Report no. 1
Interval 01.11 – 23.12.2018
for ERANET-RUS-PLUS-SODEEP project
"Study of the development of extreme events over permafrost areas"

Evaluation and selection of available remote sensing data for the study sites, in the frame of WP1 (Development of an integrated remote sensing methodology to process and interpret satellite imagery and aerial photography and establishing a permafrost dynamics database).

Purpose ond overall objectives of the project

In this project the impact of climate change on the permafrost degradation and its impact on the occurrence and development of extreme events in the high northern latitudes will be examined. The goal is to assess the role of land-atmosphere interactions on the severity and frequency of extreme events in the arctic and sub-arctic areas, which are extremely vulnerable to climate change conditions. Data from long-term in situ observations and field studies as well as medium and high-resolution satellite images together with state of the art hierarchy of numerical models both in global and regional climate simulations as well as the permafrost standalone model will be integrated.

The main activities in the frame of this reporting interval are related to the WP1 (Development of an integrated remote sensing methodology to process and interpret satellite imagery and aerial photography and establishing a permafrost dynamics database) and refer to the analysis and selection of the available satellite images from the existing archives in relation with the monitoring sites proposed in the project, such as Landsat and Sentinel-1 and -2 images that are an important source of free available data that cover a long interval and are valuable for the identification of landscape changes at local and regional scales in permafrost areas.

Activities for 2018:

- Selection and analysis of the study areas and development of spatial database with availabale data în relation with in-situ monitoring sites
- Evaluation and selection of satellite images at medium and high spatial resolution for the identification of potential landscape changes in permafrost areas.

- *Selection and analysis of the study areas and development of spatial database with availabale data în relation with in-situ monitoring sites*

For the selection and evaluation of available satellite images, existing monitoring sites for thermal regime in permafrost areas located in the arctic and sub-arctic Russia were considered important, especially for validation. The monitoring sites are distributed over the major bio-climatic zones of the Russian arctic and sub-arctic and four study areas were selected for analysis within this project: 1) the arctic tundra at the Bely Island, 2) the typical tundra at the Marre-Sale station in the western Yamal Peninsula, 3) the southern tundra at the Bolvansky Cape station in the Pechora Delta, and 4) the forest-tundra in the Urengoy region (fig.1).

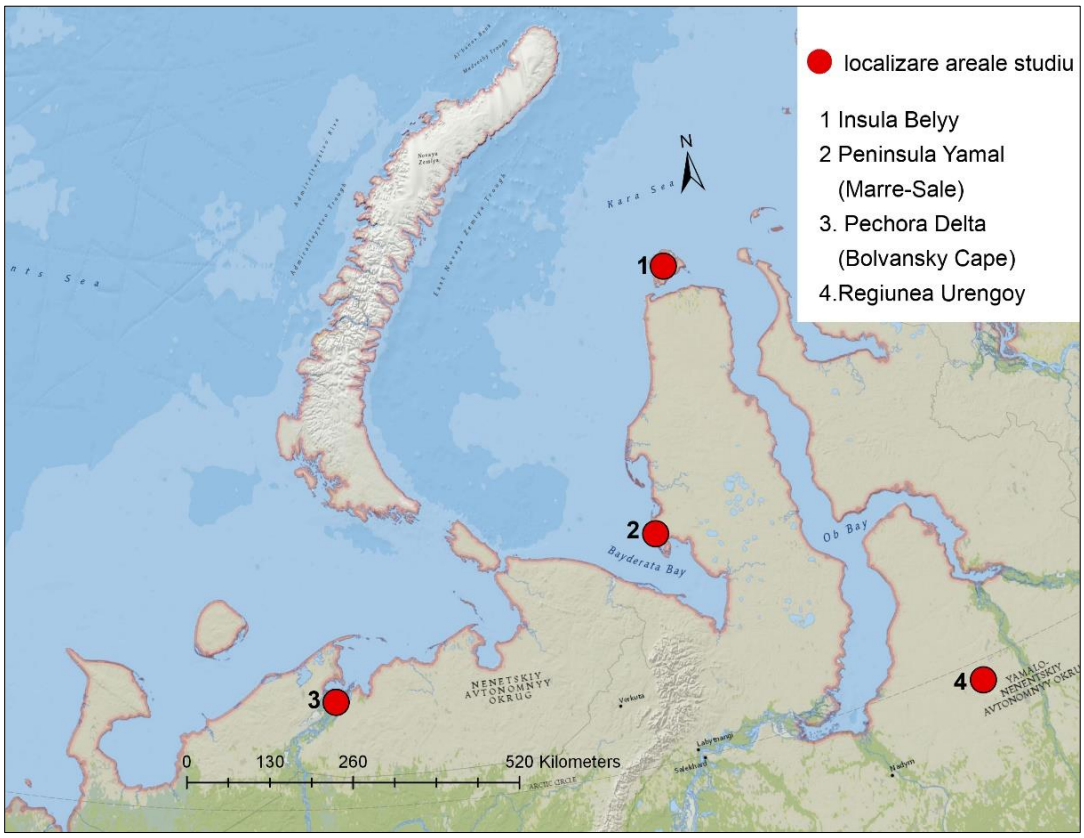

Fig. 1 Location of the study areas distributed over the circum-arctic region of Russia

