REPORT

EUROPEAN BANK FOR RECONSTRUCTION AND DEVELOPMENT

Development of Solar Power Projects in Albania

Solar Siting Study

Submitted to:

Ministry of Infrastructure and Energy (MIE)

Submitted by:

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EXECUTIVE SUMMARY

Golder Associates was requested to carry out a high-level analysis of Albanian territory aimed to find potentially suitable areas to install Utility Scale Photovoltaic Power Plants (“PV plants”).

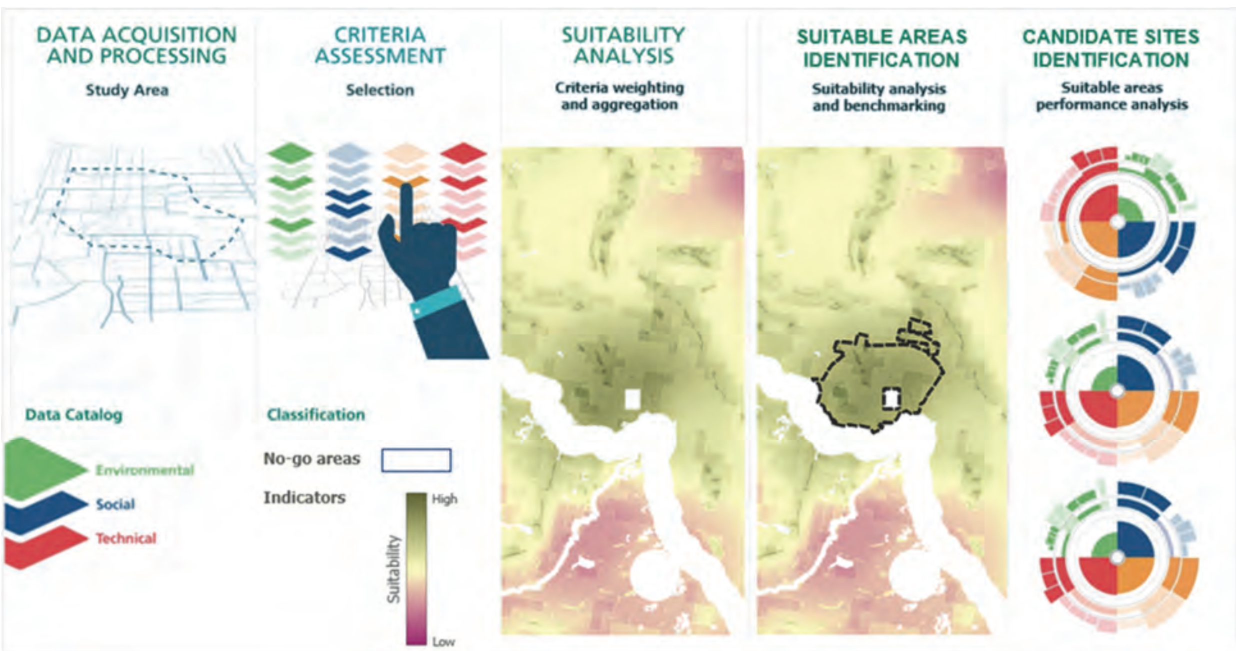
A Geographic Information System (GIS) was implemented to collect and manage relevant data describing physical, biological and social features that characterize the Country.

The methodology consisted in a Multi-Criteria Decision Analysis (MCDA), based on GIS data, used to develop spatial criteria to support the decision-making process for the identification of the most suitable areas for new PV plants.

The criteria, identified as either constraints (to identify no-go areas or exclusions) or indicators (to characterize a higher or lower suitability) were implemented in response to a series of sustainability goals set during the initial workshop with stakeholders. The criteria were grouped into three sustainability dimensions, Environmental, Social and Technical, and weighted based on their relative importance, according to a consultation process with stakeholders.

The application of the proprietary GoldSET Spatial tool allowed to combine criteria and weights to produce a Suitability map. The final step was to analyse the suitability map and to identify ten candidate areas, presenting the higher values of suitability.

The different steps of the methodology are summarized in the figure below:

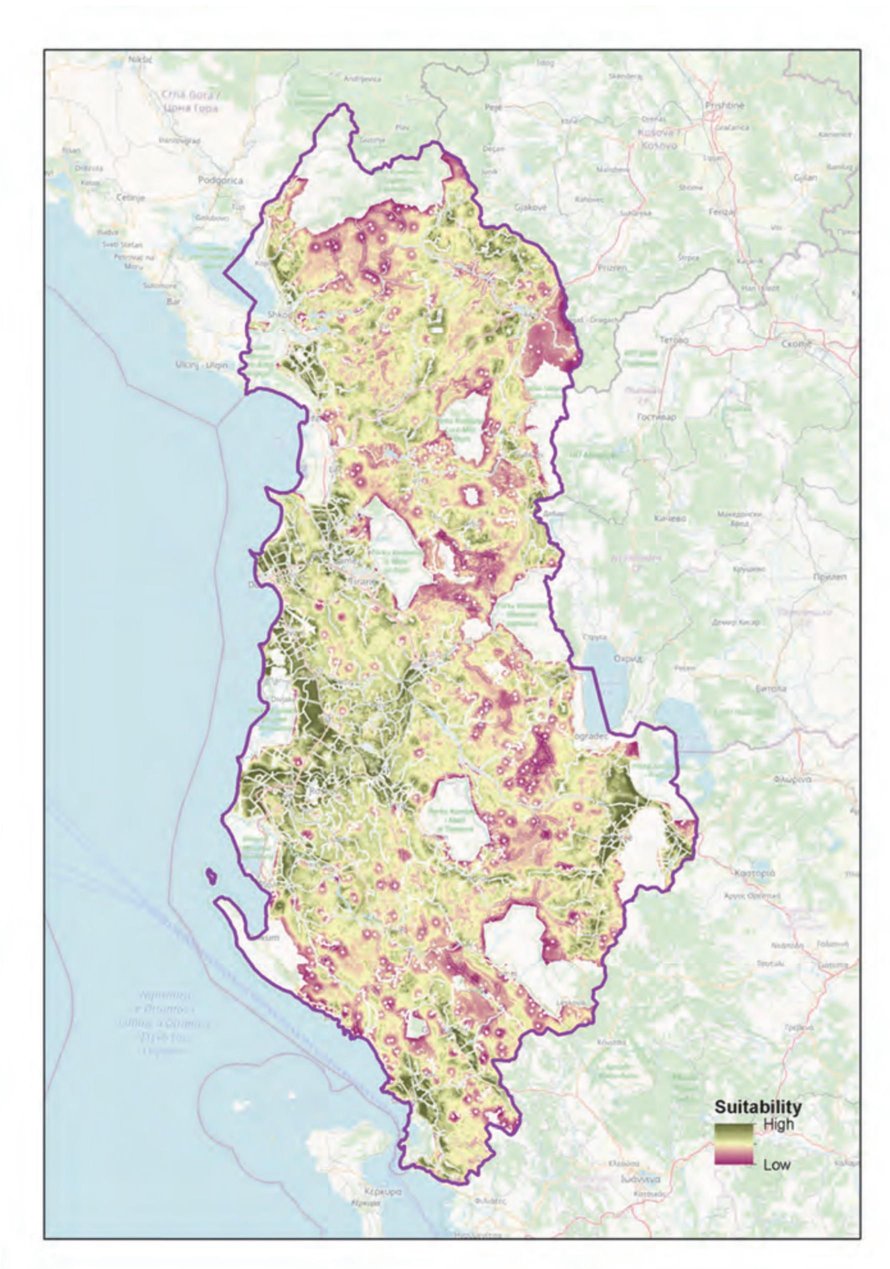


The Suitability map (here below) and the complete set of candidate areas are provided as GIS files. These deliverables are available to be used for a more in-depth analysis to locate the most reliable areas where siting a Solar Power Plant will ideally meet and best trade-off the goals of sustainability, allowing the possibility of choosing either the best or one of the best or the most acceptable solution.

The suitability framework adopted in this study and the deliverables produced may be leveraged at different stages and by multiple stakeholders involved in the solar development program.

Adopting the framework on both sides (authorities and developers) would therefore have a beneficial effect on the interplay between the parties streamlining the process, speeding up the solar program development and bringing more efficiency and clarity to the overall process.

This report illustrates the effectiveness of multicriteria analysis and suitability mapping to support the choice of candidate areas, facilitating policy makers, professionals and financial institutions in the comparison and ranking of selected sites and ultimately streamlining the permitting process of development projects.



1.0 INTRODUCTION

1.1 Background and Objectives of the work

In 2009 the 2009/28/CE European directive provided the framework in which all Member States may set their National Plans for increasing the use of Renewable Energy Sources ("RES") in the European Union. In 2016, the UN included art. 7 "Clean and affordable energy" in the 17 Sustainable Development Goals (SDGs) as part of the 2030 Agenda for Sustainable Development.

On May 3rd, 2017 the EBRD (*European Bank for Reconstruction and Development)* and the Government, acting through the Albanian Ministry of Infrastructure and Energy ("MIE"), have signed a Memorandum of Understanding to cooperate in the development of the Albanian national regulatory framework for solar power and subsequently in the development of solar power projects.

Therefore, a Consortium grouping teams of experts in various disciplines, was selected by the EBRD to provide technical and scientific support to the Government of Albania to promote and develop solar energy projects.

Golder Associates ("Golder"), as part of the Consortium, was requested by the EBRD to assess the suitability of the entire Albanian territory, commissioning an analysis and a list of suitable areas for the development of a Photovoltaic Power Plant ("PV plant").

Within this context, Golder adopted the integrated use of the multi-criteria analysis ("MCA") within its proprietary GoldSET© Spatial Module, using a multi-criteria spatial approach which combines geographic datasets with value assessments to inform the decision-making process.

1.2 Scope of work

The objective of this Siting Study is to support the definition of suitable areas for the projects of the Solar programme to ensure the programme achieves its overall objectives, i.e. to minimize the costs and negative impacts and maximize the positive impacts on the local communities. The suitability assessment considers the territory of the Republic of Albania.

Golder performed the assessment using its proprietary tool GoldSET Spatial (**Gold**er **S**ustainability **E**valuation **T**ool), a flexible, user friendly and integrated approach to support siting options by combining spatial data collected and organized in a GIS database with a multicriteria analysis and an evaluation framework.

The application of the GoldSET workflow to identify suitable areas involved the following steps:

- Methodology
  - Siting methodology & Decision framework
  - Identification of Constraints and Indicators, based on Social, Environmental and Technical Dimensions
- Siting Study
  - Data selection and acquisition
  - Indicators development and weight assessment
  - Suitability analysis combining spatial data (GIS) within the multicriteria framework.

1.3 Study area

The Siting Study was performed at a national scale and covered the entire Albanian territory (Figure 1).

Figure 1: Study area

2.0 SITING METHODOLOGY

2.1 GoldSET Spatial

GoldSET Spatial is a module of the GoldSET toolkit. It combines a multi-criteria analysis with the technology of Geographical Information Systems (GIS).

The methodology uses a GIS system to process and combine geographic datasets according to a multicriteria decision framework, based on the Analytic Hierarchy Process (“AHP”), through the definition of constraints (no go areas) and indicators along with weights (relative importance) defined by the decision makers. Constraints and indicators are based on geographic datasets (GIS data) covering the Project area, in this case the Albanian territory.

This chapter illustrates the GoldSET Spatial methodology, starting from the workshop that has defined the decision framework.

2.2 Decision framework

The initial step of the methodology entails the definition of the decision framework, i.e. the formulation of the objectives of the analysis and the definition of the success criteria. This step of the project is typically accomplished in a workshop aimed to:

- *discuss and confirm the **Study Goals***
- *illustrate the **GoldSET approach***

- *review and verify the preliminary list of siting **Criteria**, distinguished between **Constraints** and **Indicators**, that are used to model suitable areas; criteria are usually grouped in **Dimensions** (e.g. Environmental, Social, Economic[1], Technical), based on the thematic aspect they belong to*
- *agree upon (through group consensus) the set of **Weights** which reflect the trade-offs between the Environmental, Social and Technical considerations in a repeatable, transparent, and defensible way*
- *define the approach to derive the **Suitability** map and identify candidate sites or areas.*

In the following paragraphs, each task of a typical GoldSET study will be described.

2.3 Goals

The purpose of a siting study is to find the most suitable areas for locating a facility, performing some type of activity, protecting valuable resources, etc. However, the suitability of an area has a subjective component to it, that needs to be anchored in the overall goals of the study. In this respect, goals are intended as statements that define the success of the project at hand and are agreed upon by the stakeholders during the process; in order to validate the robustness of the study, goals may refer to global standards and best practices, industry-specific standards, previous studies with similar requirements, scientific publications and the technical expertise of the Subject Matter Experts ("SMEs") involved.

The confirmation of study goals is the first exercise that the group involved in a GoldSET study collaboratively works on. It serves the purpose of grounding the study to a set of achievable outcomes, creating an expectation that all stakeholders agree upon.

2.4 Dimensions, Criteria and Scenarios

The basis to apply the GoldSET methodology is the development of justifiable criteria that reflect the established goals, priorities and/or considerations for site selection. Selecting criteria is, therefore, a critical step in developing a comprehensive GoldSET analytical framework, as each criterion represents a valuable decision element, contributes to the identification of suitable areas and is subject to a quality assurance process to maintain the overall consistency of the decision analysis.

Criteria are defined as the key decision elements on which the assessment is based to be reliable and deemed reasonable; criteria are distinguished between conditions that prevent from achieving the study goals (**Constraints**) and characteristics that the candidate site/area may fulfill at various degrees of suitability (**Indicators**). The data used to develop the set of criteria for the suitability analysis, can be discrete or continuous. Whether they are discrete or continuous, the values can be qualitative, as an expression of judgment, or quantitative, as the result of measurement.

Constraints usually represent extremely sensitive areas or conditions of natural, human and technical concern where the feasibility is technically unachievable, or the environmental or socio-economic impact of the project would be unacceptable (e.g. Protected areas constraint: a plant cannot be located within a protected area). Constraints in a siting model are simply overlapped and merged to generate a map of areas where siting is prevented, called **Constraints map**.

At a high level, indicators can be considered as a measurement of a spatial characteristic that will influence site selection (e.g. distance from roads: areas closer to roads will be more suitable for a site development). Indicators are expressed in a continuous scale of suitability that quantifies the degree of fulfillment of the study objective with respect to each element of the decision framework.

[1] In this specific siting study, the economic dimension has not been assessed due to lack of relevant data

To be comparable with each other, however, it is necessary that indicators are expressed in the same range of values, i.e. a common performance score (suitability) between the most and the least preferable condition. A standardization process is therefore necessary before the aggregation of all criteria considered in the study can be performed.

All indicators are standardized between 0 (lowest suitability) and 100 (highest suitability) within GoldSET, applying a set of predefined functions. The function type identifies the relationship between the values of an indicator and the corresponding suitability scores. Such relationship can be direct (blue line in Figure 2), if the suitability increases with the indicator value, or inverse (red line in Figure 2), if the suitability decreases. An inverse relationship is used to reflect the fact that these indicators are to be minimized in order to optimize the performance (i.e., minimize emissions, energy consumption, costs, etc.).

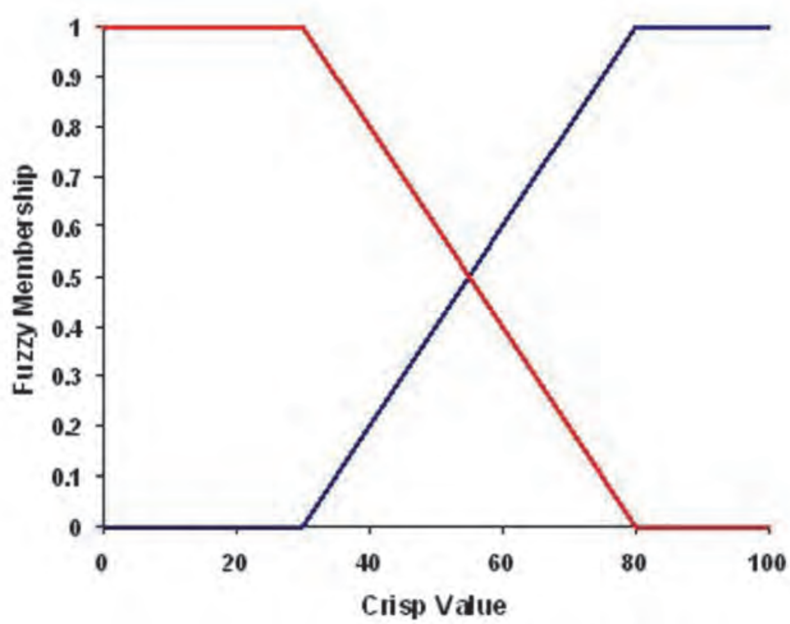


Figure 2: Direct (blue line) and inverse (red line) relationship between the indicators and the suitability scores

Sometimes the suitability of an indicator depends on the distance relationship with an existing feature (e.g. the distance from a road influences the choice of a candidate site). In these instances, indicators leverage the logic of proximity that may play the role of an attractor or repulsor. For attractors, the suitability increases with the proximity to a certain feature, for repulsors the suitability increases with the distance from that feature.

The Criteria standardization concept is reported in Figure 3.

