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# Geographic Information System– Analytic Hierarchy Process (GIS- AHP) Framework for Optimal Solar PV Deployment in Northern Samar

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**ABSTRACT:** This study assessed the land suitability for solar photovoltaic (PV) deployment in Northern Samar using a Geographic Information System (GIS)-based approach integrated with the Analytic Hierarchy Process (AHP). Four major criteria were evaluated: Solar Power Potential (41.3%), Climatology (31.2%), Geographical Factors (20.1%), and Disaster Susceptibility (7.4%), each comprising several parameters. At the parameter level, Global Horizontal Irradiance (GHI) carried the highest weight under Solar Power Potential at 60.8%, followed by Sunshine Duration (39.2%). Under Climatology, Temperature held the greatest weight at 44.9%, followed by Cloud Cover (24.4%), Precipitation (20.6%), and Relative Humidity (10.1%). For Geographical Factors, Land Use dominated with 68.6%, followed by Slope (17.5%) and Elevation (13.9%). Disaster Susceptibility consisted of Flood Susceptibility (69.3%) and Ground Shaking Hazard (30.7%). All consistency ratios (CRs) were below 10%, confirming the logical consistency of the AHP model. Spatial analysis revealed that 60.39% (2077.71 km²) of Northern Samar's total land area is moderately suitable for solar PV deployment. About 3.92% (134.87 km²) is classified as optimal, 2.77% (95.30 km²) as favorable, 7.42% (255.28 km²) as marginally suitable, and 25.5% (877.32 km²) as unsuitable. The findings show varying solar potential across Northern Samar, providing useful guidance for policymakers and stakeholders in crafting localized solar strategies. While offering a broad view, the study also emphasizes the need for detailed site assessments to support informed investments and maximize renewable energy output.

**KEYWORDS:** land suitability, solar PV, Geographic Information System (GIS), Analytic Hierarchy Process (AHP)

## 1. INTRODUCTION

Renewable energy remains central to global sustainable development, particularly in advancing Sustainable Development Goal 7: "Affordable and Clean Energy," which seeks universal access to reliable, sustainable, and modern energy by 2030 (*Goal 7*, n.d.). This aligns with global efforts to mitigate the environmental impacts of fossil fuel use, especially greenhouse gas emissions driving climate change (Gavina et al., 2024). In the Philippines, solar energy stands out as one of the most abundant and accessible renewable resources (Koons, 2024). To meet growing energy demands, the government has strengthened its renewable energy agenda through the National Renewable Energy Program (NREP) and the Renewable Energy Act of 2008 (RA 9513), which have spurred investment, cost reductions, and lower carbon emissions (Fonbuena, 2025). Solar photovoltaic (PV) capacity rose from 182 MW in 2015 to 2,971 MW in 2024 (Balita, 2025), though most installations remain concentrated in Luzon. This uneven distribution highlights the need to expand solar infrastructure in underserved areas.

Northern Samar, a province in Eastern Visayas, continues to experience limited electricity access, frequent outages, and dependence on costly diesel generators despite its high solar potential. Enhancing solar PV adoption in the province could strengthen energy resilience and support sustainable rural development (Meniano, 2024). Effective site selection requires considering multiple environmental and socio-economic factors beyond solar irradiance. Integrating Geographic Information System (GIS) technology with multi-criteria decision-making (MCDM) methods—such as the Analytic Hierarchy Process (AHP)—offers a systematic approach to assessing solar suitability (Levosada et al., 2022).

This study proposes a GIS-AHP framework to identify suitable sites for solar PV deployment in Northern Samar. By integrating spatial and non-spatial criteria such as solar potential, geography, climate, and disaster susceptibility, it aims to produce a suitability map that can inform energy planning and policy decisions. Addressing the research gap in localized renewable energy mapping, this study contributes to clean energy promotion, rural energy access, and inclusive regional development in the Philippines.

## 2. LITERATURE REVIEW

### A. *Factors Affecting Solar PV Suitability*

The suitability of solar photovoltaic (PV) deployment depends on various environmental, climatic, and geographical factors that influence energy potential and system performance. Among these, solar power potential—represented by Global Horizontal Irradiance (GHI) and sunshine duration—is a key determinant (Benti et al., 2022). GHI indicates the total solar radiation a surface receives by Fofang and Tanyi (2021), while sunshine duration measures the number of hours when solar radiation exceeds a certain threshold (Hilaire et al., 2024). Higher GHI and longer sunshine hours translate to greater power generation efficiency and cost-effectiveness, making them essential parameters in solar resource assessment (Hilaire et al., 2024). When integrated into GIS-AHP models, these indicators enable spatially precise identification of optimal locations for solar energy projects.

Climatological and geographical factors also play a crucial role in determining PV efficiency (Iqbal et al., 2023). Temperature, humidity, precipitation, and cloud cover directly affect solar irradiance and panel performance (de Luis-Ruiz et al., 2024; Del Pero et al., 2021; Tripathi et al., 2021). Cooler, less humid areas generally enhance energy output, while excessive heat or humidity reduces panel efficiency. Moderate rainfall, however, can help clean panel surfaces and sustain long-term performance (Akinyoola et al., 2024). In addition, slope, elevation, and land use influence both the technical feasibility and economic viability of installations (Prăvălie et al., 2022). Flat or gently sloped terrains are most favorable for construction (Islam et al., 2024), while elevation affects sunlight exposure and accessibility (Yao et al., 2024). Considering land use prevents conflicts with agricultural, ecological, or residential zones, supporting sustainable energy planning (Katkar et al., 2021).

