THE PRINCIPLES OF CREATING A DIGITAL FINE SCALE MAP OF PARENT MATERIALS ON THE EXAMPLE OF THE TERRITORY IN MOSCOW REGION

N.P. Kirillova, T.M. Sileova, T.Yu Ulyanova, S.Yu Rozov, I.Ye Smirnova

Faculty of Soil Science
Moscow State University

Parent materials are considered as an important factor of soil genesis.
The factors controlling the soil properties in a given point are presented in the SCORPAN model

$$S = f\,(S, C, O, R, P, A, N),$$

where S is soil, C is climate, O is organisms, R is relief, **P is parent material,** A is age, and N is spatial position in the neighborhood.

In most of the studies (76%), only one or two out of these 7 predictors are applied. According to the estimates of 2009, the **contribution of parent materials was only 6%**

Why only 6%?

- Such a low percent is due to objective difficulties: the main input data that are used, are based on lithology maps, developed by geologists.

- The number of the maps is very limited.

At the same time data on parent materials can be obtained during soil survey to produce soil maps.

The project

Digital soil map of the Training and Experimental Soil-Ecological Center (TESEC) of Moscow State University

had been launched in 2012.

The project includes all the necessary information to develop digital map of parent materials for the studied territory:

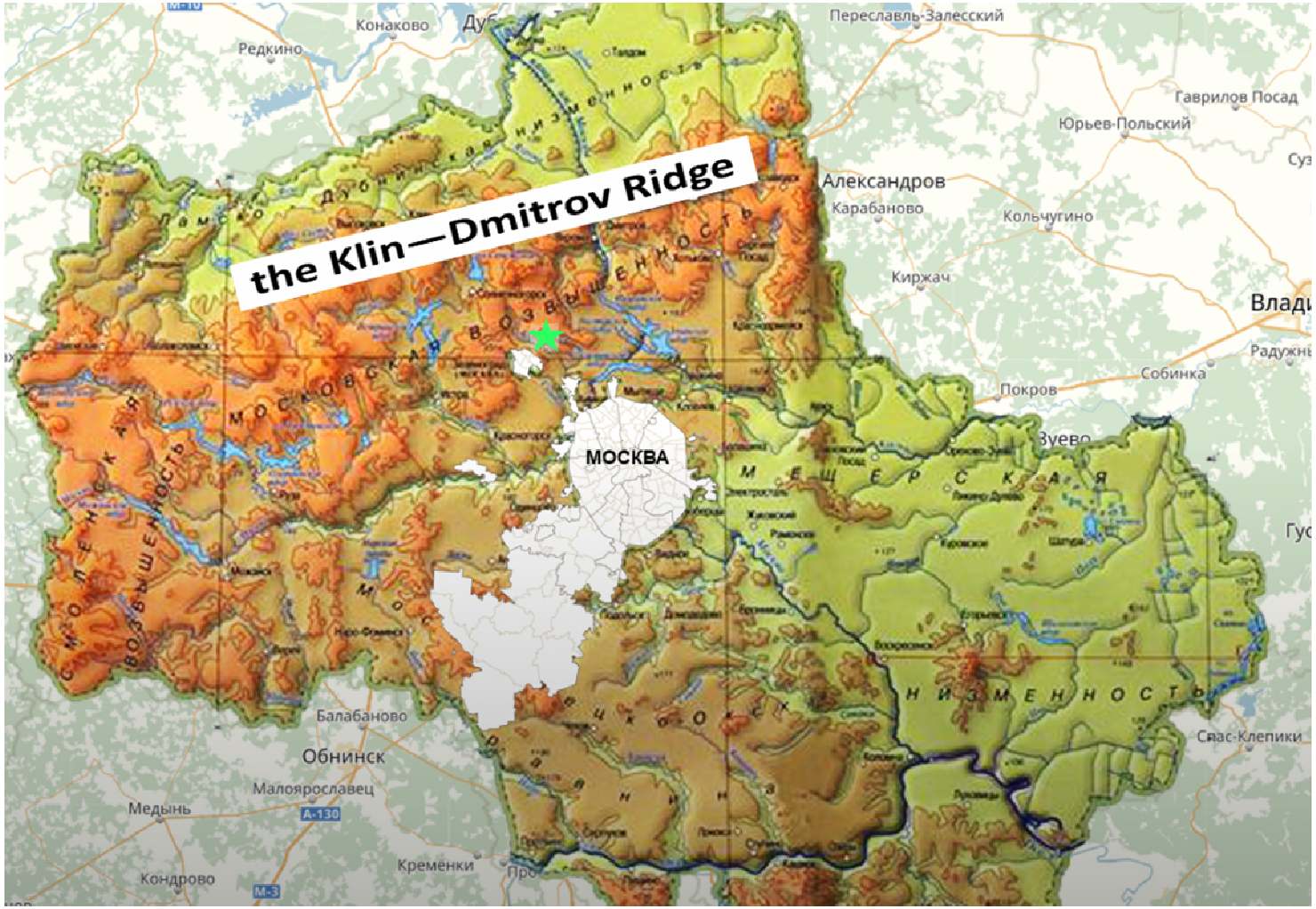
- **1. All information is entered into the database.**
2. **All pits have GPS coordinates.**
3. **The format of the annual studies of the same area allows to correct position of the parent material boundaries in question.**

THE AIM

Based on the project data, the aim of this study was to create fine-scale (1:10 000) digital map of parent materials of the TESEC territory.

