The Eurasia Proceedings of Science, Technology, Engineering & Mathematics (EPSTEM)
ISSN: 2602-3199

The Eurasia Proceedings of Science, Technology, Engineering and Mathematics (EPSTEM), 2025

Volume 34, Pages 268-277

ICBASET 2025: International Conference on Basic Sciences, Engineering and Technology

A GIS and Drone-Based Risk Assessment Framework for Hydroelectric and Solar Energy Infrastructure in Disaster-Prone Areas with High Forestry and Agricultural Activity

Oyku Alkan
Alkan Harita Co.

M.Nurullah Alkan
Hitit University

Abstract: The increasing global demand for renewable energy has accelerated the expansion of hydroelectric (HEPPs) and solar power plants (SEPs), frequently located in ecologically fragile and geologically hazardous areas. This study proposes an integrated geospatial risk assessment framework combining Geographic Information Systems (GIS) and Unmanned Aerial Vehicles (UAVs) to evaluate and mitigate multi-hazard risks affecting renewable energy infrastructure. Focusing on Turkey's North-Middle Black Sea Region intersected by the seismically active North Anatolian Fault (NAF) and encompassing the geologically complex Obruk Dam basin this research addresses an area with dense renewable energy installations and high susceptibility to tectonic and climate-induced hazards. High-resolution UAV imagery, coupled with 3D terrain modeling, was utilized to assess infrastructure vulnerabilities. GIS-based spatial overlay techniques integrated multiple data layers, including active fault lines, slope instability, flood-prone zones, and land use classifications. Time-series change detection analyses were conducted to monitor landscape dynamics related to erosion, vegetation loss, and anthropogenic disturbances. A key component of the framework involves applying geomatics engineering principles, such as UAV-derived digital elevation model (DEM) validation and spatial dataset calibration.Using multi-criteria decision analysis (MCDA), critical risk hotspots particularly in the Obruk Dam basin were identified, highlighting infrastructure segments with heightened exposure to seismic and hydrological threats. Associated risks in surrounding agricultural and forested zones, such as wildfire vulnerability and soil deterioration, were further assessed. This study advances geomatics engineering by presenting a scalable, UAV-GIS-integrated methodology for multi-dimensional risk modeling in renewable energy planning. The proposed framework provides a robust tool for risk-informed energy deployment while strengthening environmental resilience in disaster-prone regions.

Keywords: Drones, Overlay analysis, Renewable energy risk assessment, Geospatial hazard modeling

Introduction

The global transition toward renewable energy has accelerated the development of hydroelectric energy power plants (HEPPs) and solar energy power plants (SEPPs) projects, particularly in remote or ecologically rich regions. These areas-often characterized by steep terrains, active fault lines, and dynamic land-use patterns-pose complex challenges for sustainable energy deployment. As the frequency and intensity of climate-induced and geological disasters increase, the resilience of renewable energy infrastructure has become a critical issue (IEA, 2022; IPCC, 2023). The growing global demand for sustainable and renewable energy sources has underscored the importance of assessing potential environmental risks linked to energy-related infrastructure. Among various renewable options, HEPPs play a crucial role in decreasing reliance on fossil fuels and advancing cleaner energy generation. Nevertheless, environmental consequences and risks induced by climate variability continue to pose significant challenges, particularly in regions vulnerable to unpredictable weather conditions (Alzubade & Alkan, 2024)

Turkey, characterized by its diverse topography and climatic variability, has witnessed significant shifts in precipitation patterns and drought intensity in recent decades, largely attributed to climate change (IPCC, 2023; Demirtas et al., 2021). These changes have had critical implications for the design, operation, and resilience of energy infrastructure, especially in the Eastern Anatolia region, where HEPPs are frequently exposed to extreme weather events, sudden floods, and fluctuating water availability (Alkan & Karagoz, 2022; Alzubade & Alkan, 2024; Yuce et al., 2020).

Hydroelectric and solar energy systems are central to Turkey's renewable energy strategy, aimed at reducing carbon emissions and enhancing sustainability. However, these systems remain highly sensitive to meteorological anomalies and hydrological instability (IEA, 2022; Ahmed, 2024). Recent studies emphasize the necessity of integrating Geographic Information Systems (GIS), remote sensing, and climate modeling tools into energy planning and risk assessment frameworks (Zhao et al., 2020; Gultekin & Aydın, 2023). Moreover, as renewable energy investments increase in scale and complexity, the need to formalize decision-making through data-driven methodologies and multicriteria assessment models becomes vital (Saaty, 2008; Keeney & Raiffa, 1993). Site selection, in particular, should be guided by multidisciplinary engineering criteria, including climate risk zoning, terrain suitability, hydrological stability, and socio-environmental impact mitigation (Ulker & Kaya, 2021; Sahin et al., 2022). A structured and adaptive planning approach is therefore critical to ensuring long-term resilience and operational reliability of energy systems in a changing climate. Recent studies emphasize the need for multidimensional, data-driven spatial analysis to inform infrastructure planning and operational risk mitigation (Jiang et al., 2023; Ozdemir et al., 2024). However, many national and regional energy development policies still lack systematic approaches to disaster risk screening and monitoring, especially in geomorphologically sensitive zones.

