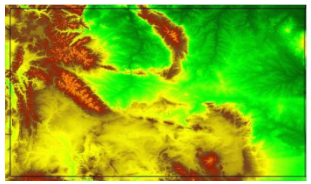
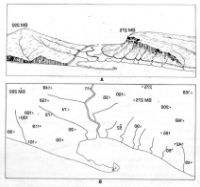
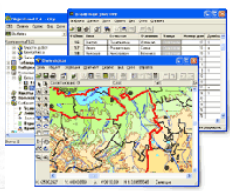




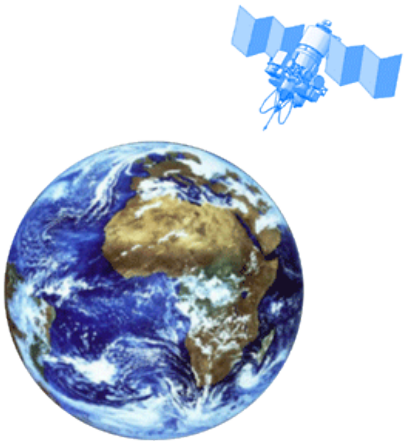



RUSSIAN ACADEMY OF SCIENCES
SIBERIAN BRANCH
BAIKAL INSTITUTE OF NATURE MANAGEMENT

Landscape dynamics assessment of dry climatic zones on the Baikal-Gobi transect from NDVI time series and field investigations

Sayapina D.O., Zharnikova M.A., Tsydypov B.Z., Garmaev E.Zh.

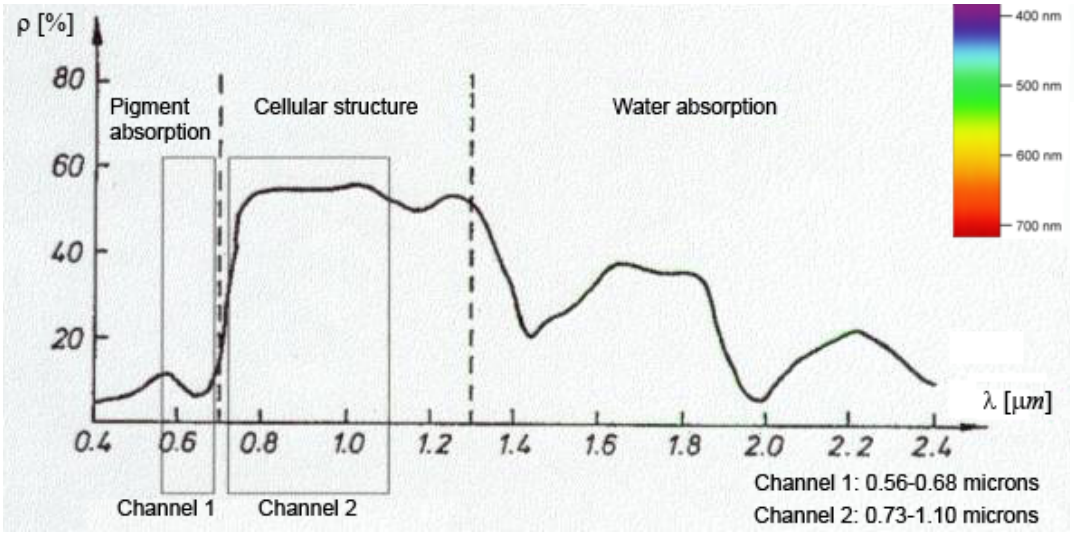
Baikal Institute of Nature Management SB RAS, Sakyanovoi st., 8,
Ulan-Ude, Russia, 670047



Tomsk – 2016

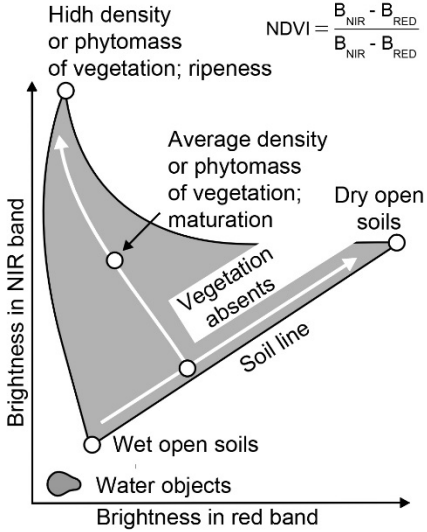
INTRODUCTION

- ✓ Land degradation and desertification processes are widespread in natural and economic territories of Russia and Mongolia.
- ✓ In the article No. 1 of the "Protocol on Scientific Cooperation between the Siberian Branch of Russian Academy of Sciences and the Mongolian Academy of Sciences" (Ulan-Ude, 16.07.2010) problems of desertification, protection of plants and pastures are among the priority directions for collaborative research. Out of 3.5 thousand kilometers of the common Russian-Mongolian border more than 60 % is the transboundary territory within the boundaries of the Baikal region. As a natural border, the transboundary territory is characterized by a unique combination of a variety of soils and landscapes, the main characteristics of which are: contrast and extremeness, exacerbated by desertification. The transboundary nature of desertification involves his study by an international collaboration between Russia and Mongolia and integrated interdisciplinary approach.
- ✓ The vegetation is the first experience the impact of desertification, and that's why investigation of its changes within the project "Development of the system of a comprehensive indication of desertification to assess the current state of ecosystems of Siberia and Central Asia, creating on its basis of prognosis models and monitoring systems" of the Program of the fundamental researches of the Presidium of RAS have a particular importance.
- ✓ Baikal Institute of Nature Management SB RAS and Space Research Institute RAS (Moscow) work together in the use of remote sensing and GIS technologies to solve scientific problems of monitoring the status and dynamics of vegetation cover. Automated methods of monitoring and dynamics of vegetation cover are based on the analysis of spatial and temporal variations of Normalized Difference Vegetation Index (NDVI) and its comparison with the index variation of the previous years.

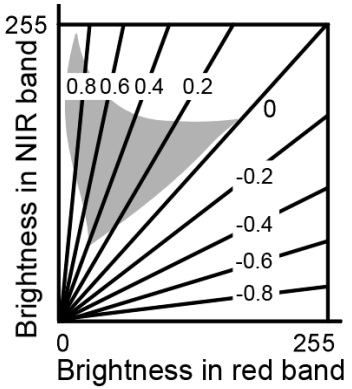


The curve of spectral brightness for active vegetative plants. Pigment absorption on the wavelength 0.66 μm, water absorption on the wavelength 1.43 and 1.93 μm

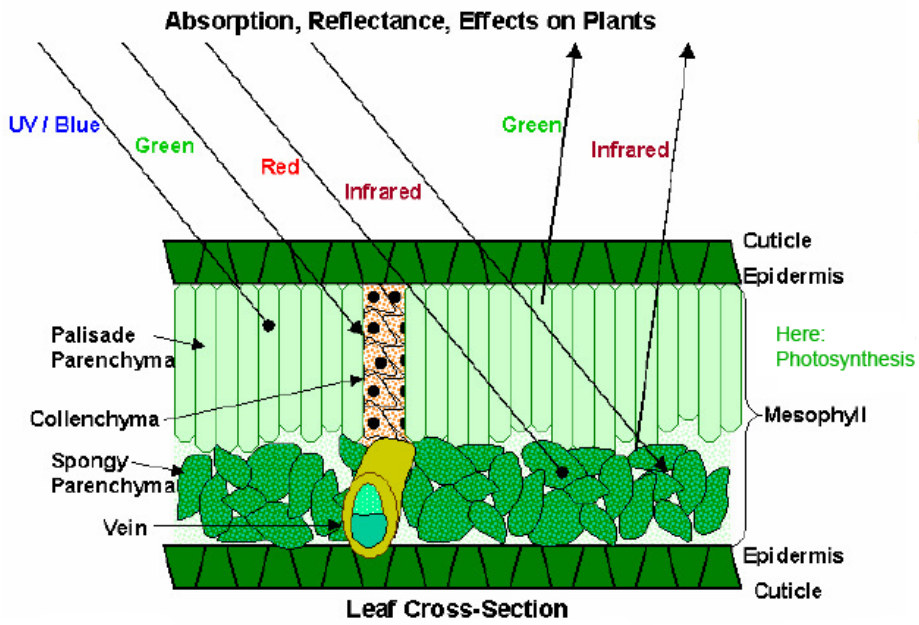
Normalized Difference Vegetation Index is numerical index of quantity of photosynthetic active biomass

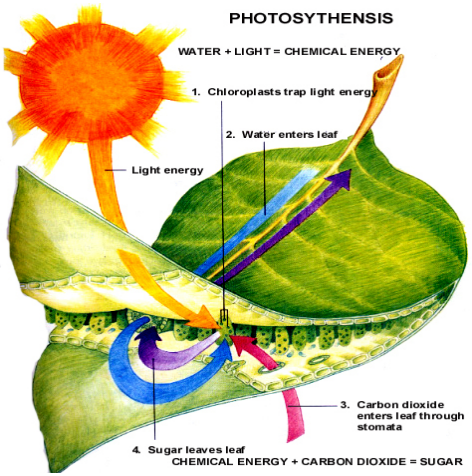


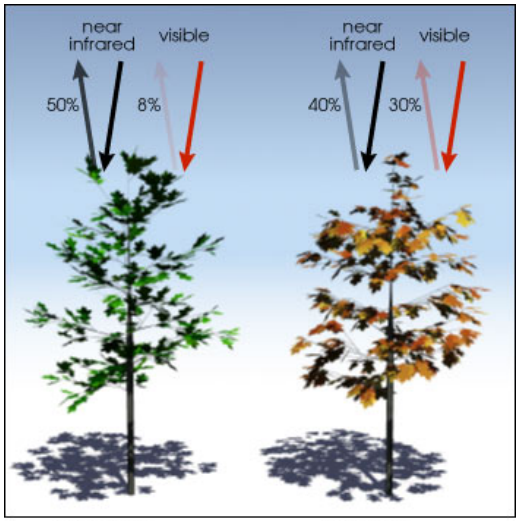
Vegetation, soils and water in the space of spectral features



