ALARM — A NEW CHARACTE RISTIC OF PERSISTENT TOXIC SUBSTANCES OF A THREAT TO HUMANS HEALTH

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Introduction

Toxicants present in a populated locality pose a threat to human health. It is evident that a degree of such exposure results both from conditions of toxicant location (whether it is present in soil or water, or concentrates at a storage site, etc.) and from its damaging properties. To assess a risk of toxic damage for humans it is necessary to conduct a multi factor analysis that would take into account all data on the toxicant along with the environmental conditions in this area. It is definitely a challenging and often impossible mission.

A few alternatives for assessing eco-toxicity were proposed. For example, Weber[1] employed a combination of toxicity values for rats and fish (LD_{50}), persistence in soils ($T_{0.5}$) and a bioaccumulation coefficient. These values were ranked and their sum was assumed as relative toxicity of the analyzed substance. A more detailed approach - "profile analysis" - was proposed by the German authors[2]. However this technique based on a larger number of parameters and included evaluation by weights. Yet the results attained by this method did not generally differ from Weber's. Both methods characterize a toxicant and in this respect are similar to the UNEP procedure for identifying farther POP (persistent organic pollutants) candidate substances to be covered by the Convention on POPs: selection of acting factor, their ranging and summation of the obtained indices. We propose a new characteristic of persistent toxic substances (PTS) - *Alarm*, which comprises the total toxicity calculation similar to that offered by Weber and new parameters related to a toxicant's threat to humans and the environment. It includes a maximum possible total toxicant's amount in the region for the moment (V_t) and parameters characterizing its acute (immediate) toxicity/LD_{50} for rats and long-term toxicity/carcinogenicity. Other damages properties do not take into account.

This paper describes applications of the new parameter *Alarm* — a new characteristic of PTS of a threat to human health on the territories of a few countries of Central and East Asia and Asian Russia.

The research was fulfilled under the UNEP/GEF Project: Regionally Based Assessment of PTS Region VII) in 2002. Region VII covers Kazakhstan, Turkmenistan, Kyrgystan, Uzbekistan, Tadjikistan, Asian Russia (except for the Arctic), Mongolia, China, Japan, and Korea.

Used data and method of calculation

For calculating *Alarm* in Region VII, we included only those countries, which, according to the available data, accounted for the highest PTS production and imports in total corresponding to over 90% of the total toxicant's amount in the region. As a result, we excluded the countries specific of PTS insignificant accumulation from the review and our calculations based on the data only for four countries (China, Korea, Japan and Asian Russia) and 14 PTS.

V_0. PTS volumes used in the calculations (V_0) reflect a total sum of a chemical produced or imported by a country prior to the date of its ban, for the exception of Dioxins, PCP (China) and PAH. For the latter, we used data on their annual emission.

DDT. According to the available data on DDT, about 500,000 t DDT was produced in the former USSR; we assumed that 1/3rd of it could be applied in the Asian territories of Russia.

PCB. In our assumption, Asian Russia should account for one half of 180,000 t PCB produced in the former USSR, i. e. 90,000 t PCB

Dioxins: The available data evidences that in Russia Dioxin emission is 10.8 kg I-TEQ/year. For computing *Alarm*, we suggested that approximately a half of this amount, i.e. 5.4 kg I-TEQ /year, falls to the share of Asian Russia. We also assumed that the same emission level preserved for the last 22 years (two $T_{0.5}$). Dioxin emission of 7.0 kg/year I-TEQ/year was accepted for Japan over the same period.

HCH. (lindane): 30000 t HCH was produced in the former USSR; we accepted that 1/3rd of it could be used in Asian Russia.

$T_{0.5}$ and LD_{50}: Data on max $T_{0.5}$ in soil and min LD_{50} for rats was taken from[5,6] and some of the values were calculated from experimental data cited in[7].

V_t. Toxicant's volumes that currently remain on this territory (V_t) for all PTS (for the exception of Dioxins, PCP (China) and PAH) were determined by the equation:

$$V_t = V_0 e^{-kt}, \quad (1)$$

where $k = 0.693/T_{0.5}$ and t —a period between the toxicant's ban or phase-out date and 2002.

For Dioxins, PCP and PAH, we employed the following expression:

$$V_t = (V_0/k)(1- e^{-kt}), \quad (2)$$

where t = 22 years for Dioxins (~$2T_{0.5}$), 5 years for PCP ($10T_{0.5}$) and 3 years for PAH. At t = $10T_{0.5}$ a stationary level of chemicals (dynamic equilibrium) is reached (ticked with (+) in the Table).

Carcinogenicity: Carcinogenicity data was taken from[3]. For computing *Alarm*, carcinogenic groups were ranged (R): group **1** was assigned with index 1000, group **2A** — 100, group **2B** — 10, and group **3** — 1.

Alarm: *Alarm* was calculated by the formula that comprised the above values:

$A = V_t \bullet R/LD_{50}$

Results and Discussion

The *Alarm* calculation results for different PTS in Region VII are given in the Table 1 and Fig. 1. The proposed characteristic allows to appraising a priority of a threat to human health posed by individual PTS both region-wide and for each country. To attain a more accurate assessment of PTS *Alarm* to human health we need considerably more data on the PTS distribution over the environment, their toxicity for humans and carcinogenicity.

