REMOTE SENSING OF THE SOIL MOISTURE AT THE AGRICULTURAL TEST FIELD IN VOLGOGRAD REGION WITH THE USING SENTINEL-1 OBSERVATIONS AND NEURAL NETWORK-BASED ALGORITHM

MUZALEVSKY K.[1], ZEYLIGER A.[2], ZINCHENKO E.[3], ERMOLAEVA O.[2], MELIKHOV V.[3], NOVIKOV A.

[1] KIRENSKY INSTITUTE OF PHYSICS OF THE SIBERIAN BRANCH OF THE RAS – DIVISION OF FEDERAL RESEARCH CENTER "KRASNOYARSK SCIENTIFIC CENTER OF THE SIBERIAN BRANCH OF THE RAS", KRASNOYARSK, 660036, RUSSIAN FEDERATION, RSDKM@KSC.KRASN.RU

[2] RUSSIAN STATE AGRARIAN UNIVERSITY – MOSCOW TIMIRYAZEV AGRICULTURAL ACADEMY, MOSCOW, RUSSIAN FEDERATION, E-MAIL: AZEILIGUER@MAIL.RU

[3] ALL-RUSSIAN SCIENTIFIC RESEARCH INSTITUTE OF IRRIGATED AGRICULTURE, VOLGOGRAD, RUSSIAN FEDERATION E-MAIL: ZINCHENKO_EV@VNIIOZ.RU

Online Session HS6.3 - "Remote sensing of soil moisture" (EGU2020-16529)
The 6 May 2020

THE EXPERIMENTAL PLOT LOCATED ON THE FIELDS OF ALL-RUSSIAN SCIENTIFIC RESEARCH INSTITUTE OF IRRIGATED AGRICULTURE

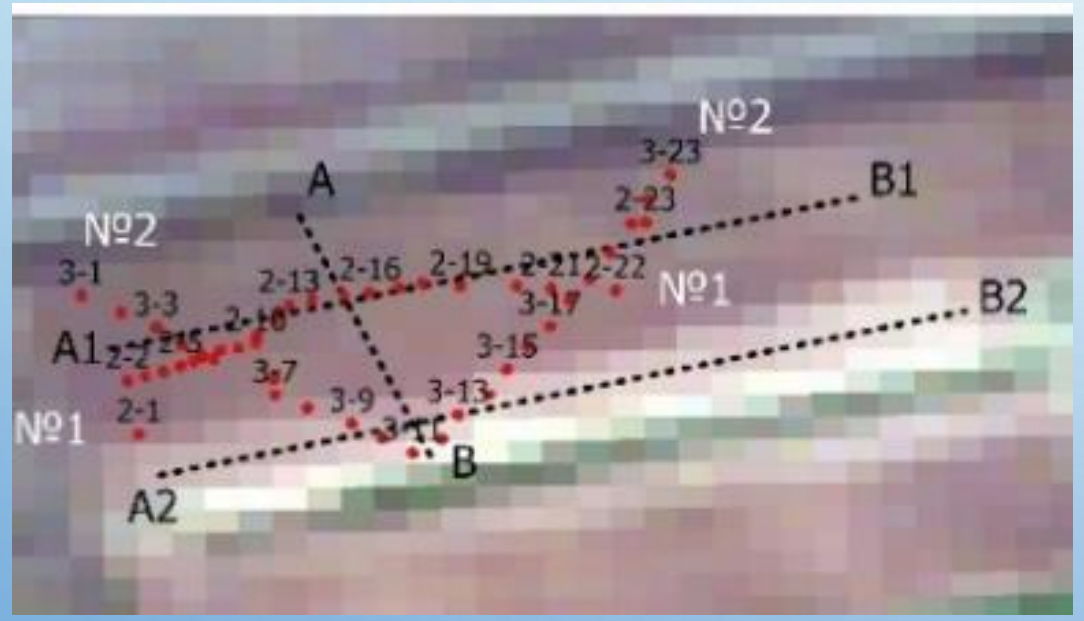
Cartographical location of the experimental plot

