

REVIEW

of the research work by *Mussaif Gauhar* titled
“Post-classification Analysis of Land Use in an Agro-industrial Area”,

submitted for the degree of Doctor of Philosophy (PhD) under the educational program
8D07302 – “Geodesy”, and completed under the supervision of the foreign scientific
consultant, Professor, Doctor of Technical Sciences Artu Ellmann
(Estonia, Tallinn University of Technology)

The study addresses a complex and multifaceted scientific problem—the comprehensive assessment of sustainable development (SD) trends in a district where agricultural lands, specially protected natural areas, and the city are uniquely integrated. The main focus is placed on the quantitative analysis of the relationships between spatiotemporal changes in land use and land cover (LULC) and economic, ecological, and social (EES) factors. The relevance of the topic is determined by its orientation toward solving an important scientific and applied problem: the post-classification analysis of spatiotemporal data (STD), as well as the comprehensive identification of development trends in the Burabay district.

Main objectives of the study:

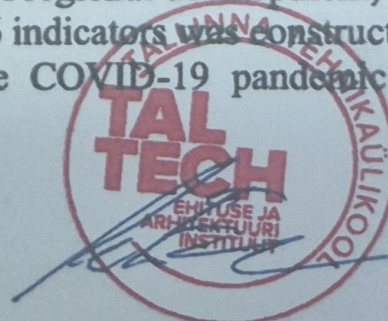
- collection, analysis, and systematization of spatiotemporal data (STD) characterizing modern development trends in individual territories;
- provision of geospatial data for the study area based on remote sensing (RS) materials;
- assessment of trends in spatiotemporal changes of LULC classes through pre- and post-classification analysis of RS data;
- investigation of the nature of long-term changes;
- identification of the sustainable development trend in the study area through the integrated use of STD and EES indicators.

The research makes a significant contribution to the methodology of sustainable development diagnostics. An effective scheme for integrating remote sensing data (Landsat, nighttime light data, climate data) with official statistical sources into a unified analytical framework is proposed. The use of the “triad” concept (urban area – agriculture – national park) represents a valuable model for assessing territories with complex spatial structures.

Author’s Personal Contribution

The study provides the following important scientific results:

- A multistage comprehensive methodology was successfully implemented on the Google Earth Engine (GEE) platform, ensuring high classification accuracy over a 23-year period (Overall Accuracy: 0.92 ± 0.044);
- Beyond simple change detection, a deep analysis of transition matrices was carried out, enabling the distinction between systematic and random processes of land use and land cover transformation;
- Using Principal Component Analysis (PCA) and Multiple Linear Regression (MLR), it was revealed that economic factors are the primary driving forces of regional development;
- A composite sustainable development index based on 36 indicators was constructed for the years 2010–2021, capturing the constraining impact of the COVID-19 pandemic in 2021, consistent with global patterns.



Summary of the Scientific Work

The scientific work represents a comprehensive, long-term geospatial analysis. Using the Random Forest algorithm on the GEE platform, the author developed a high-precision time series of LULC changes for 1999–2021. The dynamics and transitions between land categories were then examined, revealing a systematic transformation of pastures into arable land. These changes were correlated with EES factors, enabling the identification of key economic drivers of development. Ultimately, all indicators were integrated into a holistic assessment of the sustainable development trajectory of the district.

Throughout the research, Mussayf G. demonstrated a high level of proficiency in modern methods: classification of Landsat imagery using machine learning (Random Forest), application of the GEE platform, and the use of PCA and multiple regression. The integration of 36 demographic, economic, social, ecological, and climatic indicators made it possible to obtain a multidimensional assessment of territorial development.

Practical Significance

The results of the study can be used in land policy development, territorial planning, and monitoring progress toward the Sustainable Development Goals (SDGs) at the district level. Special attention is drawn to the identification of the negative impact of the COVID-19 pandemic on development rates in 2021.

The following methods were used to achieve the research objectives: creation and editing of a geodatabase; classification of satellite images and accuracy assessment; analysis of LULC changes and cross-category transitions; identification of systematic and random processes; and comprehensive assessment of sustainable development based on STD and EES indicators.

Conclusion on Scientific Work

The scientific novelty of the research lies in the fact that the author has, for the first time in the agro-industrial conditions of Kazakhstan, conducted a post-classification analysis of LULC using advanced geodetic and geoinformation methods, and developed an assessment of land cover transformation. The materials for the scientific work are presented in the following research articles published in the international journals with levels Q2 and Q1:

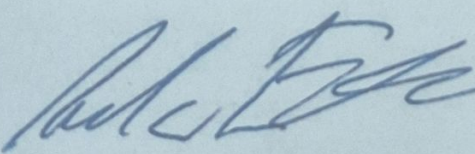
Alipbeki O., Mussaif G*, Alipbekova C., Kapassova A., Grossul P., Aliyev M., Mineyev N. Untangling the Integral Impact of Land Use Change, Economic, Ecological and Social Factors on the Development of Burabay District (Kazakhstan) during the Period 1999–2021. Sustainability 2023, 15, 7548. <https://doi.org/10.3390/su15097548> IMPACT FACTOR 3.889. CITESCORE 5.0.;

Alipbeki O., Alipbekova C., Mussaif G., Grossul P., Zhenshan D., Muzyka O., Turekeldiyeva R., Yelubayev D., Rakhimov D., Kupidura P., Alikan E. Analysis and Prediction of Land Use/Land Cover Changes in Korgalzhyn District, Kazakhstan. Agronomy 2024, 14, 268. <https://doi.org/10.3390/agronomy14020268>;

Alipbeki O., Grossul P., Rakhimov D., Kupidura P., Alipbekova C., Mussaif G., Turekeldiyeva R., Augambaev K., Begaliyeva M. Ecosystem Health Assessment of the Zerendy District, Kazakhstan. Sustainability 2025, 17, 277. <https://doi.org/10.3390/su17010277>.

The findings in the above publications fully confirm the scientific validity and quality of the research.

Mussayf Gauhar's scientific work is distinguished by its depth, relevance, high accuracy, and comprehensiveness. The combined results allow us to consider this work a significant study with clear scientific novelty and recommend Mussaif Gauhar for a **Doctor of Philosophy (PhD)** degree in program 8D07302 – “Geodesy”.



Artu Ellmann

Professor, Doctor of Technical Sciences

Head of the Research Group “Road Construction and Geodesy”,

Department of Civil Engineering and Architecture

Tallinn University of Technology, Estonia



Tallinn, Jan. 20, 2026