Management of the environmental monitoring data: UNECE ICP Vegetation case

Alexander Uzhinskiy, Gennady Ososkov, Marina Frontsyeva

Joint Institute for Nuclear Research
auzhinskiy@jinr.ru

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Introduction

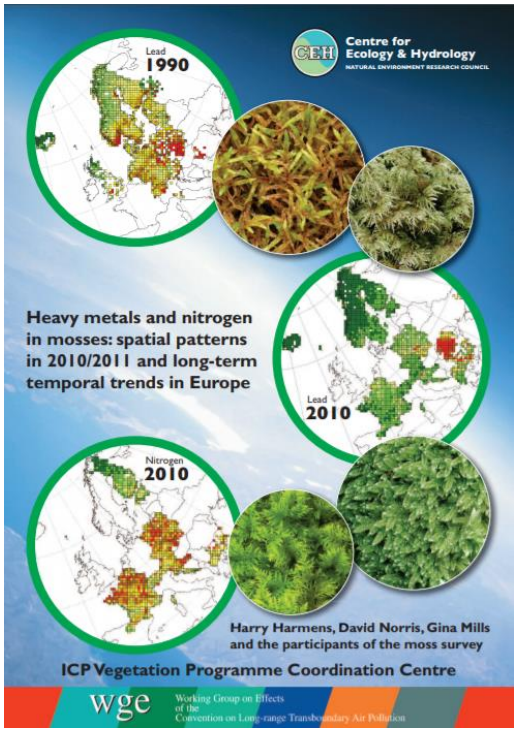
Air pollution has a significant **negative impact** on the various components of ecosystems, **human health,** and ultimately, cause significant **economic damage**.

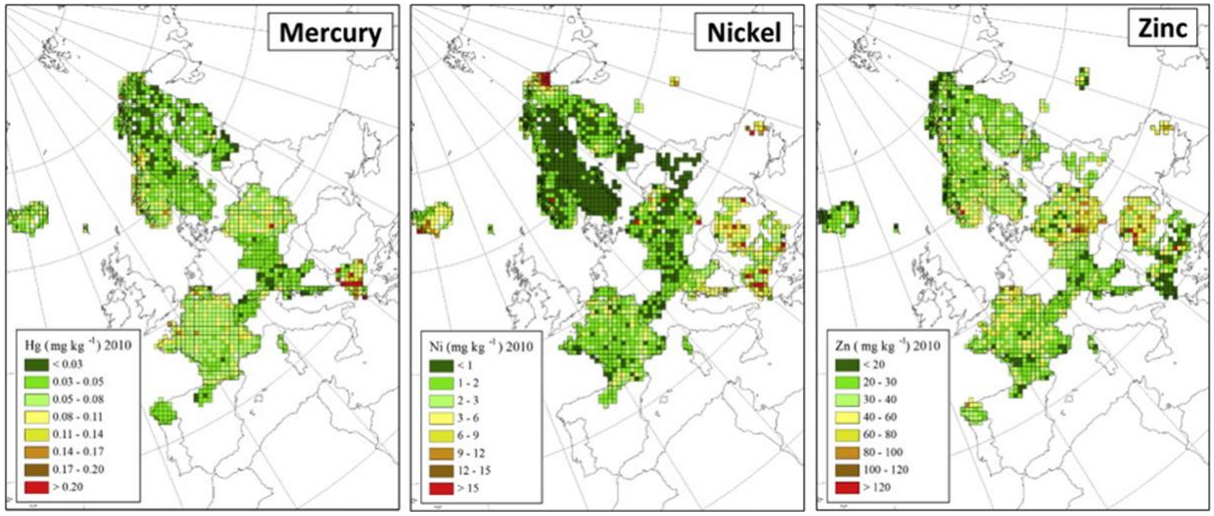
More than nine out of 10 of the world's population – 92% – lives in places where **air pollution exceeds safe limits,** according to research from the World Health Organization (WHO).

There are a lot of regional and international **environment control programs**. They use different techniques and tools but as a result, they all want to understand **what is the current situation** and how it will evolve.

ICP Vegetation

The aim of the **UNECE International Cooperative Program (ICP)** Vegetation in the framework of the United Nations Convention on Long-Range Transboundary Air Pollution is to **identify the main polluted areas of Europe,** produce regional maps and further develop the understanding of the long-range transboundary pollution. Atmospheric deposition study of heavy metals, nitrogen, persistent organic compounds (POPs) and radionuclides is based on the analysis of naturally growing mosses through moss surveys carried out **every 5 years**. The program is realized in **39 countries of Europe and Asia**. Mosses are collected at thousands of sites





Examples of distribution maps in old Atlas

Since 2014 the JINR Frank Laboratory of Neutron Physics sector of neutron activation analysis is the **coordinator of the ICP** Vegetation program

ICP Vegetation (Past)

The UNECE ICP Vegetation program had a serious drawback related to its **weak adoption of modern informational technologies**. Information on collecting and processing of samples was carried out **manually** or with minimum automation.

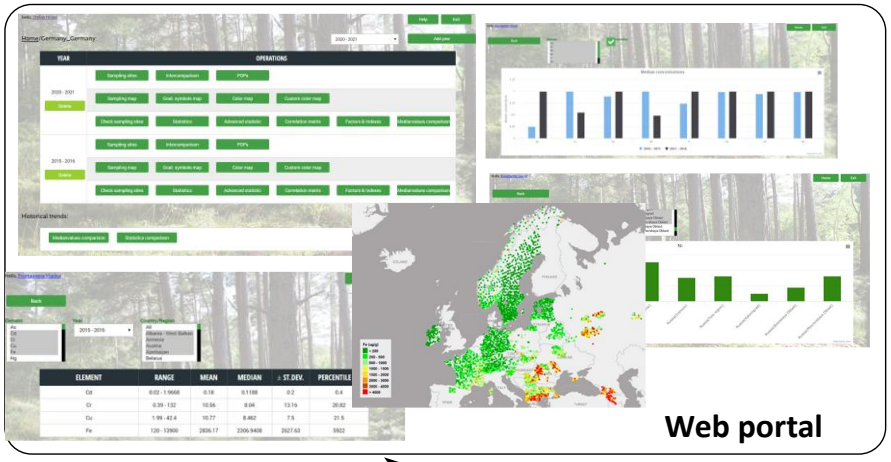
Until 2014, data mostly was stored in Excel files. It was aggregated and processed in different packages (ArcGIS, MATLAB, etc.) **manually by the coordinator**.

Files from respondents were usually passed to the coordinator **by email**. There were **no common standards** in data transfer, storing and processing software.

Such a situation does not meet the modern standards for quality, effectiveness, and speed of research and demands developing a **single web platform** to provides a comprehensive solution for biological monitoring and forecasting tasks

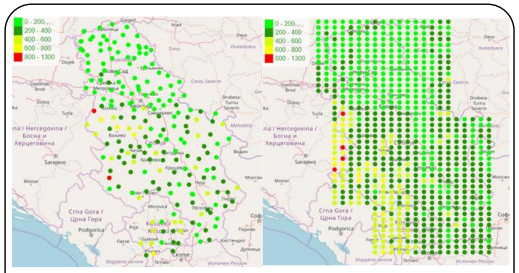
ICP Vegetation (Current)

The Data Management System (DMS) of the UNECE ICP Vegetation was developed at the Laboratory of Information Technologies and consists of a set of interconnected services and tools deployed and hosted at the Joint Institute for Nuclear Research (JINR) cloud infrastructure. DMS is intended to provide its participants with a **modern unified system of collecting, analyzing and processing of biological monitoring data.**



Web portal

Mobile application



Real Model

Prediction

OpenLayers

AJAX

php

python

mongoDB

NGINX

{JSON}

Tensorflow

Keras

Google Earth Engine

MODIS

LANDSAT

SENTINEL 2

esa proba-v

moss.jinr.ru

DMS. Data types

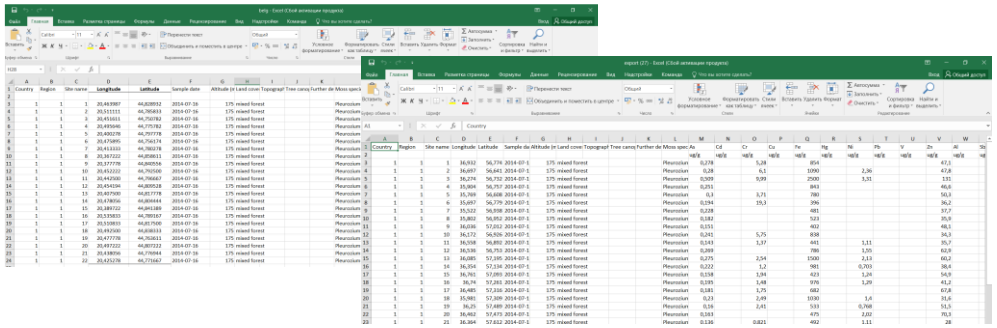
We have 4 main types of data (Sampling data, MossMet, Interlaboratory comparison, POPs) stored at the system. All of them **have tens to hundreds of different parameters**. So we use nonrelational DB.

