Pavel Sannikov*, Yuliya Khotyanovskaya*,Sergei Buzmakov*

* *Perm State University*

Applicability of aerial photography for identifying of oil mining technogenesis: mechanical transformations, bitumization, technogenic salinization

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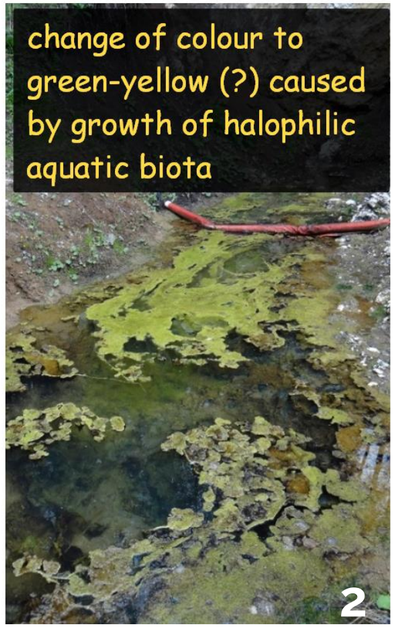
Mechanical transformations – migration and differentiation of matter in landscapes, caused by the processes of movement of solid masses.

Techno genesis

Bitumization – pollution of soils, water, bottom sediments by substances of organic origin (petrochemicals)

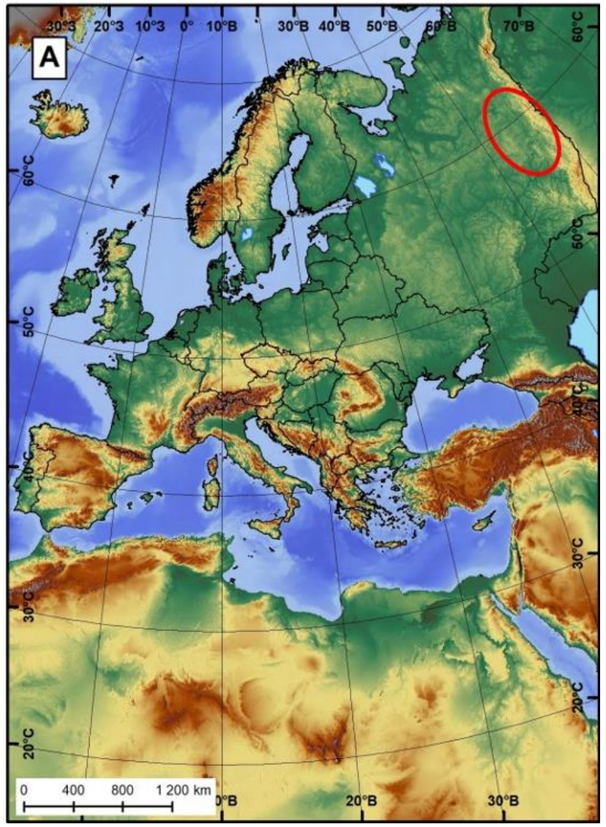
Technogenic salinization – salinization of soils, surface, subsurface and underground waters.



QUESTION – is it possible to use aerial photography for identifying of different types of oil mining technogenesis?

MATERIALS and METHODS

Research Area – mining oil field in karst area (within river basin)



METHODS

- Sampling (soil, water etc) – laboratory analysis
- Aerial photography (300-500 m) – Photogrammetry - Photo delineation
- Spatial analysis (GIS) – compare FIELD and REMOTE information

