Research Article

Site Suitability Analysis of Solar PV Power Generation in South Gondar, Amhara Region

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The Ethiopian government looked towards renewable energy resources to generate electrical power for the current demand of the country. 85% of the total population of the country lives in rural areas and uses fossil fuel for their domestic uses. Using fossil fuel poses a danger for users and the environment. And the government of Ethiopia planned to electrify 85% of the rural community with abundant available renewable resources around the community. Therefore, identifying potential locations for solar PV with GIS is a decision support tool for proposing suitable sites to the government. The solar PV suitability analysis provides optimal locations for solar PV power plant installations. To find suitable locations for solar PV, factors that affect suitability were identified and weighted using analytical hierarchy processes. Then, the weighted values and reclassified values were multiplied together to produce the final suitability map for solar PV. Due to site unsuitability, solar PV generation efficiency drops and may malfunction. By identifying the most suitable locations, a solar PV power plant is optimally located. Therefore, the objective of this study was to find the most suitable sites in the South Gondar Zone for generating power from solar PV. The suitability of the study area for a solar PV power plant is 86.5%. Eighty-six (86%) of the criteria considered in the study area were found to be suitable for optimal location of solar PV power plant. Most of the suitable areas were found in the western part of the zone. The nature of topography is a key factor in generating solar energy; it affects the solar irradiance coming to the solar PV panel surface.

1. Introduction

Site suitability analysis means finding potential locations for a solar PV installation. ArcGIS is a decision support tool for proposing suitable sites to government. Finding suitable locations for a solar PV installation enables increasing the efficiency of a solar PV power system. Thus, finding a suitable location for solar PV is one of the measurement strategies to improve the efficiency of solar power plants. Due to site unsuitability, solar PV efficiency drops and may malfunction. This is the reason why researchers have formulated recommendations for the optimal location of solar PV installations. In Ethiopia, more than 85% of the rural community benefits from the practice of finding suitable locations [1–3].

Renewable energy is derived from natural processes constantly. It is economically feasible, easy to use, less polluting, and abundant in nature. Therefore, renewable energy is more important than nonrenewable sources of energy. Using renewable energy maintains the environment and does not contribute to global warming [4, 5]. In the context of Ethiopia, it is woefully, since most of the families use wood and fossil fuel for their domestic uses. This will affect the development of the country and the health of the community. The development of the country depends on exploiting renewable energy resources and using it optimally. Ethiopia is blessed with an abundance of renewable energy resources like solar, wind, hydro, and others. Amhara is the region where these renewable energies are available throughout the year [6, 7].

Ethiopia has a higher potential to exploit renewable energies for domestic applications. This vast renewable energy resource potential was not exploited sufficiently in the country, primarily due to the lack of scientific and methodological know-how with regard to planning, site selection, and
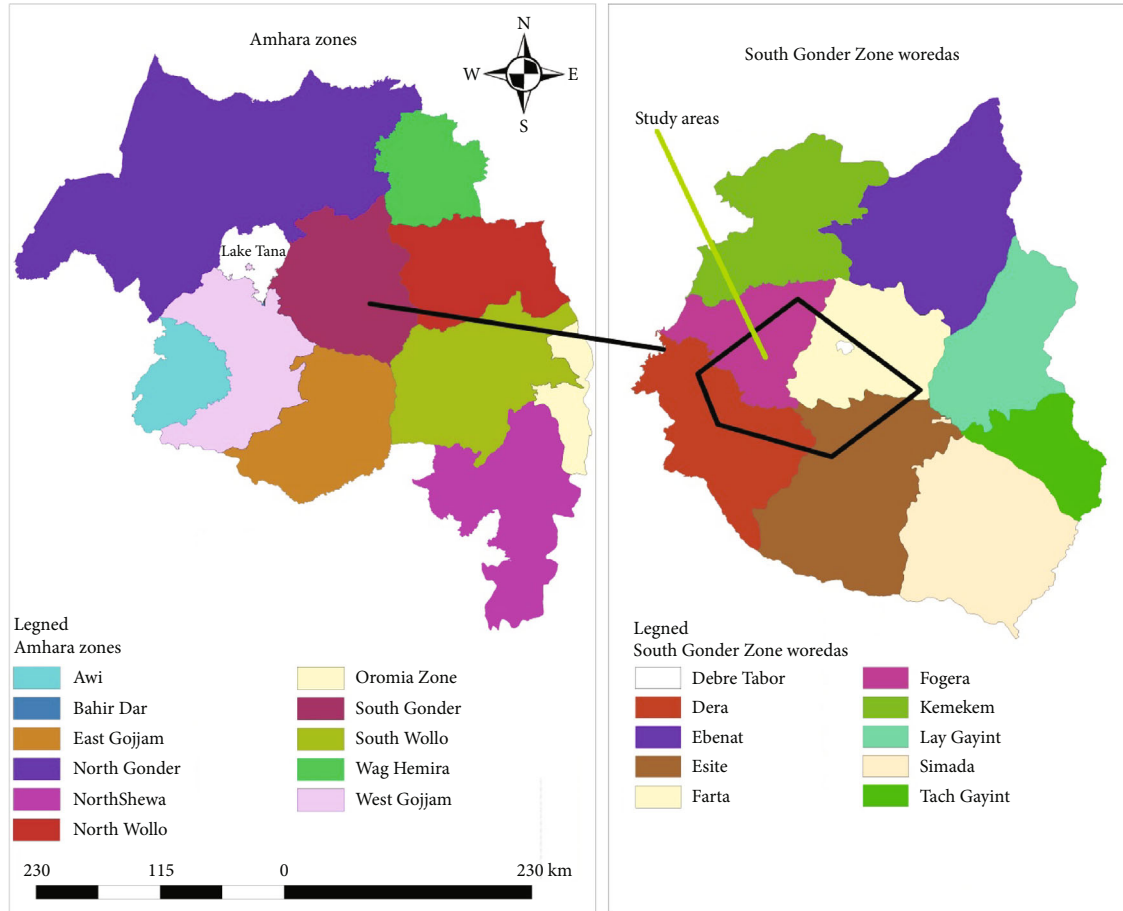
Figure 1: The map of the Amhara Region and the study area [25].

technical implementation. A further constraint prohibiting their utilization was that the real potential of these resources' location is not well-known, because of the lack of research emphasis [6, 7].

In Ethiopia, most solar power plants have low efficiency, and the cause for this efficiency drop is site unsuitability. This can be addressed through site suitability analysis. Currently, the practice of finding a suitable location in Ethiopia is low, and solar PV has been installed without considering a detailed site suitability analysis.

Even though the government of Ethiopia recently took steps towards renewable energy resources, there is a problem in identifying the exact resource locations. The efforts were not organized, and this is due to a low number of researches to explore suitable locations. Therefore, it is important to conduct short and long-term energy planning. The renewable energy resources need to be evaluated in a systematic way, and the technoeconomic issues must be considered in renewable energy resource evaluation. Therefore, this study is aimed at finding suitable locations for a solar PV for sustainable energy planning in four different districts (Dera, Estie, Farta, and Fogera) of the South Gondar Zone, Amhara Region, Ethiopia (Figure 1). Analytical hierarchy and ArcGIS were integrated for order of preference. This determined attempt is expected to inspire government stakeholders to

use a systematic planning process for renewable energy resource selection to develop renewable energy power plants.

