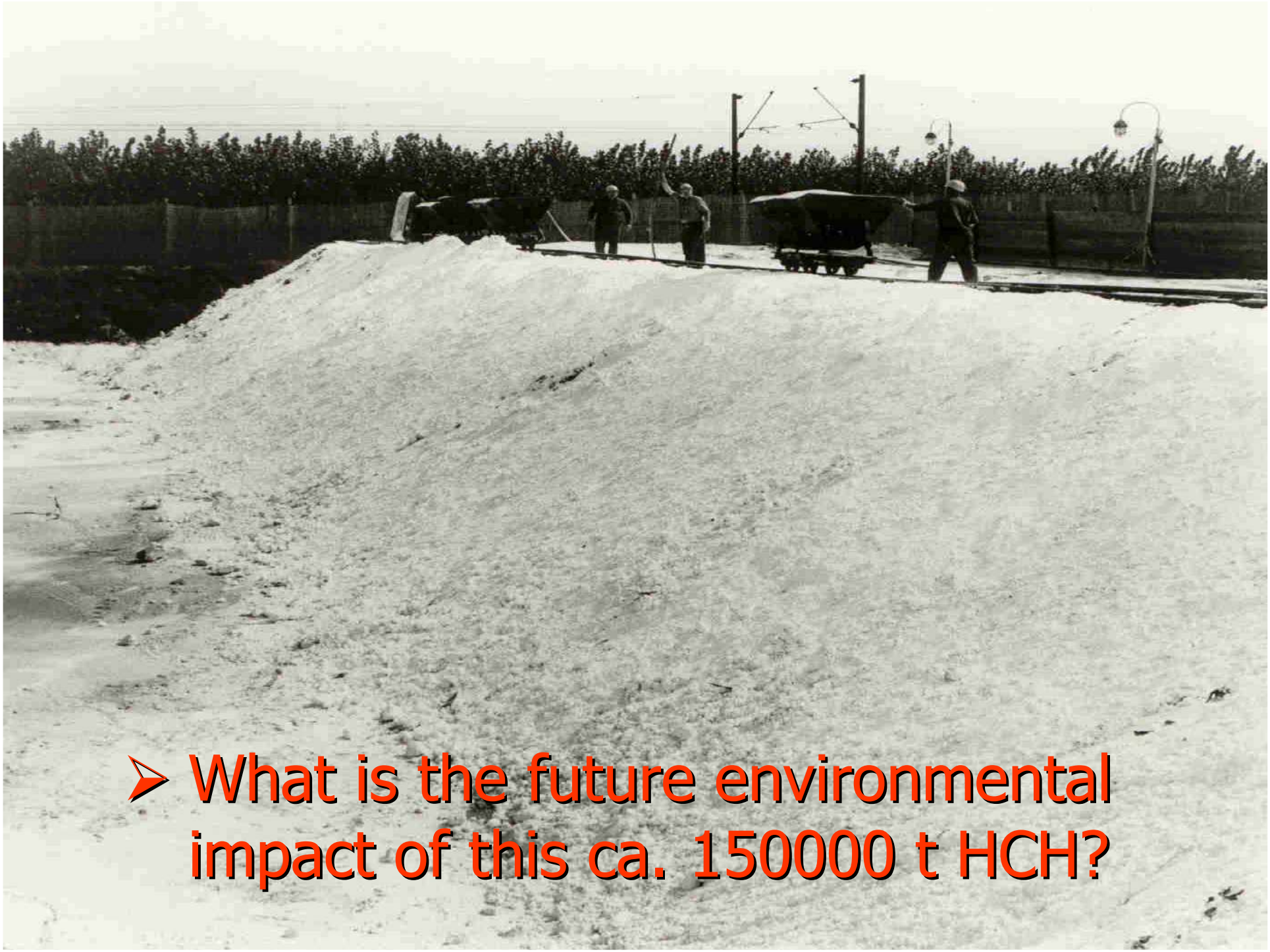
- Since 09/2009 Alpha-HCH, beta-HCH and Lindane (technical gamma-HCH) are Stockholm POPs
- During production of Lindane 85 % of HCH was useless as pesticide and mainly deposited!!
- Therefore each ton Lindane produced resulted in deposition of ca. 8-12 tons HCH-waste isomers which ended up as waste dumped near production
- 4 to 7 Million tons of HCH waste is dumped near the HCH production sites creating one of the globe's largest hazardous organic waste problem.

(total historic PCB production 1.5 to 2 mio t)

See: Vijgen, Abhilash, Weber et al Env Sci Pollut Res. 18, 152-162 (2011).
http://www.springerlink.com/content/g62g810418512421/fulltext.pdf

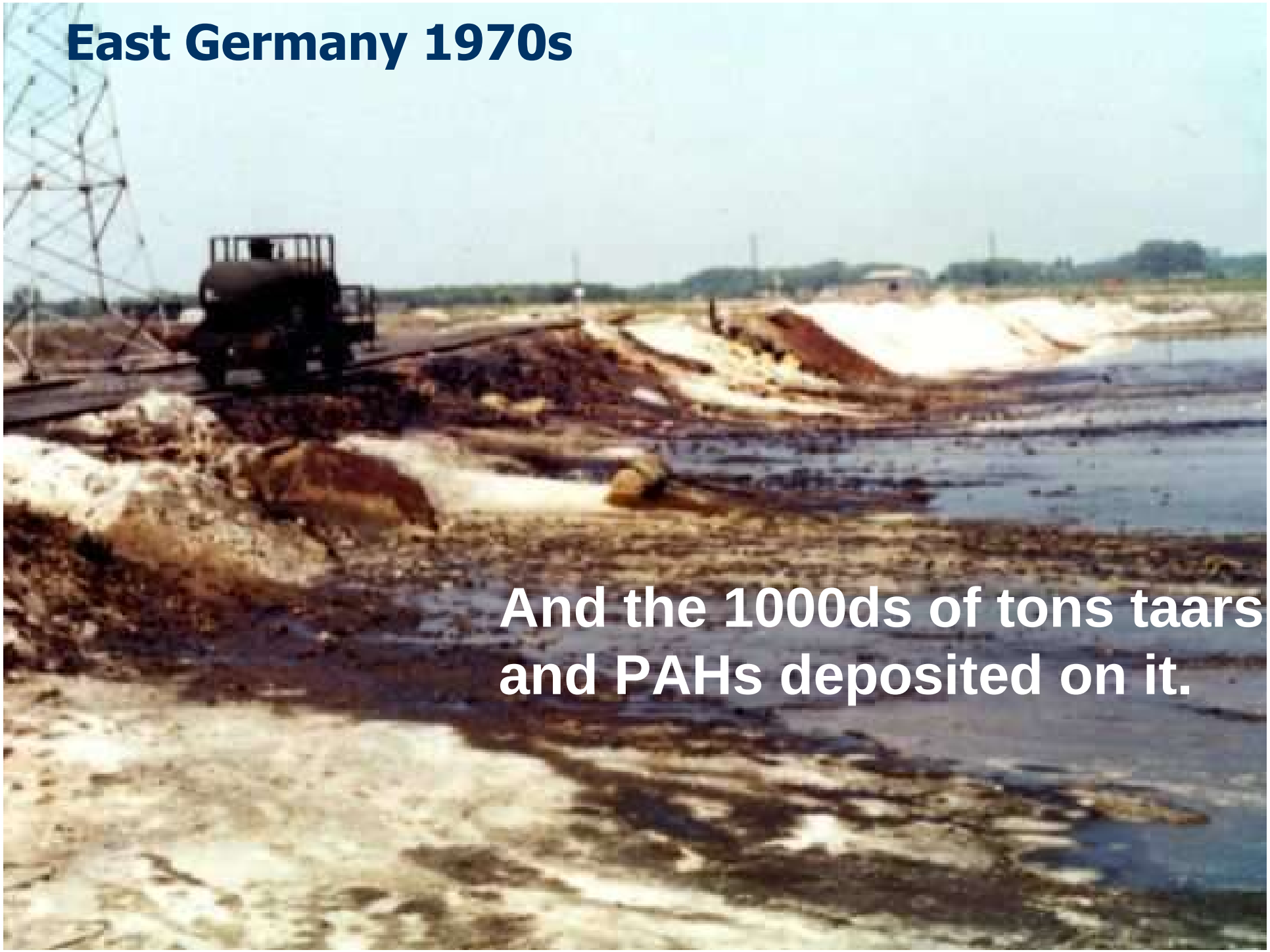
Management and deposition of HCH waste isomers