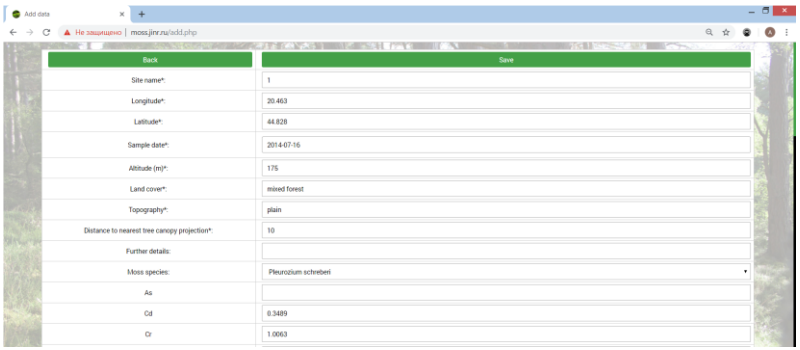
To upload their data to the DMS users can:

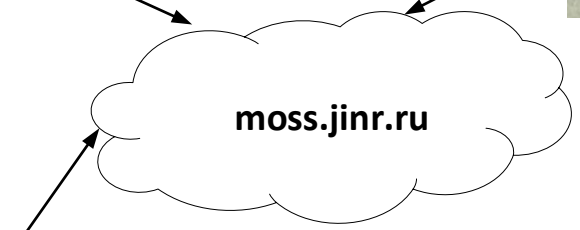
-uses web-form at the web-part of DMS

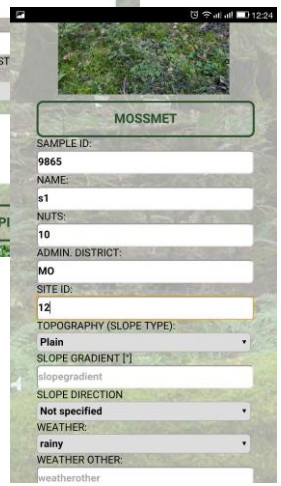
-uses an import/export mechanism based on XLS-files. Participants still can use XLS-files but they didn't send them by mail, and we can check their correctness.

- From 2020 preferable way is the mobile App.









DMS. Mobile application

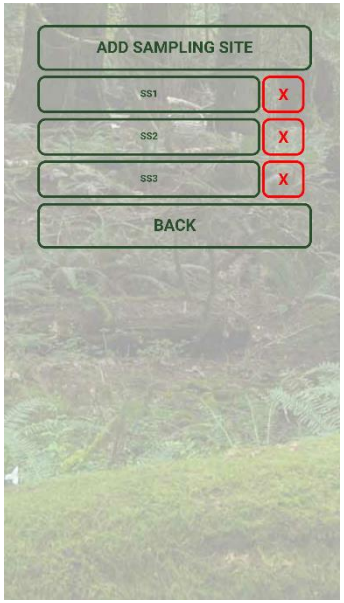
Google play: “ICP moss”. * Only android version is available

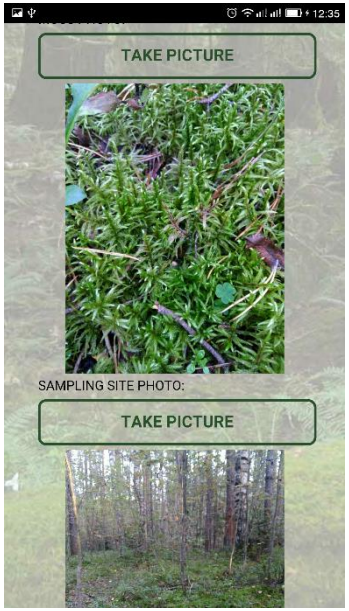
What it can:

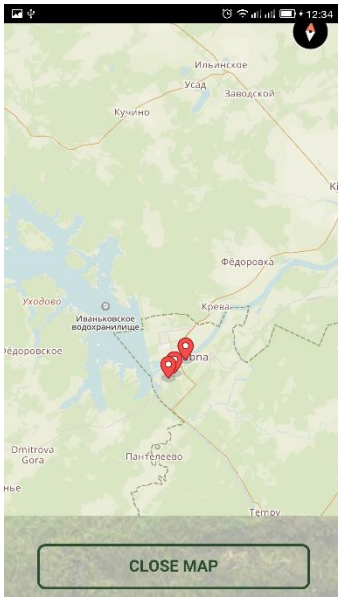
* Country/region management
* Filling in required by the UNECE ICP Vegetation manual information about sampling sites and MossMet data.

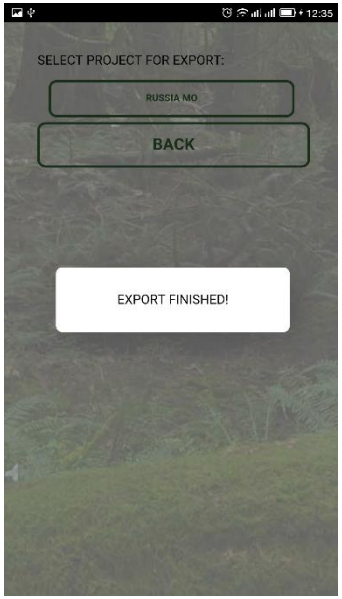
The application automatically sets longitude and latitude of the sampling site, controls the correctness of the input data and allows capturing photos of the moss samples and sampling sites.

*Application integrated with the DMS (moss.jinr.ru) and all information about sampling sites can be imported to the DMS.