Lastly, disaster susceptibility and exclusion zones are vital considerations in site selection. In provinces like Northern Samar, the risk of floods (Bošnjaković et al., 2023), and earthquakes (Ceferino et al., 2020) can significantly impact system safety and longevity. Flood-prone and seismically active areas must be excluded from deployment to prevent structural damage and power interruptions (Hao et al., 2021). Similarly, exclusion zones—such as protected areas, water bodies, and environmentally sensitive regions—are removed from consideration to ensure safe, compliant, and sustainable development. Accounting for these factors collectively enables a comprehensive and location-specific assessment of solar PV suitability.

***B. Applications of GIS and AHP in Solar PV Site Selection***

Studies have demonstrated the effectiveness of multi-criteria decision-making (MCDM) techniques, particularly the Analytic Hierarchy Process (AHP), in conducting suitability analyses for solar PV deployment. The integration of Geographic Information Systems (GIS) further enhances these analyses by enabling spatial visualization and strategic assessment of solar energy development. Local studies, such as those conducted in Simara Island (Garcia et al., 2024), Sibuyan Island (Gacu et al., 2023), and Camarines Sur (Loquias et al., 2022), have successfully employed the GIS-AHP approach.

Internationally, research has also utilized GIS-based MCDM methods for solar mapping, site evaluation, and potential assessment through Boolean overlay and weighted summation approaches (Ardakani et al., 2021). The AHP method, in particular, has been widely applied to assign weights based on expert judgment (Munier & Hontoria, 2021). Studies confirm that GIS effectively supports site evaluation by integrating physical, geographical, and socio-economic factors (Gholami, 2024; Wang & Liu, 2024)

Most existing research, however, is concentrated in urban or well-developed areas with established solar infrastructures. Limited studies address geographically isolated and disadvantaged provinces like Northern Samar, where solar PV adoption remains limited. Furthermore, few analyses integrate local climatological, geographical, and disaster-related data into a comprehensive suitability model. To fill this gap, the present study applies a GIS-AHP framework to assess solar PV deployment potential in Northern Samar, providing localized insights for sustainable and region-specific energy planning.

***C. Statement of the Problem***

This study aimed to develop a Geographic Information System–Analytic Hierarchy Process (GIS-AHP) framework for optimal solar photovoltaic (PV) deployment in Northern Samar to support renewable energy planning and sustainable rural development.

Specifically, this study seeks to answer the following questions:

1. How can the identified criteria be prioritized using the Analytic Hierarchy Process (AHP) with insights from renewable energy and geospatial planning experts?
2. How can a solar PV suitability map for Northern Samar be generated through a weighted overlay process based on AHP-derived rankings?
3. What is the percentage distribution of land area across various suitability classes—from unsuitable to optimal—for the province?
4. What is the solar PV deployment potential of each municipality based on the extent of land classified as favorable to optimal for solar development?

## 3. SCOPE AND LIMITATIONS

This study aimed to develop a Solar Photovoltaic (PV) Deployment Suitability Map for Northern Samar using a Geographic Information System–Analytic Hierarchy Process (GIS-AHP) framework. The analysis integrated four main criteria—(1) solar power potential, (2) climatology, (3) geographical features, and (4) disaster susceptibility—weighted through the AHP method based on expert input. These factors were processed within a GIS environment to produce a composite suitability map that identified areas most viable for solar PV deployment.

While the study provided valuable insights into the spatial suitability and solar energy potential of Northern Samar, several limitations were acknowledged. First, it excluded site-specific physical assessments such as shading, rooftop suitability, and slope-based installation analysis, which are essential for localized applications. Second, the study did not include economic aspects such as installation and maintenance costs or return on investment. Third, the technical design of PV systems—such as inverter sizing, battery storage, and load analysis—was beyond the scope of the research. Lastly, the precision of the results was constrained by the accuracy, resolution, and availability of spatial and climatological data for the province.

## 4. METHODOLOGY

### *A. Case Study Area and Research Design*

This study focused on Northern Samar (12°20′N, 124°40′E), a province in the Eastern Visayas region of the Philippines with 24 municipalities and a total land area of about 3,440 square kilometers, as shown in Figure 1. The province, characterized by diverse terrain and a Type II climate with year-round rainfall and short dry periods, was considered suitable for assessing the spatial potential of solar photovoltaic (PV) systems.

