



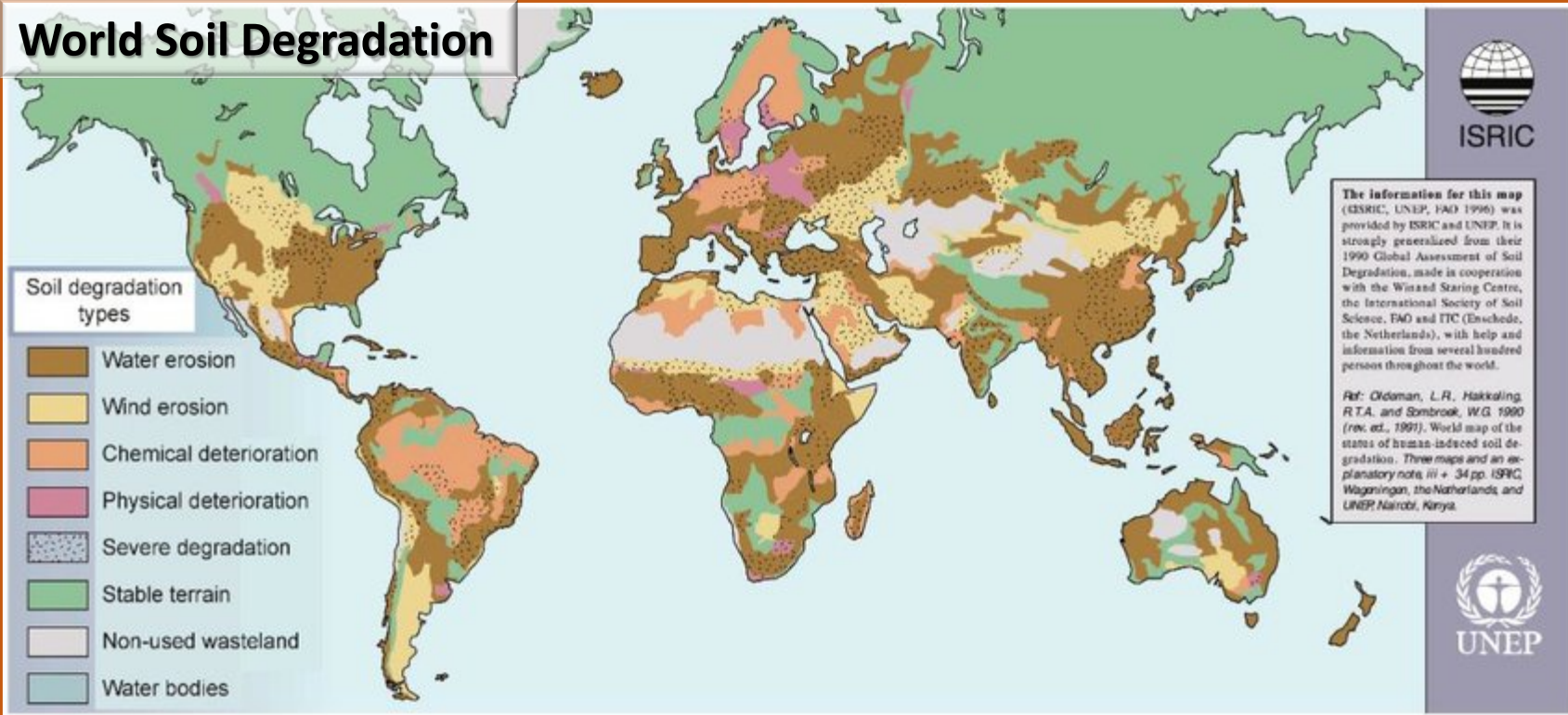
Status of soil pollution with heavy metals and fluorine derived from the application of high doses of phosphate fertilizers