Ground image of the experimental plot

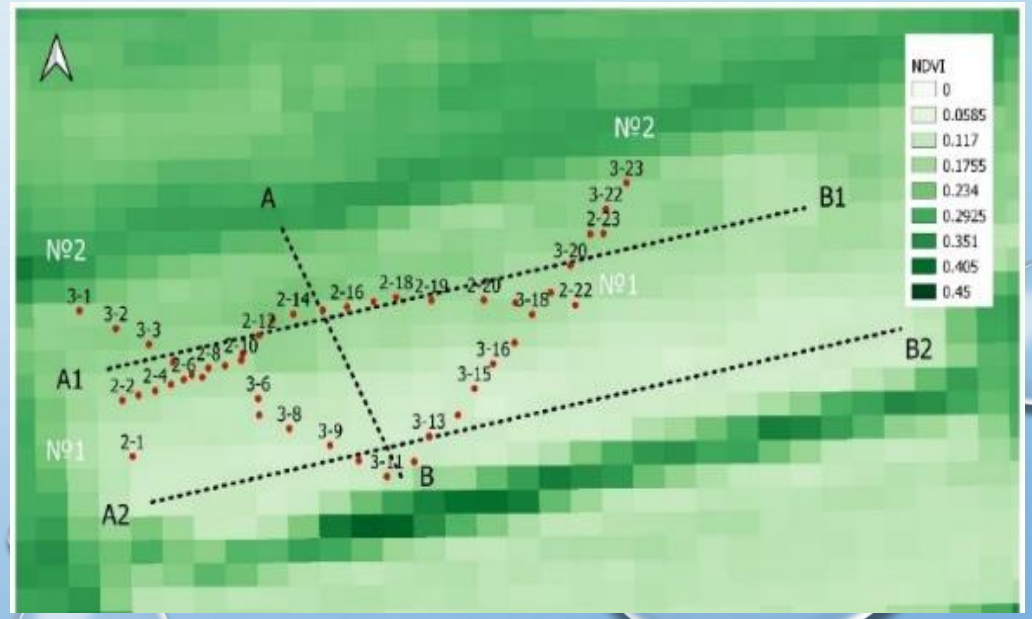
Remote Sensing of the Soil Moisture at the Agricultural Test Field in Volgograd Region with The Using Sentinel-1 Observations and Neural Network-Based Algorithm

CARTOGRAMS OF THE EXPERIMENTAL PLOT CALCULATED BASED ON THE SENTINEL-2 IMAGE ON AUGUST 21, 2019

Sentinel-2 space image (red dots indicate places for soil sampling)