East Germany 1960s

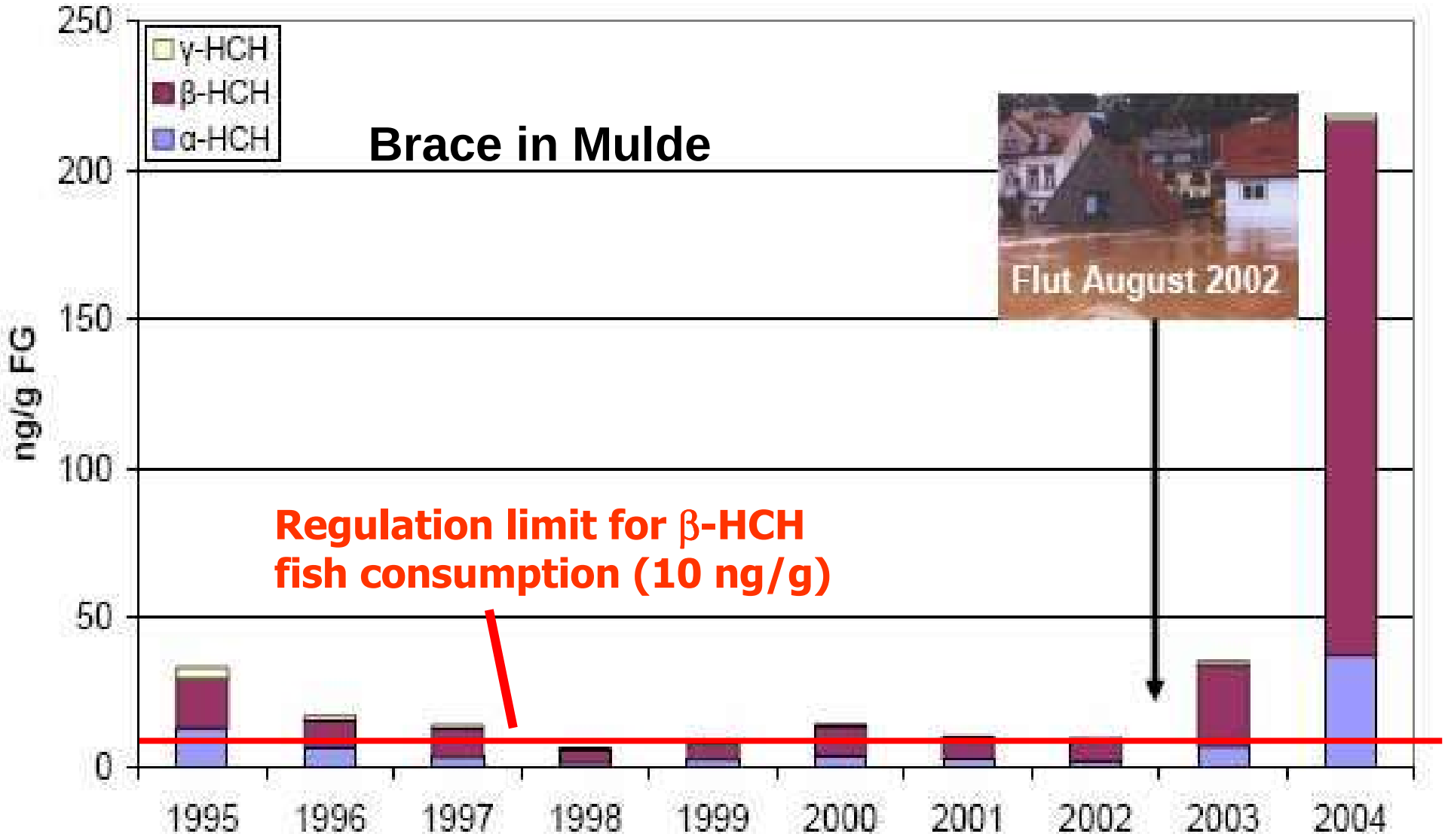


- What is the future environmental impact of this ca. 150000 t HCH?

East Germany 1970s

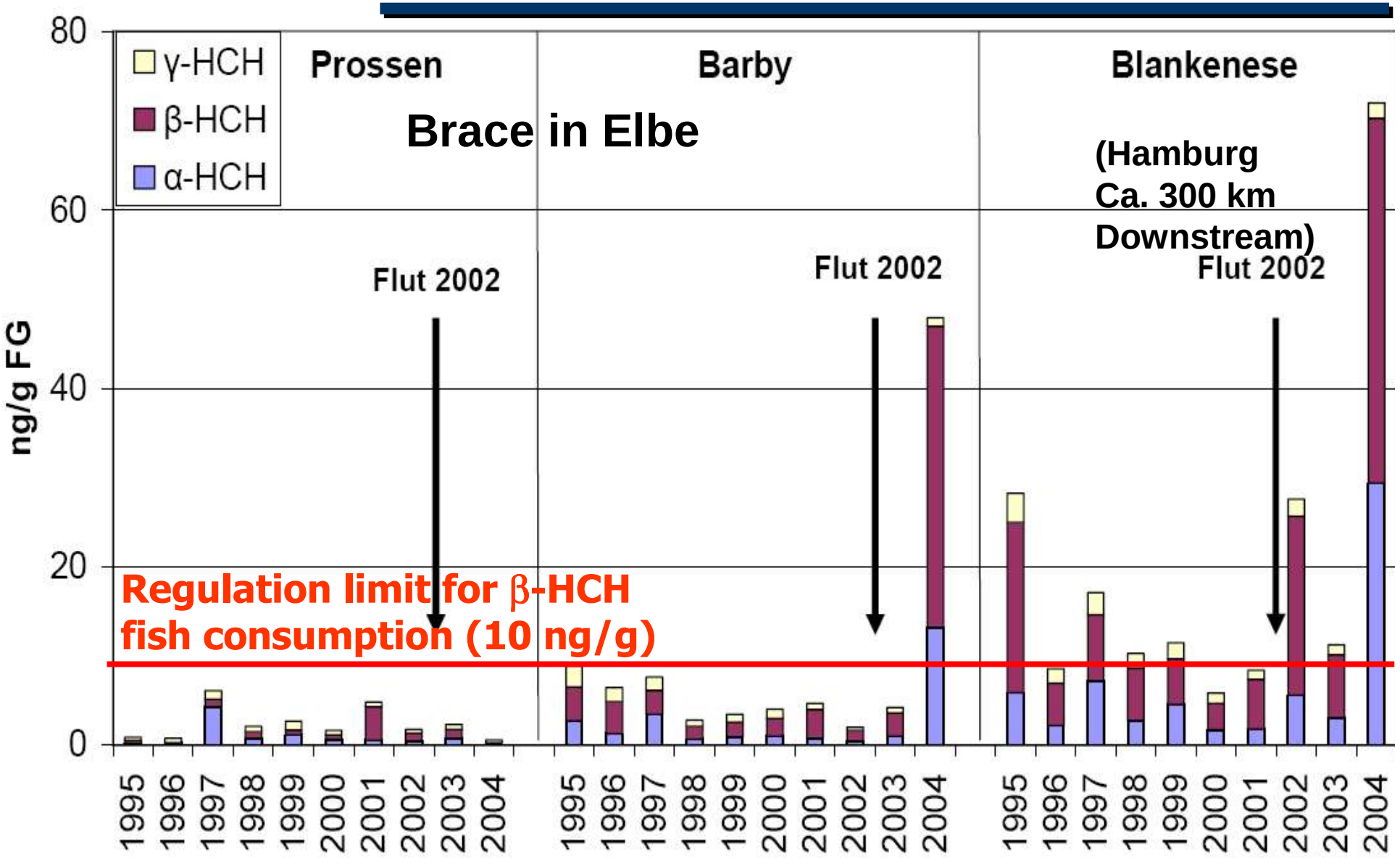


Release of HCH into Rivers
Increase HCH in Fish Mulde-Elbe



UBA (German Environmental Agency) report (2005).

Release of HCH into Rivers Increase HCH in Fish Mulde-Elbe



UBA (German Environmental Agency) report (2005).

Lindane Factory France (1972) Boardering Rhein River

- Several Lindane Factories with their deposits were/are close to rivers.
- Systematic assessment on the flooding risk not started yet.

Recent Practice: HCH Mountain India (2005)

For current operating Indian factory the levels of HCHs in two nearby rivers were high.

Source: Jit et al (2010) Environ Sci Pollut Res DOI 10.1007/s11356-010-0401-4
http://www.springerlink.com/content/b04145h35061vq28/fulltext.pdf

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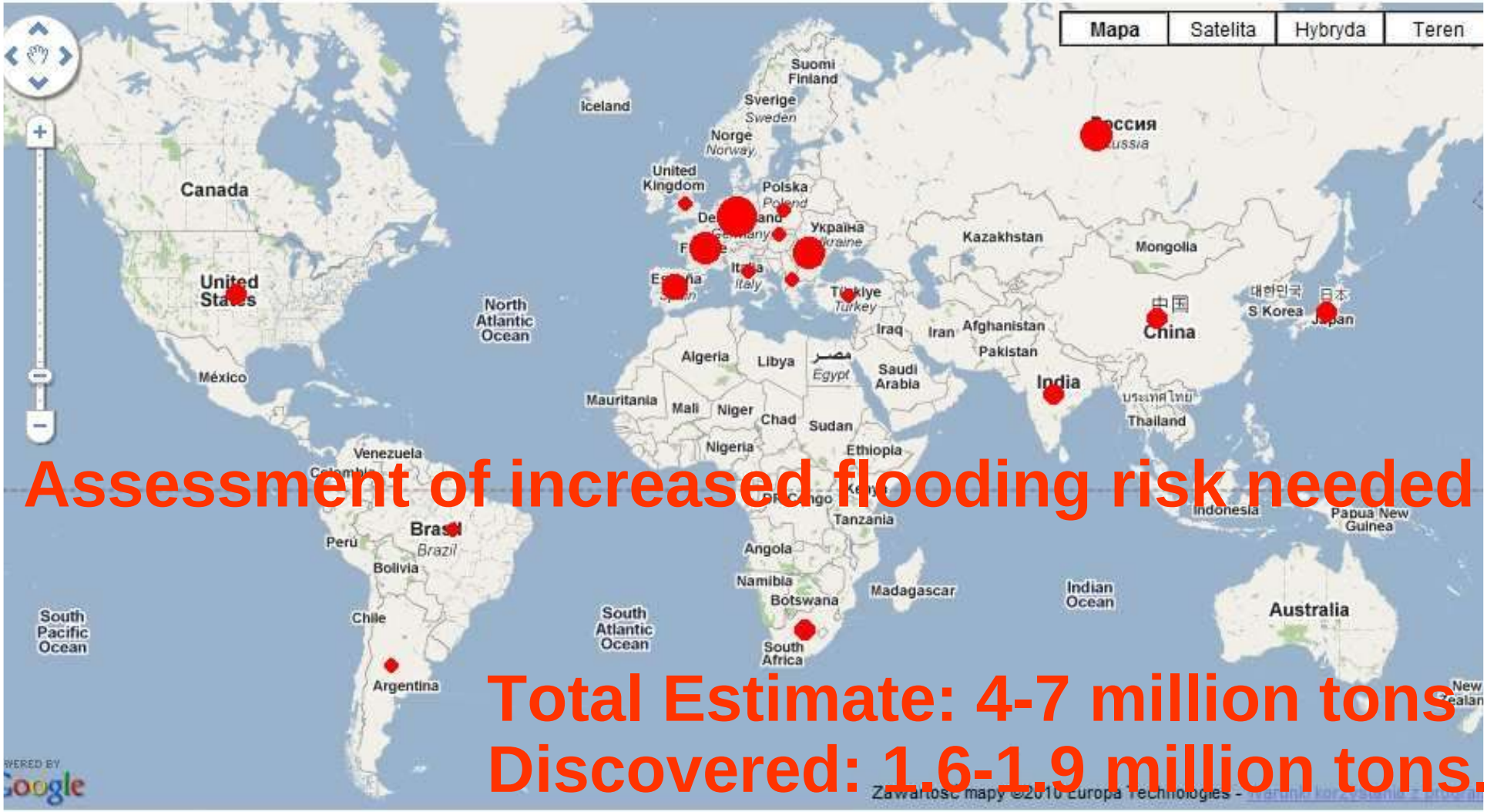
Global Map HCH Inventory of Estimated Stored Waste (IHPA 2009)

Investigations/questionnaires to governments/companies and literature survey.