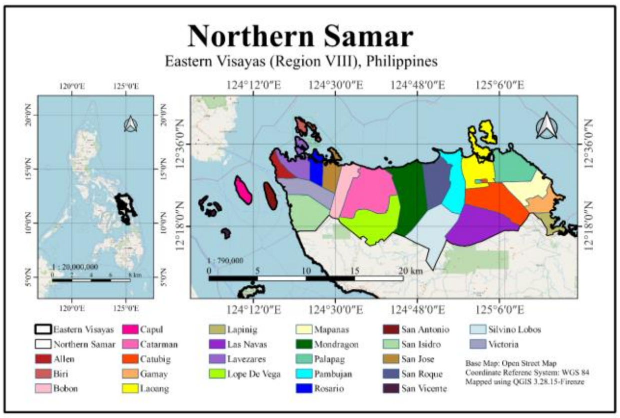


**Fig. 1. Case Study Area: Map of Northern Samar**

In this study, a two-step weighted overlay analysis was implemented. The initial stage involved conducting a literature review to identify relevant geospatial data for parameters influencing solar PV suitability. These datasets underwent preprocessing to ensure consistency and compatibility for subsequent analysis. Individual classified maps were then created for each parameter and indexed based on their relative suitability for solar PV deployment, ranging from 1 (unsuitable) to 5 (optimal). The AHP methodology was used to prioritize the various criteria and parameters contributing to solar PV suitability. Expert judgment through pairwise comparisons established the weights for both individual parameters and criteria. These AHP-derived weights were assigned to each parameter, after which a weighted overlay analysis was performed to integrate the individual suitability maps with their corresponding weights. This initial overlay process produced a preliminary map identifying areas with potential for solar PV development. To further refine the analysis, the preliminary map was integrated with the overall AHP criteria weights. An exclusion zone, encompassing areas deemed unsuitable due to environmental, social, or technical constraints, was also incorporated. This final integration produced the comprehensive Solar PV Deployment Suitability Map for Northern Samar. Figure 2 presented an overview of the methodology.

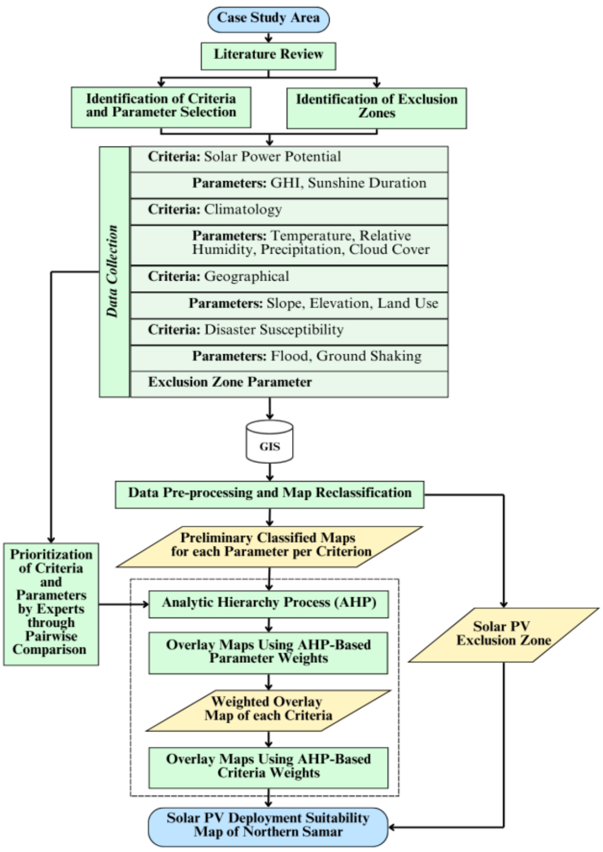


**Fig. 2. Overview of Methodology**

### *B. Criteria Selection and Data Acquisition*

The study identified four primary criteria for evaluating solar PV suitability in Northern Samar: Solar Power Potential, Climatology, Geographical, and Disaster Susceptibility. Under Solar Power Potential, parameters included Global Horizontal Irradiance (GHI) from Global Solar Atlas and Sunshine Duration from DOST-PAGASA. Climatology covered Temperature, Relative Humidity, Precipitation, and Cloud Cover from PAGASA. Geographical data, such as Slope and Elevation from NASA SRTM and Land Use from NAMRIA, described terrain and land characteristics. Disaster Susceptibility included Flood Susceptibility from NAMRIA and Ground Shaking Hazard from PHIVOLCS. Exclusion zones were also established to remove unsuitable areas like protected lands, road networks, and water bodies, with 50-meter and 100-meter buffer zones to minimize flooding and erosion risks. The resulting exclusion map supported accurate site identification for solar PV deployment across the province.

### *C. AHP Calculation and GIS Processing*

The Analytic Hierarchy Process (AHP) was applied to evaluate multiple criteria influencing solar PV suitability (Munier & Hontoria, 2021). A hierarchical structure was developed consisting of the main objective, criteria, and alternatives, followed by pairwise comparisons to determine the relative importance of each factor. A panel of ten experts in solar energy, GIS, and engineering participated in the evaluation using a nine-point scale to assess the relative significance of each criterion. Their responses were normalized to generate priority weights through the Row Geometric Mean Method. Consistency of expert judgments was verified using the Consistency Index (CI) and Consistency Ratio (CR), both of which fell within acceptable limits, indicating reliable assessments. Finally, the consolidated decision matrix integrated all expert inputs using the weighted geometric mean approach, producing the final set of criterion weights used in the GIS-based suitability analysis.

Geographic Information Systems (GIS) were used to store, analyze, and visualize spatial data for assessing solar PV site suitability in Northern Samar. Using QGIS (version 3.28.15-Firenze) with WGS 84 (EPSG:4326) as the coordinate reference system, multiple spatial criteria were integrated into suitability maps. Prior to overlaying, each parameter undergoes reclassification and normalization into a common suitability having equal intervals with five (5) levels of indices: 1 as unsuitable; 2 as marginally suitable; 3 as moderately suitable; 4 as suitable/ favorable; and 5 as optimal. The assigned weights reflect the relative importance of each factor in determining overall suitability for solar exploration.

