Monitoring of PAHs accumulation in contaminated sites of Electric Power Station

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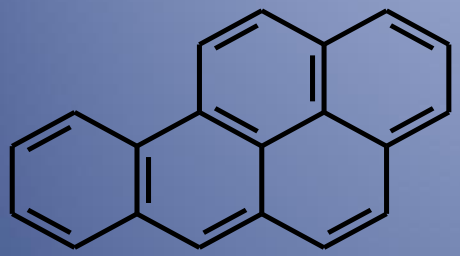
Scientific problem



Benzo[a]pyrene (BaP)

The main marker of ecosystem pollution by policyclic aromatic hydrocarbons (PAH) is BaP. The BaP presistance in all environmental objects is obligatory controlled in all countries of the world.
Relevance of BaP behavior complex researches in soils and plants is caused by the increased danger and scale of soil and plants pollution by this compound.

Properties:
- melting temperature: 179°C;
- boiling temperature: 495°C;
- density: 1,24 g/cm^3;
- carcinogen and mutagen of danger class I;
- molecular weight 252,3;
- yellow plates and needles.

Object	Maximum limited concentration
Soils	0,02 mg/kg
Plants	0,005 mg/kg (corn)
Air of settlements	0,001 mkg/m^3
Air of working zone	0,15 mkg/m^3
Drinking water	0,000001 mg/l

The purpose of the research

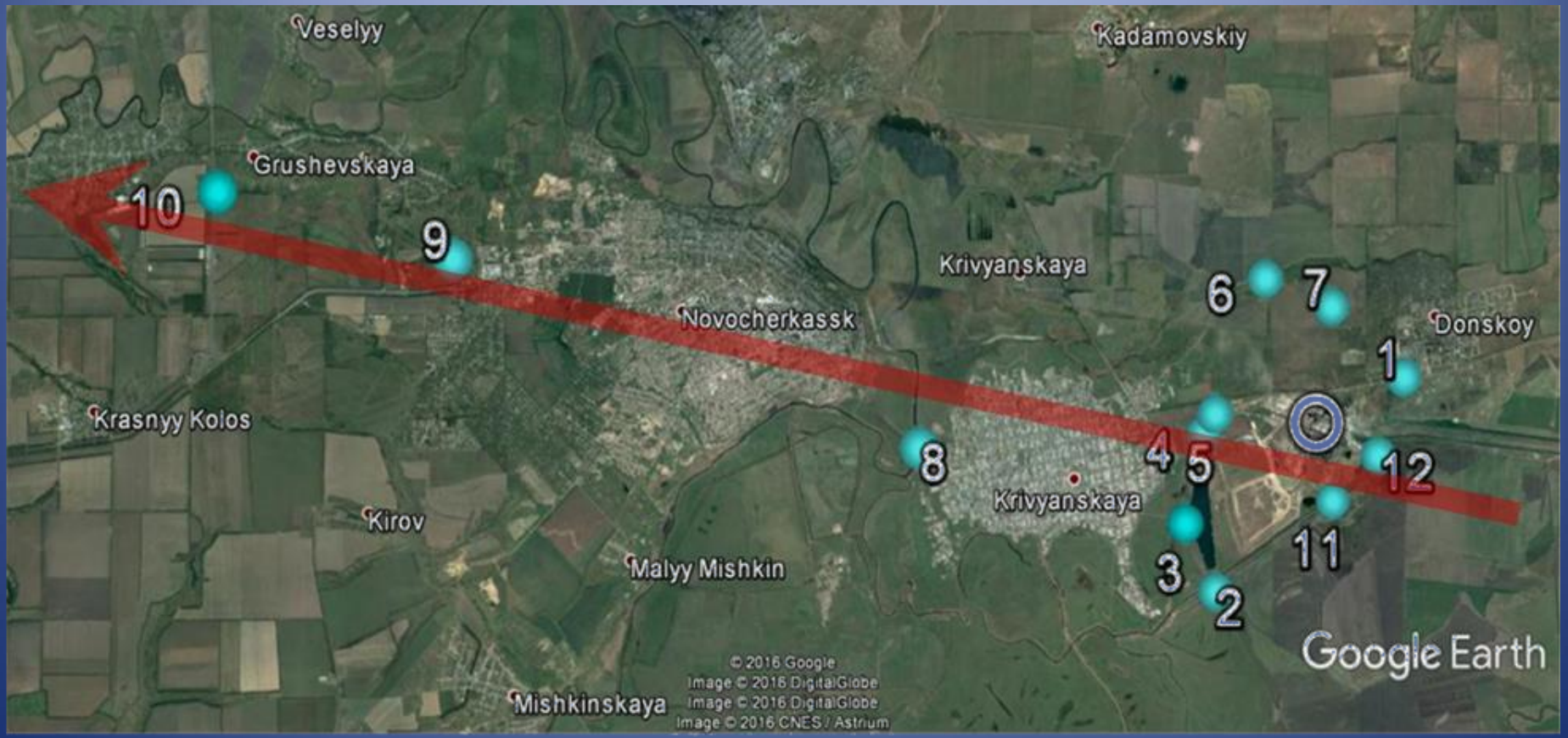
Monitoring of PAHs accumulation in contaminated sites in the anthropogenic contaminated area of Novocherkassk Power Station emission zone

Research problems:

1) To study benzo[a]pyrene distribution in contaminated sites of Novocherkassk Power Station (NPs) (Russia) emission zone.
2) To research the biological activity of the soil in NPs the emission zone polluted by PAHs.
3) To investigate the most effective and ecologically clean bioremediation methods for studied territory.

Objects and methods

Schematic map of monitoring plots arrangement



Google Earth

miles 8

km 10

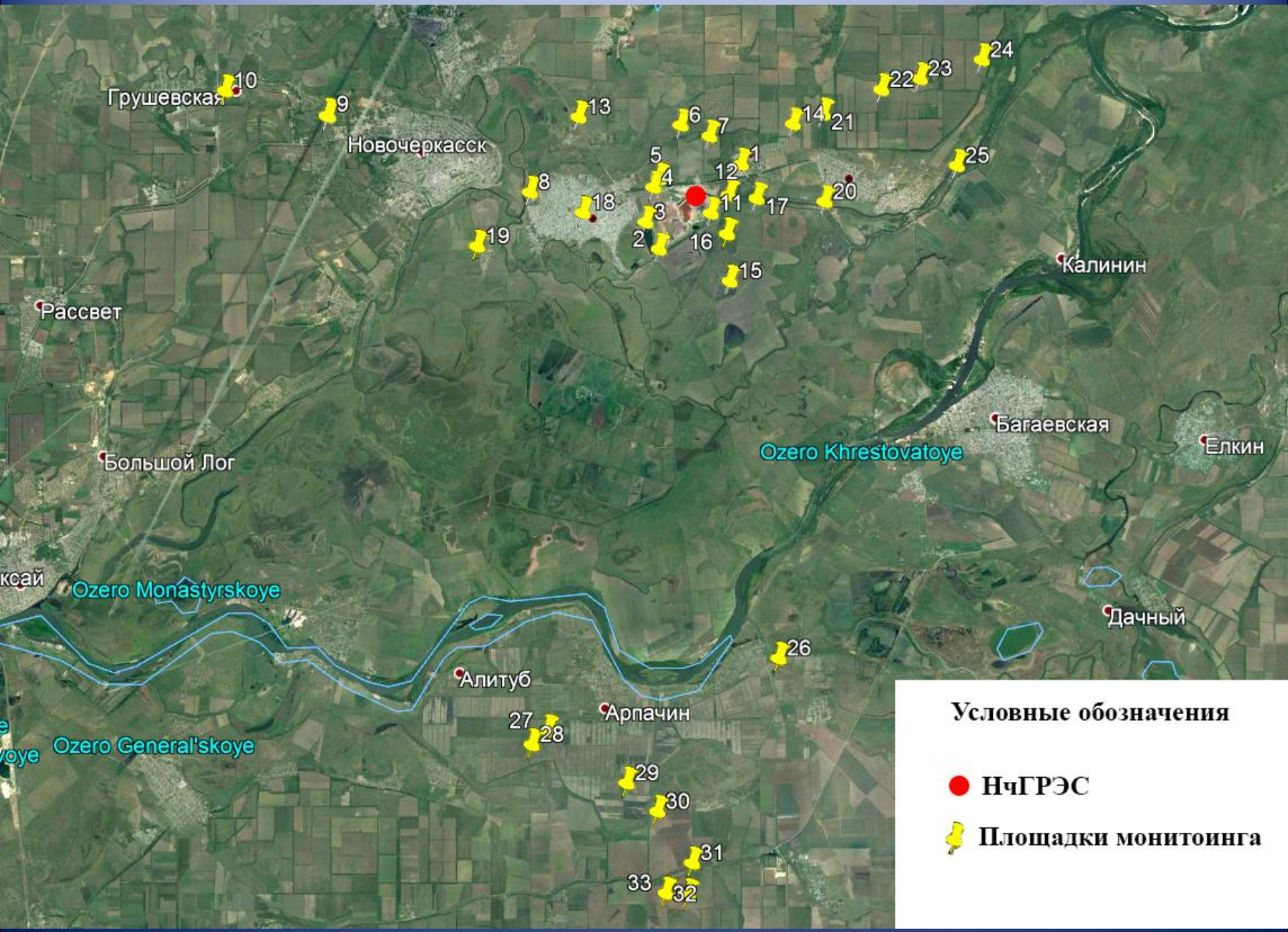
The prevailing wind direction on the territory

