XXII International Seminar
on Interaction
of Neutrons with Nuclei

HUMAN HEALTH RISK ASSESSMENT IN IVANOVO REGION FROM SOIL CONTAMINATION

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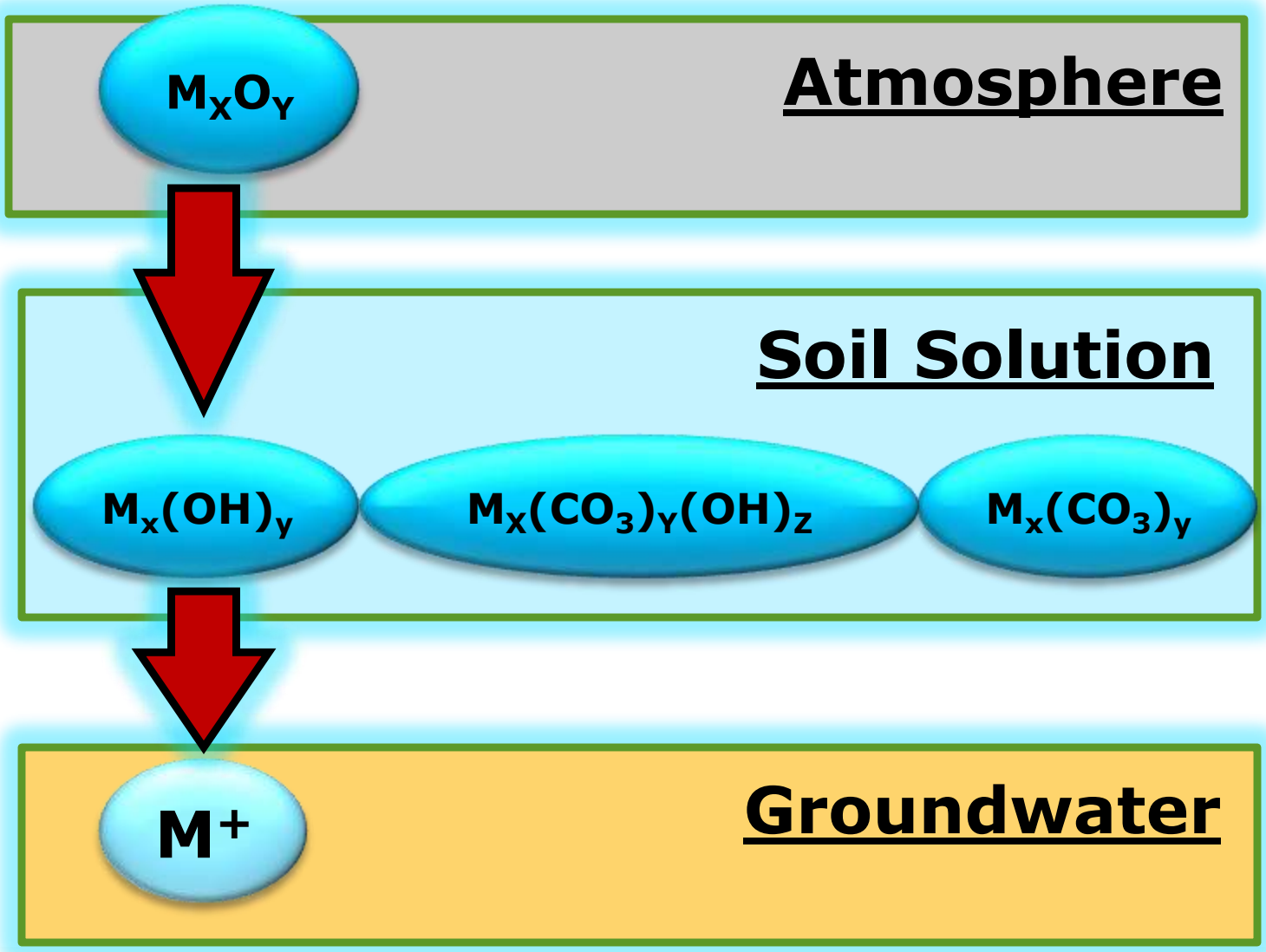
Introduction

Soil contamination is one of the possible sources of the pollutants by humans. Unfavorable quality of soil causes increasing of human health risks and loss in life expectancy (**LLE**).

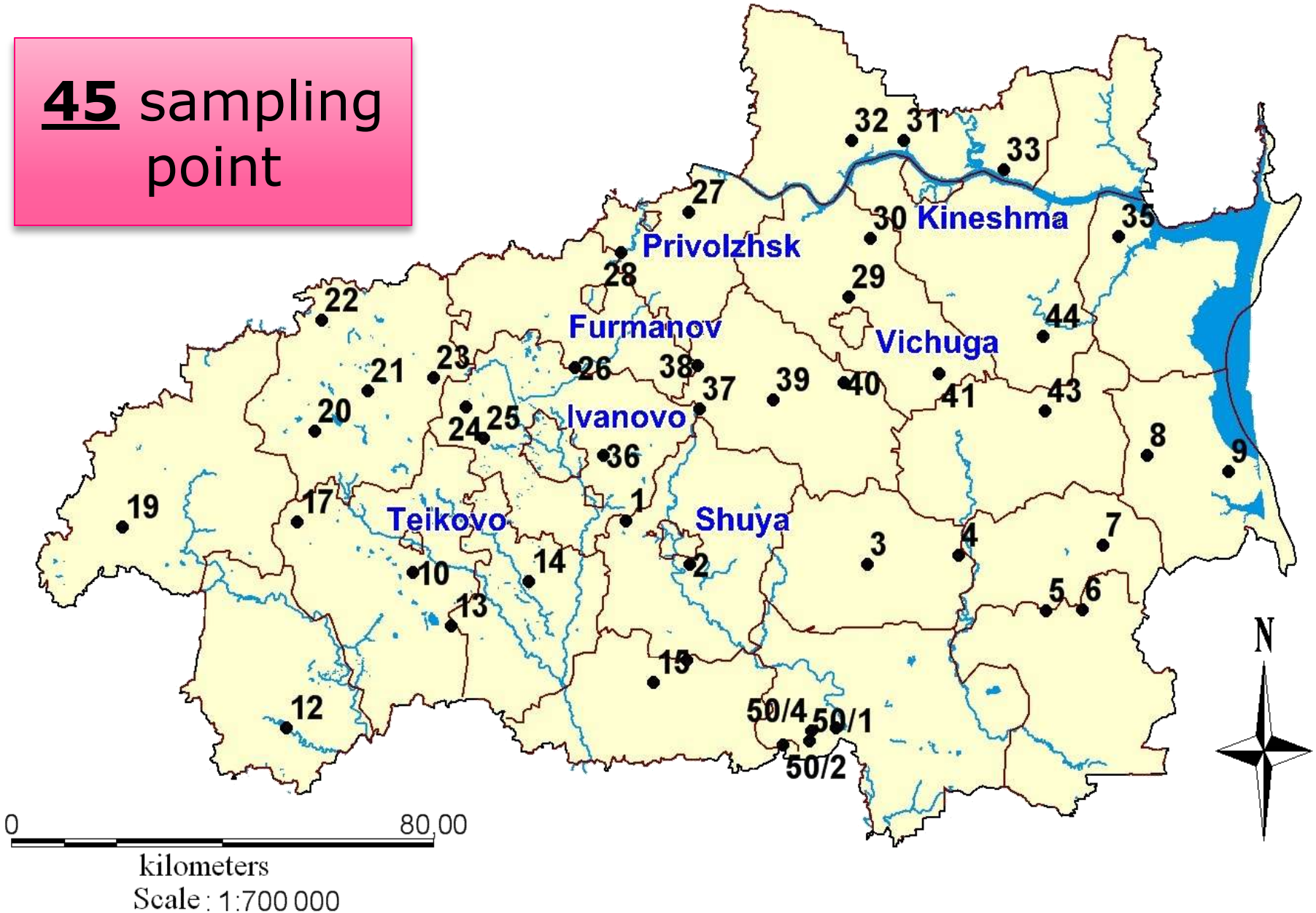
This work is concerned with the assessment of human health risk from soil contamination in Ivanovo region.

