Saint-Petersburg
State University

# Assessment of environmental risks in Urban Ecosystems of Russian Arctic in a Changing CLimate

*Evgeny Abakumov*
*E_abakumov@mail.ru, Ivan Alekssev*

# Creation of development zones in the Arctic accodring to Federal programm “development of the Arctic zone of the Russian Federation and the national security up to 2020”


- 1 – Kola, 2 –Arkhangelsk, 3 – Nenets, 4 – Vorkuta, 5 Yamal, 6-Taymyr, 7 – North-Yakutks, 8 - Chukotka

# Key Factors, Limiting the Arctic Zone Development

- *a) extreme climatic conditions, including low temperatures, strong winds and the presence of ice in the waters of the Arctic seas;*
- *b) the localized nature of industrial and economic development of the areas and low population density;*
- *c) the distance from the main industrial centers, high resource use and associated economic activities and livelihoods on supplies from other regions of Russia of fuel, food and essential commodities;*
- *d) low stability of ecological systems, defining the biological balance and climate, and their dependence even from minor anthropogenic influences*

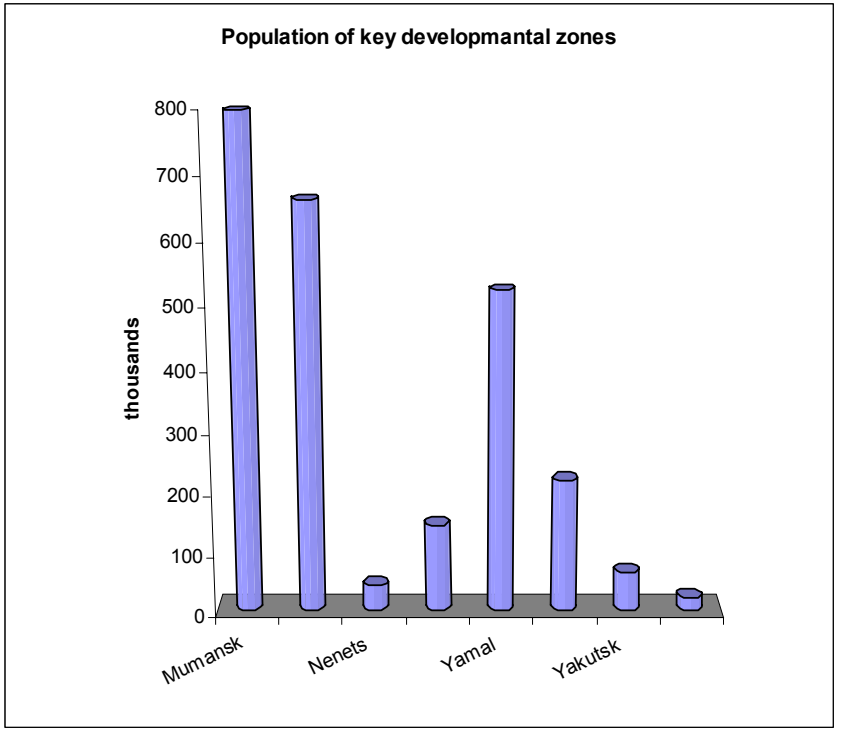
# Main Risks of Arctic Zone

- *critical state of the housing and communal services, inadequate supply of clean drinking water*
- *negative demographic trends in most of the Arctic regions of the Russian Federation, the outflow of labor (especially skilled) in the southern regions of Russia and abroad*
- *high energy consumption and low efficiency of extraction of natural resources, the costs of production in the northern no effective compensatory mechanisms, low productivity*
- *in the sphere of nature and the environment stands increase technological and human impact on the environment with increased probability of reaching its limits in some areas adjacent to the Russian*
- *certain regions of the Arctic zone of the Russian Federation particularly characterized by the presence of adverse areas, potential sources of contamination, high levels of accumulated environmental damage*