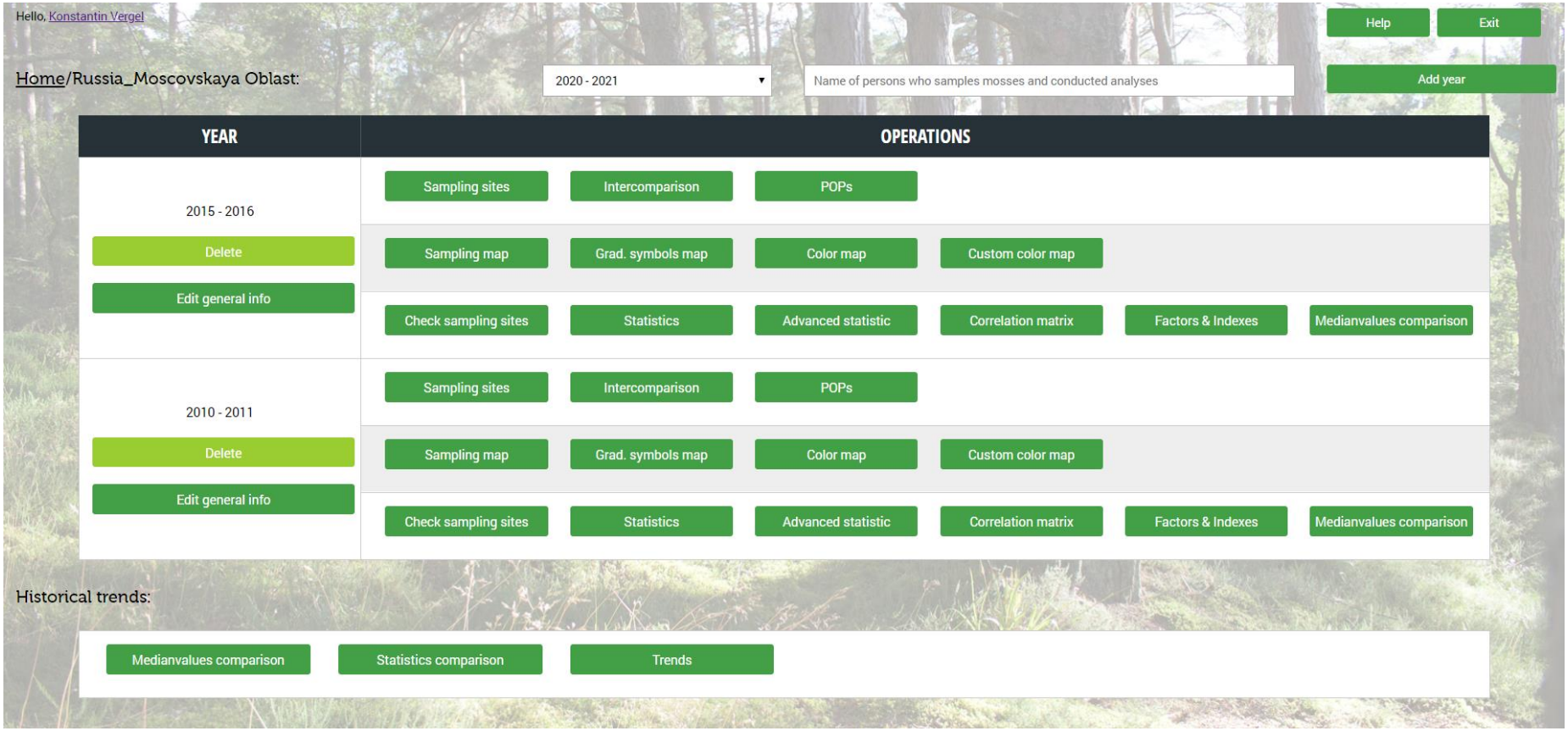








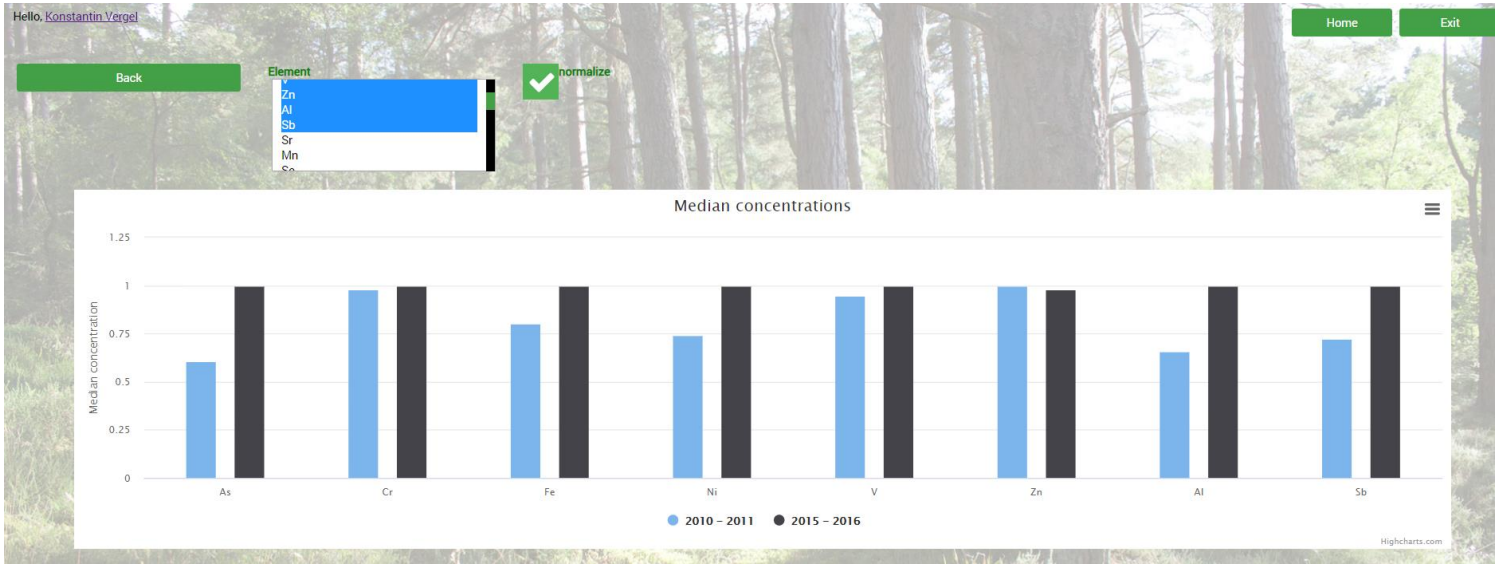
DMS. Private part - participants



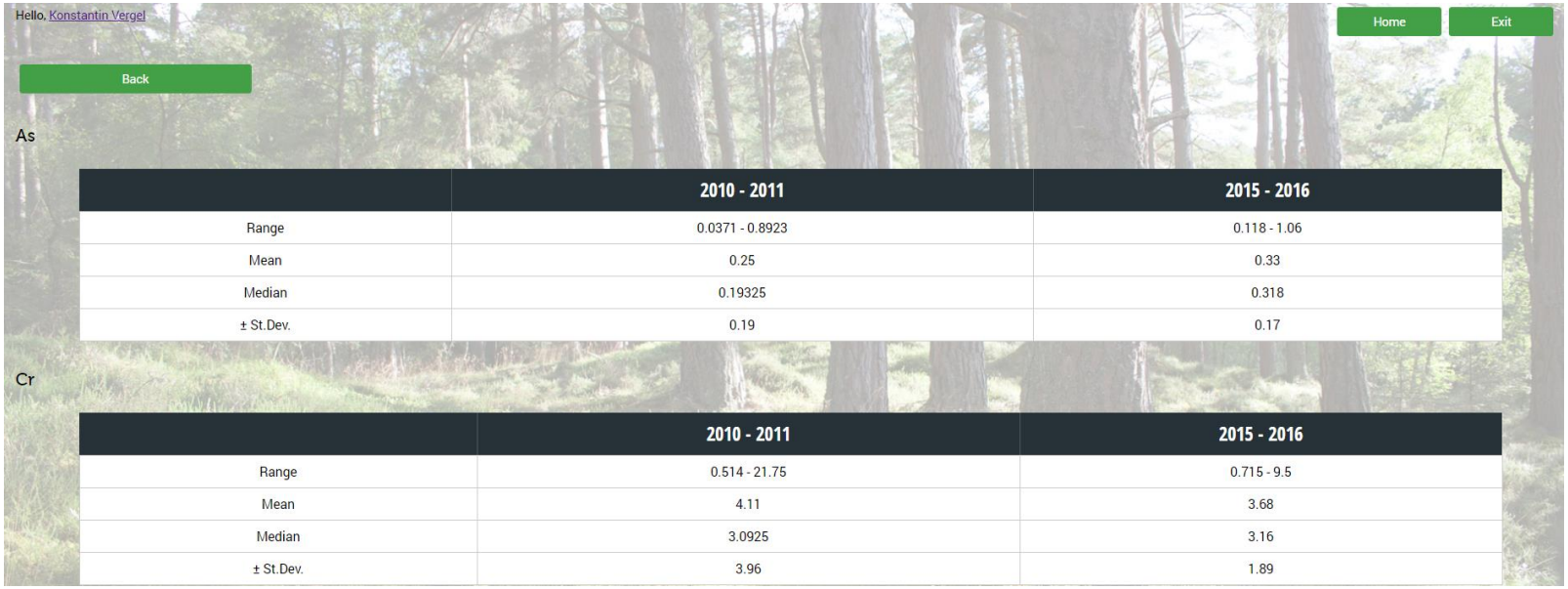
There are two parts of the portal – public and private. General information about the project and the platform is presented in the public part. The private part can be accessed only by authorized contributors and is used for data management and analysis.