Transformation of heavy metals in the ecosystem



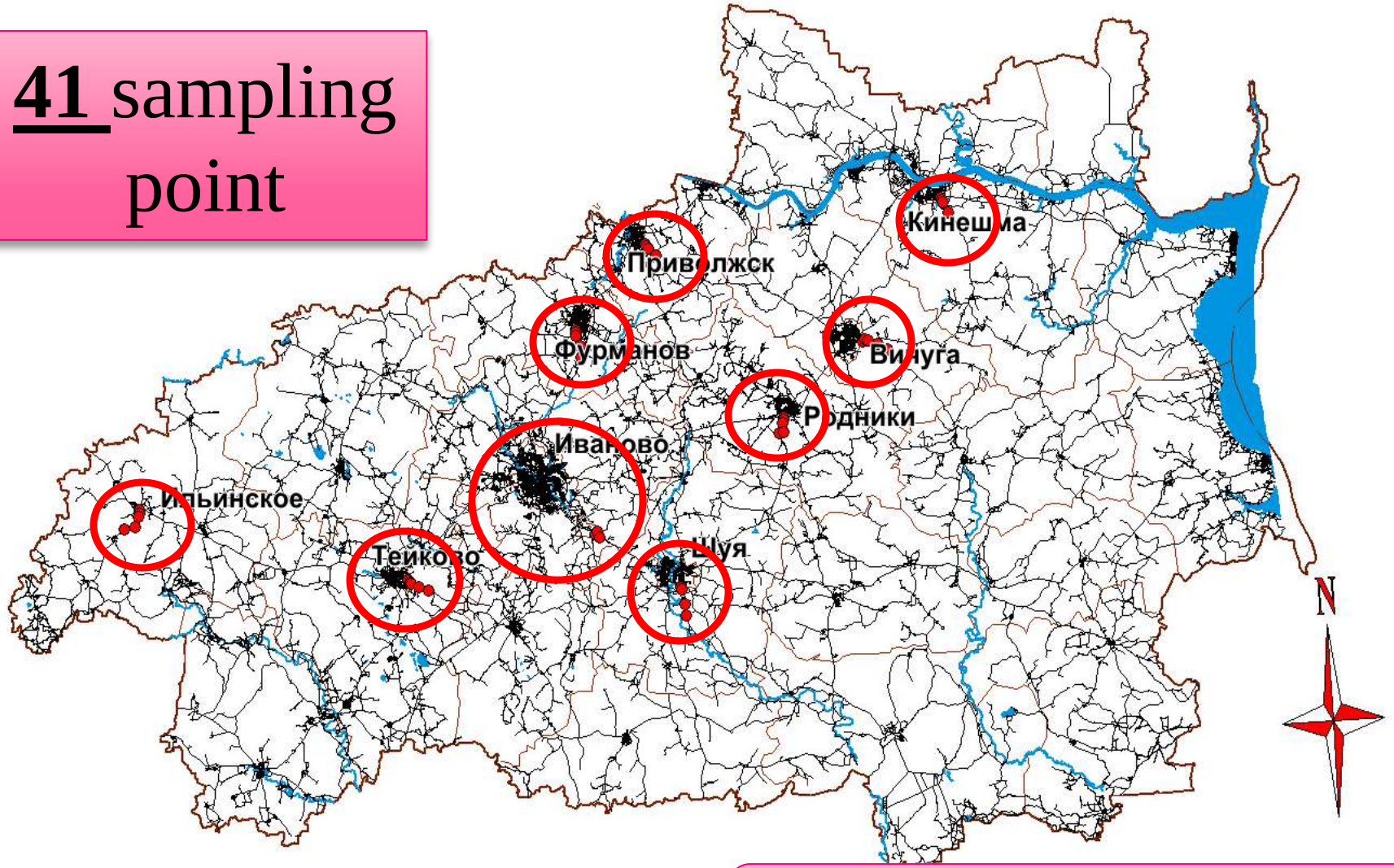
Sampling map. Background monitoring

45 sampling point



Sampling map. Anthropogenic impact monitoring

41 sampling point



Near 9 large towns

Complex analysis: NAA+AAS

H																He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	*Cu*	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	*Cd*	In	Sn	Sb	Te	I	Xe
Cs	Ba	La*	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	*Pb*	Bi	Po	At	Rn
Fr	Ra	Ac**											Rf	Db	Sg	Bh	Hs