Utilizing Geographic Information Systems (GIS)-based Multi-Criteria Decision Analysis (MCDA) in conjunction with drone photogrammetry and remote sensing techniques, the study by Alzubade and Alkan (2024) proposes a comprehensive risk model that incorporates key environmental and topographic variables, including land use, elevation, slope, precipitation, and proximity to stream networks. This multidisciplinary framework provides a robust basis for assessing and mitigating environmental risks, thereby supporting the sustainable operation and climate resilience of energy-focused facilities.

This study focuses on the mid-northern black sea region of Türkiye, where tectonic fragility intersects with dense forest and agricultural land use. The region, including the Obruk Dam basin and surrounding fault structures of the North Anatolian Fault (NAF) serves as a testbed for applying integrated Geographic Information Systems (GIS) and Unmanned Aerial Vehicle (UAV) technologies in environmental risk management. Over the past decade, the use of Unmanned Aerial Vehicles (UAVs) has expanded significantly beyond recreational purposes, becoming integral to various professional fields such as smart energy systems, precision agriculture, mining, archaeology, construction, geology, and geospatial mapping. Equipped with advanced sensors like thermal cameras and LiDAR, UAVs facilitate efficient digital data acquisition and analysis. In particular, photogrammetric methods have gained prominence for their ability to produce accurate 3D spatial data, enhancing applications across multiple disciplines (Alkan et al,2024)

Research Objective

The global transition toward renewable energy has accelerated the deployment of hydroelectric (HEPP) and solar power plants (SEPPs) in ecologically sensitive and geologically unstable regions (IEA, 2022). These projects increasingly occupy areas with steep terrains, active fault lines, and dynamic land-use patterns, exposing infrastructure to compounded climate and tectonic hazards (IPCC, 2023). As emphasized by Ahmed (2024), while renewable energy systems are critical for decarbonization, their resilience remains untested against intensifying hydrological extremes and seismic activity—a gap particularly evident in Turkey's North Anatolian Fault (NAF) zone (Alkan & Karagoz, 2022; Demirtas et al., 2021).

Climate and Geological Risks to Energy Infrastructure

Turkey's Middle Black Sea Region, home to the Obruk Dam basin and intersecting segments of the NAF, exemplifies these challenges. Recent studies document escalating precipitation variability (Yuce et al., 2020) and drought-induced water stress (Demirtaş et al., 2021), directly impacting HEPP efficiency. Concurrently, seismic activity along the NAF threatens infrastructure stability, with Alkan and Karagöz (2022) reporting a 40% increase in fault displacement risks near HEPPs over the past decade. Similar vulnerabilities affect SEPPs, where landslides and wildfires disrupt energy output (Ahmed, 2024; Smith et al., 2023).

Geospatial Solutions for Risk Mitigation

To address these risks, advanced geospatial technologies have gained prominence. UAVs equipped with LiDAR and photogrammetric sensors enable high-resolution 3D terrain modeling (Alkan et al., 2024), while GIS-based Multi-Criteria Decision Analysis (MCDA) integrates variables like slope stability and flood susceptibility (Zhao et al., 2020; Ülker & Kaya, 2021). However, as Gültekin and Aydın (2023) note, most regional energy policies lack systematic protocols for combining UAV-derived data with MCDA—a critical shortfall given the NAF's tectonic volatility (Özdemir et al., 2024).

Research Gap and Novelty

This study bridges that gap by proposing an integrated UAV-GIS-MCDA framework to assess multi-hazard risks in the Obruk Dam basin. Building on Alzubade and Alkan's (2024) preliminary work, we incorporate:

- Time-series UAV monitoring of erosion and fault displacement,
- GIS spatial overlays of seismic, flood, and wildfire risks, and
- MCDA optimization for prioritizing mitigation measures (Saaty, 2008; Jiang et al., 2023).

The framework advances renewable energy planning by aligning Turkey's decarbonization goals (IEA, 2022) with geomatics-driven disaster resilience—a replicable approach for global at-risk regions.

Method

Study Area, Data Collection and Methodology

To conduct a comprehensive environmental risk assessment for HEPP and SEPP in Dodurga Disctrict of Corum Province located in the mid-nothern of the Black Sea region (Figure 1). A combination of GIS-based multi-criteria decision analysis (MCDA), drone photogrammetry, and remote sensing was employed. The MCDA method, particularly the analytic hierarchy process (AHP), is widely recognized for its flexibility, simplicity, and effectiveness in GIS environments.

