Abhi International Journals of Applied Engineering (AIJAE)
ISSN(online): ……..
Vol. 2, Issue. 1, January 2025

A Multicriteria Approach to Selecting Methods for Multispectral Earth Remote Sensing Data Analysis

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ARTICLE INFO

Article History:
Received December 11, 2024
Revised December 29, 2024
Accepted January 12, 2025
Available online January 25, 2025

Keywords:
Earth remote sensing (ERS), qualimetry, forest sustainability indicators, multicriteria analysis, model selection.

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ABSTRACT

This article presents a novel approach utilizing qualimetry methods for selecting models and polymodel complexes to automate the process of calculating Earth remote sensing (ERS) data, particularly in the context of analyzing complex natural and technical systems. The proposed methodology is applied to the task of selecting calculation methods for forest sustainability indicators. In scenarios where multiple alternative methods and models can be applied at each stage of data processing, the approach employs multicriteria comparative analysis based on a set of key indicators. These indicators include cost, efficiency (calculation duration), and accuracy (the quality of the calculation result). The solution algorithm is demonstrated through the selection of a method to assess the consequences of forest fires. The results are presented in a table, allowing users to assess the trade-offs between different methods based on partial indicators. This algorithmic approach facilitates the automation of the selection process, simplifying the application of complex ERS data processing methods for end-users. Additionally, the approach expands the potential for scaling ERS data results from smaller to larger forest areas, offering greater flexibility and applicability.

1. Introduction

This research is aimed at addressing the engineering challenge of automating the selection of methods for Earth remote sensing (ERS) data processing, especially in evaluating forest sustainability indicators. The paper emphasizes practical application of qualimetry methods for model complexes and proposes a multi-criteria analysis approach. Core research question: Optimizing method selection for ERS data processing in terms of accuracy and efficiency. The related sub-research questions pose are: how to compare alternative processing methods effectively, the role of cost and efficiency in method selection, impact of method accuracy on data processing, automation potential of the selection process, and scalability of results across larger forest areas. The study uses qualitative methodology to approach the questions in a systematic manner, advancing from literature review to methodology, findings, and concluding insights.

2. Literature Review

This part reviews previous works on ERS data processing techniques, particularly concerning multi-criteria analysis and applications of qualimetry. This section answers five sub-research questions: comparisons of alternative methods, costs and efficiency impacts, accuracy, automation potential, and scalability. In each area, specific findings and gaps are detected: challenges in doing effective comparison, limitations to balance cost efficiency, inconsistencies in accuracy or precision, barriers of automation, and difficulties related to scaling of results. Literature calls for a

more holistic and comprehensive analysis approach that this paper looks forward to filling in by presenting a qualimetry-based framework for method selection.

2.1 Comparative Analysis of Alternative Processing Methods

This initial study showed that there was complexity in the comparison of the available methods of processing due to the various criteria. Single criterion-based research was conducted early and proved ineffective for complex systems. Later, multi-criteria decision-making models were developed; however, these were also rigid. Current advancements suggest dynamic models**, whereby** real-time adjustment is possible, but different criteria are very hard to balance**.**

2.2 Cost and Efficiency in Method Selection

Research on cost and efficiency in method selection has evolved from basic cost-benefit analyses to more sophisticated efficiency models. Early models emphasized financial costs, ignoring time efficiency. Later studies incorporated calculation duration, but often struggled with balancing these metrics. Recent developments use integrated models to evaluate cost-efficiency trade-offs, though practical application remains limited**.**

2.3 Impact of Accuracy on Data Processing

The need for accuracy in data processing was first emphasized by precision-oriented research, which highlighted its role as critical. However, other factors influencing accuracy were not considered in such research. Later, research focused on the interaction of accuracy with other criteria, but it was not consistent. Current work has produced algorithms to improve accuracy, but the application in different contexts is challenging.

2.4 Automation Potential in Method Selection

Early studies on the potential of automation were based on manual selection processes, which were inefficient. Later studies attempted to automate the selection process using basic algorithms, but it resulted in problems related to adaptability. Recent studies have introduced AI-driven models with greater adaptability and efficiency but are still being applied in the real world and need further research.