Solar power potential was evaluated using two key parameters: Global Horizontal Irradiance (GHI) and sunshine duration. GHI data from Solargis were clipped and reclassified in QGIS, where higher irradiance indicated greater suitability. Sunshine duration (2020–2023) from PAGASA stations in Borongan, Catarman, and Catbalogan was interpolated using Inverse Distance Weighting (IDW) to estimate spatial variation. Both layers were assigned higher weights for areas with stronger solar energy yield. Climatology data—temperature, relative humidity, precipitation, and cloud cover—were also obtained from the same PAGASA stations (2020–2023) and processed in QGIS through IDW interpolation. Higher temperatures and lower humidity, rainfall, and cloud cover were ranked more suitable for solar PV deployment. Specifically, temperature and dryness received the highest ratings (5), while high humidity, heavy rainfall, and dense cloud cover were rated least suitable (1).

Geographical criteria evaluated the physical characteristics affecting solar PV suitability using land use data from Geoportal PH and elevation data from SRTM. Slope, elevation, and land use were reclassified, with higher weights assigned to areas more favorable for development. Moderate elevations (102–143 m) and flat to gently sloping terrains (0–3%) were rated highest (5) for being safe and accessible, while steep and high terrains received the lowest (1). Land use suitability ranked barren lands highest (5), followed by grasslands and built-up areas (4), while forests and water bodies were least suitable (1–2) due to ecological and flood risks. Disaster susceptibility, based on flood and ground shaking data from NAMRIA and DOST-PHIVOLCS, was also mapped, where low-risk zones received higher weights (5) indicating greater PV suitability.

Solar PV exclusion zones in Northern Samar included restricted areas, road networks, and proximity to bodies of water. Protected zones such as the Biri Larosa Protected Landscape and Samar Island Natural Park were excluded due to legal and environmental restrictions (WCMC, n.d.). Buffer zones of 100 meters around water bodies and 50 meters around roads were applied to minimize risks of flooding and erosion. After classifying and weighting all parameters based on their suitability, the Analytic Hierarchy Process (AHP) was used to assign relative importance to each factor. These weights were integrated through weighted overlay analysis in QGIS, producing individual and combined suitability maps. All maps were reprojected to EPSG:4326 WGS 84, and exclusion zones were overlaid to finalize the Solar PV Deployment Suitability Map for Northern Samar.

## 5. RESULTS AND DISCUSSION

Preliminary classified maps for each parameter under every criterion were generated to visualize spatial suitability prior to applying the Analytic Hierarchy Process (AHP). These maps, derived from reclassified and normalized geospatial data, provided a consistent basis for weighting and overlay analysis. Creating these individual maps ensured that each factor's spatial influence was clearly represented before integrating them into the overall solar PV suitability assessment.

Following the generation of preliminary maps, the Analytic Hierarchy Process (AHP) was applied to assign weights to each parameter and criterion based on expert evaluation. Ten professionals specializing in solar energy, GIS, project management, and engineering participated in the pairwise comparison, normalization, and consistency analysis. Each factor's relative significance was determined using the AHP's three key steps: pairwise comparison, synthesis of priorities, and consistency checking (CR < 10%). Results showed that under Solar Power Potential, Global Horizontal Irradiance (60.8%) ranked highest, followed by Sunshine Duration (39.2%). For Climatology, Temperature (44.9%) was the most influential, followed by Cloud Cover (24.4%), Precipitation (20.6%), and Relative Humidity (10.1%). In the Geographic criterion, Land Use (68.6%) ranked highest, followed by Slope (17.5%) and Elevation (13.9%). Lastly, in Disaster Susceptibility, Flood Susceptibility (69.3%) outweighed Ground Shaking Hazard (30.7%). A second-level AHP showed that Solar Power Potential (41.3%) had the greatest overall weight, followed by Climatology (31.2%), Geographical factors (20.1%), and Disaster Susceptibility (7.4%), reflecting their combined influence on solar PV suitability in Northern Samar. These values reflect the relative influence of each criterion in identifying the most suitable areas for solar energy development. The summary of these weighted percentages is presented in Table 1.

**Table 1:Summary of the Weighted Percentage of each Parameter and Criteria**

| AHP-based Criteria Weight | | | AHP-based Parameter Weight | | |
|---|---|---|---|---|---|
| **Criteria** | **Weight %** | **CR %** | **Parameter** | **Weight %** | **CR%** |
| Solar Power Potential | 41.3 | 1.1 | GHI | 60.8 | 0.0 |
| | | | Sunshine Duration | 39.2 | |
| Climatology | 31.2 | | Temperature | 44.9 | 1.3 |
| | | | Relative Humidity | 10.1 | |
| | | | Precipitation | 20.6 | |
| | | | Cloud Cover | 24.4 | |
| Geographical | 20.1 | | Elevation | 13.9 | 0.0 |
| | | | Slope | 17.5 | |
| | | | Land Use | 68.6 | |
| Disaster Susceptibility | 7.4 | | Flood Susceptibility | 69.3 | 0.0 |
| | | | Ground Shaking Hazard | 30.7 | |

CRs below 10% confirmed the reliability of the AHP results, indicating consistent expert judgments and credible criteria ranking. A weighted overlay approach then produced the solar PV suitability maps for Northern Samar, combining Solar Power Potential (Fig. 3), Climatology (Fig. 4), Geography (Fig. 5), and Disaster Susceptibility (Fig. 6), with five categories from unsuitable to optimal.