NDVI ranging





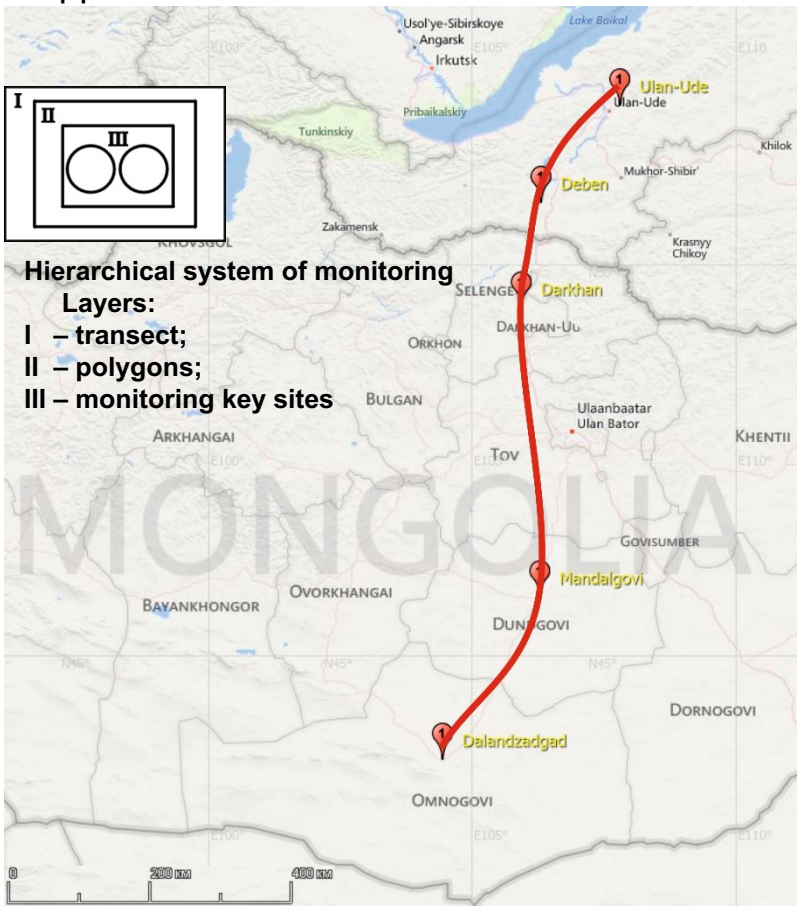


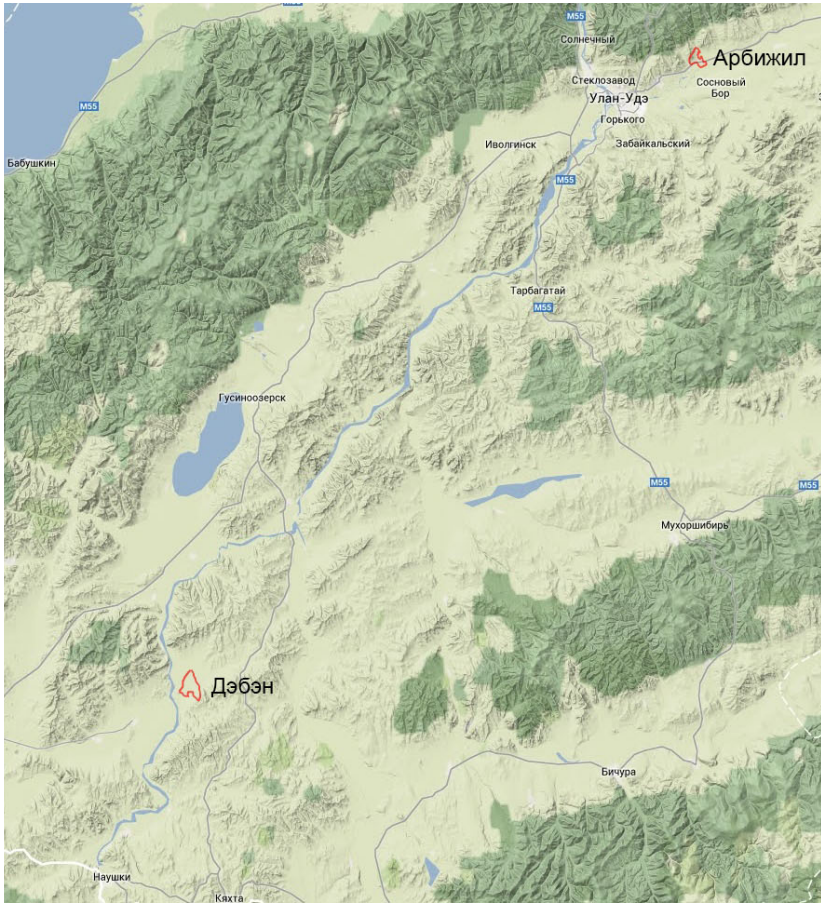
Cellular structure of active vegetative plants and processes of absorption and reflectance for different bands of optical spectrum

The example of NDVI calculation

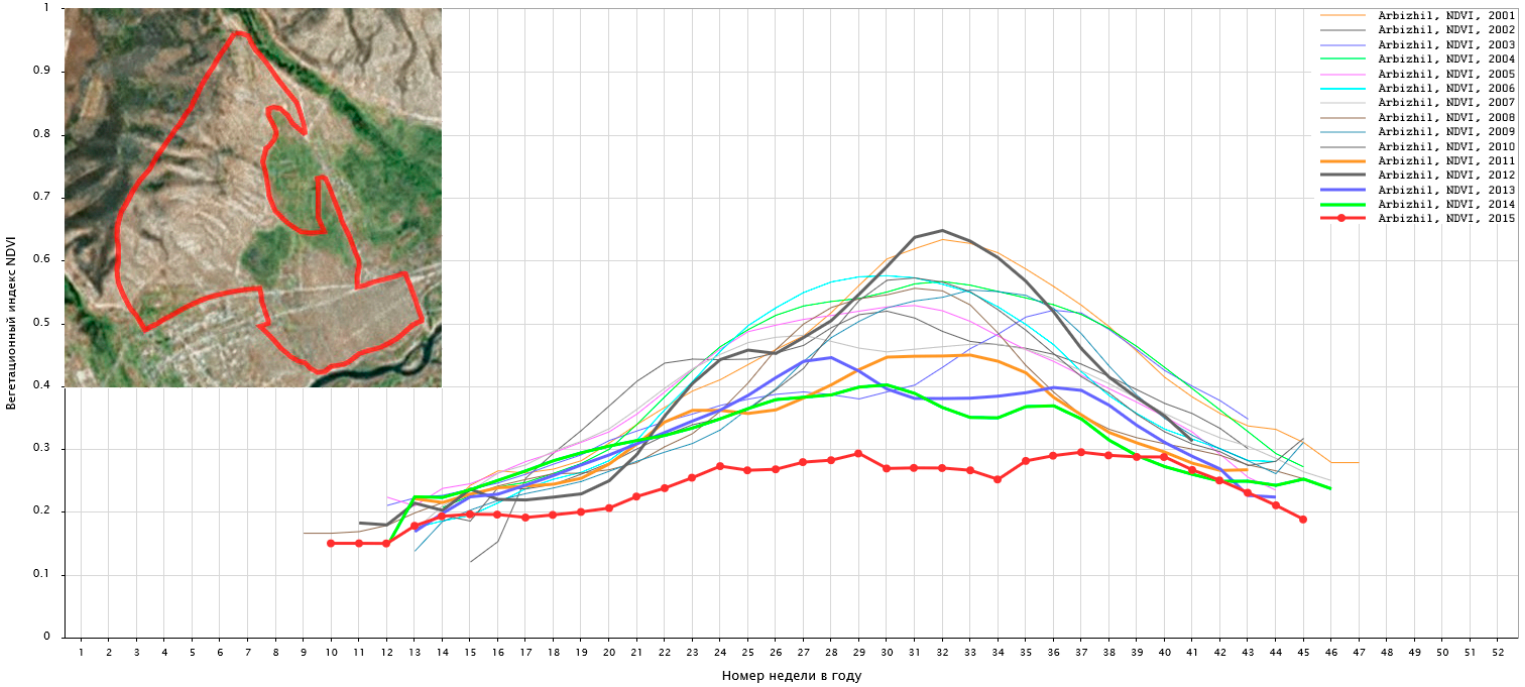
Over the years of working on the project «Development of desertification complex indication system for modern Siberian and Central Asian ecosystems and monitoring system evaluation» under the Program of fundamental scientific research, Presidium of Russian Academy of Sciences (2008-2014), a number of model monitoring polygons was established in different latitudinal zones of the Russian and Mongolian territories along the longitudinal Baikal-Gobi transect (105-107° E, 51-44° N). These polygons include a wide range of territories with dry climatic conditions. This work revealed the main factors, agents, and trends of development for desertification processes in different climatic zones on the Baikal-Gobi transect.

Two model polygons were considered in Russia: 1) «Arbizhil» (suburb of Ulan-Ude city); 2) «Deben», Selengisky district, Buryatia Republic. The first polygon is situated in a subhumid climatic zone. The second polygon is located in a semiarid climatic zone, its main feature is the prevalence of desertified steppes.

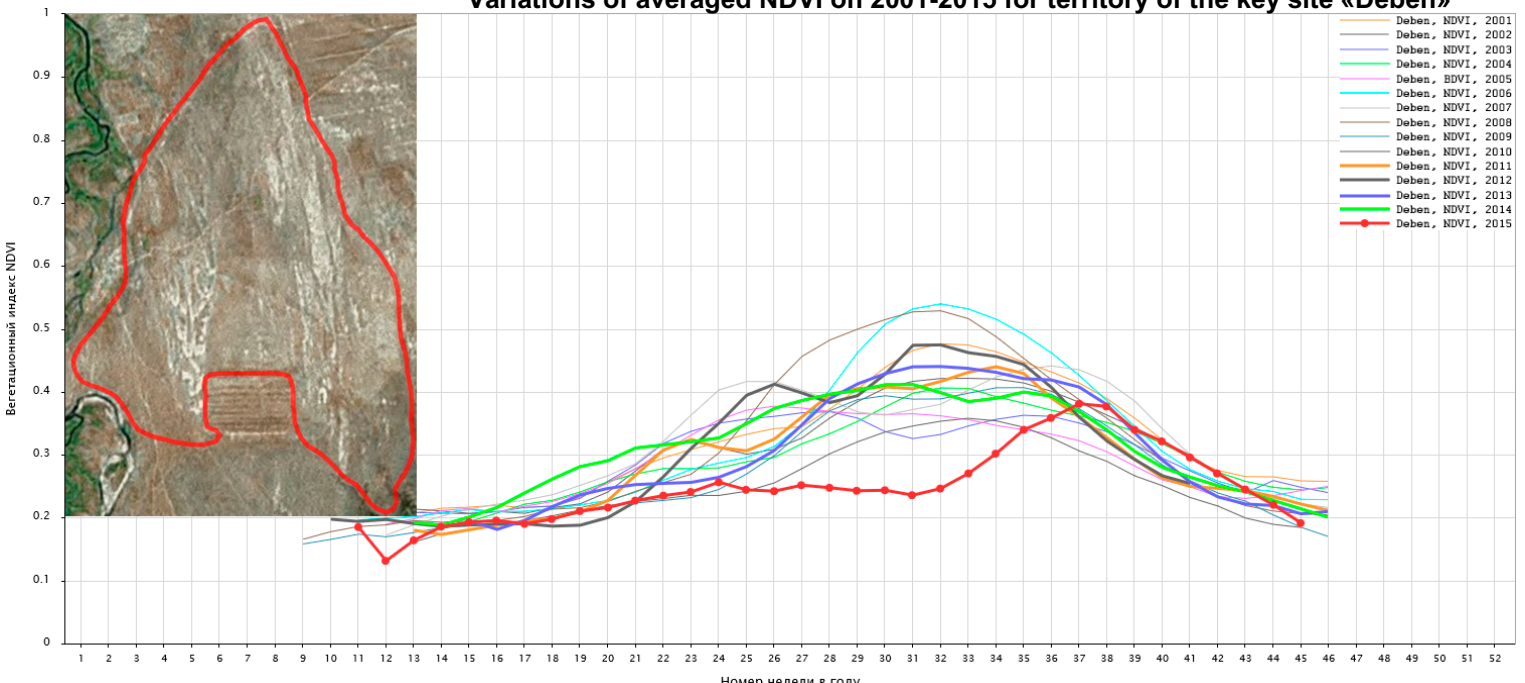


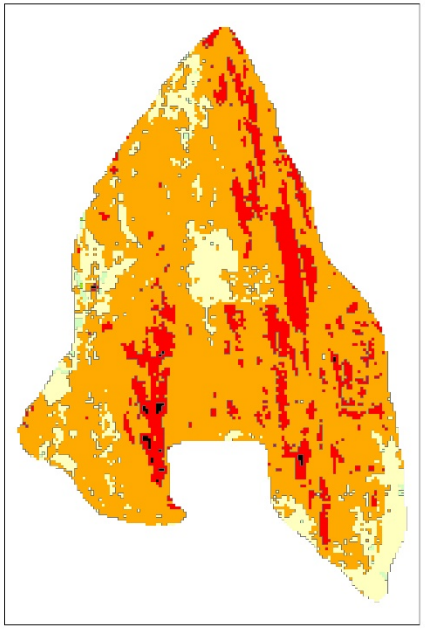


Variations of averaged NDVI on 2001-2015 for territory of the key site «Arbizhil»