Numbers of monitoring sites and their designations comprising the distance in km, direction from the NEPS, and soil type

No.	Designation	Soil type	No.	Designation	Soil
Sites located through the predominant wind direction from NEPS			Sites located around NEPS		
5	1.2nw	Haplic Chernozem	1	1ne	Haplic Chernozem
4	1.6nw	Haplic Chernozem	7	1.5n	Haplic Chernozem
8	5nw	Fluvisols	6	2n	Fluvisols
9	15nw	Haplic Chernozem	3	2.7sw	Fluvisols
10	20nw	Haplic Chernozem	2	3sw	Haplic Chernozems (Stagnic)
-	-	-	11	1.7se	Haplic Chernozem
-	-	-	12	1.2se	Haplic Chernozem

Properties of NEPS emissions zone soils

Monitoring sites №	Soil	Physical clay (particle < 0,01 mm), %	Clay (particle < 0,001 mm), %	Corg, %	pH	$CaCO_3$, %	CEC, cmol (+)/ kg
1	Haplic Chernozems	52	27	2,5	7,6	0,5	35,0
2	Calcaric Fluvic Arenosol	7	3	1,8	7,5	0,4	10,9
3	Haplic Chernozems (Stagnic)	67	37	2,7	7,3	0,2	44,8
4	Haplic Chernozems	55	29	2,7	7,5	0,7	31,2
5	Haplic Chernozems	53	27	2,5	7,5	1,0	35,7
6	Haplic Chernozems (Stagnic)	55	30	2,4	7,7	0,8	32,4
7	Haplic Chernozems	51	27	2,4	7,6	0,7	31,3
8	Haplic Chernozems (Stagnic)	60	32	2,9	7,4	0,4	47,6
9	Haplic Chernozems	52	30	2,4	7,6	0,6	31,4
10	Haplic Chernozems	53	28	2,7	7,6	0,5	36,0
11	Haplic Chernozems	33	15	2,2	7,5	0,6	38,7
12	Haplic Chernozems (Stagnic)	44	20	2,7	7,4	0,4	42,4


Грушевская
Новочеркасск
Рассвет
Большой Лог
Калинин
Багаевская
Елкин
Дачный
Алитуб
Арпачин
Ozero Khrestovatoye
Ozero Monastyrskoye
Ozero General'skoye
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Условные обозначения
НчГРЭС
Площадки монитоинга

Soils:

alluvial meadow soils

ordinary chernozems

meadow-chernozemic soils

Natural grassy vegetation:

Artemisia austriaca

Tanacetum vulgare

Elytrigia repenes

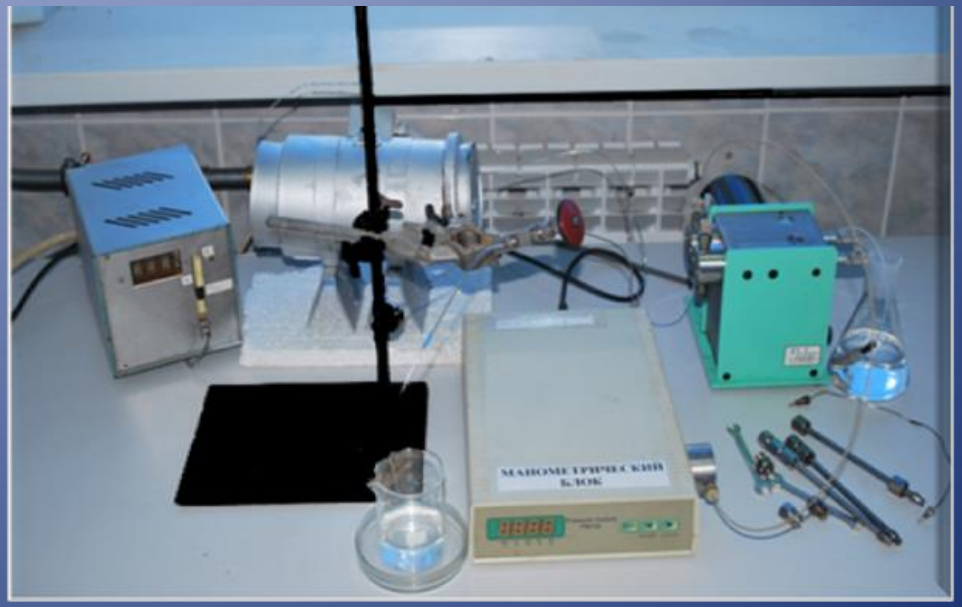
Cichorium intybus

Achillea millefolium

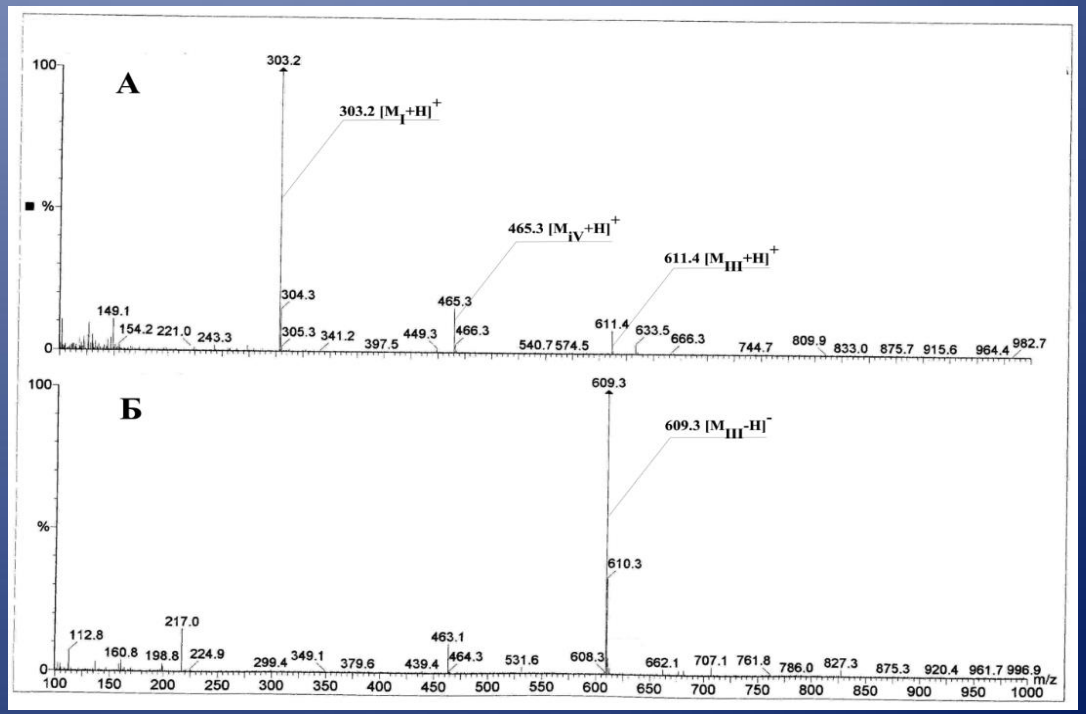
Ambrosia artemisiifolia

Benzo[a]pyrene extraction from soils by subcritical water

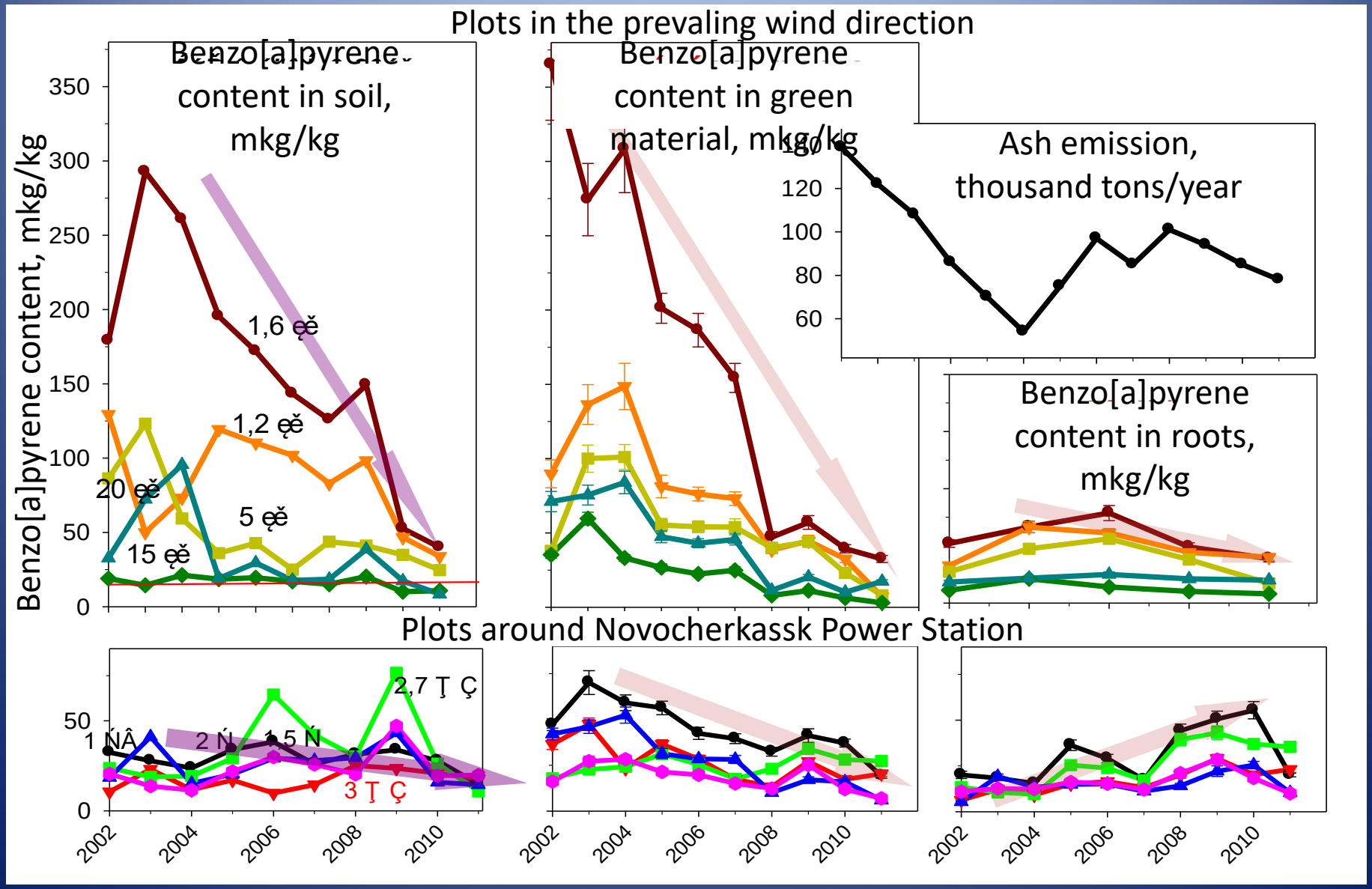
1. Average soil/plant sample
2. Dry, grind and sieve (1 mm)
3. Air-dry sample (1 g) + 8 ml double-distilled water placed into an extraction cartridge
4. Subcritical water extraction (250°C, 100 atm, 30 min), filter
5. Aqueous filtrate
6. Re-extract with *n*-hexane using a 3 × 5 ml separatory funnel
7. Hexane extract
8. Dry with anhydrous Na_2SO_4
9. HPLC analysis



Mass-spectrometry-liquid chromatography of subcritical water plant/soil extracts

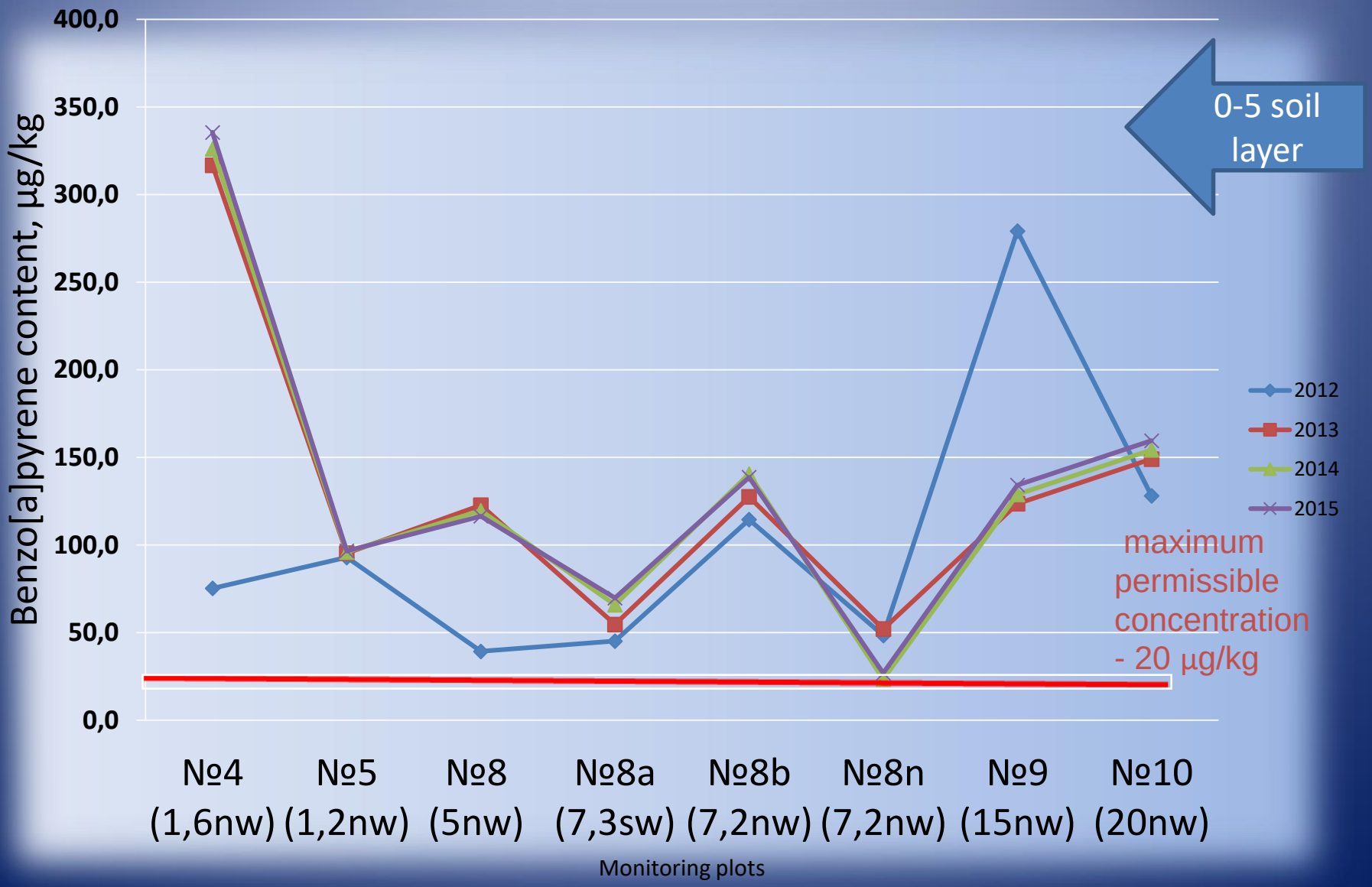


Comparison of benzo[a]pyrene accumulation dynamics in the soil and plants (green material and roots) in emission zone