Participants can manage their data, check it for correctness and completeness, calculate some statistics and Indexes, create maps, analyze data.

DMS. Historical reports



Normalized median concentration of some elements at the Moscow region



	2010 - 2011	2015 - 2016
Range	0.0371 - 0.8923	0.118 - 1.06
Mean	0.25	0.33
Median	0.19325	0.318
± St.Dev.	0.19	0.17

	2010 - 2011	2015 - 2016
Range	0.514 - 21.75	0.715 - 9.5
Mean	4.11	3.68
Median	3.0925	3.16
± St.Dev.	3.96	1.89

Statistical comparison of some elements at the Moscow region

DMS. Statistic & Indexes

Hello, Konstantin Vergel

Home Exit

Back

ELEMENT	RANGE	MEAN	MEDIAN	± ST.DEV.	PERCENTILE 90
As	0.118 - 1.06	0.33	0.318	0.17	0.4942
Cd	0.1205 - 0.6698	0.31	0.298	0.13	0.50102
Cr	0.715 - 9.5	3.68	3.16	1.89	5.88
Cu	2.8962 - 20.6715	7.29	7.0579	3.14	10.0161
Fe	300 - 3380	1127.33	1050	666.75	1808
Ni	0.659 - 8.43	3.76	3.22	2.08	6.546
Pb	0.1198 - 2.1884	0.75	0.6697	0.43	1.151
V	0.935 - 10.6	2.93	2.45	1.82	5.066
Zn	20.8 - 159	55.67	50.2	24.52	79.3
Al	445 - 6890	1536.67	1240	1239.58	2842

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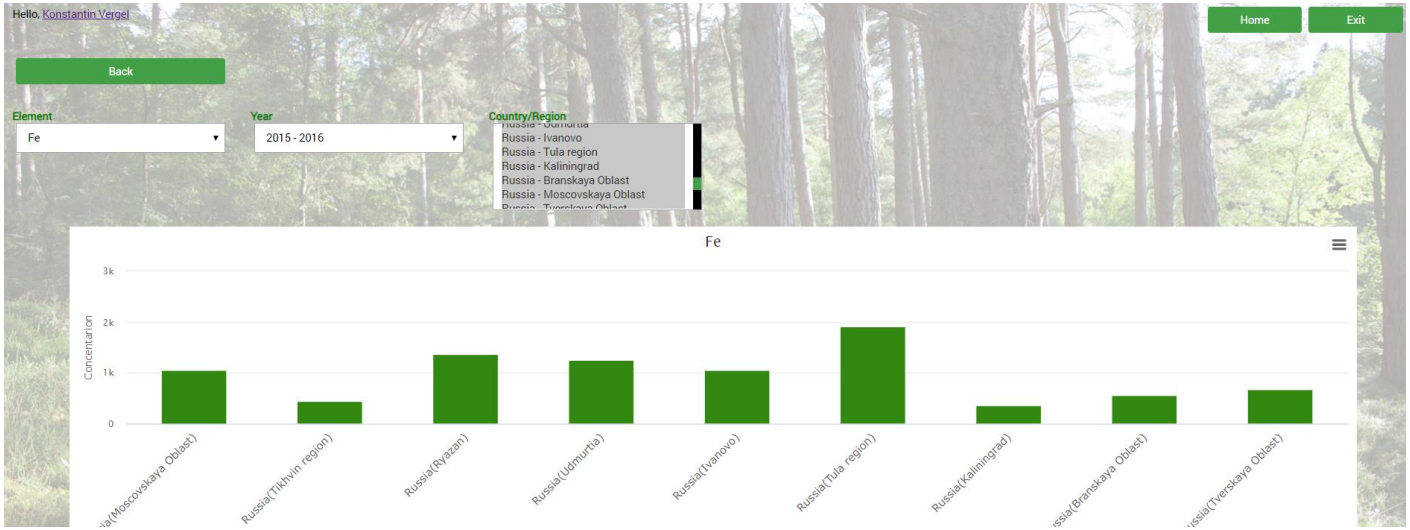
Back

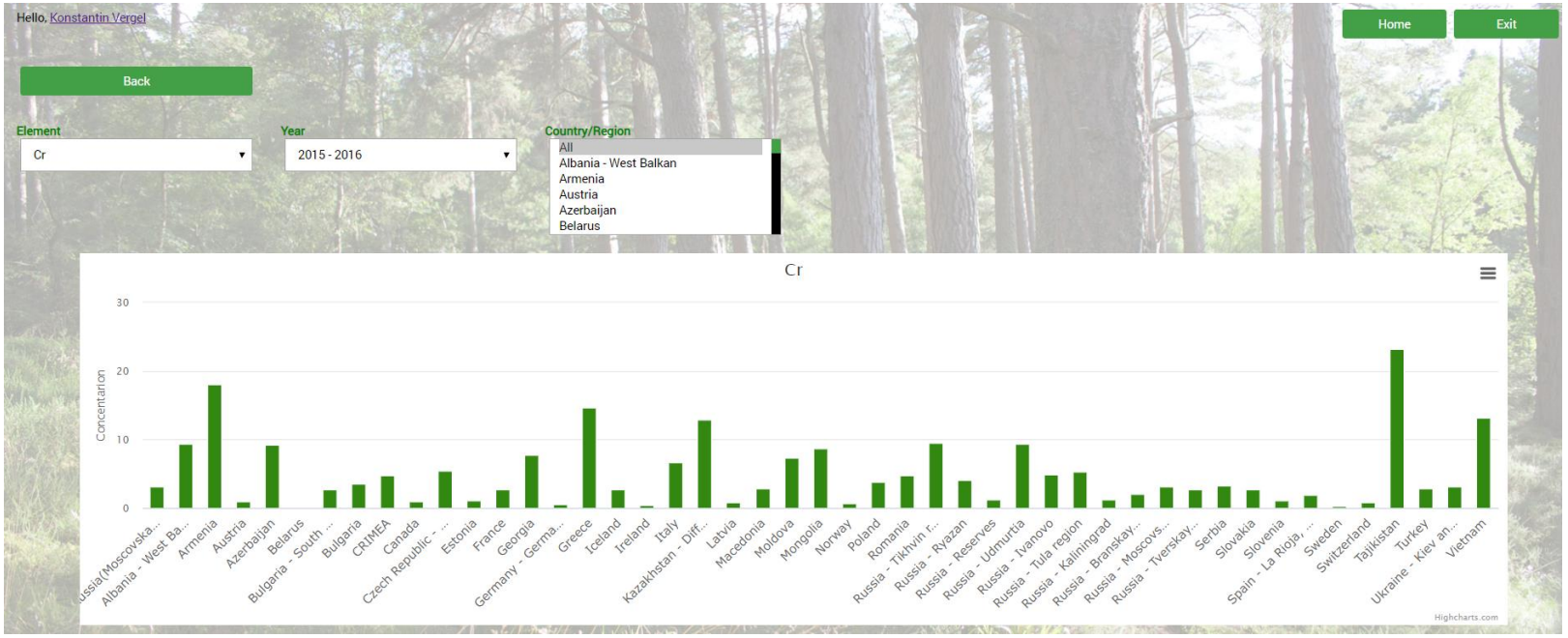
ELEMENT	RANGE	CF*	BACKGROUND LEVEL	I(GEO)**
As	0.118 - 1.06	2.69	0.118	0.84
Cd	0.1205 - 0.6698	2.47	0.1205	0.72
Cr	0.715 - 9.5	4.42	0.715	1.56
Cu	2.8962 - 20.6715	2.44	2.8962	0.7
Fe	300 - 3380	3.5	300	1.22
W	0.11 - 200	3.78	0.11	1.33