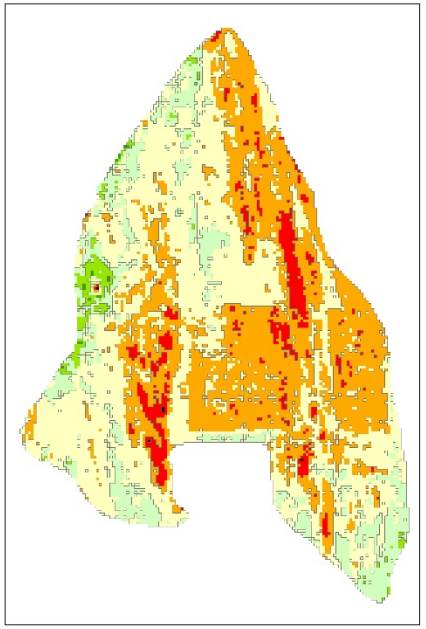


Variations of averaged NDVI on 2001-2015 for territory of the key site «Deben»

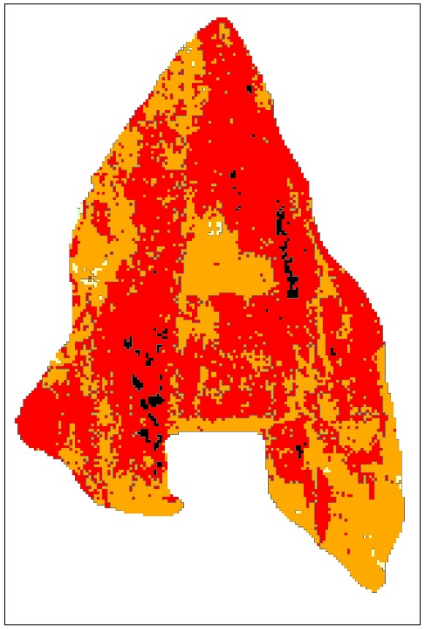




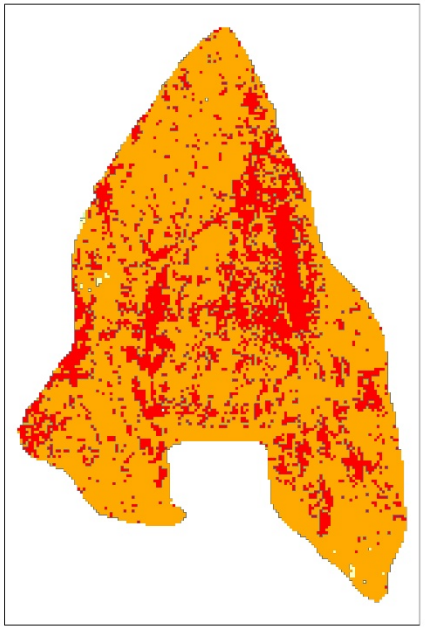
6 September, 1989



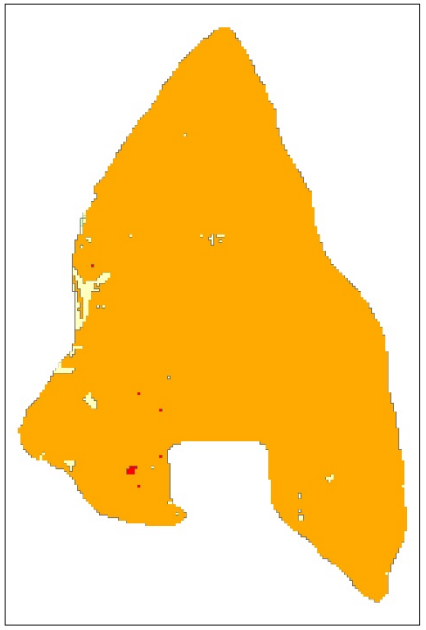
12 September, 1994



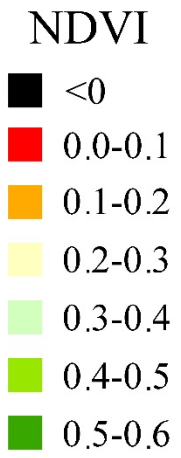
10 September, 2002



8 September, 2010



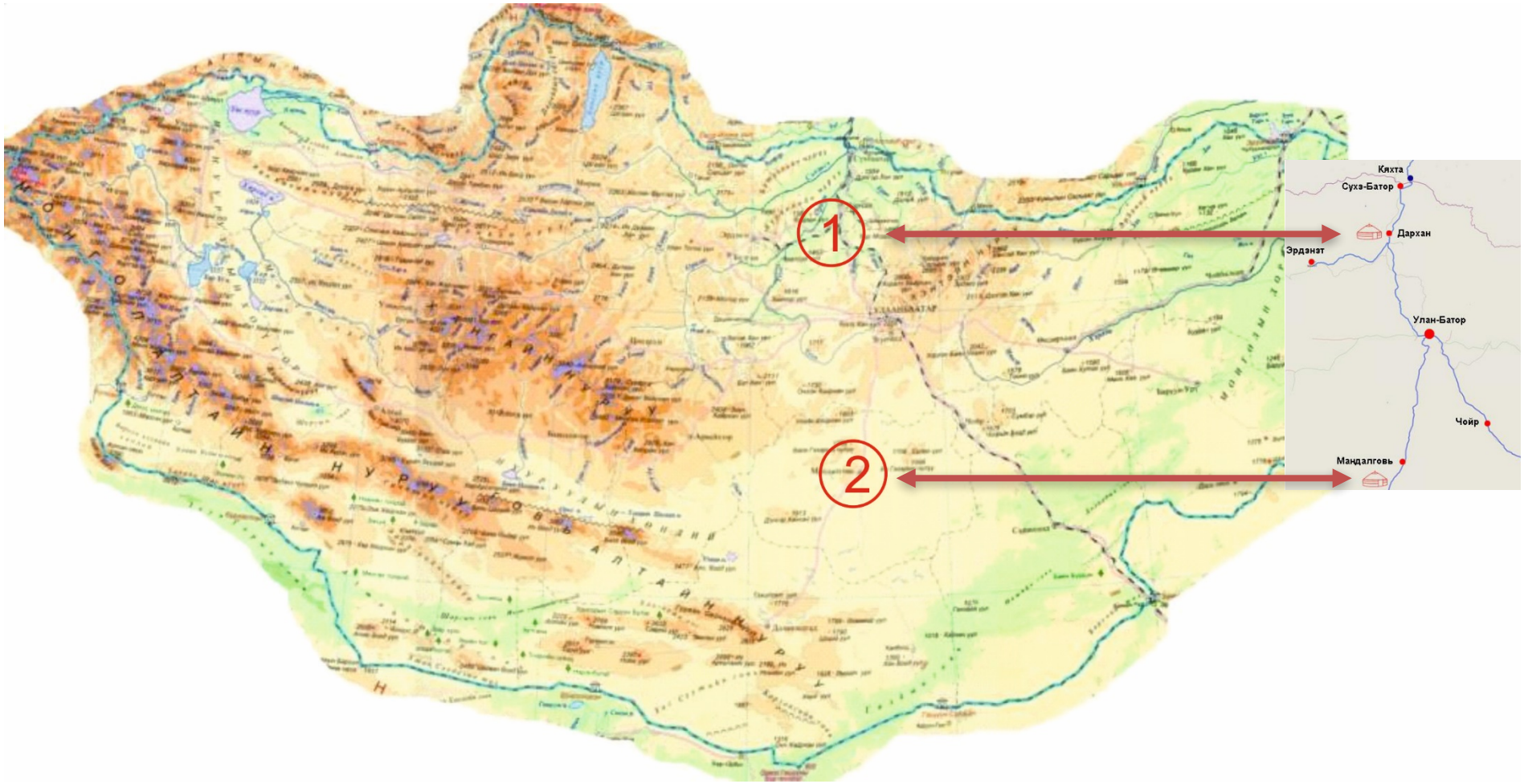
3 September, 2014

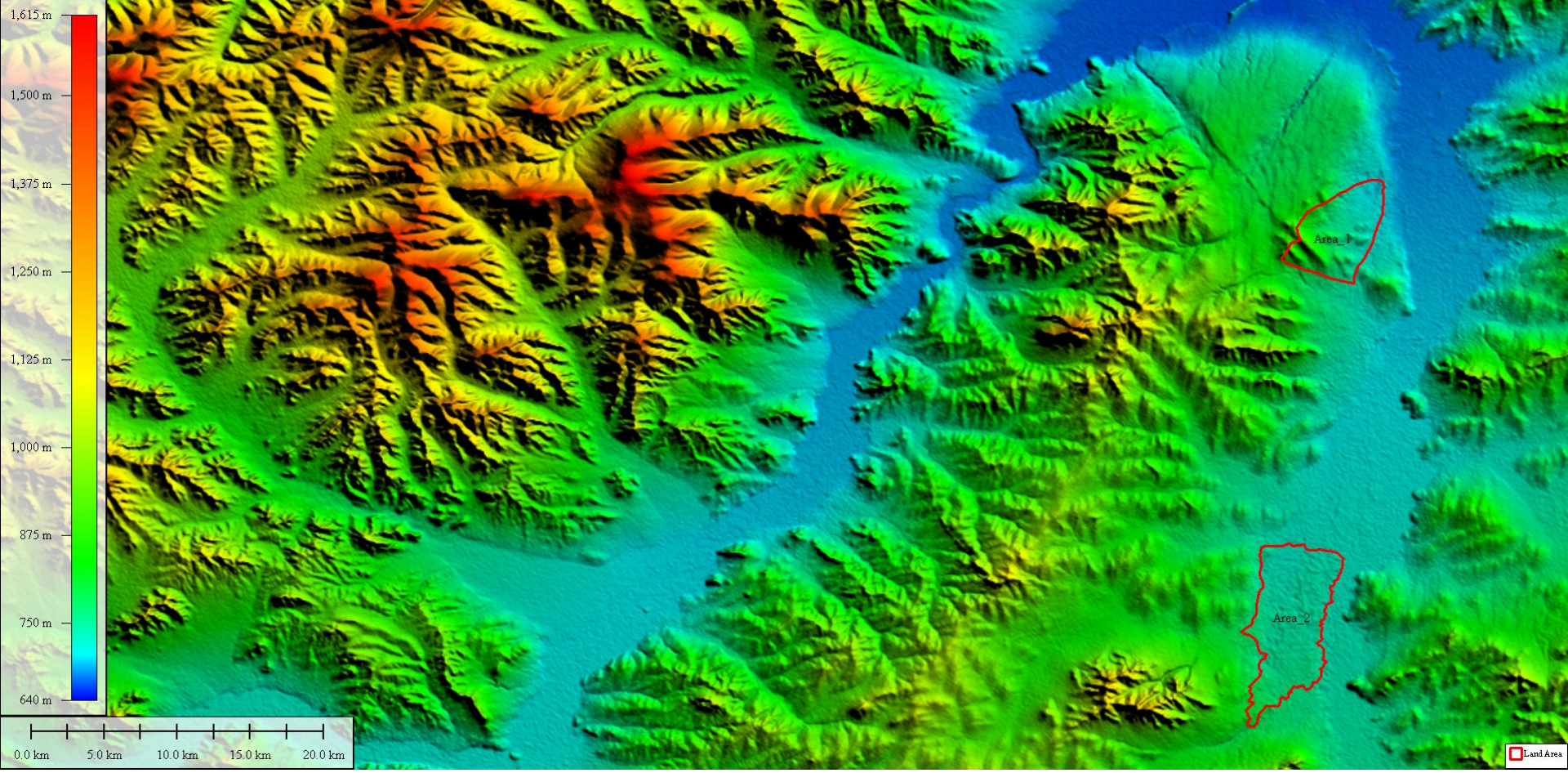


Classification on NDVI graduation for the polygon «Deben»