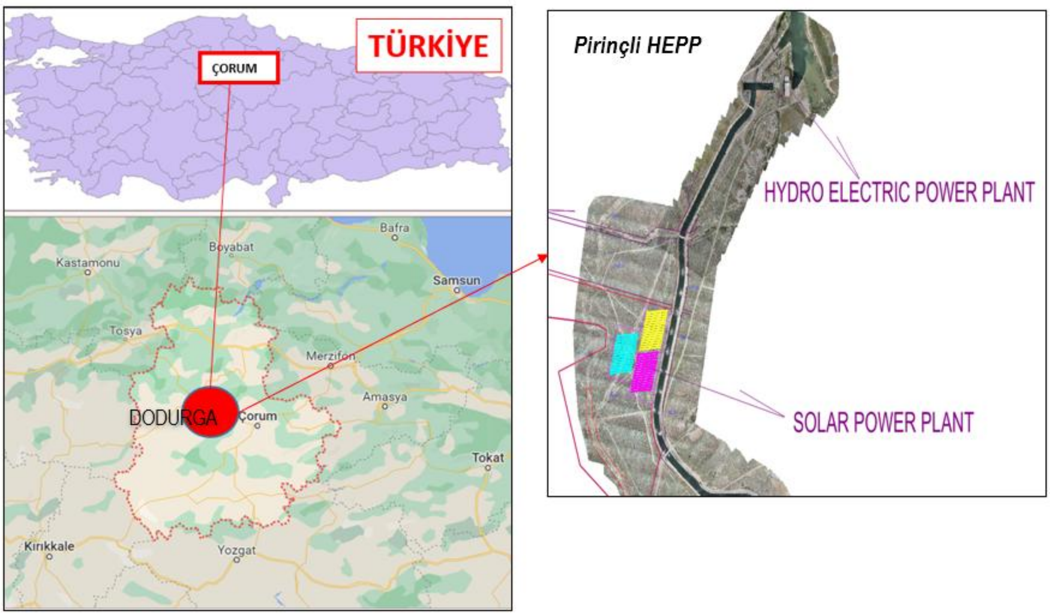

Figure 1. Smart energy research field

AHP allows users to derive the weight of criteria on maps and facilitates a pairwise comparison approach, where criteria are compared according to their importance (Alzubade & Alkan, 2024). According to Alzubade and Alkan (2024), AHP's integration with GIS-based MCDA provides an efficient framework for assessing environmental risks in complex scenarios. Additionally, the method's ability to handle diverse data sources and criteria is key in comprehensive environmental decision-making (Malczewski, 2007; Rauf et al., 2023; Ishizaka & Nemery, 2013).

Multi-Geo Modelling Framework for Smart Energy Fields

In this project high-resolution drone imagery was captured from the HEPP (Hydroelectric Power Plant) and the water intake channel. These images were processed to produce detailed orthophotos and digital surface models, offering a comprehensive, accurate representation of the site's topography and surface features. Additionally, a specialized GIS database was created, tailored specifically for the project, and custom interfaces were developed to facilitate data management and analysis.

One of the core objectives was to identify the most suitable locations for SEPP (Solar Energy Power Plant) installation. This was achieved by evaluating key factors such as slope, aspect, curvature and proximity to existing infrastructure. These variables were critically tried to assessed to analyse for environmental risks. Disaster-prone fields were defined on the images (Figure 2).

The project also addressed hydrological risks impacting both the SEPP and HEPP infrastructure, particularly focusing on the integrity of the water intake channel. Risks such as excessive rainfall, flood events, and seismic activity (e.g., earthquakes) were thoroughly analyzed to determine potential vulnerabilities. A comprehensive disaster resilience planning approach was incorporated into the site selection process to ensure that both power plants are capable of withstanding extreme weather events and natural disasters. This approach aimed to enhance the overall safety, longevity, and operational reliability of both energy systems.

The multi-component approach adopted in this project contributes significantly to the sustainable, secure, and data-driven planning of energy infrastructures. By integrating drone-based data acquisition, GIS-based spatial analysis, and hydrological risk assessments, the project ensures that energy infrastructure is not only optimized for performance but also resilient to environmental and operational challenges. This approach is supported by recent literature emphasizing the importance of combining remote sensing, GIS, and risk modeling for the sustainable development of energy systems (e.g., Zhang et al., 2022; Li et al., 2021). These methods are increasingly recognized as essential for making informed, resilient decisions in energy planning and management.