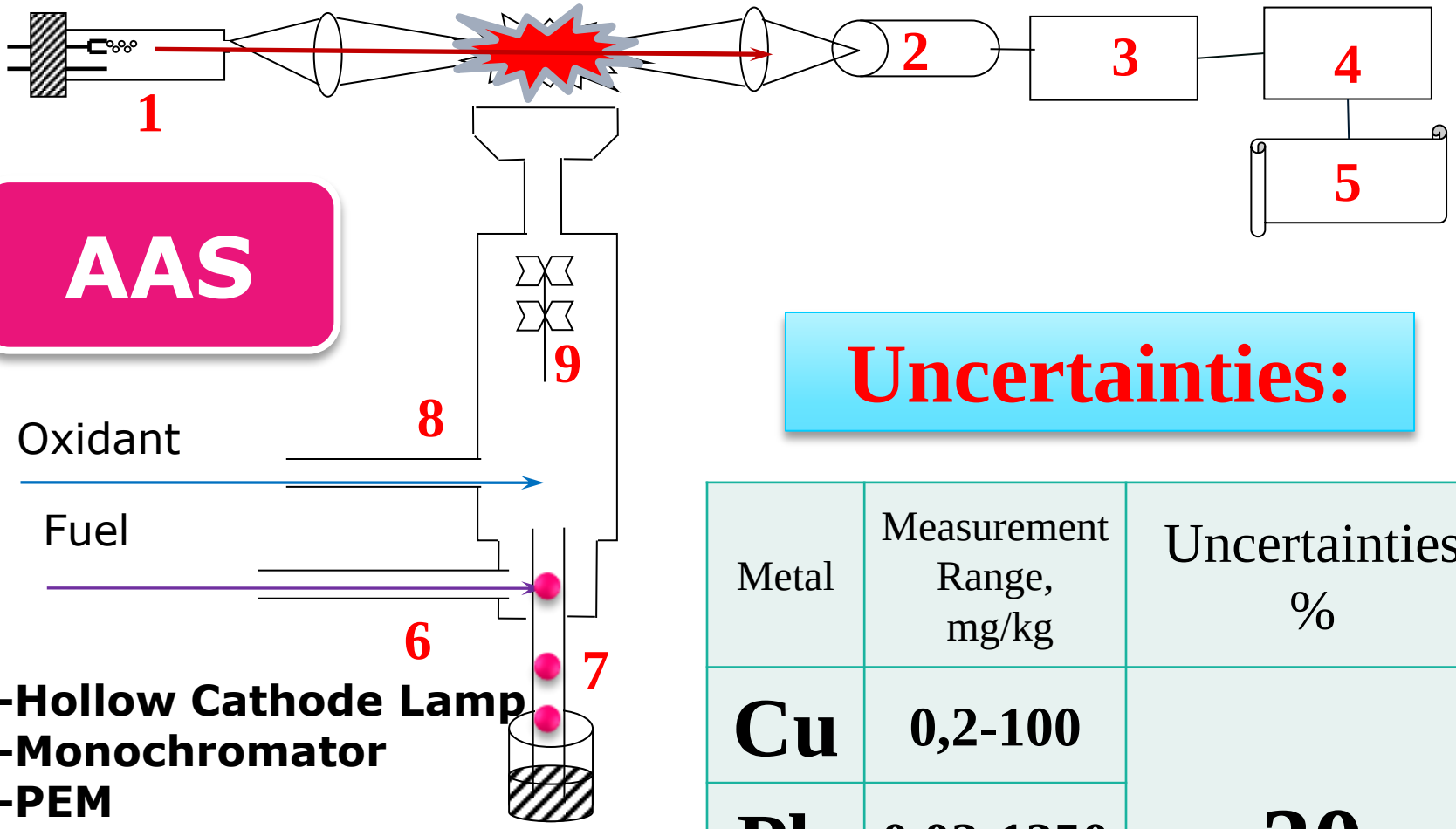
*	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
**	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lw

57 elements

- NAA

- AAS

Atomic absorption spectroscopy (AAS)

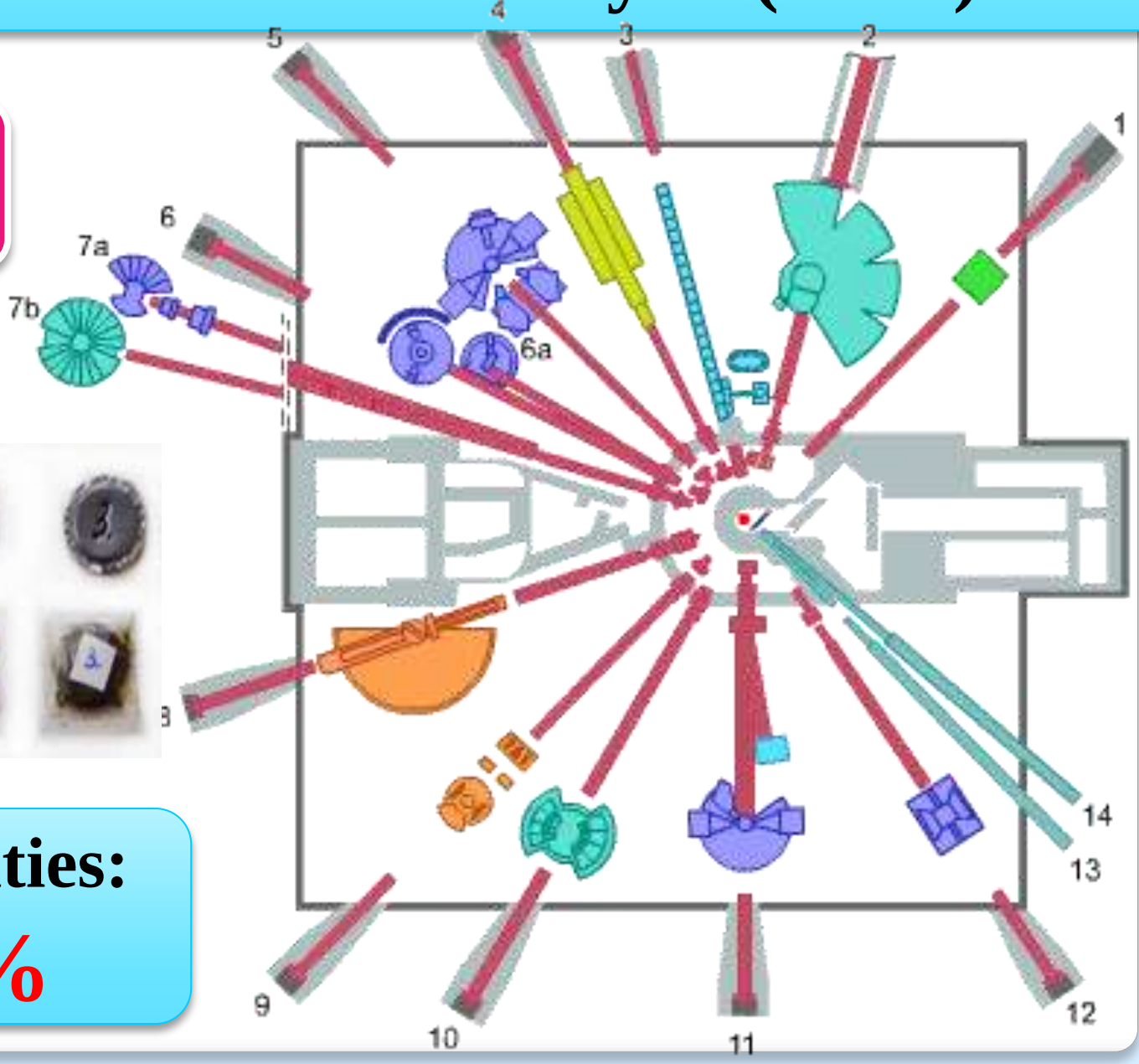


Uncertainties:

Metal	Measurement Range, mg/kg	Uncertainties %
Cu	0,2-100	30
Pb	0,02-1250	
Cd	0,05-125	

Neutron activation analysis (NAA)

NAA



Uncertainties:

5-10%

HM content in soils of Ivanovo Region

HM	Mean	Min-Max	lbg	MPC_S (APC_S)	BG[1]	BG[2]
	mg/kg					
Cr	56.8	19.6-87.8	38.7	-	140	70
Mn	746	14.3-1610	343	1500	650	750
Ni	15.3	3.3-39.0	6.79	80	51	37.3
Co	7.21	1.5-11.2	4.48	-	7.2	15
Zn	39.9	10.5-71.5	23.0	220	49	74
As	2.94	1.07-7.51	1.81	2	-	-
Mo	0.62	0.19-1.07	0.43	-	1.5	0.5
V	34.1	3.13-62.4	19.5	150	72	-
Cu	6.43	0.2-20.0	1.59	132	23	24.9
Cd	0.028	0.002-0.167	ND	2	0.3	0.375
Pb	0.22	0.02-3.32	ND	32	19	30

[1]- Methodological guidelines for determining of TM in soils and plant products
[2]- Pilyugina M.V. Environmental biogeochemical monitoring: criteria, standards, factors

Content of other elements in soils of Ivanovo Region

Element	Mean	Min	Max	lbg
	mg/kg			
Na	5120	706	7410	**3950**
Mg	1330	152	2350	**959**
Ca	3710	2070	7680	**2800**
Ti	3150	483	5350	**2330**
Al	2650	6030	50400	**21600**
Br	1.90	0.60	3,1	**1.44**
U	1.46	0.28	2.83	**1.32**
Sr	71.2	25	123	**51.3**

Content of other elements in soils of Ivanovo Region

Element	Mean	Min	Max	lbg
	mg/kg			
La	19.5	9.50	32.8	**14**
Dy	4.52	2.4	7.1	**3.56**
Nb	8.34	2.73	13.4	**8.34**
Ba	373	69.3	555	**295**
Ta	0.67	0.40	0.98	**0.54**
Sb	0.36	0.07	0.59	**0.31**

Estimation of the environmental risk parameters

One of the most common indicators of the pollutants impact on eco-system is the **environmental risk**

Public health risk

- **Probability of unfavorable events occurrence (HQ, CR)**
- **Economic Damage to Health (risks and average cost of living)**
- **Loss in Life Expectancy (LLE)**

The calculation was made for 4 groups: men, women, children and all adult population

Public health risk

Calculation of individual carcinogenic risk (**CR**) is carried out using data on the magnitude of exposure and the values of the **factors of the carcinogenic potential (SF_a)** :

$$CR = LADD \cdot SF;$$

LADD – **average daily lifetime dose**.

The risk of non-carcinogenic effects (**HQ**)

$$HQ = AD / RfD;$$

AD - **average daily lifetime dose**, **RfD** – **reference dose**.

SF and RfD values are advisory and depend only on the nature of the toxicant and the method of its receipt.

Public health risk

Loss in Life Expectancy (LLE).

$$LLE = (T_{cp} - A_{cp}) \cdot (HQ + CR)$$

T_{mean} – average life expectancy of the target population, years;

A_{mean} – the average age of the target group, years;

Economic Damage to Health

(risks and average cost of living):

$$R_{MO} = LLE \cdot N \cdot ALC$$

N – the number of people in the group;

ALC – the average living costs, mln. rub.

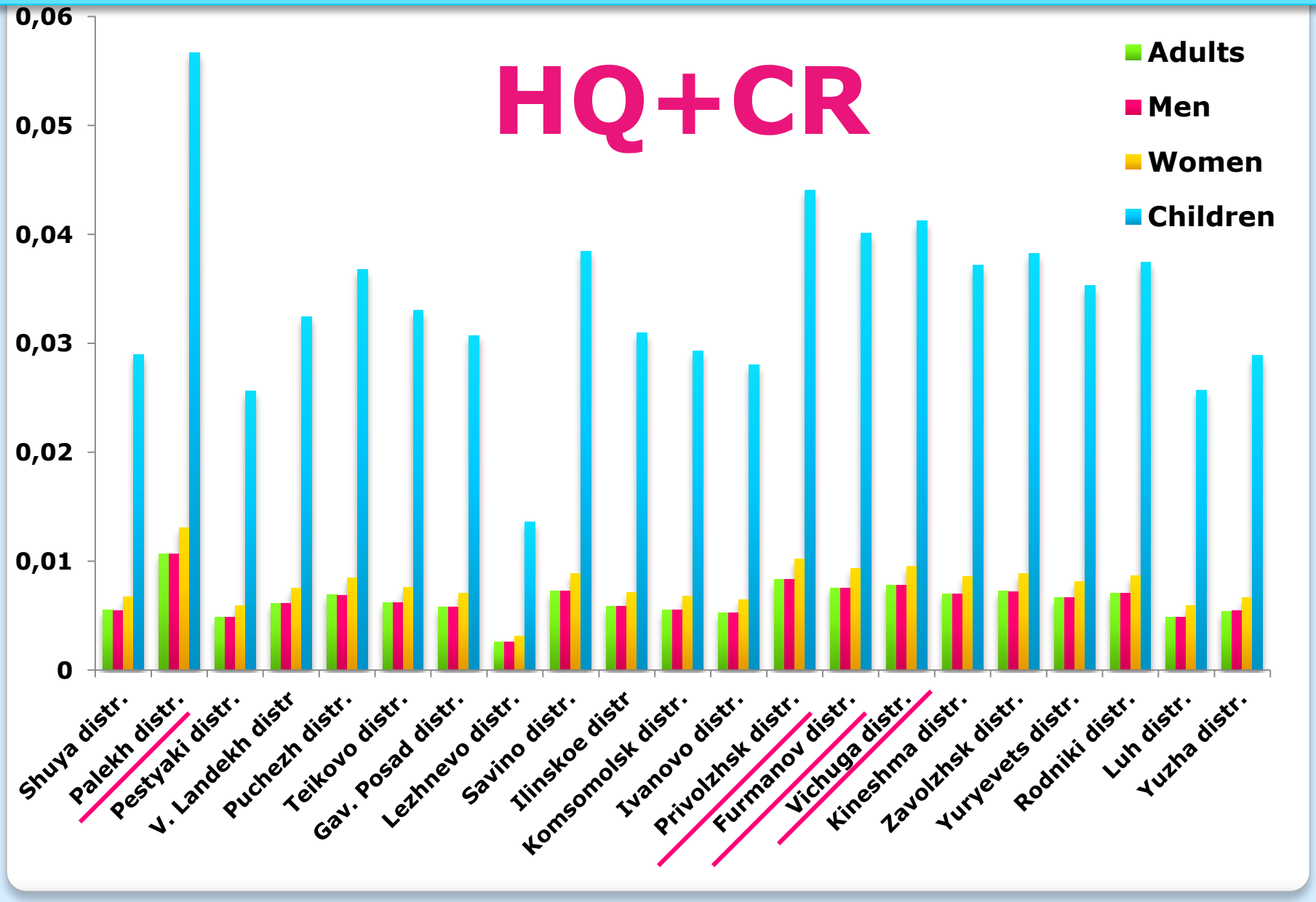
$$ALC = GDP_{RUS} / N_{RUS} \cdot T_{Mean}$$