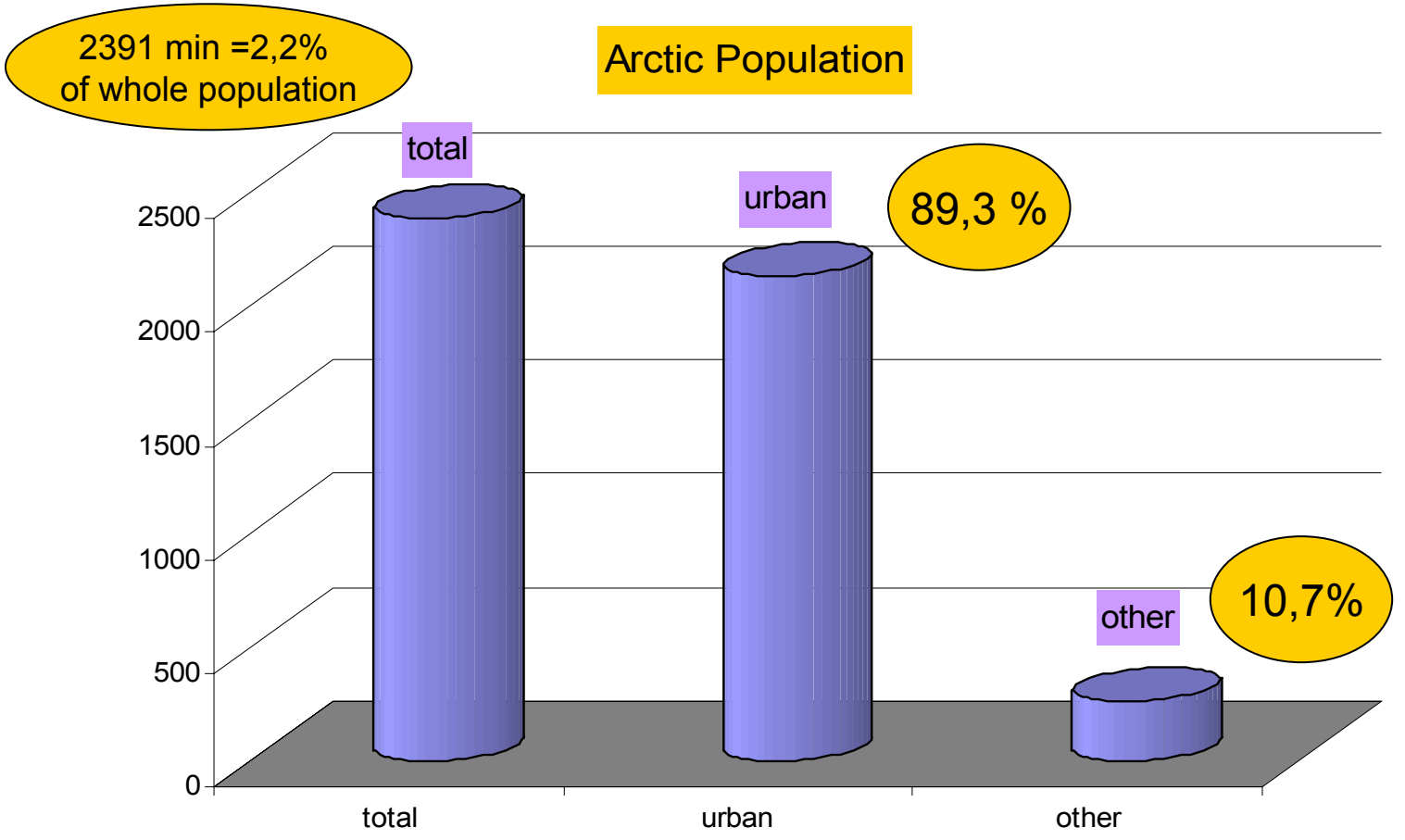
# Population of Russian Arctic

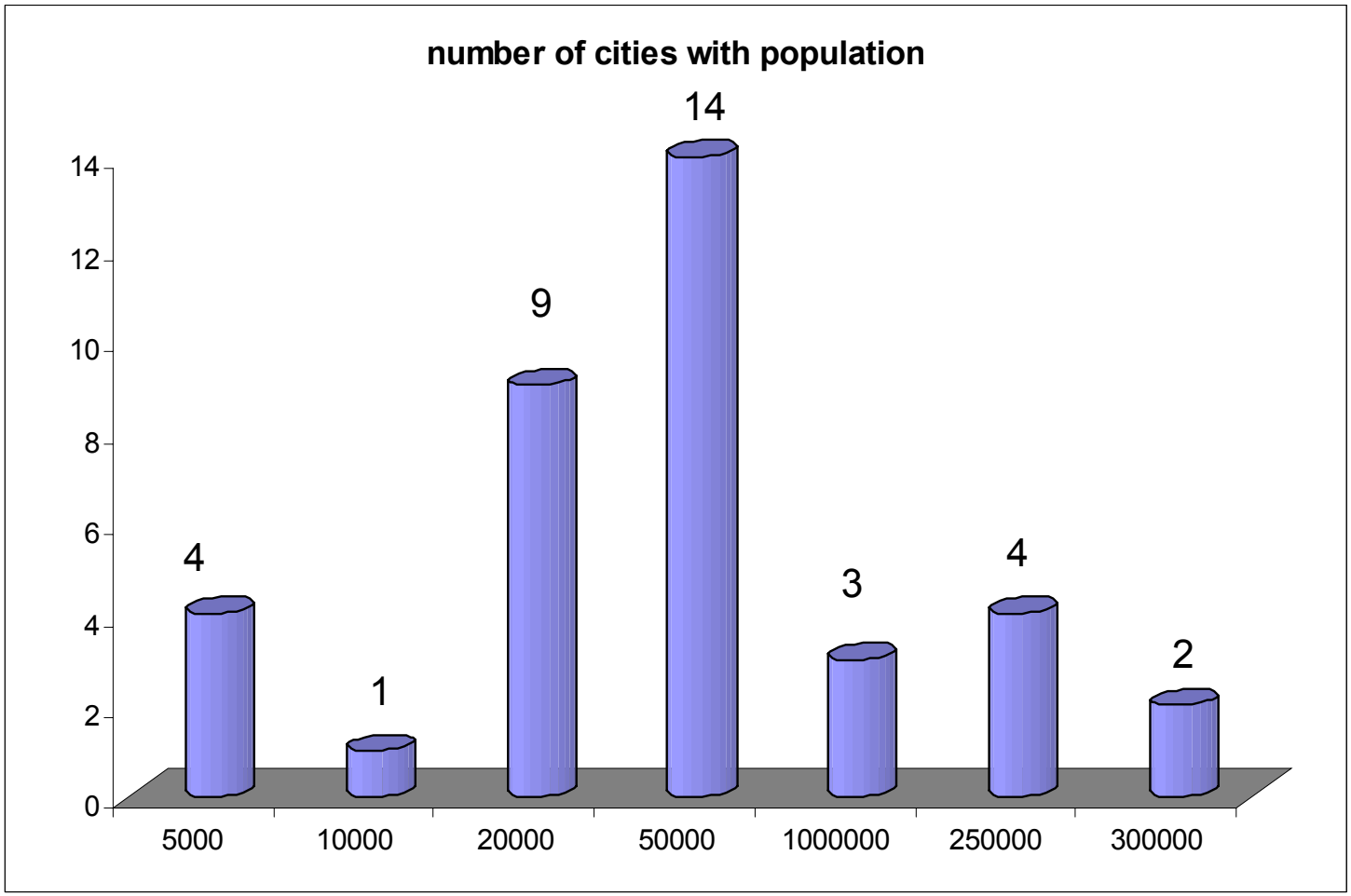
| Developmental zone | Population, thousands people |
|---|---|
| Murmansk | 796 |
| Arkhangelsk | 661 |
| Nenets | 42 |
| Vorkuta | 143 |
| Yamal | 522 |
| Taymyr | 217 |
| Yakutsk | 65 |
| Chukotka | 52 |
| Total | 2498 (involved in to economic activity - 1300) |

European part –Siberia - Chukotka



# Population of Russian Arctic




number of cities with population
14
12
10
8
6
4
2
0
4
1
9
14
3
4
2
5000
10000
20000
50000
1000000
250000
300000

# Introduction

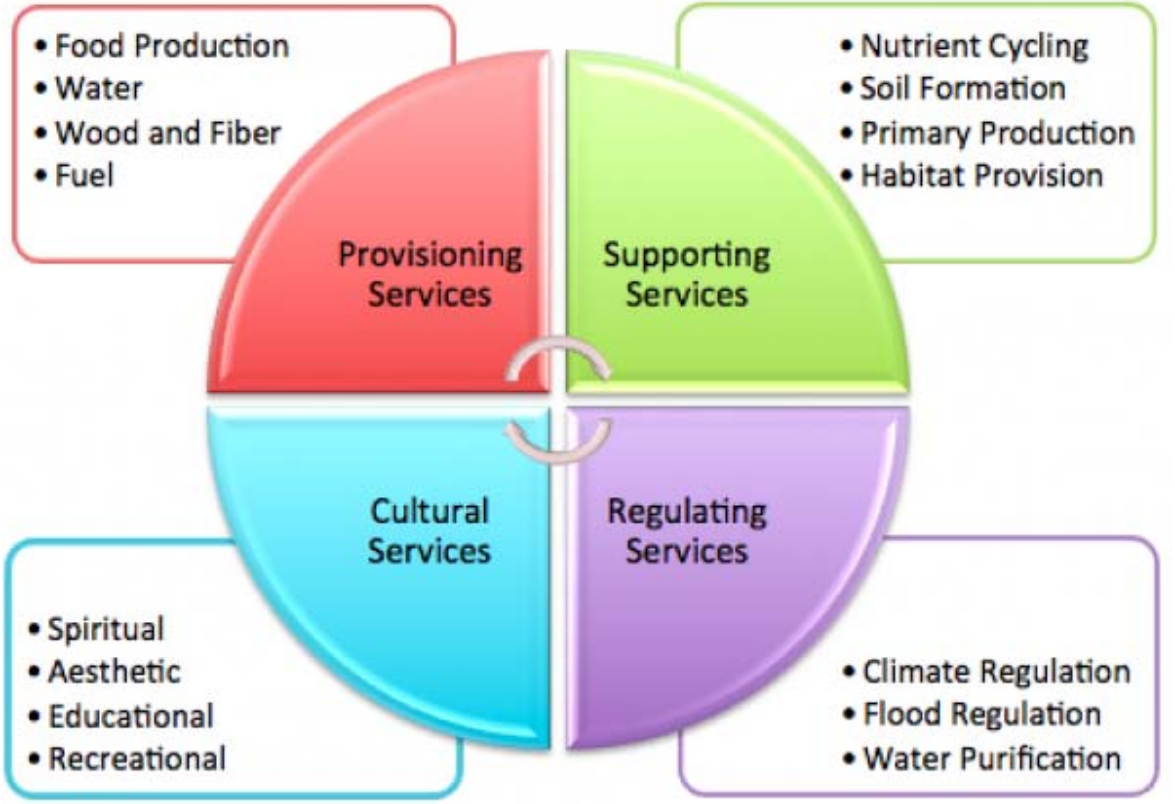
The idea of ‘ecosystem services’ developed from the long-standing recognition that humans depend on the natural world directly and indirectly.