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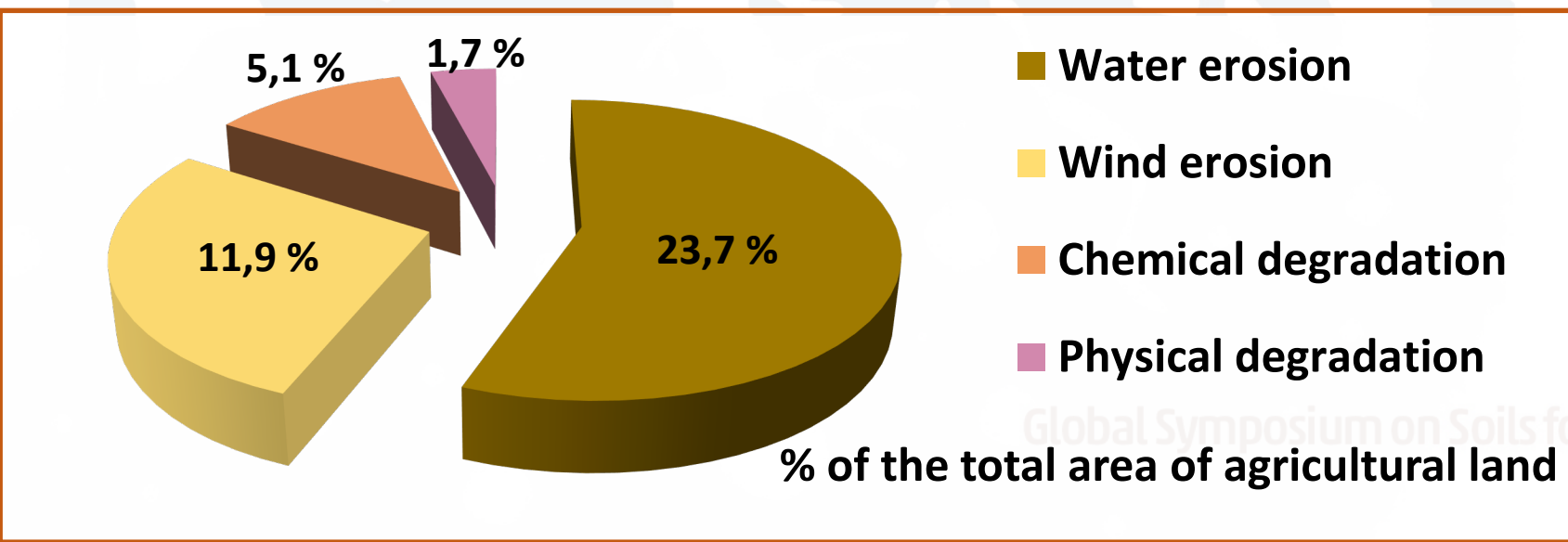