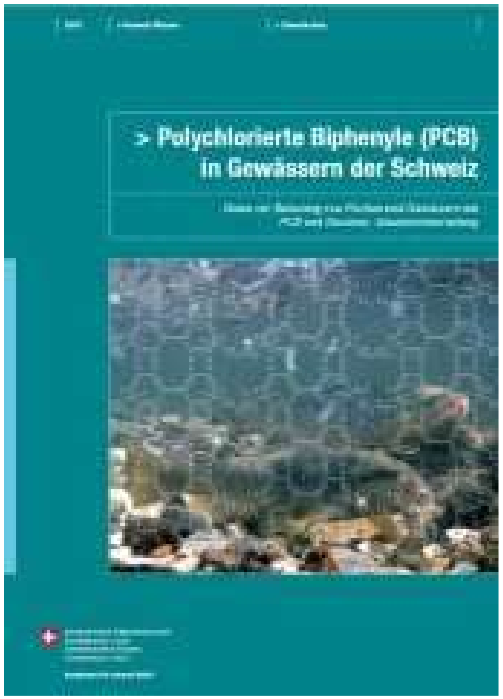
http://www.ihpa.info/actions/hch/map/

PCB Screening in Swiss Rivers & Fish
Tracking the Point Sources

- A large share of European fish are above EU limit for dl-PCB
- In some rivers in Germany PCB in fish increase last 20 years
- PCB in several fishes from river Saane (Switzerland) were far above EU maximum levels of 8 pg WHO-TEQ/g fw (2007)
- Concern of the public and authorities → increasing pressure → investigate PCB contamination of fish in all Swiss rivers.

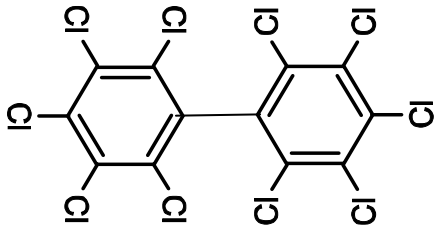
- Collect available data (older and recent)
- Determine background concentrations (PCDD/F and dl-PCB)
- **Detect possible PCB point sources**
- **Develop methods to trace PCB point sources**
- Asses the risk for human health (fish consumers)
- Asses the ecotoxicological risk (fish and aquatic foodweb)

www.bafu.admin.ch/publikationen Download



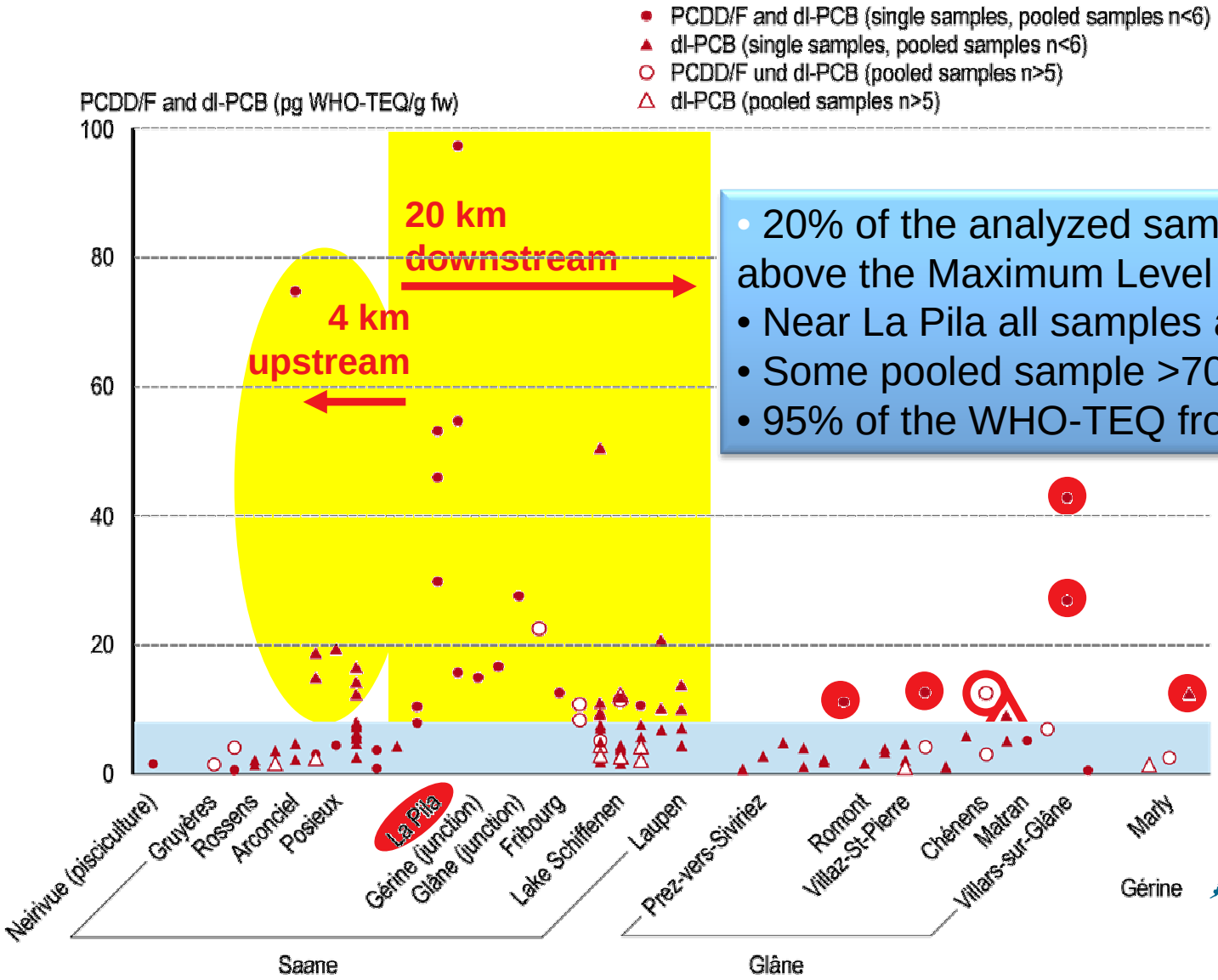
Source: Zennegg et al, Dioxin 2010, San Antonio/USA, 12-18. September 2010

Swiss Rivers with Elevated PCB in Fish



Source: Zennegg et al, Dioxin 2010, San Antonio/USA, 12-18. September 2010

PCDD/F and dl-PCB in fish from river Saane



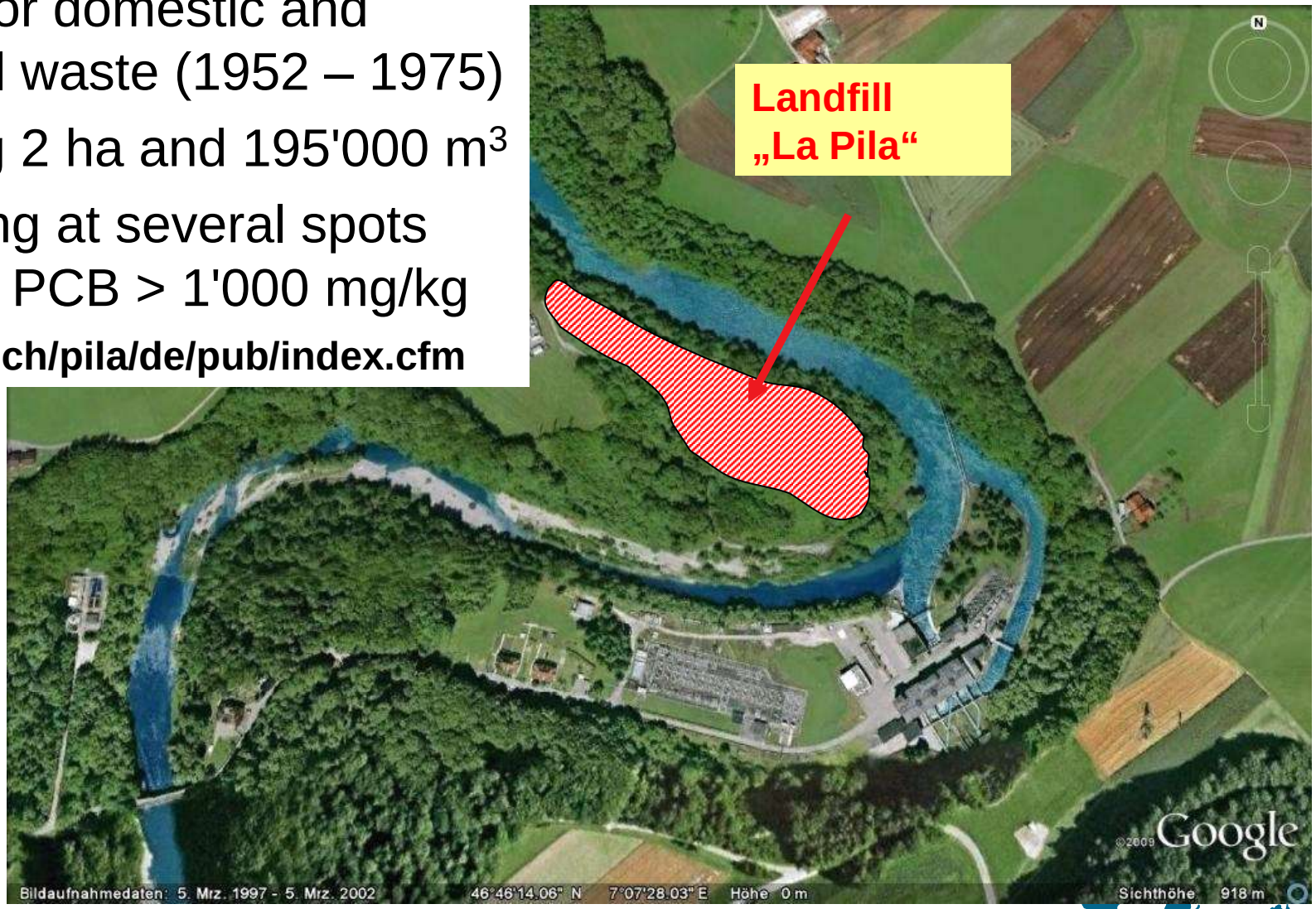
- 20% of the analyzed samples (n=120) above the Maximum Level (ML)
- Near La Pila all samples above ML
- Some pooled sample >70 individuals
- 95% of the WHO-TEQ from dl-PCB