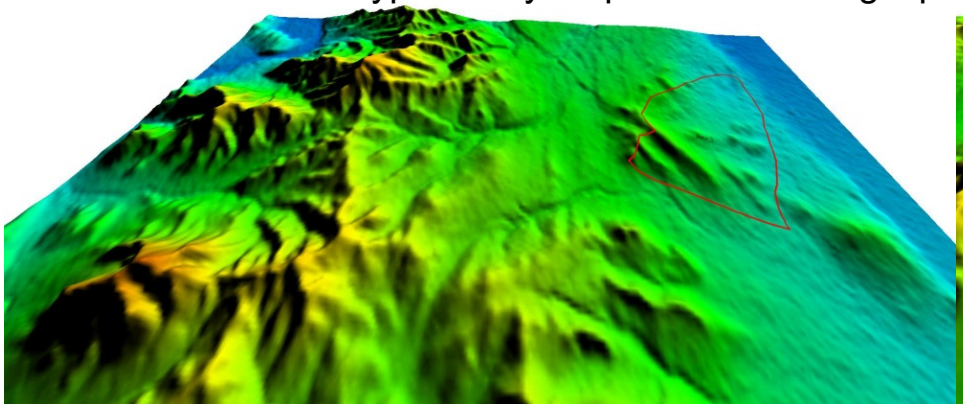
Two model polygons were considered in Central Mongolia: 1) the Kharaa River downstream basin and the Orkhon River right feeder (territory of the Selenge and Darkhan-Uul aimags); 2) the central part of Dundgovi aimag (Mid-Gobi). The first polygon is situated in a semiarid climate zone with grassland and bunchgrass steppes. The second polygon is located in an arid climate zone; from botanical and geographical points of view, its main feature is the prevalence of desertified steppe.

To study biophysical parameters of vegetation, using the normalized difference vegetation index NDVI, three main areas were chosen: two of them are situated on the territory of Kharaagol, monitoring the model polygon, and the third one is in the Mid-Goby polygon.

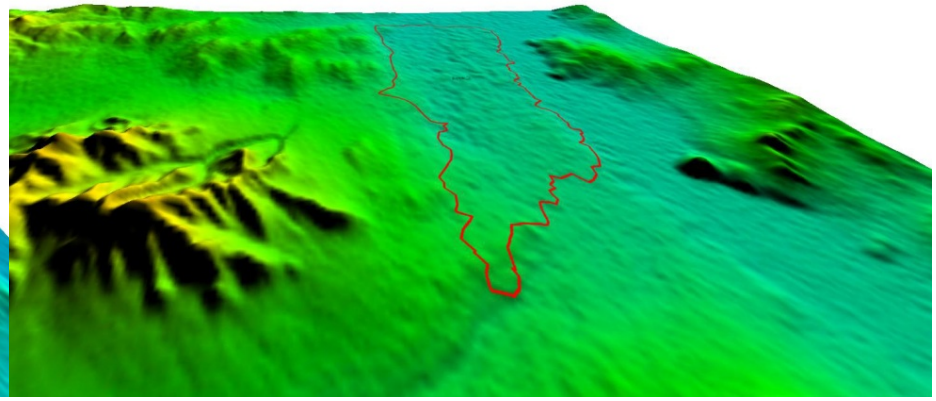




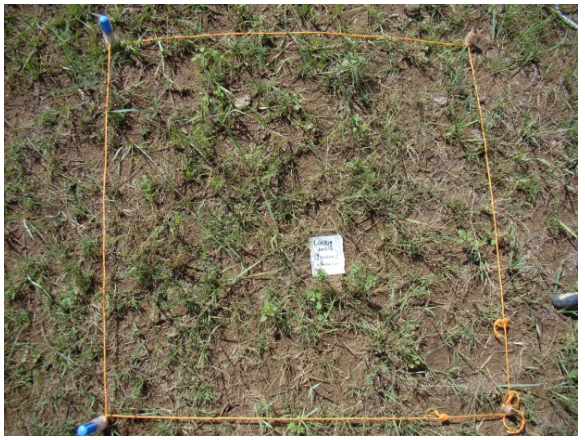
Hypsometry map of the Kharaagol polygon on the basis DEM SRTM v. 4