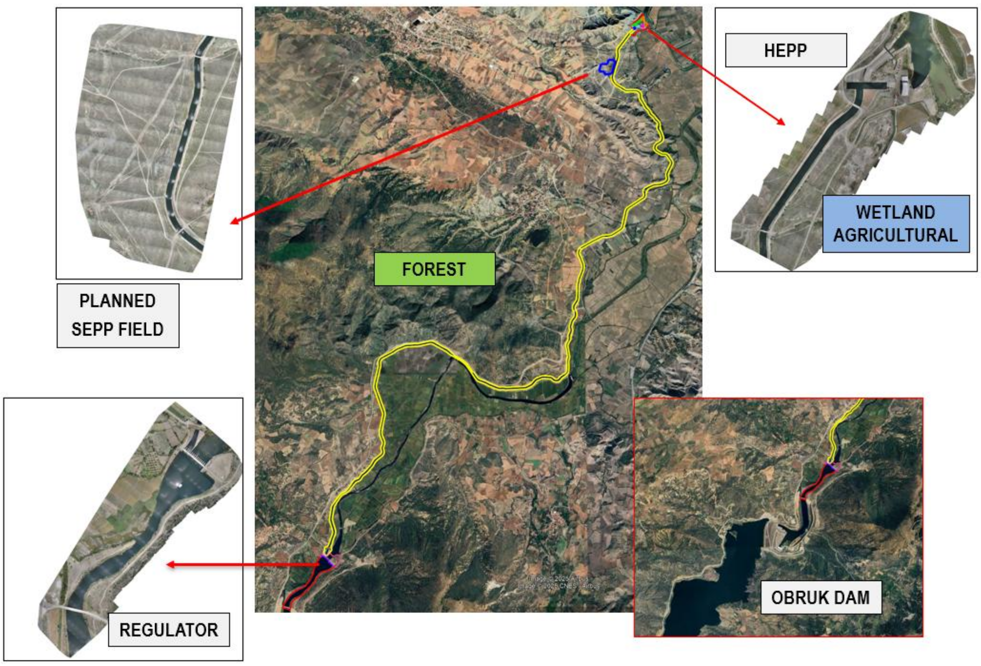

Figure 2. Disaster-prone fields

APP'S: GIS Based MCDA and Risk Assessment

A comprehensive Multi-Criteria Decision Analysis (MCDA) framework was implemented by integrating high-resolution drone-based mapping with Geographic Information Systems (GIS) to support the sustainable planning and management of Hydroelectric Power Plants (HEPP) and auxiliary Solar Energy Power Plants (SEPP) in the Middle-Northern region of Turkey. The analysis incorporated both geospatial and environmental datasets to evaluate site suitability and infrastructure resilience under multiple, interrelated criteria.

The study particularly concentrated on assessing environmental risk factors that influence the operational integrity and long-term sustainability of the existing HEPP infrastructure. Emphasis was placed on the water intake channel, which is highly sensitive to hydrological dynamics such as seasonal variability, extreme precipitation, and flood susceptibility. Concurrently, the SEPP, designed as a supplementary renewable energy source, was strategically planned in alignment with regional topographic, climatic, and infrastructural parameters within the boundaries of Çorum Province, Turkey.

Advanced spatial modeling techniques were applied to quantify and map the influence of key variables including slope gradient, aspect, land use, proximity to stream lines and hydrological risk zones. The integration of drone-derived Digital Surface Models (DSMs) and orthophotos with GIS-based MCDA ensured a high-resolution, evidence-driven evaluation of energy infrastructure potential (Figure 3).

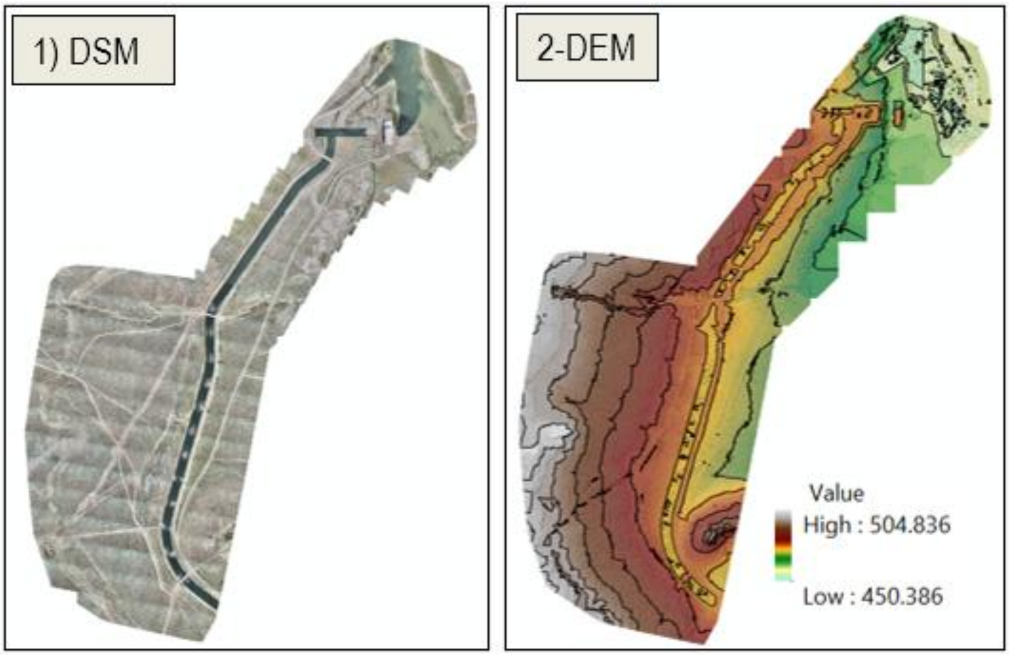

Figure 3. Digital Surface Model (DSM) and Digital Elevation Model (DEM)