The term is an effort to identify and measure “the benefits that people receive from nature” (Cambridge Conservation Initiative and BirdLife International 2011)

# Ecosystem Services Definition

The benefits people obtain from *ecosystems*. These include *provisioning services* such as food and water; *regulating services* such as flood and disease control; *cultural services* such as spiritual, recreational, and cultural benefits; and *supporting services* such as nutrient cycling that maintain the conditions for life on Earth.

# General Classification of Ecosystem Services




Source: Millenium Ecosystem Assessment, 2005.

# Ecosystem Services Classification

- **Provisioning services** are: The products obtained from ecosystems, including, for example, genetic resources, food and fiber, and fresh water.

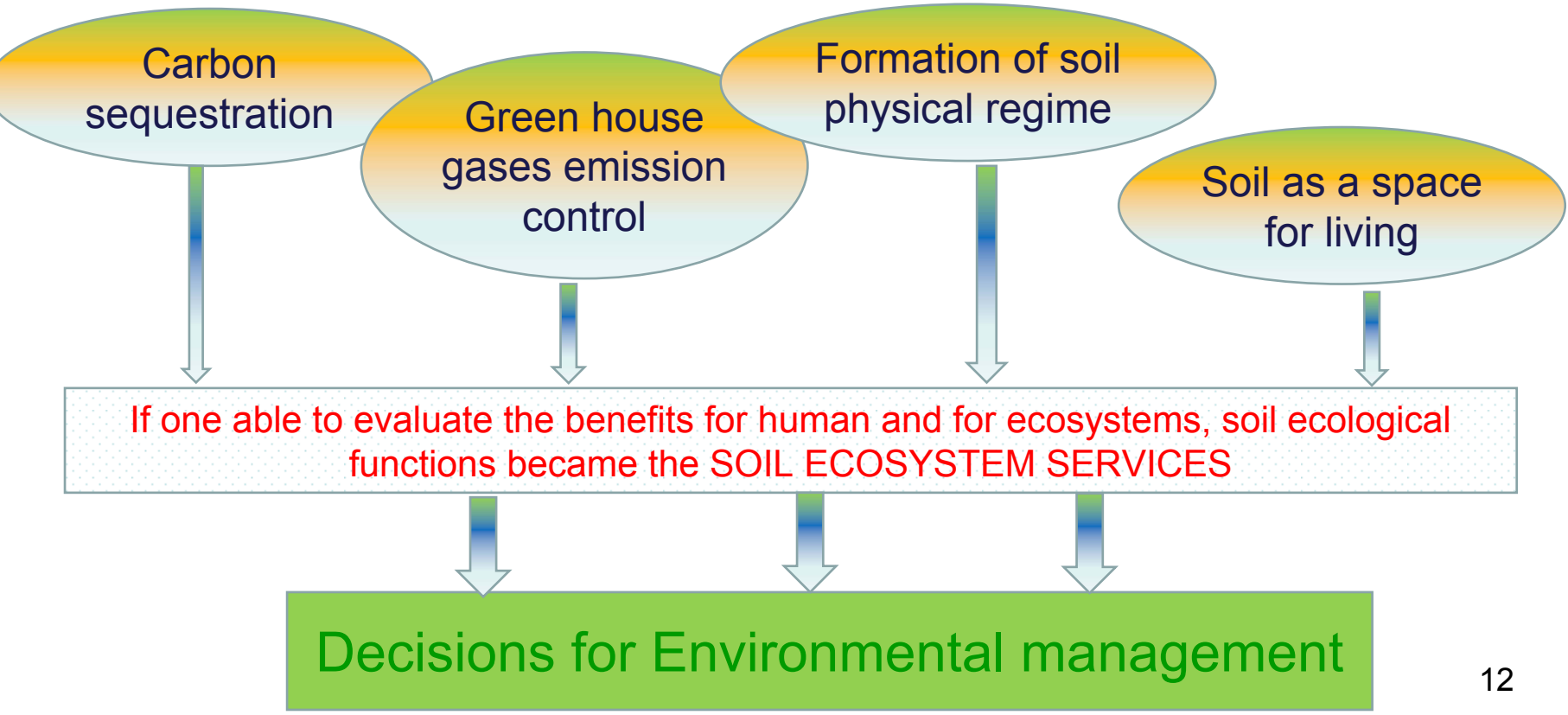
- **Regulating services** are: The benefits obtained from the regulation of ecosystem processes, including, for example, the regulation of climate, water, and some human diseases.

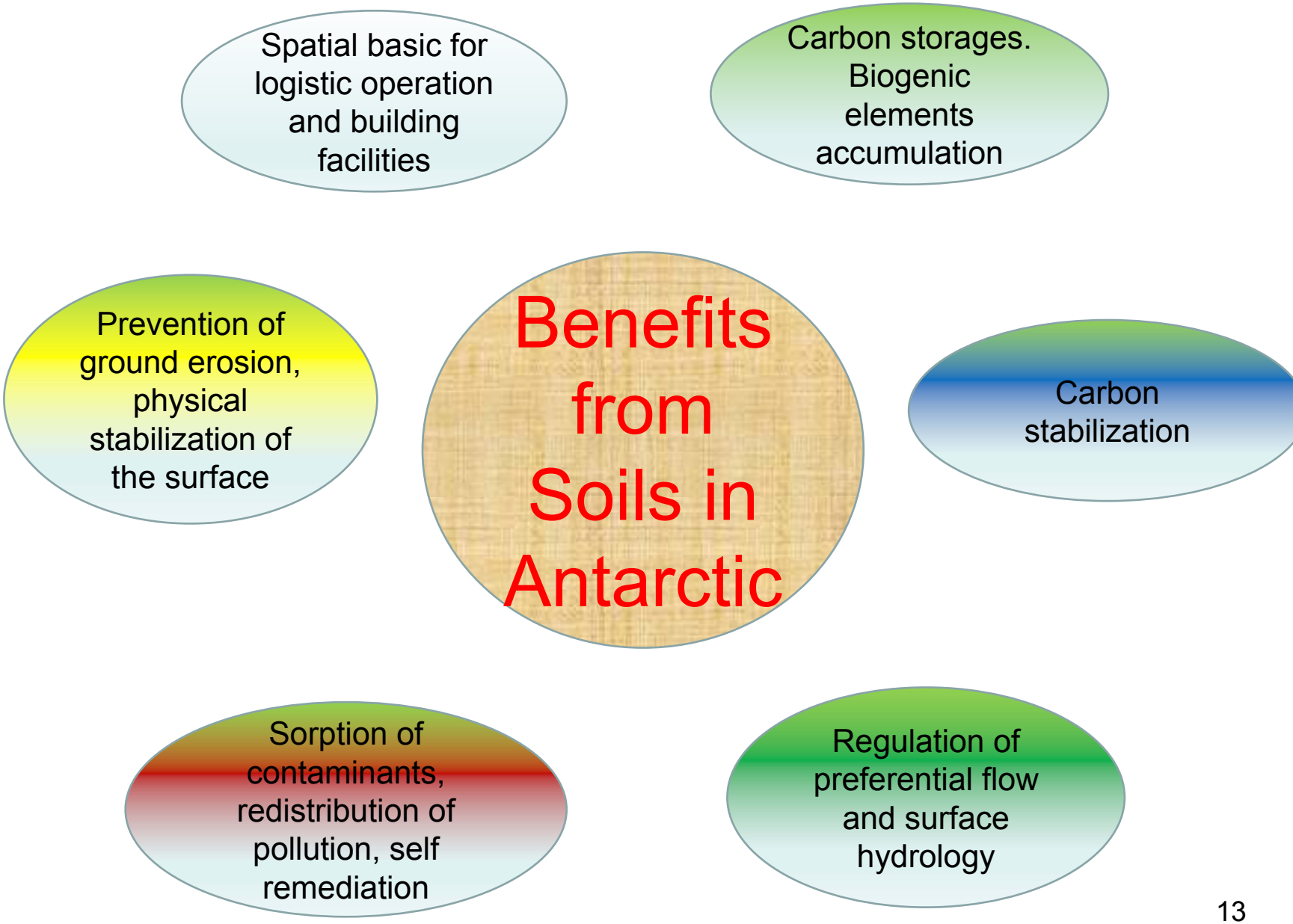
- **Cultural services** are: The non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experience, including, e.g., knowledge systems, social relations, and aesthetic values.