2. Literature Review

There are different site suitability-related studies in which multicriteria decision making have been used for different perspectives. Multicriteria decision making has been used for energy planning and policy making at different levels, risk assessments of long-term energy plans, selection of the best renewable technologies and energy management problems, and selection of suitable sites for power plant installation.

The multicriteria weight methodology has been used to rank land suitability evaluation for crop production in Morocco [8]. Most researchers [9–11] have agreed that MCDM approaches are well-suited to address strategic decision-making problems. MCDM methods provide a systemic and apparent way to enclose multiple conflicting objectives. MCDM based on multiattribute value functions is used to support energy planning and to select and prioritize the suitable location for renewable energies.

Azmi et al.'s [11] review provided an application of MCDM with GIS methods in photovoltaic site suitability analysis and suggested that AHP is the most popular method.

TABLE 1: Site suitability analysis-related studies with multicriteria perspectives.

No.	Attempt	Method	Weakness	Year	Reference
1	Multicriteria decision making for PV power plant site selection	GIS-based AHP approach	Used less number of criteria for analysis	2018	[13]
2	Multicriteria decision making for supplier selection	AHP	It was not georeferenced	2019	[14]
3	Site assessment for plant cooling system	GIS-AHP combination	Sensitivity analysis was not considered	2018	[15]
4.	Multicriteria decision making for suitable site selection of solar PV	AHP	Sensitivity analysis was not considered	2018	[16]
5.	Project risk assessment	Fuzzy-Delphi methodology	Used less number of criteria for analysis and not georeferenced	2018	[17]
6.	Multicriteria decision analysis and fuzzy for site selection problems	GIS-fuzzy	There was no specific case study area	2019	[18]
7.	Multicriteria decision making for ranking renewable energy resources	AHP	It was not georeferenced	2018	[19]
8.	Multicriteria decision making for renewable energy potential assessment	AHP	Sensitivity analysis was not considered	2019	[20]
9.	Multicriteria decision analysis for site selection problems	AHP	There was no specific case study area	2019	[21]
10.	Multicriteria decision making for optimal location selection for offshore wind-PV-seawater pumped storage power plant	AHP	It was not georeferenced	2019	[22]
11.	Multicriteria decision analysis and fuzzy for optimizing location selection for biomass energy power plants	Fuzzy-AHP	It was not georeferenced	2019	[23]
12.	Multicriteria decision making for analysis of land availability for power plants and assessment of solar photovoltaic development	AHP		2019	[24]

TABLE 2: Fundamental scale for pairwise comparisons [34, 35].

Degree of importance	Definition	Explanation
1	Equal importance	Criteria equally important to the objective
3	Moderate importance	One criterion slightly more important over another
5	Strong importance	One criterion strongly more important than another
7	Very strong importance	One criterion very strongly more important than another
9	Extreme importance	One criterion extremely more important than another
2, 4, 6, and 8	Intermediate values	A compromise is needed

TABLE 3: Information on experts involved.

Designation	Qualification	Age	Organization
Senior manager	PhD	50	Bahir Dar University
Stakeholder	MSc	35	Amhara Energy and Mining Office
Stakeholder	MSc	41	Ethiopian Electric Power
Stakeholder	MSc	42	Ethiopian Electric Power Utility
Associate professor	PhD	45	Bahir Dar University
Professor	PhD	55	Addis Ababa University
Deputy director	PhD	44	Bahir Dar University
Director	PhD	43	Ethio Telecom
Senior manager	MSc	50	Amhara Metal Industry
Director	PhD	47	Ethiopian Geoinformation System Office
Stakeholder	PhD	45	Environmental Conservation Office

TABLE 4: Decision-maker matrix of a solar PV power plant.

Criteria		1 Irradiance	2 Roads	3 Town	4 Soil	5 Slope	6 Land	7 Forest	8 Stream	9 School
1	Irradiance	1	5	6	9	8	9	3	9	9
2	Roads	1/5	1	2	2	3	1/3	1/4	2	2
3	Town	1/6	1/2	1	3	7	1	3	1	1
4	Soil	1/9	1/2	1/3	1	2	3	2	4	4
5	Slope	1/8	1/3	1/7	1/2	1	3	1	2	3
6	Land use	1/9	3	1	1/3	1/3	1	4	2	3
7	Forest	1/3	4	1/3	1/2	1	1/4	1	5	5
8	Stream	1/9	1/2	1	1/4	1/2	1/2	1/5	1	1
9	School	1/9	1/2	1	1/4	1/3	1/3	1/5	1	1

TABLE 5: Normalized decision matrix of a solar PV power plant.

Criteria		1 Irradiance	2 Roads	3 Town	4 Soil	5 Slope	6 Land	7 Forest	8 Stream	9 Schools
1	Irradiance	0.44	0.25	0.47	0.53	0.35	0.49	0.20	0.33	0.31
2	Roads	0.09	0.05	0.16	0.12	0.13	0.02	0.02	0.07	0.07
3	Town	0.07	0.25	0.08	0.18	0.30	0.05	0.20	0.04	0.03
4	Soil	0.05	0.03	0.03	0.06	0.09	0.16	0.14	0.15	0.14
5	Slope	0.06	0.02	0.01	0.03	0.04	0.16	0.07	0.07	0.10
6	Land	0.05	0.15	0.08	0.02	0.01	0.05	0.27	0.07	0.10
7	Forest	0.15	0.20	0.03	0.03	0.04	0.01	0.07	0.19	0.17
8	Stream	0.05	0.03	0.08	0.01	0.02	0.03	0.01	0.04	0.03
9	Schools	0.05	0.03	0.08	0.01	0.01	0.02	0.01	0.04	0.03

TABLE 6: Eigenvector and weights of the criteria solar attributes.

Criteria for suitability analysis		Eigenvector	Weight
1	Solar irradiance	3.38	0.38
2	Roads	0.72	0.08
3	Town	1.22	0.14
4	Soil	0.83	0.09
5	Slope	0.57	0.07
6	Land use land cover	0.82	0.09
7	Forest	0.89	0.09
8	Stream	0.30	0.03
9	School	0.27	0.03

TABLE 7: Solar irradiance reclassification.

Old values in kWh/m^2	New values
<5	1
5-5.5	2
5.5-6	3
>6	4

Ammar et al. [12] used the AHP method to map a suitable area for a photovoltaic water pumping system in Algeria (Table 1).

This study contributes to the existing literature by proposing AHP with ArcGIS methodology for solar PV site suitability analysis. The AHP approach was used to identify the weights of the criteria, whereas ArcGIS was used to map the suitable location for solar power plants.

3. Study Area and Data Settings

Suitability analysis for solar power installation was conducted in the South Gondar Zone, Amhara regional state.

The Amhara Region is located in the northwestern part of Ethiopia between 9°20′ and 14°20′ north latitude and 36°20′ and 40°20′ east longitude. Its area is estimated to be about 170000 square kilometers [25]. Ethiopia's largest inland body of water, Lake Tana, which is the source of the Blue Nile River, is located within Amhara (Figure 1). The region also contains the Semien Mountains National Park, which includes Ras Dashan, the highest point in Ethiopia. The Amhara Region is bordered by the state of Sudan to the west and northwest, and in other directions by other regions of Ethiopia: Tigray to the north, Afar to the east, Benishangul Gumuz to the west and southwest, and Oromia to the south. The region has twelve zones, and there was no more electricity access to the town and the surrounding community in these zones.