OBJECTS - STUDY AREA

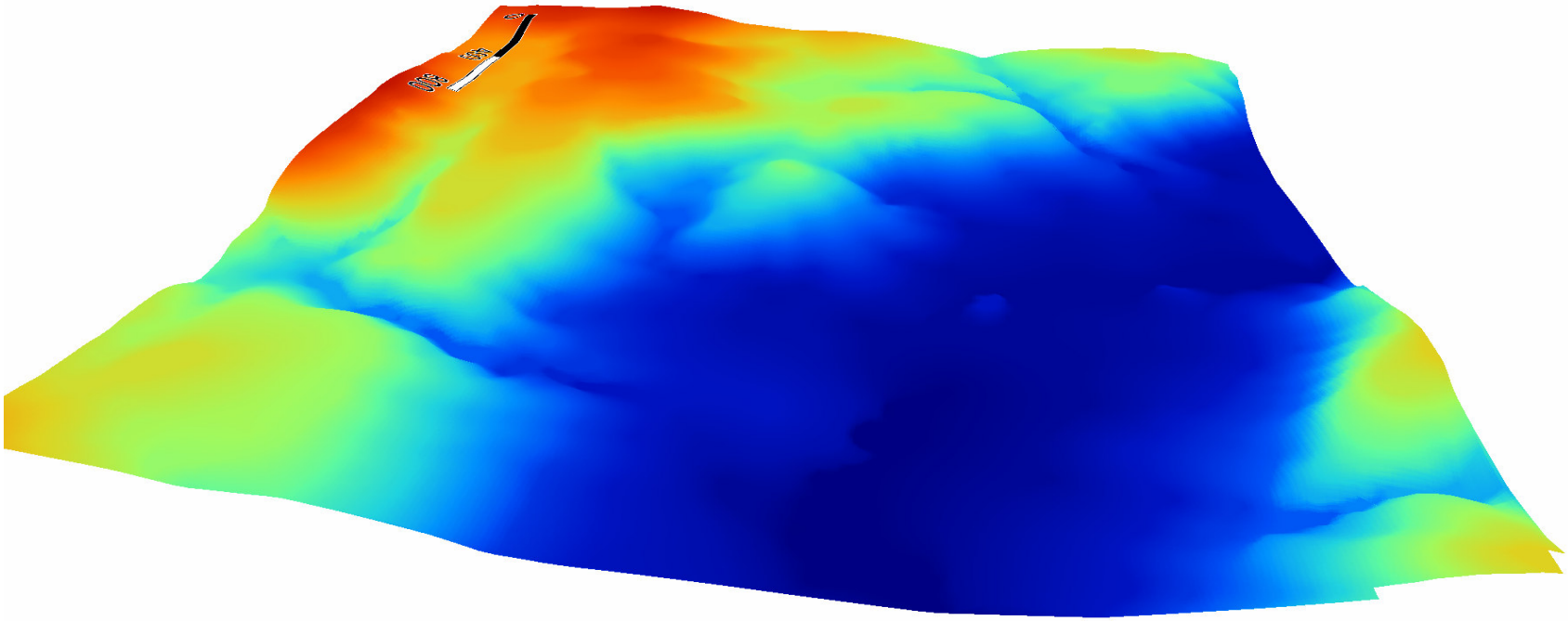
The territory of TESEC lies within the southern spurs of the Klin—Dmitrov Ridge.



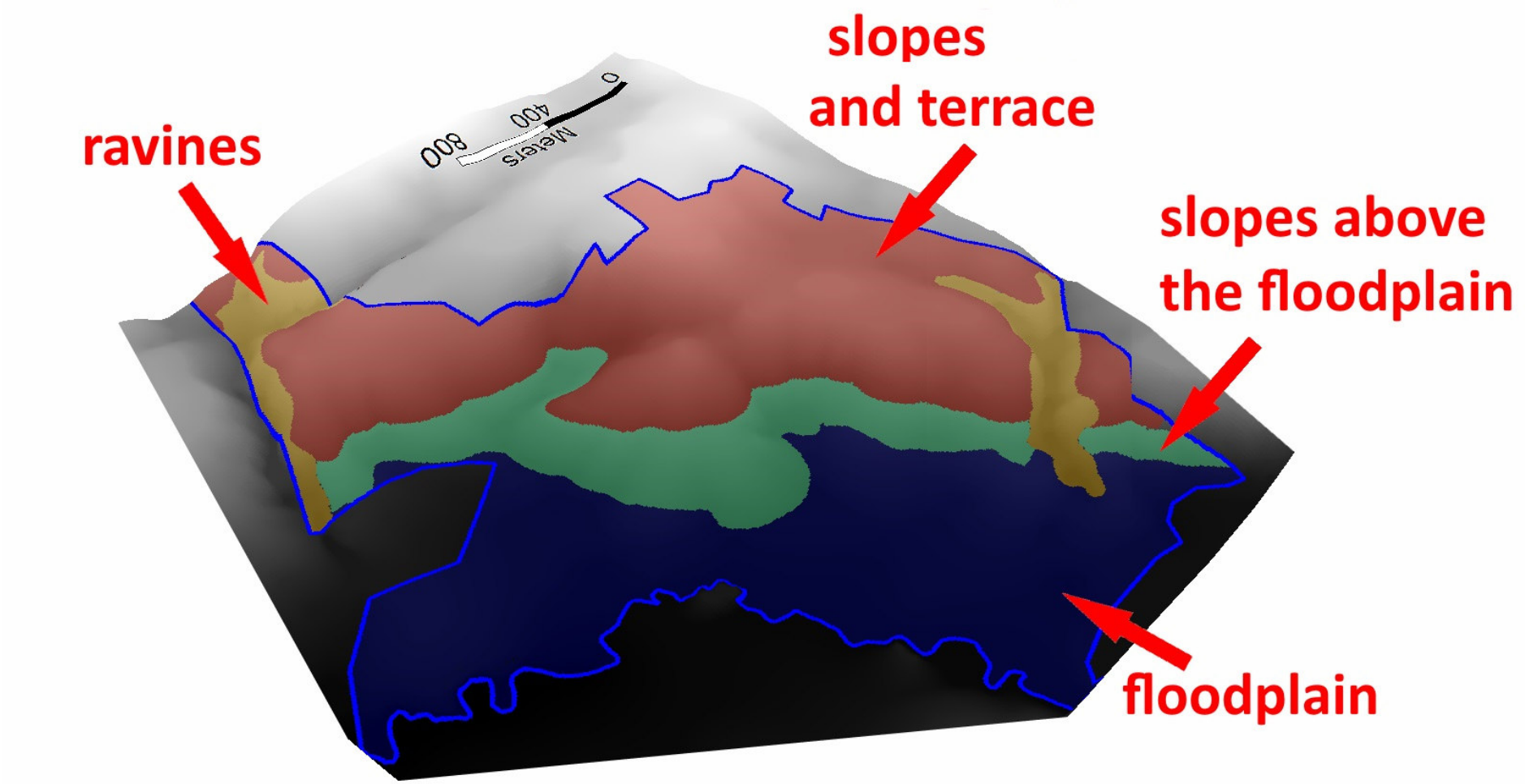
The major features of the relief were shaped by the Moscow glaciation.

