

Chemical Pollution in Low- and Middle-Income Countries

Frederik Weiss, Marianne Leuzinger, Christian Zurbrügg and Rik I.L. Eggen

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Eawag: Swiss federal institute of aquatic science and technology



Top health risk factors in percentage of disability-adjusted life years (DALYs)



Main focus in LAMICs: availability of food and diarrheal diseases

Chemical pollution and risks in LAMICs: mostly ignored (absence of data)



Chemical pollution is a serious risk to human health

Deaths from unintentional poisonings - all causes



- Risk level in LAMICs disproportionately higher than in HICs
- Study in 3,000 toxic sites → 200 million people affected by toxic chemicals (World Bank)



Future trend: Increase in chemical risks in LAMICs!

- Growing world population & rise of the average age
- Increasing living standards
- Considerable shift in production to LAMICs

- \rightarrow Intensification in demand of chemical substances
- \rightarrow General increase in chemical production especially in LAMICs
- \rightarrow Increase of use, environmental pollution and impacts on humans



Increase in chemical production in general and in LAMICs in particular

Chemical Industry Output: Higher-Income Countries (HICs)



Chemical Industry Output: LAMICs



UNEP, 2013



Report on chemical pollution in LAMICs

Aims of this Eawag study about chemical pollution in LAMICs

- Obtain integrated overview of chemical pollutants and impacts on human and environmental health - focus on LAMICs
- 2) Assess the severity of the problem different sectors
- 3) Discuss possible mitigation options
- 4) Contribute to the topic strong Eawag expertise

Outcomes of the study summarized in the report





Further reading:

Eawag: Swiss Federal Institute of Aquatic Science and Technology

Chemical Pollution in Lowand Middle-Income Countries



<u>Downloadable:</u> www.eawag.ch/en/department/ sandec/publications/chemicalpollution/

Contacts: rik.eggen@eawag.ch



christian.zurbruegg@eawag.ch







Structure of the report



Pesticides as an example

- 1) Chemical characteristics of pesticides and their potential risks
- 2) Input pathways of pesticides, their pollution trends and impacts
- 3) Alarming case studies
- 4) Best practices: Implemented and theoretical examples
- 5) Gaps in research

For every sector the same structure was used

Chemical characteristics of pesticides and their potential risks







Chemical characteristics of pesticides and their potential risks

Name	Type/ Chemical family	WHO's toxicity classification	Permission in EU	Using trend	Henry's law constant (at 25°C)	Log K _{ow} (at 25°C)	Water solubility [g/ L]	LD _{₅0} for rats [mg/kg body weight]	Environmental quality standard (in surface water bodies) AA-EQS/MAC-EQS [µg/L]
<u>Bipyridils</u>						4	0115		
Paraquat	Herbicide	II	×	•	1.23 * 10 ⁻¹²	ard	o20 (20°C)	150	NA/NA
<u>Carbamates</u>			100	f 4.	5 110 ²	051	. •1	CG	
Carbaryl	Insecticide	Tap	× *	res	ticiu	2.4		300	0.23/NA
Carbendazim	Fungicide	IV	h 3	re	used	1.5	0 . 0 0 8 (20°C)	>10000	0.34/0.57
Carbofuran	Insecticide	whi	CU C	0	3.1 * 10 ⁻⁹	2.3	0.320 (25°C)	8	0.02/NA
Carbosulfan	Insecticide	II	×	0	1.83 * 10 ⁻⁵	7.42	0.00011 (20°C)	101	NA/NA
Fenobucarb	Insecticide	II	×	≎	5.9 * 10 ⁻⁸	2.8	Practically not soluble	620	NA/NA



Pollution trends - Consumption of pesticides





Food and Agriculture Organization of the United Nations (FAO)







Consumption of pesticides

Zarcero, Costa Rica

50 t of obsolete pesticides at Vikuge State Farm in Tanzania, East Africa – 1989

282 g DDT and 63 g lindane per kg dry weight



Results – Pharmaceuticals

Diclofenac in surface waters



Weber et al., 2013 IWW



Results – Pharmaceuticals



Consumption

Production

Food-chain





Diclofenac detected in aquatic systems - 2014

Effluents from drug manufacturies Hyderabad India- 2009 Vulture dying India and Pakistan - 2004

31 mg/L antibiotics



Results – Mining pollutants

Mining – Production of most hazardous mining commodities



Cadmium, Chromium, Copper, Lead, Mercury, Manganese, Arsenic, Antimony, Asbestos

United States Geological Survey (USGS), 2012-2013



Results – Mining pollutants



Mining production

Extraction Acid Mine Drainage





USGS, 2012-2013

Miner burning a goldmercury amalgam - 2011 AMD in the Witwatersrand region of South Africa – 2011

Cr, Cd, Pb [mg/L] Hg [µg/L]



Results – E-waste

Illegal shipments of e-waste from HICs to LAMICs



Basel Action Network



Results – E-waste



Export E-waste processing Disposal WESTERN EUROPE HAILAND SENEGAL NIGERIA IVORY COAST From North America From Western Europe From Japan & South Korea From Australia **Basel Action Network Basel Action Network** ction Network Illegal shipment of e-waste Guiyu, China - 2008 Lagos Nigeria, West Afrika - 2005 from HICs in LAMICs





Similar key issues in all sectors

- Lack of data: However, the data which are available show high impacts on environmental and human health
- Weak governmental compliances, controls and regulations
- Weak education and awareness
- Missing or not implemented mitigation technologies for the reduction of pollution





Pesticides in the Tropical Rio Tapezco Catchment

- Pesticides are intensively used
- Poor pesticide using practices
- Less awarness of the toxicity of pesticides













One way forward – my PhD project



Pesticides in the Tropical Rio Tapezco Catchment

Research Aims:

I. Conduct a targeted, quantitative and comprehensive exposure assessment in water streams of a tropical catchment

II. Develop a conceptual model which explains and describes pesticide inputs, transfer and exposure pathways

III. Suggest mitigation options





Passive sampling approaches

1. SDB discs for semipolar and polar compounds



2. Water Level Proportional (WLP) Sampler for semipolar and polar compounds





3. Silicon Rubber Sheets for apolar compounds







In cooperation: Eawag with local partners



Christian Stamm (Uchem) Christian Zurbrügg (Sandec) Rik Eggen (Directory)



Clemens Ruepert

Instituto Regional de Estudios en Sustancias Tóxicas



Legend:

Health

Technology;

Department

Science

Substances