South Gondar is a zone in the Ethiopian Amhara Region. This zone is named for the city of Gondar, which was the
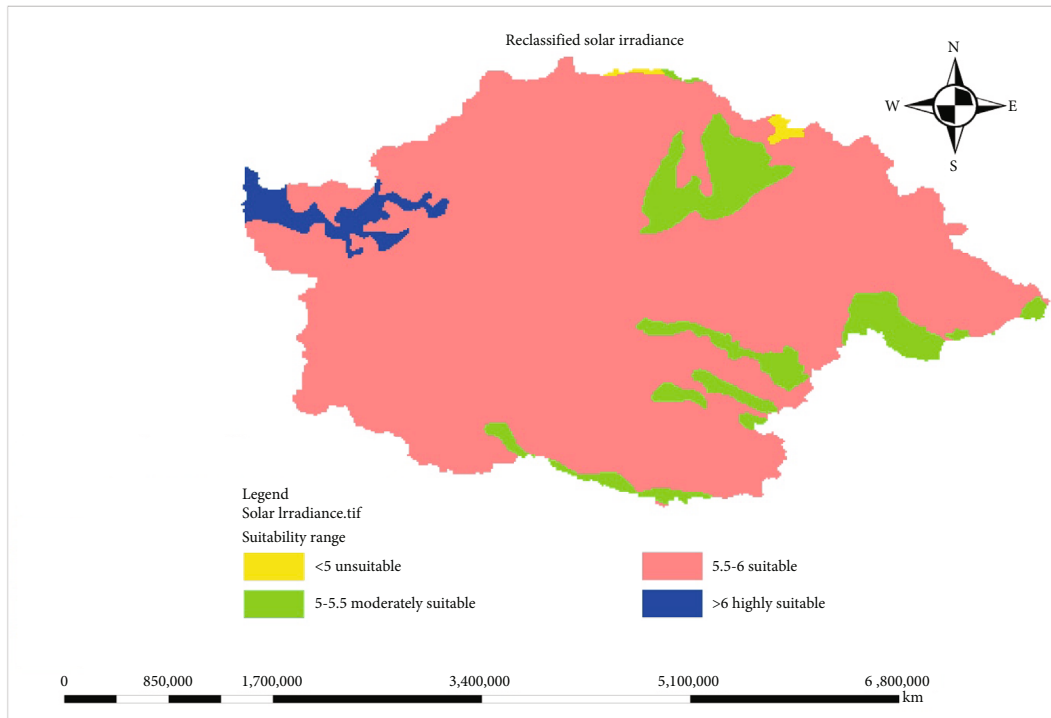
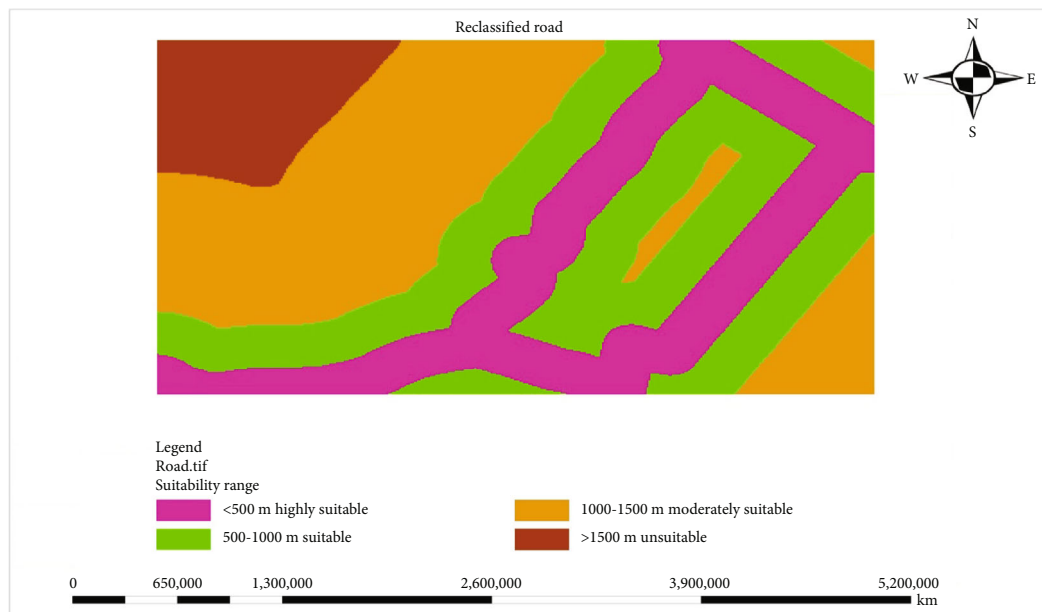FIGURE 2: Solar PV irradiance suitability map.

FIGURE 3: Suitable distance of roads.

TABLE 8: Road reclassification.

Old values(meter)	New values
<500 m	1
5000-1000 m	2
1000-1500 m	3
>1500 m	4

capital of Ethiopia until the mid-19th century, and has often been used as a name for the local province.

South Gondar is located at a latitude/longitude of $11°50'$ $19''N/38° 5'58''E$ and bordered on the south by East Gojjam, on the southwest by West Gojjam and Bahir Dar, on the west by Lake Tana, on the north by North Gondar, on the northeast by Wag Hemra, on the east by North Wollo, and on the southeast by South Wollo; the Abbay river separates South Gondar from the two Gojjam zones [25].
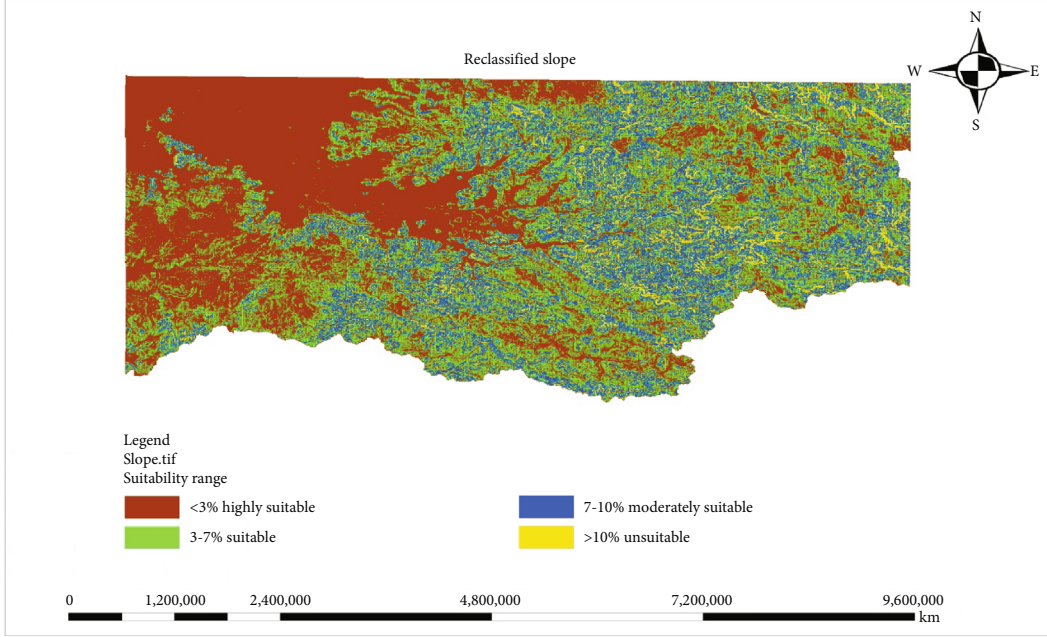
Figure 4: Suitable slopes for solar PV.