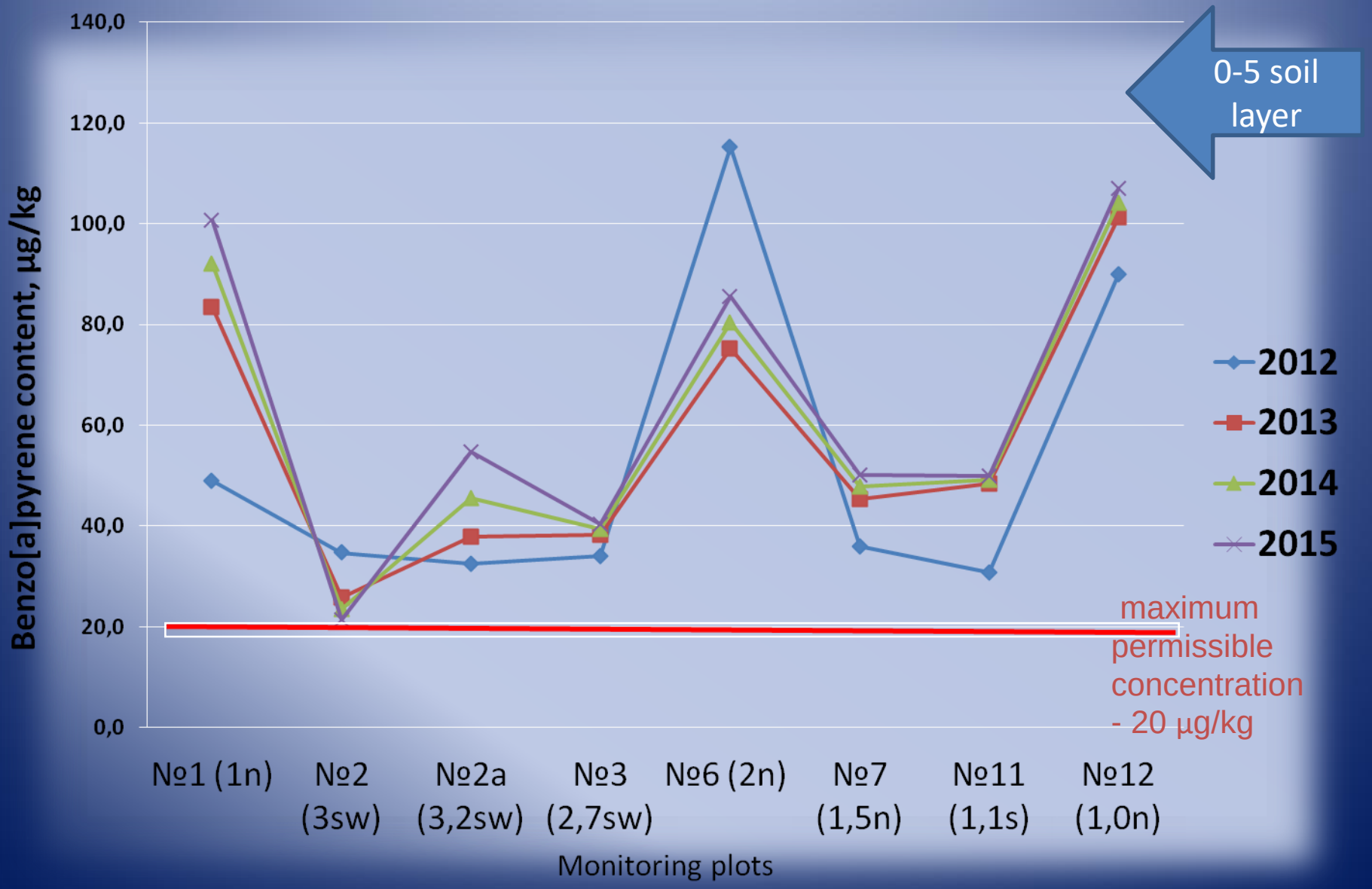


In process of decrease in losses of BaP accumulation in green material of plants decreases but its accumulation in root system increases

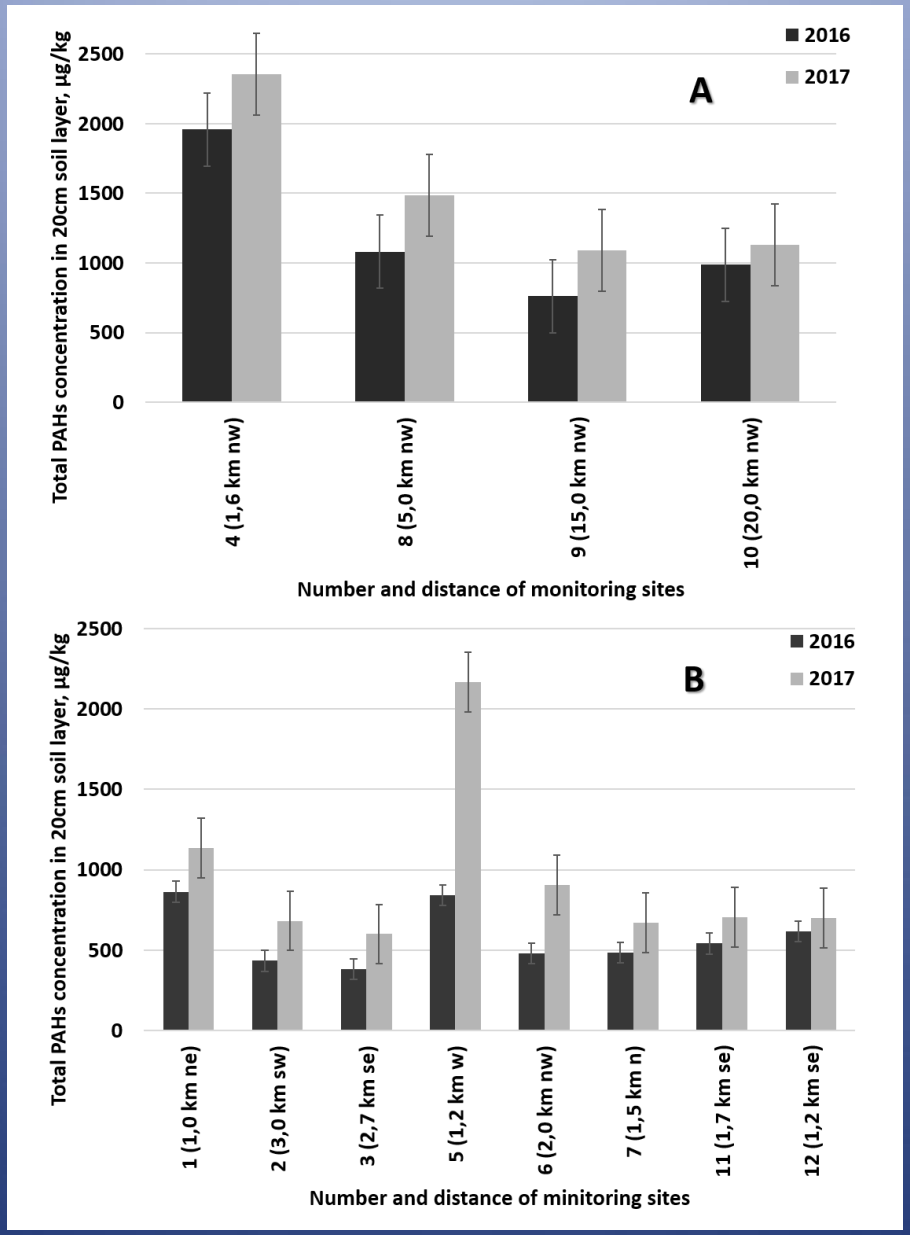
Tendencies of accumulation of benzo[a]pyrene in soil of emission zone 2012-2015 in the prevailing wind direction



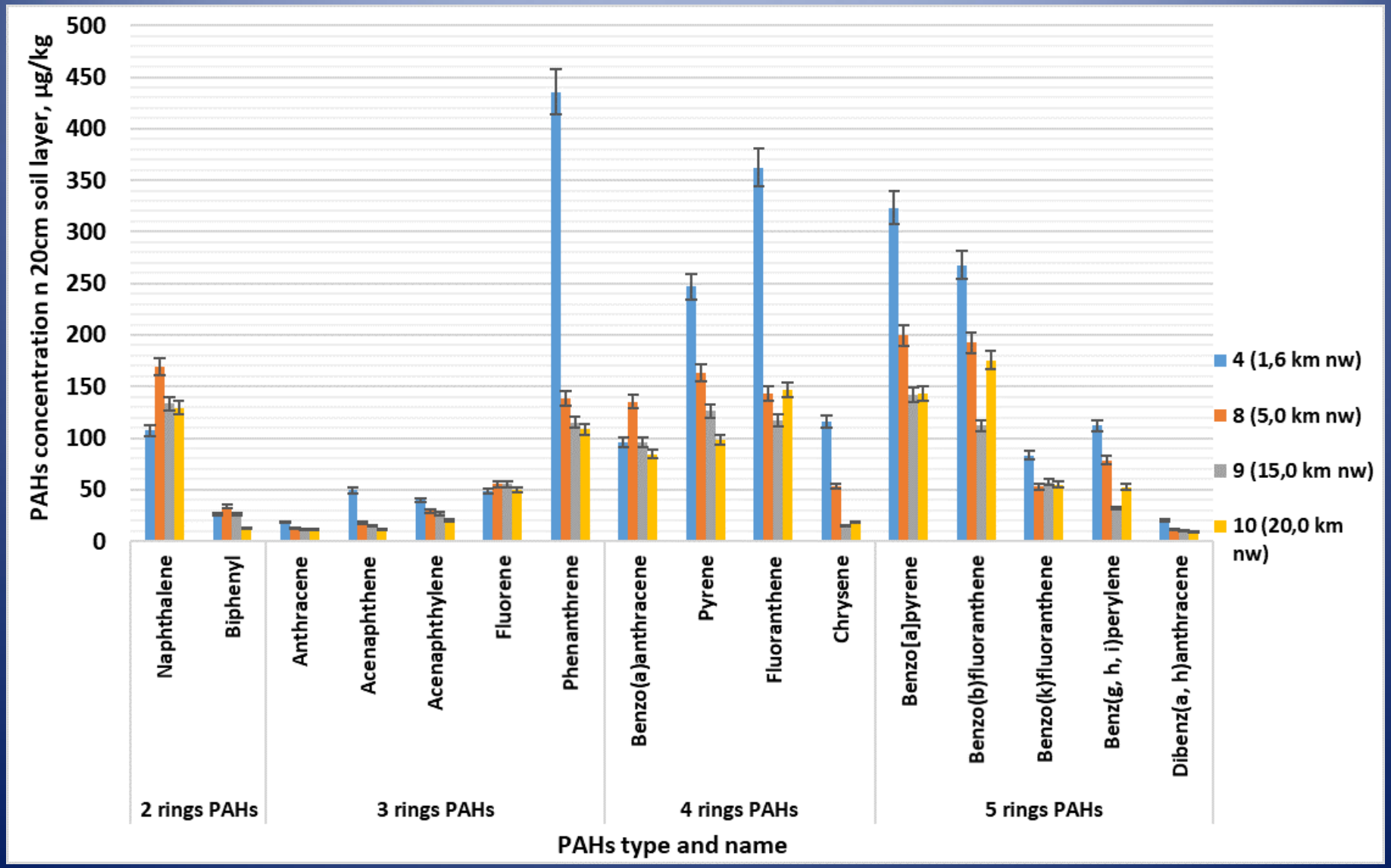
Tendencies of accumulation of benzo[a]pyrene in soil of emission zone 2012-2015 around Power Station