POPEC 2011

Landfill "La Pila" Containig Tonnes of PCBs

- Landfill for domestic and industrial waste (1952 – 1975)
- Covering 2 ha and 195'000 m^3
- Monitoring at several spots revealed PCB > 1'000 mg/kg

http://www.fr.ch/pila/de/pub/index.cfm

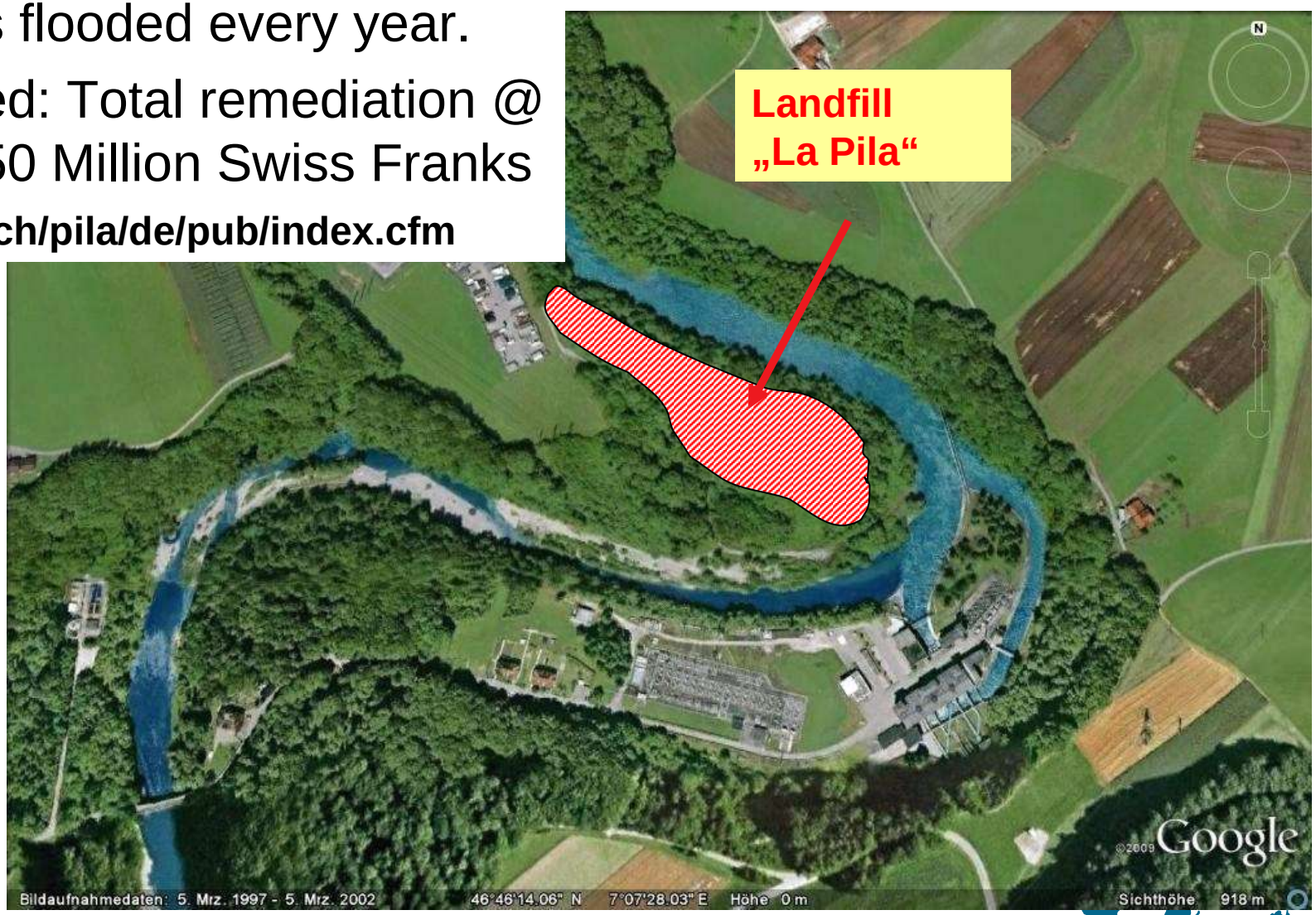


Source: Zennegg et al, Dioxin 2010, San Antonio/USA, 12-18. September 2010

Landfill "La Pila" Containig Tonnes of PCBs

- PCB inventory: several tonnes
- Landfill is flooded every year.
- Suggested: Total remediation @ cost is 250 Million Swiss Franks

http://www.fr.ch/pila/de/pub/index.cfm



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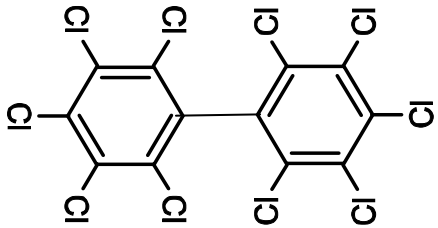
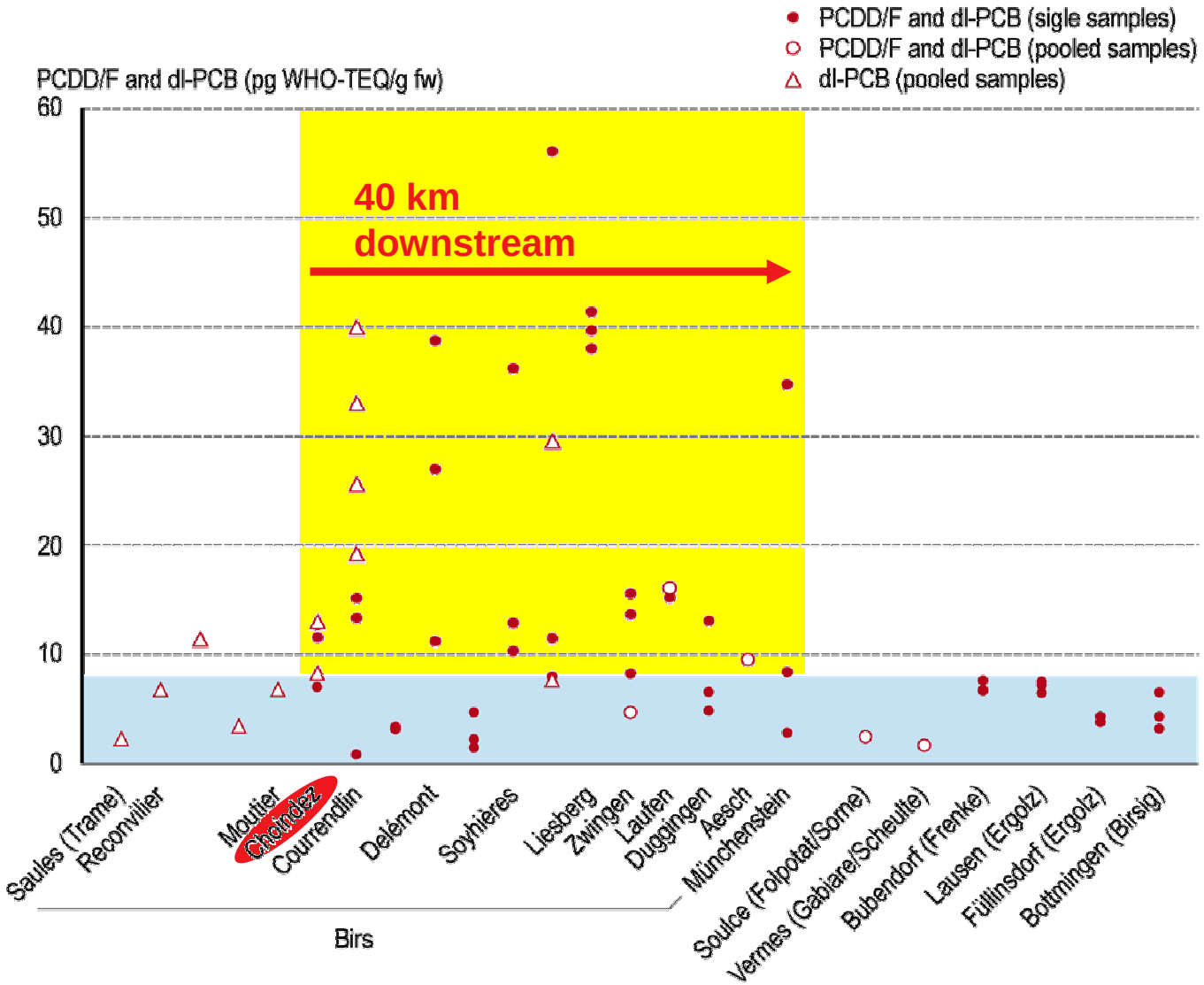
Swiss Rivers with Elevated PCB in Fish

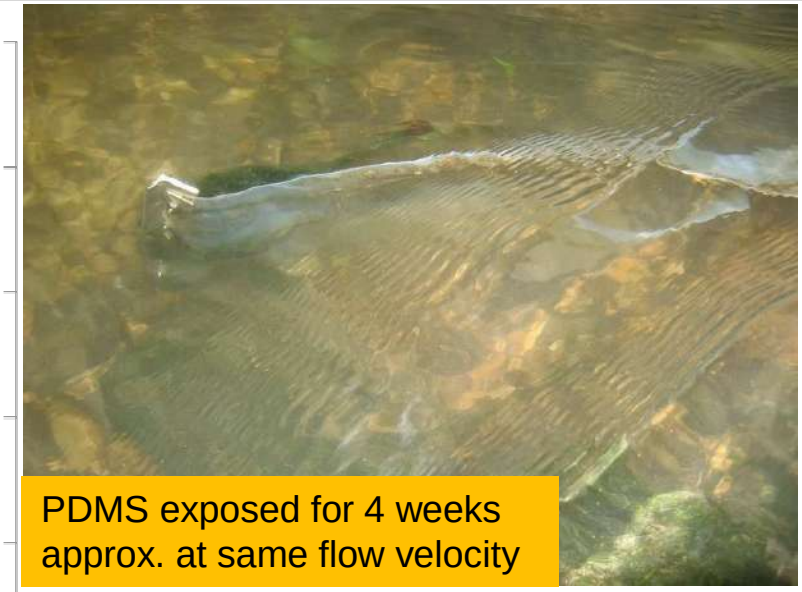


Source: Zennegg et al, Dioxin 2010, San Antonio/USA, 12-18. September 2010

PCDD/F and dl-PCB in fish from river Birs



PCB in PDMS passive sampler



PDMS exposed for 4 weeks
approx. at same flow velocity

- Distinct increase after Choindez
- Highest value in Courrendlin
- Good correlation with fish data

