

Human health risk by the consumption of POP contaminated fish in the Congo River Basin

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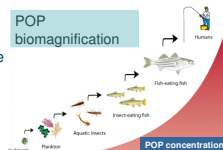
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Introduction

Persistent Organic Pollutant (POP) contamination

- PCBs & PBDEs: electrical equipment in use, e-waste, ship wreckage, use of contaminated oil
- OCPs (DDTs, HCHs, CHLs, HCB): agricultural activities and vector management
- Persistent, lipophilic, bio-accumulative & bio-magnificative, semi-volatile and toxic
- In the past, extensively produced and used
 - found worldwide in various environmental compartments
- Stockholm convention (ratification DR Congo in 2005):
 - most POPs are banned from production, importation and use
- But continued use of POPs
 - presence of obsolete stocks of POPs
 - armed conflicts and lack of appropriate legislation



Fish consumption in Congo River Basin (CRB)

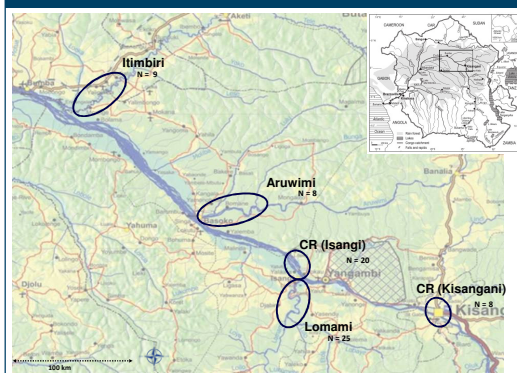
- Average fish consumption per inhabitant of DR Congo is 5.5 kg/year (FAO, 2009)
- Important protein source for subsistence fishing communities along the banks of CRB (Béné, 2009)
- Consumption of contaminated fish is an important route of human exposure to POPs

Human health risk

	Immune system	Reproductive system	Nervous system	Endocrine system	Hepatic system	carcinogenic
PCBs	+	+	+	+		+
PBDEs			+			+
DDTs		+	+			(+)
HCHs	+		+		+	
CHLs			+		+	
HCB			+	+	+	(+)

Material and methods

Study area



- 5 locations: Itimbiri, Aruwimi, Lomami and Congo River (Isangi & Kisangani)
- Banks of tributaries and Congo River itself are populated with subsistence fishing communities (resident and temporary villages)
- Fish is intensively consumed by local fishing communities + transported to larger cities



Sample collection

- Fish were collected with gill nets, filleted and skinned
- Muscle tissue extracted by hot Soxhlet
- Measurements with GC-MS

Results and Discussion

Human health risk assessment

Hazard quotient (HQ) = $\frac{\text{Estimated daily intake dose of pollutant (ng/kg-day)}}{\text{Tolerable daily intake dose of pollutant (ng/kg-day)}}$

HQ > 1 indicates potential risk

*Estimated daily intake dose of pollutant determined with - average fish consumption per inhabitant of DR Congo (5.5kg/year = 0.015kg/day)

- average bodyweight of 70kg for adult person

- 50th and 95th percentile of observed concentration of pollutant in fish (ng/g)

**International guidelines for oral consumption of POPs: Minimum Risk Level (MRL) (ATSDR), Reference dose (RfD) (USEPA IRIS), Tolerable daily intake (TDI) (WHO)