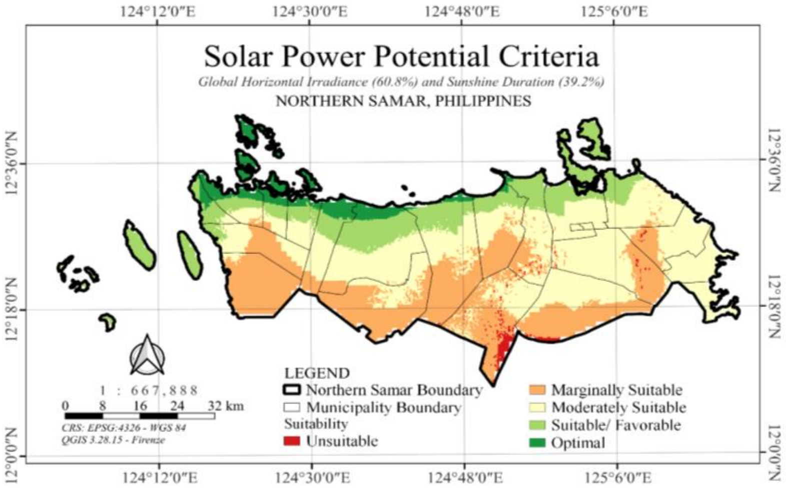


**Fig. 3. Solar Power Potential Criteria of Northern Samar**

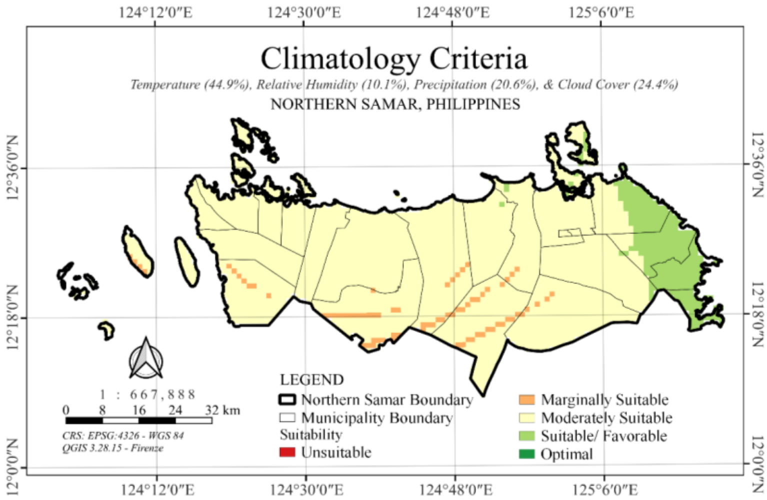


**Fig. 4. Climatology Criteria of Northern Samar**

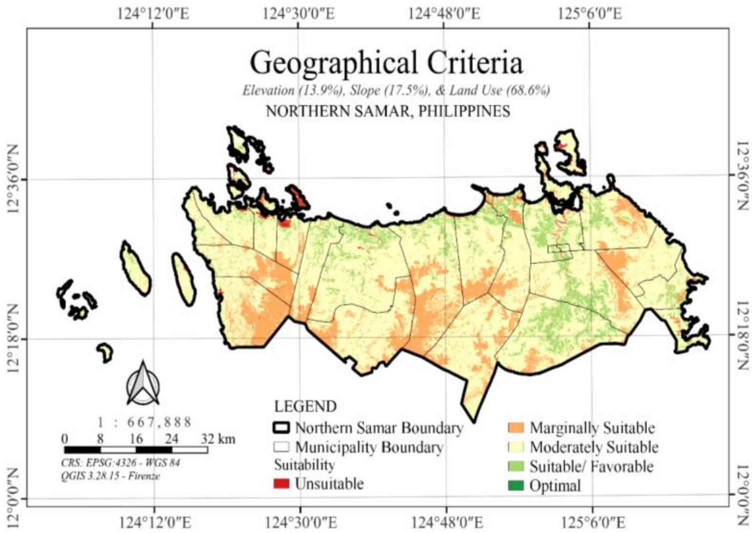


**Fig. 5. Geographical Criteria of Northern Samar**

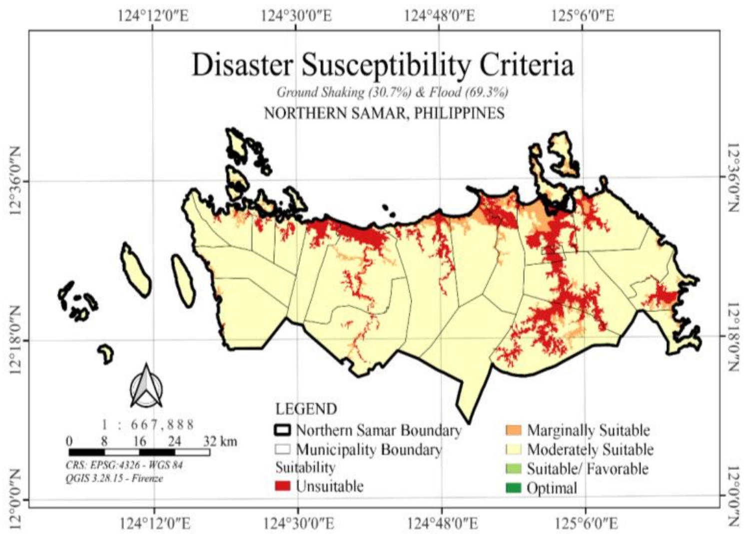


**Fig. 6. Disaster Susceptibility Criteria of Northern Samar**

The four criteria were overlaid using AHP-based weights along with the solar PV exclusion zone, shown in red for protected areas, 50 m buffers from roads, and 100 m buffers from water bodies. Creating this exclusion map (Fig. 7) minimized legal, safety, and environmental conflicts. The same five-level classification was applied to produce the final Solar PV Deployment Suitability Map (Fig. 8), highlighting areas in Northern Samar most suitable for solar PV installation.