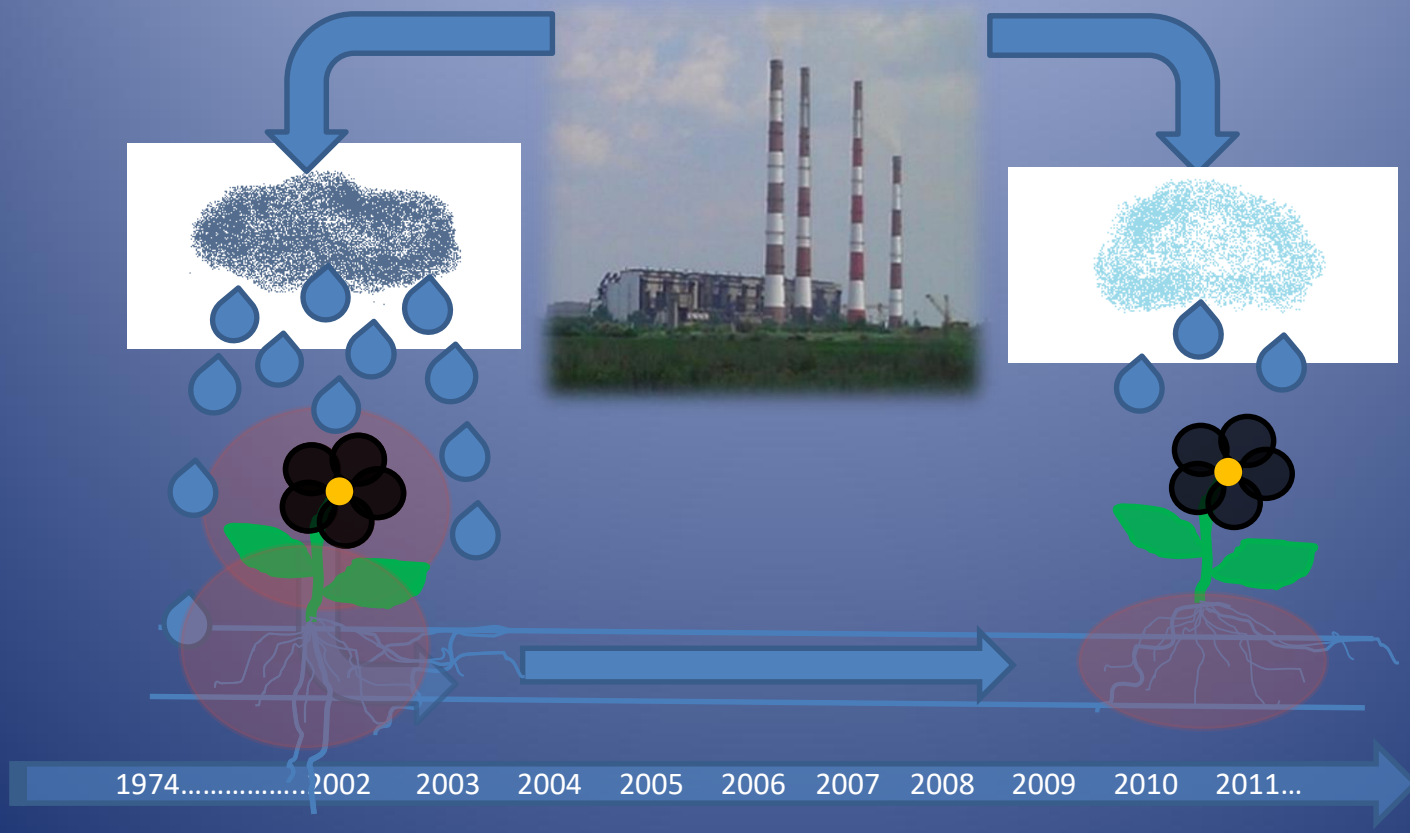
Dynamic of PAHs total concentration in 20cm soil layer of monitoring sites (A) in direction of predominant winds from NEPS, (B) around NEPS in 2016-2017