* CF - contamination factor. CF=MD(element)/Background level
** I(geo) - geo-accumulation index. I(geo)=log2(CF/1.5)

DMS. Comparative analysis

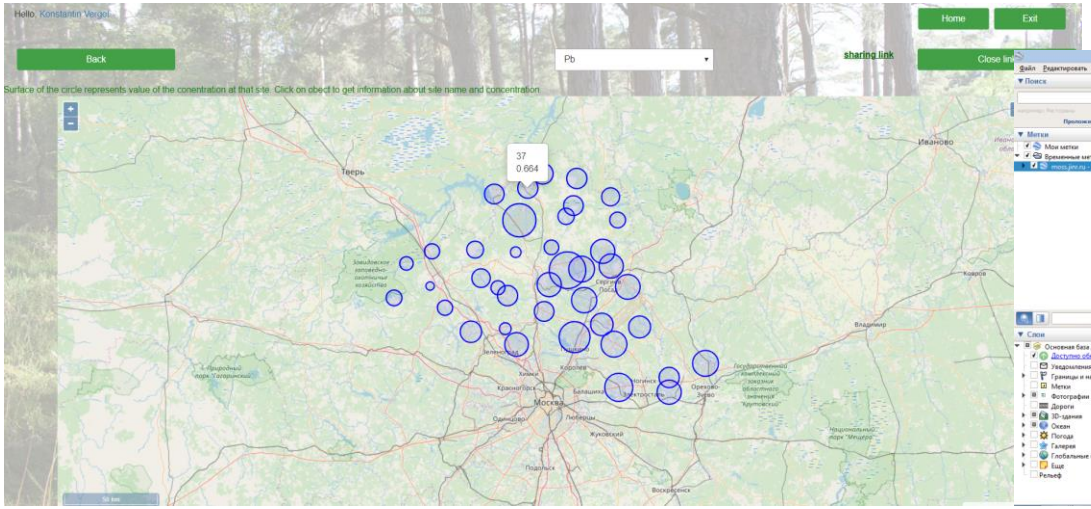


Comparison of the median concentration of Fe at the Moscow region and other regions of Russia