In finding suitable areas for solar power plants, Arc-GIS10.4.1 was used. To analyze site suitability, nonsuitable sites were excluded like towns, water bodies, and schools/protected areas, and the weight of the criteria was formulated for decision making [26–29]. Data set rasterizing and reclassifying have been conducted on vectors and raster layers like solar irradiance, distance from roads, towns, soil, slope, land use land cover, forest, stream, and distance from school areas. Finally, reclassified data were combined by using the ArcGIS overlay tool [30–32].

The data sets were obtained from different sources in vector formats, and then vector data were converted to raster with the conventional tool of ArcGIS10.4.1. Thus, the raster outputs of data sets were reclassified and finally overweighed to show results for finding suitable sites [27, 33].

There are three tasks in finding suitable areas for solar power plant installations:

(1) Data preparation and criteria formulation as the nature of the study areas, then data insertion into ArcGIS10.4.1 software as layers

(2) Reclassification of the data sets

(3) Overlaying the reclassified data

3.1. Analytic Hierarchy Process (AHP) for Criteria Evaluation.
The analytic hierarchy process (AHP) is one of the multicriteria decision-making methods. There were nine criteria in this study, and this was the reason why the analytic hierarchy process (AHP) was used to analysis site suitability. It was used to make complex decision problems. The pairwise comparison method was used to evaluate the weights of the criteria. First, the weights of criteria analysis were done to examine important criteria in finding suitable location

Table 9: Slope reclassification.

Old values (%)	New values
<3%	1
3-7%	2
7-10%	3
>10%	4

practice. Thus, ArcGIS can prioritize the sites according to the weights of the criteria. The input was obtained from subjective opinion like satisfaction feelings and preference. The pairwise comparison of the attributes makes it easy for complex problems decision. It compares the importance of two attributes at one time (Table 2).

3.2. Selecting Criteria for Solar PV Installation.
In finding the potential sites for solar power plants, site selection is dependent on the weights of each layer. Opinions of experts (Table 3) were used to determine each site selection criterion for locating solar PV [31, 32, 36]. Solar irradiance, roads, town, soil, slope, land use, land cover, forest, stream, and schools were used to create a model to identify suitable locations for solar PV as per the nature of the study area (Table 4).

The normalized decision matrix of the solar PV power plant was obtained by summing up the column and dividing it to each cell value (Table 5). The normalized values were calculated from the decision-making matrix (A_{ij}) as follows:

$$N = \frac{\sum j}{c}, \quad (1)$$

where N is a normalized value, J is the column of the matrix, C is the value of the column of the decision.
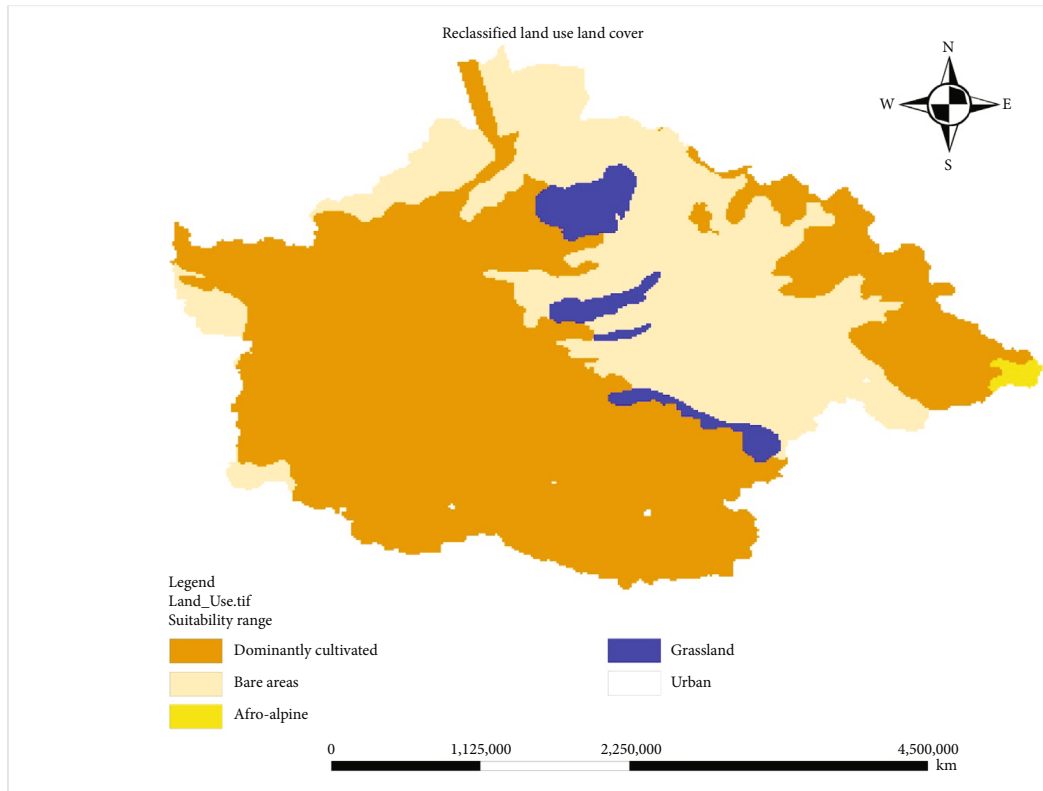
FIGURE 5: Suitable land use, land cover for solar PV.

TABLE 10: Town reclassification.

Old values (km)	New values
<2 km	1
2-4 km	2
4-6 km	3
>6 km	4

In identifying the potential sites for solar PV power plants, site selection was dependent on the weights of each layer (Table 6). The weights of the criteria were calculated from a normalized matrix (A_{nm}) as follows:

$$W = \frac{\sum n}{X},$$ (2)

where W is the weight of the criteria, n is the row value of the normalized matrix, and x is the number of criteria for suitability analysis.

3.3. Site Suitability Analysis of Solar PV. Geographic information systems (GIS) and ArcGIS were used to indicate the appropriate sites for solar PV power plants. ArcGIS can prioritize the site to determine the most suitable sites. GIS was modeled to store data, analyze data, and display spatial data on a map [6, 37].

To determine the most suitable areas for solar PV placement, nine data sets were taken as a layer. Thus, the data sets are solar irradiance, roads, forest, stream, schools, town, soil,

slope, and land use land cover. The study area was ranked to determine the most suitable sites, and the potential sites for solar PV placement were prioritized as highly suitable, suitable, moderately suitable, and unsuitable.

3.3.1. Solar Irradiance Reclassification. The solar irradiance was the most dominant factor to find the most suitable location for the solar power plants. The solar irradiance data set was taken from the NASA surface metrology which represents the average of daily totals of global horizontal solar irradiance in kWh/m^2 [27, 30, 38–43].

For twenty years, the yearly average solar irradiance layer was downloaded from NASA.