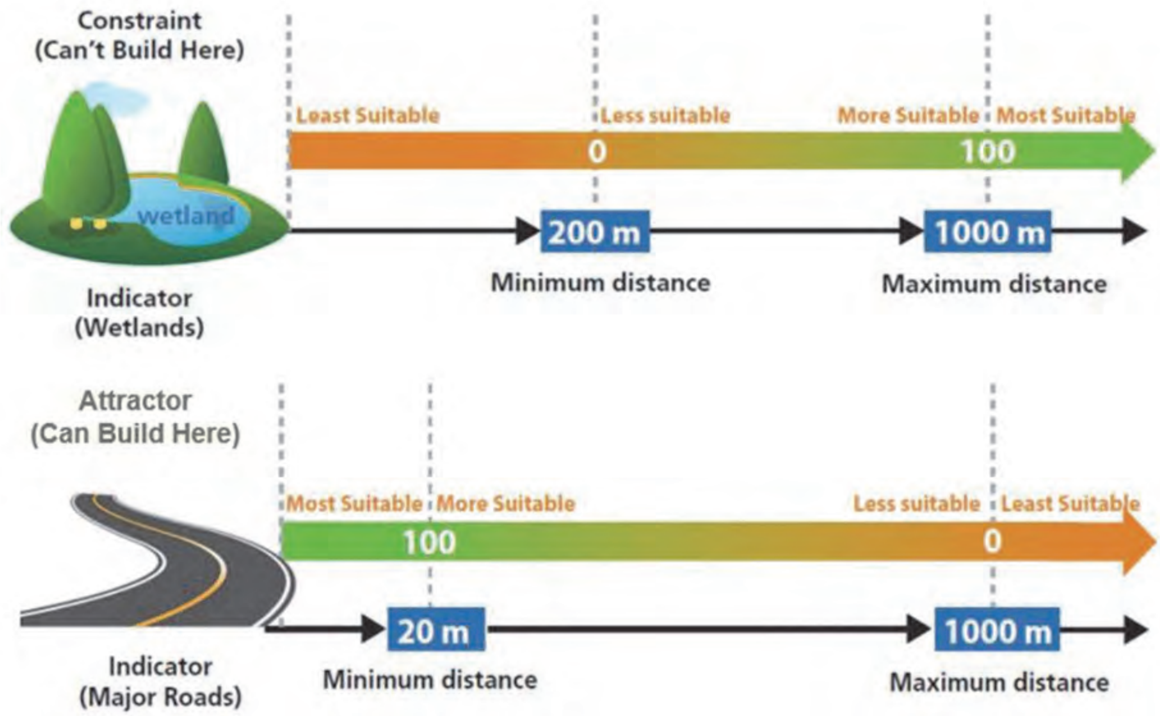


Figure 3: Criteria standardization between 0 (lowest suitability) and 100 (highest suitability), according to the proximity to existing features (Golder illustration)

Indicators are usually assigned to defined groups called **Dimensions**, which are closely linked to the notion of sustainability. Grouping indicators facilitates the assessment process and allows to speed up the assignment of relative weights, eliciting first the values of preferences within (indicator weights) and between groups (dimension weights). In case of a high number of criteria, **Themes** may be used within a dimension to group indicators that belong to the same discipline/aspect/concern. For example, within the Environmental dimension, themes may be introduced to group indicators representing Fauna, Vegetation, Water quality, Air quality, etc.

Additionally, being a spatially explicit multi-criteria analysis platform, GoldSET allows the rapid assessment of indicator-based **Scenarios**. Scenarios allow to simulate and evaluate different points of view or combinations of criteria that yield different site suitability outcomes and provide a measure of the sensitivity of the results to changing conditions. As such, GoldSET helps to balance conflicting priorities and stakeholder demands so that solutions can be optimized.

2.5 Weight assignment and Suitability mapping

The next phase of the process is the assignment of a weight to each indicator, to establish the extent to which they will influence the final evaluation. The aim of this phase is to build consensus among stakeholders on the relative contribution of the indicators to be evaluated and compared.

According to the hierarchical model that indicator grouping introduces (themes and dimensions), weights need to be elicited at each level of the decision framework. The final weight of an indicator is therefore the combination of weights of each level and expresses the overall relative importance that a given indicator has in identifying the optimal sites within the study area.

The weights assignment exercise is generally done by polling the preference of the participating stakeholders, first individually and as a group in a final review stage. Each stakeholder assigns a numerical value of importance (score) between 1 (lowest) and 100 (highest), according to their expertise, beliefs, values, professional judgment, or personal assessment. Once the scoring process is completed, the evaluations of all the participants are collected and averaged. All the assigned values are calculated for each indicator and then discussed with the stakeholders in order to confirm the evaluation as a group.

Once the final set of weights is determined, all the indicator maps are combined within GoldSET Spatial in order to create a single multicriteria "***Weighted Sum Suitability Surface***", a heat-map whose aim is to map the degree of suitability in the Study Area. The constraints are also combined together to form a single exclusion surface, called "***Constraint map***" (see Figure 12). This surface is overlaid to the result of the aggregation of indicators to obtain the overall "***Suitability map"***, that is the basis to support the identification of the best locations that satisfy the goals of the study.

3.0 SOLAR SITING STUDY

This chapter illustrates the application of the GoldSET framework to support the definition of suitable areas for the projects of the Solar programme, as stated in the scope of work. A series of workshops was organized with key stakeholders to accomplish the steps described in the Siting Methodology chapter and hereby summarized and presented.

3.1 Study goals

The study started with a multi-stakeholder Workshop carried out on May 29th, 2020 attended by representatives of institutions and subject matter experts; a total of 9 participants from Golder, MIE, EBRD, Tashko Pustina, DLA Piper, Guidehouse were involved in the initial exercise of articulating the study goals, illustrating the GoldSET approach and formulating a preliminary list of criteria.

The basis for this study is the development of justifiable criteria that reflect goals, priorities and/or considerations for ranking project sites at a national level. The aim of the project to find potential suitable areas to accommodate PV plants was confirmed during the Workshop and the following specific study goals were agreed upon:

- *Maximize solar energy production* (e.g. identify the areas with the highest amount of solar radiation).
- *Reduce regulatory complexity* (e.g. prefer locations in state-owned areas, to avoid lengthy expropriation practices; exclude areas already occupied by buildings).
- *Obtain social consent and license to operate.*
- *Minimize construction delays.*
- *Minimize costs (capital, operational).*
- *Favor constructability – ensure ease of connectivity to the existing grid* (e.g. exclude areas that are not easily accessible; prefer proximity to communication routes, which make the areas more accessible; prefer proximity to the network of electrical substations; prefer areas close to existing infrastructures, considered as possible end users of the energy produced).
- *Respect existing protection measures* (e.g. exclude protected cultural sites such as archaeological parks, castles, etc. or exclude areas of natural and environmental interest such as international/national protected areas - natural parks, etc.).

3.2 Data sources and data quality

In a GIS environment, the data used to build the criteria of the analysis are called layers and can be acquired in raster or vector format, according to the nature of the information they store. The collected data are then organized within a project geo-database and processed with GoldSET Spatial.

Regardless of the format, it is necessary to standardize all data to the same scale of measurement (suitability) and to the same spatial resolution. Datasets were therefore clipped to the Albanian national border, re-projected in a common geodetic reference system (WGS84 UTM 34N) and pre-processed as necessary.

The catalogue of data sources considered to develop the project database was the following:

- *Albanian State Authority for Geospatial Information (ASIG)*
- *United Nations Environment Program World Conservation Monitoring Center (UNEP-WCMC)*
- *Copernicus Land Monitoring Service (CLMS) - European Digital Elevation Model (EU-DEM)*
- *Corine Land Cover - Copernicus Land Monitoring Service (CLMS)*
- *Global Solar Atlas*
- *OpenStreetMap/GeoFabrik*
- *World Database on Protected Areas (WDPA)*
- *Council of Europe – European Environmental Agency*
- *Joint Research Center (JRC)*
- *Transmission System Operator (OST)*
- *Agency Territorial Development (ATD)*

Having to deal with the challenging task of data collection regarding a wide variety of sustainability issues covering the national territory, the first attempt was to collect information from the Albanian State Authority for Geospatial Information (ASIG). Through its geoportal ASIG allows the consultation of an exhaustive national geospatial database. Unfortunately, we were not allowed to source the requested data in time for processing with GoldSET Spatial. Therefore, the above-mentioned alternative data sources were identified and used in the analysis.

In some cases, datasets did not have a proper resolution (e.g., critical habitat data from UNEP-WCMC and Corine Land Cover). In other cases, there was a significant level of uncertainty which allowed to use an available data source only for preliminary analyses (such as the case of Global Solar Atlas). Finally, metadata were sometimes missing, and it was not possible to validate the content and to assess the overall quality of the data (this is the case of OpenStreetMap and ATD). Nevertheless, whenever a data source is attributed to a national entity or the operator of national assets (e.g. OST), the dataset received was deemed authoritative and added to the project database.

From an overall quality assessment, it is possible to state that the datasets used provide a reasonable degree of representativity to the criteria adopted at the scale of the study.

A more detailed description of each data source is hereby presented, inclusive of considerations about data quality.

- **United Nations Environment Program World Conservation Monitoring Center (UNEP-WCMC)**

This source was used to collect data about critical habitats. UNEP provides a Critical Habitat raster layer that draws from 20 global-scale datasets, 12 of which support screening of critical habitats in the terrestrial realm. The raster layer stores in a grid cell (1x1 km) the likely or potential presence of a critical habitat. Temporal reference is 2017.

- **Copernicus Land Monitoring Service (CLMS) - European Digital Elevation Model (EU-DEM)**

This is a source of topographic data used to characterize unsuitable terrains. Digital Elevation Models (DEMs) provide fundamental information that is required across a broad set of application areas, each with different technical and usage requirements. The EU-DEM was developed in response to an urgent need for continent-wide elevation data at 1 arc-second (approximately 30m x 30m) posting, and at an overall vertical resolution of approximately 5m. Temporal reference is 2011.

- **Corine Land Cover - Copernicus Land Monitoring Service (CLMS)**

This source was used to collect data about land use. The Corine Land Cover (CLC) inventory was initiated in 1985 (reference year 1990). Updates have been produced in 2000, 2006, 2012, and 2018. It consists of a GIS layer representing land cover in 44 classes. CLC uses a Minimum Mapping Unit (MMU) of 25 hectares (ha) for areal phenomena and a minimum width of 100 m for linear phenomena.

The CLC layer was used to extract information about critical facilities, recreation areas and other areas unsuitable for locating a solar project (such as dunes or beaches).

- **Global Solar Atlas**

Global Solar Atlas has been implemented by the World Bank Group to provide a series of global, regional and country GIS data layers and poster maps, with the aim of supporting the scale-up of solar power plants. The objective of the Global Solar Atlas is to provide reliable introductory-level data to help policymakers, researchers, and commercial solar companies to take better decisions. For project-specific analysis of large power plants, the data available via the Global Solar Atlas is suitable for preliminary analysis only.

The Global Solar Atlas was used to extract data about the average solar irradiance and the potential photovoltaic power generation based on a 25 years observation period (1994-2018).

- **OpenStreetMap/GeoFabrik**

Open Street Map is a collaborative project to create a free editable map of the world, making available free and community-maintained data. Through GeoFabrik portal it is possible to extract county specific GIS layer. Data has no associated metadata (this information is available to OpenStreetMap contributors only).

Data about Albanian transportation system (roads and railways) was collected from this source.

- **World Database on Protected Areas (WDPA)**

The WDPA is the only global database of protected areas, underpinning Protected Planet. Protected Planet is a joint product of UN Environment and IUCN, managed by the UN Environment Programme World Conservation Monitoring Centre (UNEP -WCMC). The WDPA is compiled in collaboration with a wide range of governmental and non-governmental organizations which submit protected area data to UNEP-WCMC. Data in WDPA must meet the WDPA data standards which guarantees, among other quality issues, that IUCN definitions are met, and source of information is provided.

- **Council of Europe – European Environmental Agency**

This source provided data about the Emerald Network of Areas of Special Conservation Interest. Its implementation was launched by the Council of Europe as part of its work and its objective is the long-term survival of the species and habitats of the Bern Convention requiring specific protection measures. Sites for Albania are included in the list of Emerald Network Candidate Sites which is based on the most recent data release delivered on the Central Data Repository (CDR) managed by the European Environment Agency. It contains newly nominated sites and previously nominated candidate sites (last updated in December 2019).

- **Joint Research Center (JRC)**

The Joint Research Centre (JRC) is the European Commission's science and knowledge service which employs scientists to carry out research to provide independent scientific advice and support to EU policy.

JRC Data Catalogue supplied the following data: Global Water Surface, Global Human Settlements, and the European Landslide Susceptibility Map.

Global Surface Water provides information on data collected over a 35 years period, using remote sensing tools. This dataset includes rivers and lakes. The Global Surface Water dataset also provides some ‘metadata’ information which are statistics on the overall number of water detections, number of observations and valid observations that are present in the 1984-2018 period.

Global Human Settlements depicts the distribution and density of population, expressed as the number of people per cell (grids of 250 m and 1 km of spatial resolution). The correspondent GIS layer is part of the data package 2019 that contains the new GHSL data produced at the European Commission Directorate.

European Landslide Susceptibility Map shows landslide susceptibility levels at European scale, derived from heuristic-statistical modelling of main landslide conditioning factors also using landslide location data. The map has a 200 m resolution, and it was released in 2018.

- **Transmission System Operator (OST)**

The transmission system of electricity in Albania is operated by the Transmission System Operator (OST) that provided detailed data about existing substations. This dataset had no associated metadata. However, considering that we received these data directly from OST, we assumed no issues regarding data quality, accuracy and update.

- **Agency of Territorial Development (ATD)**

Agency of Territorial Development carries out the functions of the technical secretariat of the National Council of Territory (NCT).

This source allowed the collection of water surface, historic resources, critical facilities (caves, TAP, wind farms, industrial areas), airports, urban areas. This dataset had no associated metadata concerning accuracy, last update, and quality.

3.3 Dimensions and criteria selection

During Workshop #1 (May 29th, 2020) the participants worked on the preliminary list of criteria (constraints and indicators), which were selected to reflect the key decision criteria and goals upon which the assessment is based.

As described in section 2.4, in order to simplify the evaluation process, the indicators were aggregated within three dimensions: Environmental, Social, and Technical. Golder was tasked to develop the indicators using available geographic data (see section 3.2), so all the criteria consistently refer to the spatial dimension.

Environmental dimension

This group of indicators encompasses various environmental characteristics and values that occur within the Study Area. The general aim of this dimension is to minimize and/or avoid potential negative effects to sensitive environmental factors and natural areas which must be monitored and safeguarded. According to this rationale, zones farther from natural areas are prioritized for site selection.

In this context, indicators in this dimension address the following goal:

- *Respect existing environmental protection measures*.

Social dimension

This group identifies the human presence in the territory and its related aspects, taking into consideration the regional and local priorities and concerns with respect to risks and perceived nuisance factors (e.g. dust, noise, increased traffic). As an example of indicator, areas not proximal to existing settlements are prioritized for site selection.

In this context, indicators in this dimension address the following goals:

- *Reduce regulatory complexity*
- *Obtain social consent and license to operate*
- *Favor constructability – ensure ease of connectivity to the existing grid.*

Technical dimension

This dimension reflects considerations with respect to the technical characteristics and performances or requirements of the project; satisfying these criteria will also positively affect the economic dimension. These indicators are related to infrastructure elements such as rail lines, transmission lines, road access, industrial areas. Generally, areas closer to important infrastructures are prioritized for site selection.

In this context, indicators in this dimension address the following goals:

- *Maximize solar radiance availability (for a Solar Plant Project)*
- *Reduce regulatory complexity*
- *Minimize construction delays*
- *Minimize costs (capital, operational)*
- *Favor constructability – ensure ease of connectivity to the existing grid*.

As a result of the criteria selection, 23 criteria were selected (Table 1, Table 2 and Table 3), 6 belonging to the Environmental, 6 to the Social and 11 to the Technical dimension. Among these, a total of 11 constraints was identified, respectively 2 Environmental, 3 Social and 6 Technical. A *constraint* map showing the no-go areas (simple overlap of all available constraints) was derived to identify unsuitable locations (Figure 12).

Table 1: Selected indicators and constraints summary

Dimensions	Indicators no.	Constraints no.
Environmental	4	2
Social	3	3
Technical	5	6

The Indicators Workbook, reported in APPENDIX A, was prepared as a communication tool and used during the workshops to show the progress of the study and to facilitate the review process.

The indicators workbook is the project criteria catalog that details the data sources and the process applied to develop every criterion used in the siting analysis. It lists constraints and indicators classified per sustainability dimension and provides name, objective, data source and data provider, data processing (filtering, buffering, etc.) any comment or description available and a map of the study area overlapped by the spatial representation of the criteria.

A sample of workbook page is reported here below.