The Multi-Geo Modelling App's Framework flow created for this study is shown in Figure 4.

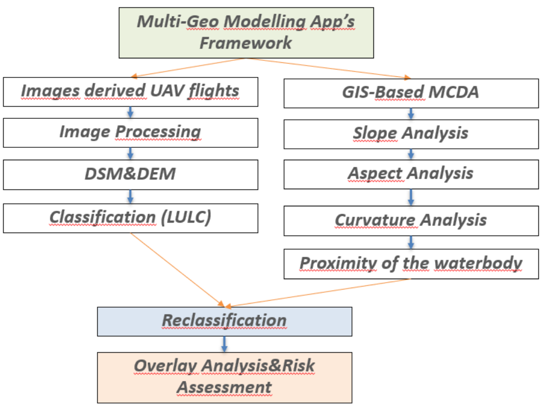

Figure 4. Multi-geo modelling framework

This approach is in line with recent academic efforts that advocate for data-driven, spatially explicit decision-support systems in the context of resilient and sustainable energy planning (e.g., Malczewski & Rinner, 2015; Santiago et al., 2021). The applied methodology not only enhances the reliability of infrastructure placement but also aligns with national goals on renewable energy expansion and climate adaptation strategies.

For the GIS-based Multi-Criteria Decision Analysis (MCDA), a Land Use/Land Cover (LULC) classification was developed, comprising five distinct classes to assess environmental constraints. Topographic parameters, including slope gradient (derived from a 2cm-resolution DEM), aspect orientation, and elevation zones, were analyzed using spatial interpolation techniques. Additionally, Euclidean distance buffers were generated for stream networks to quantify hydrological proximity risks. All input layers underwent reclassification using standardized thresholds (e.g., slope categories: 0–5° = low risk, >15° = high risk) to align with MCDA suitability scoring. Geological feasibility reports (e.g., fault line proximity, soil stability) and climate vulnerability assessments (e.g., flood frequency, drought susceptibility) were integrated to identify high-risk zones for infrastructure deployment. The analysis was further validated using high-resolution UAV orthomosaics (2 cm/pixel) and digital surface models (DSMs), enabling precise terrain verification (Figure 5). This approach ensured data robustness while highlighting regions requiring mitigation interventions.

