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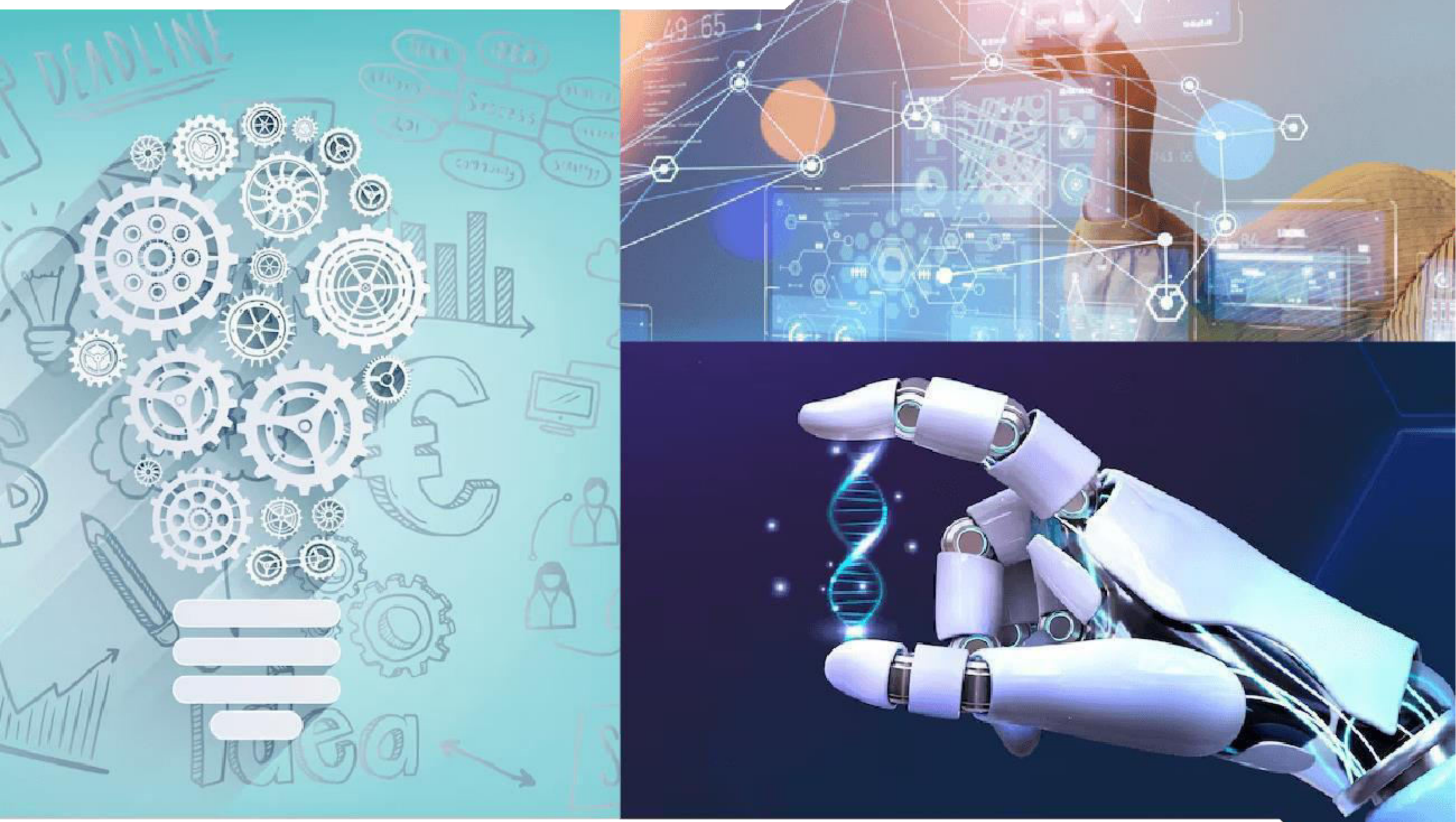

International Journal of Advanced Research in Education and TechnologY (IJARETY)