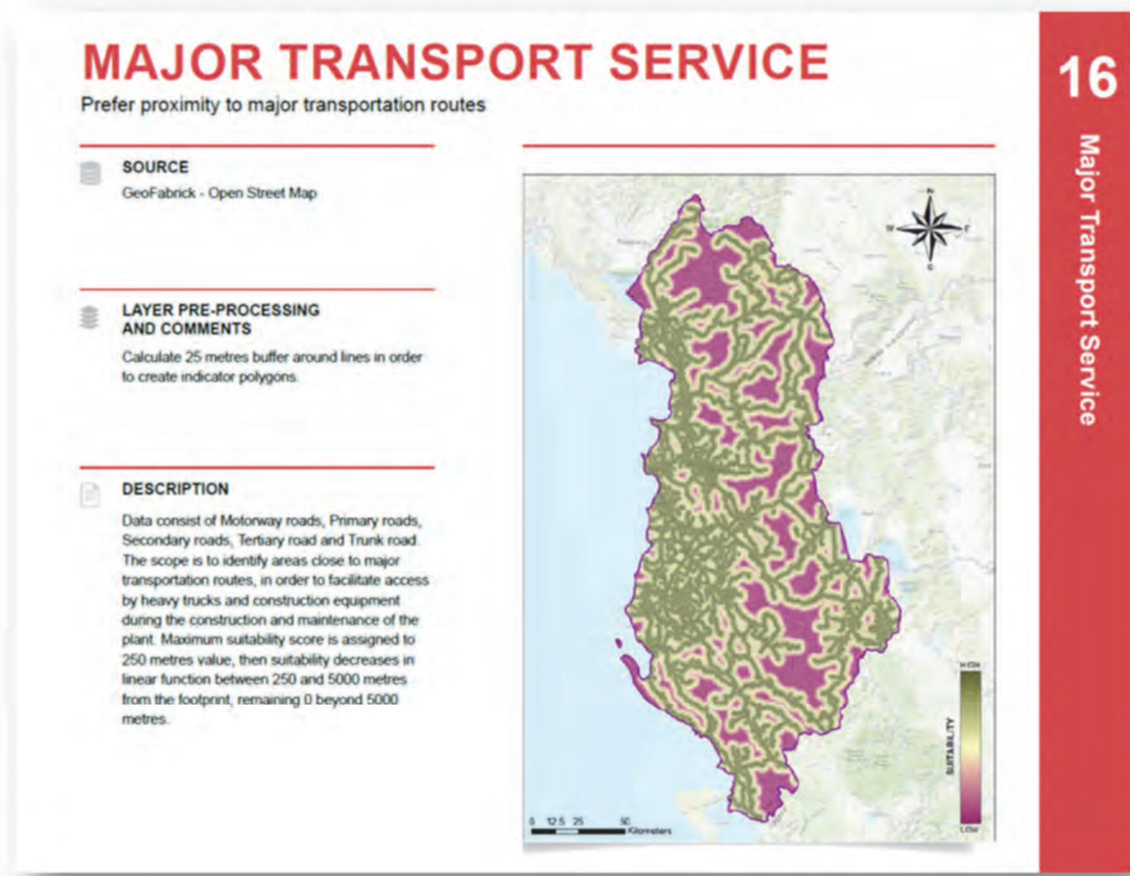


Figure 4: Indicators workbook sample page

Table 2: List of constraints, identified during the decision framework definition

Dimensions	Constraints (NO-GO areas)
ENVIRONMENTAL	**Critical Habitat Constraint** Avoid areas identified as critical habitat (footprint + 250m buffer)
	Protected Areas Constraint Avoid protected areas (footprint)
SOCIAL	**Historic Resources Constraint** Avoid historic resources sites (footprint)
	Recreation Areas Constraint Avoid green urban areas and leisure centres (footprint + 250m buffer)

Dimensions	Constraints (NO-GO areas)
	Urban Constraint Avoid built-up areas (footprint)
	Airports Constraint Avoid airports (footprint)
TECHNICAL	**Critical Facilities Constraint** Avoid industrial and commercial areas, harbours, landfills and dumps, quarries, wind farms (footprint)
	Major Transport Service Constraint Avoid footprint of major roads (footprint + 250m buffer)
	Railway Constraint Avoid railway tracks (footprint)
	Unsuitable Areas Constraint Avoid difficult terrain (footprint)
	Water Surface Constraint Avoid water surfaces (footprint)

Table 3: List of indicators, identified during the decision framework definition

Dimensions	Indicators
ENVIRONMENTAL	**Critical Habitat** Minimize proximity to Critical Habitats
	Geohazard Minimize use of areas potentially affected by geohazards
	Protected Areas[2] Minimize proximity to protected areas
	Water Surface Minimize proximity to water surface
SOCIAL	**Critical facilities** Prefer proximity to critical facilities areas
	Historic Resources Minimize proximity to historic resources areas
	Population density Avoid highly populated areas
TECHNICAL	**Airports** Minimize proximity to airports
	Major Transport Service Prefer proximity to major transportation routes

[2] Protected areas considered are those of IUCN Categories: “Strict Nature Reserve (Category I IUCN), “National Park” (Category II IUCN), “Nature Monument” (Category III IUCN), “Managed Nature Reserve” (category IV IUCN), “Protected Landscape” (Category V IUCN), “Resource Reserve” (Category VI IUCN), along with the “Ramsar Site, Wetland of International Importance”, “Specially Protected Areas of Mediterranean Importance (Barcelona Convention)”, “World Heritage Site (natural or mixed)”.

Dimensions	Indicators
	Solar irradiance Prefer areas with high solar irradiance
	Substations Prefer proximity to substations
	Unsuitable terrain (slope) Avoid steep slopes

3.4 Weight assignment

The weighting process of the selected criteria was carried out during Workshop 1 (May 29th, 2020), in accordance with the methodology described in Section 2.5, by taking into consideration the level of preference/importance (from 1, less important, to 100, more important) assigned by stakeholders. The assigned importance was used to calculate the aggregate average score for each indicator.

The average scores were used to derive the indicators' relative weight that expresses, in percentage terms, to what extent the criterion will influence the final evaluation within its dimension. Dimensions could be also weighted, skewing the results towards more technical, environmental, or social scenarios, where the overall relative weight of an indicator would be affected also by the weight assigned to the dimension. In this study, scenarios based on the influence of dimensions were not developed.

In the following figures (Figure 5, Figure 6 and Figure 7) the set of weights agreed upon, through consensus, during Workshop 1 are presented.

Considering the Environmental dimension, the "Protected areas" indicator is valued the most important with an average score of 96.7. The "Historic resources" criterion has the highest value within the Social group, while the most influential criterion within the Technical group is the "Solar irradiance" with an average score of 99.6.

On the other hand, the indicators based on proximity to respectively "Water surface", "Urban facilities" and "Airports" are the least influential criteria, for Environmental, Social, and Technical dimension.

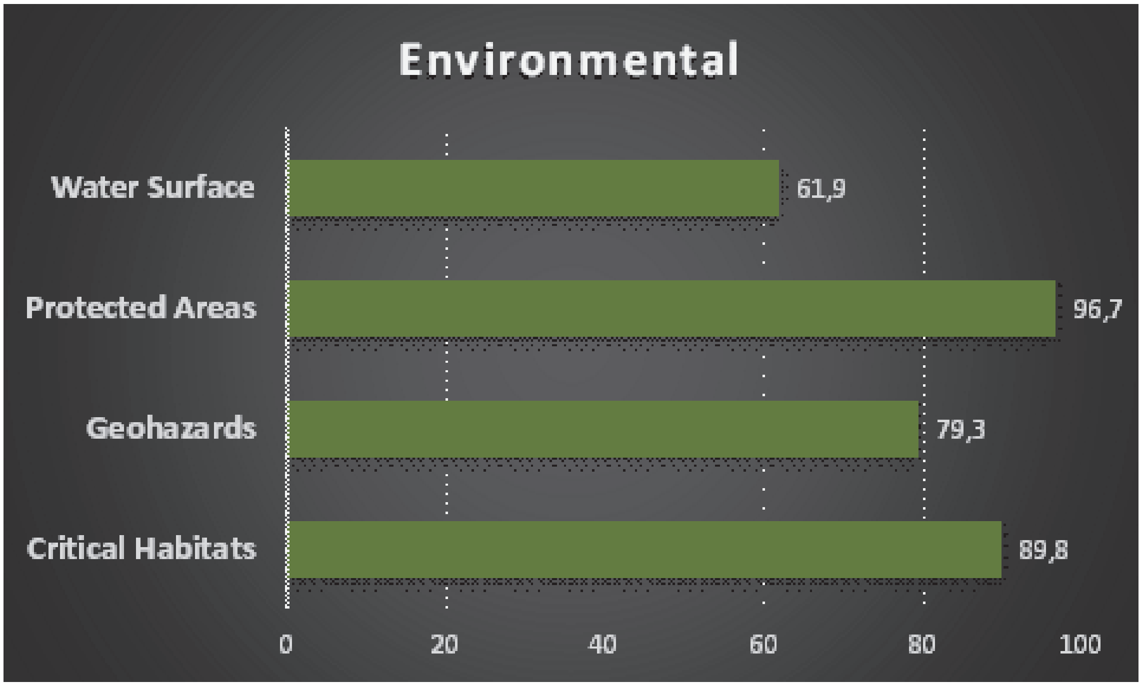


Figure 5: Environmental indicators weights

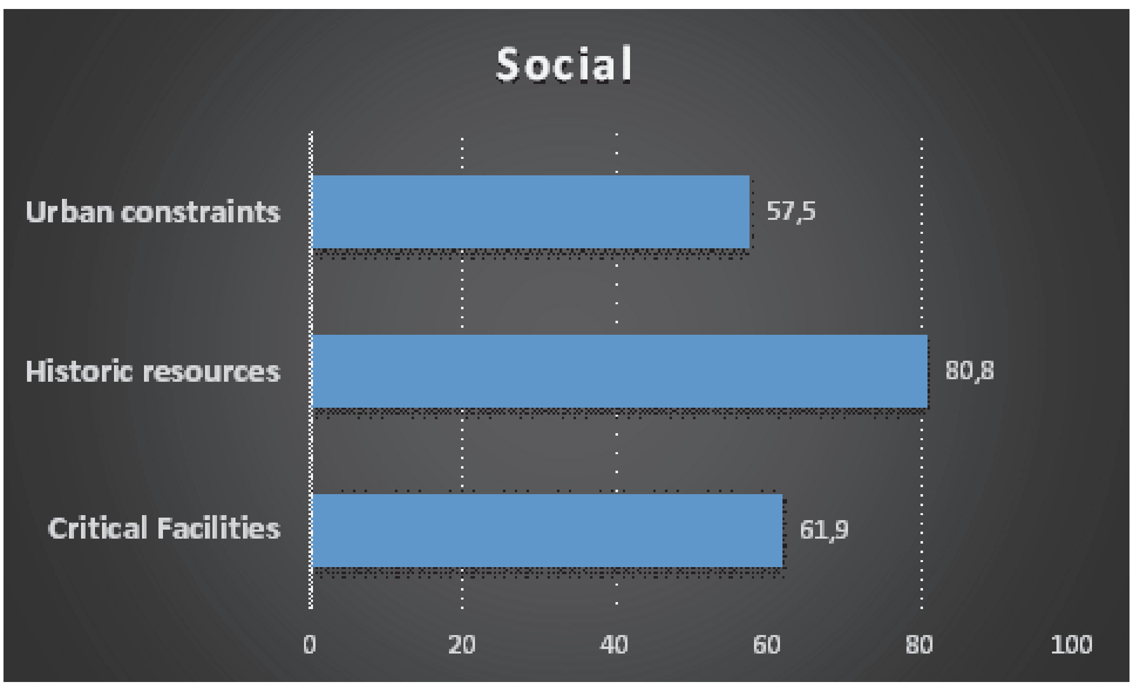


Figure 6: Social indicators weights

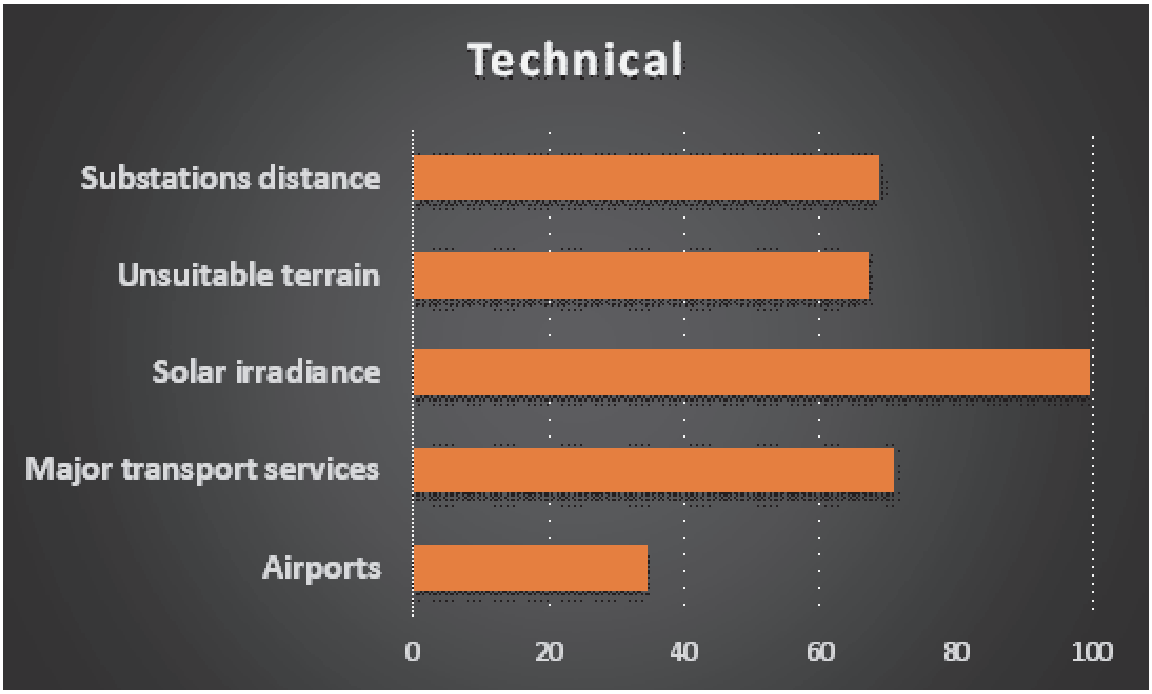


Figure 7: Technical indicators weights

3.5 Suitability mapping

All the indicators with their weights were combined within GoldSET Spatial to create the single multicriteria "***Weighted Sum Suitability Surface***". The constraint criteria were also combined to form the "***Constraints Surface***" (shown in Figure 10) and subtracted from the result of the aggregation of indicators to obtain the overall "***Suitability Surface***" (Figure 11 and APPENDIX B).

The Suitability Surface is usually represented as a heat-map whose cell values express, through a cumulative surface, the suitability degree of the Albanian territory for the installation of a Solar Plant.

The Suitability Surface is derived by a weighted combination of the indicators listed and mapped in APPENDIX A (Indicators workbook). Prior to the aggregation, each indicator was standardized according to predefined functions. For instance, the solar irradiance indicator was transformed by a linear stretch function between the minimum and maximum values of estimated photovoltaic power generation potential available for the country, rescaling the indicator to a continuous suitability range from 0 to 100. The minimum potential for the country is assigned the value of 0 (least suitable location), the maximum potential available for the country obtains a value of 100 (most suitable location). For the protected areas indicator, the footprint is a no-go area (Protected Areas Constraint), the locations within a distance of 500 m have a value of 0 (least suitable locations), suitability then increases linearly between 500 and 2000 meters from the footprint up to the most suitable value of 100. All locations above 2000 meters from the protected areas footprints are assigned a suitability value of 100, with the rationale that at such a distance no negative effect will occur.

All indicators were combined within their dimension according to the weights assigned during the workshop. The dimensions have been considered to have the same importance, so the weight assigned is the same for environmental, social and technical. Combining standardized indicators (0-100 continuous scale) and applying the relative weights according to the following table (Table 4), the final result is a multicriteria suitability surface with values ranging between 0 and 100.

Table 4: List of dimensions, indicators and relative weights

Dimension	Dimension Weight	Indicator	Importance (Workshop)	Relative WEIGHT
Environmental	0.33333	CRITICAL HABITATS	89.8	27.4
		GEOHAZARDS	79.3	24.2
		PROTECTED AREAS	96.7	29.5
		WATER SURFACE	61.9	18.9
Social	0.33333	CRITICAL FACILITIES	61.9	30.9
		HISTORIC RESOURCES	80.8	40.4
		POPULATION DENSITY	57.5	28.7
Technical	0.33333	AIRPORTS	34.6	10.1
		MAJOR ROADS	70.9	20.8
		SOLAR IRRADIANCE	99.6	29.2
		SLOPE	67.2	19.7
		SUBSTATIONS	68.7	20.1

3.6 Suitable areas identification and benchmarking

The suitability surface and its set of underlying criteria are tools to support in the identification and characterization of suitable areas for a specific objective, in our case the installation of a solar power plant.

To identify a list of suitable areas for the installation of a PV plant for the entire country, a set of characteristics and requirements have to be specified to perform the site aggregation analysis. These requirements usually include a minimum extent, directly correlated with the capacity of the photovoltaic plant in megawatt (MW), a suitability value threshold, land ownership data (e.g. derived from digital cadastral maps), co-location of sites, etc.

Land ownership is often a crucial variable that drives the choice of the available sites. Land could be state owned or private, contained in a single parcel or fragmented in many parcels, owned by a single vendor or associated to many different ownerships. The Suitability map is the ideal tool to characterize the different candidate areas and assist in the choice of the best site(s), facilitating the decision makers in the comparison, highlighting the main challenges, benefits, and drawbacks according to the project requirements.

If digital parcel maps are not available, as in this study, the Suitability map can drive a hypothetical identification of sites, still based on a multicriteria approach. On the other hand, if the information of the plant size and geometric configuration is available as a requirement, GoldSET can help identify a site that trades off those spatial requirements (size, shape and orientation) with the highest suitability.