NDVI index based on the Sentinel-2 image on August 21, 2019

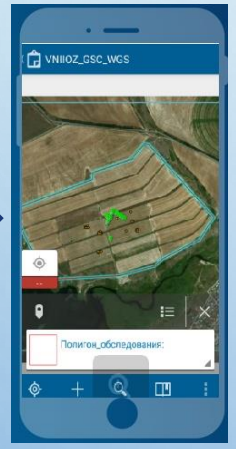


EXPERIMENTAL METHODOLOGY

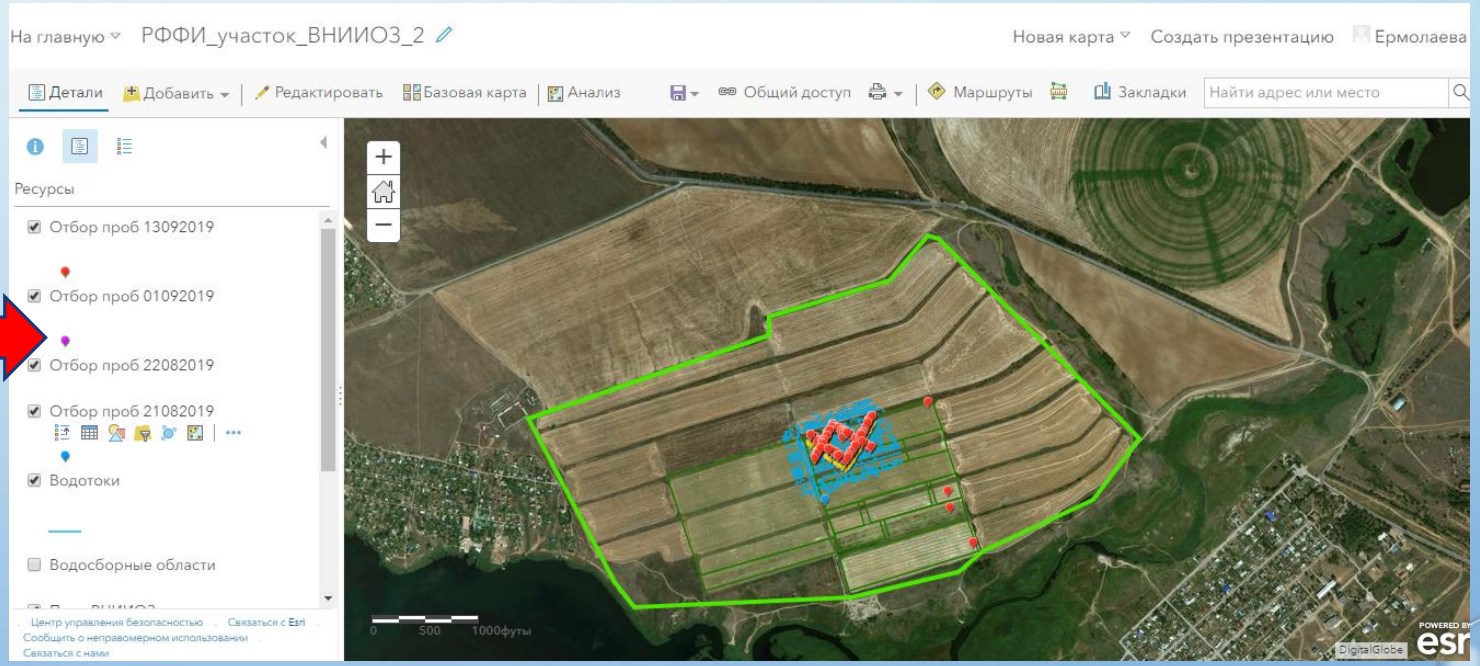
Georeferencing and provisioning datasets of soil surface moisture content

Soil sampling

Data recording and transferring



Visualization of created geadatabase at ArcGIS ONLINE of ground datasets



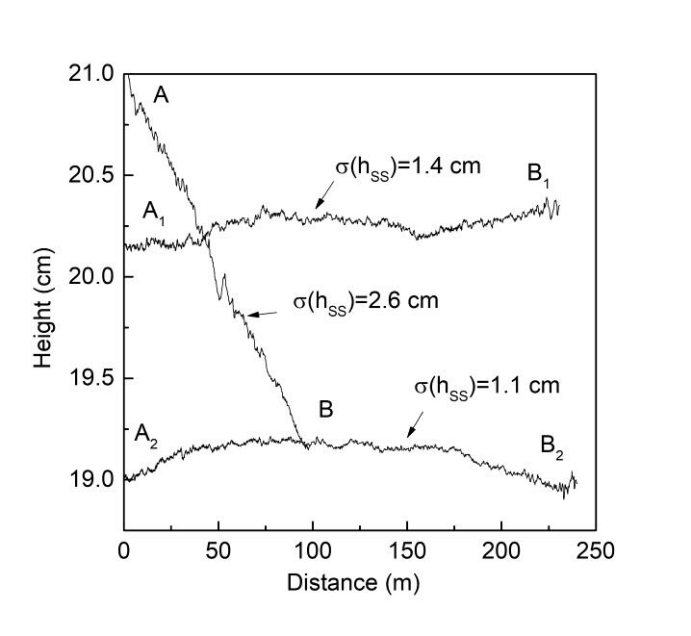
Remote Sensing of the Soil Moisture at the Agricultural Test Field in Volgograd Region with The Using Sentinel-1 Observations and Neural Network-Based Algorithm