Average risks of carcinogenic CR and non-carcinogenic effects HQ in Ivanovo region

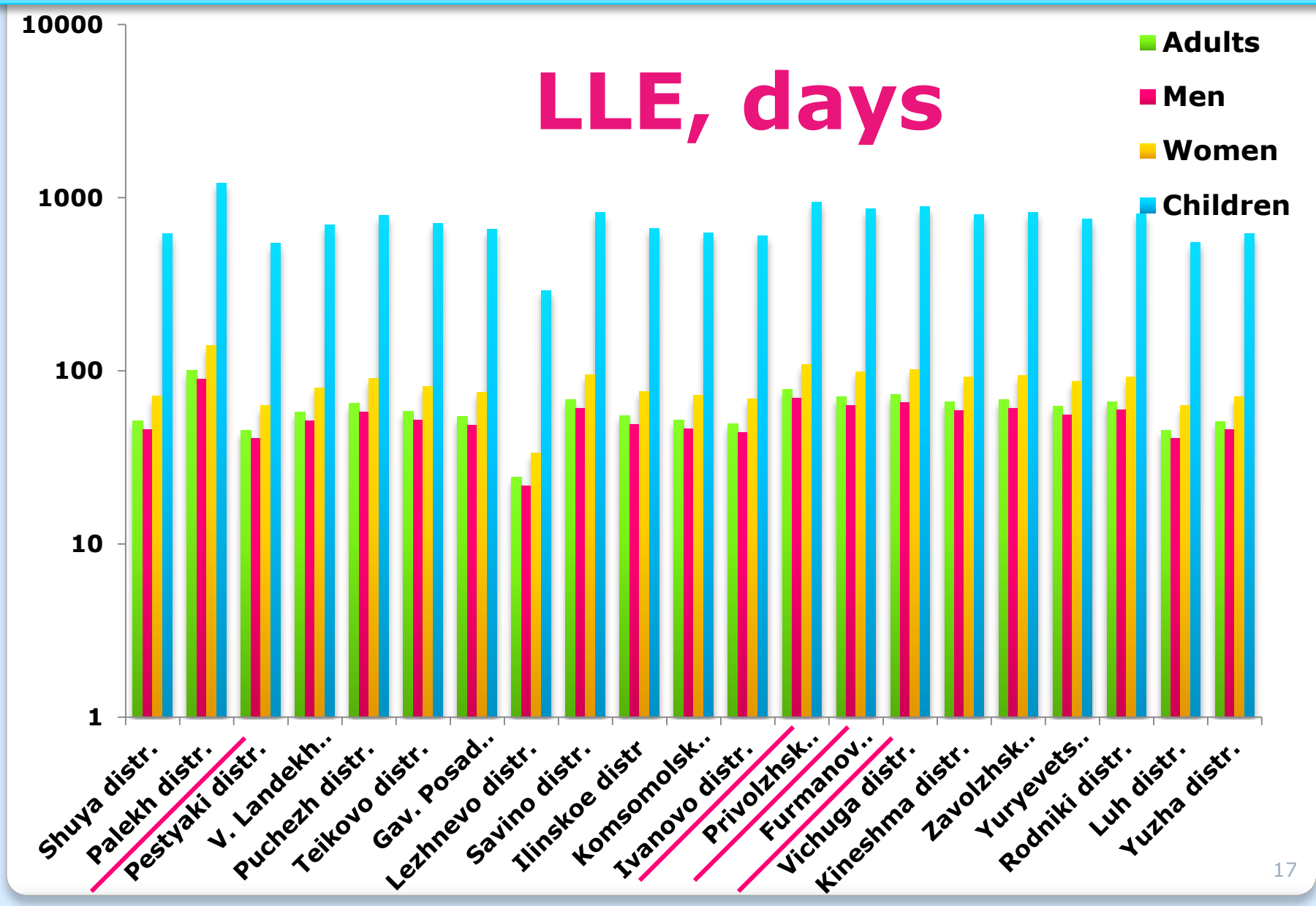
	HQ	CR	$R_{permiss.}$
Adults	$6.05 \cdot 10^{-3}$	$3.68 \cdot 10^{-4}$	$1.50 \cdot 10^{-4}$
Men	$6.03 \cdot 10^{-3}$	$3.62 \cdot 10^{-4}$	$1.66 \cdot 10^{-4}$
Women	$7.4 \cdot 10^{-3}$	$4.28 \cdot 10^{-4}$	$1.37 \cdot 10^{-4}$
Children	$3.27 \cdot 10^{-2}$	$1.24 \cdot 10^{-3}$	$1.50 \cdot 10^{-4}$