POPEC 2011

Possible origin of contamination

Von Roll Hydro SA Choindez/Courrendlin

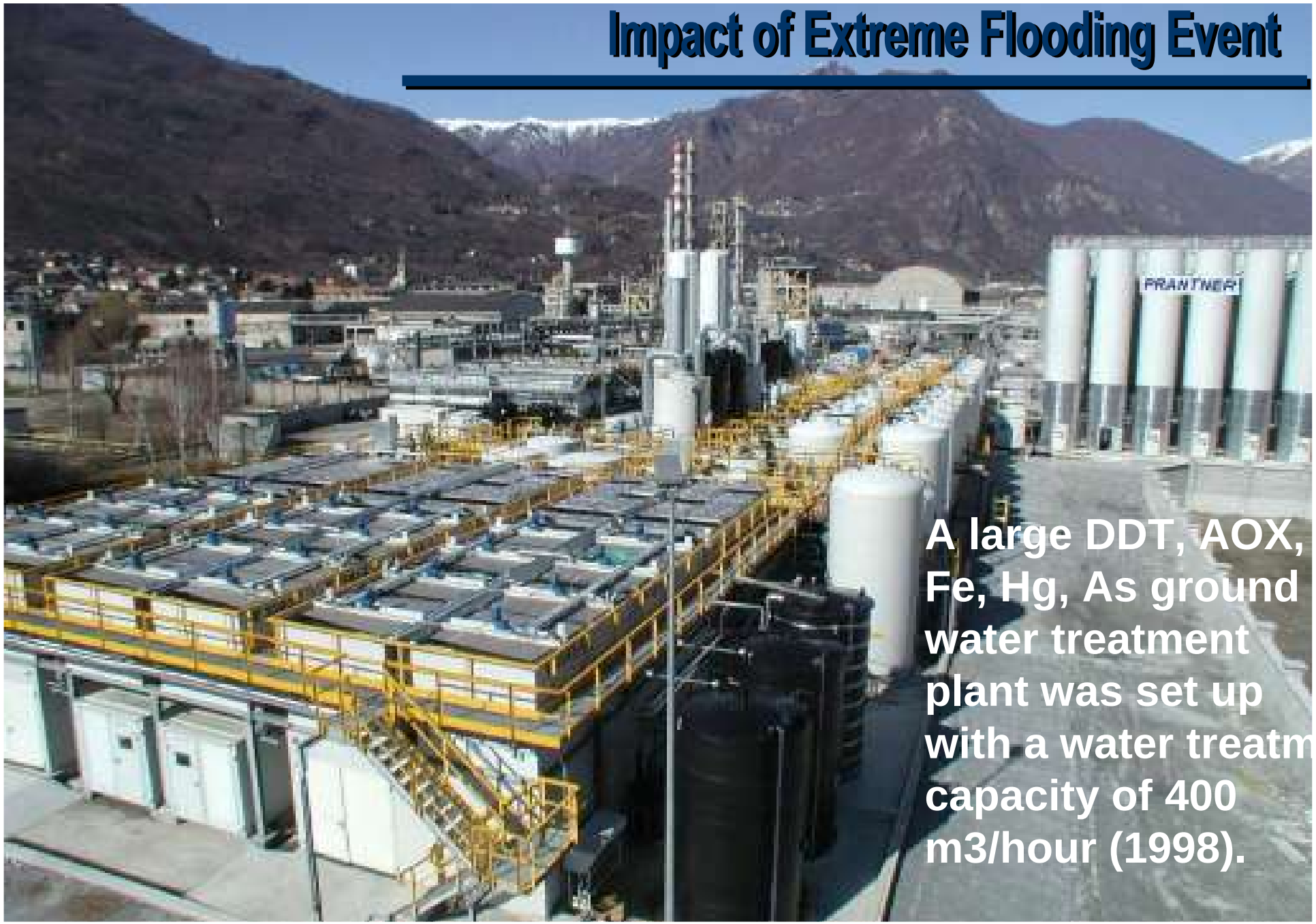
- **Production of cast iron pipes since 1850**
- **Last blast furnace in Switzerland (stop 1982)**
- **Used PCB transformers**
- **No other industry as far as Courrendlin**
- **The PCB contaminated area/deposit not yet**
- **Relevance of flooding for this site not assessed yet.**

Ground Water Treatment former DDT Production - Impact of Extreme Flooding Event

- Lago Maggiore has high DDT levels in fish & mussles up to the ppm levels. Stop of fishery for some areas.
- Source of pollution: Former DDT production located at a tributary river with high releases of DDT (2 ug/l), AOX (4000 ug/l), arsenic and mercury into the river.

Ground Water Treatment former DDT Production -

Impact of Extreme Flooding Event



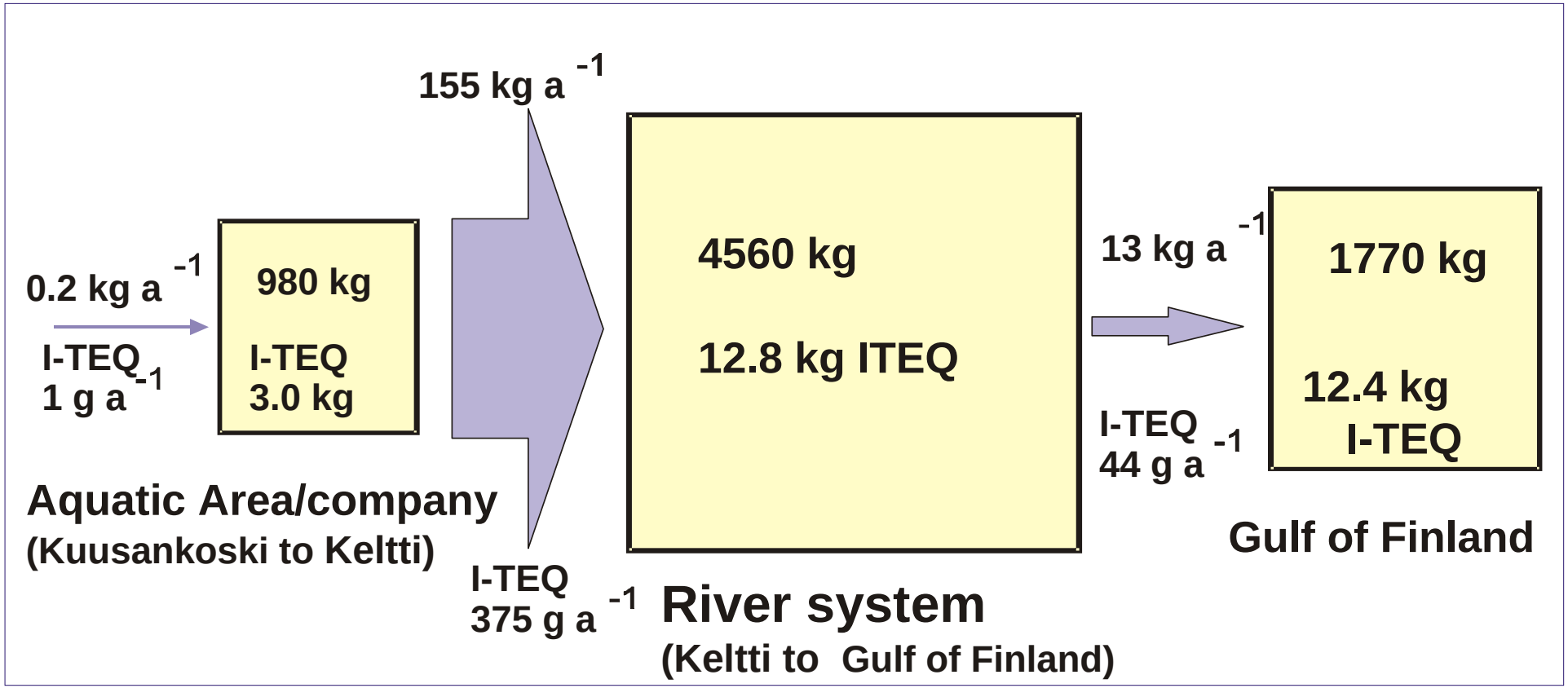
A large DDT, AOX, Fe, Hg, As ground water treatment plant was set up with a water treatm capacity of 400 m3/hour (1998).

Ground Water Treatment former DDT Production - Impact of Extreme Flooding Event

- In October 2000 a heavy flood occurred and lake waters exceeded the maximum flooding level for 10 days, the highest levels for the 20th century.
- During this period DDT were transported from contaminated soils, groundwater and river sediments to the lake with increasing DDT levels in water, sediments and the DDT concentrations in zebra mussels had increase in 2001 compared to 1990s.
- The ground water treatment plant were enlarged to a capacity of 850 m3/h.

Chloralkali/PxCP Factory Finnland: Sediment PCDD/F burden/fluxes (2001)

PxCP factory and chloroalkali production (1940 – 1984) discharged 28 kg I-TEQ in the river Kymi of which 12 kg meanwhile entered the Gulf of Finland (Baltic).

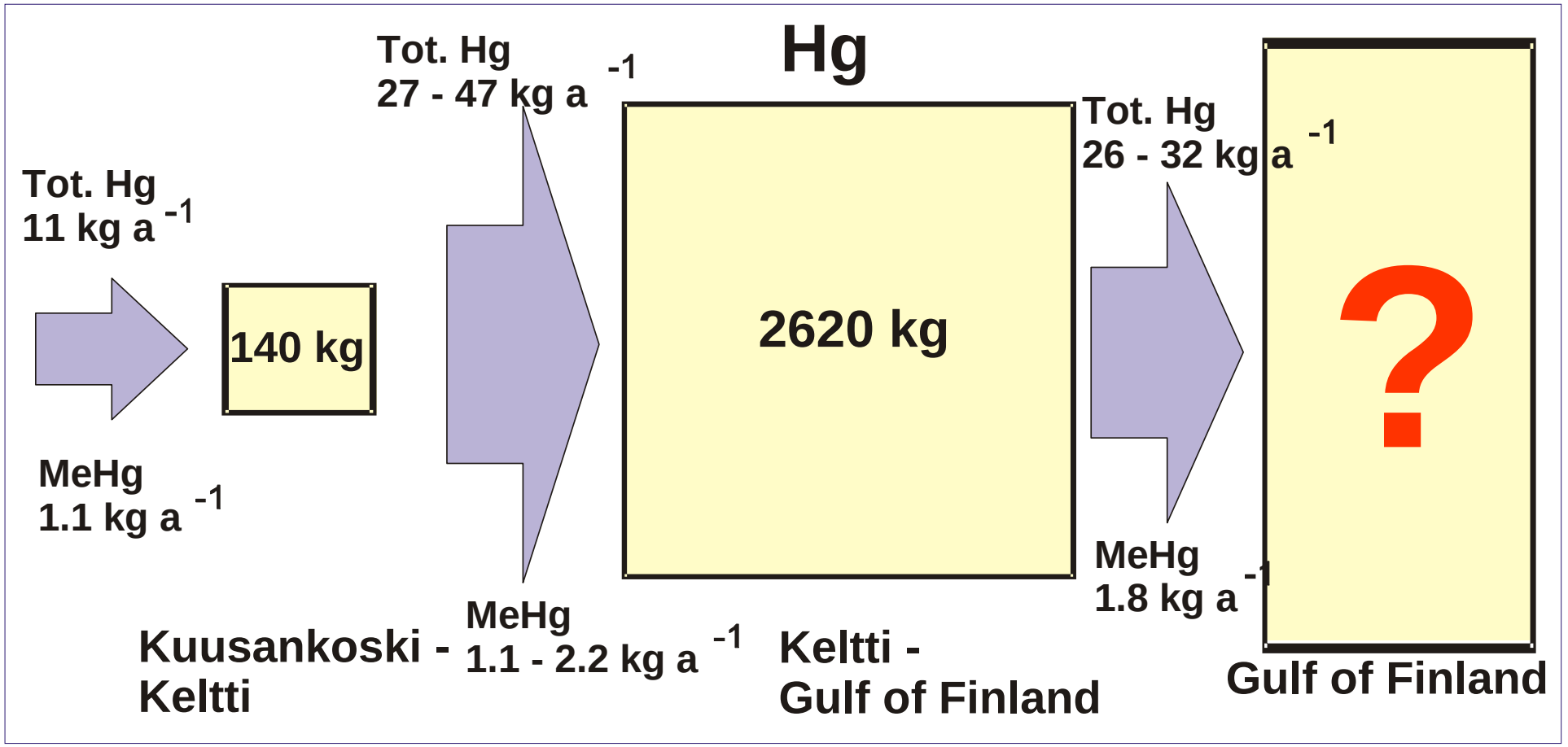


Matti Verta, Markku Korhonen, Simo Salo Finnish Environment Institute (SYKE)