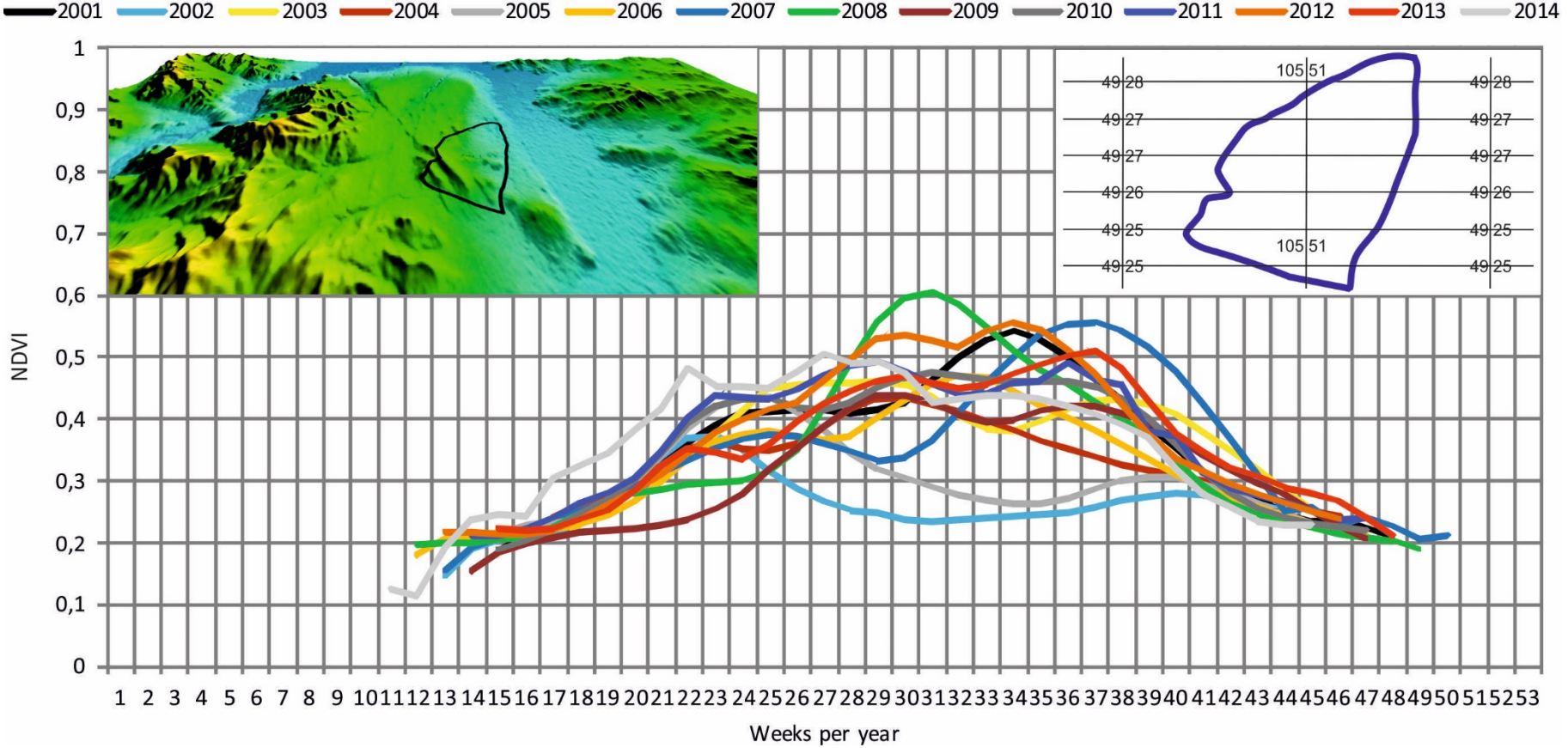


3D-view of the north area of the Kharaagol polygon

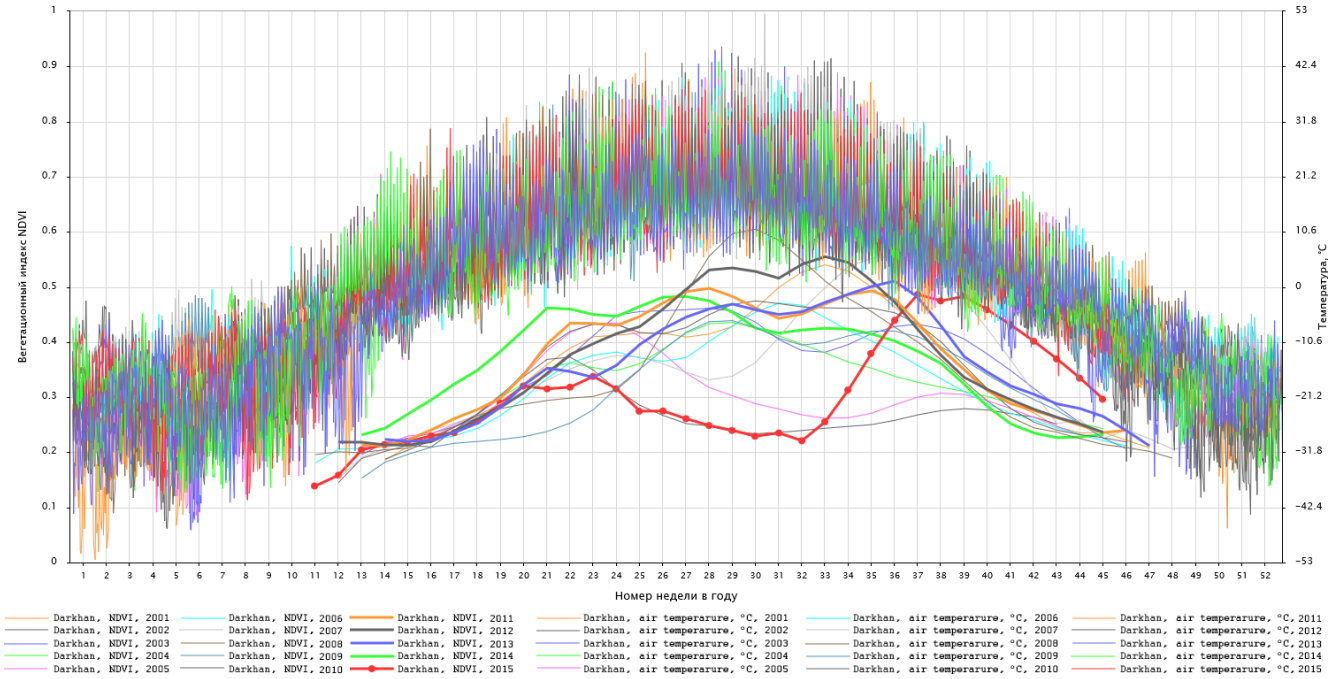


3D-view of the south area of the Kharaagol polygon

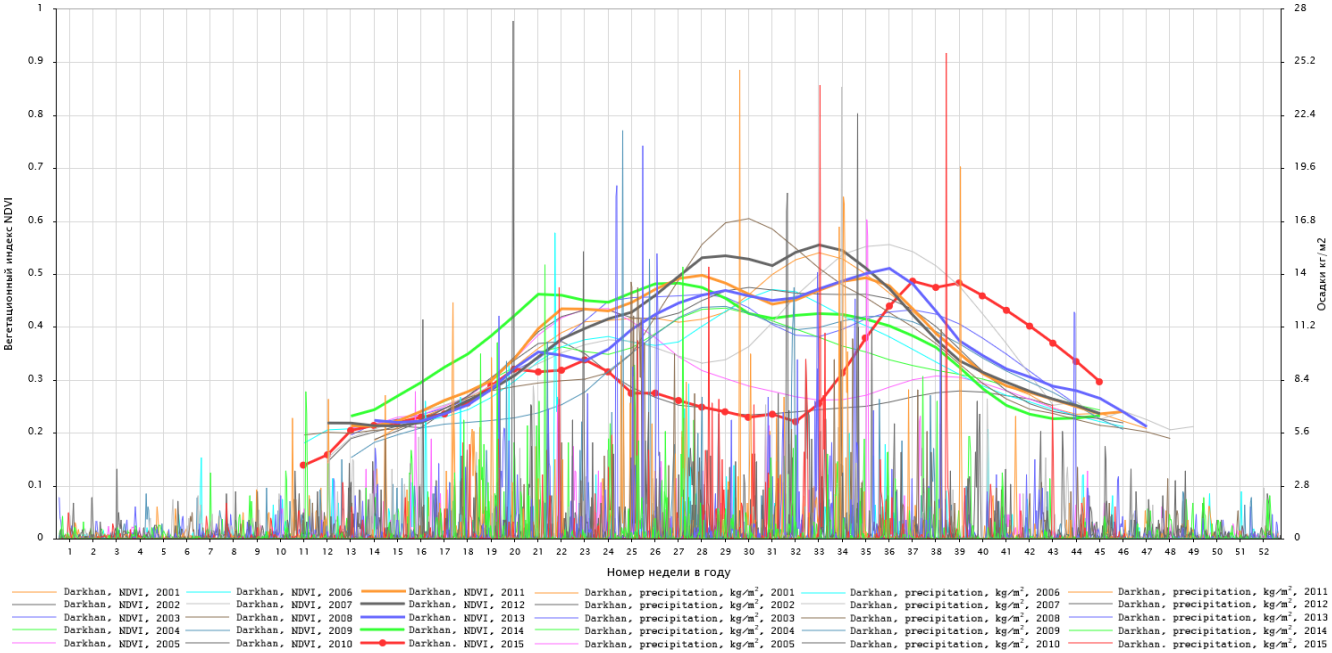




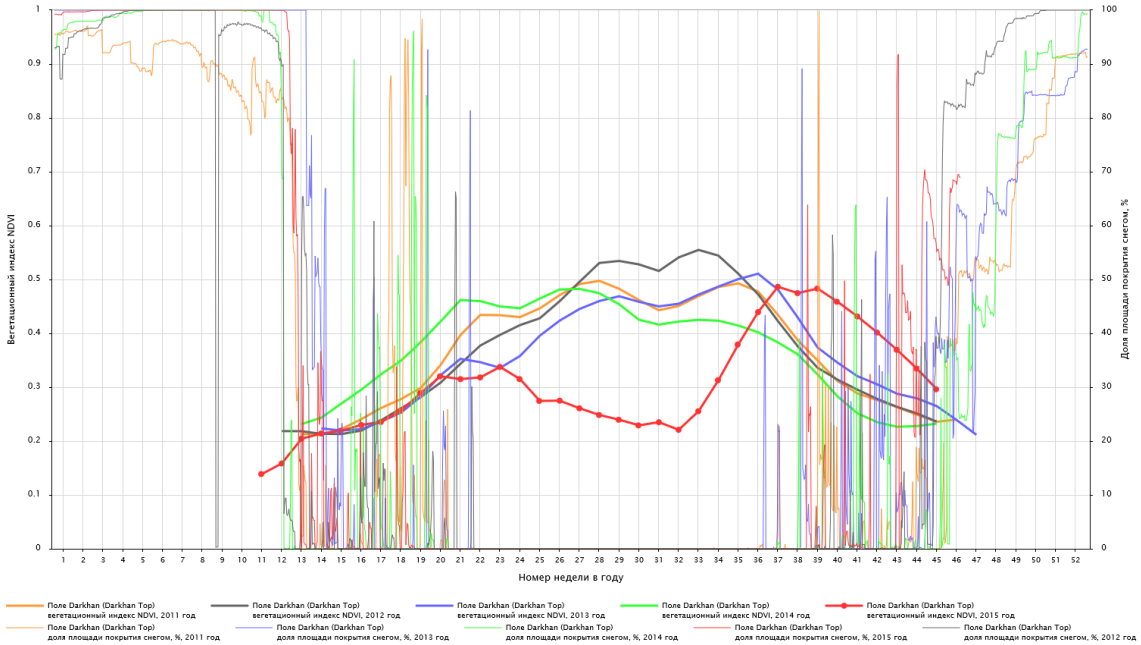
Variations of averaged NDVI on 2001-2014 for the north area of the Kharaagol polygon. The upper-right inserted image is the scheme of the site; the upper left inserted image is a 3D-view on the base of DEM SRTM



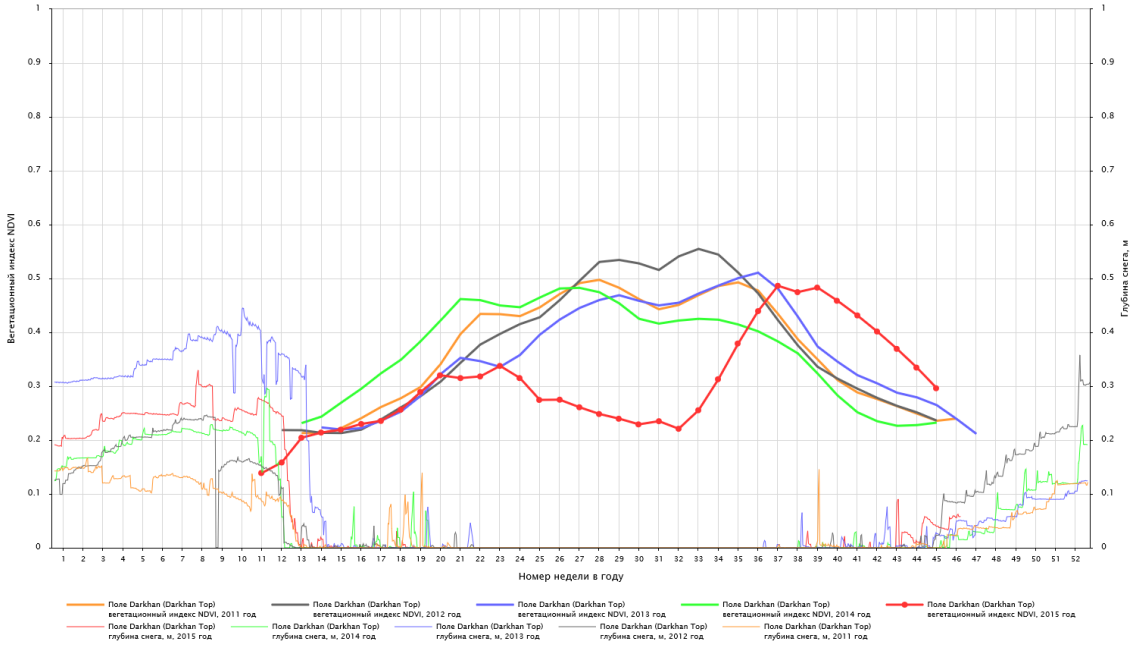
Ход осредненного NDVI и температуры воздуха за 2001-2015 гг. для территории участка № 1 Хараагольского полигона



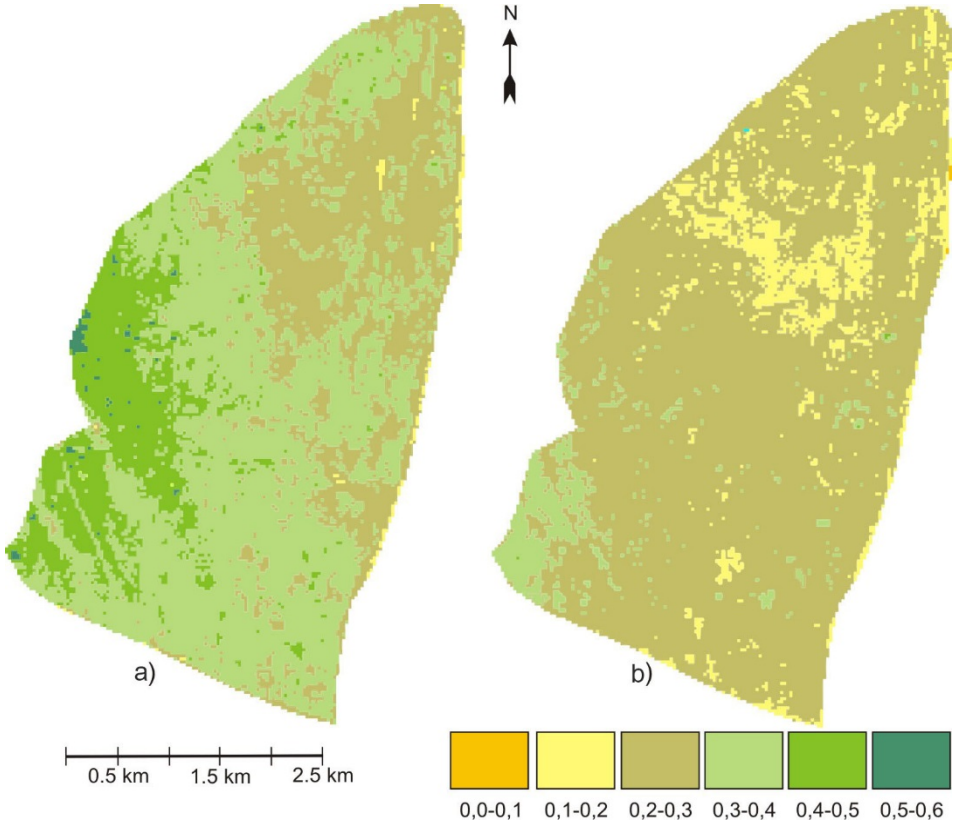
Ход осредненного NDVI и количества осадков за 2001-2015 гг. для территории участка № 1 Хараагольского полигона