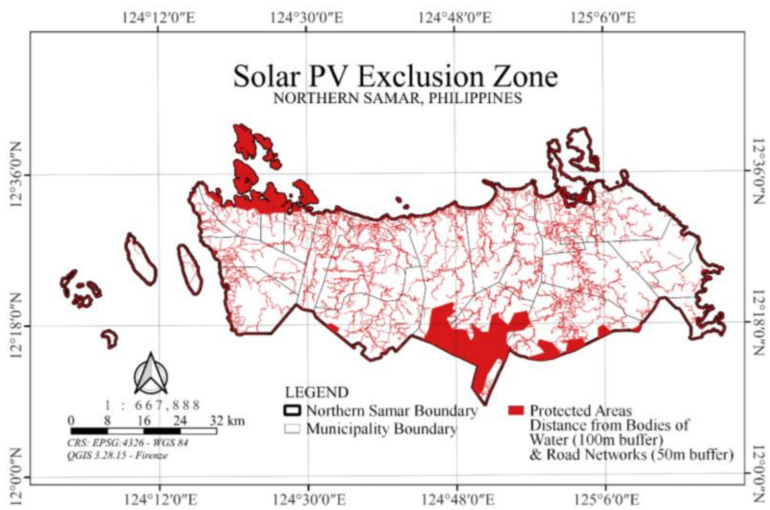


**Fig. 7. Solar PV Exclusion Zone of Northern Samar**

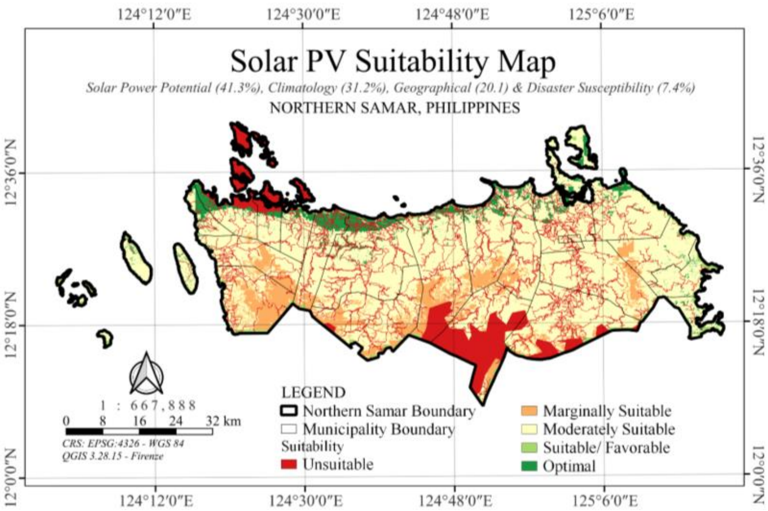


**Fig. 8. Solar PV Suitability Map of Northern Samar**

The solar PV land suitability map for Northern Samar showed that most of the province is Moderately Suitable (Class 3), covering 60.39% (≈2,077.71 km²), indicating potential for large-scale solar development with manageable constraints. Unsuitable areas (Class 1) accounted for 25.5% (≈877.32 km²), including protected zones, steep terrain, and flood- or seismic-prone locations, while Marginally Suitable areas (Class 2) covered 7.42% (≈255.28 km²), suitable only for small-scale or off-grid projects with careful planning. Favorable (Class 4) and Optimal (Class 5) lands, totaling 6.69% (≈230.17 km²), represent the most strategic areas for solar farm investment. These results, based on a total land area of 3,440.49 km², provide guidance for prioritizing solar PV development, zoning, and policy planning, with proportions illustrated in Fig. 9.

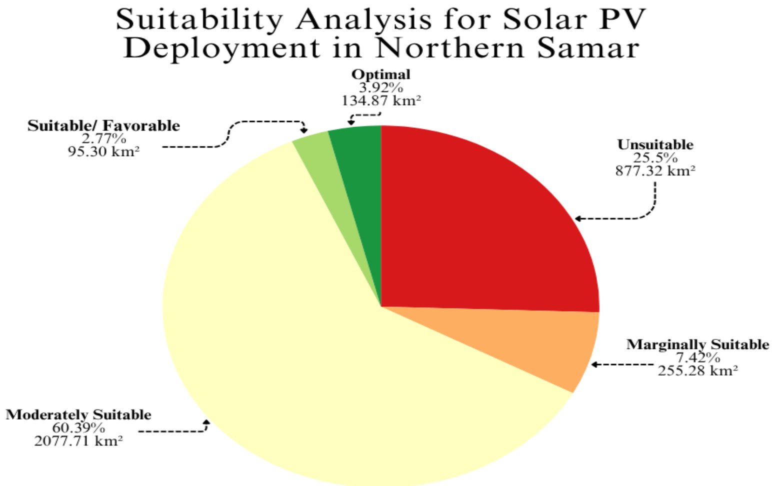


**Fig. 9. Percentage of Northern Samar's Land Area Favorable for Solar PV Deployment**

Municipalities such as Catarman (27.12 km²) and Bobon (20.48 km²) showed the largest share of highly favorable to optimal areas for solar PV deployment, with Catarman having 8.95% optimal and 72.3% moderately suitable, and Bobon 17.1% optimal and 51.7% moderate, indicating strong potential and flexibility. Other municipalities with notable suitability include Laoang (9.4% optimal, 64.5% moderate), Allen (25.2% optimal, 58.5% moderate), San Roque (6.54% optimal, 64% moderate), Palapag and Pambujan (over 78.1% and 67.8% moderate), Lavezares (14.9% optimal, 38.3% moderate), and San Vicente (43% favorable), demonstrating their feasibility for scalable solar installations. In contrast, Biri was entirely unsuitable due to ecological sensitivity, and Las Navas, Lope De Vega, San Isidro, and Silvino Lobos had 0% optimal areas, indicating limited potential for ideal solar PV deployment.