Direct field sampling of the substances and taking photo

Name of Sampling Plots	*2016*		*2018*		
	spring	*summer*	*winter*	*spring*	*summer*
Spring-well 1	2OW-2S	OW-OS-S	OW-S	OW-S-Ph	OW-OS-S
Spring-well 2	2OW-2S	OW-OS-S	OW-S	OW-S-Ph	OW-OS-S-Ph
Spring-well 3	2OW-2S	OW-OS-S	OW-S-Ph	OW-S-Ph	OW-OS-S
Dam, stream 1	-	OW-OS-S	OW-S-Ph	OW-S	OW-OS-S
Spring-well 5	OW-S	OW-OS-S	OW-S	OW-S	OW-OS-S
Lake, swallow-hole	OW-S	OW-OS-S	OW-S	OW-S	OW-OS-S-Ph
New swallow-hole	-	OW-OS-S	-	OW-S	OS
Pipelines	OW-S	OW-OS-S	-	-	-
Ponomarevskaya Cave	OW-S	OW-OS-S-Ph	OW-S	OW-S	OW-S-Ph
Spring-well 7 (stream 1)	OW-S	OW-OS-S-Ph	OW-S	OW-S	OW-OS-S
Spring-well 8	OW-S	OW-OS-S	-	OW-S	OW-OS-S
Spring-well 9, Yasyl river outlet	OW-S	OW-OS-S	OW-S	OW-S	OW-OS-S
Polluted sinkhole	-	OS-Ph	-	-	OS
Spring-well 6, upper reaches of the Yasylsky ravine, pond-oil trap	-	-	OW-S	OW-S-Ph	OW-OS-S
Stream 2, below the oil trap	-	-	OW-S	OW-S-Ph	OW-OS-S
Stream 3, below the confluence of the streams 1 and 2	-	-	-	OW-S	OW-OS-S
Stream 4	-	-	-	OW-S	-
Yasyl river, above the confluence of the stream 5	-	-	-	OW-S	OW-OS-S
Yasyl river, below the confluence of the stream 5	-	-	-	OW-S	OW-S
Yasyl river, below the ponds	-	-	OW-S	OW-S	OW-OS-S
Yasyl river, mouth	-	-	-	OW-S	OW-OS-S
Wells cluster N°9	-	OS-Ph	-	Ph	OS

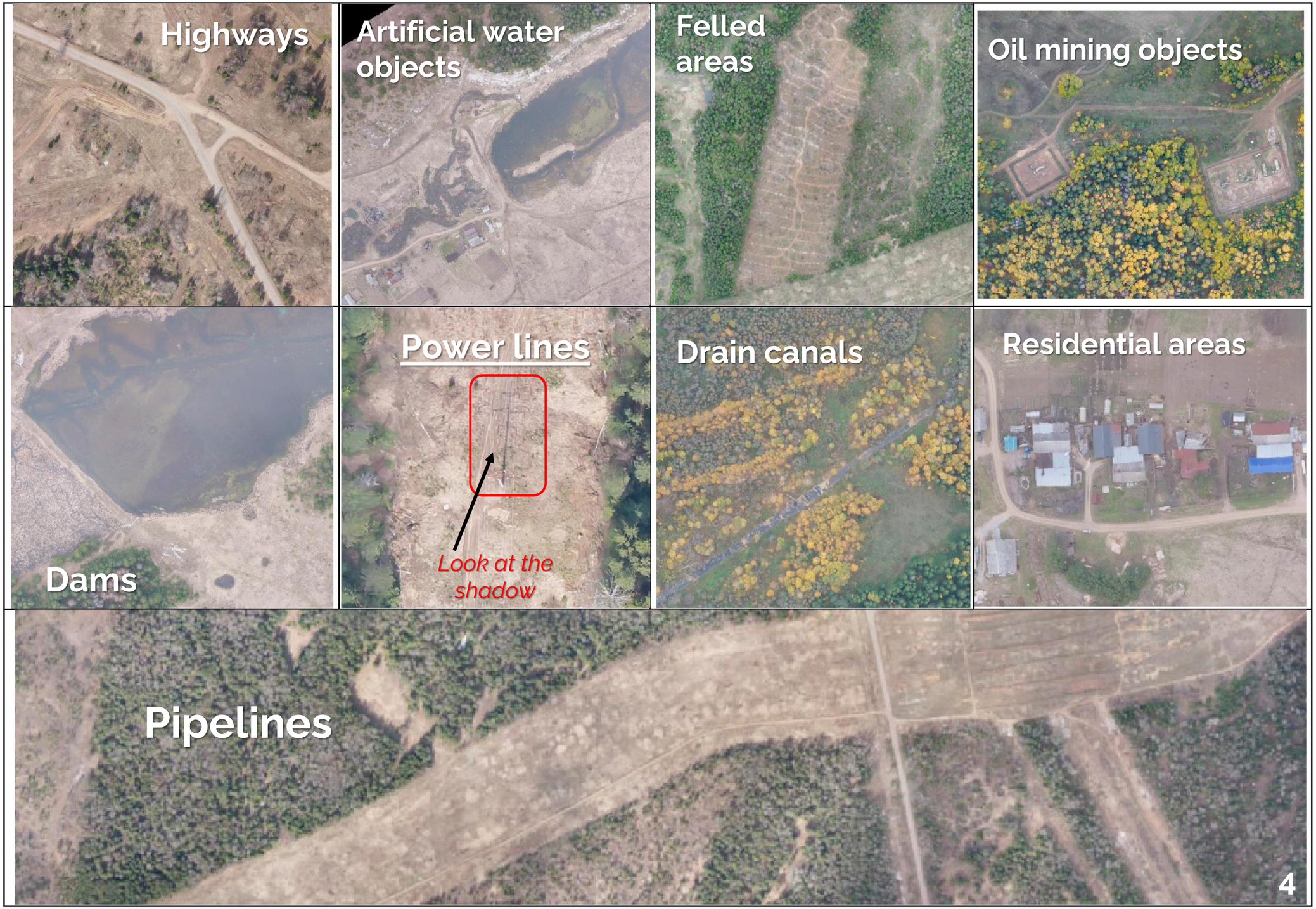
* **Note**. OW – oil products in water, OS – oil products in soil, S – salts in water, Ph – photo. An index, for example, 2OW means the number of samples taken in a given season.