EXPERIMENTAL & CALCULATED DATASETS

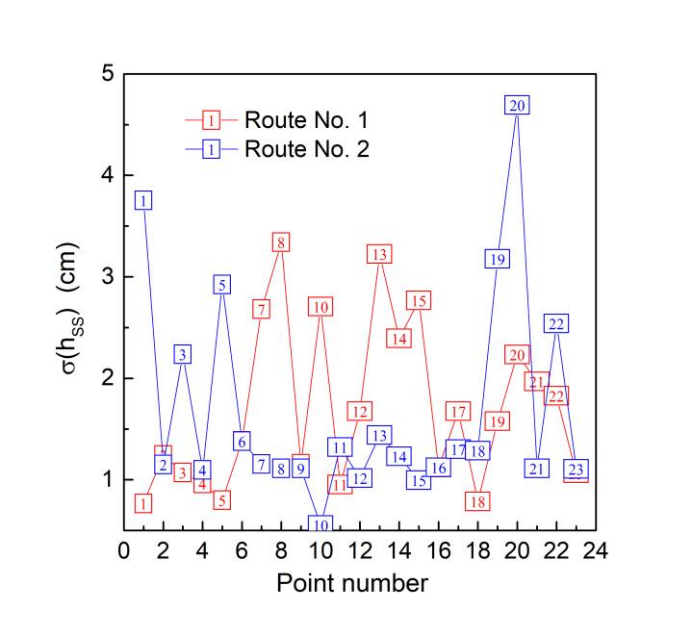
- DIRECT OBSERVATIONS OF SOIL MOISTURE (5CM THICKNESS) WAS DONE AT EXPERIMENTAL PLOT AT STUDY SITE OF THE ALL-RUSSIAN SCIENTIFIC RESEARCH INSTITUTE OF IRRIGATED AGRICULTURE, NEAR THE VILLAGE VODNYY, VOLGOGRAD REGION.
- CALCULATED SOIL MOISTURES FOR THE PLACES OF SOIL SAMPLING WAS DONE USING THE PERMITTIVITY MODEL BASED ON THE ESTIMATES OF SOIL SURFACE CHARACTERISTICS: A) REFLECTIVITY.
- REFLECTIVITY WAS CALCULATED BY THE NEURAL NETWORK METHOD FROM SENTINEL-1 OBSERVATIONS
- SURFACE ROUGHNESS WAS OBTAINED FROM DIGITAL ELEVATION MODEL CALCULATED FROM STEREOSCOPIC SURVEY WITH UAV PHANTOM 4 PRO.
- THE RASTER SET OF MOISTURE GEODATA WAS OBTAINED BASED ON THE REFLECTIVITY GEODATA RASTER SET IN SOLVING THE INVERSE PROBLEM USING A PERMITTIVITY MODEL THAT TAKES INTO ACCOUNT THE SOIL TEXTURE OF THE TEST PLOT.

CHARACTERISTICS OF SOIL SURFACE ROUTHNESS

Profiles of elevation of daylight soil surface along the lines A-B, A1-B1 and A2-B2

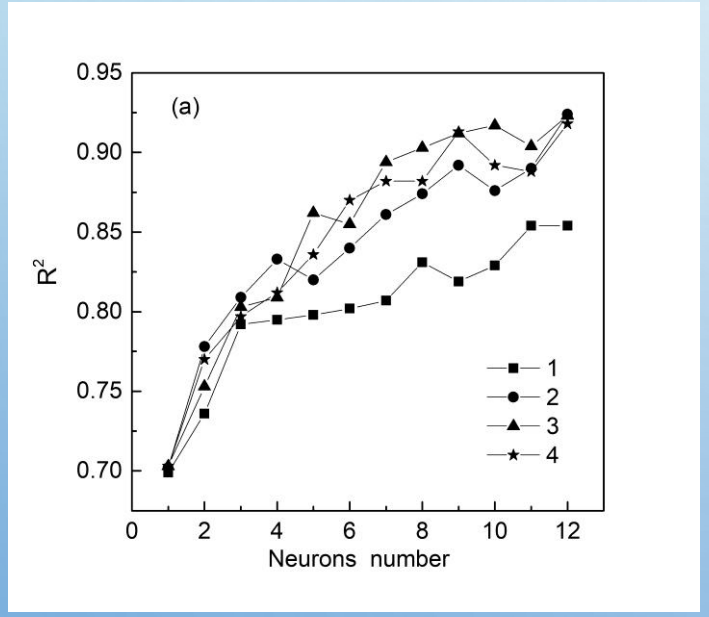


The standard deviation of the soil surface roughness $\sigma(h_{ss})$ along the routes No. 1 and No. 2