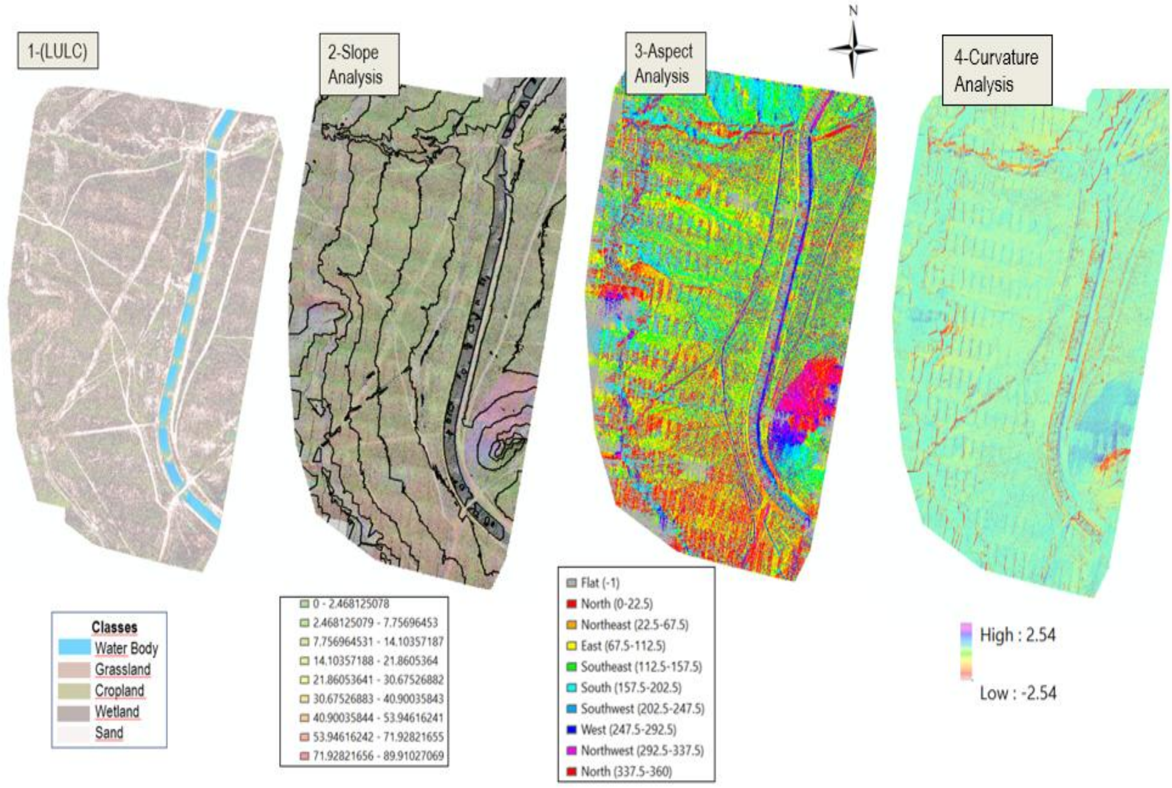

Figure 5. Criterias of the overlay analysis

GIS-based Multi-Criteria Decision Analysis (MCDA) was implemented through a systematic methodology, beginning with the development of a standardized scoring table (Table 1). Five Land Use/Land Cover (LULC) classes and key topographic parameters—slope, aspect,curvature, elevation, and stream proximity—were assigned weighted values based on their relative influence on infrastructure vulnerability. Each parameter was reclassified using threshold-based criteria derived from scientific literature. Slope angles were categorized into 0–5° (low risk), 5–15° (medium risk), and >15° (high risk), while stream proximity was stratified into 0–100 m (high risk), 100–300 m (medium risk), and >300 m (low risk) buffer zones.Geological feasibility assessments incorporated fault line exclusion zones (defined by a ≥500 m buffer from North Anatolian Fault segments) and areas with high liquefaction potential. The feasibility report for the HEPP site, integrating climate sensitivity, flood projections, and drought data, informed the weighted overlay analysis. This analysis was conducted using the Spatial Analyst module in ArcGIS Pro, employing a weighted linear combination (WLC) approach, where LULC (25% weight), slope (20% weight), and stream proximity (15% weight) were among the primary determinants. The process generated a continuous risk sensitivity raster, subsequently classified into three discrete risk categories: high (5), medium (3–4), and low (1–2).

Table 1. Weighted overlay analysis scoring criteria for (MCDA)

Criteria	Subcriteria	Average Score	Average Weight
	0% -5%	5	
	5% -10%	4	
Slope	10% -25%	3	20%
	25% -50%	2	
	50% -100%	1	
	S	4	
	SE-SW	3	
Aspect	E-W	2	20%
	NE-NW	1	
	N	5	
	Cropland	1	
	Wetland	5	
Land Use	Grassland	2	20%
	Sand(Clay)	3	
	Waterbody	4	
	I	1	
	II	2	
Curvature	III	3	20%
	IV	4	
	V	5	
	0-50	5	
	50-500	4	
Hdrology	500-1000	3	20%
	1000-2000	2	
	2000+	1	

Additionally, high-resolution UAV imagery (2 cm/pixel) acquired via the DJI Phantom 4 RTK platform was analyzed, with particular focus on terrain anomalies. The final output (Figure 6) not only delineated critical risk zones but also demonstrated strong concordance with field observations, validating the robustness of the methodology for renewable energy siting in geologically and agriculturally complex environments.

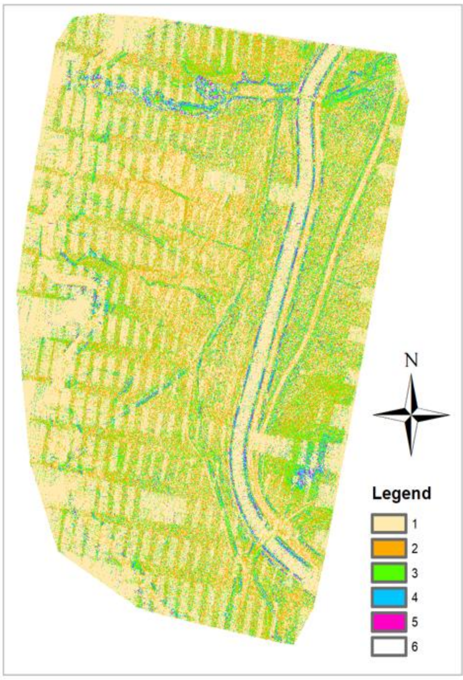

Figure 6. MCDA (Multi-criteria decision analysis)