Ancient glacial hollows were processed by the Klyaz'ma River and small rivulets

The modern hilly topography corresponds to the moraine landscape at different stages of erosion. The slopes are dissected by ravines. The river bed crosses the ancient lacustrine depression with peat deposits.



The four distinguished geomorphological areas are discussed



In total, 6 types of parent materials (11 - including binomial types) were identified on the studied area

1. **Covering loams** - loesslike deposits.

2. **Moraine deposits** - marginal zone of the moraine of Moscow age.

3. **Fluvioglacial deposits** - unsorted polymineral sand, cemented with iron hydroxides.

4. **Deluvial deposits** can be considered as shifted covering loams.

5. **Alluvial deposits** of the Klyazma river are very diverse, often layered, have different granulometric composition.

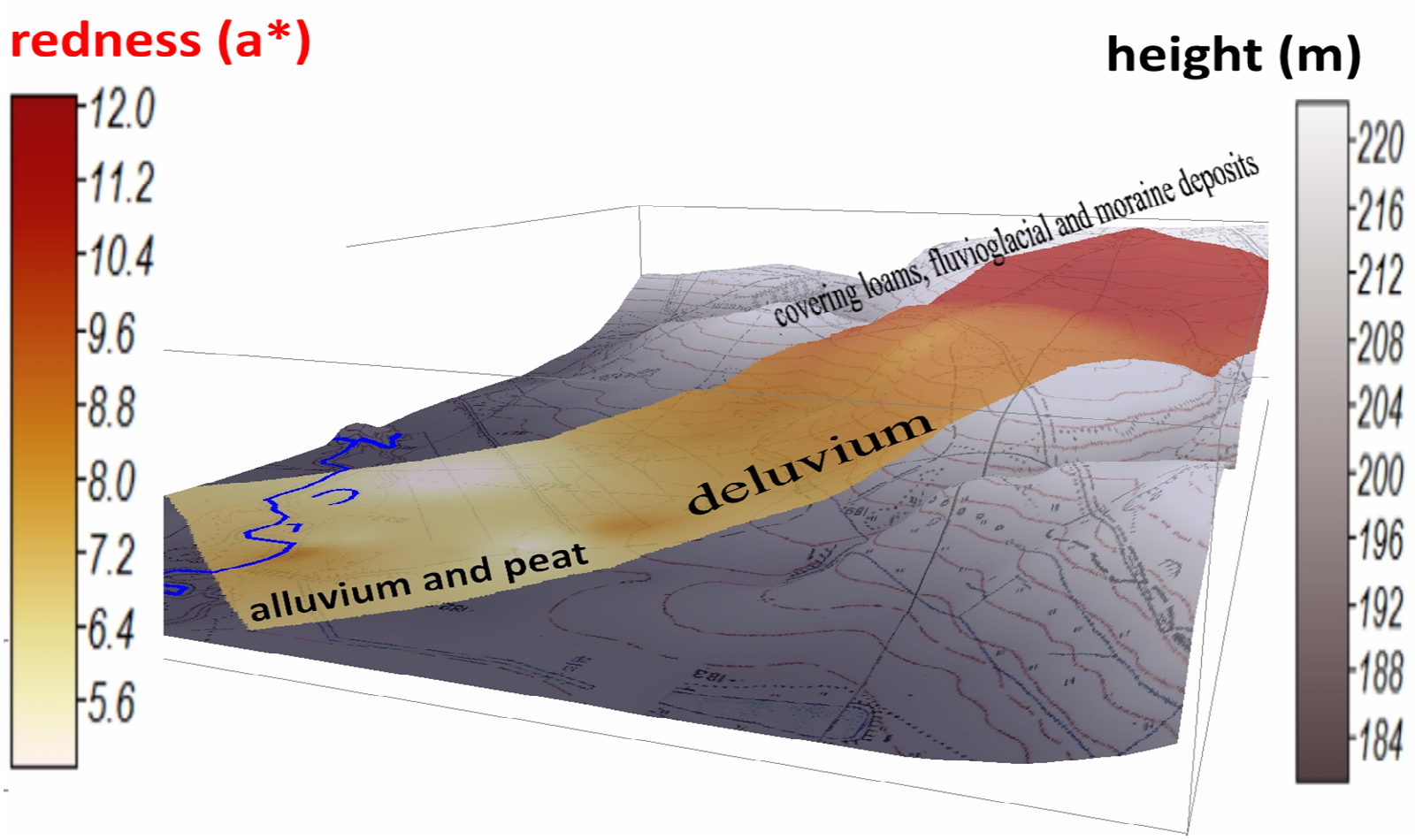
6. **Peat.**

To improve the diagnostic of parent materials we used their colour estimation with the spectrophotometer.

The parent materials can be differentiated by 1-3 colour coordinates in CIE-LAB colour space.