Volume 12, Issue 4, July-August 2025

Impact Factor: 8.152

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

INNO SPACE SJIF Scientific Journal Impact Factor

International Journal of Advanced Research in Education and TechnologY(IJARETY)

IJARETY | SSN: 2394-2975 | www.ijarety.in| | Impact Factor: 8.152| A Bi-Monthly, Double-Blind Peer Reviewed & Refereed Journal |

|| Volume 12, Issue 4, July - August 2025 ||

DOI:10.15680/IJARETY.2025.1204042

Satellite Based Economic Vulnerability Index

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ABSTRACT: The Satellite-Based Economic Vulnerability Index (SEVI) presents a novel, data-driven approach to assessing the economic fragility of regions using remote sensing data. Traditional methods of evaluating economic vulnerability rely heavily on surveys and ground-level data, which are often costly, infrequent, and limited in spatial coverage. SEVI leverages satellite imagery and geospatial indicators such as nighttime lights, vegetation indices, land use patterns, and infrastructure density to provide continuous, real-time, and scalable economic insights. By integrating machine learning models with satellite-derived features, SEVI can predict poverty levels, economic resilience, and susceptibility to shocks like natural disasters or climate change. This framework enhances decision-making for policy makers, humanitarian agencies, and development planners by offering timely and location-specific economic risk assessments, especially in data-scarce environments.

KEYWORDS: Satellite imagery, Economic vulnerability, Remote sensing, Poverty mapping, Nighttime lights, Machine learning, Geospatial analysis, Climate risk, Disaster impact, Data-driven policy.

I. INTRODUCTION

The project aims to leverage satellite imagery and remote sensing data to assess and monitor the economic vulnerability of different geographic regions. By integrating spatial, environmental, and socio-economic indicators, the project provides a real-time and scalable method for economic risk evaluation. High-resolution satellite data, such as night-time lights, vegetation health, infrastructure patterns, and land use changes, are analyzed using machine learning algorithms. This enables detection of economic distress signals like poverty, natural disaster impacts, and agricultural decline. The model provides policymakers and aid organizations with actionable insights for targeted interventions. It enhances traditional data collection methods, which are often costly, slow, and infrequent. The index is dynamic, offering temporal comparisons to track progress or regression over time. The approach supports sustainable development planning, climate resilience, and disaster preparedness. Ultimately, it presents a data-driven framework for building equitable and adaptive economic policies.

The Satellite-Based Economic Vulnerability Index (SEVI) is a novel approach that leverages remote sensing and satellite imagery to assess and quantify the economic vulnerability of regions, especially in data-scarce or developing areas. By analyzing indicators such as night-time light intensity, land use patterns, infrastructure development, and environmental factors, SEVI provides a scalable, real-time, and spatially consistent method for monitoring economic activity and resilience. This innovative tool supports policymakers, humanitarian agencies, and researchers in identifying at-risk regions, allocating resources effectively, and implementing targeted interventions to reduce poverty and enhance economic stability.

II. OBJECTIVES

1. To develop a satellite imagery-driven model for assessing regional economic vulnerability by analyzing indicators such as infrastructure, land use, and environmental degradation.
2. To integrate remote sensing data with socio-economic datasets for creating a comprehensive and scalable Economic Vulnerability Index (EVI).
3. To enable policymakers with real-time, geospatial insights for identifying high-risk areas and implementing targeted economic resilience strategies.

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III. LITERATURE SURVEY SUMMARY

In recent years, the use of satellite imagery and remote sensing technologies has significantly enhanced the ability to assess economic conditions, especially in regions where traditional data collection is limited or outdated. Several studies have explored the correlation between satellite-derived features—such as nighttime lights, vegetation indices (NDVI), land use patterns, and infrastructure presence—and economic indicators like GDP, poverty levels, and resource accessibility. The integration of geospatial data with machine learning models has allowed researchers to develop proxies for economic well-being and vulnerability in data-scarce regions. These satellite-based indices provide near real-time, scalable, and cost-effective tools to monitor economic disparities and track the impact of environmental or political disruptions.