The solar PV suitability assessment of Northern Samar showed that, although optimal sites were limited, large areas classified as moderately suitable offered substantial potential for solar energy development. These moderately suitable zones provide favorable conditions for scalable installations with manageable design considerations. Smaller areas classified as suitable or favorable further supported the province's viability for renewable energy investment. Conversely, portions of the province were constrained by ecological sensitivity, terrain, or natural hazards, emphasizing the need for site-specific evaluation and careful balancing of energy development with environmental protection and risk management.

## 6. CONCLUSION

This study identified the most suitable areas for solar PV deployment in Northern Samar using GIS and AHP. Among the four main criteria, Solar Power Potential had the highest AHP weight at 41.3%, followed by Climatology (31.2%), Geographical Conditions (20.1%), and Disaster

Susceptibility (7.4%). Within these, the most influential parameters were GHI (60.8%), Temperature (44.9%), Land Use (68.6%), and Flood Susceptibility (69.3%). All AHP consistency ratios were below 10%, ensuring sound judgment and reliability.

Out of the 3,440.49 km² total land area, 60.39% (2,077.71 km²) was moderately suitable, 25.5% (877.32 km²) unsuitable, and 7.42% (255.28 km²) marginal. Only 3.92% (134.87 km²) was classified as optimal, while 2.77% (95.30 km²) was rated favorable. Catarman and Bobon showed the highest optimal areas at 27.12 km² and 20.48 km², respectively. Other key municipalities include Allen (11.21 km² optimal), Laoang (19.35 km²), and Lavezares (15.43 km²). In contrast, Biri was fully unsuitable, and four municipalities (Las Navas, Lope De Vega, San Isidro, Silvino Lobos) had 0% optimal zones. The study establishes a strategic foundation for solar energy planning, revealing that while optimal sites are few, the wide availability of moderately suitable areas offers strong potential for decentralized solar deployment and sustainable energy development in the province.

## 7. RECOMMENDATIONS

Based on the solar PV suitability analysis in Northern Samar, local governments and energy planners should prioritize moderately suitable to optimal areas for solar PV projects, while future studies integrate technical, social, and economic factors to develop a sustainable roadmap for Northern Samar.

## REFERENCES


1) Akinyoola, J., Oluleye, A., & Gbode, I. (2024, July 15). *A Review of Atmospheric Aerosol Impacts on Regional Extreme Weather and Climate Events | Aerosol Science and Engineering*. https://link.springer.com/article/10.1007/s41810-024-00223-x
2) Ardakani, A. H. H., Shojaei, S., Shahvaran, A. R., Kalantari, Z., Cerdà, A., & Tiefenbacher, J. (2021). Selecting potential locations for groundwater recharge by means of remote sensing and GIS and weighting based on Boolean logic and analytic hierarchy process. *Environmental Earth Sciences*, *81*(1), 8. https://doi.org/10.1007/s12665-021-10071-4
3) Balita, C. (2025, August 8). *Philippines: Solar energy capacity 2024*. Statista. https://www.statista.com/statistics/1006143/philippines-total-solar-energy-capacity/
4) Benti, N. E., Aneseyee, A., Asfaw, A., Amente, C., Tiruye, G., & Mekonnen, Y. (2022). Estimation of global solar radiation using sunshine-based models in Ethiopia. *Cogent Engineering*, *9*, 2114200. https://doi.org/10.1080/23311916.2022.2114200
5) Bošnjaković, M., Stojkov, M., Katinić, M., & Lacković, I. (2023). Effects of Extreme Weather Conditions on PV Systems. *Sustainability*, *15*(22), Article 22. https://doi.org/10.3390/su152216044
6) Ceferino, L., Liu, C., Alisjahbana, I., Patel, S., Sun, T., Kiremidjian, A., & Rajagopal, R. (2020). *Earthquake Resilience of Distributed Energy Resources*.
7) de Luis-Ruiz, J. M., Salas-Menocal, B. R., Pereda-García, R., Pérez-Álvarez, R., Sedano-Cibrián, J., & Ruiz-Fernández, C. (2024). Optimal Location of Solar Photovoltaic Plants Using Geographic Information Systems and Multi-Criteria Analysis. *Sustainability*, *16*(7), 2895. https://doi.org/10.3390/su16072895
8) Del Pero, C., Aste, N., & Leonforte, F. (2021). The effect of rain on photovoltaic systems. *Renewable Energy*, *179*, 1803–1814. https://doi.org/10.1016/j.renene.2021.07.130
9) Fofang, T. F., & Tanyi, E. (2021). *Effects of Global Horizontal Irradiance on Power Output of Hybrid Solar PV/Mini-hydro Renewable Energy System*. https://doi.org/10.5281/zenodo.4781315
10) Fonbuena, C. (2025, September 28). Philippines' renewable sector races to meet targets as coal plants linger and LNG grows. *PCIJ.Org*. https://pcij.org/2025/09/29/philippines-renewable-sector-races-to-meet-targets-as-coal-plants-linger-and-lng-grows/
11) Gacu, J., Garcia, J., Fetalvero, E., Catajay-Mani, M., & Monjardin, C. E. (2023). Suitability Analysis Using GIS-Based Analytic Hierarchy Process (AHP) for Solar Power Exploration. *Energies*, *16*, 6724. https://doi.org/10.3390/en16186724
12) Garcia, J., Gacu, J., & Ical, M. L. (2024). Suitability Analysis for Solar PV Farm Installation using GIS and Analytical Hierarchy Process (AHP) in Simara Island, Province of Romblon, Philippines. *E3S Web of Conferences*, *473*. https://doi.org/10.1051/e3sconf/202447301013
13) Gavina, C. J. A., Ibañez, J. A., Benitez, I. B., Lumabad III, C. D., & Principe, J. A. (2024). ASSESSMENT OF REANALYSIS DATA FOR SOLAR PV OUTPUT FORECASTING IN THE PHILIPPINES: CASE OF PANGASINAN, NEGROS OCCIDENTAL, AND DAVAO DEL NORTE. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, *XLVIII-4-W8-2023*, 279–284. ISPRS ICWG IV/III<br>Philippine Geomatics Symposium (PhilGEOS) 2023 - 6–7 December 2023, Diliman, Quezon City, Philippines. https://doi.org/10.5194/isprs-archives-XLVIII-4-W8-2023-279-2024
14) Gholami, H. (2024). A Holistic Multi-Criteria Assessment of Solar Energy Utilization on Urban Surfaces. *Energies*, *17*(21), Article 21. https://doi.org/10.3390/en17215328
15) *Goal 7: Affordable and Clean Energy | UNEP - UN Environment Programme*. (n.d.). Retrieved October 26, 2025, from https://www.unep.org/topics/sustainable-development-goals/why-do-sustainable-development-goals-matter/goal-7
16) Hilaire, K., Arnaud, H., Waidi, O., & Ferdinand, H. (2024). Assessment of Sunshine Duration Trends in Benin through Polygonal Methods. *Journal of Basic and Applied Research International*, *30*(6), Article 6. https://doi.org/10.56557/jobari/2024/v30i69001
17) Iqbal, S., Khan, S. N., Sajid, M., Khan, J., Ayaz, Y., & Waqas, A. (2023). Impact and performance efficiency analysis of grid-tied solar photovoltaic system based on installation site environmental factors. *Energy & Environment*, *34*(7), 2343–2363. https://doi.org/10.1177/0958305X221106618
18) Katkar, V. V., Sward, J. A., Worsley, A., & Zhang, K. M. (2021). Strategic land use analysis for solar energy development in New York State. *Renewable Energy*, *173*, 861–875. https://doi.org/10.1016/j.renene.2021.03.128