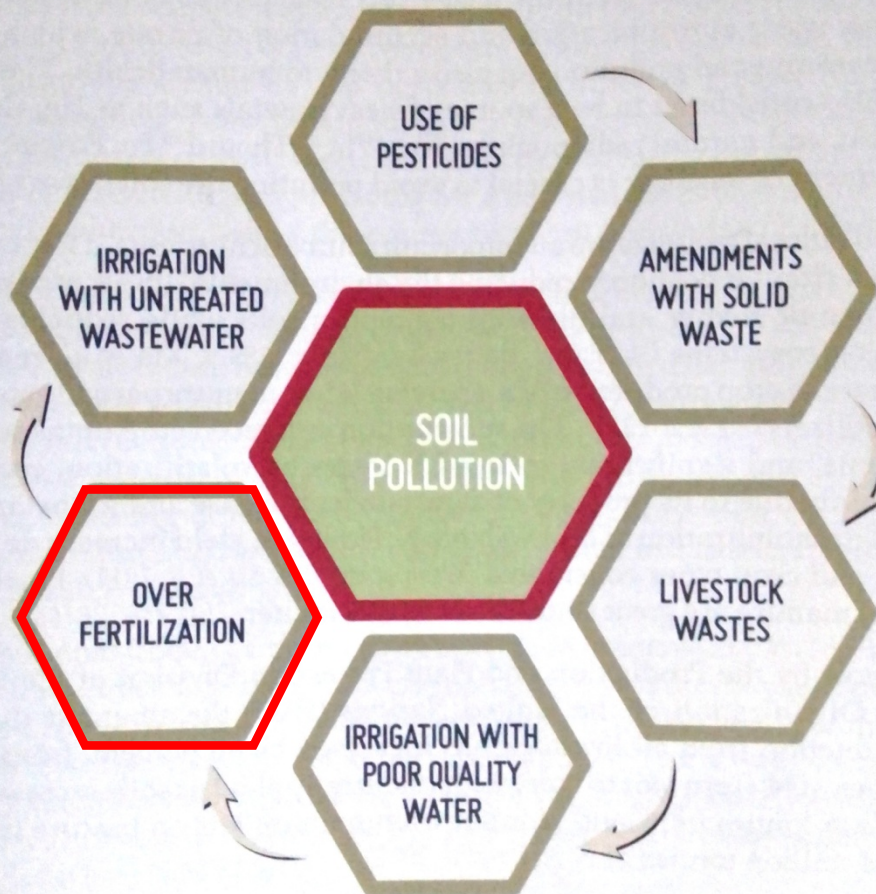


International Soil Reference and Information Centre, 2017

Distribution of degradation processes in the soils of Ukraine

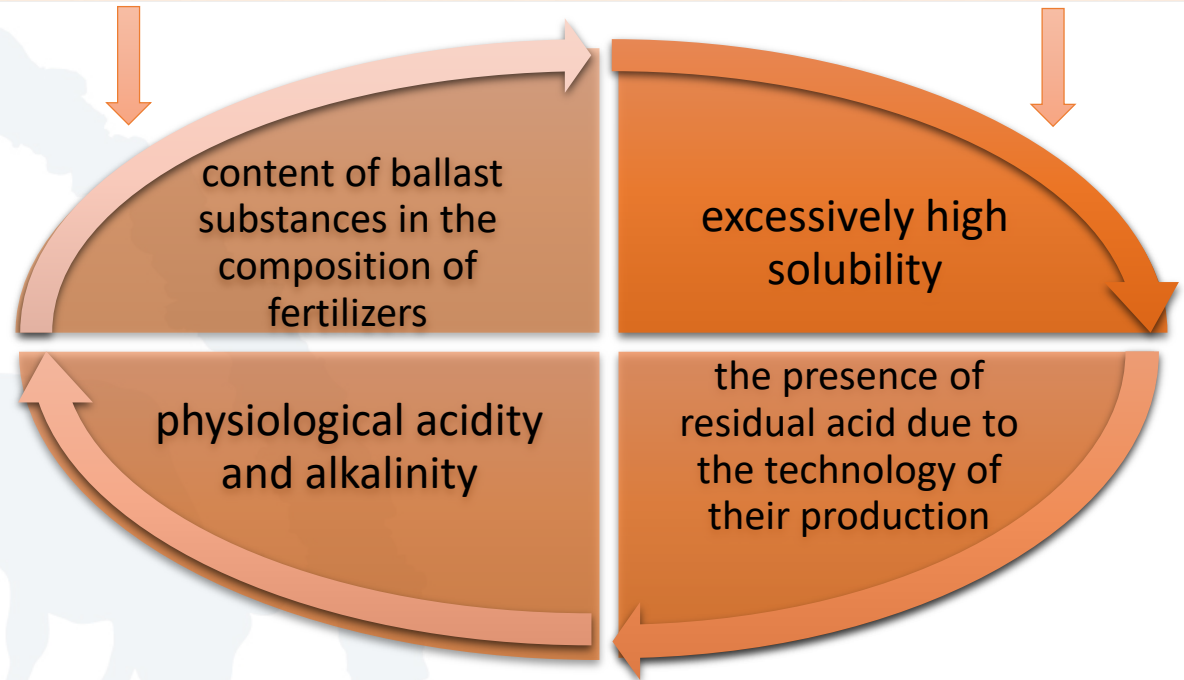
Type of soil degradation	% of arable land area (32 million hectares)
Loss of humus and nutrients	43
Soil compaction	39
Silting and crusting	38
Water erosion	20
Acidification	14
Waterlogging	14
Radionuclide contamination	11,1
Deflation, loss of the top layer soil	11
Pesticide pollution and other organic substances	9,3
Heavy metal pollution	8
Salting, alkalizing	4,1
Side effect of water erosion	3
Deformation of the Earth's surface by wind	0,35
Soil aridization	0,21
Sealed Soils (Under Construction)	4,4 million hectares





FAO, 2018

The negative effect of fertilizers on soils is associated with



Annually in Ukraine, 30-500 g of heavy metals (9-30 g of cadmium) are supplied with precipitation per hectare of agricultural land.