According to the national renewable energy laboratory report [44], areas with 3.56 kWh/m^2 solar irradiance per day are economically feasible. Therefore, areas with less than 3.56 kWh/m^2 solar irradiance per day were considered as unsuitable in the study (Table 7). The raster solar irradiance was reclassified as unsuitable (<5 kWh/m^2 per day), moderately suitable (5-5.5 kWh/m^2 per day), suitable (5.5-6 kWh/m^2 per day), and highly suitable (>6 kWh/m^2 per day) (Figure 2).

3.3.2. Road Reclassification. Transportation cost was the dominant factor for any power plant installations. Thus, the areas far from roads are not economically feasible and unsuitable. Therefore, locations with less than 500 m distance were selected as highly suitable sites for solar PV [27, 33, 43, 45, 46]. Locations with a distance of 500-1000 m are suitable, 1000-5000 m are moderately suitable, and greater than 1500 m are unsuitable (Figure 3).
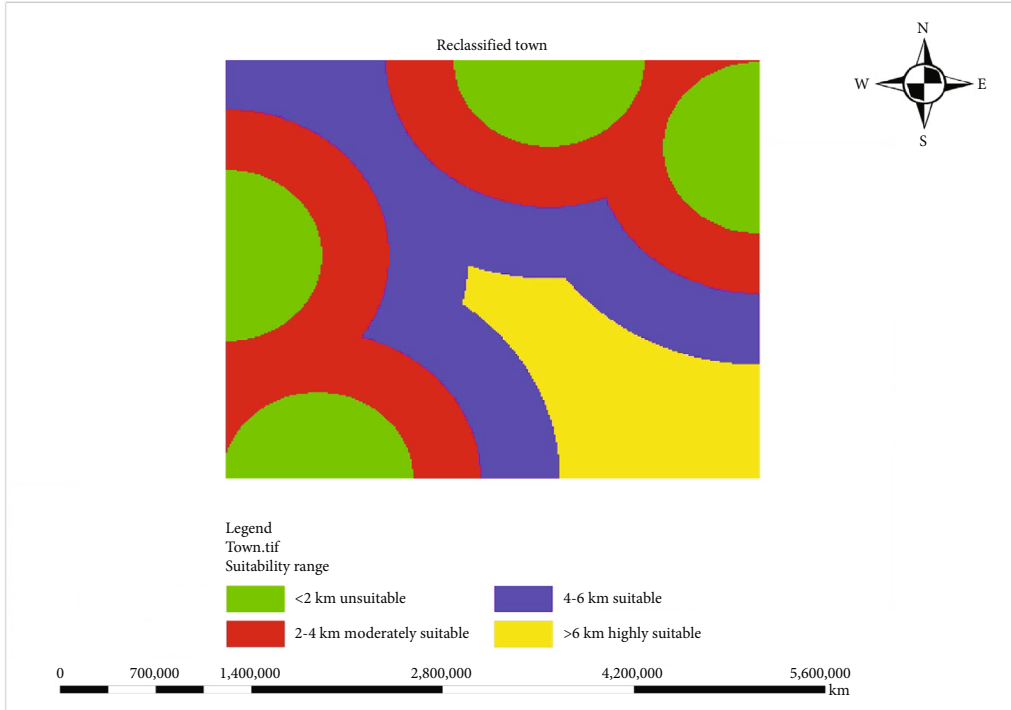
Figure 6: Suitable town distance for solar PV.

Table 11: School reclassification.

Old values (meters)	New values
<300 m	4
300-400 m	3
400-1000 m	2
>1000 m	1

The Euclidean distance was used for road data reclassifications in the ArcGIS tool and the Euclidean distance was reclassified (Table 8).

3.3.3. Reclassification of Slope. The surface of the earth was an important factor in finding suitable locations for solar power plants. The earth's gradient affects receiving radiation from the sun. Thus, flat areas receive the most radiation and produce more energy from solar PV [25, 26, 47].

Areas that have less than 3% gradient were reclassified as highly suitable and greater than 10% gradient were unsuitable (Figure 4). The slope reclassification data sets have shown that the western part of the zone was flatter (Table 9). On the other hand, the eastern part had higher slope areas.

3.3.4. Land Use, Land Cover. Land use land cover was a key factor in finding the optimal location for solar PV power plants. Cultivated/agricultural areas, forest areas, and urban areas were excluded in this study [25]. The open areas were considered as highly suitable areas for solar power plant installations (Figure 5).

3.3.5. Distance from Town. The towns will expand, and there will be a shading effect due to large buildings. Thus, solar PV efficiency drops. Therefore, the distance from towns was another important factor in finding suitable sites for solar PV power plants [25, 48]. The farthest distance from the town was considered as highly suitable and the shortest was considered as unsuitable for solar PV in this study (Table 10).

The town data set was reclassified as highly suitable (>6 km), suitable (4-6 km), moderately suitable (2-4 km), and unsuitable (<2 km) (Figure 6).

3.3.6. Distance from Schools. Historical places, recreation areas, and schools were excluded in indicating optimal locations for a solar PV power plant [5, 43]. Based on the nature of the study area, the distances from schools were reclassified into four categories, i.e., less than 300 m, 300-400 m, 400-1000, and greater than 1000 m (Table 11). The farthest distance from schools was considered as a highly suitable area, and the shortest distance was considered as an unsuitable site for solar PV power plants (Figure 7).