To illustrate the process of identifying suitable areas and the use of summary statistics to rank and characterize the results, we applied two selection criteria: a minimum suitability threshold and a minimum size of 140 hectares, simulating the location of a new photovoltaic plant of 140 MW like the Voltalia Karavasta Solar Park (1 MW requires as a minimum 1 ha of land or more, depending on the panels technology).

Using a minimum suitability threshold value of 75, we extracted the locations (pixels) corresponding to the most suitable quartile (Figure 12 and APPENDIX C). Based on their adjacency, these locations were aggregated in polygons and then characterized and ranked according to the average performance in the multicriteria suitability surface, in every dimension and for each indicator. The resulting set includes around 350 areas of at least 140 hectares for a total of 161.292 hectares of land with a high degree of suitability to locate a solar power plant.

As an example of these metrics, we extracted the top 10 areas according to the average suitability, 2.835 hectares in total. Table 5 shows the performance and related ranking in the Environmental, Social and Technical dimensions. The selected areas are also presented as maps in APPENDIX D.

Table 5: Performance of the top 10 suitable areas.

Suitability Rank	Area Code	ha	Overall Suitability	ENV Suit	SOC Suit	TEC Suit	ENV RANK	SOC RANK	TEC RANK
1	16675	304,0	93,6	98,1	95,6	87,2	**1**	**5**	**1**
2	34751	602,9	89,8	90,4	97,2	81,9	**4**	**4**	**8**
3	33651	468,1	89,7	92,3	92,1	84,6	**2**	**9**	**5**
4	31618	382,6	89,2	87,6	94,6	85,3	**5**	**7**	**4**
5	31583	140,3	88,7	81,1	98,1	86,7	**10**	**3**	**2**
6	7465	160,7	88,4	92,1	90,1	83,1	**3**	**10**	**6**
7	35840	154,5	88,3	84,1	100,0	80,9	**8**	**1**	**9**
8	31264	260,4	88,0	84,0	94,3	85,6	**9**	**8**	**3**
9	37098	221,0	87,8	85,4	99,5	78,6	**6**	**2**	**10**
10	31790	140,4	87,6	84,7	95,5	82,6	**7**	**6**	**7**

Within this sample set, the most suitable area (Area code 16675, 304 ha) has the best performance also in the environmental and technical dimensions but is only 5th in the social rank. The second area in terms of overall suitability (602,9 ha) ranks 4th in environmental and social, 8th in technical. Even if we are dealing with high values of suitability, these metrics demonstrate that the best solution is often a tradeoff among the environmental, social and technical criteria (Figure 8).

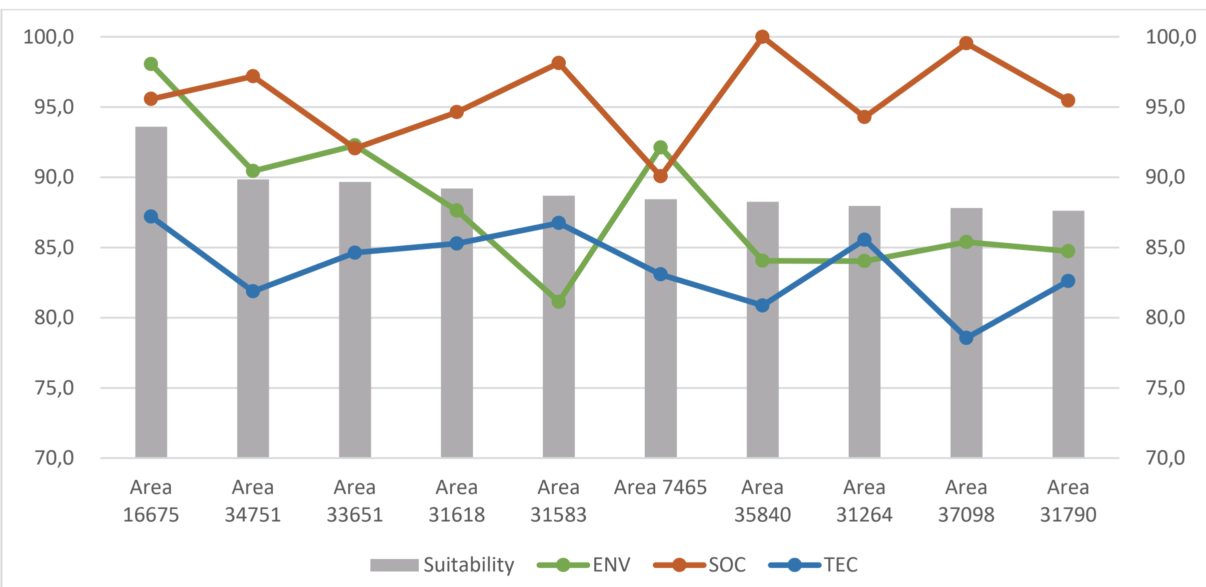


Figure 8: Suitability and dimensions performance of top ten suitable areas.

A candidate site or area performance can also be presented using a three dimensional radar chart (Figure 9). It is noticeable that the top three sites do not have a great absolute performance in the technical dimension with values ranging from 81.9 (area 34751) to 87.2 (area 16675). This type of chart helps appreciate the balance or skewness of performance of each area in the dimensions of the analysis.

Figure 9: Areas performance in the three dimensions (top three candidate areas).

Drilling further down to analyze the performance of the selected areas, benchmark statistics may be derived for each criterion/indicator considered in the suitability analysis (see Table 6). It is interesting to notice the weak performance of the indicator evaluating the distance from the airports ("airports" column in the table) even within this set of areas with the highest suitability. This is the result of the weights assessment where the indicator has been assigned the overall lowest contribution (weight) for the suitability analysis. All the indicators that have been assigned a relatively high score (historic resources, critical facilities, protected areas) perform well in the most suitable areas.

Table 6: Performance of the top suitable areas by indicator

Area Code	ha	Suitability	CRITICAL HABITAT	GEOHAZARD	WATER SURFACE	PROTECTED AREAS	CRITICAL FACILITIES	HISTORIC RESOURCES	POPULATION DENSITY	AIRPORTS	MAJOR ROAD	SLOPE	SOLAR IRRADIANCE	SUBSTATIONS
16675	304	93,6	100,0	100,0	89,7	100,0	86,0	100,0	99,7	12,9	93,3	100,0	94,4	95,4
34751	602,9	89,8	100,0	89,8	85,2	85,4	91,7	99,6	99,8	1,7	87,9	100,0	85,6	93,1
33651	468,1	89,7	96,5	100,0	64,5	99,8	82,8	93,5	100,0	6,1	94,4	100,0	95,6	83,1
31618	382,6	89,2	100,0	50,0	98,6	100,0	82,6	100,0	100,0	17,7	90,1	100,0	93,0	88,8
31583	140,3	88,7	100,0	50,0	64,2	100,0	94,2	100,0	99,7	16,1	93,5	100,0	93,0	93,3
7465	160,7	88,4	99,7	100,0	58,7	100,0	67,9	100,0	100,0	3,1	95,3	100,0	86,0	90,0
35840	154,5	88,3	100,0	100,0	15,6	100,0	100,0	100,0	100,0	2,3	87,1	100,0	84,9	89,5
31264	260,4	88,0	100,0	50,0	79,5	100,0	81,6	100,0	99,9	18,1	92,6	100,0	93,0	87,3
37098	221	87,8	100,0	100,0	22,9	99,8	98,5	100,0	100,0	5,5	83,0	100,0	84,0	81,9
31790	140,4	87,6	100,0	99,6	19,7	100,0	85,6	100,0	99,7	0	93,9	99,3	87,3	89,5

As a final consideration, the exemplary screening of suitable areas described in this paragraph, especially for analyses performed at Country level, is a useful first step to guide follow-up activities and provide developers of solar facilities with an initial set of location where a more detailed site selection can be performed.

Local factors and conditions pertaining to weather, flood risks, site preparation, etc. require data of appropriate spatial resolution and will need to be considered to further optimize the performance of the site and ultimately the plant itself.

It should be therefore noted that the presentation of this set of 10 areas is of illustrative value of the possible steps leading to prioritizing areas. Given the importance of ownership information (i.e. cadastral data) in the area delineation process, these results should therefore be treated within the exemplary context that they have been developed and not interpreted as a finalized list of candidate areas.

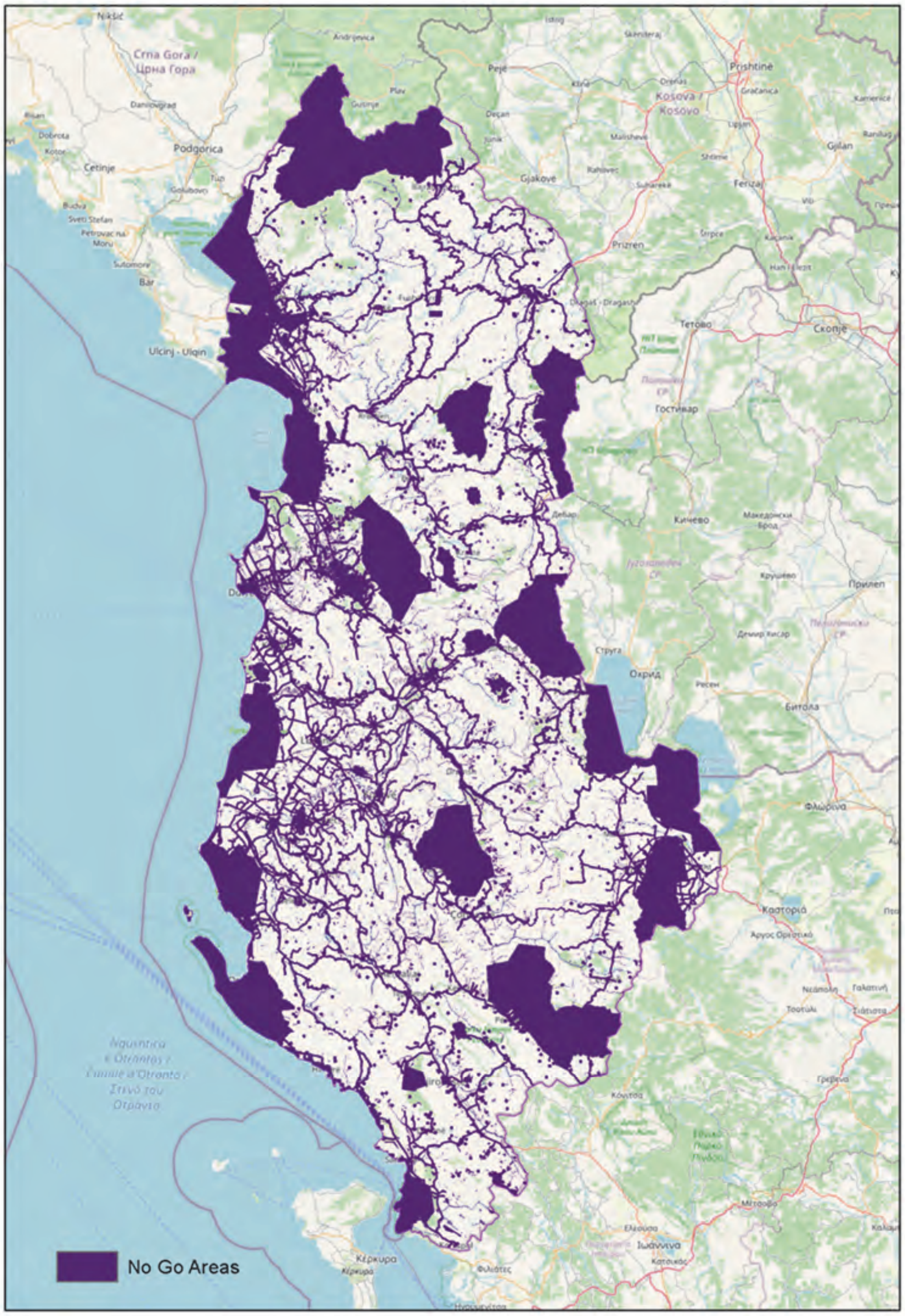


Figure 10: Constraints map for solar plant siting

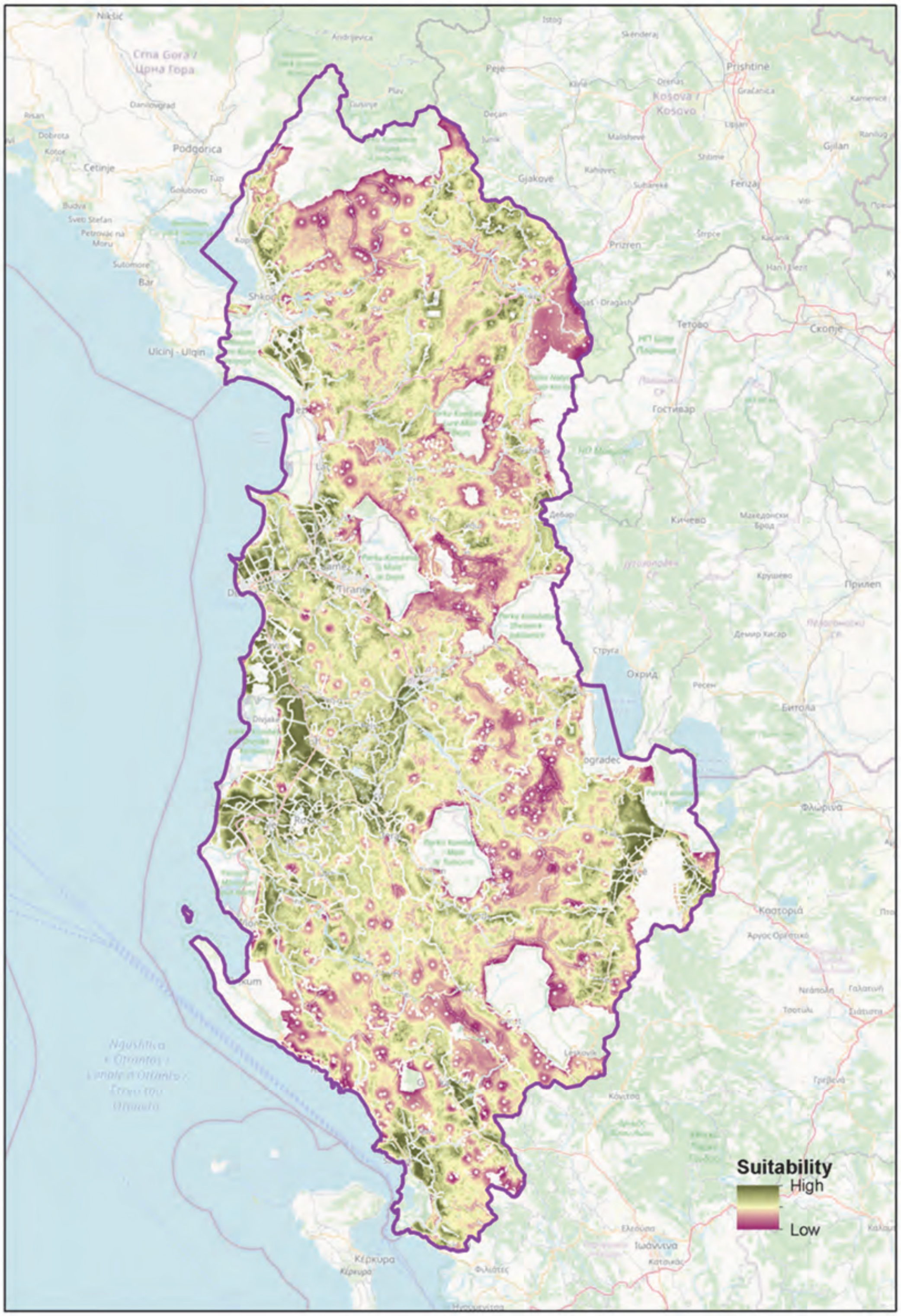


Figure 11: Suitability map for solar plant siting

Figure 12: Areas above 75% of suitability for solar plant siting

3.7 Applications of the siting framework

The suitability framework adopted in this study and the deliverables produced may be leveraged at different stages and by multiple stakeholders involved in the solar development program.

From the perspective of authorities involved in the permitting process, the framework provides a systematic, transparent, repeatable workflow that follows a consolidated and consistent methodology. The present study represents an initial snapshot in time, dependent on the release date of the datasets utilized to perform the study; maintaining the proposed workflow, authorities are in a position of updating on a regular basis the suitability products once the underlying datasets are updated. In this respect, the suitability framework may play the role of a tool rather than a point in time result of an analysis.

On the other end, developers, interested in investing in Albania, may base their proposed bids on a guiding geographic dataset that allows them to pre-screen projects from a series of environmental, social and technical aspects, reducing the risks of project feasibility and informing them on the permitting consequences of siting choices they make. The suitability mapping products would allow developers to focus their attention to locations that combine favorable resource availability conditions with lower levels of interference with existing regulatory, social or technical conditions or requirements.

Adopting the framework on both sides (authorities and developers) would therefore have a beneficial effect on the interplay between the parties streamlining the process, speeding up the solar program development and bringing more efficiency and clarity to the overall process.

Finally, public participation processes as well as investment risk assessments would be better informed by a nationally adopted workflow and well documented spatial datasets.