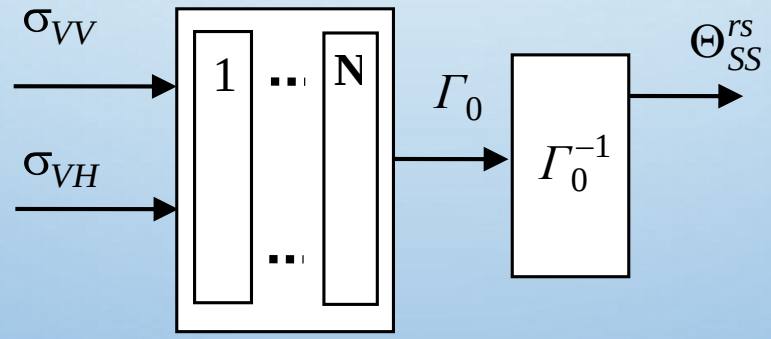


METHOD OF A POSTERIORI ESTIMATION OF SOIL MOISTURE BASED ON SENTINEL-1 GEODATA USING A NEURAL NETWORK

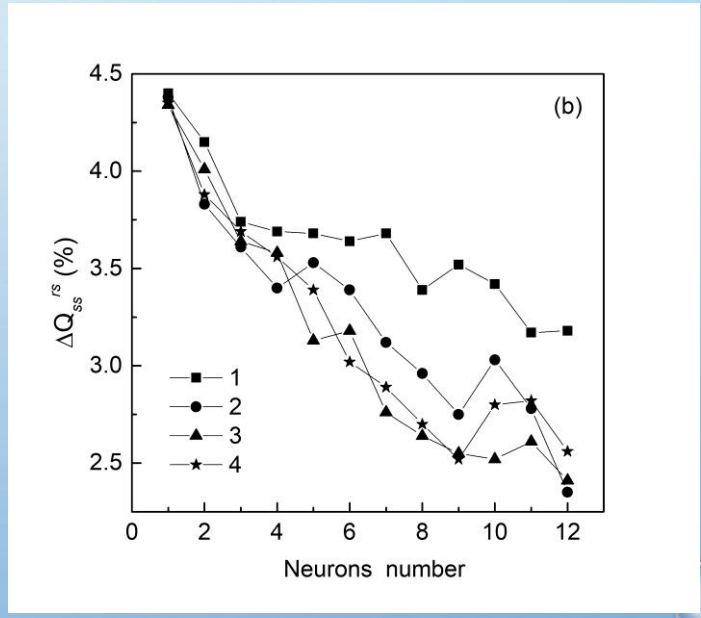
Determination coefficient between Γ_0^N and $\Gamma_0(\Theta_{ss}^{gr}, f_{clay})$



Simple feed-forward neural network with *N* hidden layers



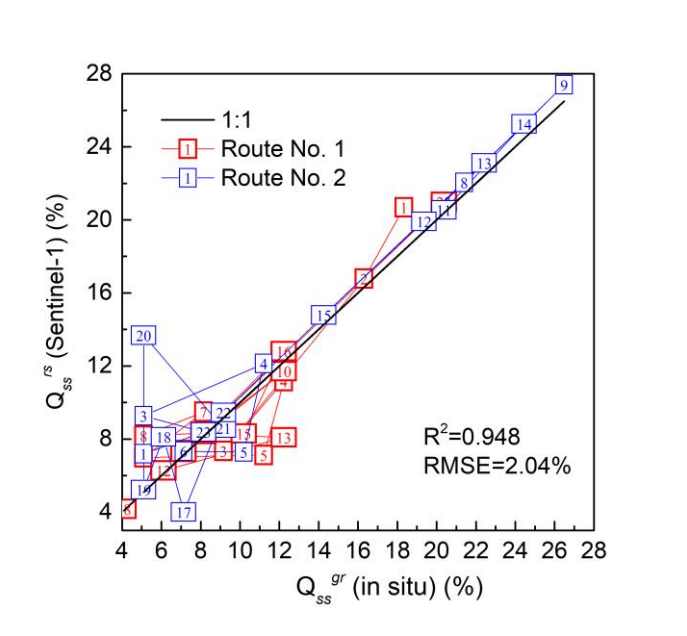
Standard deviation between Θ_{ss}^{rs} and Θ_{ss}^{gr}