Pollutant	oral RID (USEPA IRIS) (ng/kg bw - day)	50 th and 95 th percentile of observed concentration per location (ng/g)										HQ									
		Itimbiri	Aruwimi	Lomami	CR Isangi	CR Kisangani	Itimbiri	Aruwimi	Lomami	CR Isangi	CR Kisangani	Itimbiri	Aruwimi	Lomami	CR Isangi	CR Kisangani	Itimbiri	Aruwimi	Lomami	CR Isangi	CR Kisangani
ΣPCB	20	26	42	1.8	6.7	1.8	4.9	2.5	51	1.6	19	0.27	0.45	0.02	0.07	0.02	0.05	0.03	0.55	0.02	0.20
HCB	800	0.037	0.064	0.035	0.055	0.021	0.058	0.050	0.093	0.036	0.051	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
pp-DDT	500	0.075	0.095	0.048	0.18	0.062	0.63	0.095	0.19	0.10	1.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
ΣCHLs	500	0.0046	0.0046	0.0046	0.041	0.0046	0.076	0.0046	0.10	0.0046	0.12	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
γ-HCH	300	0.14	0.29	0.088	0.19	0.024	0.14	0.13	0.35	0.054	0.13	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
BDE 99	2000	0.080	0.043	0.093	0.42	0.054	0.48	0.18	0.61	0.12	1.1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Detected PBDE and OCP levels were low and HQs are < 1, so no risk for human health by fish consumption for these pollutants is expected.

Observed levels of PCBs (50th and 95th percentile) in fish from the Itimbiri river were high and indicate the presence of a PCB contamination source in the Itimbiri basin.

Possible sources: dumping of electrical equipment, Ship wreckage?, industrial activity more upstream?

Based on the average fish consumption per inhabitant from DR Congo of 0.015kg/day, HQs for PCBs are elevated but < 1 so potential risk on human health is low.

For the subsistence fishing communities who are living on the banks of the CR and its tributaries, fish is the most important protein source. The average consumption is expected to be more than 0.015kg/day.

How much kg fish/day can be consumed without potential human health risks taken into account the observed pollutant concentrations?

- PBDE and OCPs: No risk for human health by fish consumption

- PCBs: Potential human health risks by the consumption of contaminated fish

e.g.: a person of 70 kg, who eats more than 0.055kg of fish a day (50th percentile - Itimbiri River), exceeds the oral RID for PCBs

Pollutant	maximum amount of fish consumption (kg/day)									
	Itimbiri	Aruwimi	Lomami	CR Isangi	CR Kisangani	Itimbiri	Aruwimi	Lomami	CR Isangi	CR Kisangani
ΣPCB	0.055	0.033	0.79	0.21	0.76	0.29	0.56	0.027	0.87	0.074
HCB	1.5 x 10 ²	8.8 x 10 ²	1.6 x 10 ³	1.0 x 10 ³	2.7 x 10 ³	9.7 x 10 ²	1.1 x 10 ³	6.0 x 10 ²	1.6 x 10 ³	1.1 x 10 ³
pp-DDT	4.7 x 10 ²	3.7 x 10 ²	7.3 x 10 ²	1.9 x 10 ²	5.7 x 10 ²	56	3.7 x 10 ²	1.9 x 10 ²	3.3 x 10 ²	24
ΣCHLs	7.7 x 10 ²	7.7 x 10 ²	7.7 x 10 ²	8.6 x 10 ²	7.7 x 10 ³	4.6 x 10 ²	7.7 x 10 ³	3.4 x 10 ²	7.7 x 10 ³	3.0 x 10 ²
γ-HCH	1.5 x 10 ²	73	2.4 x 10 ²	1.1 x 10 ²	8.9 x 10 ²	1.5 x 10 ²	1.7 x 10 ²	61	3.9 x 10 ²	1.7 x 10 ²
BDE99	1.7 x 10 ²	9.9 x 10 ²	1.5 x 10 ³	3.4 x 10 ²	2.6 x 10 ³	2.9 x 10 ²	7.7 x 10 ²	2.3 x 10 ²	1.1 x 10 ³	1.3 x 10 ²

Conclusion

Based on the average fish consumption per inhabitant of DR Congo, human health risk by the consumption of contaminated fish of the CRB is low. (HQs < 1). But subsistence fishing communities are expected to consume more than 0.015kg/day. Based on the 50th percentile of observed PCB concentrations, a potential human health risk could occur if consumption exceeds 0.055g of fish from the Itimbiri River a day. Based on the 95th percentile, only 0.033g of fish from the Itimbiri, 0.027g from the CR Isangi and 0.074g from the CR Kisangani a day can be consumed without human health risks. PCBs have been demonstrated to cause a variety of adverse health effects such as cancer and effects on the immune, reproductive, nervous and endocrine system.