Multi-season aerial photography

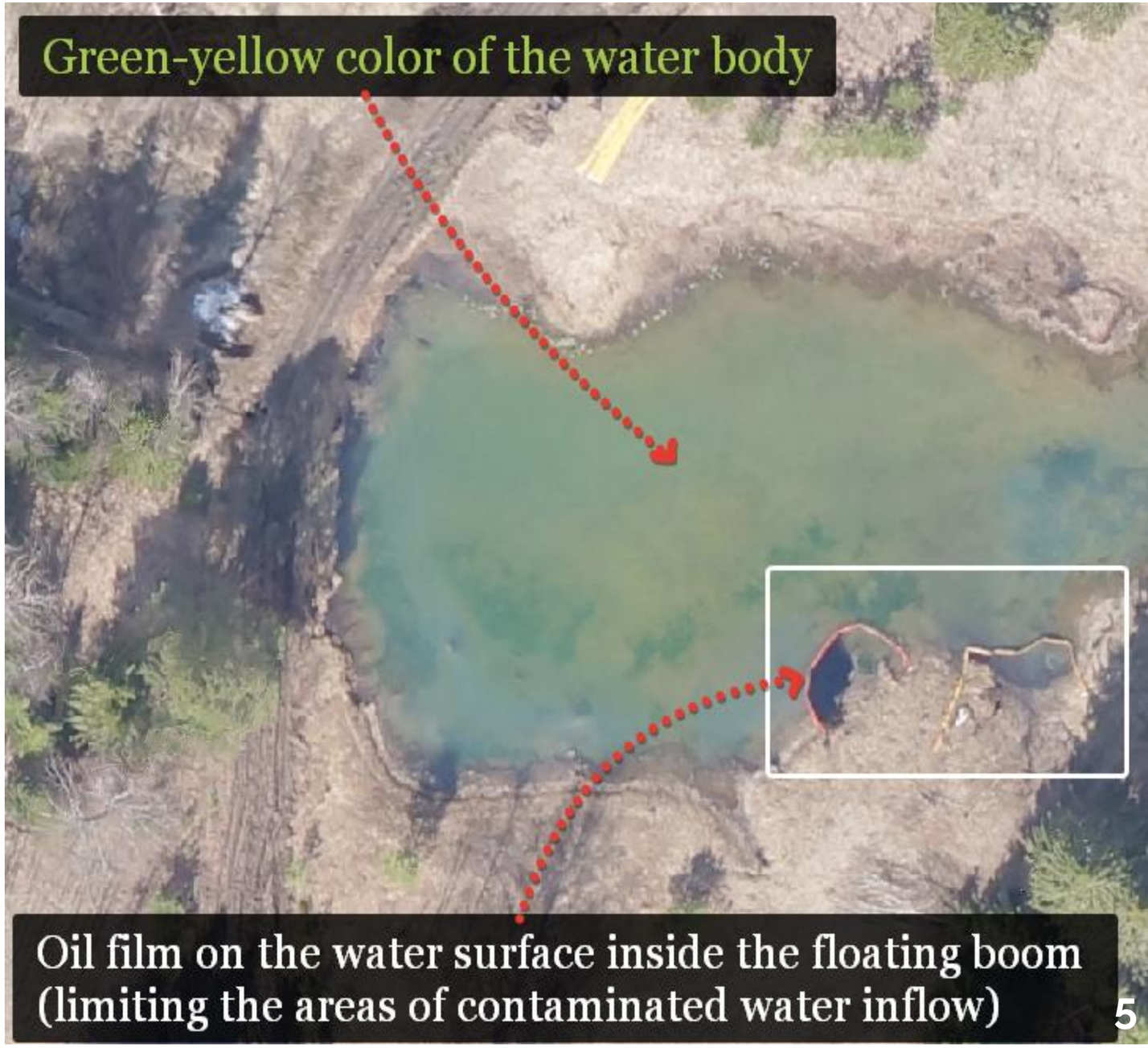
N°	Date of aerial ph.	Spatial resolution, cm	Spatial coverage of the orthophoto
1	16.03.2016	9 / 50	The entire river basin
2	29.04.2016	20 / 50	The entire river basin
3	29.09.2016	9 / 20 / 50	Upper and middle part of the river basin
4	29.09.2016	6	River valley
5	25.05.2018	9	Upper part of the river basin