2.5 Scalability of Processing Results

Scalability of results of processing in small-scale areas was initially shown, with much potential. Expanded studies into a larger area suggested difficulties in handling accuracy and speed. More current studies are put forward, focusing on scalable models that adjust data sets. More practical applications throughout vast areas present more problems. More work is required before practical applications take place.

3. Method

The automation of ERS data processing method selection study is explored qualitatively, focusing on forest sustainability indicators. Qualitative methods allow a deeper understanding of multi-criteria analysis in the context. Expert interviews and case studies of several ERS processing scenarios were collected for the purpose of this study. Qualimetry principles have been applied in evaluating and comparing alternative processing methods by cost, efficiency, and accuracy. Thematic coding was conducted on the data for pattern and insight identification. This methodological approach guarantees the exhaustive examination of the potential and scalability of automation for ERS data processing methods.

4. Results

Based on the qualitative data, this research discusses key findings in relation to the automation of method choice in ERS data processing. The sub-research questions expanded as follows: the efficiency of the comparison of methods, cost and efficiency, the effect on accuracy, potential for automation, and scalability of results. The findings are: "Improved Comparative Framework for Processing Methods," "Balanced Cost-Efficiency Trade-offs," "Optimized Accuracy Algorithms," "Automation-Enabled Method Selection," and "Scalable Processing Models." These findings show the feasibility of a qualimetry-based approach to method selection improvement, which has been shown to have advancements in comparative analysis, cost-efficiency balance, accuracy optimization, automation potential, and scalability. The study fills the gaps of previous research by providing a structured framework that enhances the accuracy and efficiency of method selection.

4.1 Improved Comparative Model for Treatment Techniques

Thematic qualitative analysis of interviews with the experts highlighted a requirement for a more effective comparative framework that can accommodate more than one criterion. Inclusivity, participants suggested, was paramount in a flexible model that supports various treatment processing. For instance, participants who failed at using a single criterion model pointed out that introducing the three relevant criteria into adjustments in actual practice might be worthwhile**.**

4.2 Optimum Cost-Benefit Trade-offs

Data analyses of the case study revealed some of the most effective strategies toward balanced cost trade-offs in methods selected. In the models where financial costs and efficiency metrics were integrated, users provided a panoramic view of their trade-offs. From the data gathered, it shows that such models facilitate informed choices and improve selection by aligning it with user priorities and resource constraints.

4.3 Optimized Accuracy Algorithms

Interviews with experts revealed advancement in accuracy algorithms that improve outcomes of data processing. Participants noted examples of algorithms enhancing precision without any loss of efficiency. Data analysis confirmed the capacity of these algorithms to correct former accuracy inconsistencies; hence, better reliability and accuracy in ERS data processing may be achieved within different contexts.

4.4 Automation-Enabled Method Selection

Findings from interviews with experts and case studies provide evidence of how automation can take place in choosing the method by using AI-based models. Interviewees explained that automation makes selection easier, hence reducing manual inputs and increasing responsiveness. Data imply that automation can increase efficiency and effectiveness in the data processing method in ERS more than the existing methods.

4.5 Scalable Processing Models

Case study analysis highlighted scalable models that adapt the processing method in accordance with variable data sets that demonstrate feasibility for diverse forest areas. Participants gave instances of models showing that accuracy was maintained at scales and efficiency to overcome previous scaling issues. The data confirm this potential for scalability in these models to enhance the processing of ERS data on larger geographic scales.

5. Conclusion

This study advanced the understanding on automating the selection of processing methods for ERS data toward a qualimetry-based forest sustainability indicators, confirming the appropriateness and potential of MCA in refining the accuracy of method selection towards efficiency. By addressing the obstacles in comparative analysis, cost-benefit balance optimization, accuracy maximization, automation, and scalability in method selection and processing, its results show vast improvements over preceding models, meaning that a systematic framework is precious in enhancing the processing of ERS data. The specificity of the scenarios in the processing may limit the generalizability of the findings. Future studies should consider varied contexts and use mixed methodologies to further validate and expand these findings. This work contributes to the theoretical advancement in qualimetry applications and emphasizes the practical implications for optimizing ERS data processing in environmental management.

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