- **Supporting services** are: Ecosystem services that are necessary for the production of all other ecosystem services. Some examples include biomass production, production of atmospheric oxygen, soil formation and retention, nutrient cycling, water cycling, and provisioning of habitat.

# Soil Ecology vs Ecosystem Services

Soil Ecology is part of soil science which characterizes the Soil Ecological functions, e.g.:




Spatial basic for logistic operation and building facilities
Carbon storages. Biogenic elements accumulation
Prevention of ground erosion, physical stabilization of the surface
Benefits from Soils in Antarctic
Carbon stabilization
Sorption of contaminants, redistribution of pollution, self remediation
Regulation of preferential flow and surface hydrology

# Examples of ecosystem services.

**Redistribution of the pollutants in soil profile due to cryoturbation**

# Permafrost

- Definition: Soil, sediments or rocks with temperatures continuously below 0 °C for more than 2 years.
- Extent over 24 % of northern hemisphere land surface.
- Depth up to 1500 m in Siberia.
- Carbon storage of 1300 ± 200 Gt C in soils and deeper sediments of permafrost regions (Hugelius et al. 2014).

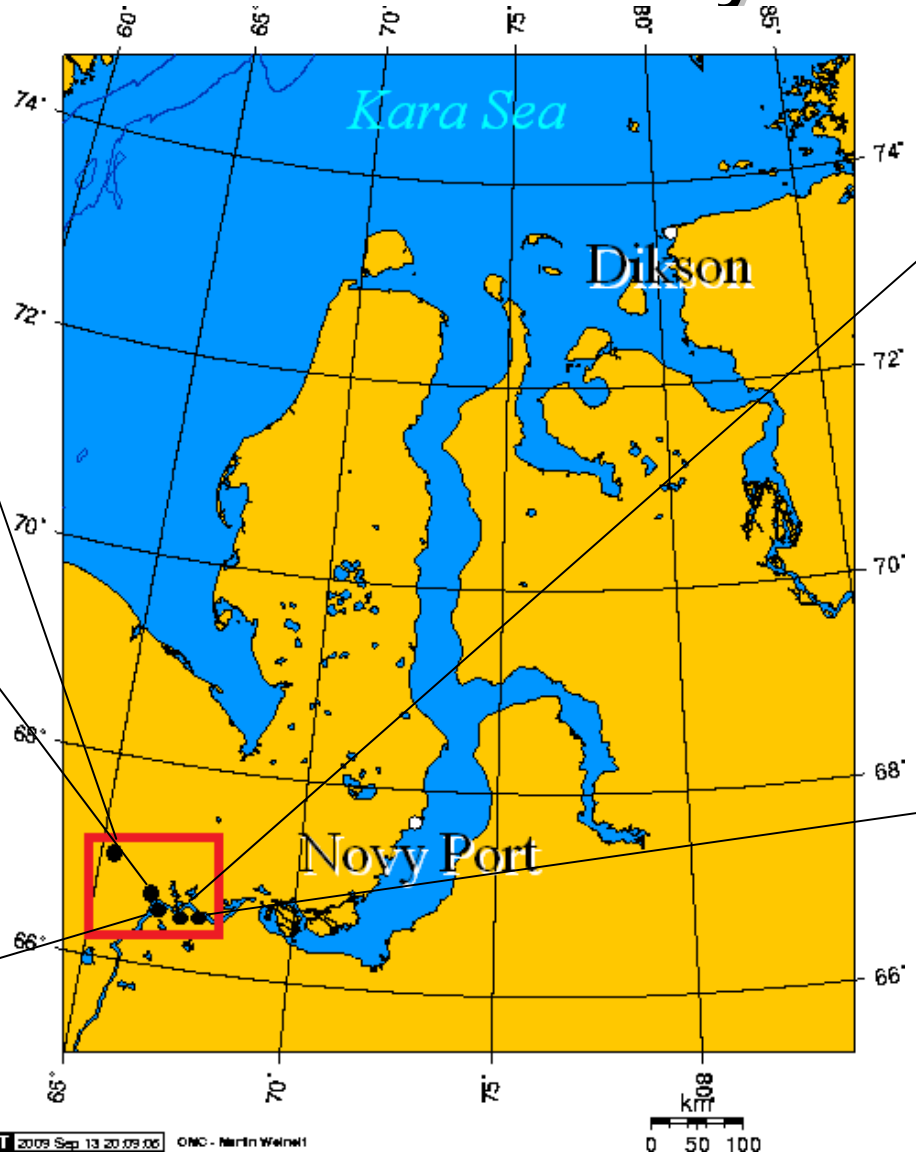

Brown et al. (199

# Area of study

**Kharp**

**Labytnangi**

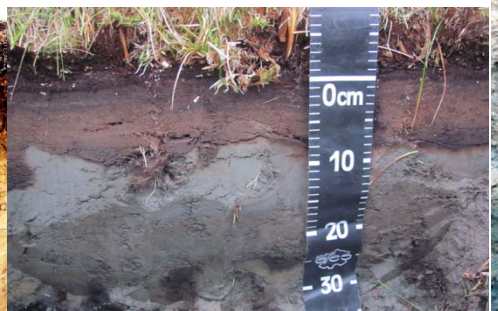
**Salekhard**

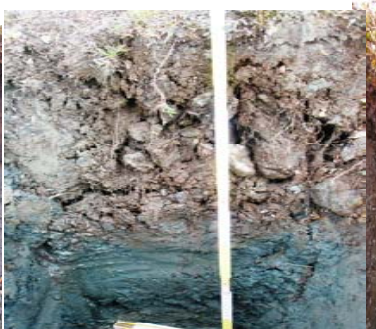


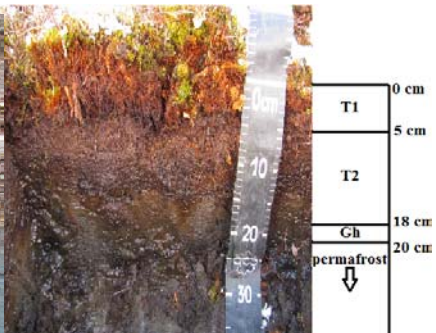

**Harsaim**

**Aksarka**

# Salekhard – city on thawing permafrost





# Cities and settlements of Yamal


***Карта района исследования***

***Salekhard city – capital of Yamal autonomous region***

***Population – 48 31***
***(2015)***

Labytnangi – the northern most city, connected With main Russian by railway

***Population – 26 549 (2015)***

***Harsaim – settlement on the coast of the Ob river***

***Population – 575 (2010)***

***Aksarka – settlement, administrative center of Pryuralskiy municipality***

***Population - 3133 (2010)***

***Harp town – city of Jail houses***

***Population – 6141 (2015)****

**** - without taking into account the population of prisons***

# Cryoturbation

***Cryoturbation (frost churning)*** is the mixing of the soil matrix within the pedon due to influence of freezing-thawing processes.