RESULTS:

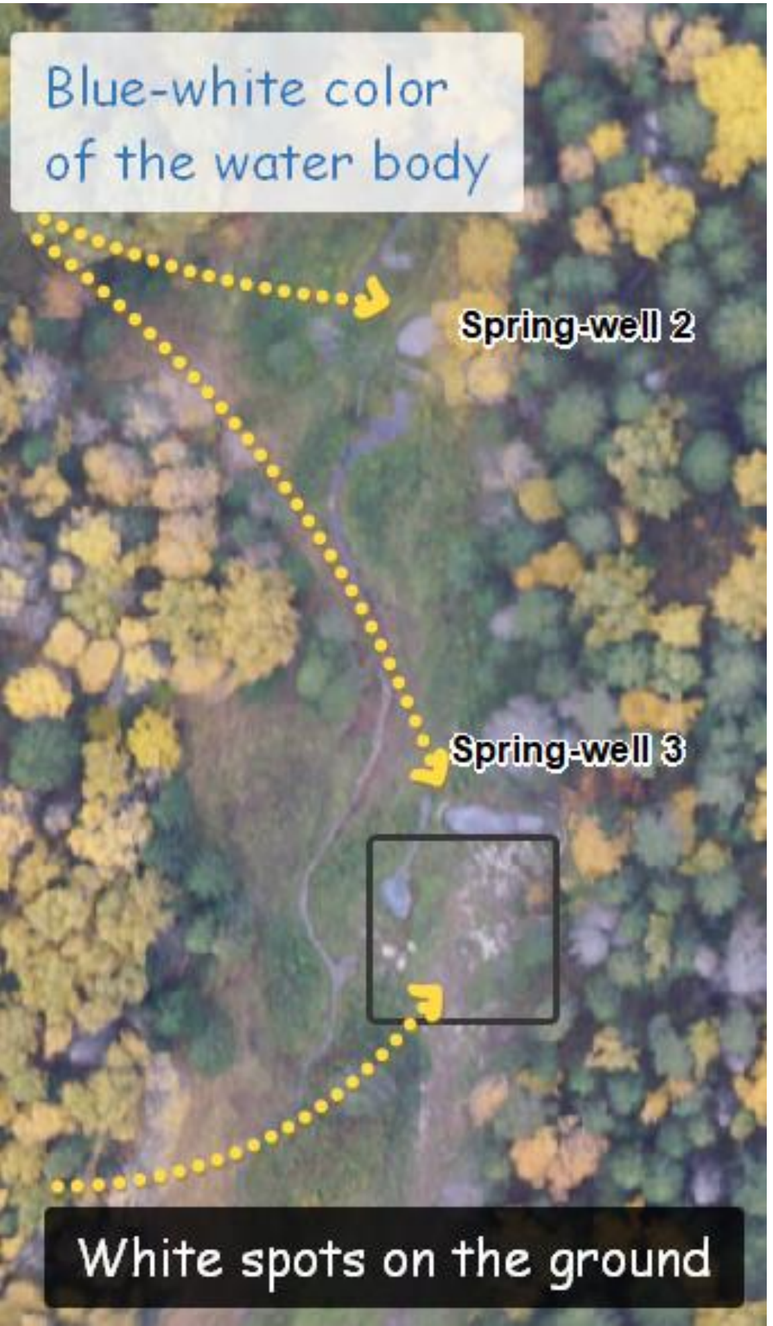
photo delineation of mechanical transformations