10^{-4}-10^{-3}-Unacceptable risk

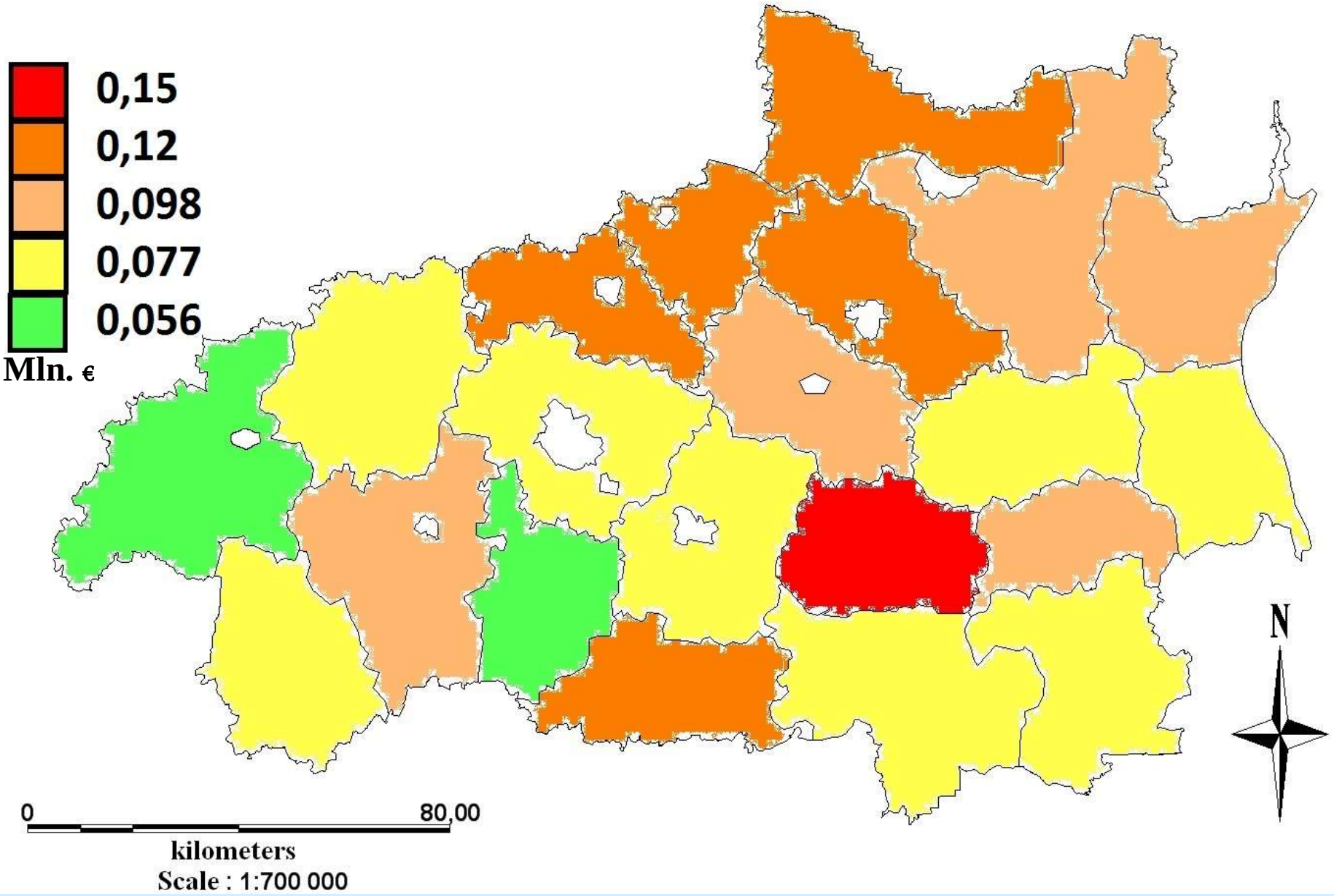
Summary risks in Ivanovo region



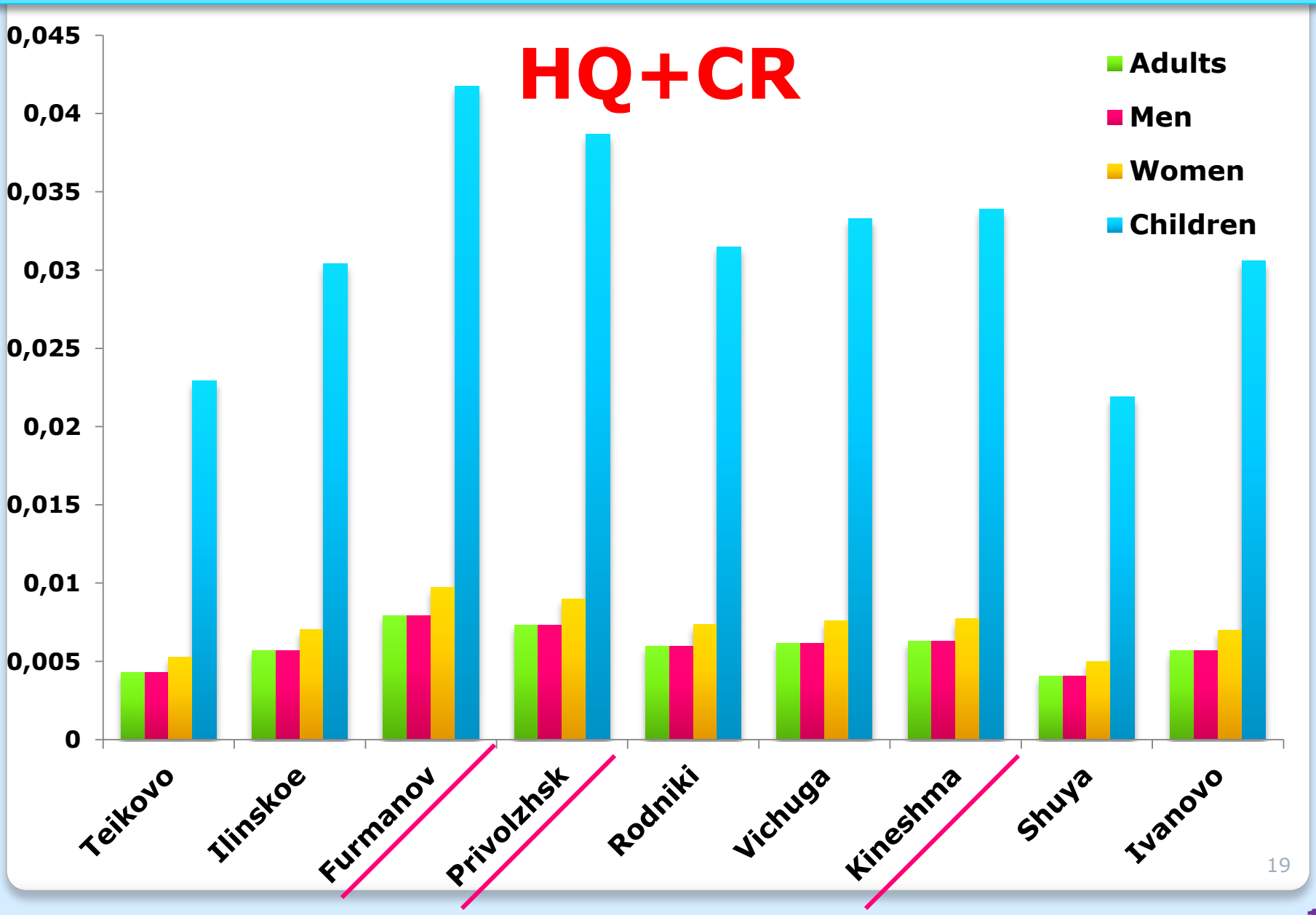
Loss in Life Expectancy in Ivanovo region