Chloralkali/PxCP Factory Finnland: Sediment PCDD/F burden/fluxes (2001)

PxCP factory and chloroalkali production (1940 – 1984)

Highest risk from Hg!!



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Austria: Mapping of Landfills & Assessment of Flooding Risk

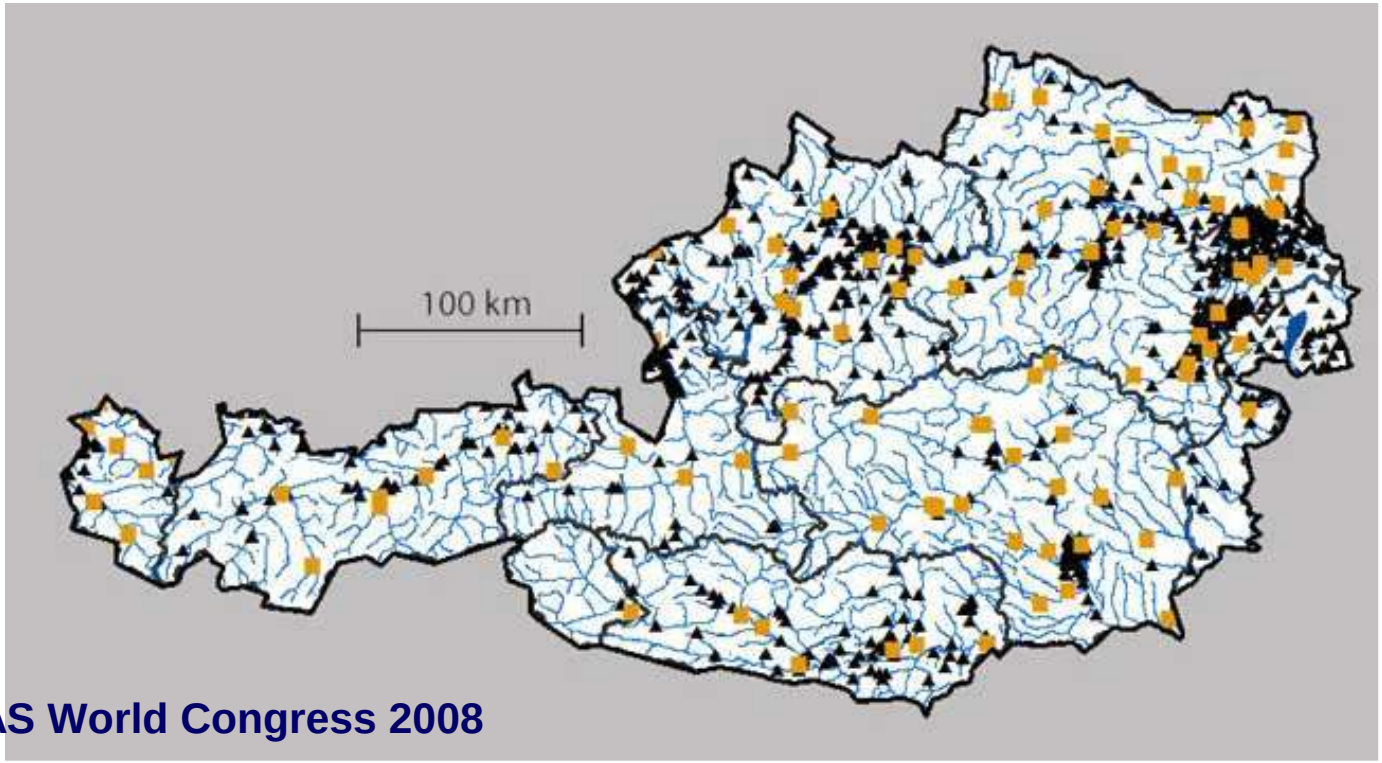
- Aims of the study (ISWA; Vienna University; Prof. Brunner)
  - Evaluation of flood risk exposure of Austrian landfills
  - Investigation of the potential environmental significance of emissions emanating from flooded MSW landfills
  - Site specific assessment of the potential impact of these emissions on subjects of protection.
- Procedure:
  - Data MSW landfills and flood risk zones in Austria
  - Estimation of substance releases during a flood event (scenario based)
  - Hydrodynamic modelling for 3 selected sites (ongoing)

    → potential effect of emissions on vulnerable uses (e.g. drinking water well)

Austria: Mapping of Landfills & Assessment of Flooding Risk

- Data collection landfills:
  - Controlled MSW landfills:
    - Published data by federal and regional authorities
  - Old MSW landfills:
    - Austrian Federal Environmental Agency (AFEA)

- 103 controlled MSW landfills
- 961 old MSW landfills



Lahner et al ISWA/WMRAS World Congress 2008

Austria: Mapping of Landfills & Assessment of Flooding Risk

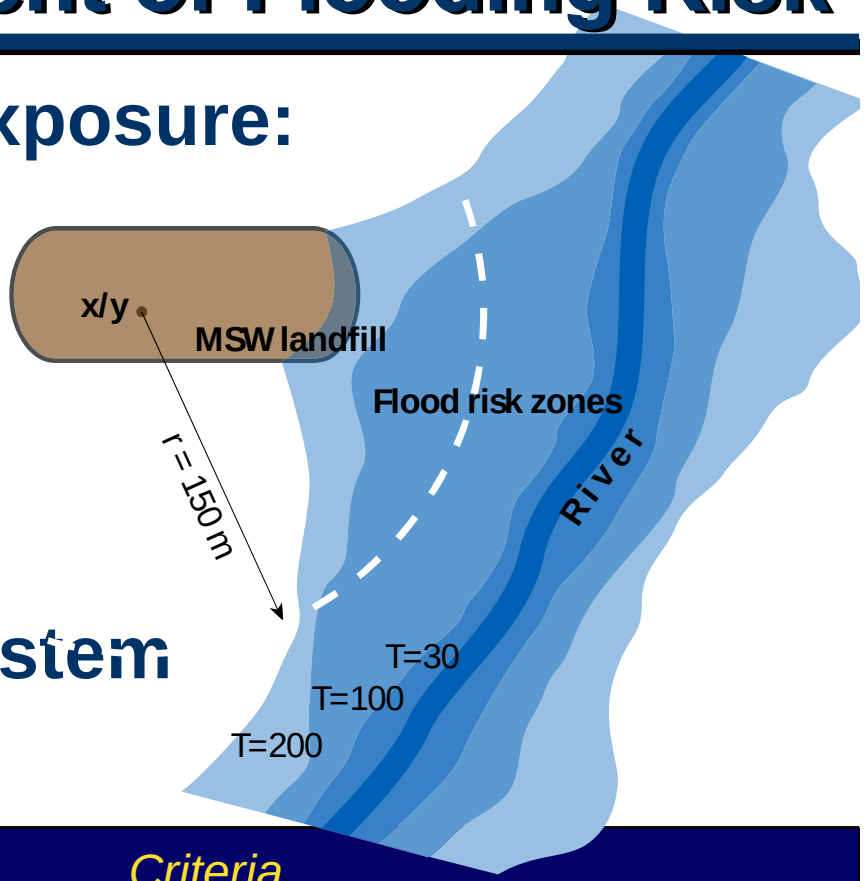
Evaluation of the flood risk exposure:

Site coordinates

+

nation-wide data on flood risk zones

→ geographic information system



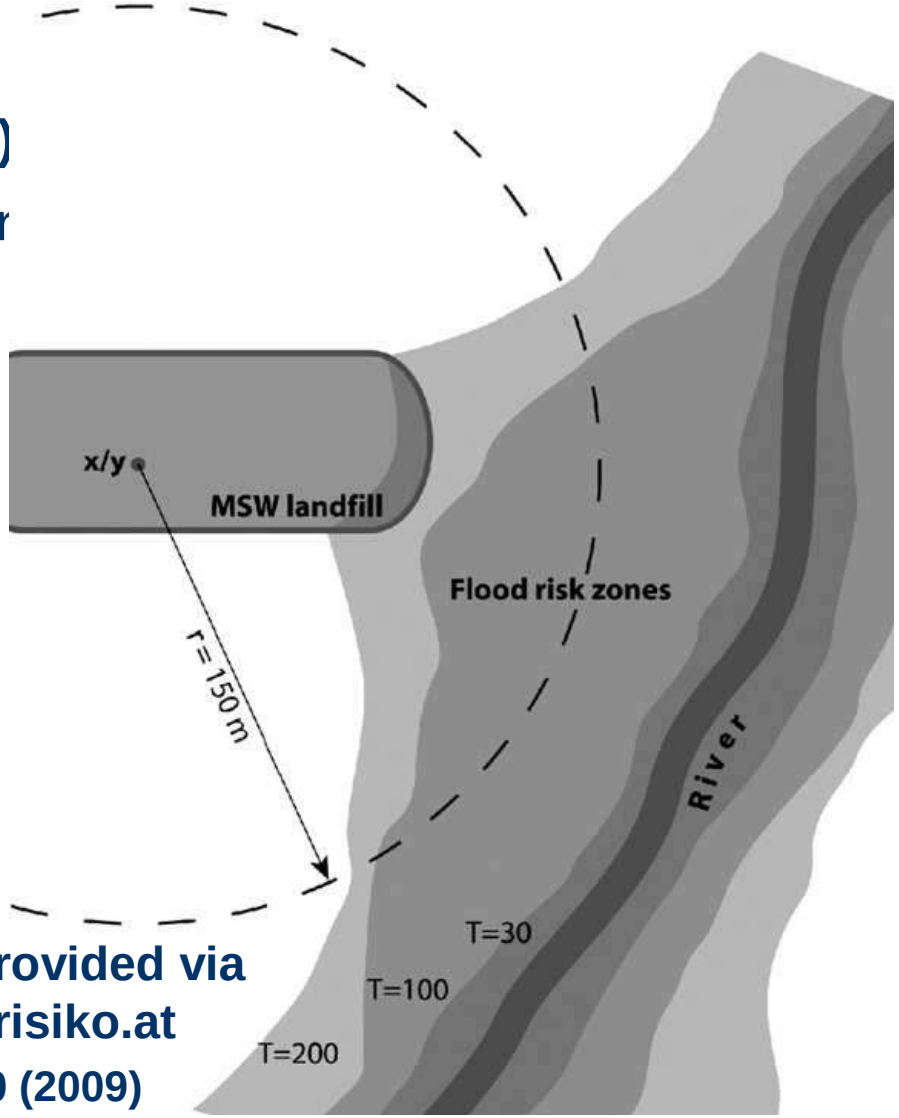
Category	*Criteria*
Probably not endangered	No designated flood risk zone within a distance of 150 m
Probably endangered	A designated flood risk zone lies within 150 m.
Endangered	Situated in a designated flood risk zone.