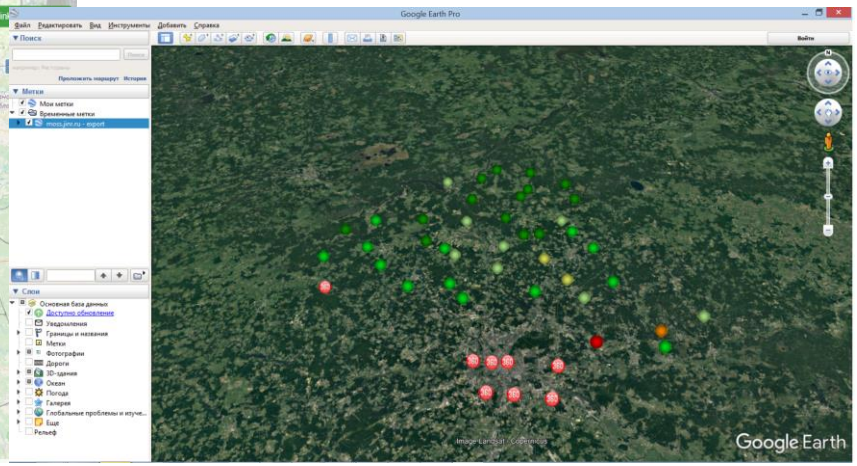


Comparison of the median concentration of Cr for all countries and regions

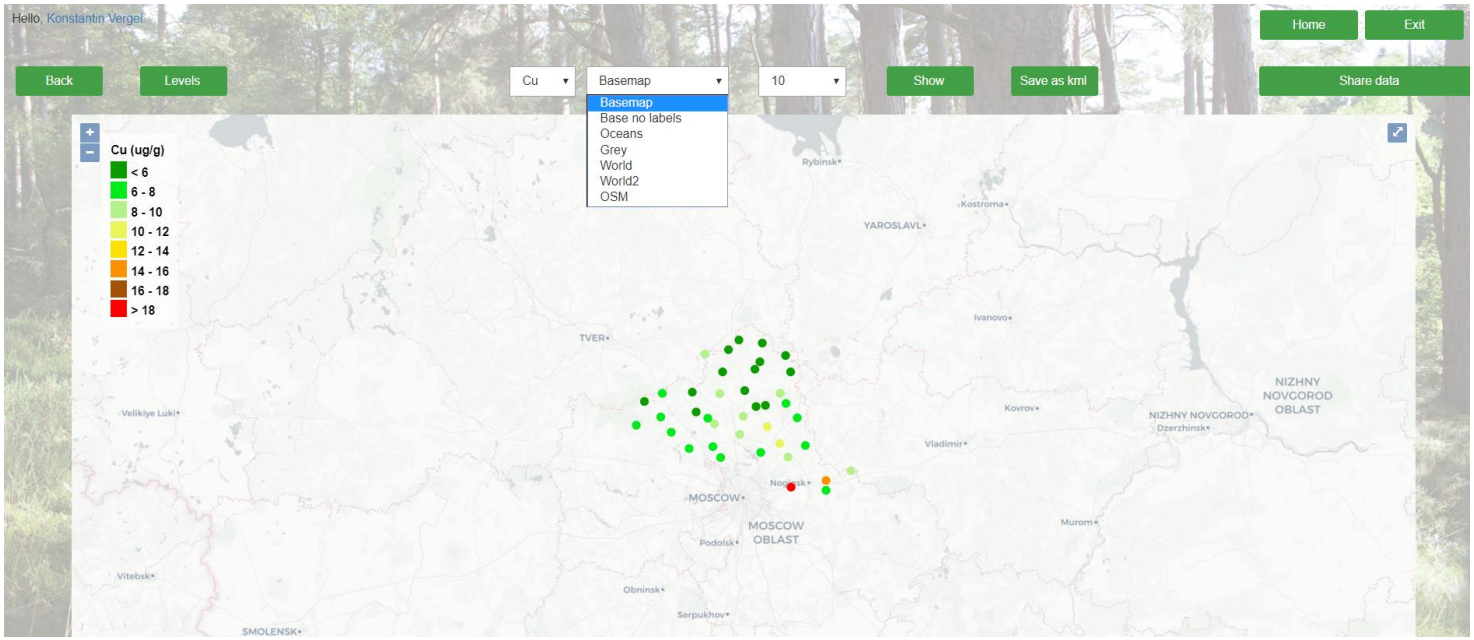
DMS. Maps



Example of the map in DMS

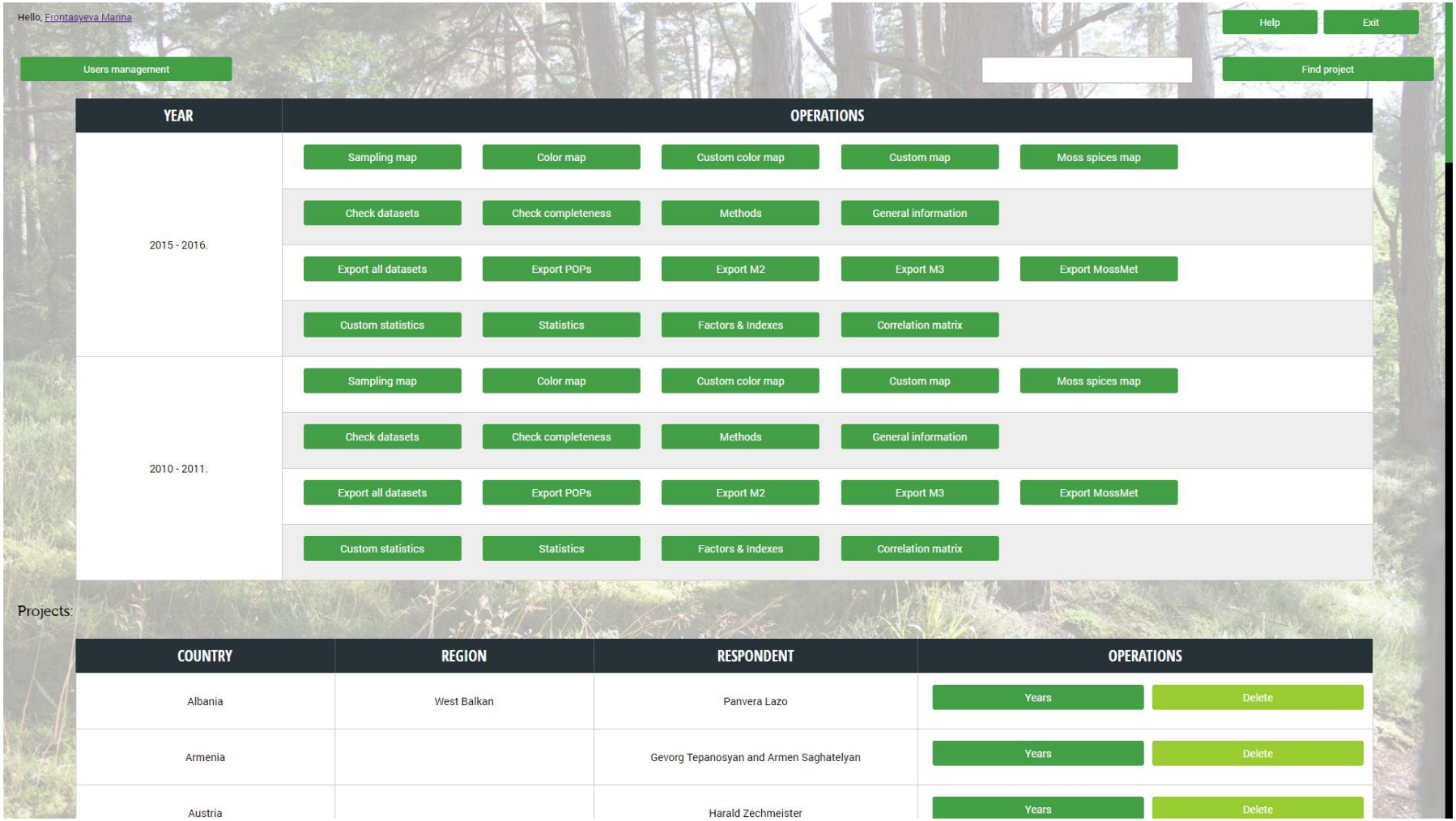


Google Earth with exported from DMS data



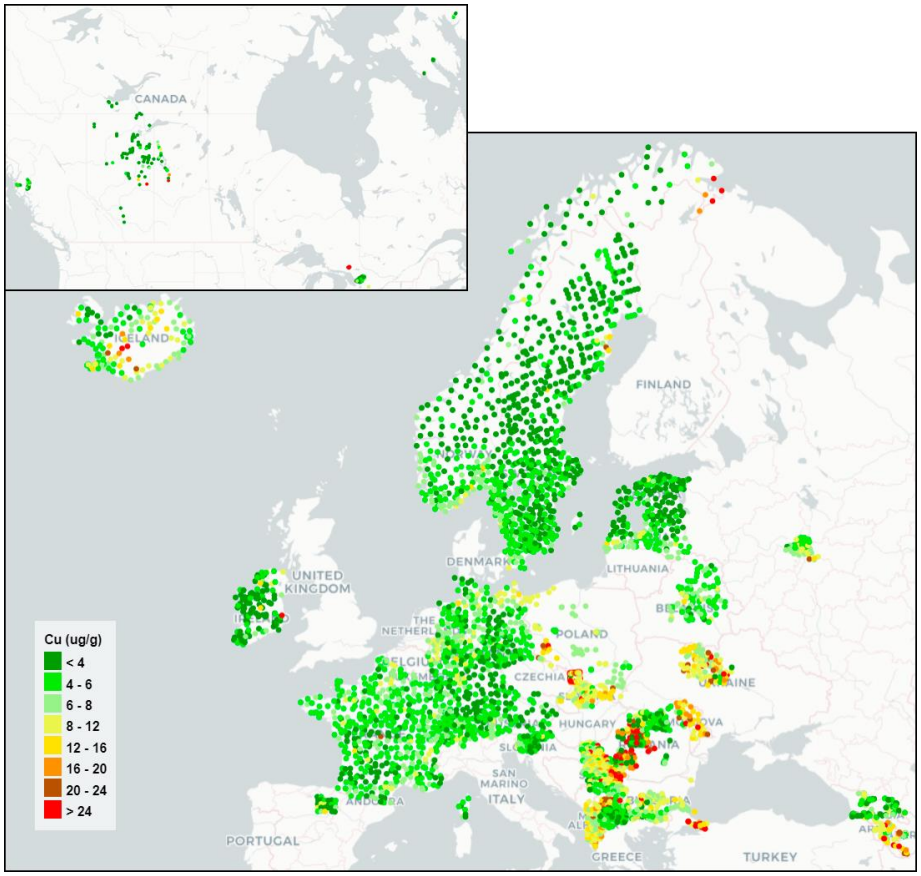
Custom map generation interface

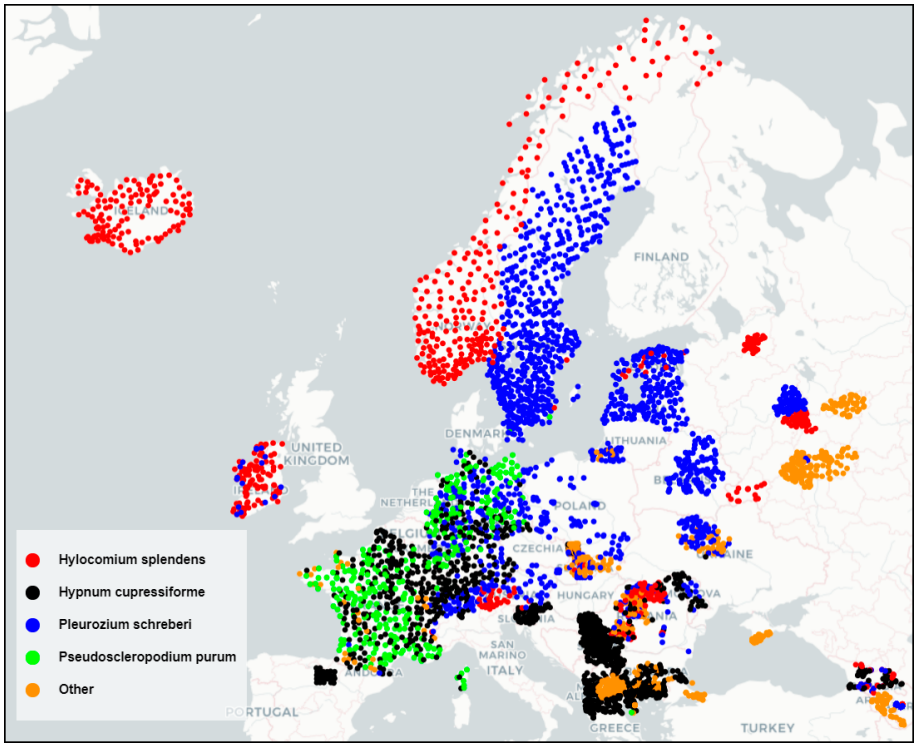
DMS. Private part - supervisors



Supervisors can access any contributor's data and tools. They can execute group operation with data and build general reports.