The Belly Island is located on the northern site of Yamal Pensinsula and has a lowland terrain. The landscape is characterized by cereal-cotton, grass-moss bogs and tundra and spotted-fractured tundra (Drozdov et al, in press). In this area there are two observation sites located near the M. V. Popov station on a flat surface, and two sites of seasonal thaw layer monitoring located on well-drained sandy hilltop and on the poorly-drained loam gentle slope.

The Marre-Sale area is located on the western coast of Yamal Peninsula, with a monitoring site near the Marre-Sale meteorological station. The landscape is dominated by drained tundra, sandy fields, wet tundra, swamp, peatbog and gully (Drozdov et al, in press).

The area Urengoy has two monitoring sites located north from Novy Urengoy city, one is in southern tundra and one in forest-southern tundra. The first is dominated by drained flat peatbog tundra and mossy swamp and the other by forests and bushes, one ought to speak about a changing tendency from seasonal thaw to seasonal freezing and about the formation of talik above the permafrost.

The study area from Pechora river delta has a monitoring site located on the northernmost extremity of Cape Bolvansky, which is just into the Pechora Inlet. The site in located on an irregular plain with numerous lake depressions and large flat-bottom valleys, some of them with permanent creeks.

For all these study areas, a GIS database was established, containing information related to the extent of these areas in relation to the available satellite images, the location of monitoring existing sites for thermal regime of permafrost (provided by the project partners), landcover types, and other auxilliary spatial data.

1.2 Evaluation and selection of satellite images at medium and high spatial resolution for the identification of potential landscape changes in permafrost areas.

The Landsat archive represent a valuable source of free images that extend over more than 30 years of observations. The entire Landsat satellite images archive of Thematic Mapper (TM), Enhanced Thematic Mapper+ (ETM+) and Observing Land Imager (OLI) sensors was searched and the images overlapping the study areas were selected for analysis. The scenes were downloaded using EarthExplorer platform at a processing level L1T (radiometrically and geometrically terrain-corrected). The selected scenes were acquired only from July and August and with a maximum of 80% cloud cover. The first selected scenes were from 1985 and the most recent from 2018. An example of Landsat scenes selected for Belly Island areas can be observed in fig. 2.