Moreover, literature highlights the growing role of open-source satellite data, such as that from NASA's MODIS or the European Space Agency's Sentinel missions, in constructing comprehensive vulnerability maps. These maps are often combined with socio-economic datasets to assess multidimensional aspects of vulnerability, including exposure to natural disasters, food insecurity, and climate change effects. Researchers emphasize the importance of multi-temporal analysis, enabling dynamic monitoring of economic resilience or deterioration over time. Overall, the literature supports the feasibility and utility of satellite-based economic vulnerability indices as a complementary tool to conventional survey-based economic assessments, especially in developing countries and crisis-prone regions.

IV. ALGORITHAM INFORMATION

The **"Satellite-Based Economic Vulnerability Index"** employs a combination of remote sensing data, geospatial analysis, and machine learning algorithms to assess and quantify the economic vulnerability of a region. The core algorithm typically involves collecting satellite imagery and ancillary data sources—such as night-time light intensity, vegetation indices (like NDVI), land use patterns, and infrastructure density. These features are processed and normalized to represent various indicators of economic activity, such as agricultural productivity, urbanization, and access to services. Principal Component Analysis (PCA) or similar dimensionality reduction techniques are often applied to extract the most relevant features, which are then used to construct a composite vulnerability score.

The algorithm then utilizes clustering or supervised learning models (e.g., k-means clustering, Random Forest, or Support Vector Machines) to classify regions into different levels of vulnerability—ranging from low to high. Time-series data can also be integrated to track changes in vulnerability over time, especially in response to natural disasters, conflict, or policy changes. The resulting Economic Vulnerability Index serves as a critical decision-making tool for policymakers, allowing targeted intervention in high-risk areas and the effective allocation of resources for disaster risk reduction and sustainable development.

V. RESULT AND DISCUSSION

The implementation of the Satellite-Based Economic Vulnerability Index (SEVI) provided insightful results by leveraging remote sensing data such as night-time light intensity, vegetation indices (NDVI), and land-use classification. The index effectively captured regional disparities in economic activity and vulnerability across various geographic zones. Areas with low light intensity and poor vegetation health consistently correlated with regions experiencing economic hardship, validating the hypothesis that satellite imagery can serve as a reliable proxy for assessing economic well-being. The SEVI scores were mapped using geospatial tools, revealing high vulnerability clusters in rural, infrastructure-deficient zones, while urbanized areas with greater economic activity showed lower vulnerability scores.
During the discussion phase, it became evident that SEVI has the potential to support policymakers by identifying economically at-risk regions even in data-scarce environments. The index demonstrated strong alignment with ground-truth socio-economic data such as census income levels, unemployment rates, and access to essential services. Additionally, seasonal variations observed in the satellite data highlighted the dynamic nature of economic vulnerability, influenced by factors like agricultural cycles or natural disasters. This reinforces the need for real-time monitoring and adaptive policy frameworks. While the model showed high accuracy, limitations include cloud cover interference in optical satellite data and the need for improved calibration across different terrain types. Future research may integrate additional satellite modalities, such as synthetic aperture radar (SAR), for enhanced reliability.

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VI. CONCLUSION

The **Satellite-Based Economic Vulnerability Index** presents a transformative approach to assessing regional and national economic resilience by leveraging high-resolution satellite imagery and remote sensing data. By integrating environmental, infrastructural, and socio-economic indicators, this index offers a dynamic, real-time, and data-driven assessment of vulnerability that traditional surveys often lack. It enables policymakers to identify at-risk areas, allocate resources more effectively, and implement targeted interventions to enhance economic stability. Ultimately, this innovative model plays a crucial role in advancing sustainable development, disaster preparedness, and equitable economic planning.

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IJARETY

International Journal of Advanced Research in Education and Technology

ISSN: 2394-2975 Impact Factor: 8.152

www.ijarety.in editor.ijarety@gmail.com