Austria: Mapping of Landfills & Assessment of Flooding Risk

Evaluation of the flood risk exposure of Austrian MSW landfills

Risk category Criteria (based on HORA data base: „Austrian flood risk zones“)

- **Endangered Landfill: is situated within a flood risk zone with a recurrence interval of 200 years or less.**
- **Probably endangered: Distance between landfill and a flood risk zone with a recurrence interval of 200 years is less than 150 m.**
- **Probably not endangered: No designated flood risk zone within a distance of 150 m to the landfill.**



Public access to the flood risk mapping is provided via an Internet platform http://www.hochwasserrisiko.at

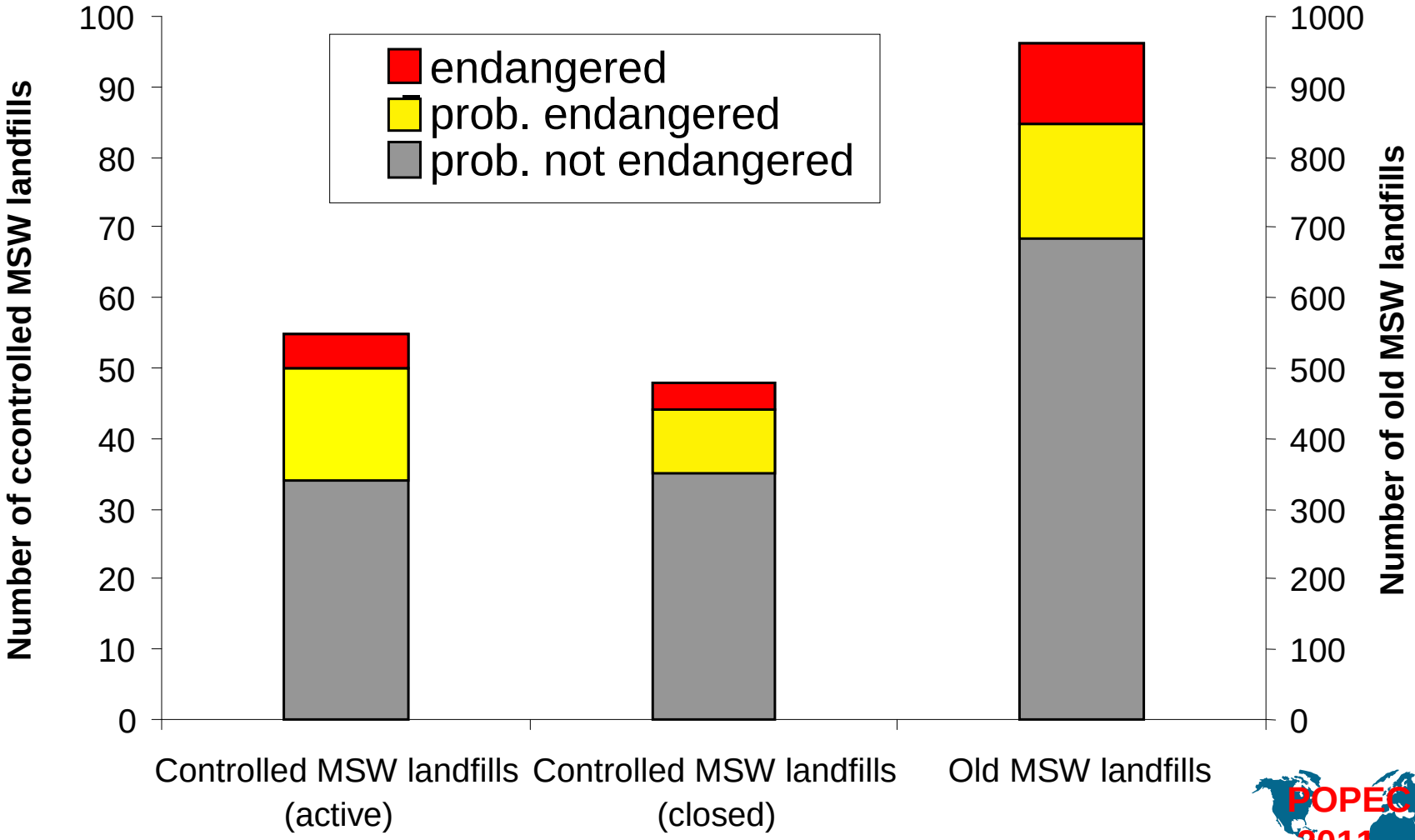
Laner et al. Science Total Environ. 407, 3674–3680 (2009)

Austria: Mapping of Landfills & Assessment of Flooding Risk

Lahner et al ISWA/WMRAS World Congress 2008

Austrian Inventory of Landfills - Flood Risk Exposure

Evaluation of the flood risk exposure of Austrian MSW landfills

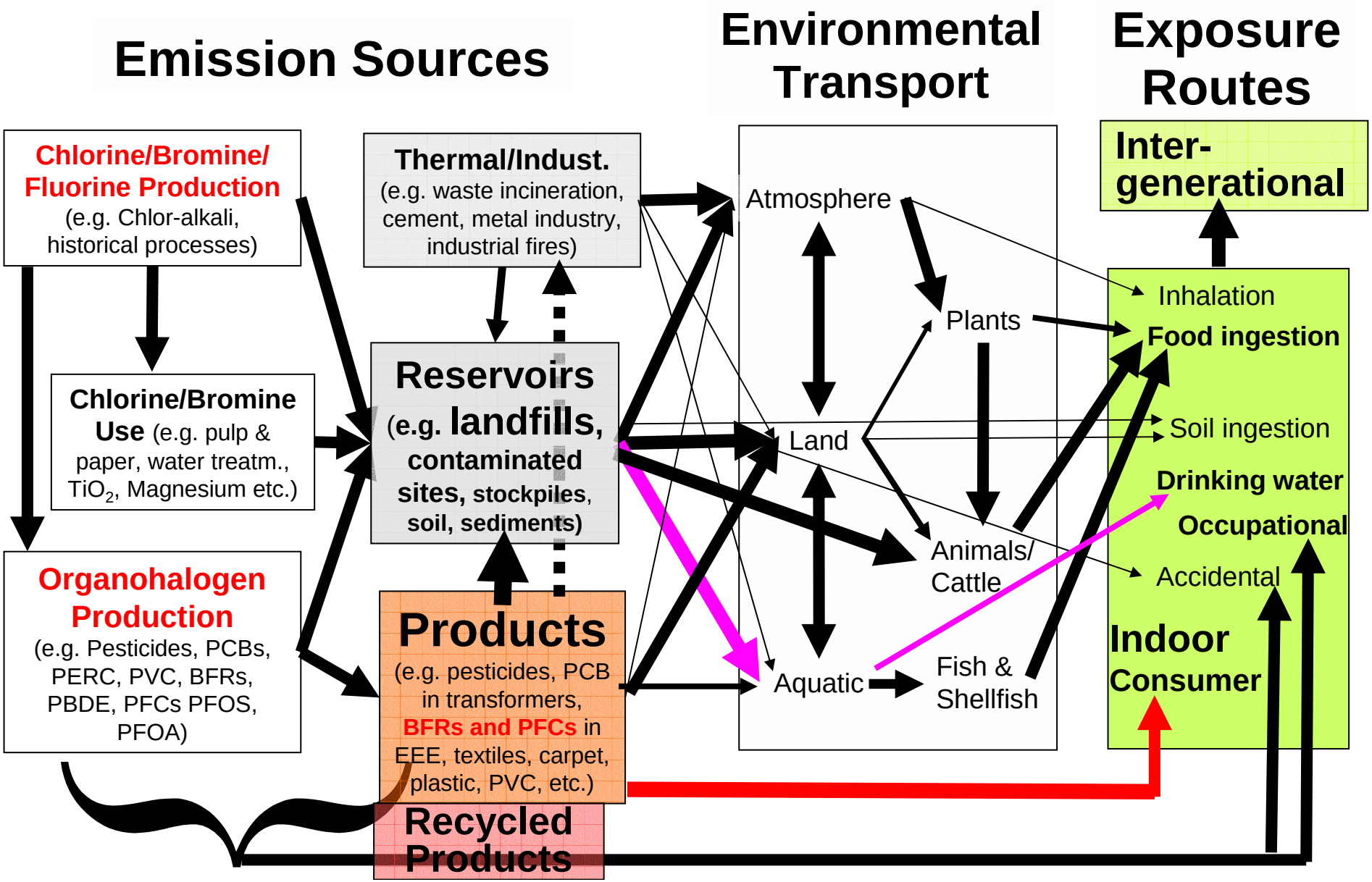


Lahner et al ISWA/WMRAS World Congress 2008

Austria: Mapping of Landfills & Assessment of Flooding Risk

- 1/3 of MSW landfill sites in Austria are potentially endangered by flooding
- Substance releases during a flood event might increase by to up six orders of magnitude compared to conventional conditions
- Research needed to understand metabolism and geotechnical properties of flooded landfills.
- For a site-specific evaluation of the environmental relevance of a flooded MSW landfill detailed investigations are necessary (inundation zones, infiltration scenarios, subjects of protection)