The content of heavy metals in phosphate fertilizers ranges from 15-250 mg per kg. So, at an application rate of 200 kg per ha (40 kg P_2O_5), only 3-50 g of heavy metals per hectare (0.6-6 g of cadmium) are supplied to the soil.

Research aim

to investigate the impact of application of high doses of phosphorus fertilizer over a long period (39 years) on status of chernozem soil pollution with heavy metals and fluorine

Research methodology

The scheme of experiment

No.	Experiment options	Total phosphorus applied during six rotations, kg ha ⁻¹
1	Control (without fertilizer)	0
2	N ₁₈₀₀ P ₁₈₀₀ K ₁₈₀₀ (application in reserve) + N ₆₀ P ₆₀ K ₆₀ (systematically application)	3280
3	N ₁₈₀₀ P ₁₈₀₀ K ₁₈₀₀ (application in reserve) + N ₁₂₀ P ₁₂₀ K ₁₂₀ (systematically application)	4480

Our study was conducted on **chernozem soil of Eastern Ukraine** in the long-term field experiment that had started in **1969**. Soil samples were taken at the end of the sixth rotation with the following alternation of crops:
1) pea-oat mixture; 2) winter wheat; 3) sugar beet; 4) barley; 5) corn for silage; 6) winter wheat.

Research methodology



Mobile forms of **Cd, Cu, Ni, Pb, Mn, Fe, Zn** (extracted with an ammonium acetate buffer solution with pH 4.8) were determined by atomic absorption spectrometry, **fluorine** in water extract.

The following types of mineral fertilizers were used in the experiment: nitrogen - **ammonium nitrate**, phosphorus - **simple granular superphosphate**, potash - **potassium chloride**.