4.0 CONCLUSIONS

A comprehensive geographic dataset was compiled to carry out this study at Country level covering the territory of Albania. A combination of national, regional and global datasets was assembled to build the set of criteria (indicators and constraints) required to perform the multicriteria siting analysis. The best available information was included, based on data availability, data quality and metadata information. The final choice does not always correspond to the most accurate or the highest resolution, given that some data sources were not made available by data owners despite multiple attempts. The data sources and associated metadata were recorded and presented in a catalog of indicators (Indicator Workbook), documenting the data source and its usage to derive decision criteria included in the analysis process.

Based on the available data at the time of execution of this study, the Suitability map was used to extract the most suitable areas to accommodate one or more plants according to a pre-defined suitability threshold and area requirements.

Typically, siting projects start from the availability of land parcels, (state or privately owned), that cover a contiguous area required to allocate the number of panels needed for the planned PV plant size. Statistics based on the multicriteria Suitability map and on selected key indicators then facilitate the comparison among the different candidate parcels, highlighting the main challenges, benefits, and drawbacks. In this case a set of parcels could not be preselected, but the information of the plant size and geometric configuration is available.

Candidate sites were therefore identified using the multicriteria surface and the GoldSET tool allows to search for the most suitable site that meets the spatial characteristics of minimum size, shape and orientation. This allowed to identify about 350 sites with an area of at least 140 hectares (minimum for the production of 140 MW, selected as a reference) for a total of 161.292 hectares of land with a high degree of suitability to setup a solar power plant. All these areas have been characterized according to the statistics based on the multicriteria suitability, the environmental, social and technical dimensions and to the complete set of indicators. The performance of a selection of the most suitable areas has been illustrated and commented using tables, intuitive graphics and diagrams.

The Suitability map and the complete set of candidate areas are provided as GIS files. These deliverables are available to be used for a more in-depth analysis to locate the most reliable areas where siting a Solar Power Plant will ideally meet and best trade-off the goals of sustainability, allowing the possibility of choosing either the best or one of the best or the most acceptable solution.

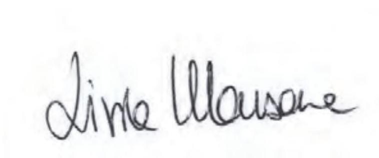
The adopted criteria are deemed adequate for the scale of the Study so that the suitable areas proposed can be considered a reliable screening to guide follow-up activities where a more detailed site selection can be performed by adding local data at an appropriate resolution to address local factors and conditions.

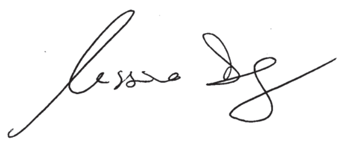
Leveraging this analysis framework both on the side of authorities as well as by the developers has the potential of streamlining the solar program, bringing more efficiency and clarity to the overall process.

In conclusion, Multicriteria analysis and Suitability mapping are an effective methodology to support the choice of candidate areas, facilitating developers of solar facilities ,policy makers, professionals and financial institutions in the comparison and ranking of selected sites and ultimately streamlining the permitting process of development projects.

Signature Page

Golder Associates S.r.l.





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APPENDIX A

WORKBOOK - EBRD Albania Solar Project - Siting Evaluation

WORKBOOK

EBRD
Albania Solar Project

Siting Evaluation

GOLDER

European Bank

GoldSETSpatial

ENVIRONMENTAL

Indicators

01 . Critical Habitat

02 . Critical Habitat Constraint

03 . Geohazard

04 . Protected Areas

05 . Protected Areas Constraint

06 . Water Surface

CRITICAL HABITAT

Minimize impact to Critical Habitat

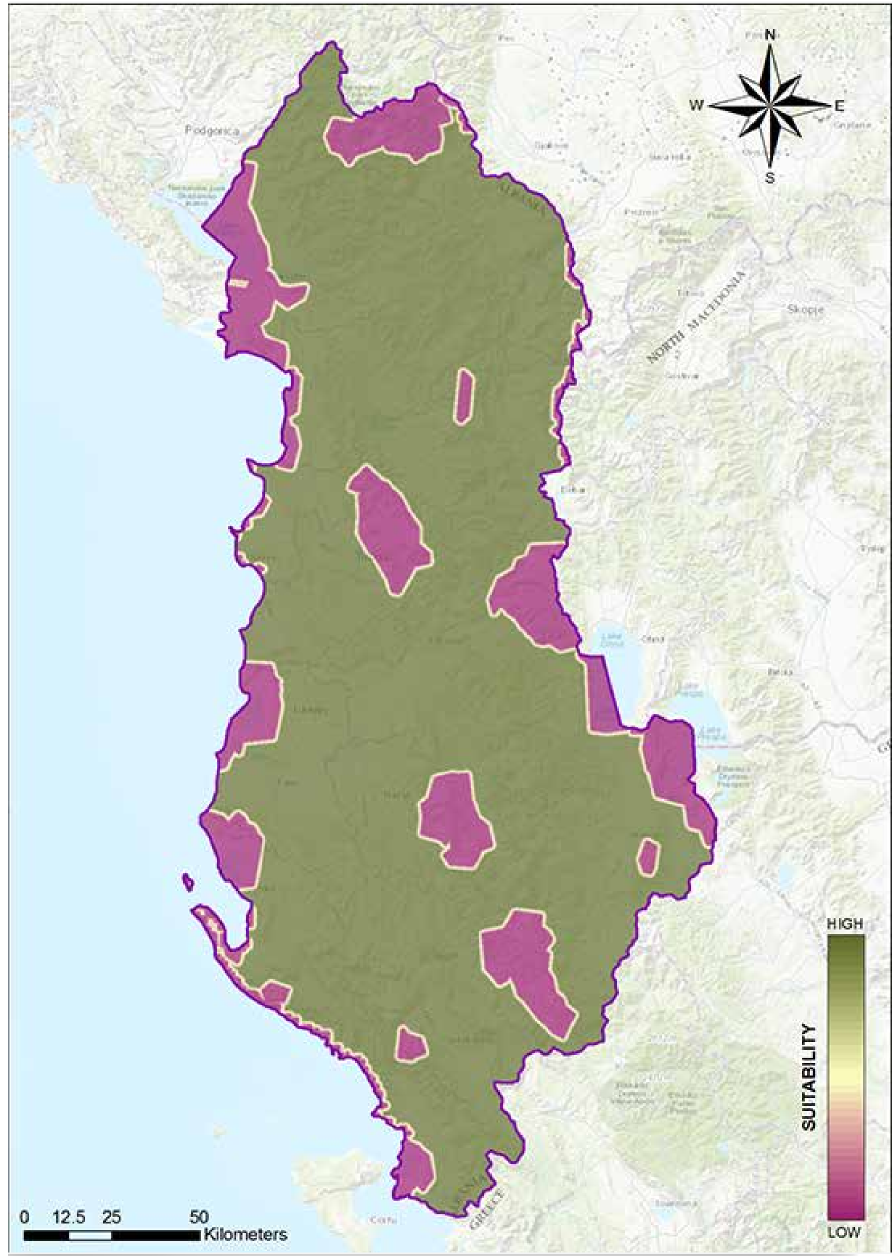
SOURCE

UN Environment Programme World Conservation Monitoring Center (UNEP - WCMC)

LAYER PRE-PROCESSING AND COMMENTS

DESCRIPTION

Data consist of areas of likely or potential Critical Habitat as defined by the International Finance Corporation Performance Standard 6 (IFC PS6). The areas are identified based on the presence of threatened and endemic species, concentrations of migratory or congregatory species, unique and threatened ecosystems, evolutionary processes and other key biodiversity feature. The suitability is 0 at a buffer of 250 metres from the footprint, then increases with linear function to 100 at 2km and above.



CRITICAL HABITAT CONSTRAINT

Avoid areas identified as critical habitat

SOURCE

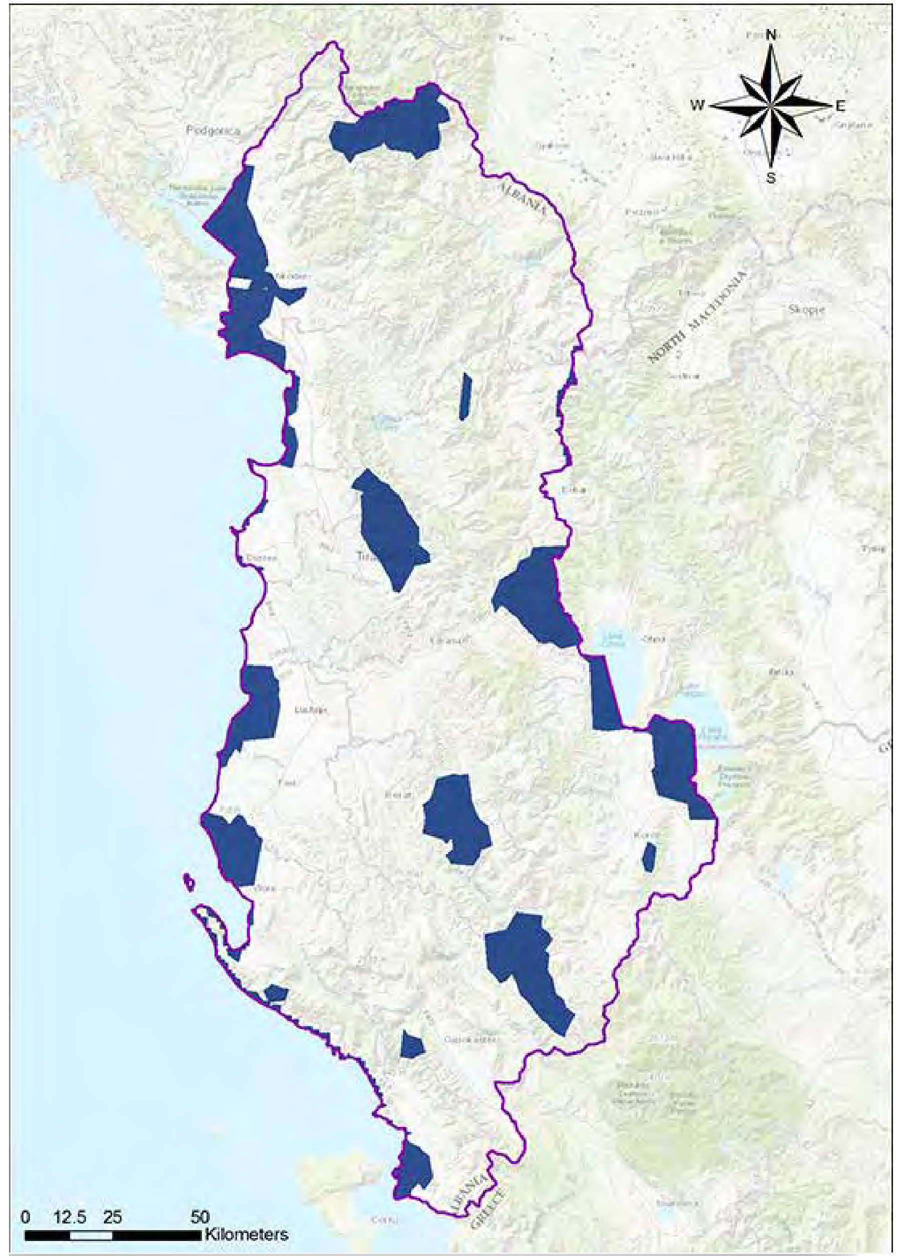
UN Environment Programme World Conservation Monitoring Center (UNEP - WCMC)

LAYER PRE-PROCESSING AND COMMENTS

Select polygons.

DESCRIPTION

Data consist of areas of likely or potential Critical Habitat as defined by the International Finance Corporation Performance Standard 6 (IFC PS6). The areas are identified based on the presence of threatened and endemic species, concentrations of migratory or congregatory species, unique and threatened ecosystems, evolutionary processes and other key biodiversity feature. Constraints areas are only likely ones. A buffer of 250 metres is established as an exclusion.



GEOHAZARD

Minize use of areas potentially affected by geohazards

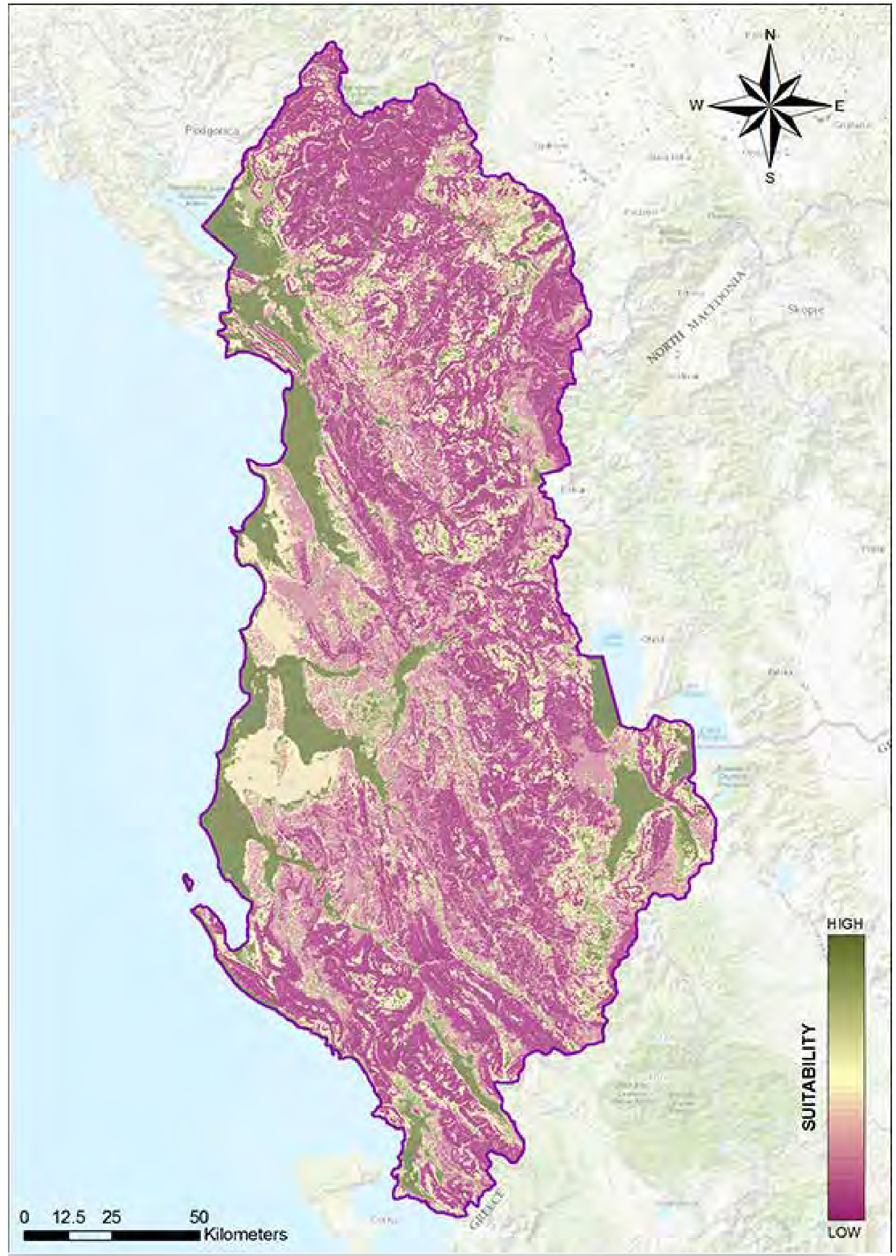
SOURCE

Join Research Centre - European Landslide Susceptibility Map

LAYER PRE-PROCESSING AND COMMENTS

DESCRIPTION

ELSUS (European Landslide Susceptibility) data describe spatial distribution of probability of generic landslide occurrence. Data are coded, based on landslide susceptibility level (0 = no data; 1 = very low; 2 = low; 3 = moderate; 4 = high; 5 = very high). Suitability scores increase as the ELSUS code decreases.