3.3.7. Distance from the Stream. The solar power plant locations were affected by streams and water bodies. The farthest locations were the most suitable locations [32]. The streams were reclassified into four main categories depending on the distance from the sites. The farthest locations were taken as more suitable, and the nearest locations were taken as unsuitable (Figure 8). Distance greater than 2000 m was taken as highly suitable, 1000-2000 m as suitable, 500-1000 as moderately suitable, and less than 500 m as unsuitable (Table 12).
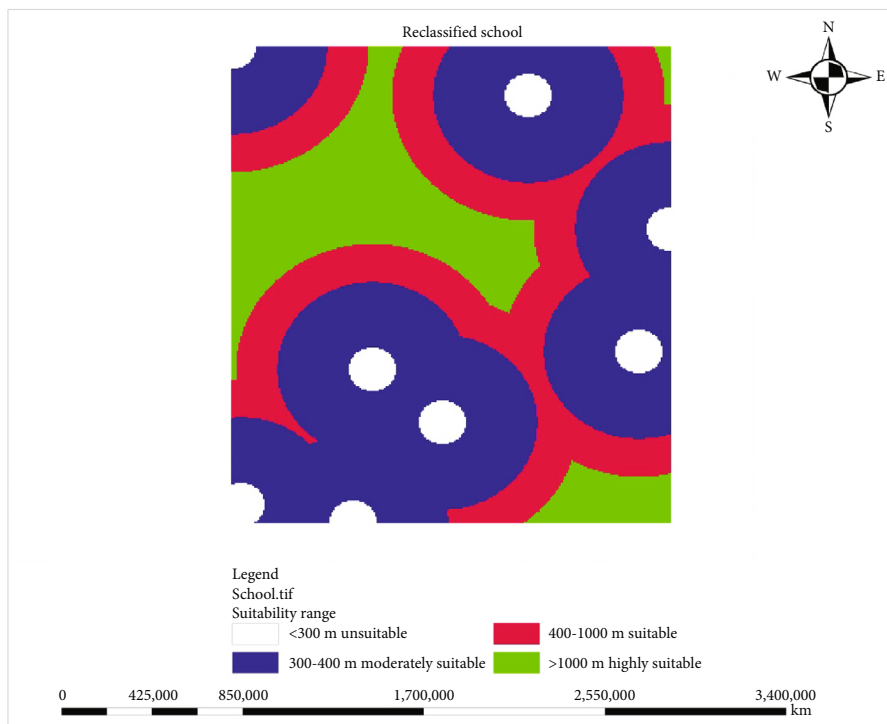
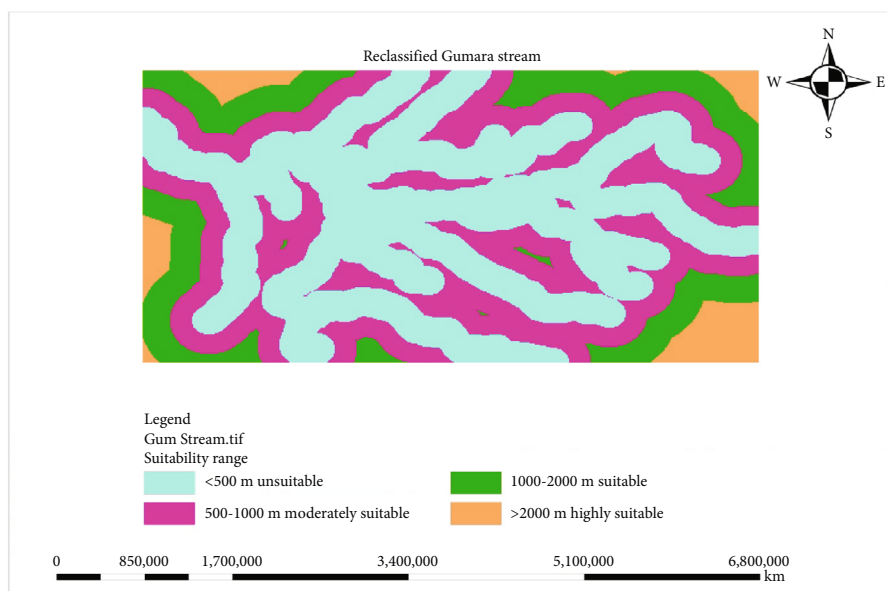FIGURE 7: Suitable school distance for solar PV.

FIGURE 8: Suitable stream distance for solar PV.

<table>
<tr><td colspan="2" align="center">TABLE 12: Stream reclassification.</td></tr>
<tr><td>Old values (meters)</td><td>New values</td></tr>
<tr><td><500 m</td><td>4</td></tr>
<tr><td>500-1000 m</td><td>3</td></tr>
<tr><td>1000-2000 m</td><td>2</td></tr>
<tr><td>>2000 m</td><td>1</td></tr>
</table>

Old values (meters)	New values
<500 m	4
500-1000 m	3
1000-2000 m	2
>2000 m	1

TABLE 13: Forest reclassification.

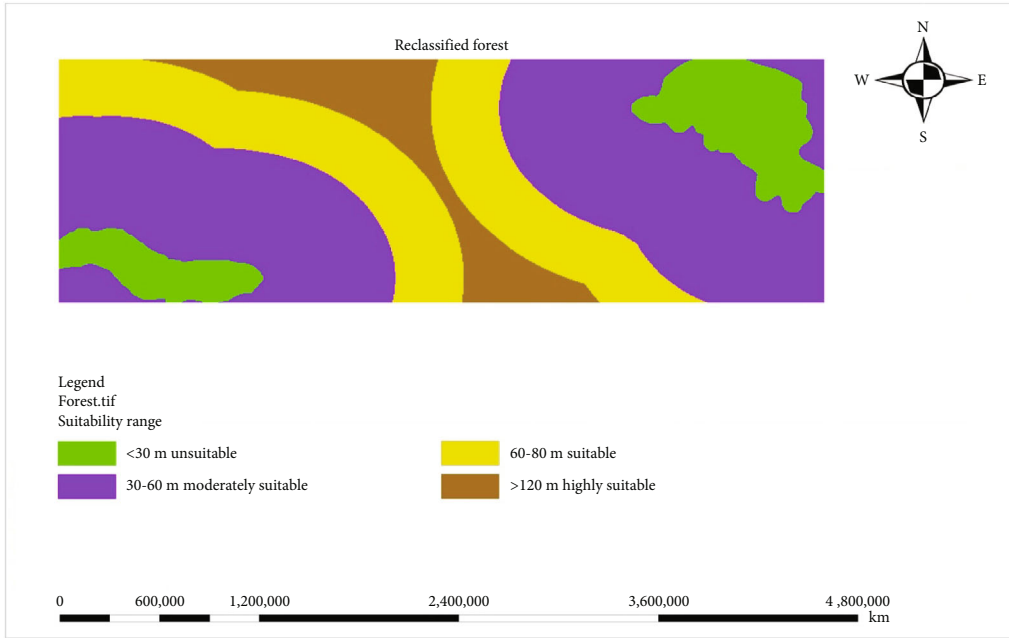| Old values (meters)	New values
<30 m	4
30-60 m	3
60-80 m	2
>120 m	1

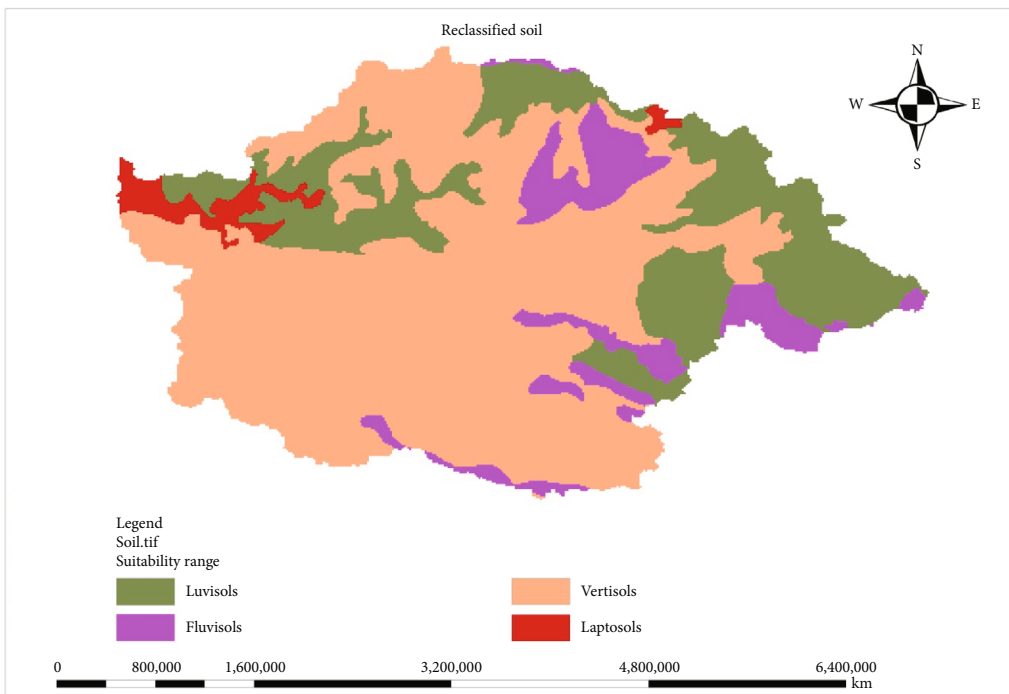Figure 9: Suitable forest distance for solar PV.