"Life-Cycle" of POPs/PTS and Human Exposure

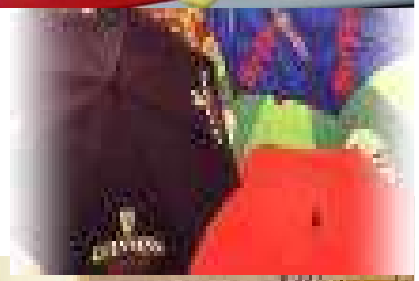


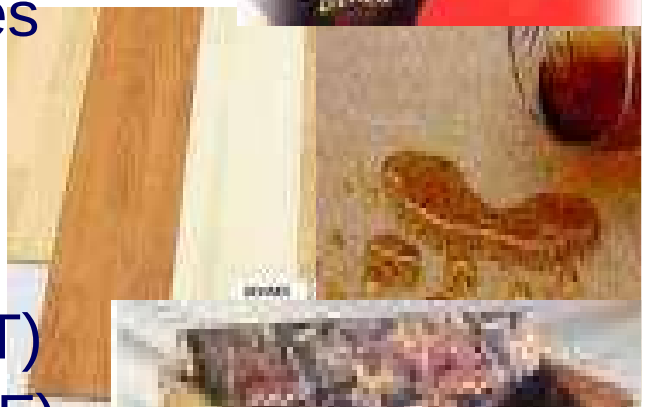
New POPs in Landfills: Per/Polyfluorierter Tenside (PFC)

- **PFCs Surface protectants**
  - **Textiles**
  - **Carpets**
  - **Leather**
  - **Paper and packaging**

Largest use volume

- Additives
  - Cleaning agents, polishes
  - Paints,
  - Cosmetics. pesticides
- Performance chemicals
  - Polymerization aids (PFT)
  - Fire-fighting foams (AFFF)
- Electro-plating industry
- Semi conductor industry





Per/Polyfluorinated Chemicals in Landfill Effluents

PFCs are released via landfill leachates !

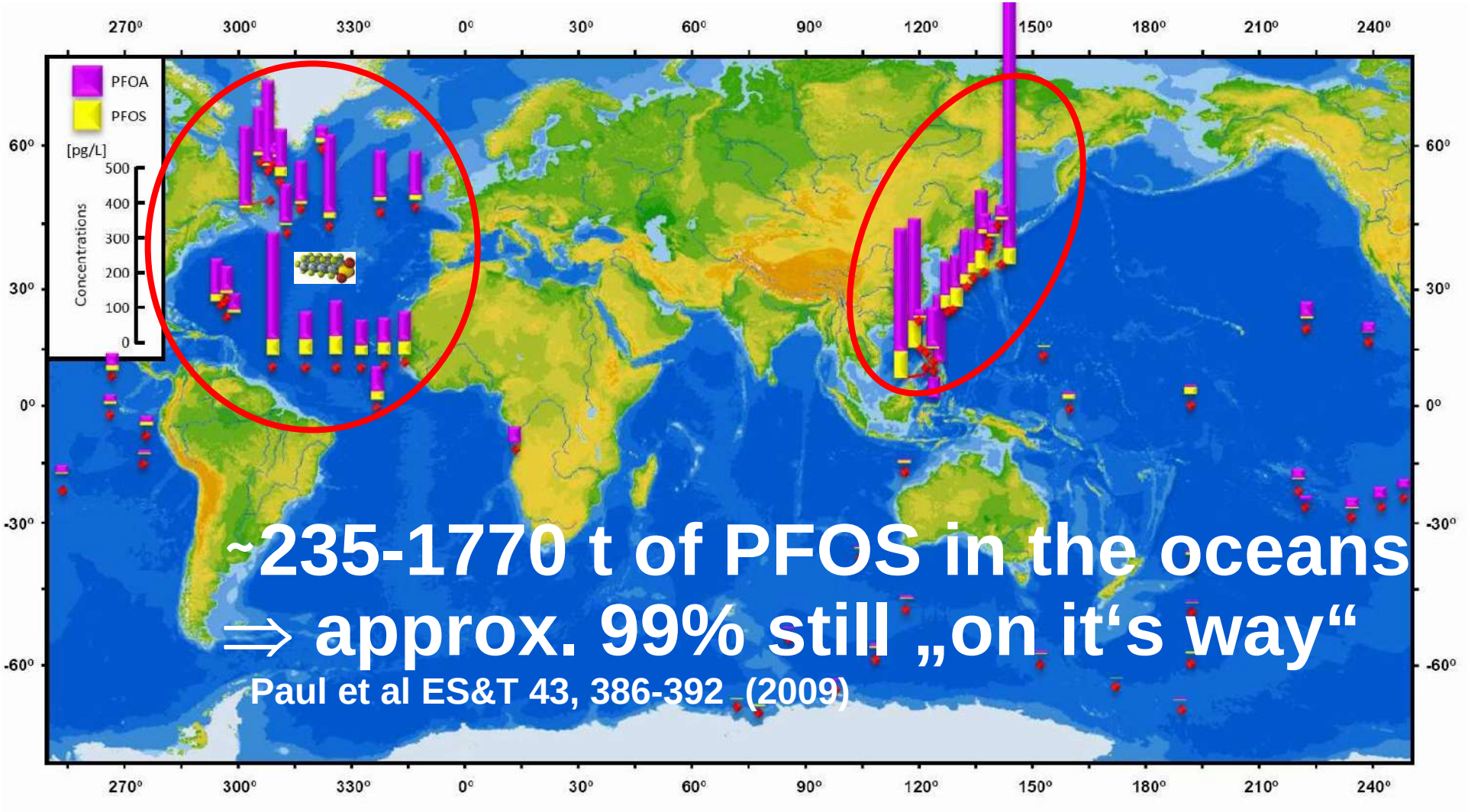
	(3M, 2001) ($n = 3$)	(Woldegiorgis et al., 2008) ($n = 4$)	(Kallenborn et al., 2004) ($n = 6$)	(Busch et al., 2010) ($n = 20$)
PFBS	NA	<0.5–110 (37.3)	5.64–112 (51.5)	<0.39–1356 (220)
PFHxS	NA	12–1800 (518)	12.4–143 (77.0)	<0.24–178 (22.2)
PFOS	<25–52.7 (17.7)	32–1500 (555)	32.8–187 (82.5)	0.01–235 (30.9)
PFDS	NA	<1–0.28 (0.07)	NA	ND
PFBA	NA	<12–30 (7.5)	NA	<3.36–2968 (458)
PFHxA	NA	<7–310 (77.5)	26.4–697 (228)	<0.37–2509 (234)
PFHpA	NA	<20–260 (197.5)	NA	<0.12–280 (48.1)
PFOA	ND–48.1 (16.9)	38–1000 (537)	92.4–516 (293)	<0.40–926 (145)
PFNA	NA	<18–100 (43.5)	4.7–61.5 (34.8)	<3.63–80.1 (7.29)
PFDA	NA	<20–220 (82.5)	NA	<0.21–55.1 (5.98)
PFUnA	NA	<59	NA	<0.11–2.98 (0.36)
PFOSA	NA	<2–7 (2.75)	NQ–3.28 (1.17)	<0.15–14.0 (2.77)

[a] NA = not analysed. ND = not detected. <x = below the respective method quantification limit (MQL).

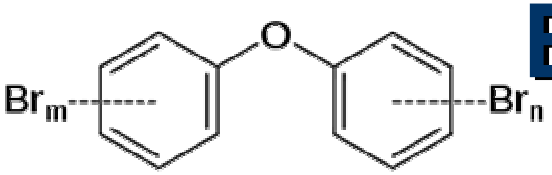
Landfills in industrial countries are a source for PFOS/PFC-release into the environment and have to be considered as stock or “contaminated site“.

Probably >80% of PFOS/precursor deposited!

PFOS/PFOA Contamination Oceans



Yamashita et al Chemosphere 70 (2008) 1247–1255



Brominated Flame Retardants in Products/Use

- Electrical devices (computer, TV, cables, etc.) ending up in Ewaste,
- Transport sector (plastic and upholstery in trains, cars, air plane)
- Clothes, US: Baby/kids sleep wear
- Curtains, carpets, mattresses
- Insulation in construction materials (presently increasing with increasing oil prices and incentives for insulation of houses)

Estimation PBDE:
>80% in landfills

Where Does Ewaste/Used Electronics End Up?

Mixtures of Toxic Chemicals from E-Waste into Water and Soil

A wide range of released POPs (PBDEs, BFRs, PCBs), UPOPs (PCDD/F; PBDD/F, PXDD/Fs, PAHs), heavy metals cause complex polluted mega-sites from E-waste.

E-waste, at river bank SE-Asia „Flooding used as waste management tool“

Ashes from e-waste burning covered with sand and dumped at Langjiang river Guiyu, China (Photo: Basel Action Network

Conclusion POPs Inventories & Climate Change

- Leaching from POPs in deposits are contaminating water, sediments & floodplains which are relevant pathways to human exposure via fish/cattle. More water soluble POPs (hexachlorbutadiene, PFOS) are detected in drinking water.
- Over the time frame of decades/centuries, containments in metal drum and landfill engineering systems will inevitably degrade and loose their abilities to contain contamination.
- The impacts of climate change and extreme weather events will facilitate: The increased flooding and the raise of water levels will increase leaching of deposited POPs into ground and surface water impacting rivers and lakes.
- Other impact of climate change to POPs release:
  - Drying of top clay layers of landfills leading to porosity
  - Increased evaporation of POPs
  - Increased release of POPs from melting glaciers/ice

Conclusion POPs Inventories & Climate Change

- **Inventories of deposited POPs and other PTS should be established, their locations comprehensively mapped and linked to future flooding scenarios for the prediction of contamination of the precious water resources and the risk of food contamination (e.g. fish; cattles in flood plains)**
- **This interdisciplinary task will require the cooperation between POPs experts, contaminated site/landfill experts, geotechnical engineers, water management specialists and geoscientists working on climate change and flooding.**

& we need a CLIMATE CHANGE in policy on hazardous chemicals and on waste management or Earth is flooded

Spolana - Flooding as Remediation Argument

Thank you for your attention!

"More dirt!"

PFOS, PFOA, PFHx
PBDE, PBB, HBCD,
PBDD/F, HBBz PBP
TBBPA, TBPAE,
SCCP, MCCP, LCCP
PeCB, PCN, HCH,
Chlordecone,
Endosulfan,
PAHs, Nitro-PAH
Halogenated PAHs
Sn-Organics
Hg, Cd. Pb et al.
Biocides
Pesticides
Pharmaceuticals

www.pops.int ; www.ospar.org; www.ipen.org
www.springerlink.com/content/0q10km8582605r1x/fulltext.pdf

POPEC 2011