# Remote identification of winter wheat crops in monitoring tasks

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## SUMMARY

In this article, satellite images of Landsat-8 and terrestrial imagery were used as a source of information for the automated recognition of winter wheat sowing fields. The land of the Lichanka territorial community, Kyiv-Svyatoshinsky district of Kyiv region was selected as a research object. During the work, a correlation was established between the brightness values of terrestrial snapshots RGB of winter wheat, obtained from terrestrial field surveys, with the pixel brightness values of remote sensing images of different spectral channels and NDVI values. The most significant correlation coefficients of magnitude (RGB) with the values of brightness are as follows, r: channel 5 - 0.77, channel 6 - 0.69, channel 7 - 0.53, channel 10 - 0.74, channel 11 - 0, 59, NDVI - 0.91. Given the significant correlation between magnitudes (RGB) and NDVI, high informativeness of the 5th channel near infrared (0.845-0.885 μm), chosen to build the identification model should be considered natural. The use of the developed model of culture recognition allowed to territorially identifi winter wheat crops and distinguish them from other vegetation. The results of comparing the model's identification ability and the NDVI's vegetation index indicate its reliability and the feasibility of further improvement.

## Introduction

Remote sensing technology is widely used in crop identification and mapping, (Liu et al., 2018) due to the easy accessibility of the materials, the wide spatial coverage and the ability to analyze retrospective images. Some studies have described the features of using multifaceted images for crop classification (Hentze et al., 2015; Li et al.,2015; Durgun et al., 2016; Vreugdenhil et al., 2018; Sun et al., 2019). In doing so, a phenological metrics was used to identify areas with different types of crops (Bargiel, 2017), (Waldner et al., 2015). It should be noted, that information about placing crops in the fields of agribusiness have the status of internal use and access to them is only possible through Earth remote sensing (ERS) (Cakharova et al., 2016). At the same time, for the assessment of the development of the agricultural sector in Ukraine by the state authorities, the results of forecasting the future crop yield are important. Nowadays, the service of identification of crops of winter and spring crops in the environment of the public cadastral map of Ukraine has become widely available. There are many works dedicated to the recognizing crops of different cultures.The most stable indicators of classification quality were found for the method of maximum similarity (Moskalenko, 2017). Winter wheat is one of the most important grain crops in Ukraine. Therefore, it is very important for the government to obtain accurate information on the area under sowing, the yield of winter wheat to shape the state's agricultural policy and ensure food security (Wu et al., 2006). Traditional but time-consuming methods of obtaining winter wheat sowing include manual selective identification (Zheng et al., 2016), but the cost of which remains too high. Generally accepted use of the Standardized Vegetation Index NDVI, RNDVI to evaluate the status of winter crops and the introduction of technologies for their care at different stages of organogenesis (Trofymenko et al., 2019). Development of methodology and models of identification of winter wheat crops is very important in view of annual crop rotation in crop rotation fields, change of area and configuration of land tracts (Cakharova et al., 2016).

## Methods

The exploration was conducted in 2020 on the territory of the Lichanka territorial community, Kyiv-Svyatoshinsky district of Kyiv region, near the villages of Lichanka and Negrashy (φ = 50.385053, λ = 30.116549). The exploration area belongs to the Polesie zone on the border with the Forest-steppe zone, with characteristic soils: sod-podzolic sand, dark gray and gray podzolic soils. An adjusted multispectral image (LC08_L1TP_182025_20200206_20200211_01_T.tif) obtained from Earth Explorer was used. Acquisition date 06.02.2020, start time 2020:037:08:55:09.8154870, stop time 2020:037:08:55:41.5854870. Cloud cover 7%.

During the field work, winter wheat was photographed using a 12MP camera phone from a height of 1 m, 15.02.2020.

Statistical processing of data was performed in Microsoft Excel 2010. The bitmap processing was done using the Spatial Analyst module and the "Raster Calculator" tool. RGB image brightness is defined in Adobe Photoshop software. Field survey points are linked using the WGS-84 coordinate system.

## Results

In the study area, 1 field was selected with points with established coordinates and 5 verification test fields with winter wheat sowing in the tillering phase, the presence of which was confirmed by field surveys. Areas of verification test fields with winter wheat crops: № 1 - 143 hectares, № 2 - 31 hectares, № 3 - 35 hectares, № 4 - 31 hectares, № 5 - 28 hectares, № 6 - 16 hectares.

Field №1 has 17 probing points and their GPS anchor (Figure 1).

Taking pictures three times (51 snapshot). The location of the points was selected based on the condition of the crops: plant density and vegetative mass, which was evaluated visually in the field (Figure 2).

In the next step, a correlation-regression analysis was performed between the RGB brightness values and the brightness values for each spectral channel of the multispectral image and calculated NDVI values in each of them.


***Figure 1*** *Research area based on monochrome Channel 1, Landsat-8*

Photo, numbers and coordinates of the point

| Point № 17 | Point № 9 | Point № 6 |
|---|---|---|
| φ = 50.3814639 | φ = 50.3875758 | φ = 50.3864112 |
| λ= 30.1100057 | λ = 30.1206852 | λ = 30.1159286 |

***Figure 2*** *Photographs of crops at points with coordinates and transect positions with points to remove brightness values in RGB format*

On the basis of the analysis data, we obtained the equation of $\overline{\text{RGB}}$ values of winter wheat sowing photos and brightness values of 5 near infrared channel (0.845-0.885 µm) (Figure 3).