## Soil features:

- irregular or broken horizons;
- involutions;
- accumulation of organic matter on the permafrost table;
- oriented rock fragments;
- silt caps on rock fragments

**Heterogeneity of soil profile and profile distribution of soil properties**

# Urban Soil diversity

**Podzol (Salekhard)**

**Entic podzols (Salekhard)**

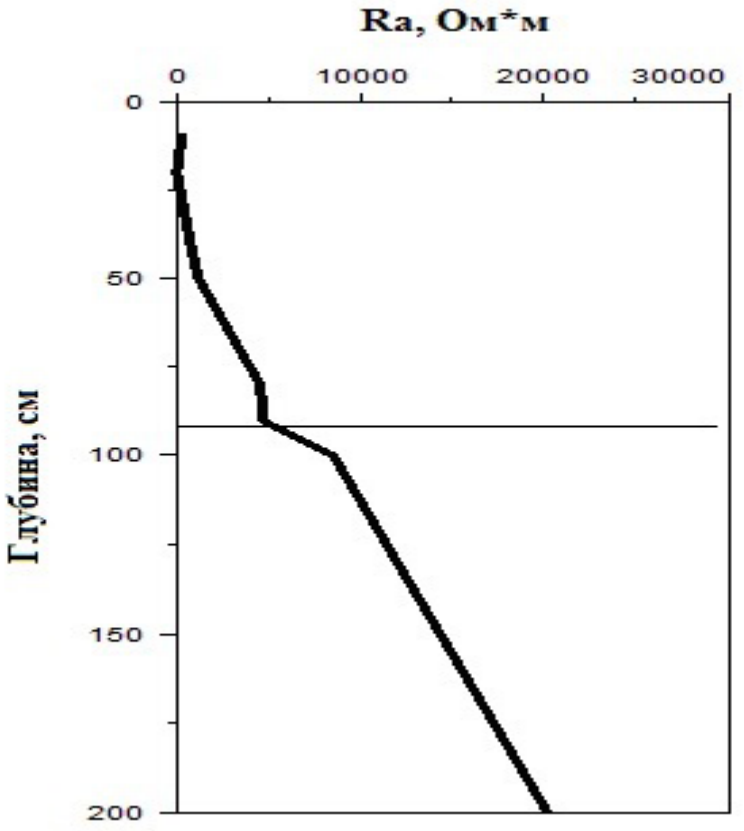
**Gleysols with manifestation of cryoturbation (Aksarka settlement)**

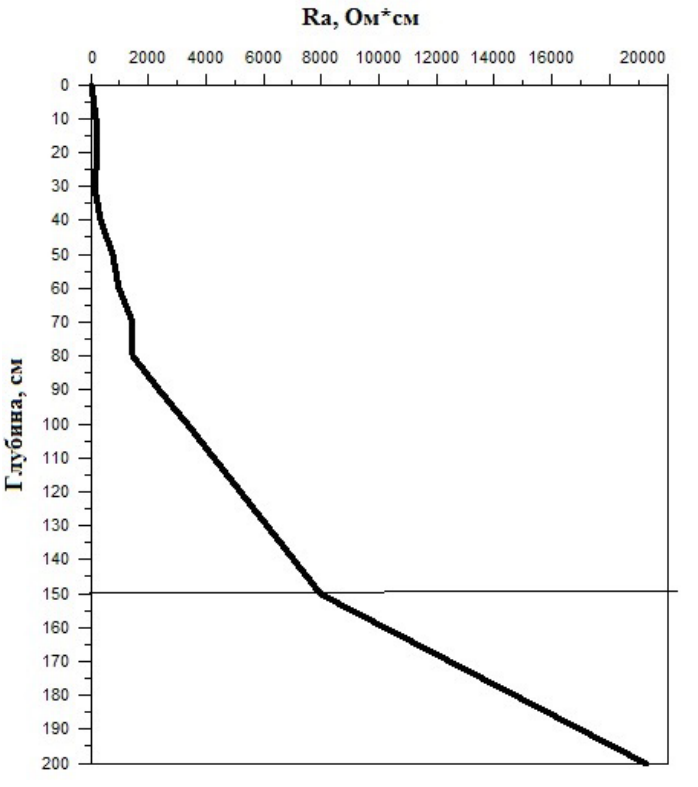
**Agrosoil (Salekhard)**

# Urban Soil diversity: agrosoils

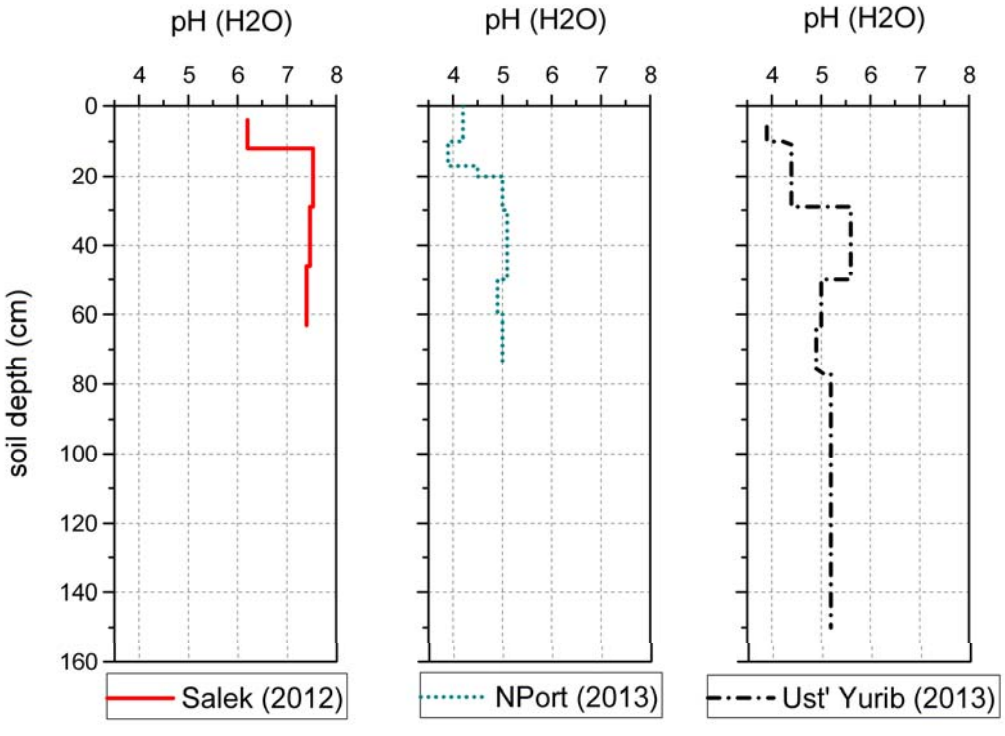
# Permafrost affected soil of South Siberia: Cryic Chestnut soils (left) and Cryic Chernozem (right)