Figure 10: Suitable soils for solar PV.

3.3.8. Distance from Forest. Distance from the forest was the dominant factor for solar PV power plant site selection. The solar radiation is highly affected by the forest shadow [4, 30, 38, 39, 47]. Thus, the distance far from the forest was considered as the most suitable and the nearest distance was considered as unsuitable locations (Table 13).

The forest data set was reclassified into four classes in this paper, with greater than 120 m as highly suitable, 80-100 as

suitable, 30-60 m as moderately suitable, and less than 30 m unsuitable (Figure 9).

3.3.9. Soil Reclassifications. The soil was also an important factor in finding the optimal location for a solar PV power plant. Thus, luvisol was considered as the most suitable for support erection of solar PV and laptosol was considered as unsuitable for support erections [25, 28].

TABLE 14: Suitability area percentage of sensitivity analysis.

Criteria for suitability analysis		Original weight	1% change	2% change	3% change	5% change
1	Solar irradiance	0.38	0.3838	0.3915	0.4032	0.4193
2	Roads	0.08	0.0792	0.0776	0.0753	0.0723
3	Town	0.14	0.1386	0.1358	0.1318	0.1265
4	Soil	0.09	0.0891	0.0873	0.0847	0.0813
5	Slope	0.07	0.0693	0.0679	0.0659	0.0632
6	Land use land cover	0.09	0.0891	0.0873	0.0847	0.0813
7	Forest	0.09	0.0891	0.0873	0.0847	0.0813
8	Stream	0.03	0.0297	0.0291	0.0282	0.0271
9	School	0.03	0.0297	0.0291	0.0282	0.0271

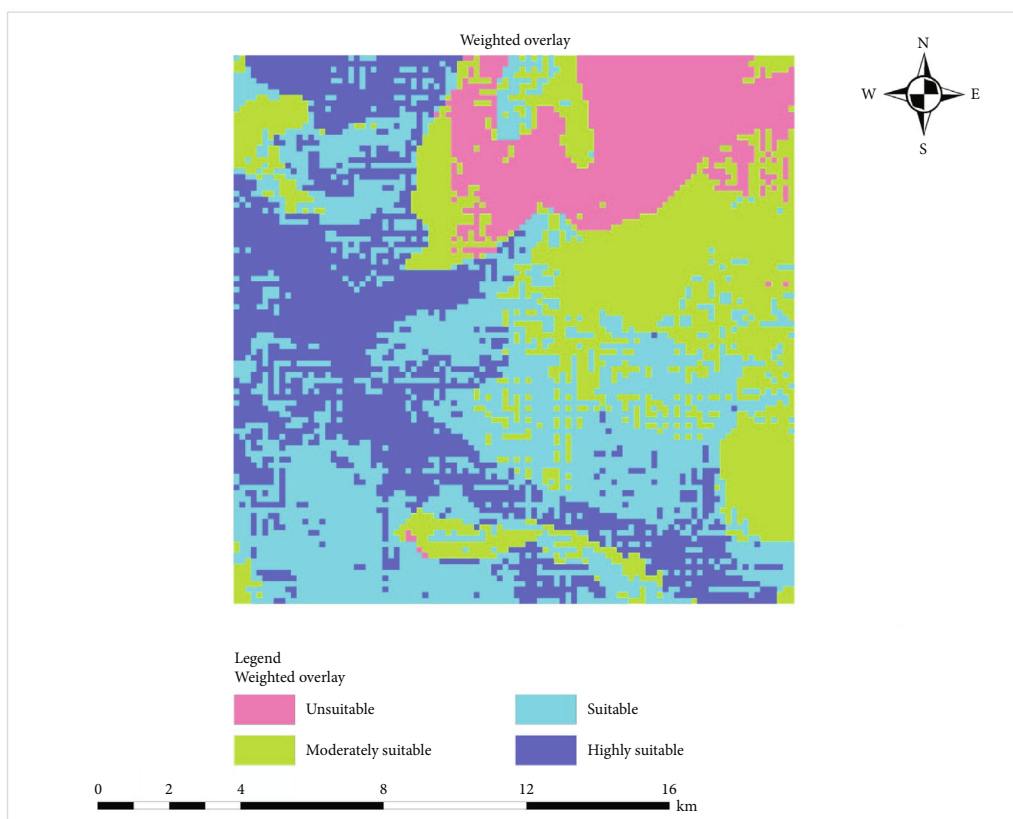
FIGURE 11: Suitability map of solar PV.

TABLE 15: Study area solar suitability in percent.

No.	Area (square meters)	Percent	Suitability
1	32925525.8544	13.5	Unsuitable
2	61558441.5047	25.3	Moderately suitable
3	86790957.7469	35.7	Suitable
4	62078674.8941	25.5	Highly suitable

TABLE 16: Suitability area percentage of sensitivity analysis for one percent change in solar irradiance.

No.	Suitability	Suitability area (%)	Suitability area with one percent change
1	Unsuitable	13.5	13.524
2	Moderately suitable	25.3	24.850
3	Suitable	35.7	27.043
4	Highly suitable	25.5	34.583

Based on the nature of the study area, the soil type was reclassified into four main categories, and these were (luvisol) highly suitable, (fluvisol) suitable, (vertisol) moderately suitable, and (laptosol) unsuitable (Figure 10).

3.4. Weighted Overlays of Solar PV Suitability Analysis. All weights of the criteria were combined by using the ArcGIS10.4.1 weight overlay tool. The reclassified data set of the criteria which includes solar irradiance, distance from
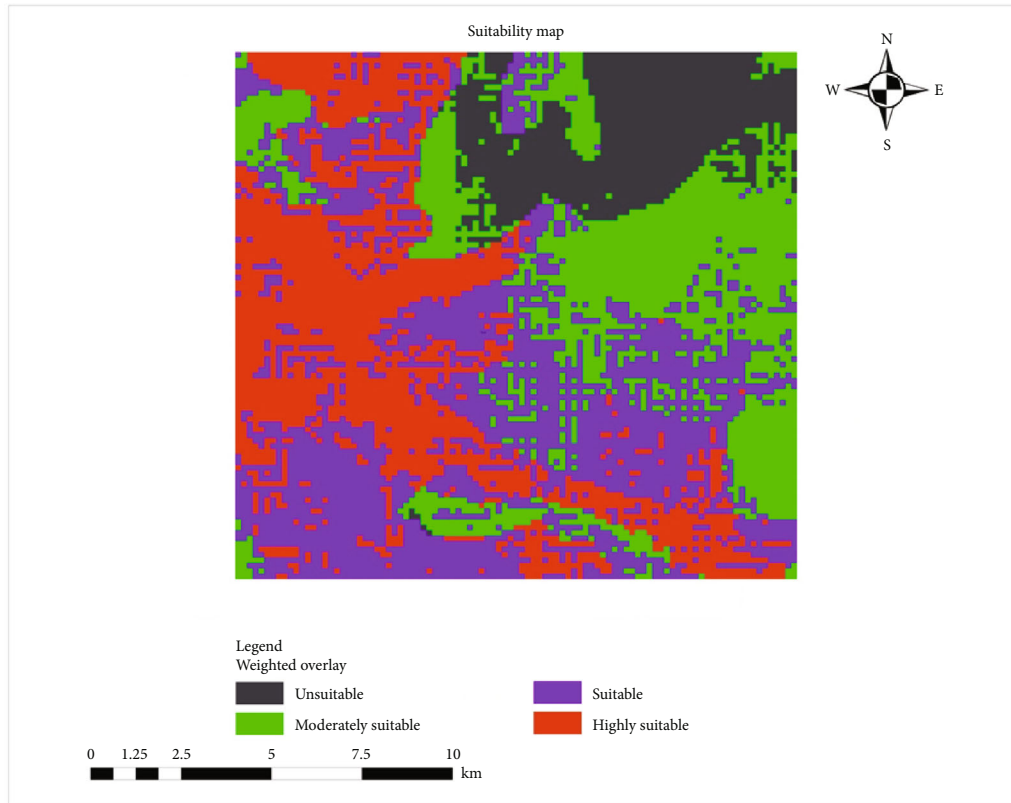
FIGURE 12: Suitability map with one percent change.