Table 1: Used data and PTS *Alarm* characteristics for Region VII.

PTS	Volume of production or import (V_0)		Date of ban	Max. $T_{0.5}$ in soil	Volume of PTS to 2002 (V_t)	Carcinogen. group (G) and range (R)		Min. LD_{50} for rats	Alarm (relative units)	
	State	Tons	Year	Years	Tons	R	G	mg/kg	State	Region
Aldrin	Japan	2500	1981	5	136	1	3	10	13.6	19.6
	Korea	550	1986		60				6.0	
Chlordane	Japan	13300	1986	4	833	10	2B	200	41.7	192
	China	3000	use		3000				150	
	China	400000	1983	15	165900	10	2B	113	14680	1811
DDT	Russia	170000	1970		38700				3425	0
	Japan	683	1981	4	18	1	3	40	0.45	
Dieldrin	Korea	201	1970		0.8				0.02	0.5
	Japan	1500	1981	12	447	1	3	7.5	59.6	
Endrin	Korea	30	1969		4.4				0.6	60
	Korea	1650	1979	2	0.57	10	2B	40	0.14	
Heptachl	Japan	1500	1986		5.89				1.47	1.6
o	Japan	70000	1979	5.7	4260	10	2B	3500	12.2	
	China	2000	use		2000				5.7	18
HCB	China'	117	1997	10	82	10	2B	235	3.5	
	China	24000	1980	12	674	100	2A	50	1348	3.5
Mirex	Korea	99	1982		31				62	1410
Toxaphen	Japan	126000	1981	6	11090	100	2A	1000	1109	
	Russia	90000	1990		2240				224	1412
PCBs	China	10000	1980		788				79	
	China	10/year?	-	12	?	1000	1	0.022	?	
	Japan	0.007/year	-		0.087				3950	6770
Dioxins/	Russia	0.005/year	-		0.062				2820	
Furans	China	4900000	1983	1	9.1	1	3	60	0.15	
	Russia	9000	1987		0.28				0.005	0.16
HCH	Japan	175700	1990	0.49	0.031	1	3	50	0.0006	
(Lindan)	China	6000/year	use		4240[+]				85	85
PCP	Russia	13.2/year	-	0.34	6.5[+]	100	2A	10 (mice)	65	65
PAHs										

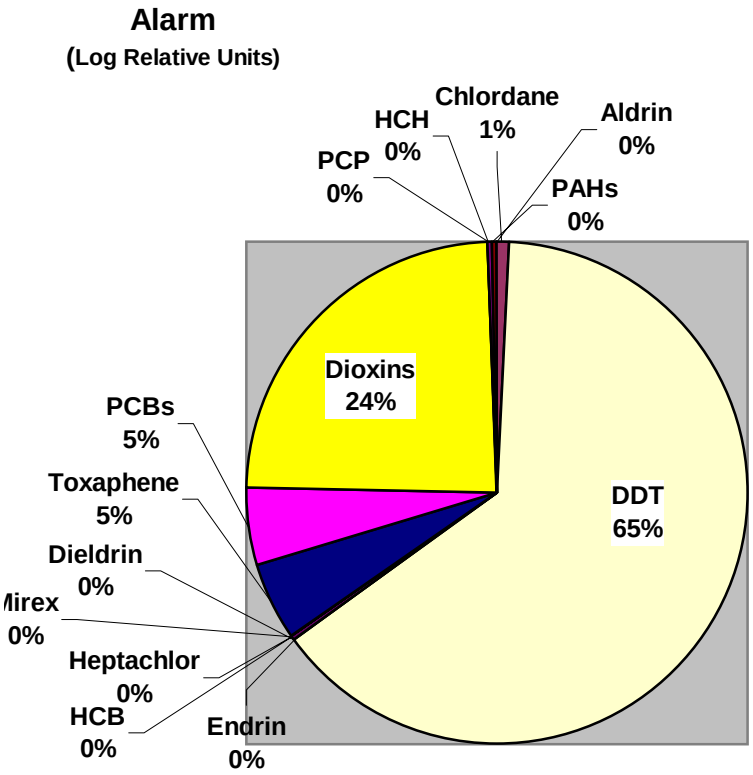
'SAR of China (Hong Kong)
[+]Stationary level

Conclusion

1. A new parameter *Alarm* for assessment of PTS a threat to human health in contaminated areas that takes into account both real-time total volume of PTS and their acute toxicity and carcinogenicity was proposed
2. *Alarm* values for 14 PTS (among them - 10 POPs) were calculated for the states of Region VII, including Asian Russia.
3. It was shown that 95% *Alarm* for the whole Region VII falls to the share of DDT (65%), Dioxins (24%) and PCB (5%).

4. Priority of the PTS parameter *Alarm* for individual countries may dramatically differ from its priority for Region VII as a whole. For instance, in Japan the main PTS hazard is associated with Dioxins and PCB, in Hong Kong (SAR of China) with mirex, and in China the DDT threat is aggravated by toxaphene.

Figure 1: Relative input (%) in *Alarm* for different PTS in Region VII



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