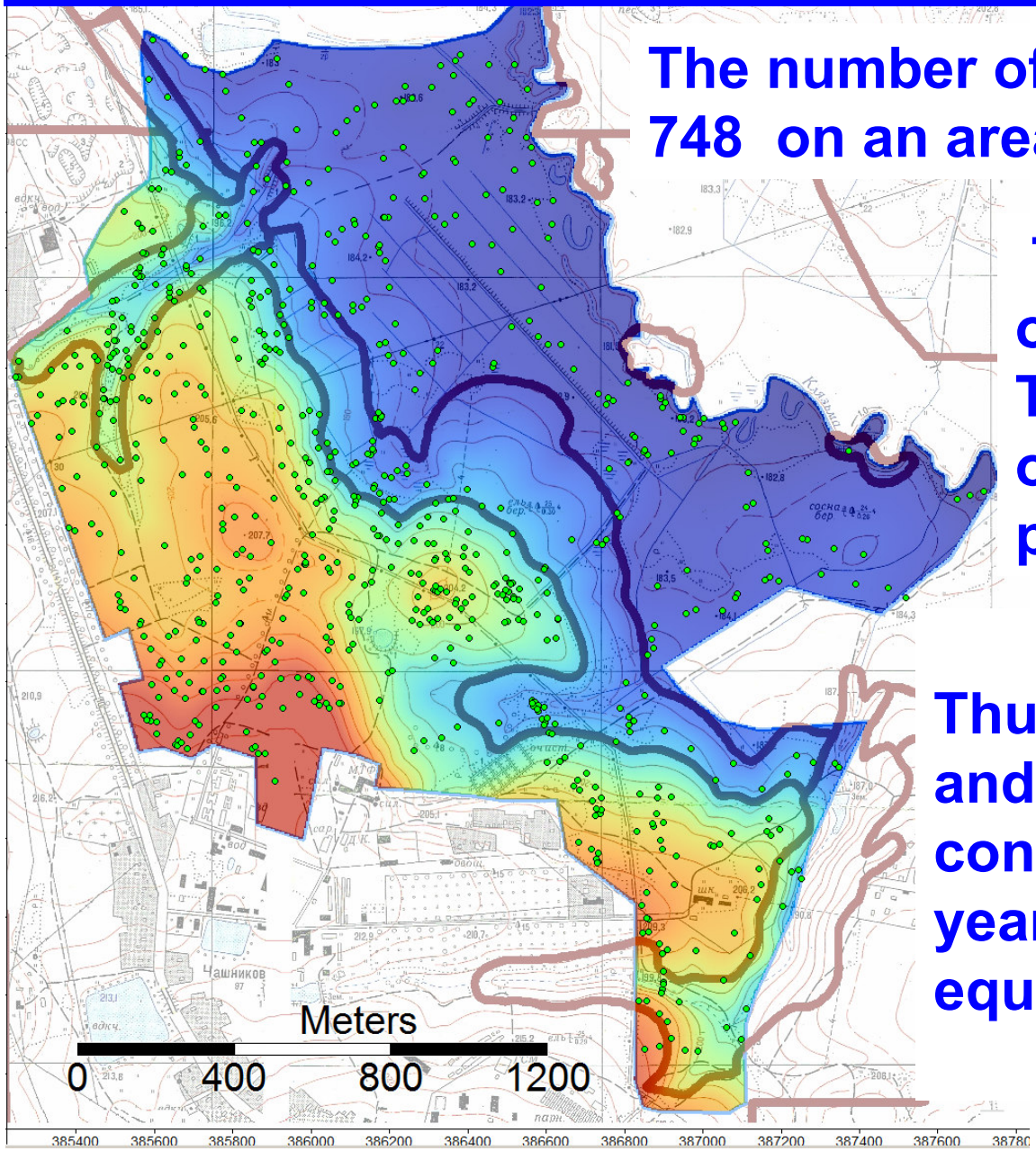
Parent materials	*N*	Colour	L*±SE_{L*}	a*±SE_{a*}	b*±SE_{b*}
Peat	37		29.1±1.7	5.3±0.3	8.1±0.9
alluvial deposits	26		51.3±1.7	5.6±0.3	15.5±0.7
deluvial deposits	7		51.6±6.2	7.0±0.5	16.5±2.0
covering loams	15		53.5±1.3	10.4±0.4	22.2±0.4
fluvioglacial deposits	6		46.8±0.9	11.1±0.8	21.7±1.0
moraine	4		49.6±1.6	13.4±0.9	23.4±0.6

When moving from the floodplain (alluvium and peat) upwards (covering loams, fluvioglacial and moraine deposits) through the floodplain slopes (deluvium) redness of the parent materials increases.



The colour characteristic of parent materials provides a reliable criterion for their differentiation.

The data sets



The number of sampling points - 748 on an area of 339 hectares.

Training set included odd sampling points. The test set consisted of even sampling points.

Thus, both the training and the tested samples contained data of all the years of the study in equal proportions.

To build a digital map we used 5 methods, where the independent variables were:

X, Y coordinates,
height, slope,
plan and profile curvature,
and a categorical geomorphological index of the territory.

Methods of building a digital map

Method	*A0*	*Kappa*
KNN - *K-Nearest Neighbors*	0.70	0.66
MM - *Match Method*	0.74	0.70
SANN - *Automated Neural Networks*	0.63	0.57
SOLIM - Solim Solution 2013, Sample-based	0.68	0.63
SVM - *Support Vector Machines*	0.64	0.57

A0 **- *overall accuracy***

Kappa - ***the smaller the kappa, the higher the probability that the coincidence is purely accidental***

The method to build a parent materials map does not significantly affect the overall accuracy of the digital map.

The highest values are for the K-Nearest Neighbors method and the Match Method. It is not surprising, since they both use the same computing algorithm - the proximity of points to each other by distance.