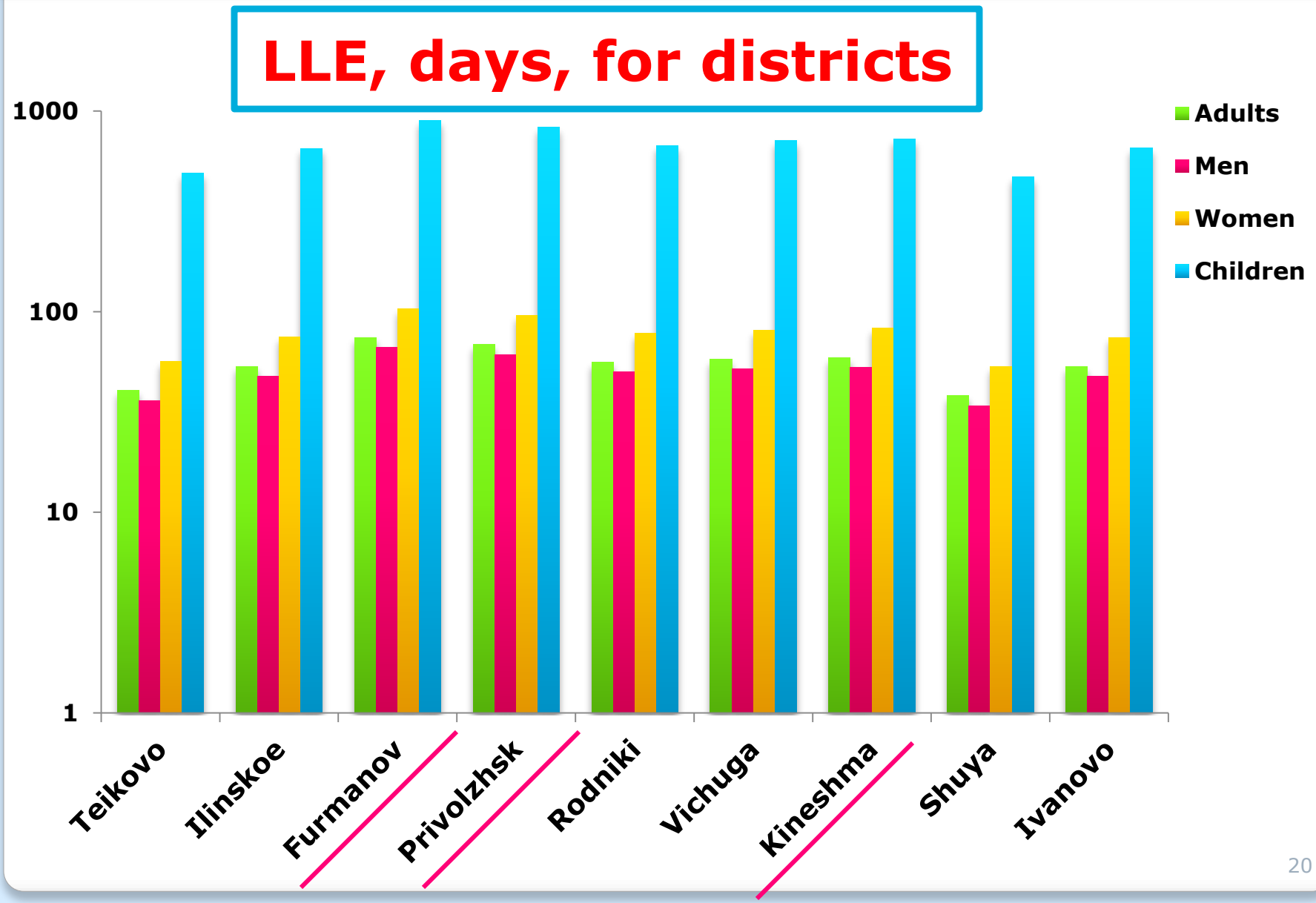
Economic Damage to Health in Ivanovo region. Mln. €.