# ANTROPOGENIC DYNAMICS OF PERMAFROST TABLE AND ACTIVE LAYER DEPTH: PRISITNE SOIL AND URBAN ONE



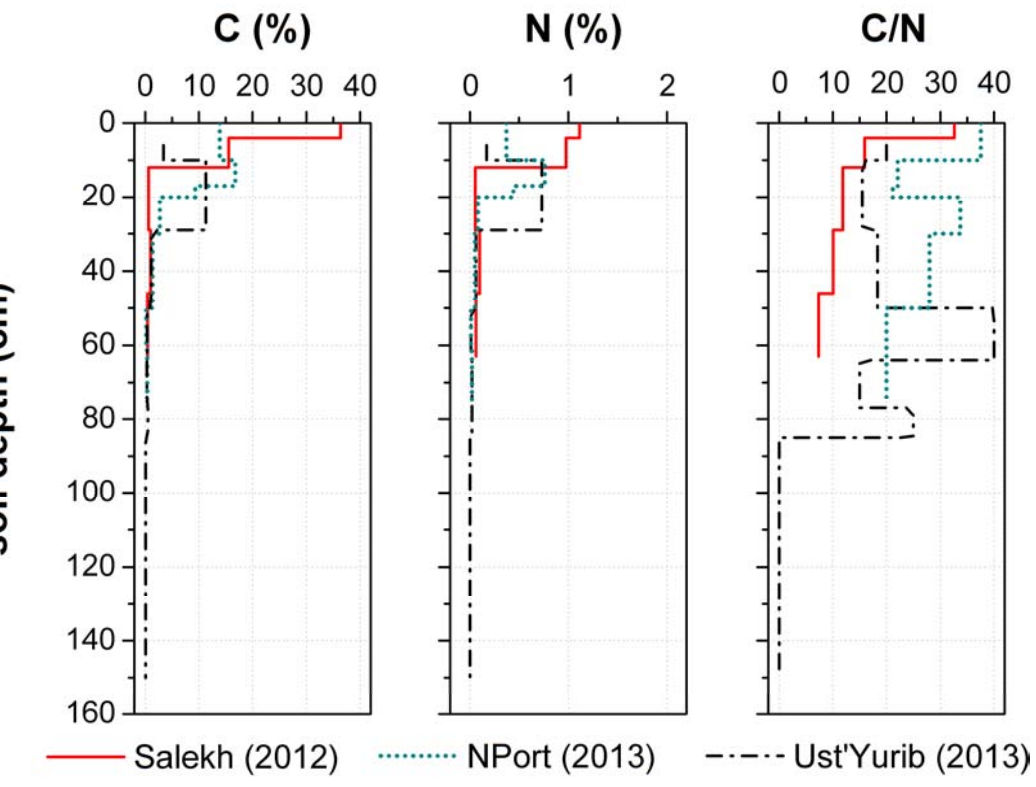
# Soil pH




**Main features:**

- Acid values in most soils;
- Profile distribution of the pH values is heterogeneous due to cryogenic processes;
- Topsoils are the most acid due to accumulation of the Histic material