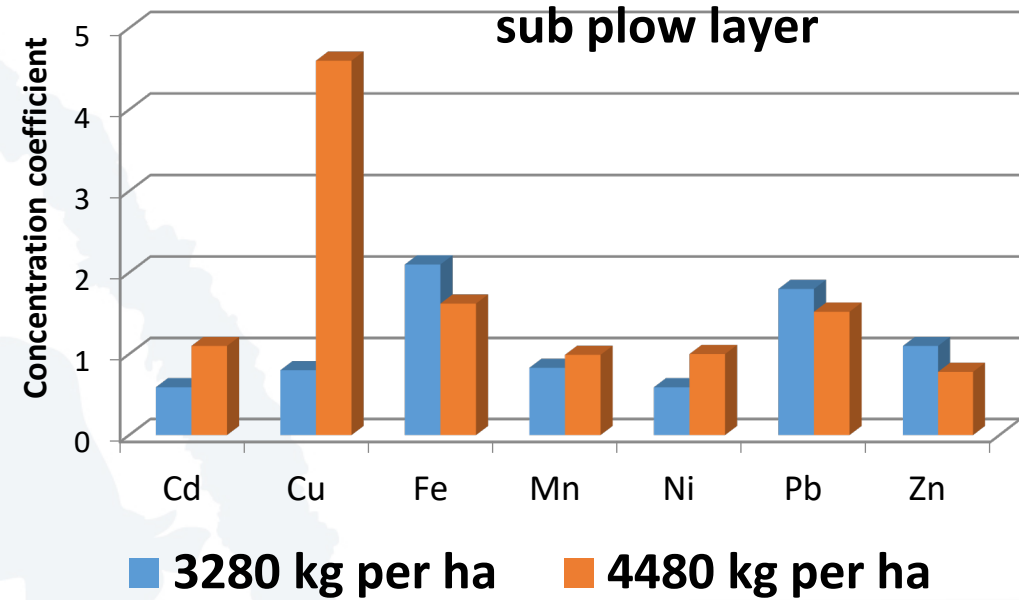
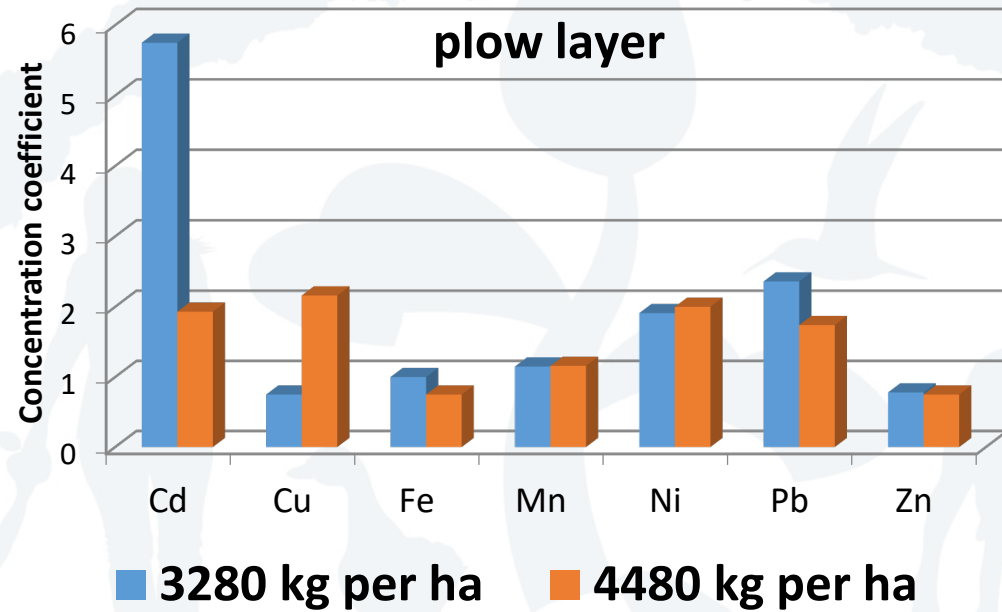
Average content of heavy metals in fertilizers, mg per kg

Type of fertilizers	Mn	Cu	Zn	Ni	Pb	Cd
Ammonium nitrate	7	15	0.5	0.9	0.3	0.3
Simple superphosphate	200	20	19	24	12	3.5
Potassium chloride	20	1	12	19	12	4.3

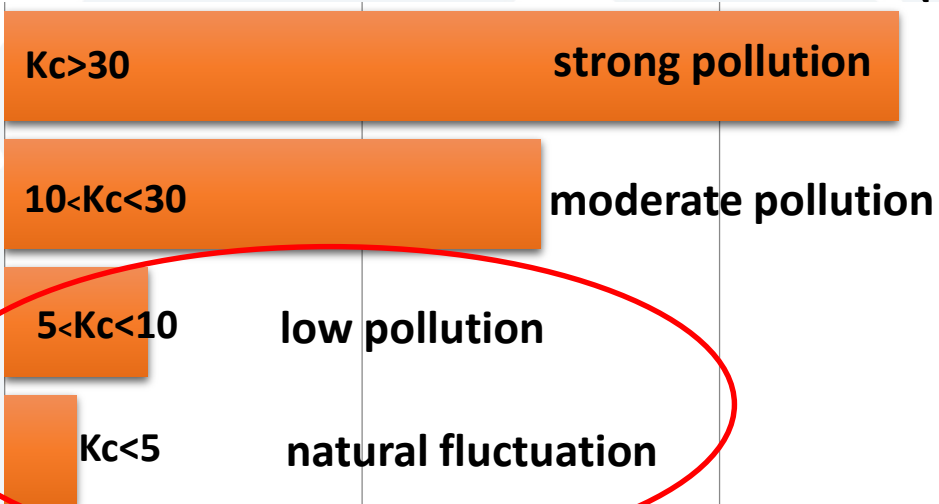
Effect of high doses of phosphorus fertilizers on changes in the content of mobile forms of heavy metals in chernozem