Corresponding Author: Elmera S. Doro 

19) Koons, E. (2024, June 11). Solar Energy in the Philippines—Current State and Future. *Energy Tracker Asia*. https://energytracker.asia/solar-energy-in-the-philippines/
20) Levosada, A. T. A., Ogena, R. P. T., Santos, J. R. V., & Danao, L. A. M. (2022). Mapping of Suitable Sites for Concentrated Solar Power Plants in the Philippines Using Geographic Information System and Analytic Hierarchy Process. *Sustainability*, *14*(19), 12260. https://doi.org/10.3390/su141912260
21) Loquias, R., Palima, N., Juanillas, M., Magno, L., Compuesto, K., Zagada, A., Isaac, V., Tabal, K. M., & Terano, H. J. (2022). Suitability Mapping of Solar Energy Potential of Selected Areas in Camarines Sur using ArcGIS. *Journal of Engineering and Emerging Technologies*, *1*, 37–49. https://doi.org/10.52631/jeet.v1i1.185
22) Meniano, S. (2024, December 9). *Northern Samar green lane draws 14 key investments*. https://www.pna.gov.ph/articles/1239539
23) Munier, N., & Hontoria, E. (2021). Rationality of the AHP Method. In N. Munier & E. Hontoria (Eds.), *Uses and Limitations of the AHP Method: A Non-Mathematical and Rational Analysis* (pp. 31–39). Springer International Publishing. https://doi.org/10.1007/978-3-030-60392-2_4
24) Prăvălie, R., Sîrodoev, I., Ruiz-Arias, J., & Dumitrașcu, M. (2022). Using renewable (solar) energy as a sustainable management pathway of lands highly sensitive to degradation in Romania. A countrywide analysis based on exploring the geographical and technical solar potentials. *Renewable Energy*, *193*, 976–990. https://doi.org/10.1016/j.renene.2022.05.059
25) Tripathi, A. K., Ray, S., Aruna, M., & Prasad, S. (2021). Evaluation of solar PV panel performance under humid atmosphere. *Materials Today: Proceedings*, *45*, 5916–5920. https://doi.org/10.1016/j.matpr.2020.08.775
26) Wang, X., & Liu, Z. (2024, March 11). *Navigating Aged Care Services with GIS: Trends, Developments, and Future Directions | BMC Geriatrics*. https://link.springer.com/article/10.1186/s12877-024-04799-4
27) WCMC. (n.d.). *Protected Planet*. UNEP-WCMC. Retrieved October 26, 2025, from http://production-wordpress.unep-wcmc.org/nature-conserved/protected-planet/
28) Yao, Y., Xu, P., Li, J., Hu, H., & Qi, Q. (2024). Advancements and Applications of Life Cycle Assessment in Slope Treatment: A Comprehensive Review. *Sustainability*, *16*(1), Article 1. https://doi.org/10.3390/su16010398



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