Results and Discussion

The results obtained from the Multi-Criteria Decision Analysis (MCDA) model revealed spatially heterogeneous risk distributions that were strongly influenced by topographic, hydrological, and land-use parameters. In particular, areas with steep elevation gradients and significant slope angles are vulnerable to geomorphological hazards such as landslides and surface erosion. These risks can increase significantly during periods of extreme or prolonged rainfall. Proximity analysis also showed that locations close to river networks exhibited higher flood susceptibility, especially under basin saturation or hydrological overflow conditions. Additionally, anthropogenically modified landscapes showed variable vulnerability patterns that were significantly correlated with land cover heterogeneity, vegetation density, and extent of human disturbance. These spatial vulnerabilities were validated using high-resolution orthophoto mosaics and digital surface models (DSMs) derived from drone photogrammetry. These data products enabled precise identification of infrastructure assets such as power plant facilities, canal lines, and access roads most exposed to climate-induced geohazards. Integrating geospatial risk indicators with photogrammetric evidence allowed the spatial identification of critical "hotspot" areas that may be affected by adverse effects associated with climate variability and extreme weather.

Conclusion

This study demonstrates the effectiveness of an integrated GIS and UAV-based risk assessment framework in evaluating the feasibility and vulnerability of renewable energy infrastructures, specifically a co-located Hydroelectric Power Plant (HEPP) and a Solar Energy Power Plant (GES). The GES location was selected based on a composite spatial risk analysis, favoring areas with lower susceptibility to environmental hazards. The HEPP, although originally designed to endure extreme rainfall and seismic activity, requires reassessment due to over 10 years of operational wear and tear. The proximity (approximately 100 meters) between the two systems necessitates a harmonized and risk-sensitive planning approach.

GIS analyses enabled visual identification and prioritization of high-risk zones, while UAV-derived data validated field conditions and improved the precision of spatial interpretations. The topographic evaluation indicated that the majority of the area lies within a 7%–21% slope range, with meadow regions under 30% slope proving most suitable for GES installation. Nevertheless, the presence of a dry stream to the north and a transmission channel to the east highlights the necessity for hydrological risk precautions under extreme weather events.

The application of Multi-Criteria Decision Analysis (MCDA) provided a structured methodology to anticipate the impact of unexpected and high-magnitude natural anomalies, enabling proactive risk mitigation strategies. The integration of feasibility assessments, UAV observations, and GIS layers resulted in a comprehensive risk profile that supports safer infrastructure planning and investment efficiency.

Importantly, GIS and drone-based analyses enable early identification of disaster risks, thereby contributing to environmentally sound and economically viable renewable energy developments. Making such scientific disaster risk analyses a mandatory part of planning processes will significantly enhance the sustainability and resilience of energy infrastructure. The methods and risk modeling techniques presented in this study are adaptable and can be replicated across various renewable energy scenarios. Multidisciplinary science, encompassing geospatial analysis, engineering, and environmental monitoring, should be at the core of future energy investment strategies.

Future-oriented developments in AI-powered remote sensing are expected to enable more precise and automated risk detection across infrastructure projects. The integration of real-time data with Geographic Information Systems (GIS) will enhance dynamic decision-making processes during both construction and operational phases. Unmanned Aerial Vehicles (UAVs) and remote sensing (RS) technologies will continue to serve as essential tools for continuous monitoring and assessment. Moreover, sustained innovation in spatial technologies and analytical methodologies will play a pivotal role in enhancing the sustainability and resilience of infrastructure systems against various natural and anthropogenic disasters.

Recommendations

When evaluated in terms of the richness of its spatial and environmental datasets, the methodological integrity of its analytical framework, and its alignment with principles of environmental sustainability, the study demonstrates a high degree of technical and scientific robustness. Given the integration of multi-source geospatial data, the application of reproducible and interdisciplinary methodologies—including drone-based remote sensing, GIS-based modeling, and multi-criteria decision analysis—and the prioritization of environmentally sensitive site selection, it is anticipated that the outcomes of this planned work will yield long-term applicability and relevance. Moreover, the project sets a precedent for scalable and resilient energy infrastructure planning, positioning it as a replicable model for similar regional and national renewable energy development initiatives.

In addition, considering the presence of active fault lines in the broader region—many of which are well-documented in current geological literature and remain the focus of ongoing tectonic studies—it would be methodologically advantageous to incorporate seismic risk assessments into future iterations of this framework. Including the potential geohazard impacts of these fault systems on hydroelectric and solar energy assets would not only enhance the comprehensiveness of the environmental risk profile but also contribute to the structural and operational resilience of the energy infrastructure in a seismically sensitive landscape.

Scientific Ethics Declaration

* The authors declare that the scientific ethical and legal responsibility of this article published in EPSTEM Journal belongs to the authors.

Conflict of Interest

* The authors declare that they have no conflicts of interest

Funding

* This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors

Acknowledgements or Notes

* This article was presented as an oral presentation at the International Conference on Basic Sciences, Engineering and Technology (www.icbaset.net) held in Trabzon/Türkiye on May 01-04, 2025.