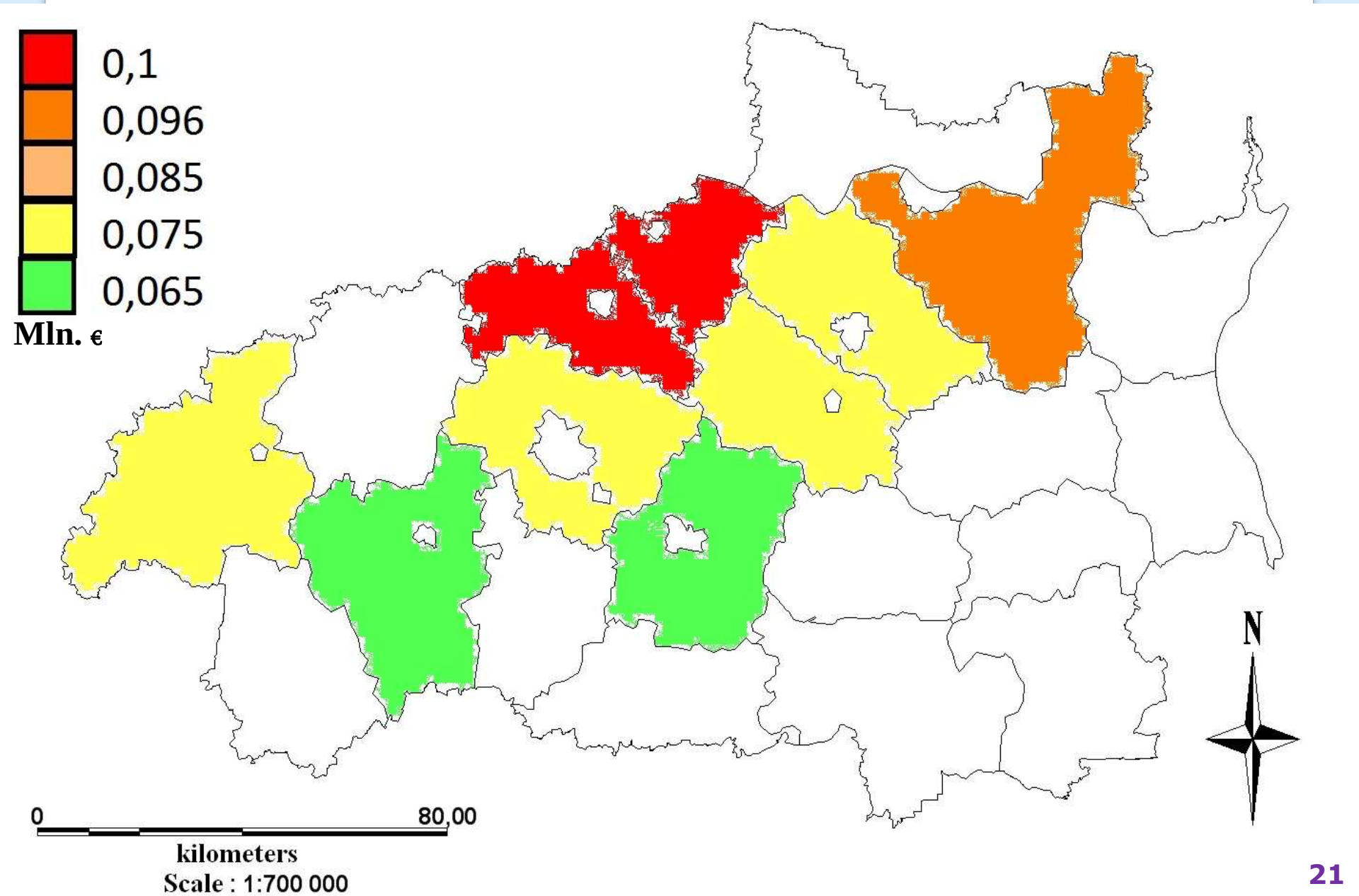
Summary risks near to large towns



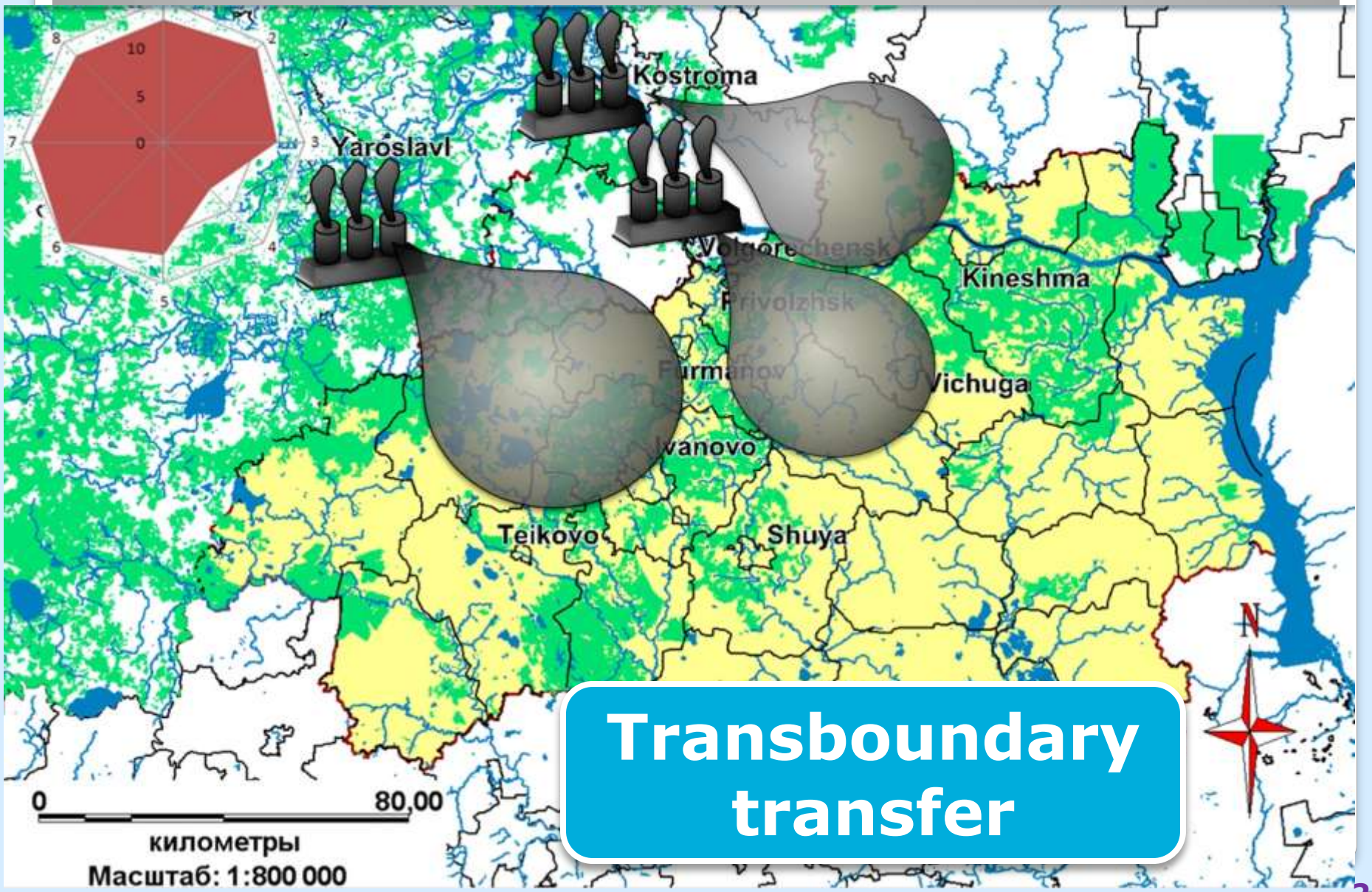
Loss in Life Expectancy near to large towns



Economic Damage to Health near to large towns. Mln. €.



The main sources of impact



Conclusions:

1) The results of calculation justified a **significant human health risk values** from the soil contamination. In some districts this fact is in a good agreement with environmental quality assessment results.

2) It was established that the risk data in selected points around large cities and the risk level of Ivanovo region districts are coincided. It indicates an insignificant contribution to the level of pollution by cities.

3) The main source of the elements under study in the Ivanovo region soil is the impact of trans-boundary emission from industrially developed territories of Yaroslavl and Kostroma regions.

Thank you for attention