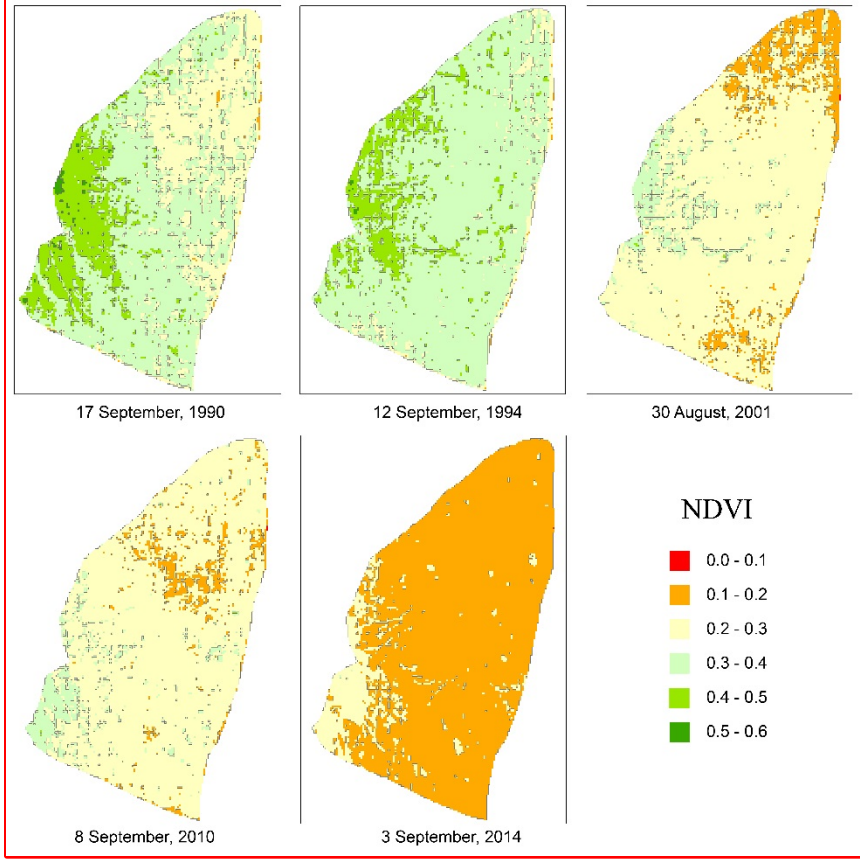


Ход NDVI и доли площади покрытия снегом за 2011-2015 гг. для территории участка № 1 Хараагольского полигона



Ход NDVI и глубины снега за 2011-2015 гг. для территории участка № 1 Хараагольского полигона



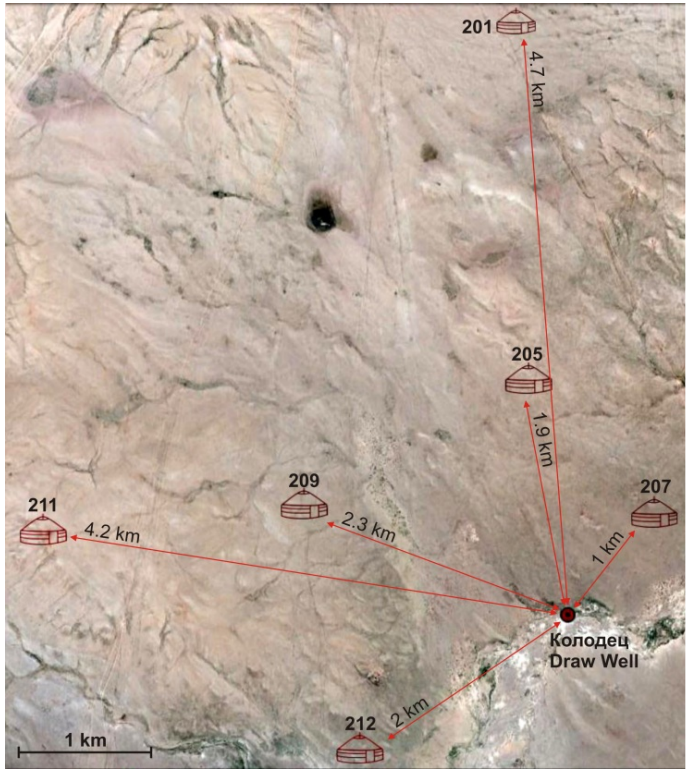


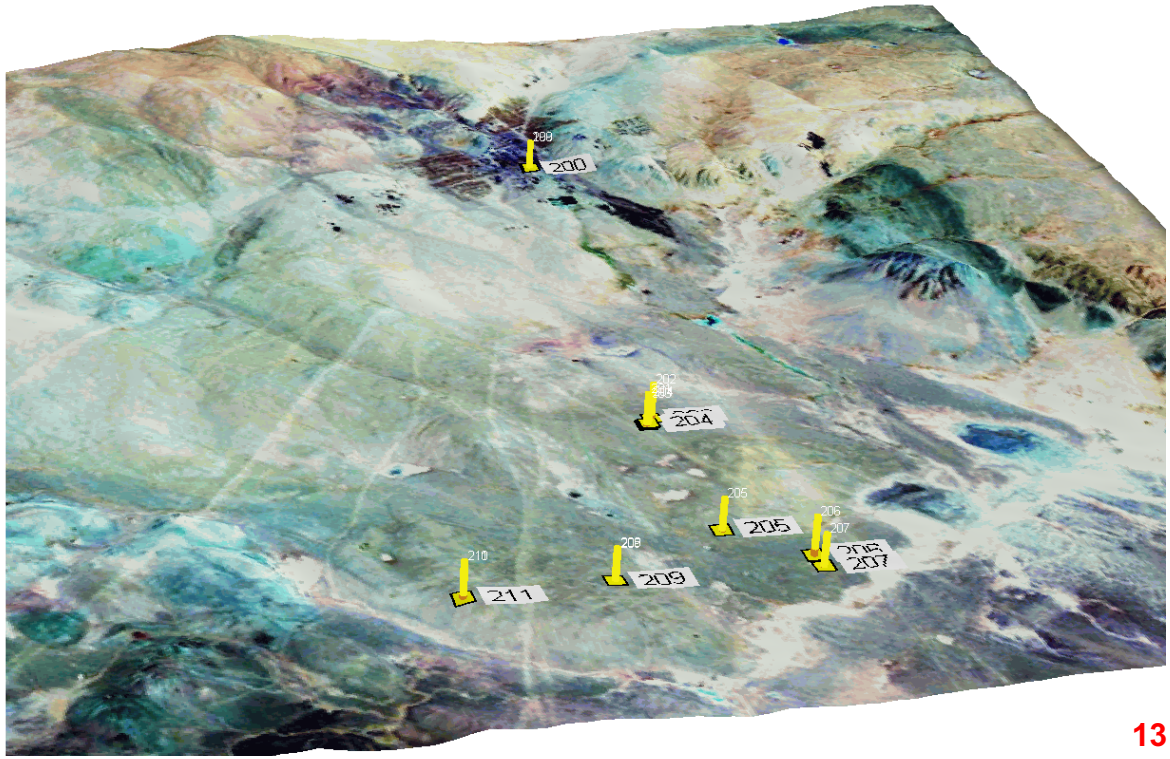
Classification on NDVI graduation for the north area of the Kharaagol polygon

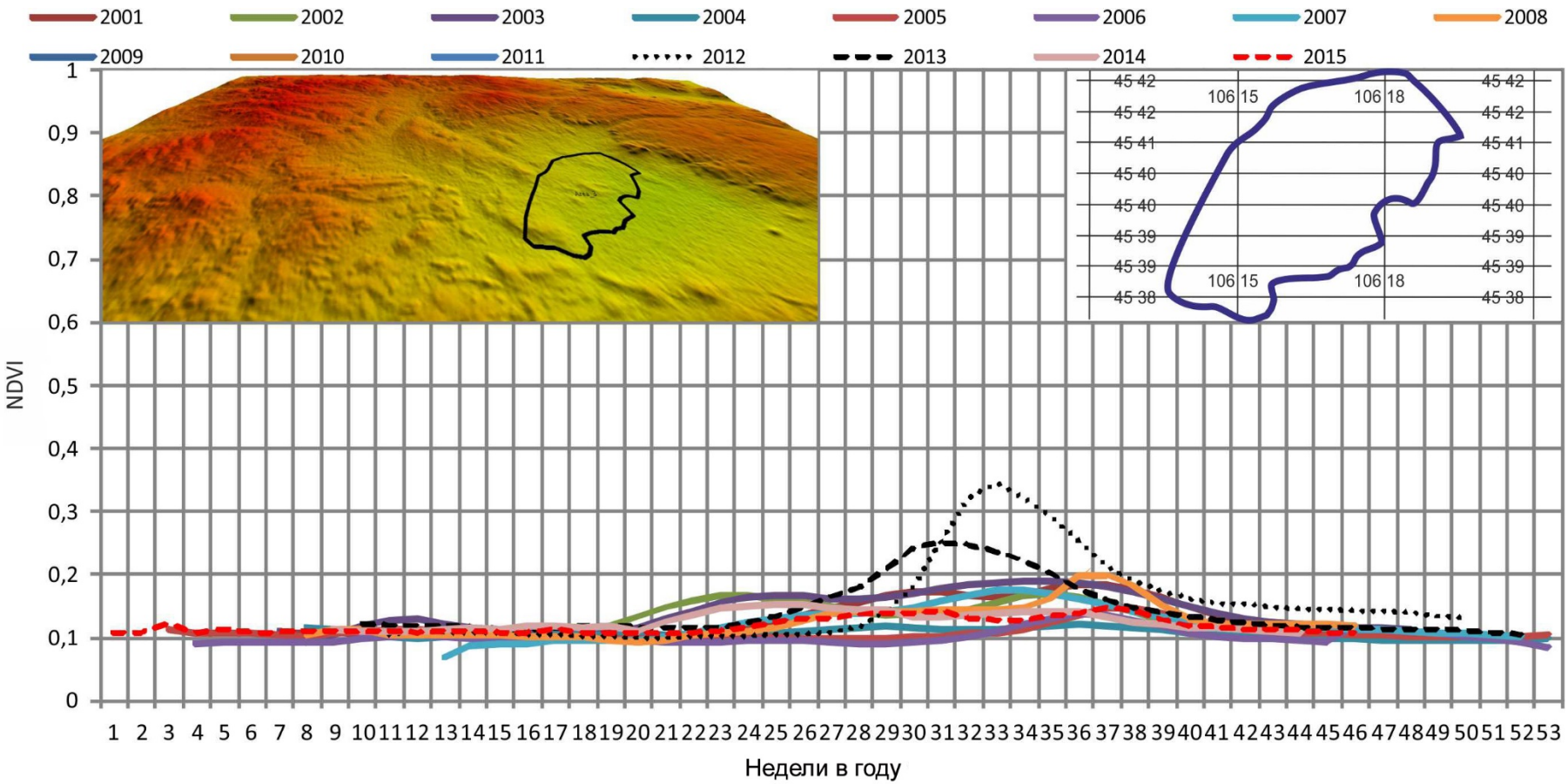
NDVI	September 17, 1990		September 8, 2010	
	Area, km^2	Area, %	Area, km^2	Area, %
0,0÷0,1	0.00	0	0.01	0
0,1÷0,2	0.12	1	1.58	8
0,2÷0,3	5.44	28	16.45	86
0,3÷0,4	10.19	53	1.12	6
0,4÷0,5	3.30	17	0.01	0
0,5÷0,6	0.12	1	0.00	0
Total:	19.16	100	19.16	100

On the territory of Dundgov aimag (Mid-Gobi), moving from north to south, there is a gradual landscape substitute: desertified steppes of semi-deserts are changed by deserts with saxaul (*Haloxylon* sp.). Studies showed that in conditions of insufficient moisture (an annual sum of atmospheric condensation less than 100 mm on the territory of Ulziit somon of the southern part of Dundgov aimag, a maximal value of 150 mm in the north, or a complete absence of fresh surface water), Gobi landscapes are affected by degradation processes easily, especially by the physical weathering, deflation, and degradation of vegetation. Even though the general pasture load is low on the territory of Dundgov aimag because of the rather low density of the animal base, the land surface is trodden around bases within a 0.5-0.7 km radius, and there is hardly any vegetation cover (plant cover from 0 to 1 %).