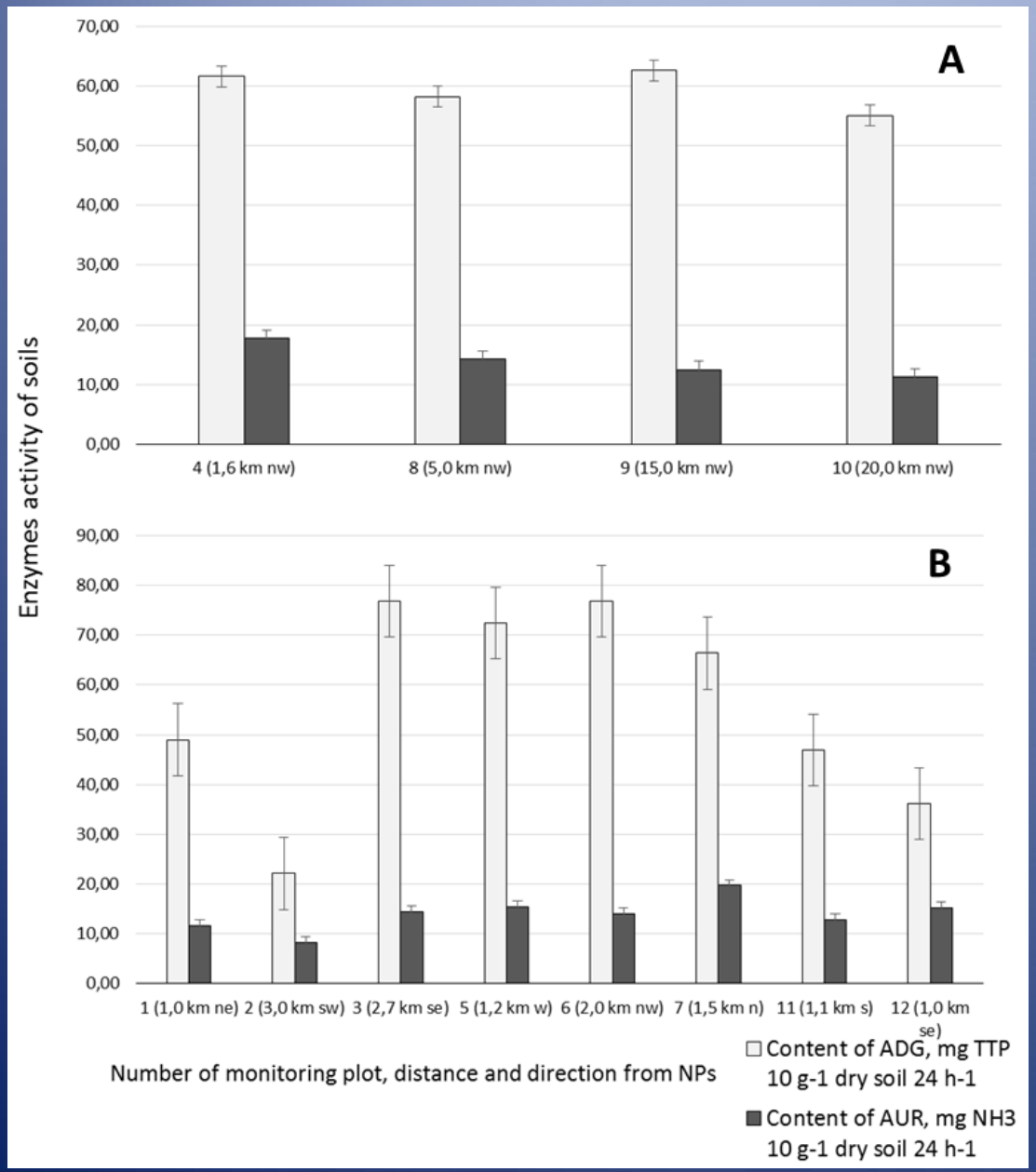
Priority PAHs composition in NEPS zone



Dynamics of PAHs accumulation in emission zone

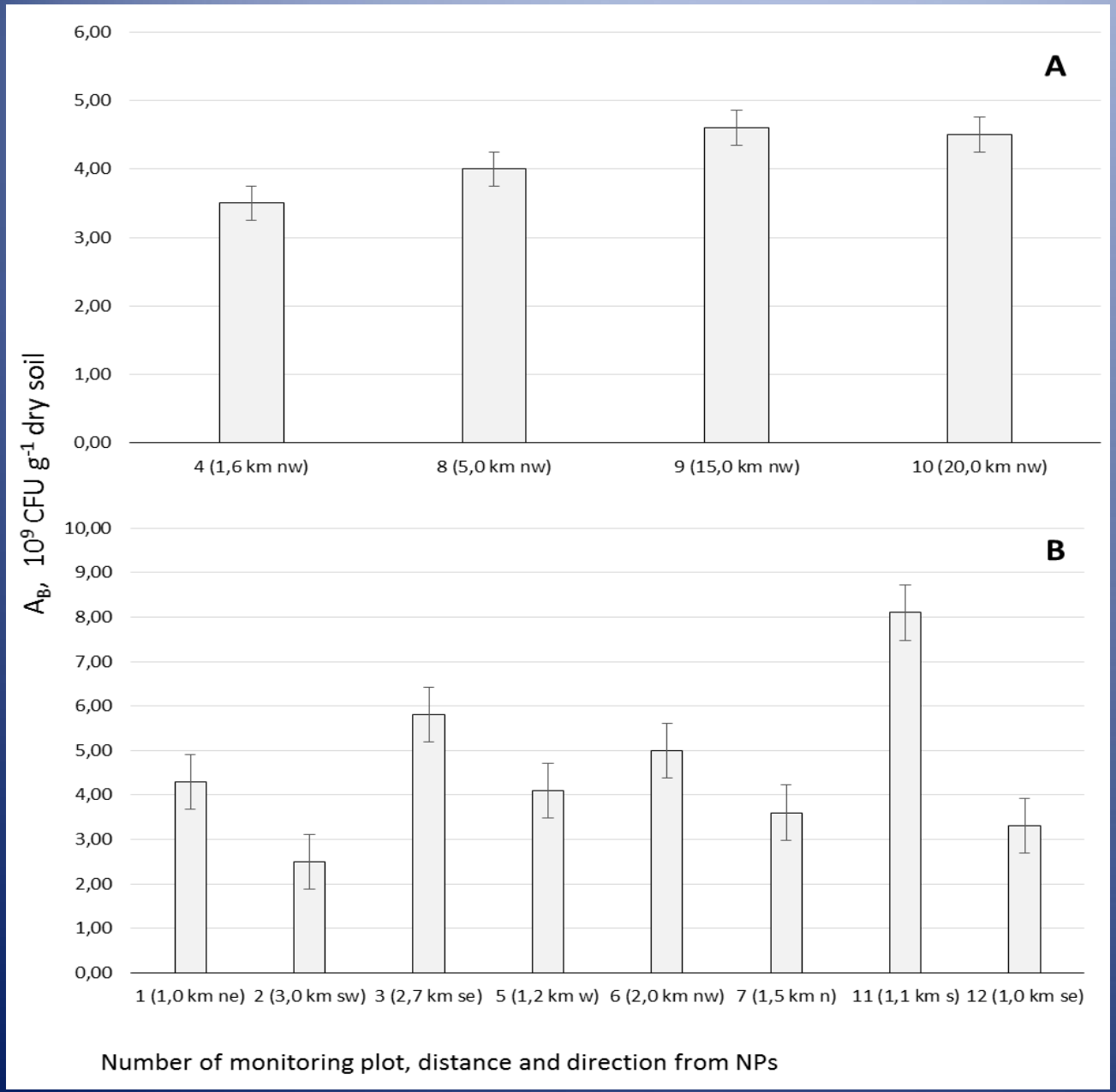


Enzymes activity of soils in the soil of monitoring plots (activity of dehydrogenases (ADG); activity of urease (AUR))



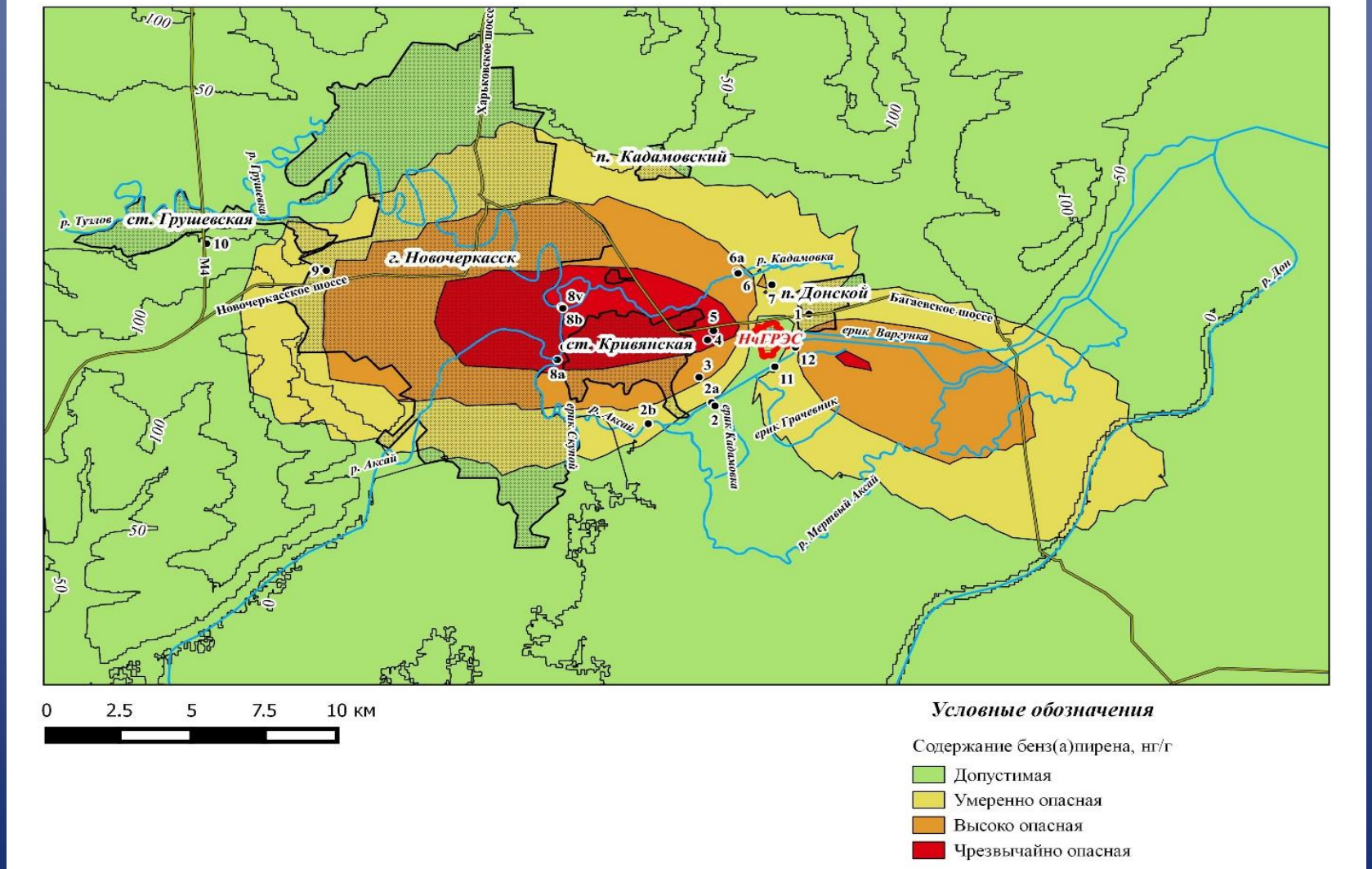
A. Situated though the prevailing wind direction from NPs;
B. situated around NPs