Method selection

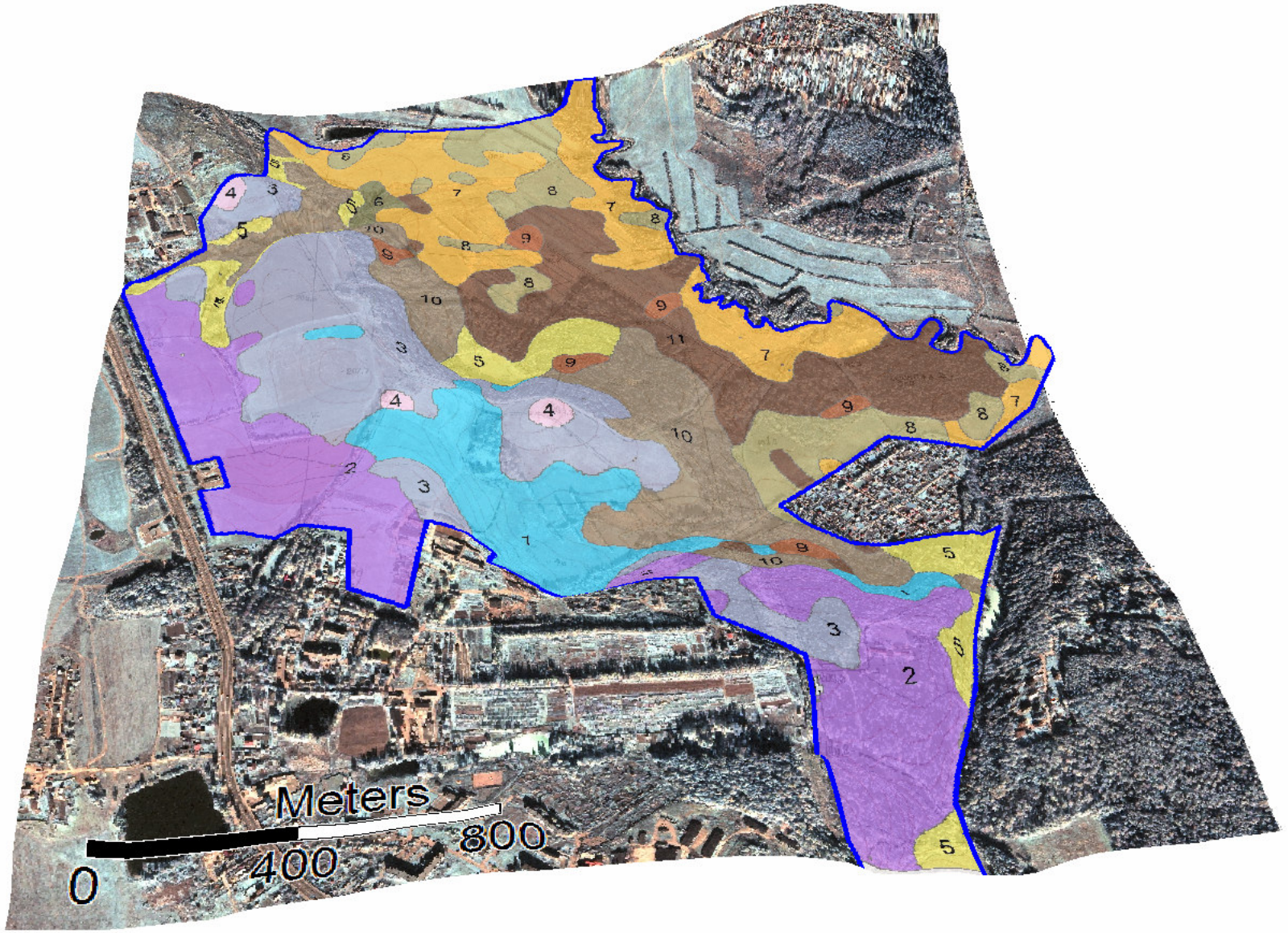
For further calculations we chose **the match method** as the best in the overall accuracy, and available as an automated software module directly connected with the SAGA, which greatly facilitates the work on building the map.

The **match method can be considered as formalized expert knowledge** based on interviews of experts, Russian normative documents on the building of soil maps, as well as the Russian classification of 1977.

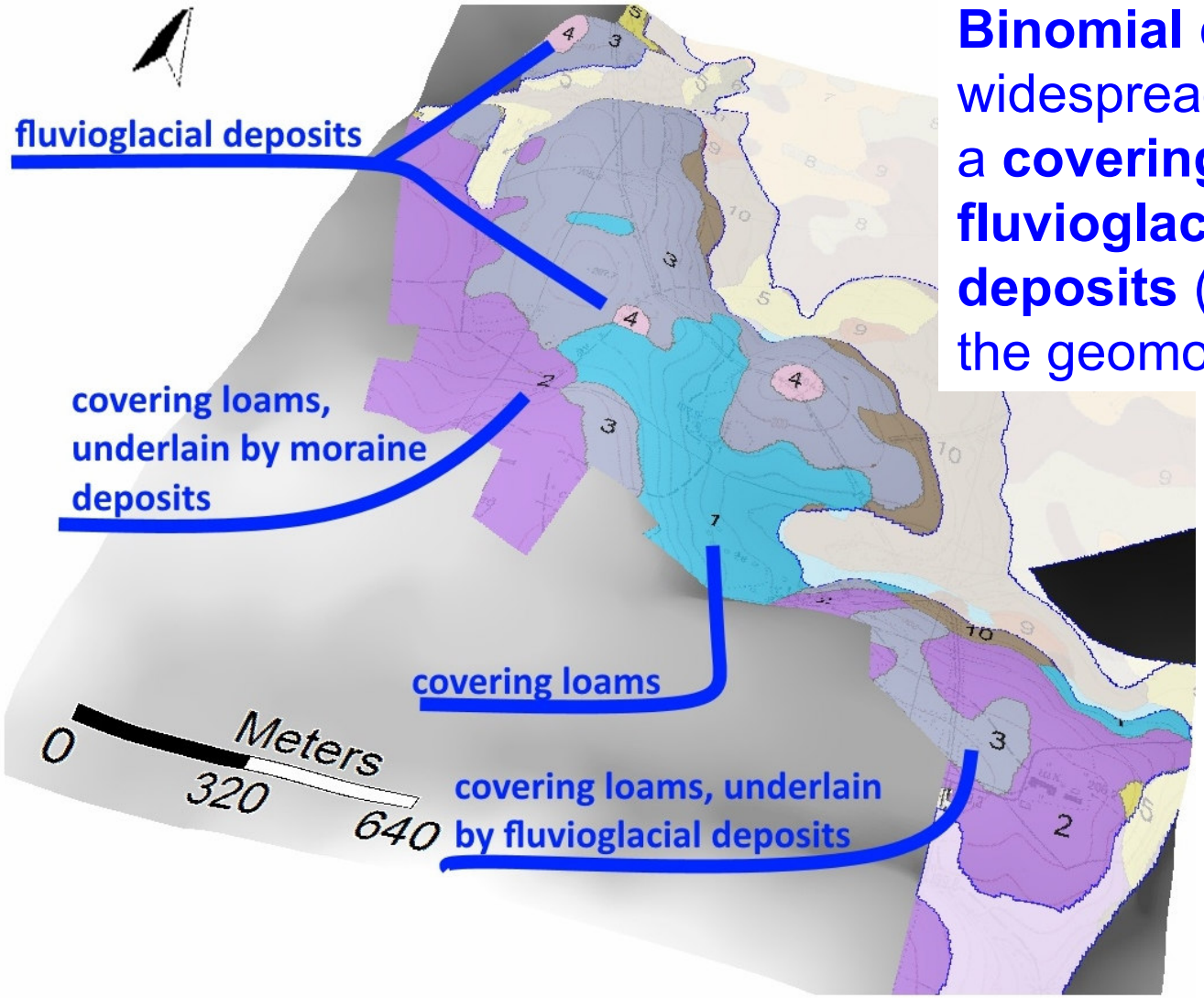
Building a map

After determining the method, having the greatest accuracy, a map of parent materials was built for all sampling points (both even and odd).
SAGA was used as the GIS platform.