PROTECTED AREAS

Minimize proximity to protected areas

SOURCE

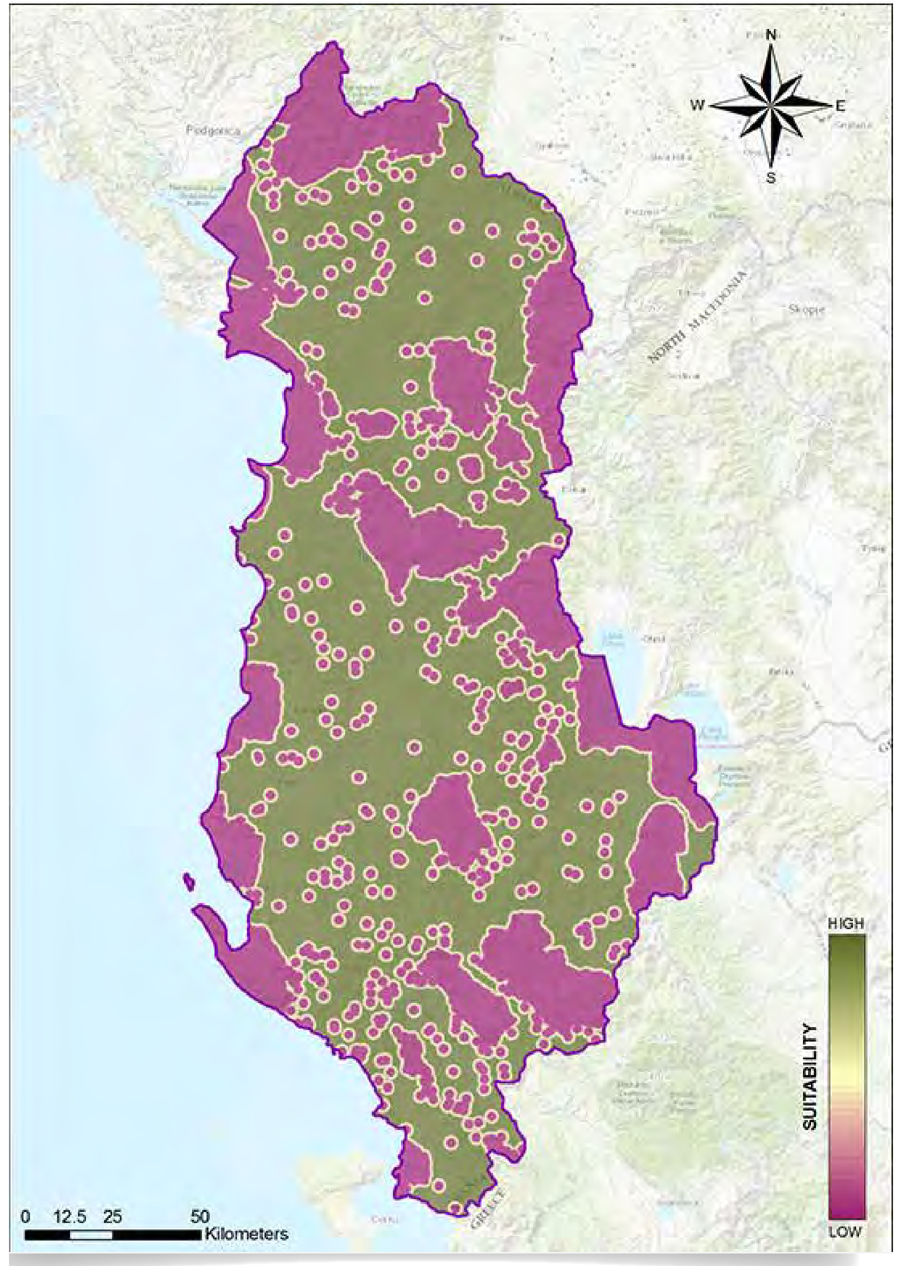
World Database on Protected Areas (WDPA); Council of Europe – European Environmental Agency

LAYER PRE-PROCESSING AND COMMENTS

For WDPA, polygons representing these categories were selected: “Managed Nature Reserve (category IV IUCN)”, “Protected Landscape (Category V IUCN)”, “Resource Reserve (Category VI IUCN)”, “National Park (Category II IUCN)”, “Nature Monument (Category III IUCN)”, “Ramsar Site, Wetland of International Importance”, “Specially Protected Areas of Mediterranean Importance (Barcelona Convention)”, “Strict Nature Reserve (Category I IUCN)”, “World Heritage Site (natural or mixed)”.

DESCRIPTION

The dataset includes features form the World Database on Protected Areas (WDPA) and from Emerald Networks sites. The World Database on Protected Areas is a global database of marine and terrestrial protected area, monthly updated. Data are categorized based on International Union for Conservation of Nature (IUCN) criteria. The Emerald Network is an ecological network made up of Areas of Special Conservation Interest. For Albania it includes only candidate sites. The suitability is 0 from the footprint to a buffer of 500 metres, then increases with linear function to 100 at 2km and above.



PROTECTED AREAS CONSTRAINT

Avoid protected areas

SOURCE

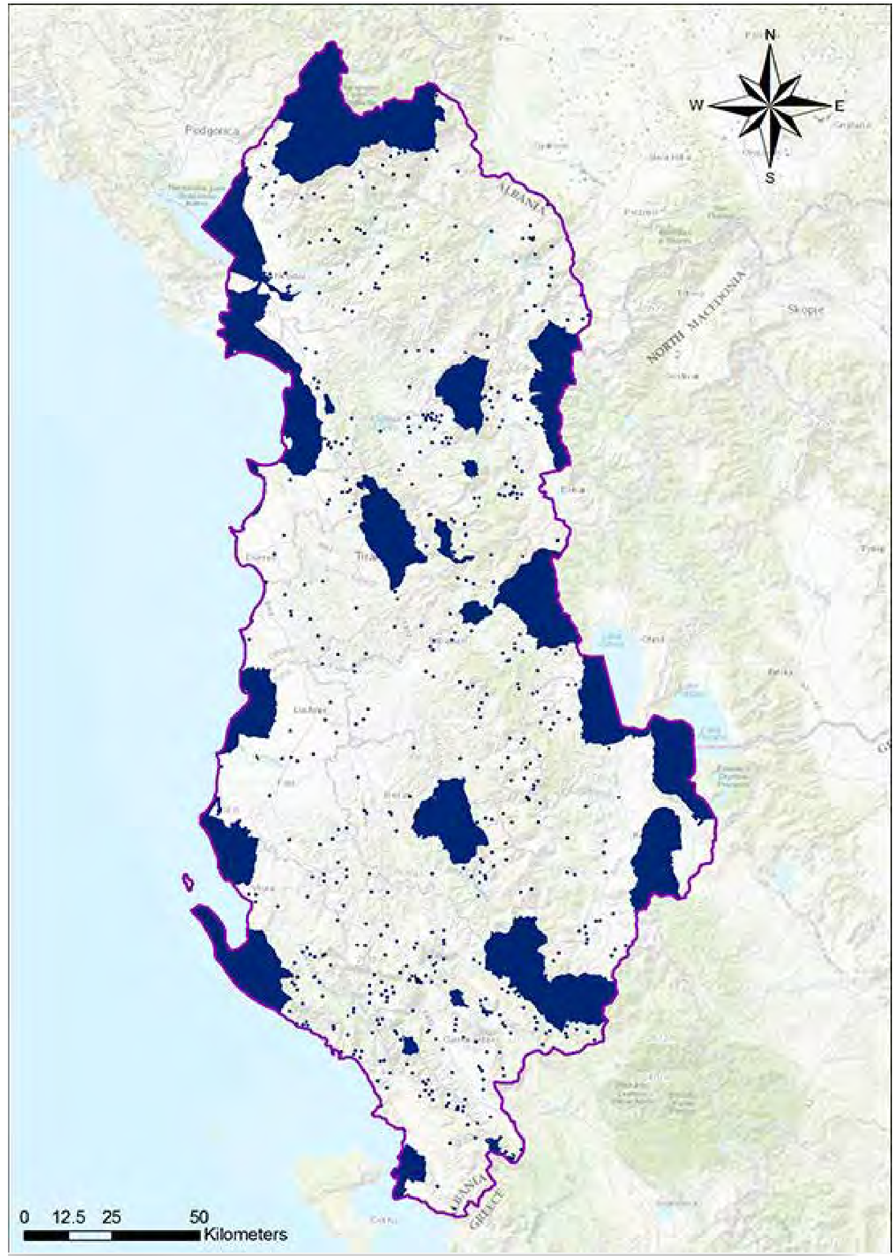
World Database on Protected Areas (WDPA); Council of Europe – European Environmental Agency

LAYER PRE-PROCESSING AND COMMENTS

For WDPA, only polygons representing “National Park (Category II IUCN)”, “Nature Monument (Category III IUCN)”, “Ramsar Site, Wetland of International Importance”, “Specially Protected Areas of Mediterranean Importance (Barcelona Convention)”, “Strict Nature Reserve (Category I IUCN)” and “World Heritage Site (natural or mixed)” are considered as constraint. The selected feautures, together with Emerald Network sites, identify the more articulate and complex areas, with elaborated interactions.

DESCRIPTION

The dataset includes features form the The World Database on Protected Areas (WDPA) and from Emerald Networks sites. The World Database on Protected Areas is a global database of marine and terrestrial protected area, monthly updated. Data are categorized based on International Union for Conservation of Nature (IUCN) criteria. The Emerald Network is an ecological network made up of Areas of Special Conservation Interest. For Albania it includes only candidate sites.



WATER SURFACE

Minimize proximity to water surface

SOURCE

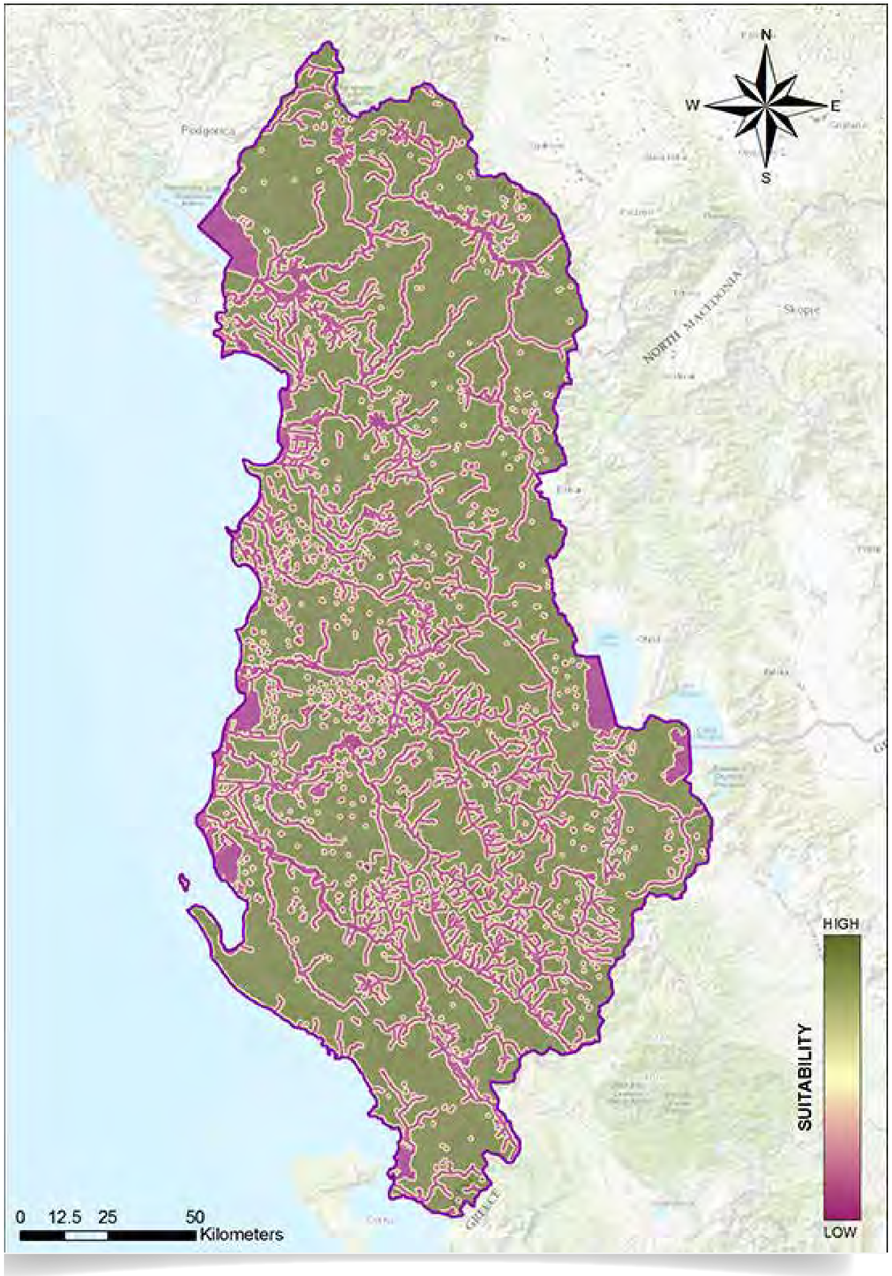
Joint Research Centre - Global Surface Water; Agency of Territorial Development (ATD)

LAYER PRE-PROCESSING AND COMMENTS

Convertion of Global Surface Water data from raster type to vector type. Merge different sources.

DESCRIPTION

Global Surface Water provides information on data collected over 35 years period, using remote sensing tools. Dataset includes rivers and lakes. Data provided by ATD consists of 50 metres buffer around waterways and includes: streams, rivers, canals, ditches, drains, dams, weirs, trickles, ponds. Suitability is 0 from footprint to 100 metres distance, then increases (in linear function) to 100 at a distance of 1000 metres.



SOCIAL

Indicators

07 . Critical Facilities

08 . Historic Resources

09 . Historic Resources Constraint

10 . Population Density

11 . Recreation Areas Constraint

12 . Urban Constraint

CRITICAL FACILITIES

Prefer proximity to critical facilities areas

SOURCE

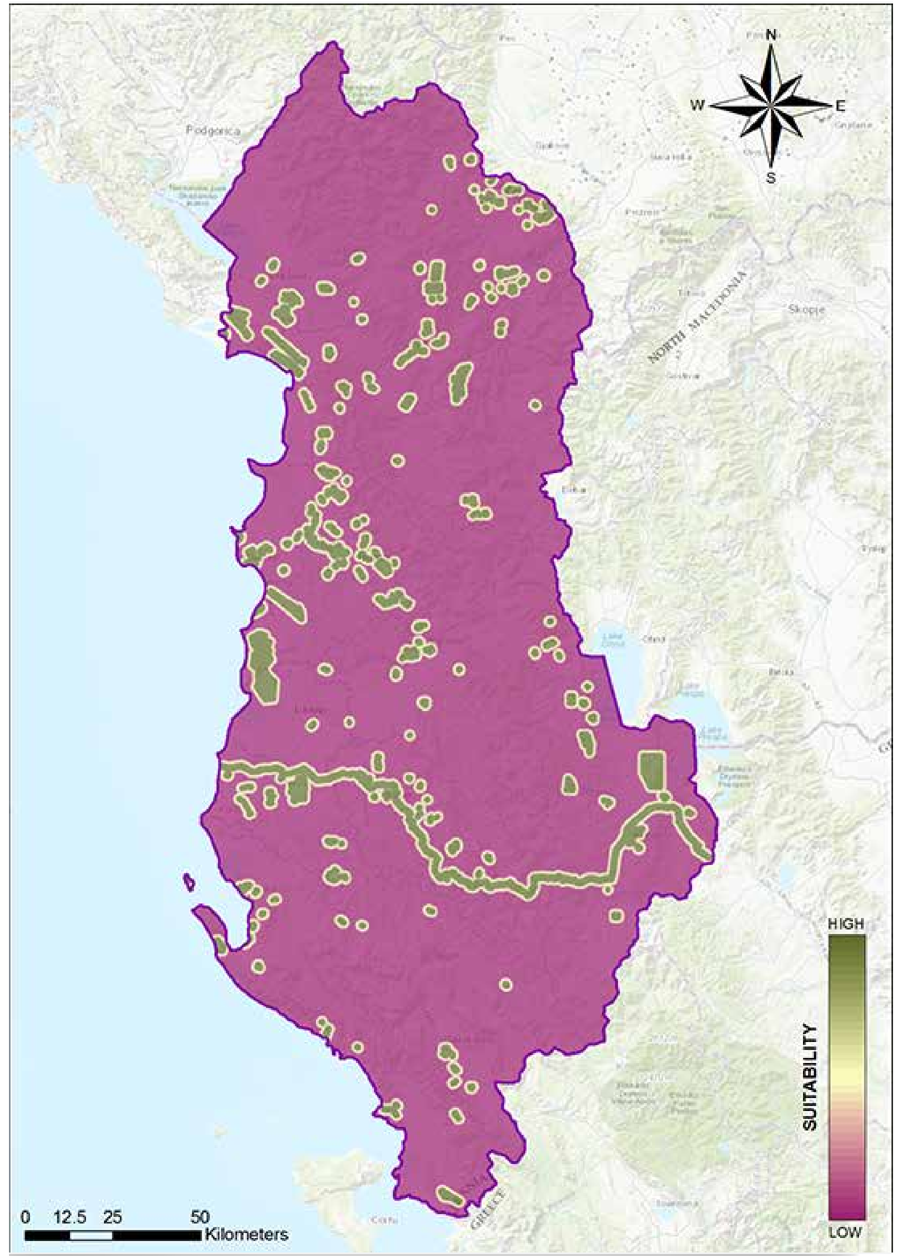
Copernicus Land Monitoring Service (CLMS) - Corine Land Cover; Agency of Territorial Development (ATD)

LAYER PRE-PROCESSING AND COMMENTS

Select Corine Land Cover areas. Combine data sources.

DESCRIPTION

The dataset includes: Industrial or commercial units (CLC121), Port areas (CLC123), Mineral extraction sites (CLC 131), Dump sites (CLC 132), Construction sites (CLC 133) from Corine Land Cover and caves, TAP, wind farms, industrial areas from ATD. Suitability value is maximum from the footprint to 500 metres. The suitability decades between 500 and 2000 metres from the footprint. Above 2000 is 0.