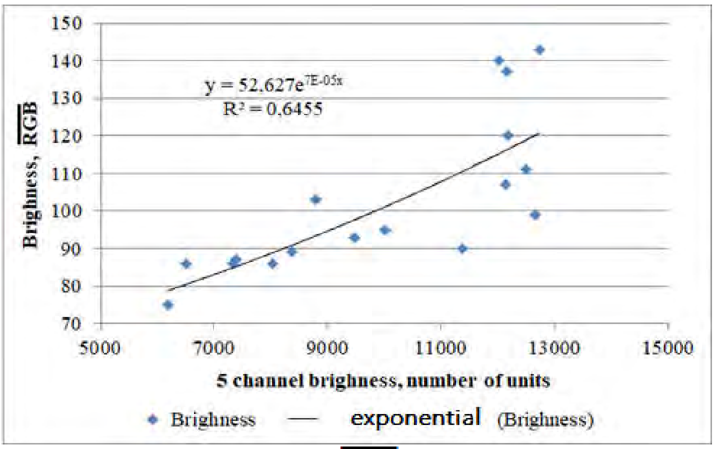


***Figure 3*** *The dependence of the brightness of the* $\overline{\text{RGB}}$ *image and image of Landsat-8, channel 5*

Weighted average $\overline{RGB}$ values were calculated from image analysis in Adobe Photoshop by transect insertion (see Figure 2).
The most significant values of the correlation coefficients are as follows, r: channel 5 - 0.77, channel 6 - 0.69, channel 7 - 0.53, channel 10 - 0.74, channel 11 - 0.59, NDVI - 0.91 .
On the basis of the multispectral image, a map was constructed according to the vegetation index NDVI (Figure 4 A) and the obtained model (Figure 4 B), equation 1:

$$y = 52{,}627^{7E-05x} \quad (1)$$

The results of the pixel analysis based on the Landsat-8 image make it possible to obtain spatial differentiation of the green vegetation available on the ground.

**«A» - NDVI** **«B» – model of crop identification - $\overline{RGB}$**

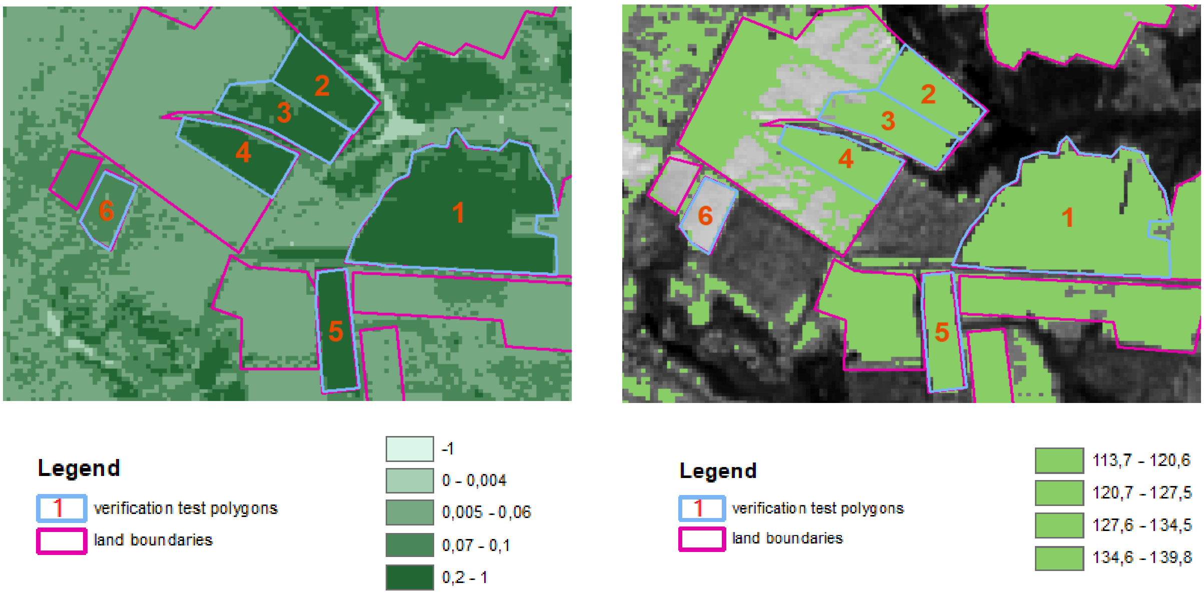


***Figure 4*** *Spatial differentiation of existing vegetation in the study area based on the NDVI index (A) and the winter wheat identification model (B).*

Therefore, the model developed allows identifying fields with winter wheat crops, while the NDVI indicates the presence of vegetation without deciphering its species. Diagnostic value $\overline{RGB}$ ranges from 113 to 140 units. Comparing spatial analysis data on Verification Test Field № 6, NDVI identified them as very weak crops (0.005 - 0.1 units).
At the same time the specified area did not appear on the identifying model as winter wheat sowing. This is confirmed by terrestrial studies: the area under number 6 is a field with stubble after the growing of cereals in 2019.
Based on the above, it can be argued that the developed model for identifying wheat crops allows you to determine the location of crops of different status, including good, medium and bad. The developed model does not identify areas with available green vegetation of other species, that meet the objectives.

**Conclusions**
As a result of the researches, a model of automated identification of winter wheat crops was developed, based on the spectral reflectance in the near infrared spectrum (channel 5) of the Landsat-8 and the brightness value of the terrestrial images ($\overline{RGB}$ ).
As a result of comparing the identification capacity of the NDVI vegetation index with the model developed during the remote detection of winter wheat crops, a slight advantage of the latter was

established. The areas with available green vegetation of other species developed model does not identify that meets the objectives.
But, the developed model does not clearly identify winter wheat crops of poor quality and therefore needs improvement.

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