Analysis of the distribution of parent materials across the territory



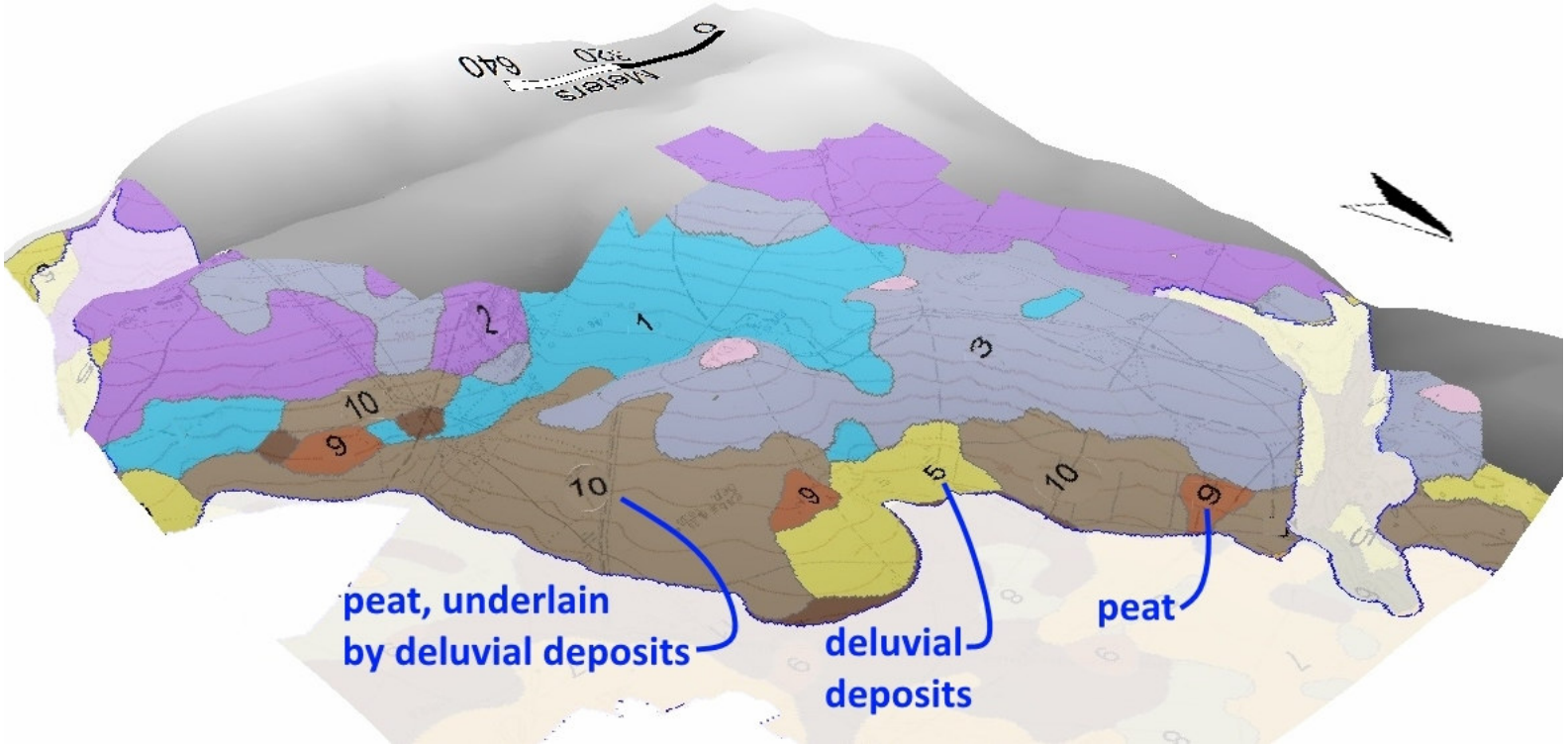
Slopes and terraces



Binomial deposits are most widespread:
a **covering loams**, underlain by **fluvioglacial** (41%) or **moraine deposits** (35% of the area of the geomorphological region)