HISTORIC RESOURCES

Minimize proximity to historic resources areas

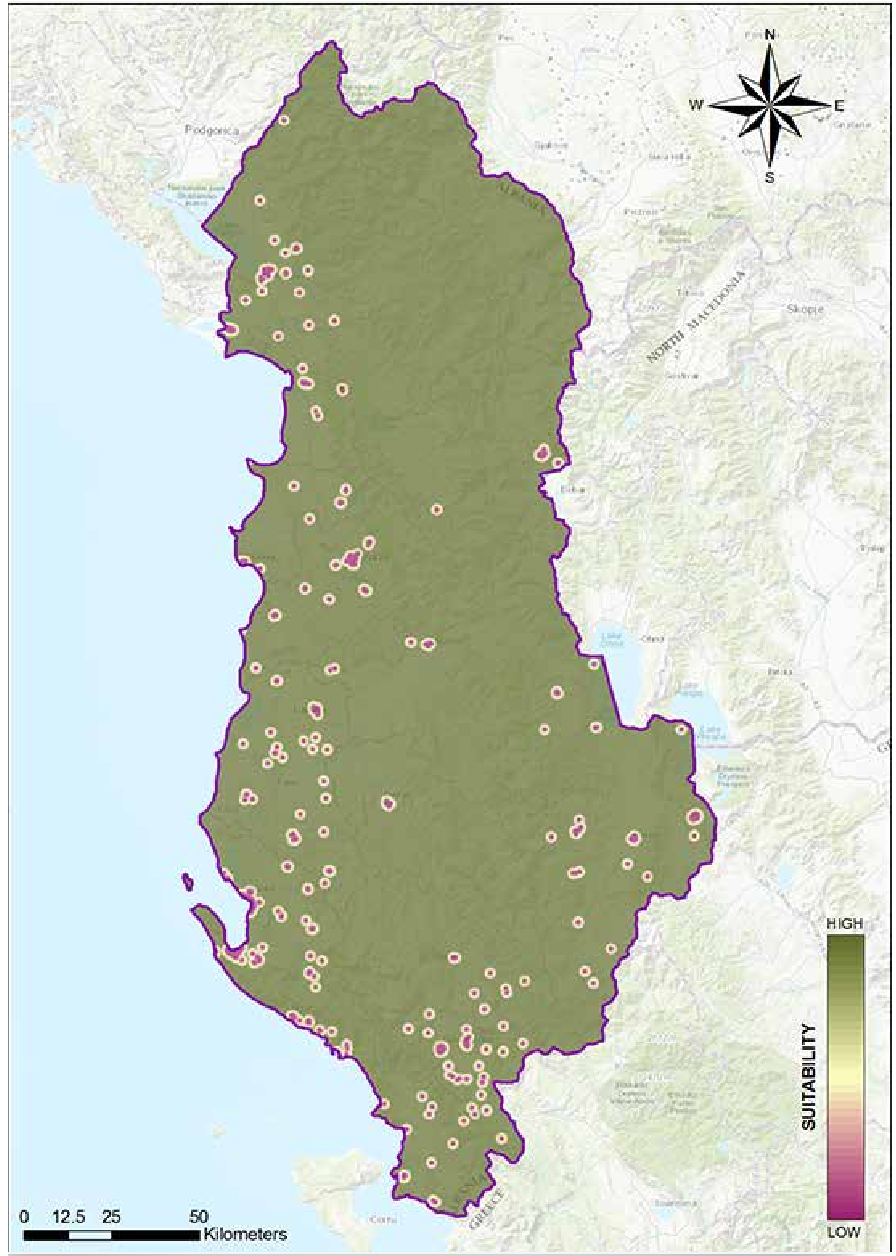
SOURCE

Agency Territorial Development (ATD)

LAYER PRE-PROCESSING AND COMMENTS

DESCRIPTION

The dataset includes: archaeological parks, castles, towers, monumental areas, museums, art galleries, historic buildings, churches, mosques, bridges, necropolis. Areas between the footprint and a buffer of 250 metres distance are less eligible (0 value) for the plant, then increases to the maximum (100) with linear function at 2km and above.



HISTORIC RESOURCES CONSTRAINT

Avoid historic resources sites

SOURCE

Agency Territorial Development (ATD)

LAYER PRE-PROCESSING AND COMMENTS

DESCRIPTION

The dataset includes: archaeological parks, castles, towers, monumental areas, museums, art galleries, historic buildings, churches, mosques, bridges, necropolis.

POPULATION DENSITY

Avoid highly poputated areas

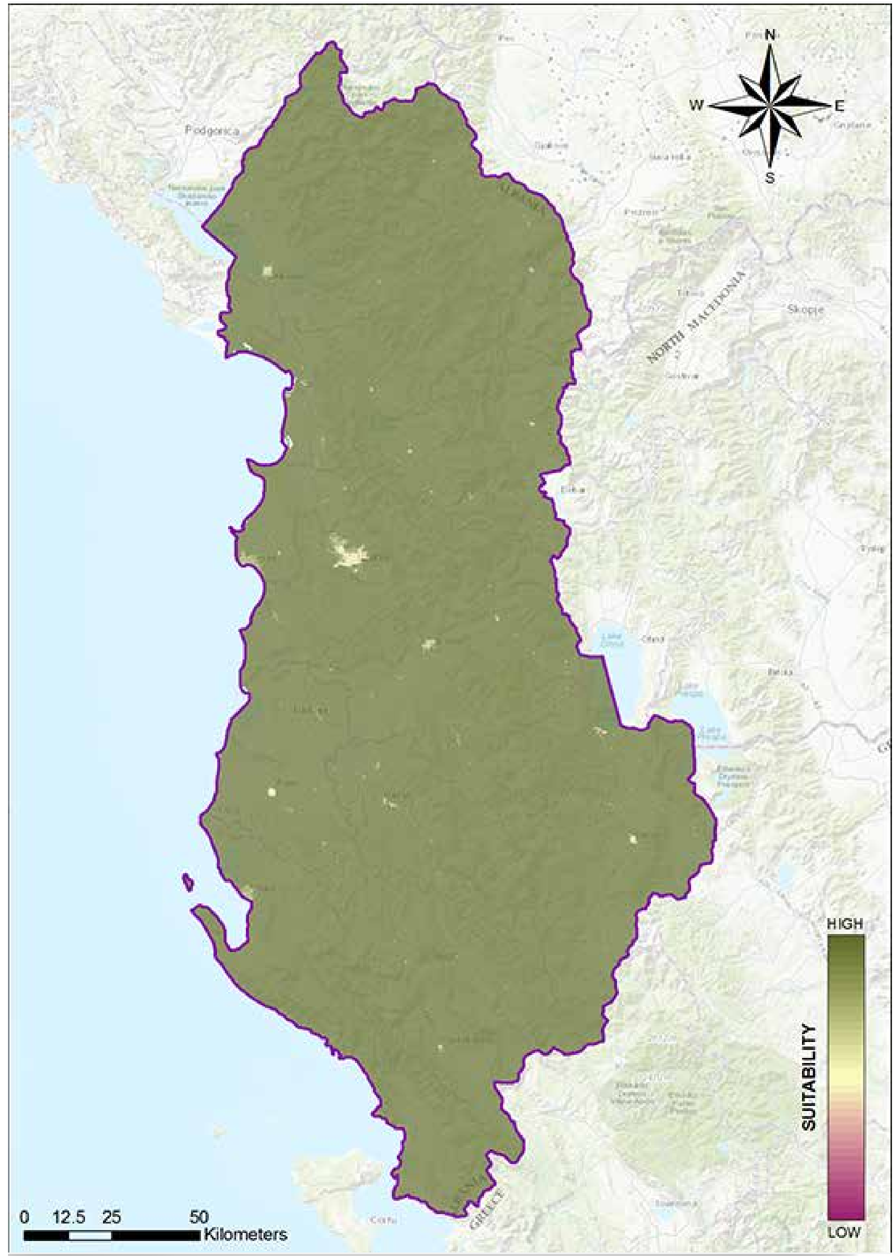
SOURCE

Join Research Centre - Global Human Settlement Layer

LAYER PRE-PROCESSING AND COMMENTS

DESCRIPTION

Human Settlement population grid depicts the distribution and density of population, expressed as the number of people per cell (250m2). Presence of population is estimated by built-up presence. The scores are assigned in order to make the cells with the highest values less suitable (by a linear function).



RECREATION AREAS CONSTRAINT

Avoid green urban areas and leisure centres

SOURCE

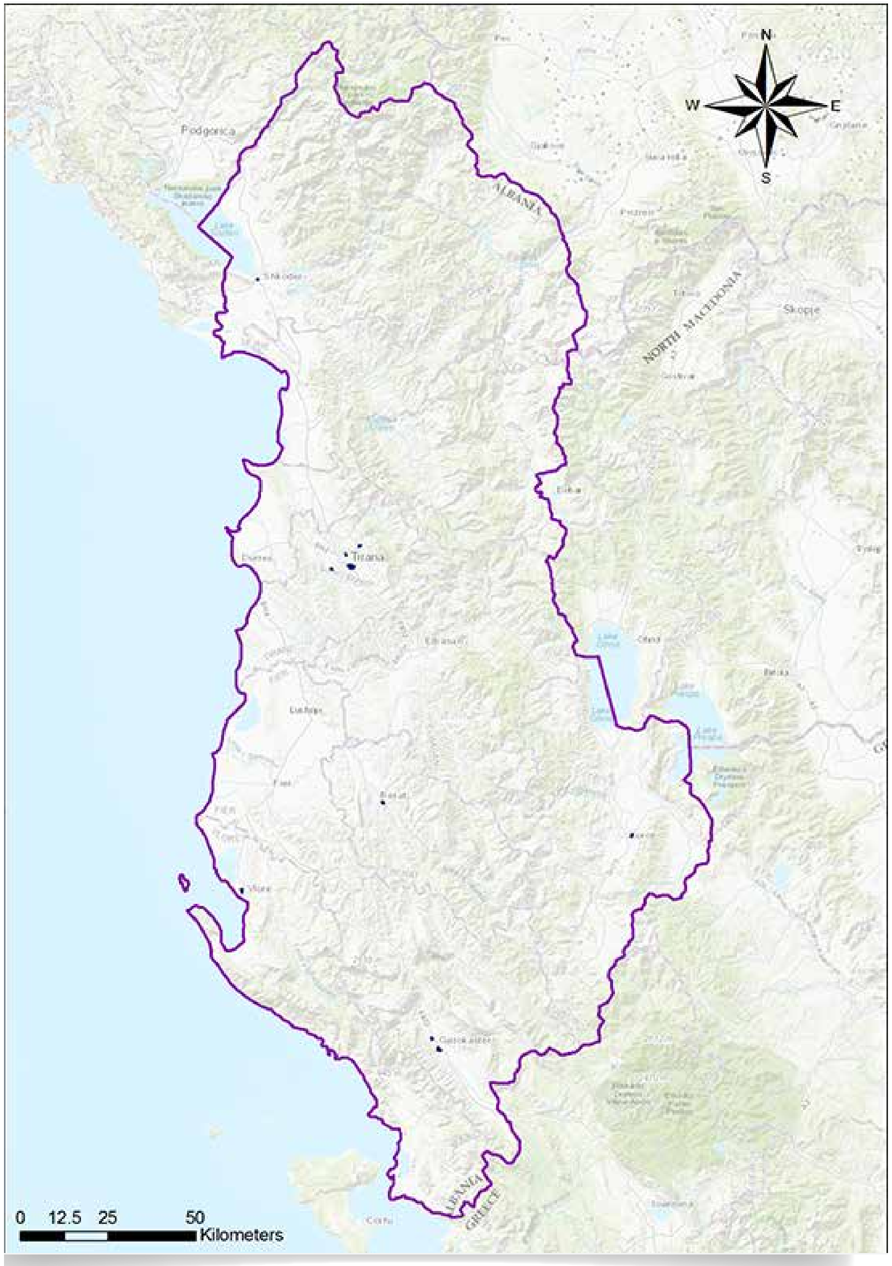
Copernicus Land Monitoring Service (CLMS) - Corine Land Cover

LAYER PRE-PROCESSING AND COMMENTS

Select Corine Land Cover areas. Calculate 250 metres buffer.

DESCRIPTION

The dataset includes: Green urban areas (CLC 141), Sport and leisure facilities (CLC 142). A buffer of 250m is established as an exclusion.



URBAN CONSTRAINT

Avoide built-up areas

SOURCE

Agency of Territorial Development (ATD)

LAYER PRE-PROCESSING AND COMMENTS

DESCRIPTION

Data represent urban and build-up zones.

TECHNICAL

Indicators

13 . Airports

14 . Airports Constraint

15 . Critical Facilities Constraint

16 . Major Transport Service

17 . Major Transport Service Constraint

18 . Railway Constraint

19 . Solar irradiance

20 . Substations

21 . Unsuitable Areas Constraint

22 . Unsuitable Terrain (slope)

23 . Water Surface Constraint

AIRPORTS

Minimize proximity to airports

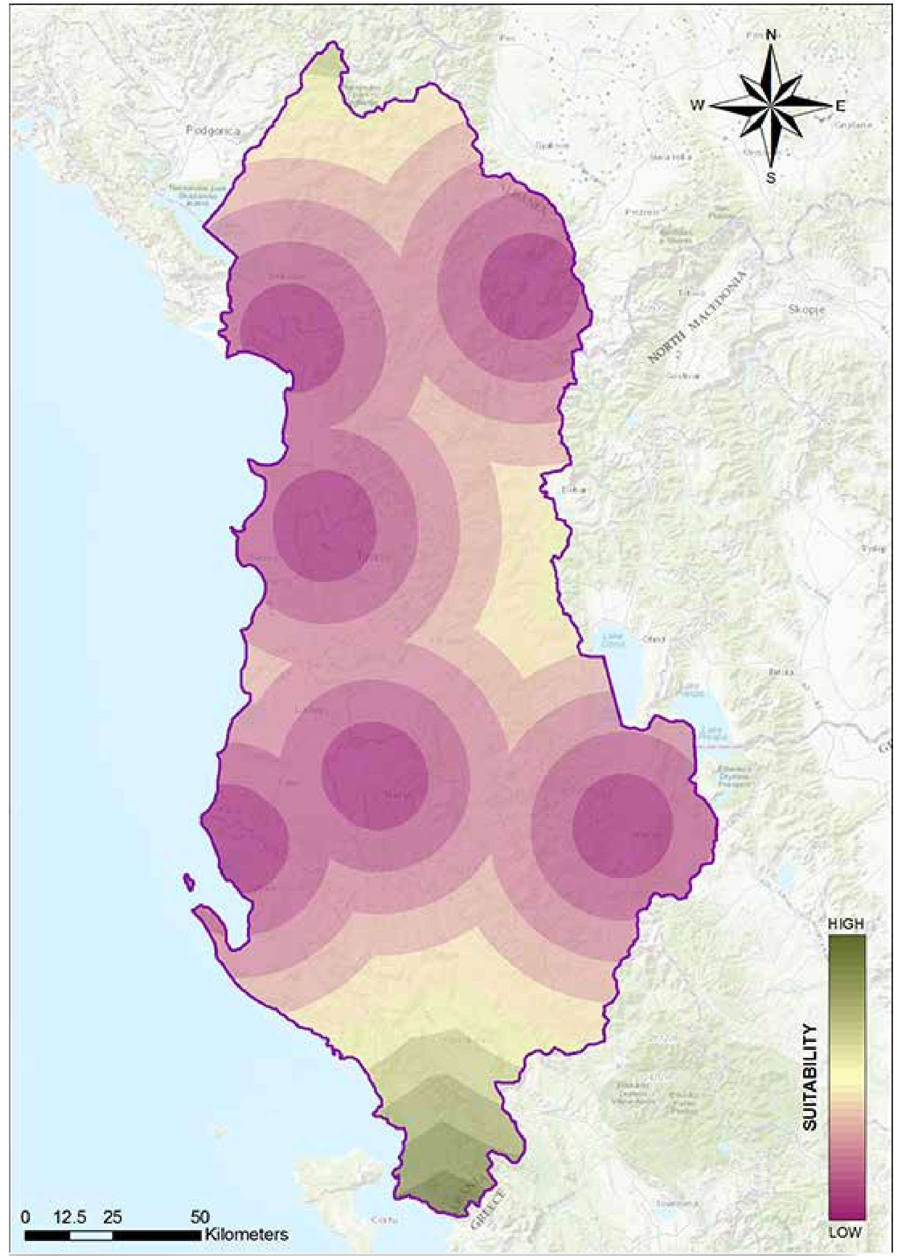
SOURCE

Agency of Territorial Development (ATD)

LAYER PRE-PROCESSING AND COMMENTS

DESCRIPTION

Data represent the footprint of airports in the whole country. Airports present several constraints due to navigation safety rules. Areas between the footprint and a buffer of 1000 metres distance are less desirable (0 value) for the plant.



AIRPORTS CONSTRAINT

Avoid Airports

SOURCE

Agency of Territorial Development (ATD)

LAYER PRE-PROCESSING AND COMMENTS

DESCRIPTION

Data represent the footprint of airports all over the country.

CRITICAL FACILITIES CONSTRAINT

Avoid industrial and commercial areas, harbours, landfills and dumps, quarries, wind farms

SOURCE

Copernicus Land Monitoring Service (CLMS) - Corine Land Cover; Agency of Territorial Development (ATD)

LAYER PRE-PROCESSING AND COMMENTS

Select Corine Land Cover areas. Combine data sources.

DESCRIPTION

The dataset includes: Industrial or commercial units (CLC121), Port areas (CLC123), Mineral extraction sites (CLC 131), Dump sites (CLC 132), Construction sites (CLC 133) from Corine Land Cover and caves, wind farms, industrial areas from ATD.