DMS. Maps





Examples of the maps for the Atlas 2015-2016

DMS. Atlas 2015-2016

JINR

CEH Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

'Mosses as biomonitors of air pollution: 2015/2016 survey on heavy metals, nitrogen and POPs in Europe and beyond'

Naturally-occurring mosses have been sampled across Europe and beyond to monitor the deposition of heavy metals, nitrogen and persistent organic pollutants (POPs) from the air. Since 1990, the moss survey has been repeated at five-yearly intervals for heavy metals. Since 2005 and 2010, nitrogen and POPs respectively were included too in some countries. In 2015/2016, mosses were collected at approximately 5,100 sites in 34 countries for heavy metals, 1,500 sites in 12 countries for nitrogen and at selected sites in eight countries for POPs. In 2015/16, participation in the moss survey has greatly increased in countries in Eastern Europe, Caucasus and Central Asia (EECCA region). The highest concentrations of heavy metals were often observed in South-Eastern Europe and the EECCA region, whereas the highest concentrations of nitrogen were found in parts of central Europe. In countries that have participated in at least four out of the six surveys, the concentration of lead and cadmium in mosses has declined the most (81% and 64% respectively since 1990) and the concentration of mercury has hardly changed (2% decline since 1995). The nitrogen concentration in mosses has hardly changed too since 2005 (5% decline).

This report is for scientists, policy makers and others with an interest in air pollution.

For further information or copies contact:

Dr Marina Frontasyeva
Moss Survey Coordination Centre
Joint Institute for Nuclear Research
Division of Nuclear Physics
Frank Laboratory of Neutron Physics
Department of Neutron Activation Analysis and Applied Research
Joliot-Curie, 6, Dubna, Russia
Dubna 141980, Russian Federation

Telephone: +7 (496)21 65609
Email: marina@nf.jinr.ru
Website: moss.jinr.ru

Dr Harry Harmens
ICP Vegetation Coordination Centre
Centre for Ecology & Hydrology
Environment Centre Wales
Deiniol Road
Bangor
Gwynedd LL57 2UW
United Kingdom

Telephone: +44 (0) 1248 374500
Email: hh@ceh.ac.uk
Website: icpvegetation.ceh.ac.uk

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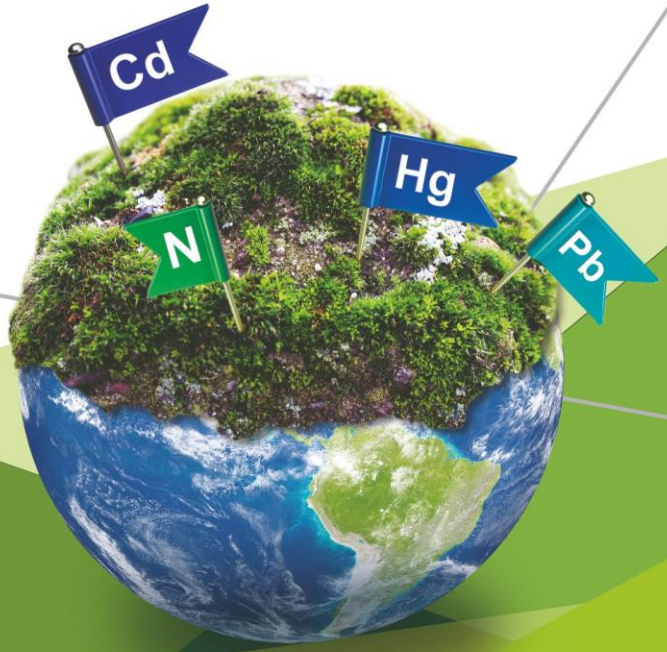
JINR

LRTAP
Long-range Transboundary Air Pollution

MOSSES AS BIOMONITORS OF AIR POLLUTION:

2015 / 2016 survey on heavy metals, nitrogen and POPs in Europe and beyond



Marina Frontasyeva, Harry Harmens, Alexander Uzhinskiy and the participants of the moss survey

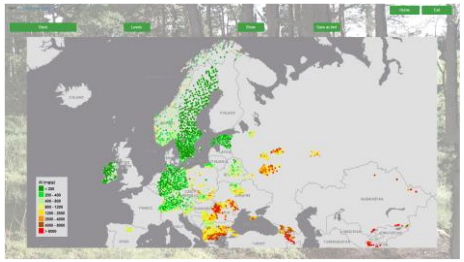
ICP VEGETATION

wge Working Group on Effects of the Convention on Long-range Transboundary Air Pollution

Is this all that we have?

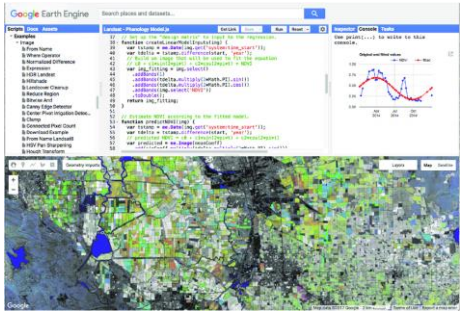
DMS. Prediction

Prediction is an important step in data analysis in any ecological survey. We try to use **satellite imagery data** and the **artificial neural network** to **predict concentration**. The general idea is to use data that we can get from satellite images together with sampling data from DMS to learn NN and then use only data from satellite images to predict concentration.



DMS

Google Earth Engine

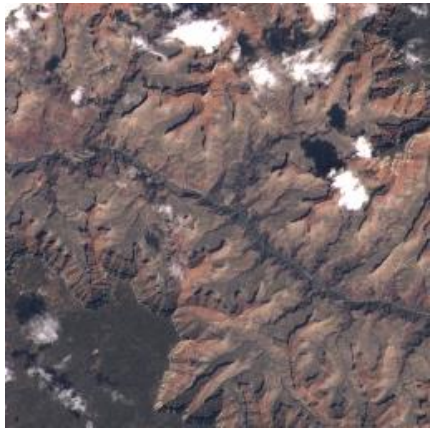


Google Earth Engine

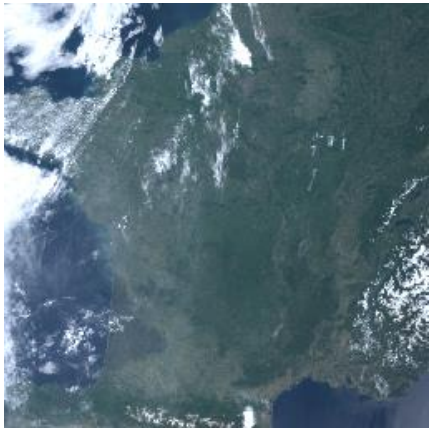
Training → Learned model

Learned model → Prediction

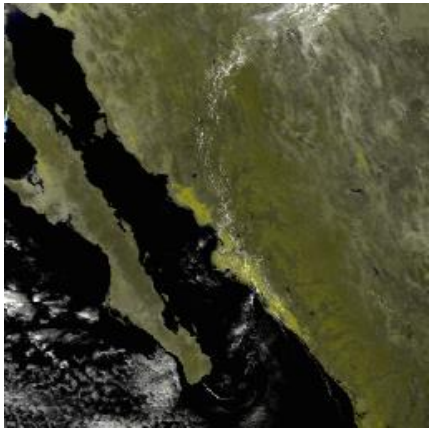
DMS. Indexes (features)



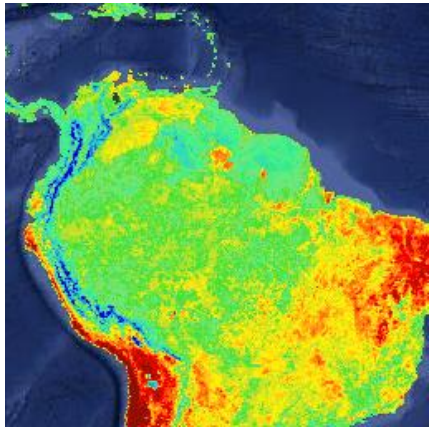
Landsat (15-30m Resolution)