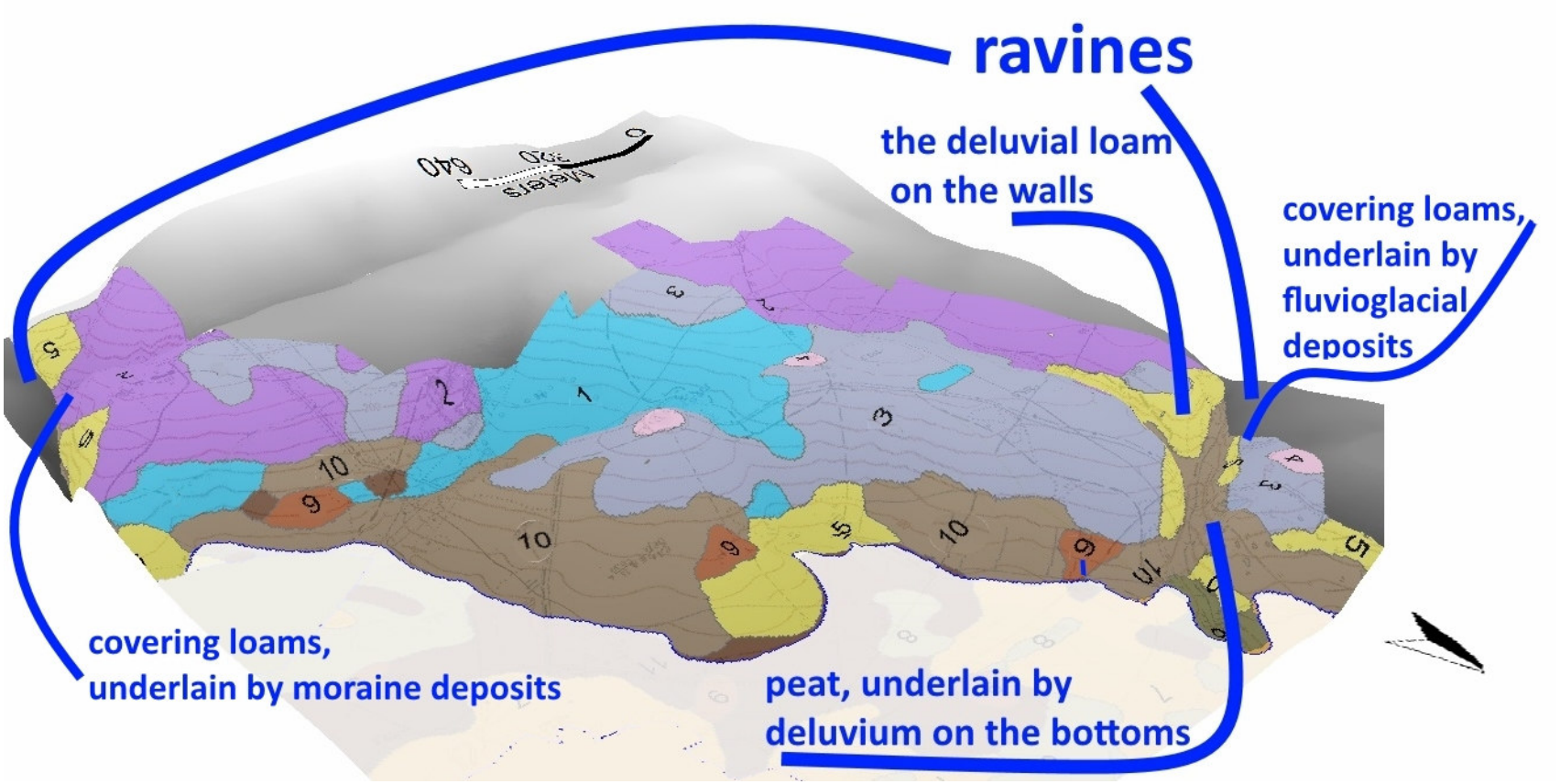
The **covering loams**, per se - 17%.
Small areas are occupied by **fluvioglacial deposits** on elevated relief elements (1%)

Floodplain slopes



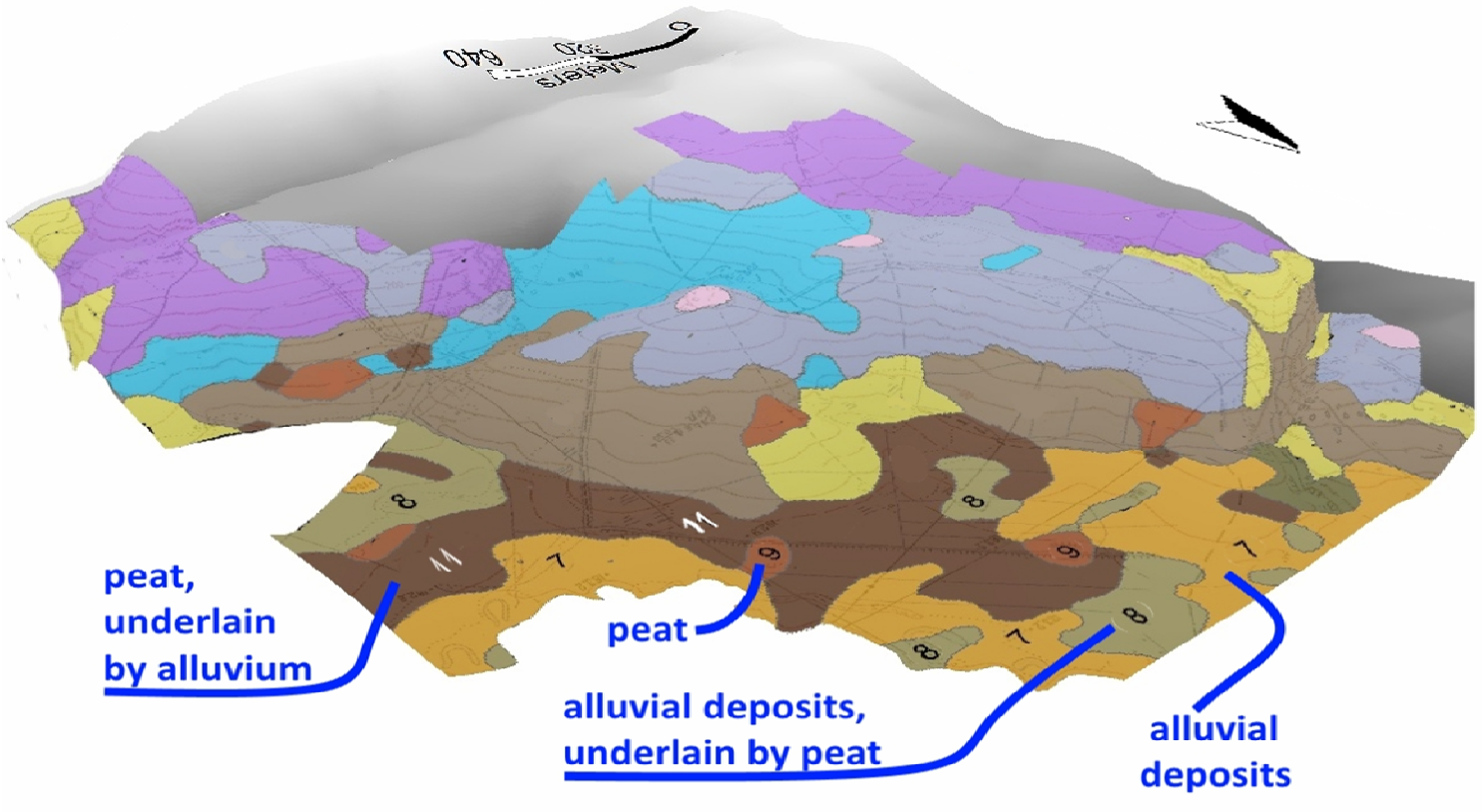
Floodplain slopes are marshy area, despite the melioration carried out, with a wide distribution of **peat, underlain by deluvial deposits** (66%), and **peat** (6%). In the not bogged parts parent materials are represented by **deluvial deposits** (21%).