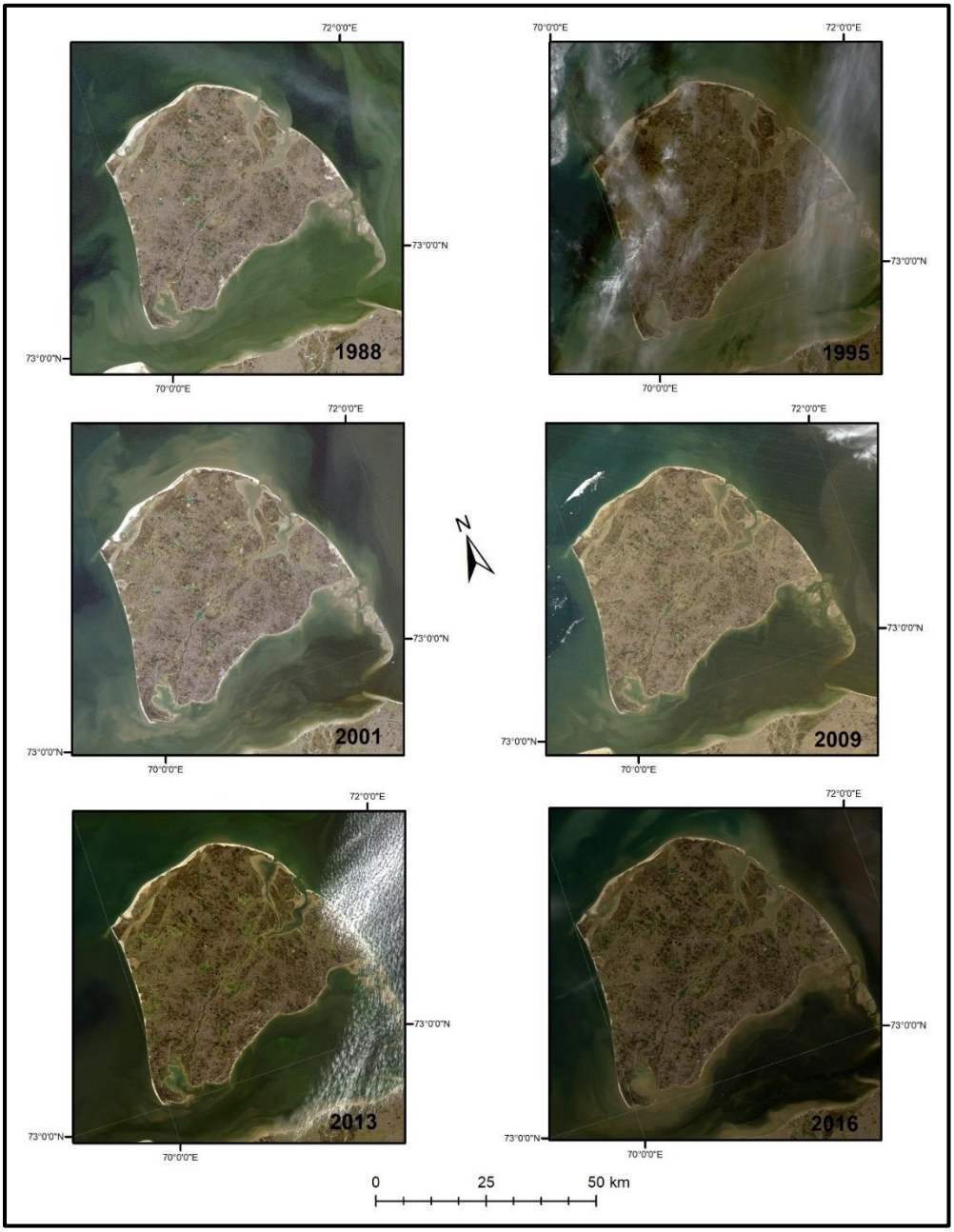

Fig. 2 Selected Landsat scenes for Belly Island study site

Besides Landsat images, we analized also the archive of Sentinel-2 optical images, that provide scenes with 13 spectral bands at 10, 20 and 60 m spatial resolution. The scenes were downloaded using Copernicus open acces hub platform from ESA. All the scenes for the study sites were from the July and August interval, same as Landsat data (example of Sentinel-2B scene from Pechora delta – fig. 3).

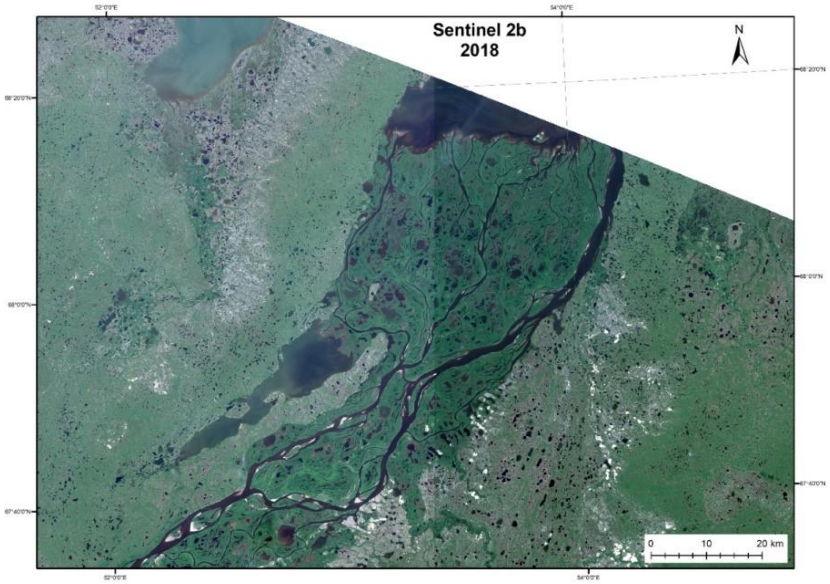

Fig. 3 Natural color composite Sentinel-2B image from 2018 located in Pechora delta

The selected scenes for two study areas were analyzed and several indices were derived, such as NDVI, NDMI and NDWI. The analysis of these indices show that the most important changes are related to the dynamics of thermokarst processes - lakes drainage and expansion in some areas like western Yamal Peninsula, changes that were mentioned also in other studies in the Arctic (Nitze et al., 2017, Nitze and Grosse, 2016).

In the same time, the analysis of NDVI between 1987 -2017 over the study site from western Yamal Peninsula indicated a positive trend, a greening similar with other results from the Arctic (Nitze and Grosse, 2016, Yu et al, 2011, Raynolds et al., 2008). This change can be correlated with the increase trend in air temperatures (Daan et al., 2011).

A local analysis of the landcover maps derived from Landsat satellite images from the beggining of July for several years in the interval 1987-2016, exhibit a decrease in areas covered by ice and an increase of water class.

The analysis will be further extended for all study sites and compared with results mentioned in other areas distributed over the Arctic.

References

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