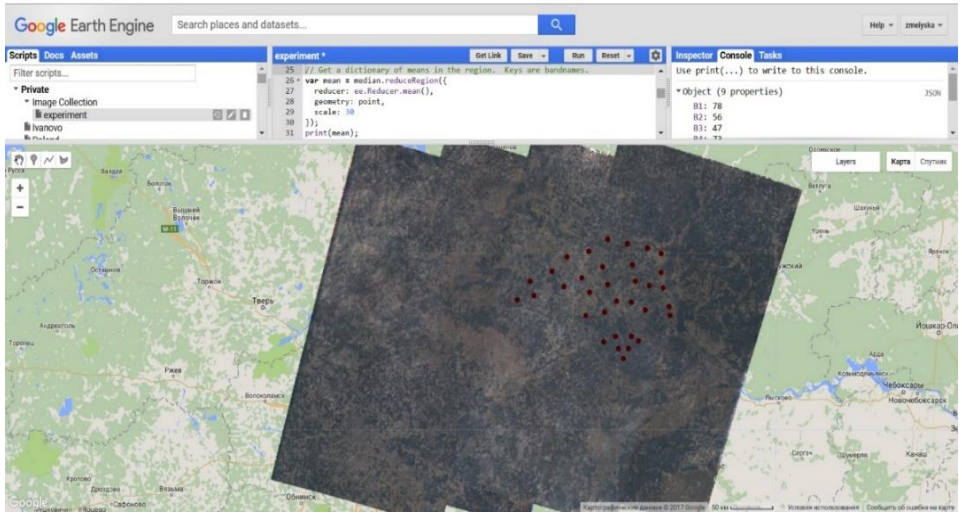
Modis (250-500m Resolution)



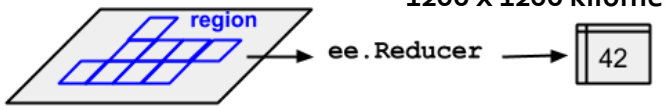
Sentinel (250-500m Resolution)



The MOD11A2 V6 average 8-day land surface temperature (LST) in a 1200 x 1200 kilometer grid.



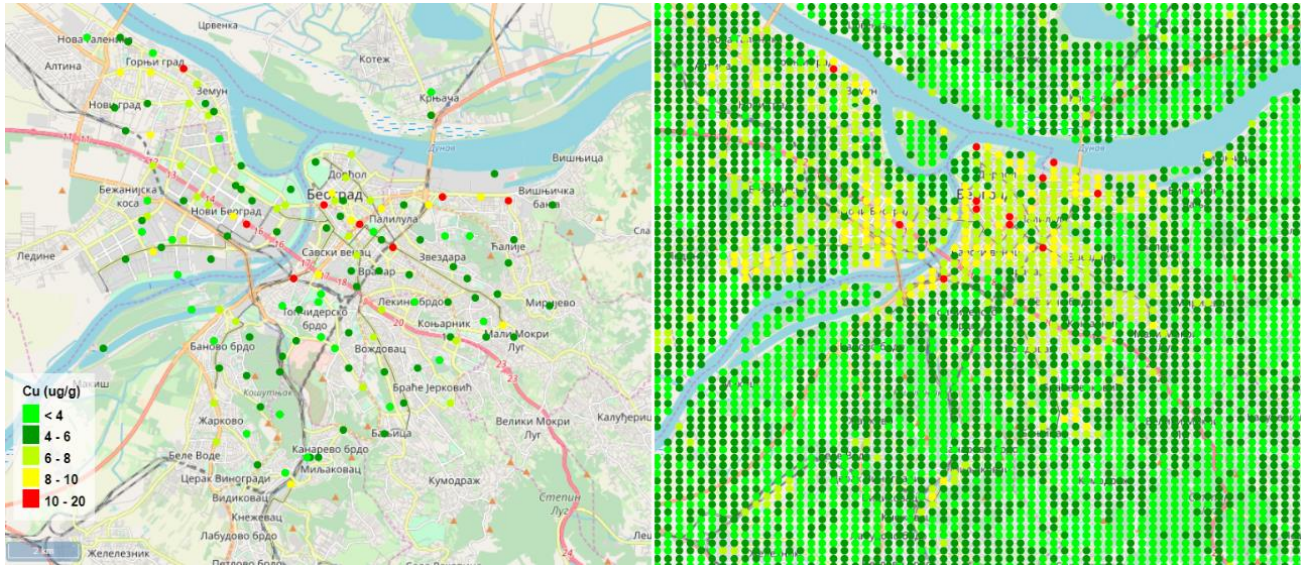
Google Earth Engine JavaScript online editor




```
var region = ee.Geometry.Rectangle(20.661, 44, 28, 48.5);

var collection = ee.ImageCollection('MODIS/006/MOD09A1')
  .filterDate('2015-01-01', '2016-12-31')
  .filterBounds(region)
  .sort('CLOUD_COVER', true);

var median = collection.median();

var area =ee.Geometry. Rectangle(21.00, 42.00, 61.01, 42.01);

// Get a dictionary of means in the region.  Keys are bandnames.
var mean = median.reduceRegion({
 reducer: ee.Reducer.mean(),
 geometry: area,
 scale: 30 });
```

There are more than **100 satellite programs** and modeled datasets. Google Earth Engine has **JavaScript online editor** to create and verify code and **python API** to communicate with user's applications.

DMS. Why



Belgrad Cu at summer. Left – real life, right - prediction

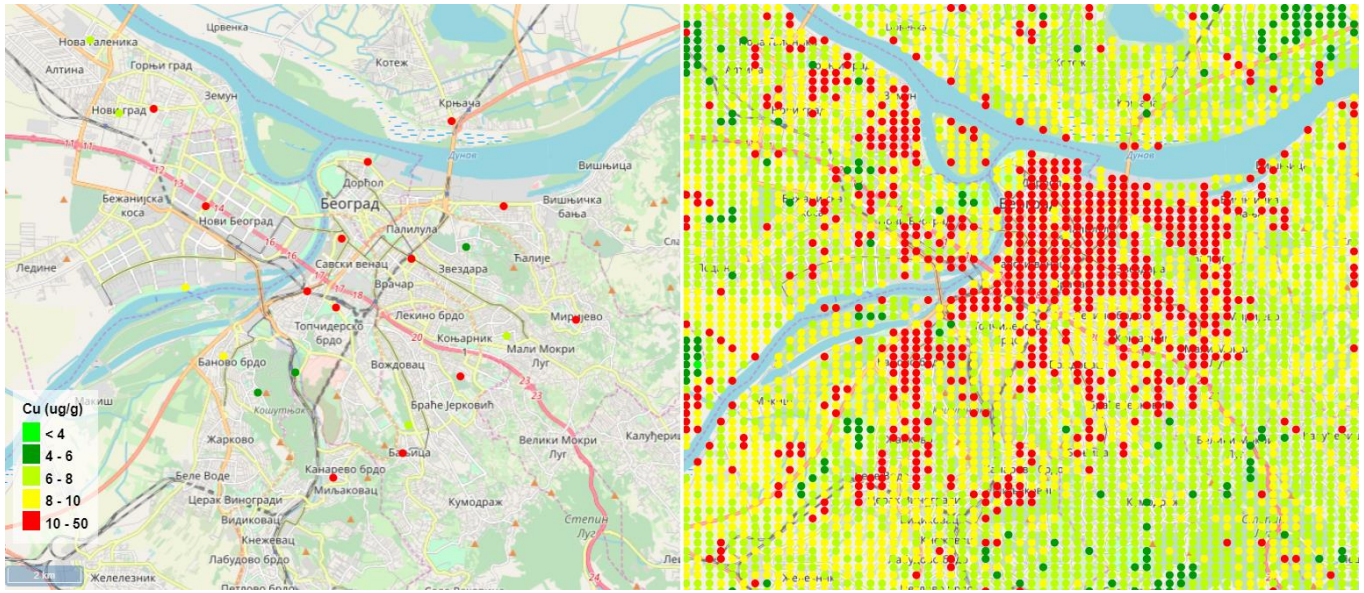
Researchers will be able to:

- monitor the evaluation of situation when it needed,

- get detailed information about areas of interests,

- check the situation in the cross border areas,

- partly automate the environment control process (automatically run the model and get a notification when the contamination level is higher than the critical level).



Belgrad Cu at winter. Left – real life, right – prediction of the summer model

ICP Vegetation (Plans)

- Prediction
  - Calculate indexes for all
  - An auto-search of the network architecture
  - Optimization of the model
  - Verification and distribution of the model results
- Cluster analysis
- Factor analysis

Thank you for your attention