

## Brief information about the project

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| Title of project | AP25794147 «GIS Modeling of Winter Cereal Crop Yields in the Southern Regions of Kazakhstan Based on Remote Sensing Data under Climate Change Conditions.»                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Relevance        | <p>The territory of the Turkestan region is distinguished by a diversity of landscapes, soils, and agroclimatic resources. Significant areas (up to half of the region) are occupied by plains and sands in the north and west of the region. In the central part of the region, the Karatau ridge runs from the northwest to the southeast, with most peaks around 1800 meters, separating the flat areas from the mountainous regions. In the southeast of the region, there are low- and high-altitude ranges of the Western Tien Shan (elevations ranging from 1500–2000 to 2500–3500 meters and more). The region's terrain diversity has led to significant heterogeneity in soil and climate conditions, as well as the specialization of agriculture in different areas. Winter cereal cultivation is mainly concentrated in the foothills of the Turkestan region. Winter crops are a major focus for Kazakhstani farmers in the foothill zone. The sown area of winter cereals varies significantly from year to year, depending on crop rotations and weather conditions.</p> <p>The scientific novelty of the project lies in the integration of satellite data with yield modeling of winter cereals in the Turkestan region, which has not yet been implemented at this level in the region. The use of multispectral and hyperspectral remote sensing data, combined with precise field measurements, allows for the creation of a unique forecasting system adapted to local conditions. This provides an opportunity not only to assess the current state of the crops but also to model future yields, taking into account the dynamics of crop development and the influence of biotic and abiotic factors.</p> <p>The use of vegetation indices, such as NDVI and EVI, for the analysis of the spatiotemporal dynamics of crops in southern Kazakhstan is a significant component of the project's scientific novelty. These indices were previously used for monitoring other agroecosystems, but their adaptation for yield assessment of winter crops in the specific conditions of the Turkestan region represents an important scientific breakthrough. Including weed infestation parameters in the yield forecasting models further enhances the accuracy of crop condition assessment and yield prediction and the significance of the results obtained.</p> <p>The project's scientific significance also lies in its practical application. Remote sensing-based models can be used to create weed maps and zones of potentially high and low yields, as well as to detail the heterogeneity of individual field segments with stressed crop conditions. These maps can be integrated into precision farming systems for more efficient agricultural planning, which is a relevant task in the face of rapid climate change and the growing demand for food.</p> |
| Purpose          | The project aim is to develop a GIS based winter wheat yield forecasting modeling support for the Turkestan region. Agrometeorological conditions and trends in their deviations from climatic data, crop conditions, weed infestation levels, based on satellite monitoring will be used for the analysis.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Objective        | 1. development and adaptation of a GIS model for forecasting the winter wheat crop yields, by processing satellite and ground-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

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|                                                                                                                                    | <p>based data (meteorological and climatic data, as well as biometric parameters of crop conditions and weed infestation based on field inspections).</p> <ol style="list-style-type: none"> <li>2. preparation a database of long-term key meteorological and climatic parameters, characterizing the hydrothermal conditions of the wheat vegetative period with trends change analyses over recent years.</li> <li>3. conducting a combined analysis of RS , meteorological and climatic indicators, field crops observations with the proper modeling forecasting.</li> <li>4. testing the modeling field data from the Turkestan region to evaluate its accuracy for the calibration and verification use.</li> <li>5. carrying out RS assessment of winter wheat targeted sowing areas with efficient satellite indices, preparing user-friendly maps for farmers.</li> <li>6. preparing user-friendly maps of winter wheat crop conditions during the spring and summer vegetative periods with yield forecasts by using RS and ground-based data , which should support the efficient agricultural practices in south Kazakhstan.</li> </ol>                                                              |
| Ожидаемые и достигнутые результаты                                                                                                 | <p>I. An adapted model will be developed to forecast the yield of winter cereal crops based on remote sensing data, climatic factors, crop conditions, and weed infestation levels. The model will take into account the specific soil and weather conditions of the southern regions of Kazakhstan, providing more accurate and well-grounded yield forecasts;</p> <p>II. Key parameters, such as satellite data, climatic indicators, crop conditions, and field weed infestation, will be analyzed. These parameters will be integrated into the model to enhance the reliability of yield and crop condition forecasting;</p> <p>III. Based on the collected data and analysis, a prototype model will be created to forecast the yield and condition of winter crops at various stages of their development. This approach will become an important tool for agricultural enterprises, enabling more precise decision-making in crop management;</p> <p>IV. The research results will be published in two articles in international peer-reviewed scientific journals with a high percentile in the Scopus database or in journals ranked in the top three quartiles by impact factor in Web of Science.</p> |
| Research team members with their identifiers (Scopus Author ID, Researcher ID, ORCID, if available) and links to relevant profiles | <ol style="list-style-type: none"> <li>1. Arystanov Asset Amirkhanovich – Project Leader, Senior Research Fellow. H-index – 1; Scopus Author ID: 59387339400; ORCID ID: 0009-0000-0341-5381.</li> <li>2. Jay Sagin – Professor. H-index – 16; Scopus Author ID: 57204467637; ORCID ID: 0000-0002-0386-888X.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| List of publications with links to them                                                                                            | <p><b>Arystanov, A.,</b> Sagin, J., Karabkina, N., Arystanova, R., Yermekov, F., Kabzhanova, G., Bekseitova, R., Aktymbayeva, A., &amp; Kutymova, N. (2025). Automatic Classification of Agricultural Crops Using Sentinel-2 Data in the Rainfed Zone of Southern Kazakhstan. <i>Agronomy</i>, 15(9), Article 2040.<br/> <a href="https://doi.org/10.3390/agronomy15092040">https://doi.org/10.3390/agronomy15092040</a>.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

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