Abundance of soil bacteria (AB) of monitoring plots:



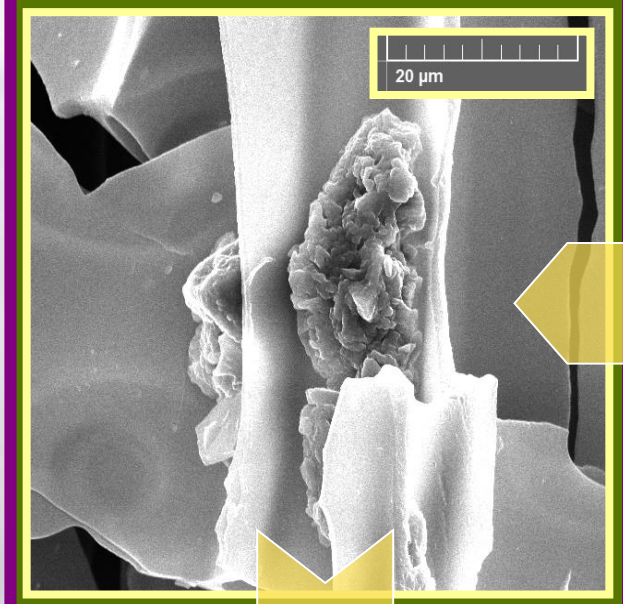
A. Situated though the prevailing wind direction from NPs,
B. situated around NPs

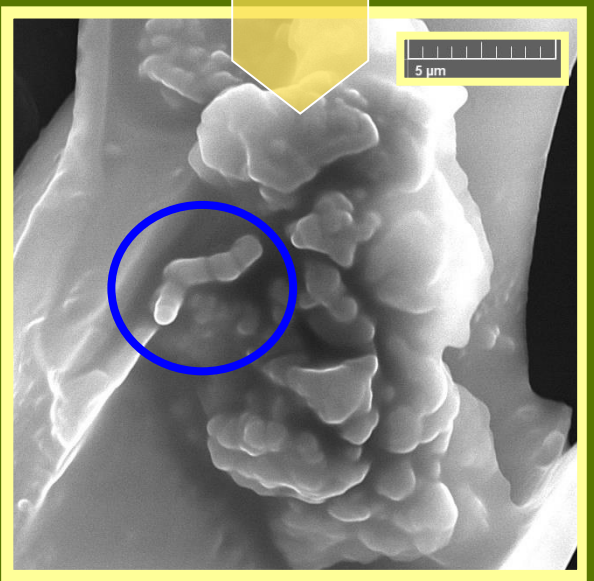
Categories of soil pollution by benzo[a]pyrene, 5-cm soil layer, 2016

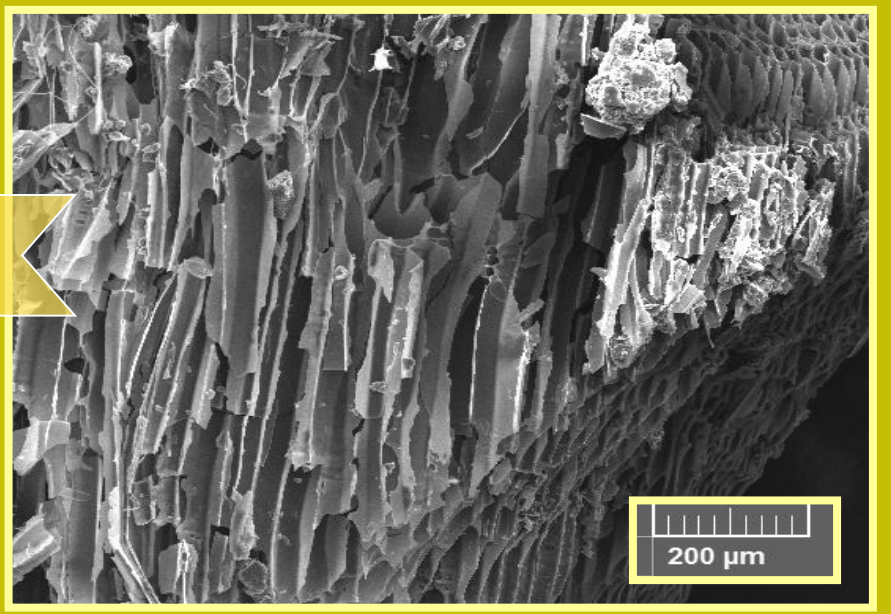


* Sanitary and epidemiologic requirements to quality of the soil (Sanitary Regulations and Norms 2.1.7.1287-03, 2003)