Ravines



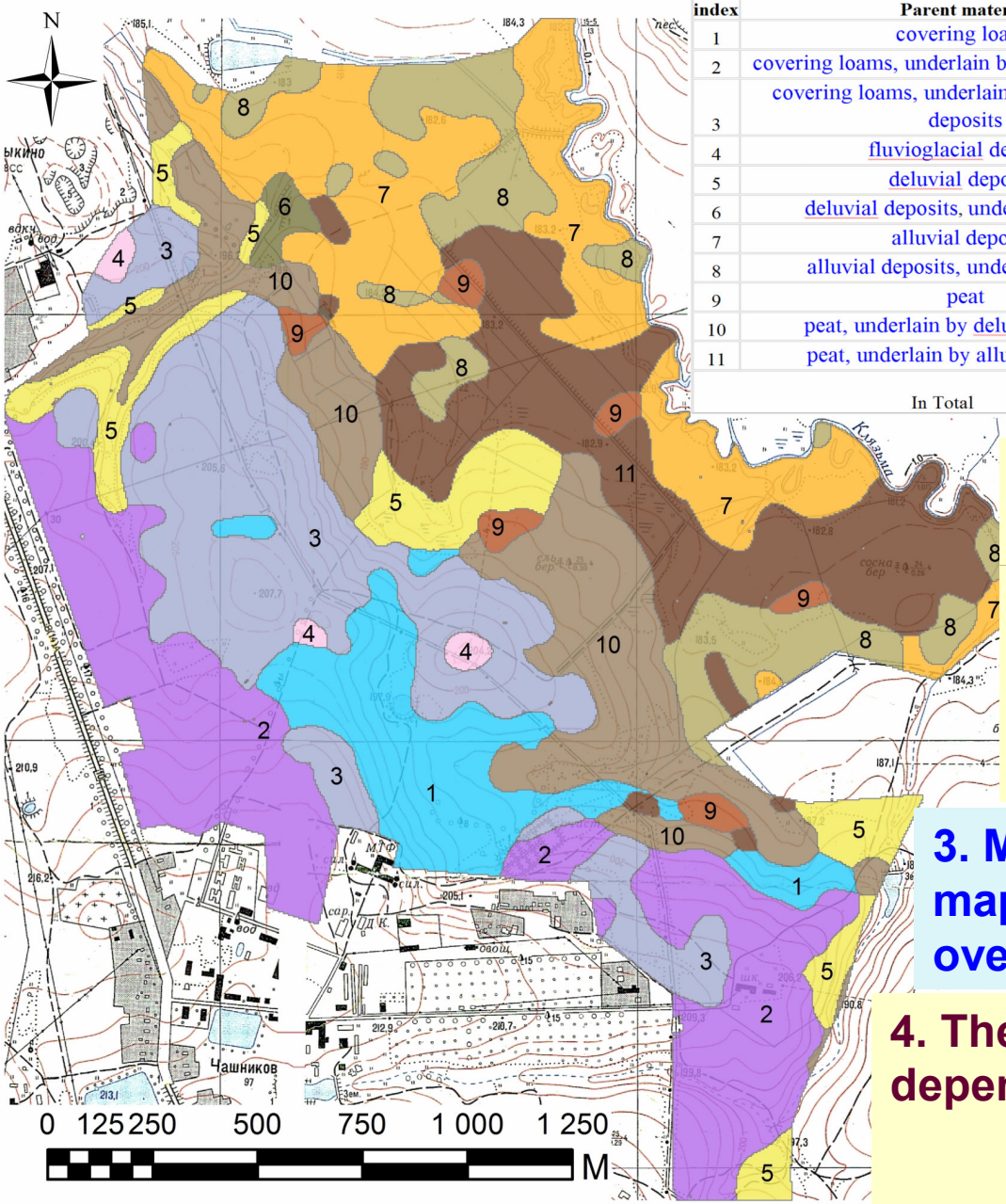
Two ravines reveal the deposits of the slopes, lying higher. Therefore, in addition to the deluvial loams on the walls of ravines (41%) and peat, underlain by deluvium on the bottoms (24%), there are covering loams, underlain by moraine (28%) or fluvioglacial deposits (2%).

Floodplain



Alluvial deposits of the Klyazmy river are extremely diverse in texture and colour.

In addition to the alluvium per se (40%), there are peat (2%), alluvium above peat (23%), and peat, underlain by alluvium (35%). In the soil profiles there are ironstone includings and marl horizons, sometimes a clear stratification of alluvial deposits is visible.The bottom horizons are often gleyed.



index	Parent material	Area,%
1	covering loams	7,9
2	covering loams, underlain by moraine deposits	16,7
3	covering loams, underlain by fluvioglacial deposits	17,2
4	fluvioglacial deposits	0,6
5	deluvial deposits	6,6
6	deluvial deposits, underlain by peat	0,4
7	alluvial deposits	14,5
8	alluvial deposits, underlain by peat	8,4
9	peat	1,6
10	peat, underlain by deluvial deposits	13,2
11	peat, underlain by alluvial deposits	12,9
	In Total	100 (339 ha)

Conclusion

1. Based on extensive field survey, the main types of parent materials of the studied territory were revealed.

2. A statistically reliable criterion for the diagnosis of parent materials using colour characteristics in the CIE-LAB system is proposed.

3. Methods to build a parent materials map do not significantly affect the overall accuracy of the digital map.

4. The distribution of parent materials depends on the territory relief.

THANK YOU
FOR YOUR ATTENTION


16418
podzolic soil


16413
soddy soil


16415
peaty black bog soil


16421
soddy gley soil


16422
bog podzolic soil


16423
alluvial soddy acid soil


16425
alluvial meadow acid soil


16431
alluvial meadow bog soils


16424
alluvial bog limous peat soil

SOIL TYPES

TESEC CHASHNIKOVO, MOSCOW STATE UNUVERSITY