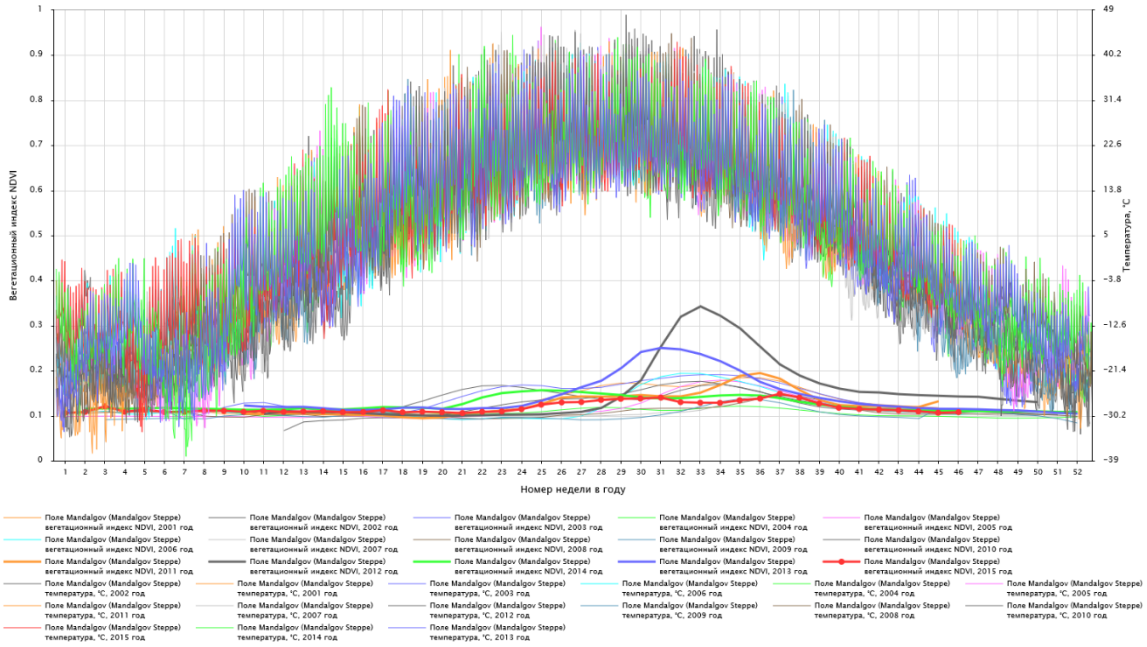
Up north from the aimag center Mandalgov, southern dry steppe landscapes dominate. They are located on 70-80 % of the territory. Desertified steppe take up 10-20 %, while saline and alkali saline soil comprise under 8 %. South from Mandalgov, within the limits of the Mid-Gobi model polygon, desertified steppe landscapes prevail (65-75 %). The southern steppe take up 20-30 %, and the saline ones comprise less than 9 % of the territory.



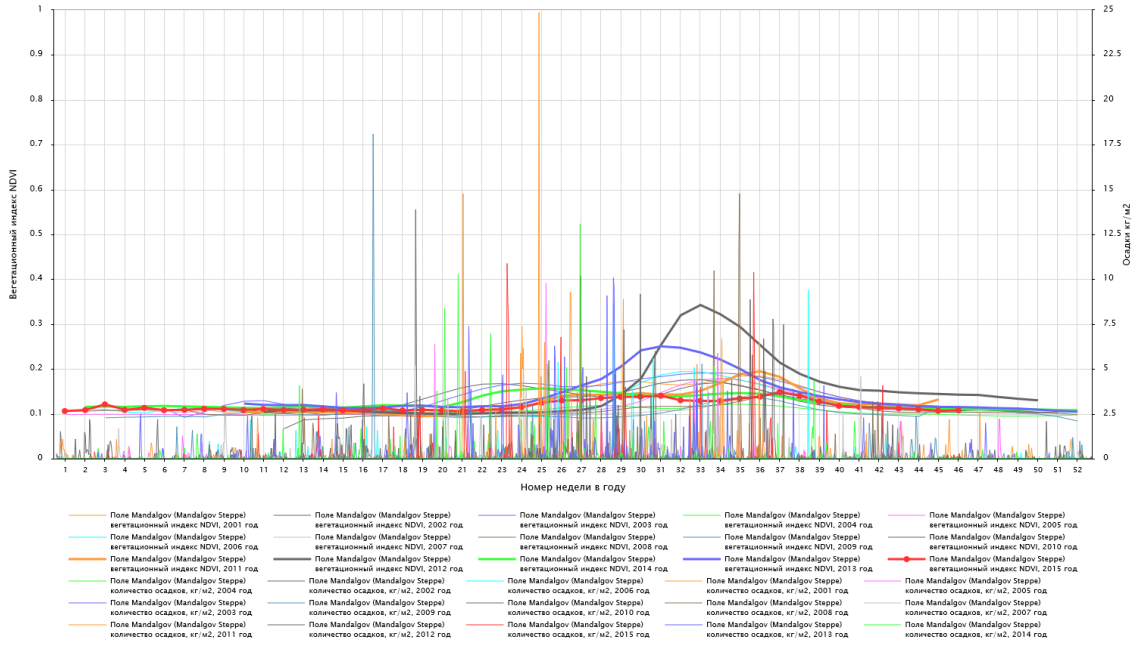




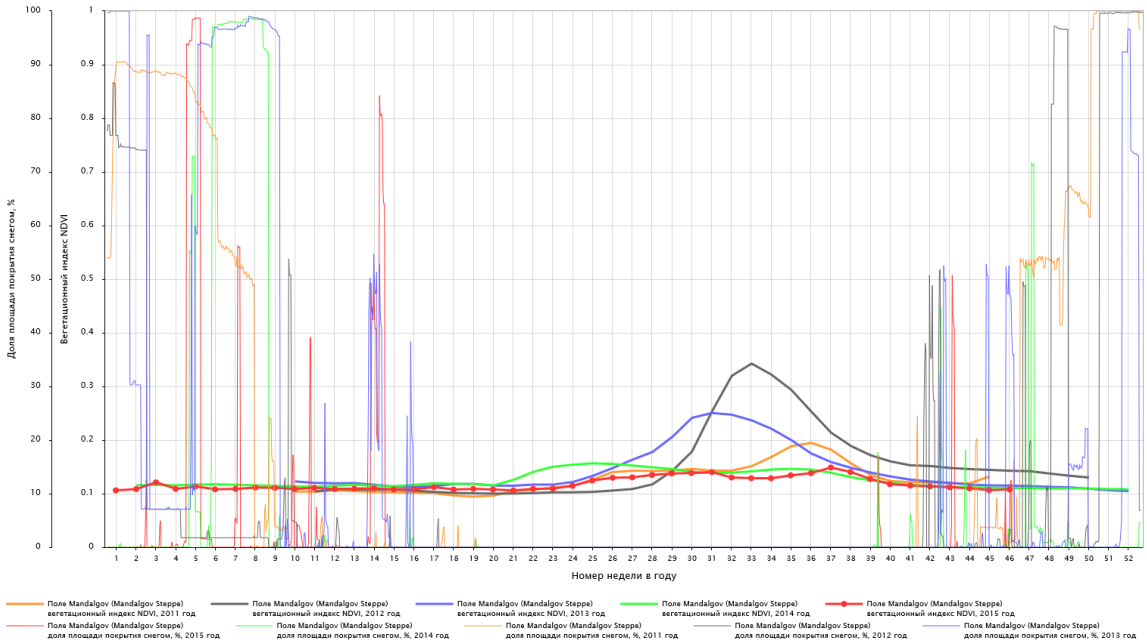
Mandalgov, NDVI for 2001-2015. The average NDVI value for the last decade (2001-2015) aggregated for the model Mid-Gobi polygon is 0.12, which proves poor vegetation



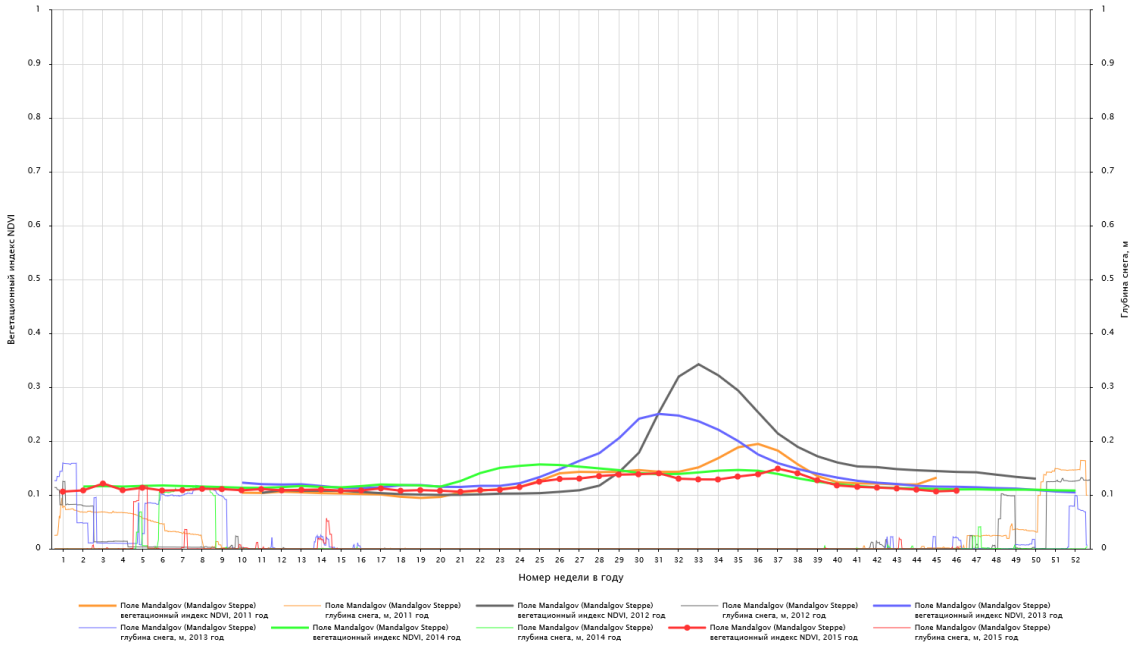
Ход NDVI и температуры воздуха за 2001-2015 гг. для территории Среднегобийского полигона