roads, distance from schools, distance from town, slope, distance from forest, soil type, and land use land cover were overlaid to the aggregate result [30, 37, 43].

The final map of suitability was obtained by multiplying each reclassified value with each weight value and summing up all layer products. The range of solar PV suitability was from one to four. Thus, the study area was separated into four main categories for placing solar PV.

3.5. Sensitivity Analysis Concepts in ArcGIS. Sensitivity analysis is used to evaluate the multicriteria model output on small changes in the input. Criteria weight is the most important attribute in sensitivity analysis. In this study, a suitability map is produced for solar PV-suitable sites. The criteria weights were changed with a certain percent from that of original weights to show the change in the suitability map of solar PV [30, 48–53].

The sensitivity analysis was performed in such a way that when one priority criterion is increased by 1 percent, the other criteria are decreased with the same percent. This was done with different changes in criteria weights (Table 14).

4. Result and Discussion

4.1. Suitability Map of Solar PV. The western and southwestern parts of South Gondar were suitable for solar PV from the candidate locations. This is mainly due to a high solar irradiance, a low slope, a short distance from roads, and at a distance far from the town, far from the forest, and far from the stream. The northwestern areas were also suitable in addition to the western and southwestern parts of South Gondar, and there were some potential areas in the southeast of the zone. The most unsuitable areas are found in the northeastern parts of the zone due to the near distance to the forest and Gumara stream (Figure 11).

From a total of 243, 353, 600 km^2 candidate areas taken in this study, 62078674.8941 km^2 was highly suitable which represented 25.5% of the study area, 86790957.7469 km^2 areas (35.7%) were suitable, and 25.3% of the areas were moderately suitable. Around 13.5% of the study area was unsuitable for solar power plant placement (Table 15).

4.2. Sensitivity Analysis. Sensitivity analysis was done to show the uncertainties of the criteria and to minimize bias of criteria selection of the experts. For analyzing the changes by which a decision maker can be able to get a better idea for a decision-making process, sensitivity analysis was done. When solar irradiation criteria weight was increased by one percent, the other criteria decreased by one percent. Thus, there is a small change in the suitability area (Table 16). A one percent change in solar irradiation has increased the suitability area by one percent, and the rest remains the same. And a suitability map was done for a one percent change in priority weight's criteria (Figure 12).

Similarly, sensitivity analysis was done for a 5% change in solar irradiance weight (Figure 13). Thus, solar irradiance weight was reduced by 5 percent and the remaining
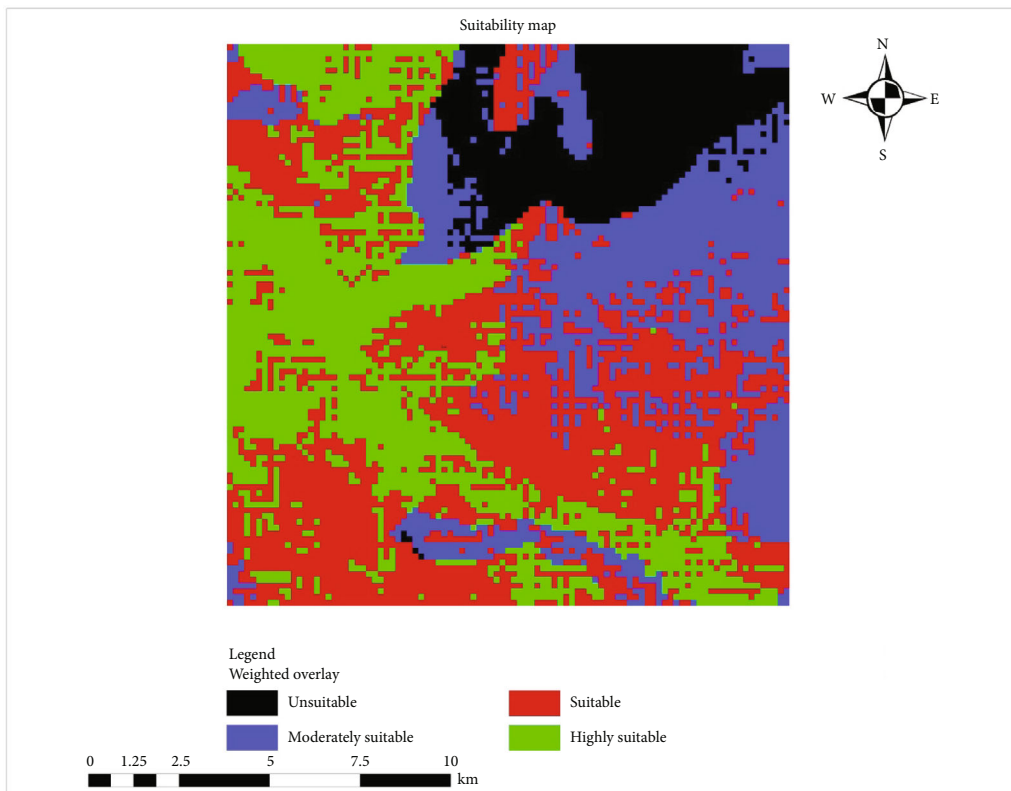
Figure 13: Suitability map with five percent change.

Table 17: Suitability area percentage of sensitivity analysis for one percent change in solar irradiance.

No.	Suitability	Suitability area (%)	Suitability area with five percent change
1	Unsuitable	13.5	13.103
2	Moderately suitable	25.3	23.343
3	Suitable	35.7	27.007
4	Highly suitable	25.5	36.547

criteria were increased by 5 percent to detect the change (Table 17).

The suitable areas were changed to unsuitable or moderately suitable which provides that sensitivity analysis is required for such uncertainties.

5. Conclusion

There were higher potentials of solar power generation in the western and southwestern parts of the South Gondar Zone. This potential contributes to fill the energy gap between the demand and supply of the country. It is also used to bridge the energy gap between rural and urban communities if the country starts to use this high green solar potential to generate power needs.

The majority of the areas fulfilled the suitability analysis criteria. Solar irradiance, slope, soil type, land use, land cover, and distances from roads, forest, town, stream, and schools were the determinant factors for solar PV power site suitability analysis.

Data Availability

The data of this study will not be shared publicly due to sensitive participant informations.

Conflicts of Interest

The authors declare that there are no conflicts of interest with regard to the publication of this paper.

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