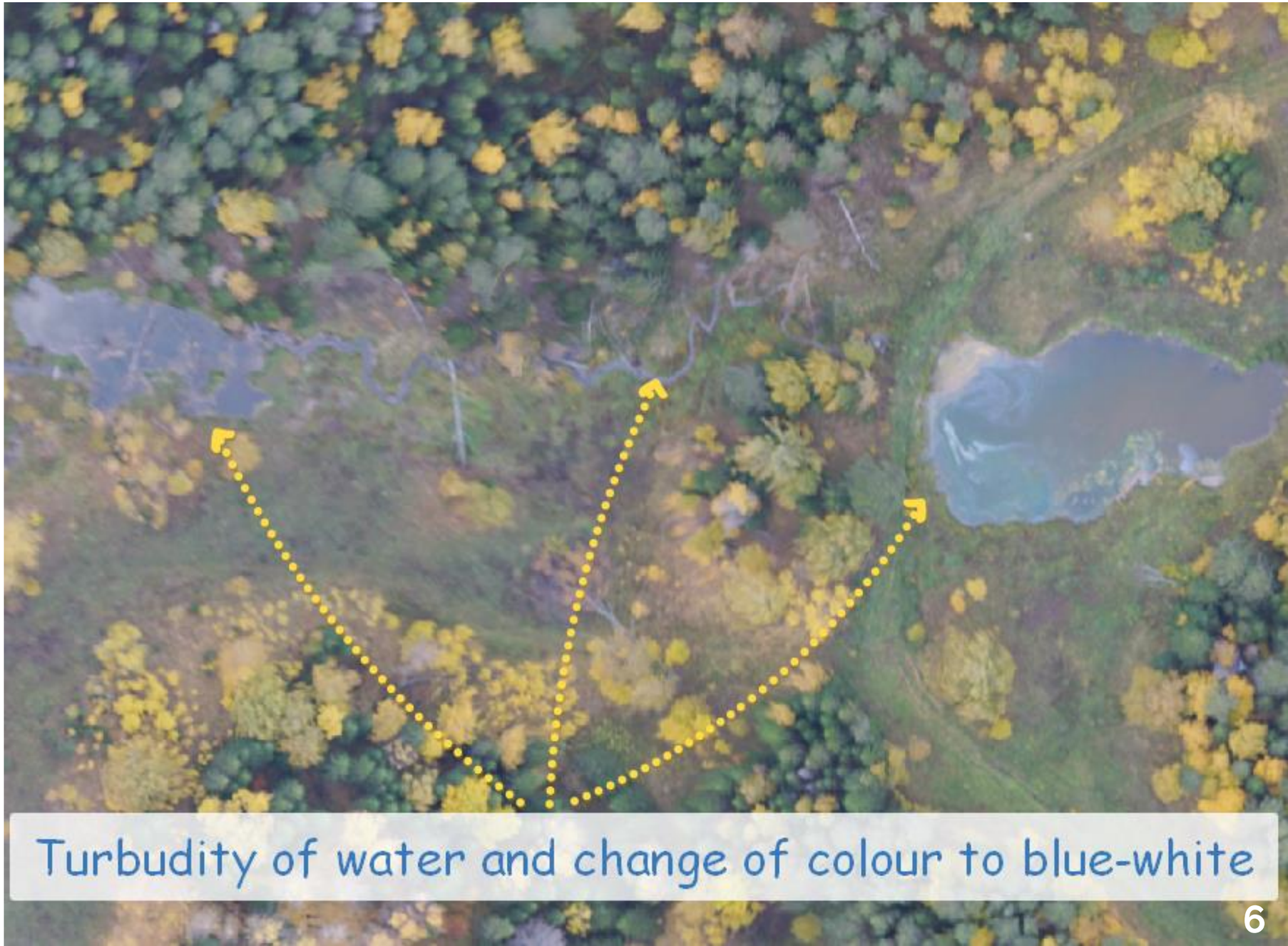


RESULTS: photo delineation of bitumization



RESULTS: photo delineation of technogenic salinization





CONCLUSIONS

To identify most of mechanical transformations, direct photo delineation signs (shape, colour and some special signs (e.g. embankments around wells)) are sufficient. It seems more difficult to identify some linear objects, such as: power lines, gas pipelines, oil pipelines, cable lines, felled areas, etc.

The technogenic salinization are recorded according to the following signs: turbidity of water and the acquisition of a blue-white colour; a change in the colour of the water body to green-yellow (sometimes bright green-yellow); and white spots on the soil surface. The presence of dispersed hydrogenated sulphates in water bodies is especially well determined.

The bitumization process is only sufficiently identified if black oil spots/film are present on the surface of the ground or water. If bitumization is not accompanied by sufficiently large spots of the heavy (black) fraction of oil (at least 5-6 pixels in diameter) on the surface of the water or soil, but is only detected by hydrocarbons dissolved in water or located inside the soil, the visual identification of such sites by orthophotos is impossible.

Methodological conditions for the use of aerial photography to identify oil mining technogenesis are formulated. High requirements are placed on the spatial resolution of the orthophotos due to the small size of the identified objects. The permissible level is not less than 20 cm/pixels and the optimal level is not less than 10 cm/pixels.

Aerial photography should be carried out in a snowless period, in clear or fair weather with some clouds. The efficiency of photo delineation will decrease sharply with an increase in the forest cover of the territory. The crowns and shadows of trees should be considered as a factor that significantly complicates the identification of the effects of bitumization and technogenic salinization.

PROSPECTS

Using of multispectral aerial photography can significantly expand the range of photo delineation capabilities. The most promising capability seems to be the comparison of images of bitumization and technogenic salinization sites in panchromatic mode, with photographs obtained in narrow spectral channels, as well as with spectral indexes, e.g. indexes that record the waterlogging processes in the soil.

One of the identified types of transformation of water bodies is a change in colour to green-yellow, which we presumably associate with salinization. At the moment there is no apparent interpretation of the nature of this process. At the moment we suppose that it is result of development of halophyte aquatic vegetation and algae. For test the hypothesis we want to make synchronous sampling of aquatic biota and water chemical content to be promising.

During the 2021, direct surveys and sampling were organized at two other oil fields in the region. Aerial photography was carried out there, as well. The surveyed oil fields are located in the subzones of the middle taiga and mixed coniferous-deciduous forests. In the future this will reveal the zonal differences of oil mining technogenesis.