* We gratefully acknowledge the support of Derya Elektrik Co. for facilitating and permitting the conduct of this research.

References

Ahmed, T. (2024). Climate resilience in solar energy infrastructure: A global review. *Renewable and Sustainable Energy Reviews, 189*(Part A), 113–129.

Alzubade, M. K., & Alkan, O. (2024). Multidimensional analysis of potential cost-to-cost risks of climate disruption for energy-focused facilities using remote sensing, drone photogrammetry and GIS methods. *The Eurasia Proceedings of Science, Technology, Engineering & Mathematics (EPSTEM), 26*, 11–20.

Alkan, M., & Karagoz, O. (2022). Seismic risk assessment of hydroelectric dams along the North Anatolian fault. *Journal of Geotechnical and Geoenvironmental Engineering, 148*(3), 112–129.

Alkan, O., Alzubade, M.K. & Alkan, M.N. (2024). UAV photogrammetry for 3D terrain modeling in energy infrastructure monitoring. *International Journal of Applied Earth Observation and Geoinformation, 126*(2), 103562, 45–67.

Alkan, O., Alzubade, M. K., & Alkan, M. N. (2023). Assessing the effects of alluvial transport in the Kızılırmak River on dams with local, photogrammetric and remote sensing methods. *The Eurasia Proceedings of Science, Technology, Engineering & Mathematics (EPSTEM), 26,* 1–10.

Demirtas, R., Karabacak, V., & Turker, U. (2021). Climate-induced hydrological changes in Eastern Anatolia: Implications for hydropower. *Journal of Hydrology: Regional Studies, 36*(4), 100845, 501–520.

Gultekin, C., & Aydın, A. (2023). Machine learning-enhanced landslide risk mapping for renewable energy sites. *Engineering Geology, 315*(C), 108432, 1–15.

International Energy Agency (IEA). (2022). *Climate resilience for energy transition (report no. 978-92-64-48712-5).* OECD Publishing.

IPCC. (2023). *Climate change 2023: Impacts, adaptation, and vulnerability (working group II report).* Cambridge University Press.

Jiang, L., Wang, H., & Li, X. (2023). Multi-hazard risk assessment for Himalayan hydropower projects using GIS-MCDA. *Renewable Energy, 202*(1), 113298, 1–18.

Keeney, R. L., & Raiffa, H. (1993). *Decisions with multiple objectives: Preferences and value trade-offs* (2nd ed.). Cambridge University Press.

Malczewski, J., & Rinner, C. (2015). *Multicriteria decision analysis in geographic information science*. Springer.

Santiago, J.-L., Sanchez, B., Rivas, E., Vivanco, M. G., Theobald, M. R., Garrido, J. L., Gil, V., Martilli, A., Rodríguez-Sánchez, A., Buccolieri, R., & Martín, F. (2022). High spatial resolution assessment of the effect of the Spanish national air pollution control programme on street-level no_2 concentrations in three neighborhoods of Madrid (Spain) using mesoscale and CFD modelling. *Atmosphere, 13*(2), 248.

Ozdemir, A., Sen, Z., & Boyacı, S. (2024). UAV-based flood risk modeling for Andean hydropower systems. *Natural Hazards and Earth System Sciences, 24*(1), 1–22.

Saaty, T. L. (2008). Decision making with the analytic hierarchy process. *International Journal of Services Sciences, 1*(1), 83–98.

Smith, J., Brown, K., & Davis, P. (2023). UAV-LiDAR for fault displacement monitoring: Case studies from California and Turkey. *Remote Sensing of Environment, 285*(5), 113402, 1–14.

Ulker, D., & Kaya, S. (2021). GIS-MCDA for sustainable HEPP site selection in tectonically active regions. *Energy Policy, 178*(C), 1028–1045.

Yuce, M., Alkan, M., & Ozturk, S. (2020). Sediment erosion risks in Turkish hydropower reservoirs: A geospatial analysis. *Water Resources Management, 34*(8), 2563–2580.

Zhao, X., Chen, W., & Zhang, L. (2020). GIS-based flood risk assessment for hydropower projects. *Journal of Hydrology, 584*(C), 124663, 1–12.

Author(s) Information

Oyku Alkan
Alkan Tech-App's Co. Çorum,Türkiye
Contact e-mail: *oyku.alk@gmail.com*

Mehmet Nurullah Alkan
Hitit University, Çorum,Türkiye

To cite this article:

Alkan, O., & Alkan, M.N. (2025). A GIS and drone-based risk assessment framework for hydroelectric and solar energy infrastructure in disaster-prone areas with high forestry and agricultural activity. *The Eurasia Proceedings of Science, Technology, Engineering and Mathematics (EPSTEM), 34,* 268-277.