Ход NDVI и количества осадков за 2001-2015 гг. для территории Среднегобийского полигона



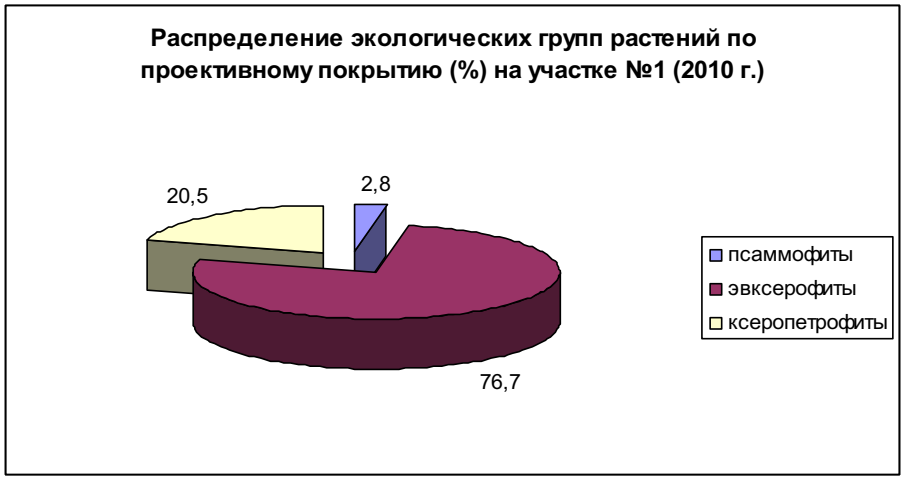
Ход NDVI и доли площади покрытия снегом за 2011-2015 гг. для территории Среднегобийского полигона



Ход NDVI и глубины снега за 2011-2015 гг. для территории Среднегобийского полигона

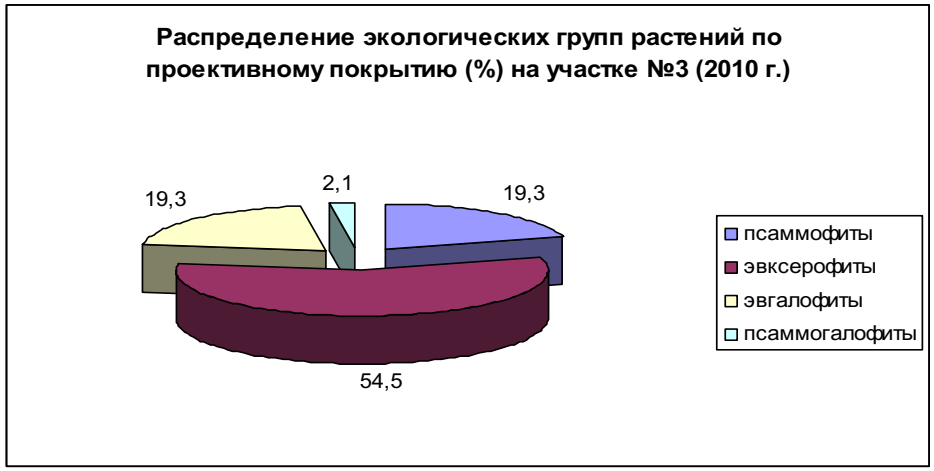
Plants: Kind, form	**Vegetation of semidesertified Gobi key site.** 44º 37’ 8.82’’ N, 106º 17’ 4.09’’ E, H = 1170-1180 m, Date: 05.08.2011.					
	Quantity		Plant cover		Above-ground phytomass	
	Pieces/ 10 m^2	% of total quantity	%	% of total plant cover	g/m^2	% of total above-ground phytomass
Shrubs:						
Caragana bungei	12	3.3	1.5	5.4	–	–
Haloxylon ammodendron	7	1.9	2.0	7.2	–	–
Dwarf subshrubs:						
Anabasis brevifolia	86	23.6	8.0	28.7	4.5	36.8
Artemisia xerophytica	12	3.3	0.5	1.8	–	–
Ajania trifida	16	4.4	1.5	5.4	–	–
A.fruticulosa	4	1.1	0.2	0.7	–	–
Perennial herbs, grasses:						
Stipa gobica	32	8.7	4.5	16.2	2.5	20.5
Onions:						
Allium polyrrhizum	29	7.9	2.5	8.9	1.9	15.6
A.mongolicum	8	2.2	1.0	3.6	0.7	5.7
Motley grasses:						
Asparagus gobicus	6	1.6	0.2		0.1	0.8
Lagochilus ilicifoius	7	1.9	0.1	0.3	–	–
Rheum nanum	5	1.4	0.1	0.3	–	–
Scorzonera divaricata	4	1.1	0.2	0.7	–	–
Ptilotrichum canescens	11	3.0	0.1	0.3	0.4	3.3
Astertamnus centralasiaticus	9	2.5	0.5	1.8	–	–
One-biennial grasses:						
Bassia dasiphylla	25	6.8	1.0	3.6	0.5	4.1
Salsola festipera	21	5.7	0.5	1.8	–	–
Total:	365		27.8		12.2	

Onion desert steppe area in 7 km to the south of Mandalgovi (45° 41' N, 106° 16' E).



Results of the investigations of vegetation composition on the key site Mandalgovi (flat stony onion desert steppe)

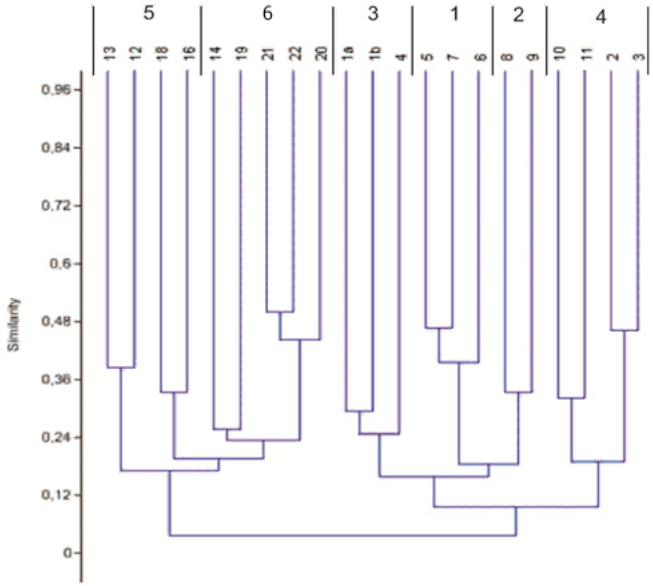
The desert steppe on the Gobi foothill sites in 13 km to the north-east of Khuld (45°04’ N, 105°45’ E). August, 2011



Results of the investigations of the vegetation composition on the key site Khuld
(low mountain dissected stony desert steppe)

The similarity dendrogramme of the primary cenoflora (according to Jacquard)

1 – луково-змеевковые deserts с *Achnatherum sibiricum* (L.) Keng ex Tzvelev
2 – ковыльно-баглуровые **deserts**
3 – овсянницево-баглурово-**semidesert steppes**
4 – щетинниково-реомюриевые **desert steppes**
5 – житняково-осоковые **true steppes with *Ulmus pumila* L.**
6 – змеевково-ковыльно-осоковые **true steppes**

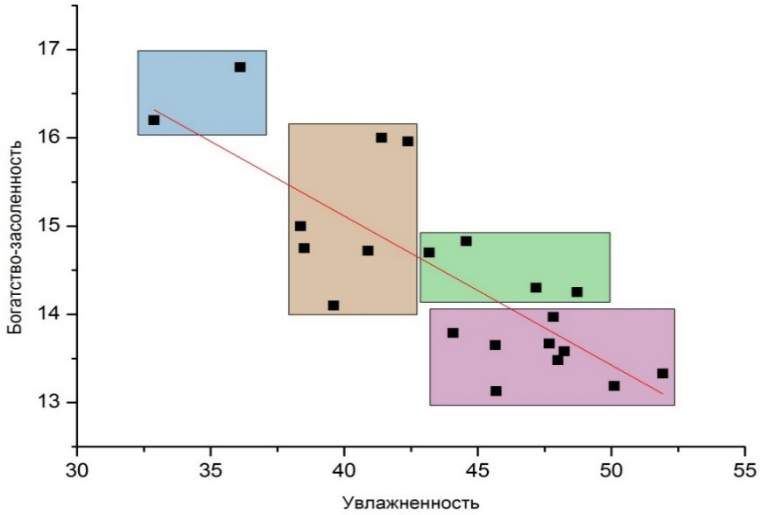


Floracenotype (FCT) bunchgrasses steppes
The formation group of buchgrasses stipa steppes
cleistogenes-stipa-sedge steppes (6)
The formation group of shrubs bunchgrasses тырсовые steppes
agropyron-sedge steppes with Ulmus (5)

FCT semidesert bunchgrasses and subshrubs bunch grasses steppes
The formation group of холодно-полынные змеевково-ковыльковые steppes
овсянницево-баглурово-semideserts steppes (3)

FCT subshrubs bunchgrasses and bunchgrasses allium desert steppes
The formation group балагурово-ковыльковые steppes
щетинниково-реомюриевые desert steppes(4)

FCT bunchgrasses subshrubs deserts
The formation group ковыльково-карагановые steppes
луково-змеевковые deserts (1)
ковыльно-баглуровые deserts (2)



The ordination according to ecological scale by A.Yu. Koroluk

Areas of the blue color include ковыльно-баглуровые **deserts** – 2,
The brown color – овсянницево-баглуровые **semideserts steppes** и щетинниково-реомюриевые **desert steppes** – 3, 4,
The green – луково-змеевковые **deserts** – 1,
The pink – злаково-осоковые true **steppes** – 5, 6).

CONCLUSION

- ✓ Remote sensing combination with ground research is important tool for land cover study.
- ✓ The conducted investigations based on the analysis of spatial and temporal variations of the Normalized Difference Vegetation Index show good possibilities for operative monitoring of degraded and desertified geosystems. The conducted studies prove that the degradation of the vegetation cover is increasing.
- ✓ Remote sensing methods, based on the analysis of spatial and temporal differentiation of biophysical vegetation parameters, quickly allow a determination of areas of ecological intensity conditioned by the degradation of vegetation cover and desertification.
- ✓ It is necessary to take urgent organizational and economic activities for vegetation conservation to reduce ecological stress on areas with identified desertification trends.
- ✓ Cattle overgrazing is observed on the studied areas. It conditions overload for pastures and leads to the digression of their vegetation cover. Therefore, livestock farmers and other land users have to use pasture rationally, changing grazing areas from time to time and thus regulating the grazing rotation.
- ✓ Thus, at the present time in different climatic zones of Central Asia and Transbaikalia there are different trends of desertification processes associated with both climatic fluctuations (mainly aridization) and anthropogenic impact. Positive trends in terms of ecological situation occur in dry subhumid climatic zone, the negative trends lead to negative environmental impacts within other more arid zones.

Thank you for attention!