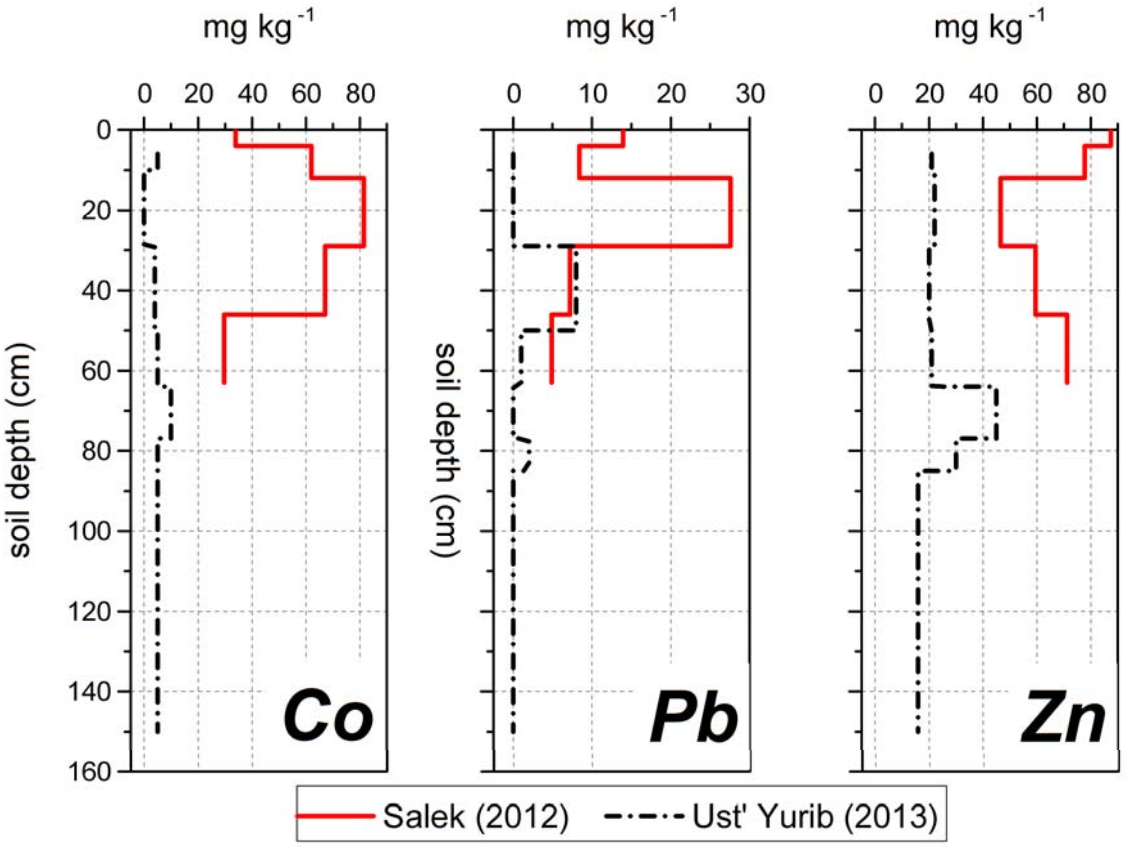
# SOC and C/N ratio



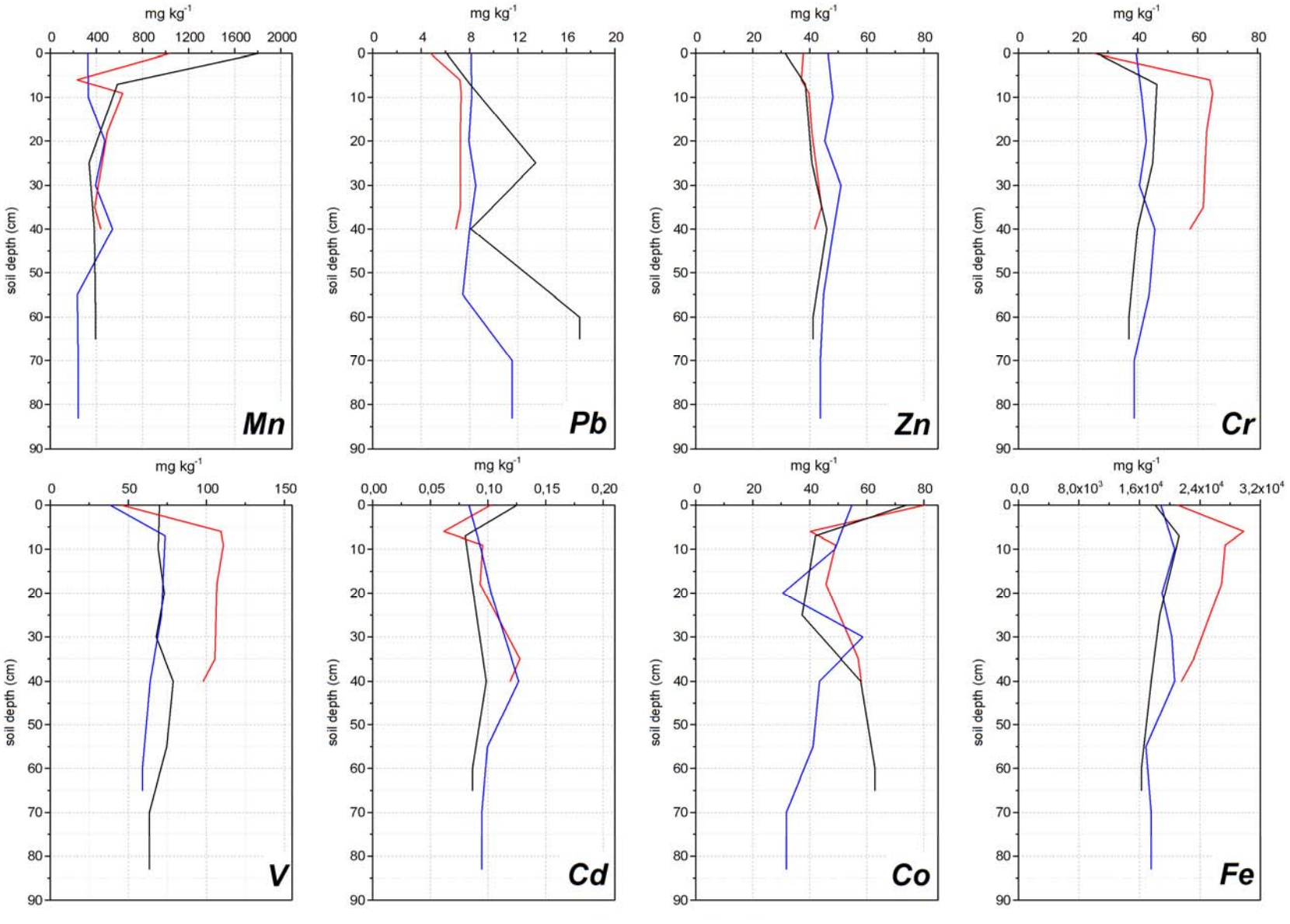

**Main features:**

- Organic matter is accumulated in topsoils
- Carbon content increases in north-south direction within the area
- High variabillity of C/N ratio in soils of Yamal peninsula due to more prominent cryogenic processes