Biochar

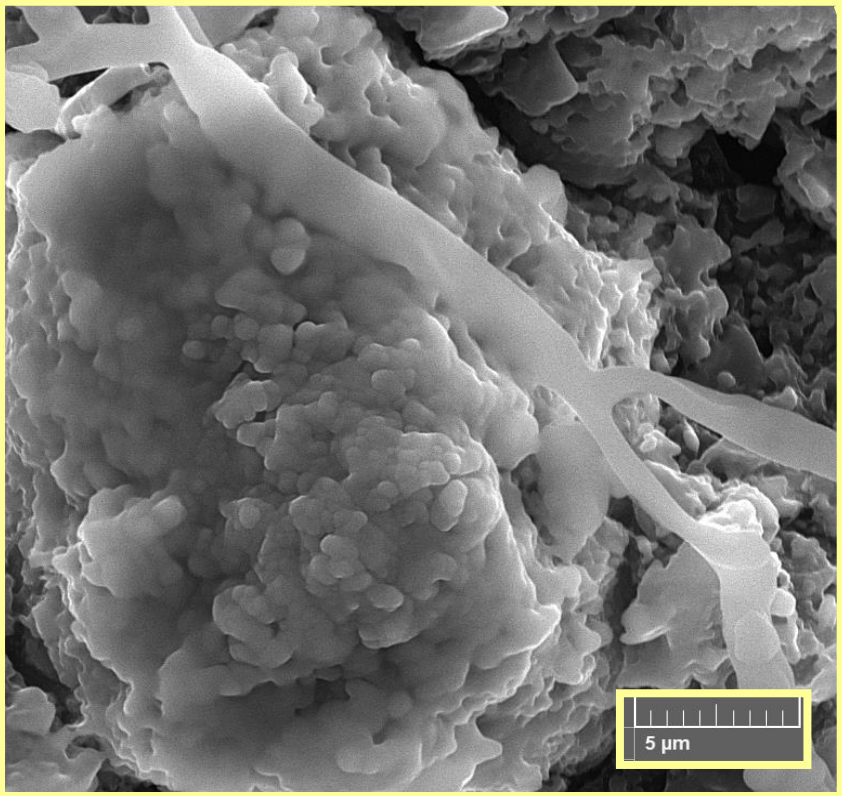




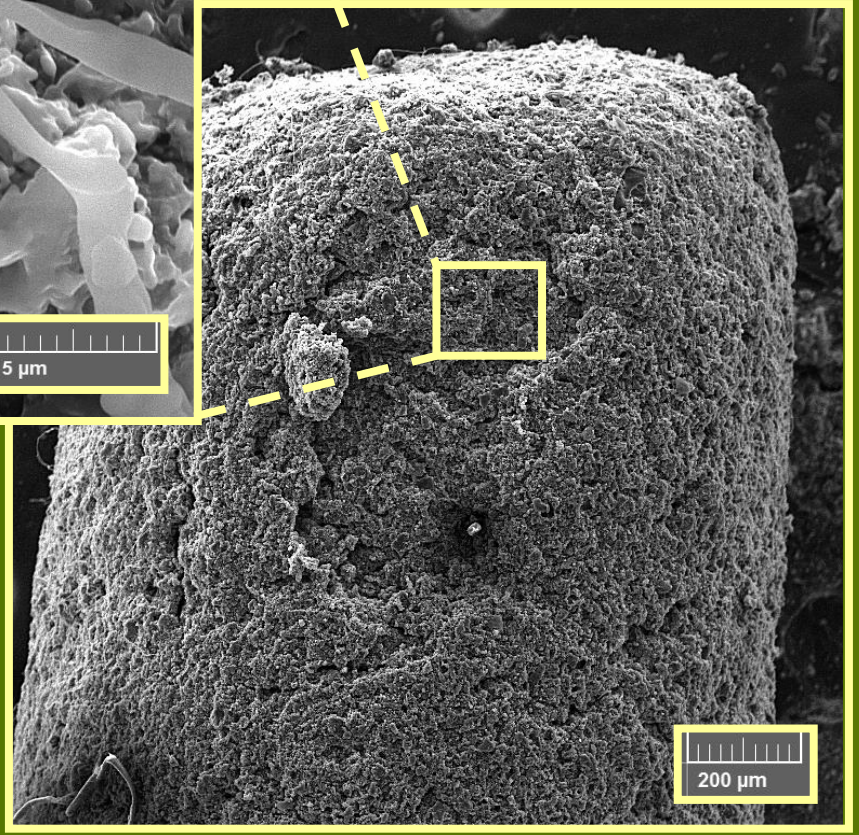


Biochar is the carbon produced by pyrolysis process with shortcoming oxygen

Activated carbon



One of the carbon forms, producing from different carbon materials

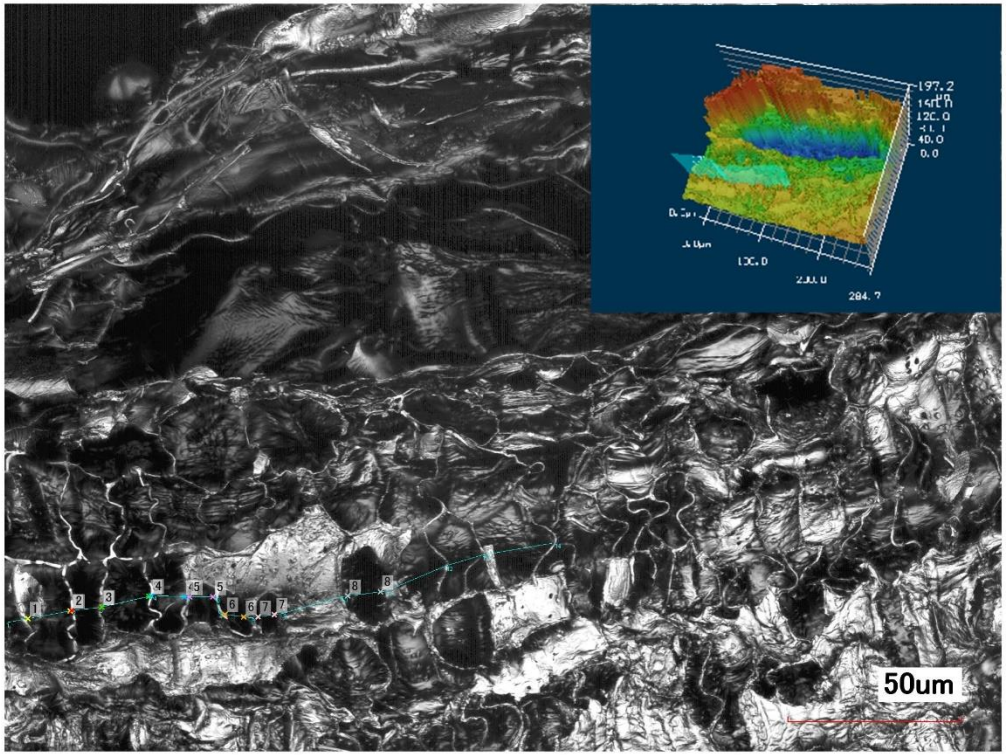


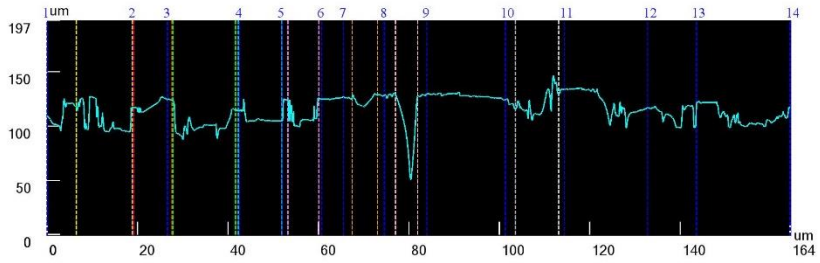
It has a lot of porous and high sorbtion capacity

Research of optimum conditions for biochar production

Pyrolysis temperature – 300-900°C with step 100°C
Pyrolysis time 15-90 min step 15 min

›20 millions tons of sunflower husks every year in Rostov Region

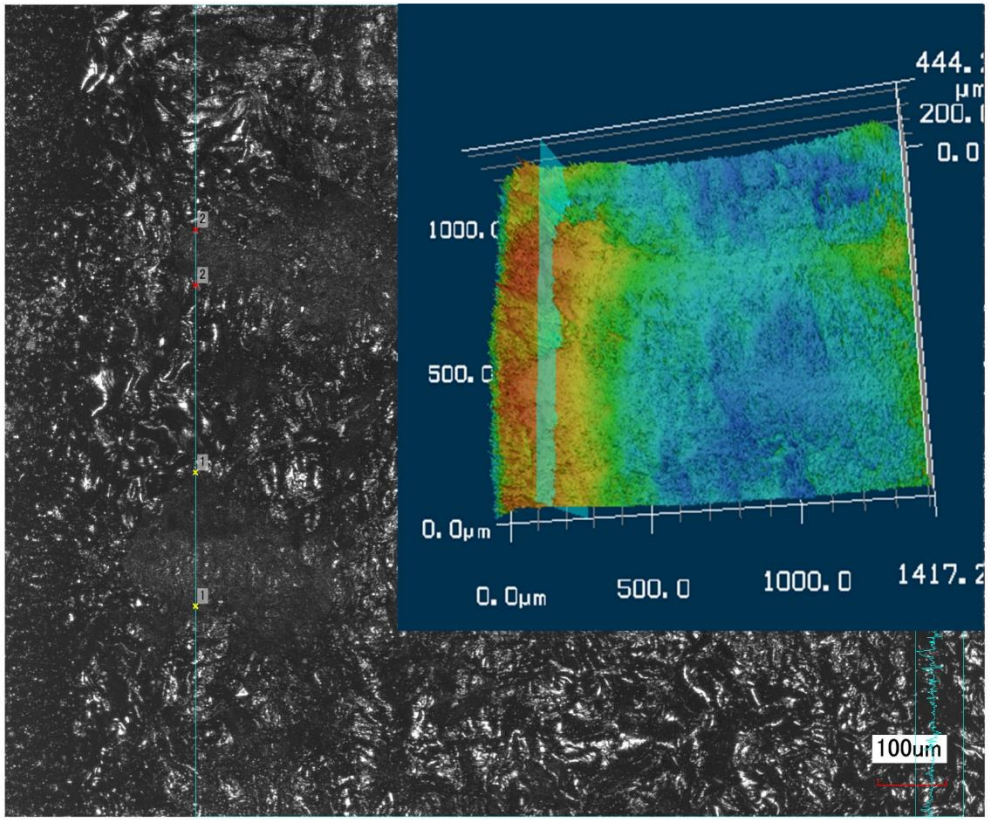


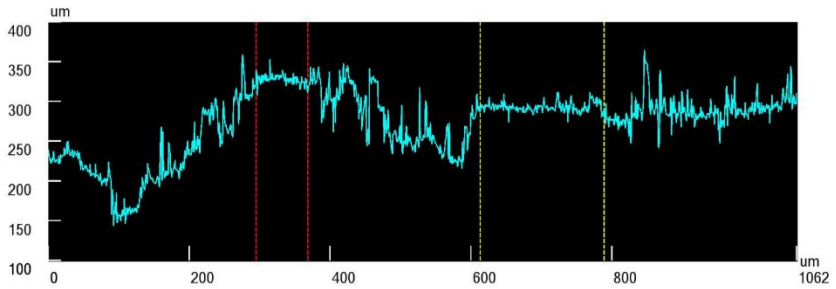


Profile1	Horz. dist.	Hght. diff.	Hght. ave.	Angle	C.S. length	C.S. area
All	164um	7um	115um	2°	1623um	18861um2
Seg.1	12um	1um	106um	4°	229um	1324um2
Seg.2	8um	6um	119um	37°	44um	1029um2
Seg.3	14um	9um	101um	32°	144um	1413um2
Seg.4	10um	9um	107um	44°	53um	1040um2
Seg.5	7um	2um	107um	16°	173um	747um2
Seg.6	6um	4um	123um	33°	30um	701um2
Seg.7	5um	5um	98um	44°	154um	489um2
Seg.8	10um	14um	120um	56°	171um	1166um2

Pyrolysis temperature 700-900°C

decreasing the porous size





Profile1	Horz. dist.	Hght. diff.	Hght. ave.	Angle	C.S. length	C.S. area
All	1062um	71um	274um	4°	10794um	291115um2
Seg.1	175um	3um	293um	1°	1093um	51684um2
Seg.2	73um	9um	328um	7°	555um	24261um2


Thank you for attention
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