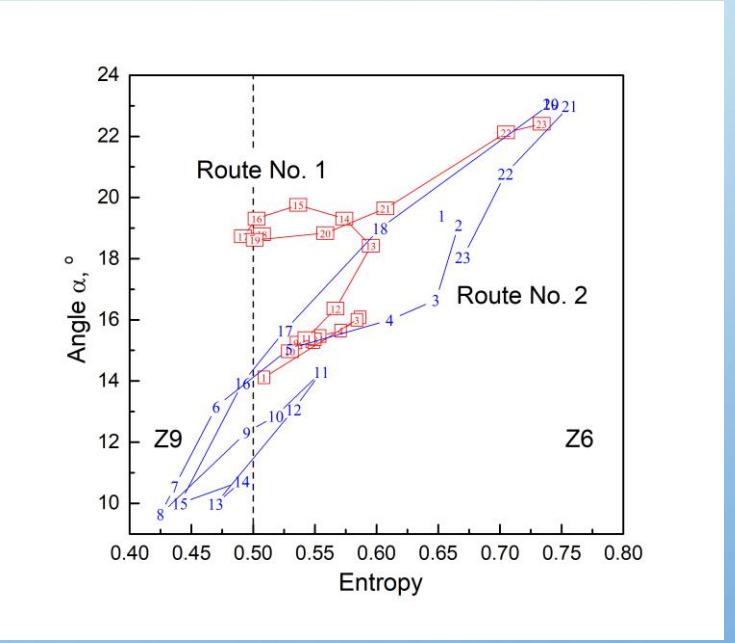
Remote Sensing of the Soil Moisture at the Agricultural Test Field in Volgograd Region with The Using Sentinel-1 Observations and Neural Network-Based Algorithm

ESTIMATION THE SOIL SURFACE MOISTURE (Θ_{SS}^{RS}) VALUES FOR ALL 46 SOIL SAMPLING POINTS AT THE TEST PLOT

Correlation between predicted from remote sensing data Θ_{ss}^{gr} and measured in situ Θ_{ss}^{rs} soil moisture values along the routes No.1 and No.2



Measured in situ Θ_{ss}^{gr} profiles along the routes No.1 and No.2 on August 20, 2019



CONCLUSIONS

- THE VALUES OF DETERMINATION COEFFICIENT (0.948) AND THE STANDARD DEVIATION (2.04%) WERE OBTAINED AS A RESULT OF COMPARING GRODATA SETS OF MOISTURE GEODATA
- A SATISFACTORY REPRODUCTION OF THE GROUND BASED SOIL MOISTURE BY CALCULATED IN THE BASE OF REMOTELY SENSED DATA BY THE DEVELOPED METHOD USING SENTINEL-1 RADAR DATA AND DIGITAL ELEVATION MODEL.
- THE DEVELOPED METHOD CAN BE CONSIDERED AS THE SCIENTIFIC AND METHODOLOGICAL BASIS OF THE NEW TECHNOLOGY FOR CARTOGRAPHIC MONITORING OF SOIL SURFACE MOISTURE
- THIS NEW TECHNOLOGY CAN BY USED TO AUGMENT EFFICIENCY OF PRECISION IRRIGATED AGRICULTURE.

THANK YOU FOR YOUR TIME AND ATTENTION!

- THE RESEARCH WAS CARRIED OUT WITHIN THE FRAMEWORK OF THE RUSSIAN FOUNDATION FOR BASIC RESEARCH PROJECT 19-29-05261 MK "CARTOGRAPHIC MODELLING OF SOIL MOISTURE RESERVES BASED ON COMPLEX GEOPHYSICAL WATER CONTENT MEASUREMENTS FOR DIGITAL IRRIGATED AGRICULTURE".