# Heavy metals in Yamal soils: high heterogeneity in soil profile



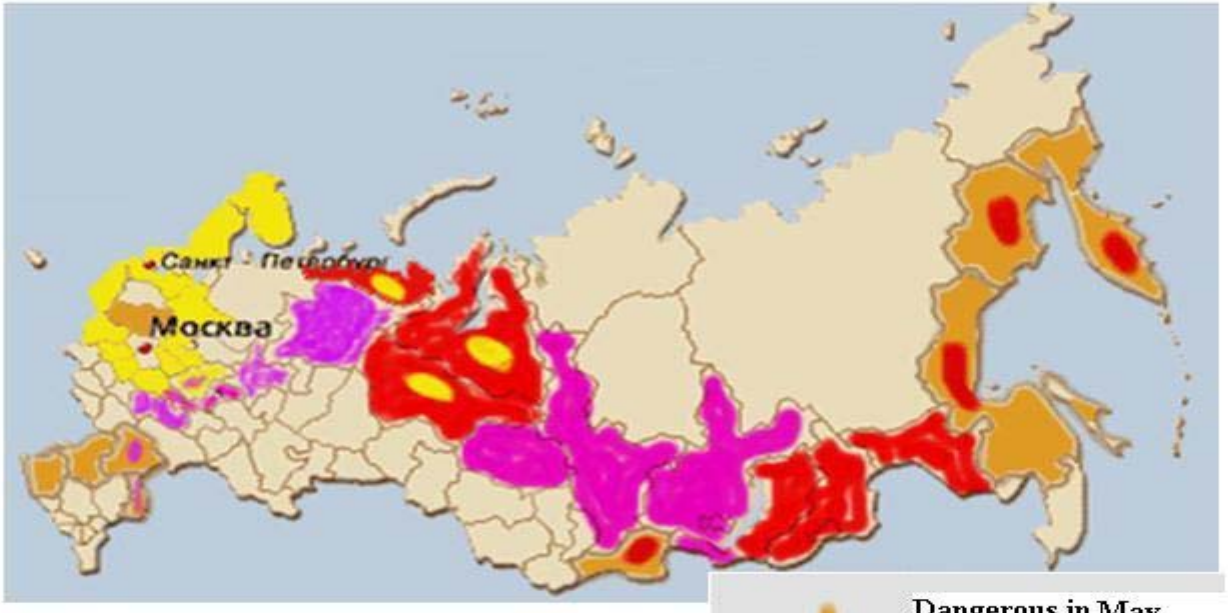

*(E. Abakumov et al. 2014)*


mg kg-1
soil depth (cm)
Mn
Pb
Zn
Cr
V
Cd
Co
Fe
Yenisei;
Guda Yuribei;
Yavai

# Case study 2: Termoabrasion

# COASTAL DEGRADATION AND TERMOABRASION

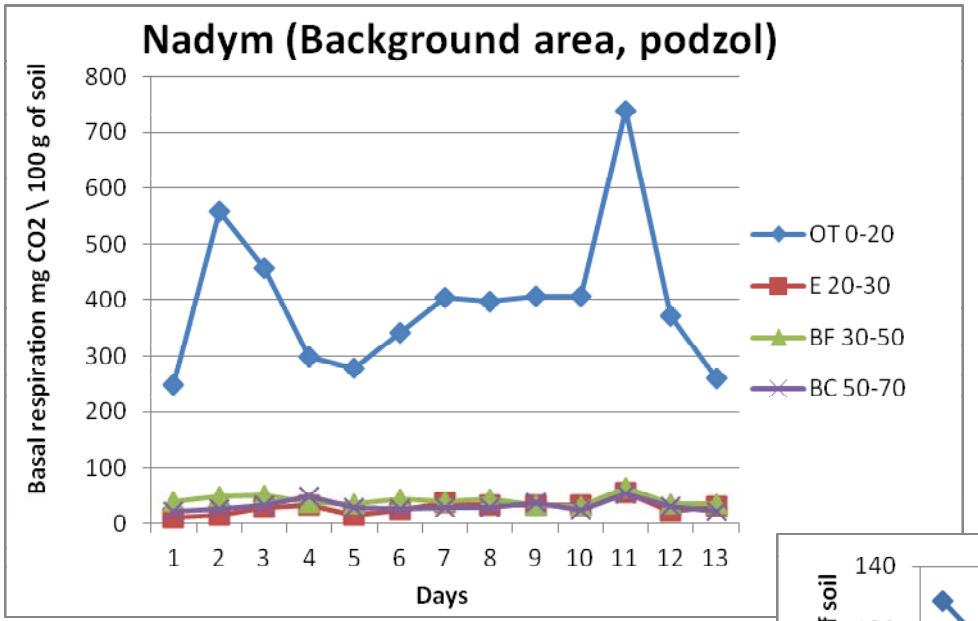
# Case study 3. Wild Fires

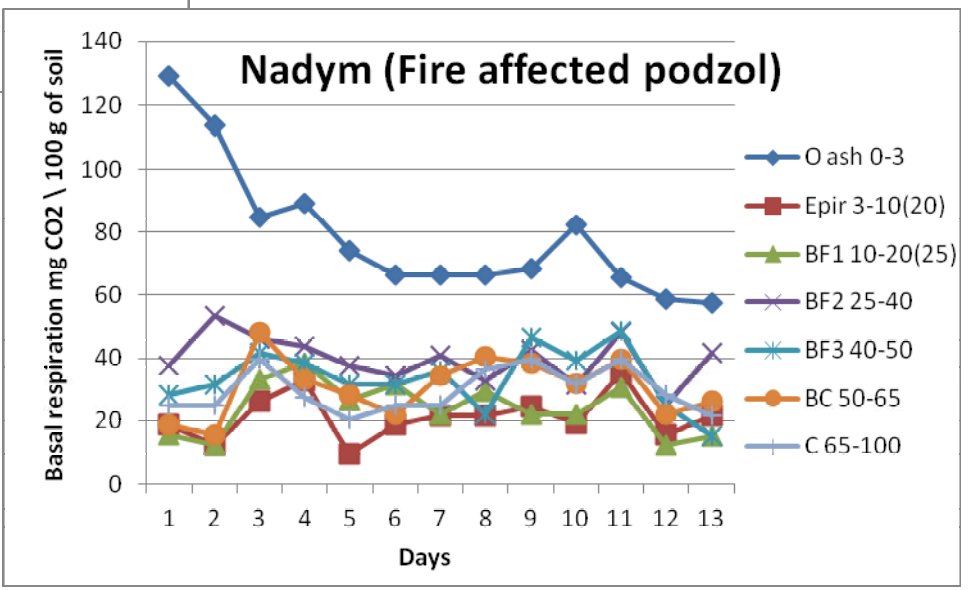



PROBABILIY OF WILF FIRES IN DIFFERENT MONTHES

# Pristine and Fire-Affected Soils

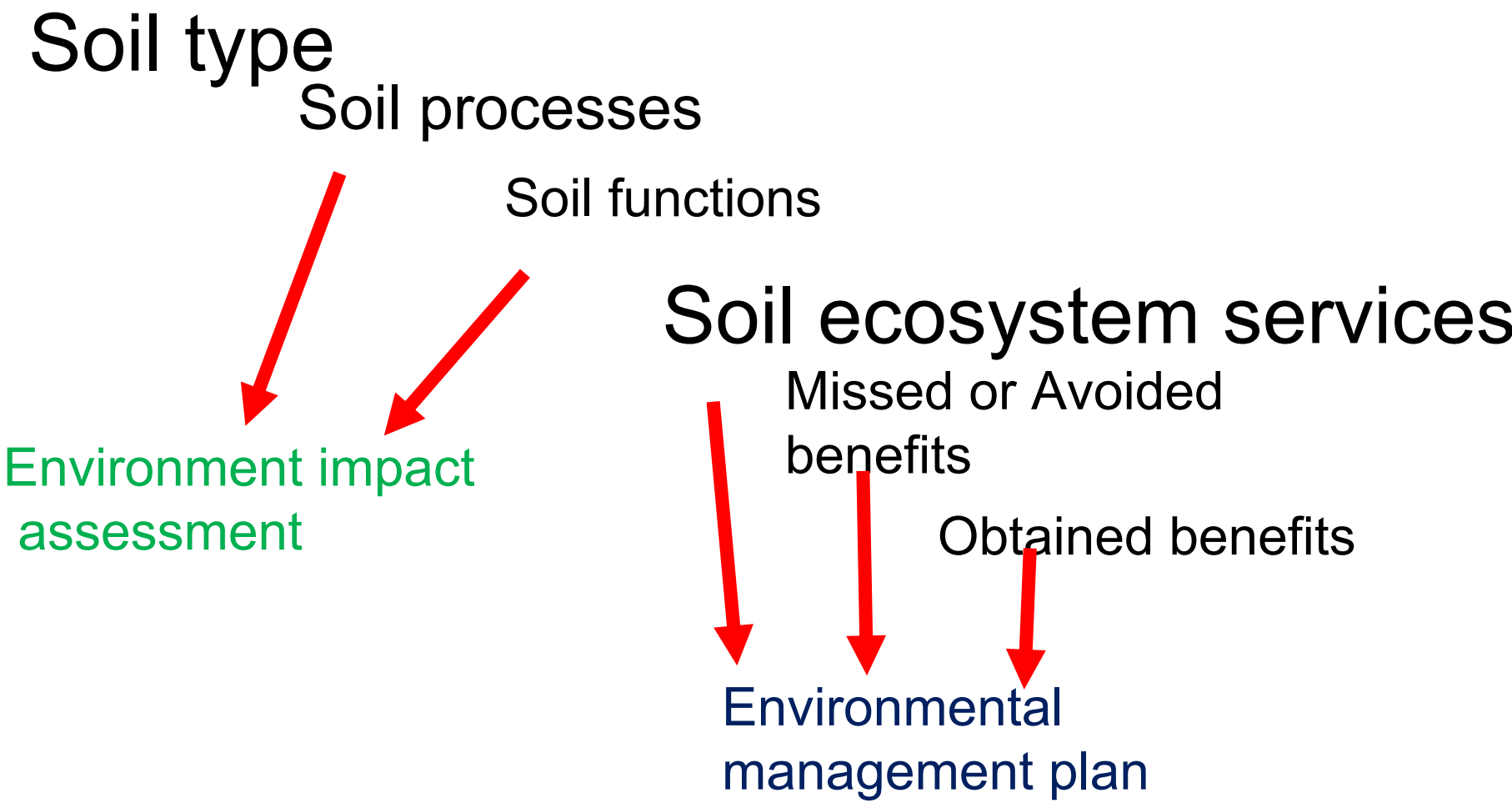

# Laboratory imitation of possible CO2 emission



- Polar soils play an essential role in redistribution of contaminants and their accumulation in middle Cryic and lower – Permafrost subllayed horizons. These results in “decreasing” of contamination rate in the Topsoil. This should be taken into account during environmental studies, because national regulation manage to sample soil material for HMs concentrations assessment only form layer 0f 0-20 cm depth.

# CONCLUSIONS: Ecosystem Services as new tool for Environmental Management



# CONCLUSIONS: Ecosystem Services as new tool for Environmental Management

-Classical pedological point of view can be enriched by paradigm of Ecosystem Services

-Assessment of ESs in isolated soil areas can be more effective than in discontinuous soil environments of Eurasia