Total phosphorus applied during six rotations, kg per ha	Soil layer	The content of trace elements in the soil, mg per kg						
		Cd	Cu	Fe	Mn	Ni	Pb	Zn
0	plow layer	0,11	0,21	5,9	34,2	0,3	1,07	0,57
	sub plow layer	0,14	0,15	4,32	31,5	0,26	1,05	0,32
3280	plow layer	0,32	0,09	9,1	42,9	1,4	2,67	0,48
	sub plow layer	0,13	0,04	7,45	29,8	0,43	1,84	0,55
4480	plow layer	0,31	0,26	9,1	43,1	1,4	1,97	0,46
	sub plow layer	0,24	0,23	5,76	35,5	0,75	1,56	0,39
LSD(P ≤ 0.05)		0,10	0,11	1,9	5,6	0,3	0,57	0,10
IMPC		-	3,0	-	100	4,0	6,0	23
Background		0,16	0,12	6,7	37,0	0,7	1,13	0,61

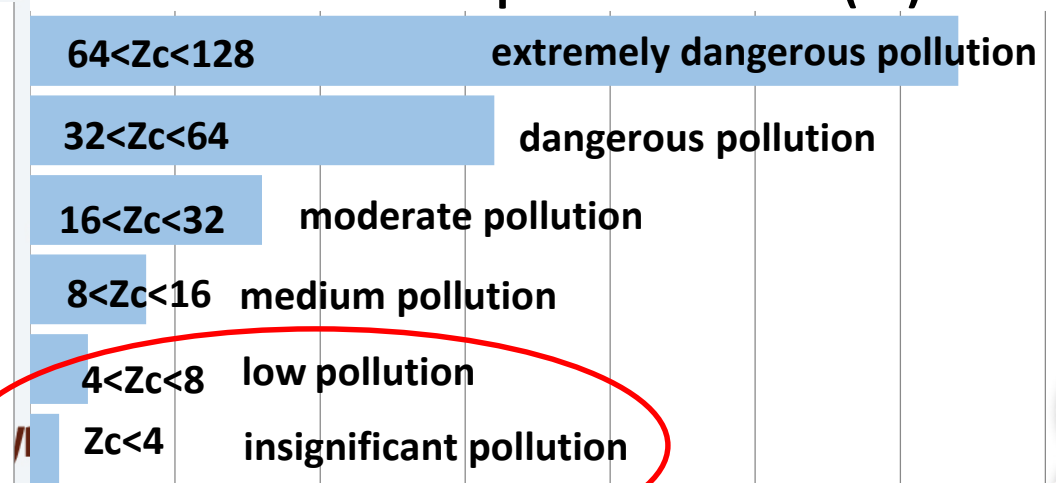
Effect of high doses of phosphorus fertilizers on concentration coefficients (Kc) of heavy metals in chernozem



Value of concentration coefficient (Kc)



Value of total pollution index (Zc)



Effect of high doses of phosphorus fertilizers on changes in the content of water-soluble fluorine in chernozem

Total phosphorus applied during six rotations, kg ha ⁻¹	Soil layer	Content of water-soluble fluorine, mg per kg
0	plow layer	0,1
	sub plow layer	0,1
3280	plow layer	0,9
	sub plow layer	0,3
4480	plow layer	0,5
	sub plow layer	0,4
LSD(P ≤ 0.05)	-	0,09
MPC		10,0

The fluorine content in phosphorous fertilizers has the following values: in **simple and granular superphosphate** 1.4 - 1.7%, in **ammophos** - 3.5%, **nitroammophos** - 2.0%.

Main conclusions

The obtained data indicate only certain regularities in the increasing content of mobile forms of fluorine and heavy metals in the chernozem under the application of high doses of phosphate fertilizers.

And there can be a number of reasons for this, but the main ones are:

- ✓ high buffering capacity of this type of soil
- ✓ and significant increases in the productivity crops of rotation (by 80-82%) on fertilized variants, which contributes to a significant increase in the removal of heavy metals from the soil.



Thank you !



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