MAJOR TRANSPORT SERVICE

Prefer proximity to major transportation routes

SOURCE

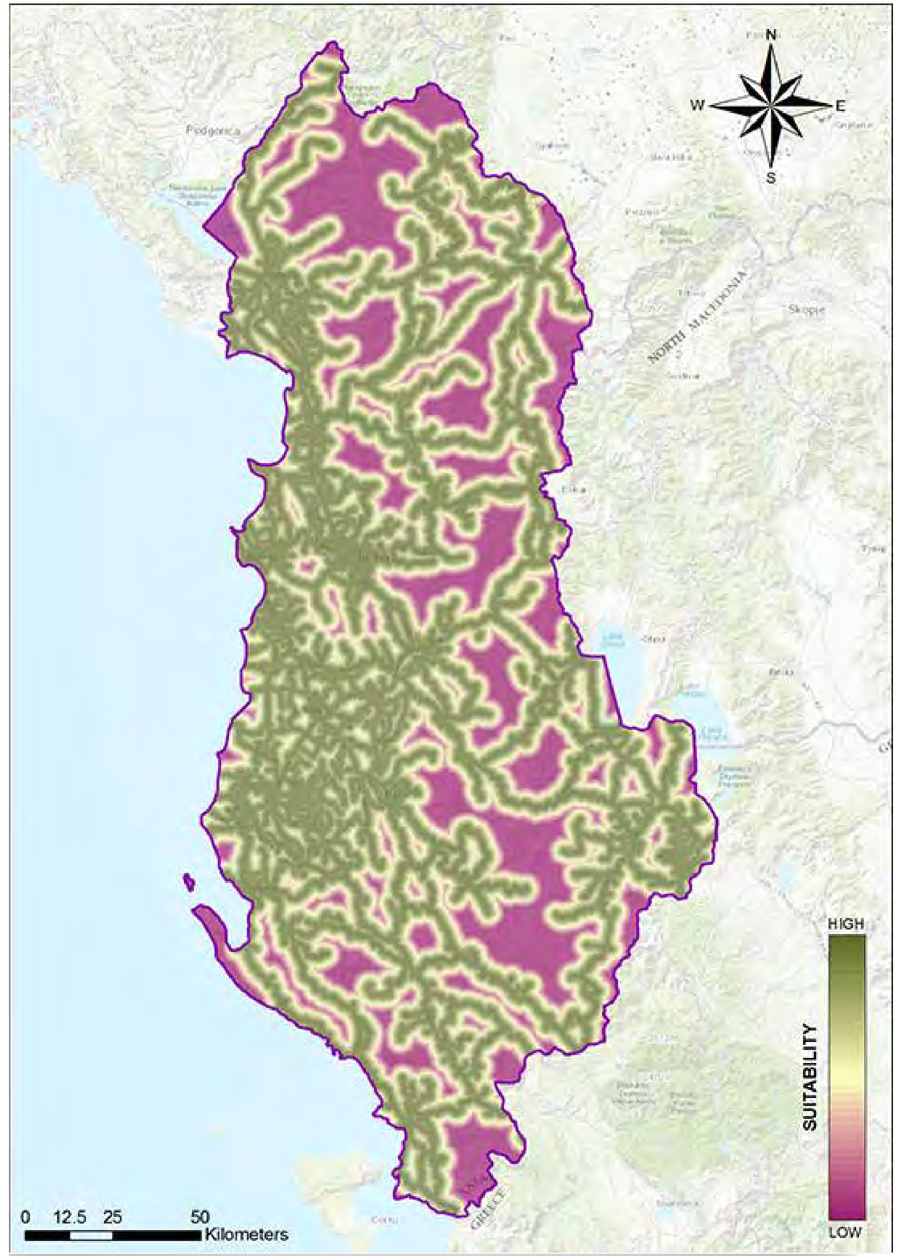
GeoFabrick - Open Street Map

LAYER PRE-PROCESSING AND COMMENTS

Calculate 25 metres buffer around lines in order to create indicator polygons.

DESCRIPTION

Data consist of Motorway roads, Primary roads, Secondary roads, Tertiary road and Trunk road. The scope is to identify areas close to major transportation routes, in order to facilitate access by heavy trucks and construction equipment during the construction and maintenance of the plant. Maximum suitability score is assigned to 250 metres value, then suitability decreases in linear function between 250 and 5000 metres from the footprint, remaining 0 beyond 5000 metres.



MAJOR TRANSP. SERVICE CONSTRAINT

Avoid footprint of major roads

SOURCE

GeoFabrick - Open Street Map

LAYER PRE-PROCESSING AND COMMENTS

Calculate 25 metres buffer around lines in order to create constraint areas.

DESCRIPTION

Data consist of Motorway roads, Primary roads, Secondary roads, Tertiary road and Trunk road.

RAILWAY CONSTRAINT

Avoid railway tracks

SOURCE

GeoFabrick - Open Street Map

LAYER PRE-PROCESSING AND COMMENTS

Calculate 25 metres buffer around lines in order to create constraint areas.

DESCRIPTION

SOLAR IRRADIANCE

Prefer areas with high solar irradiance

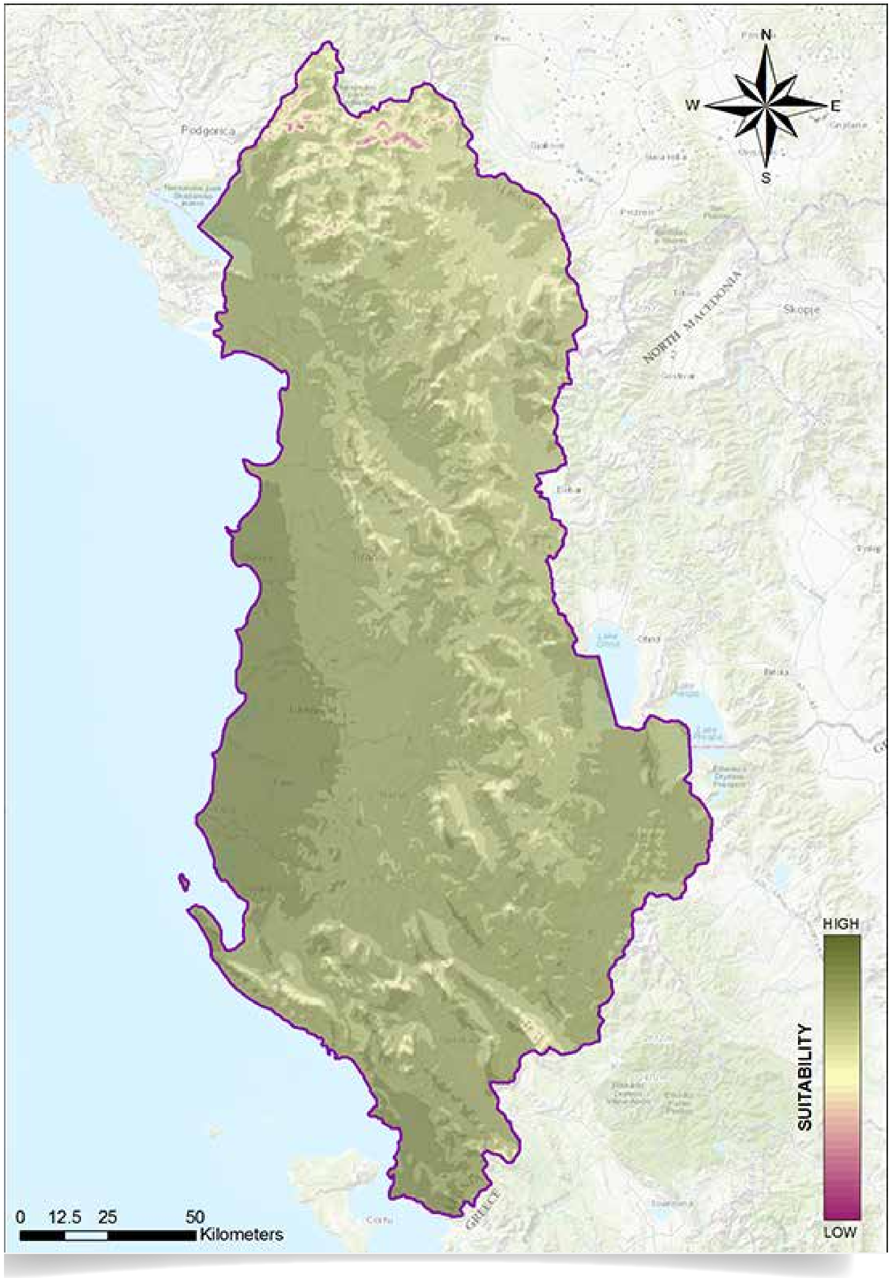
SOURCE

Global Solar Atlas

LAYER PRE-PROCESSING AND COMMENTS

DESCRIPTION

Data consist of estimated photovoltaic (PV) power generation potential. It represent the average yearly totals of electricity production from a 1 kW-peak-grid-connected solar PV power plant, calculated for a period of 25 recent years (1994-2018).



SUBSTATIONS

Prefer proximity to substations

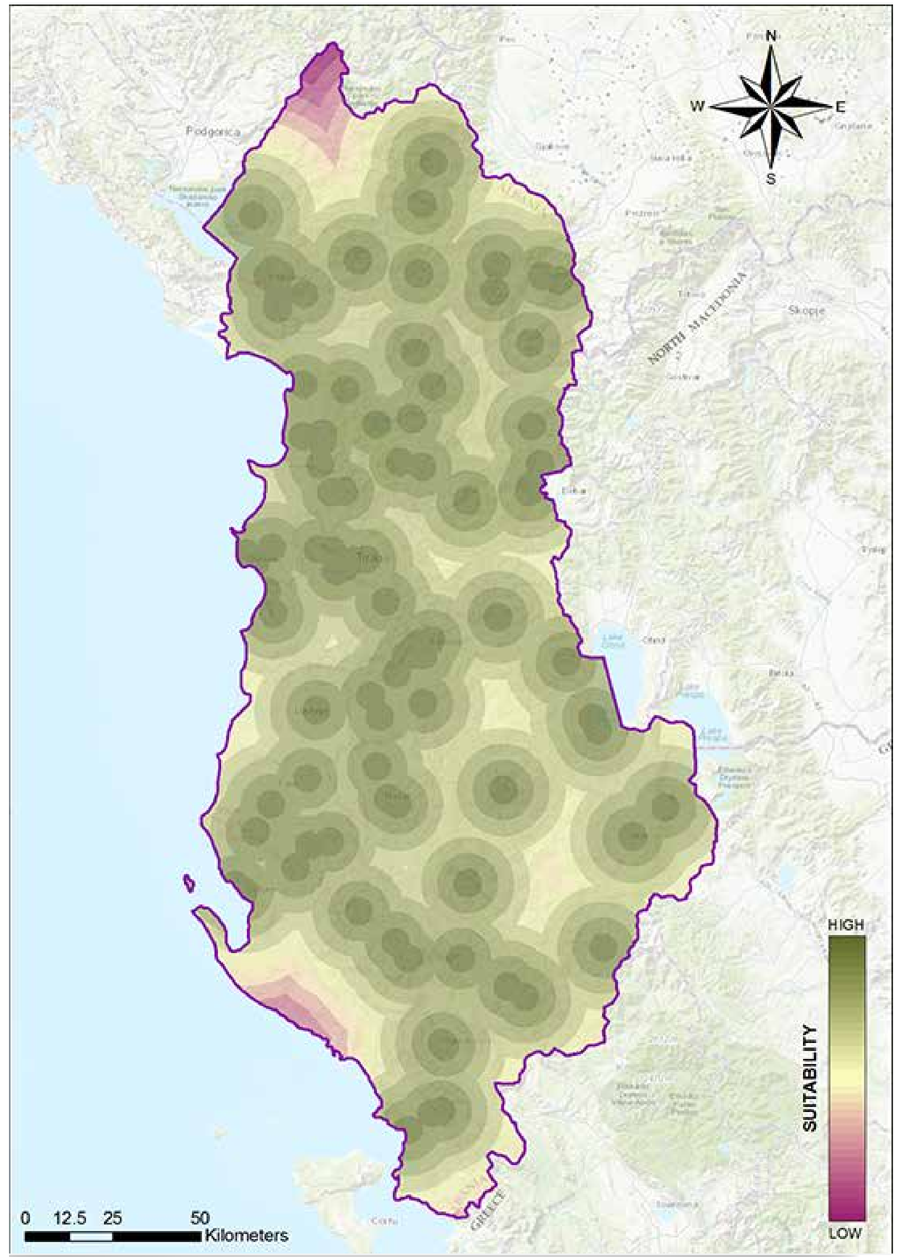
SOURCE

OST (Operatori i Sistemit te Transme.mit, Transmission System Operator, Albania)

LAYER PRE-PROCESSING AND COMMENTS

DESCRIPTION

Dataset includes the location of 110 kV and 220-400 kV electrical substations of the Albanian Power System under the administration of the Transmission System Operator (OST). This information was published pursuant to DCM no. 166, dated 01.03.2017, “On the determination of the responsible authority that administers the single point of information, for the provision of minimum information for infrastructure networks at the national level”.



UNSUITABLE AREAS CONSTRAINT

Avoid difficult terrain

SOURCE

Copernicus Land Monitoring Service (CLMS) - Corine Land Cover

LAYER PRE-PROCESSING AND COMMENTS

Select Corine Land Cover areas.

DESCRIPTION

The dataset consists of: Corine Land Cover "CODE 331 Beaches, dunes, sands", "CODE 332 Bare rocks", "CODE 334 Burnt areas","CODE 335 Glaciers and perpetual snow".

UNSUITABLE TERRAIN (SLOPE)

Avoid steep slopes

SOURCE

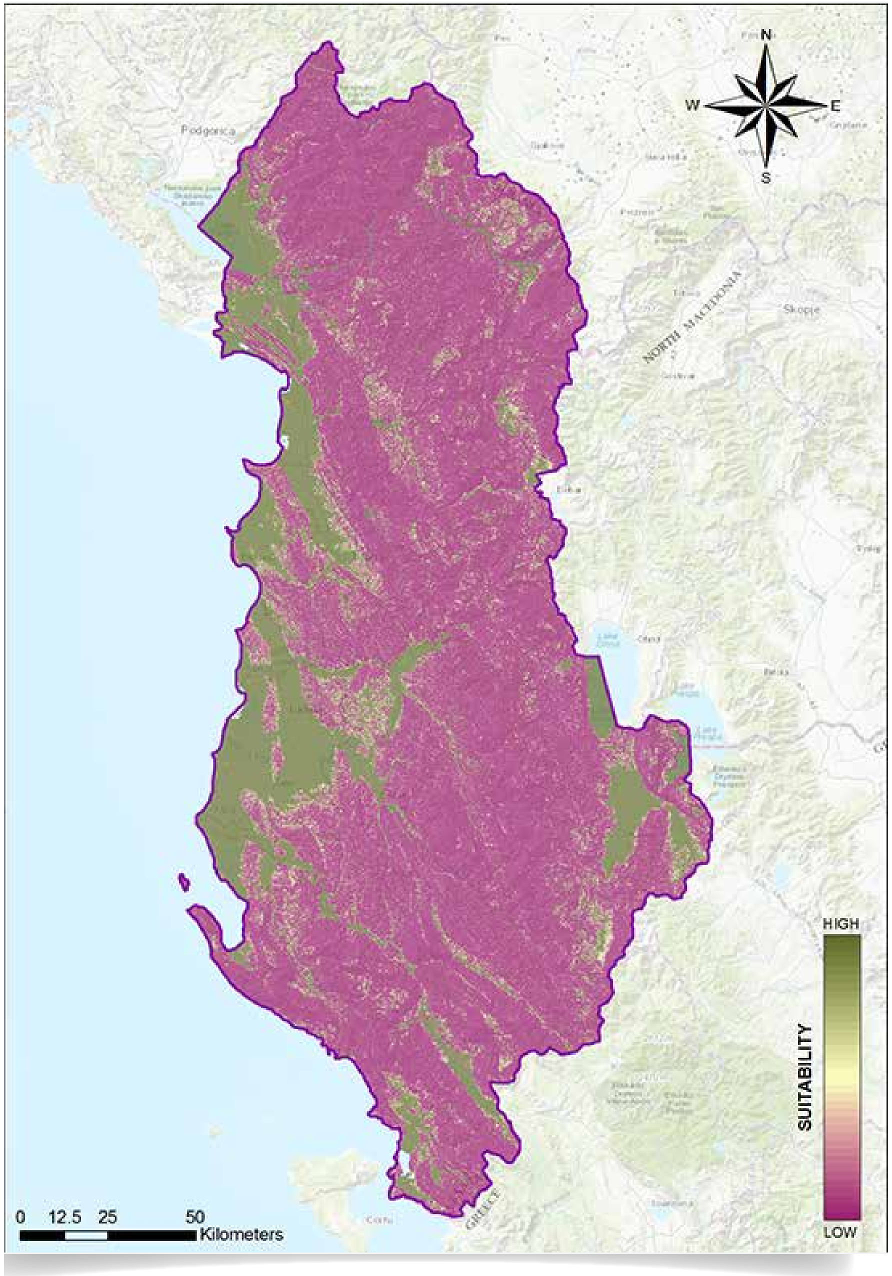
Copernicus Land Monitoring Service (CLMS) - European Digital Elevation Model (EU-DEM)

LAYER PRE-PROCESSING AND COMMENTS

Calculate slope from Copernicus DEM.

DESCRIPTION

Slope is calculated by a 25 m cell size DEM (Digital Elevation Model) in degree units. Data range from 0 to 5% are identified as most suitable. Suitability decreases between 5% and 15%. Slope values higher then 15% have score 0 of suitability.



WATER SURFACE CONSTRAINT

Avoid water surfaces

SOURCE

Joint Research Centre - Global Surface Water; Agency of Territorial Development (ATD)

LAYER PRE-PROCESSING AND COMMENTS

Convertion of Global Surface Water data from raster type to vector type. Merge differente sources.

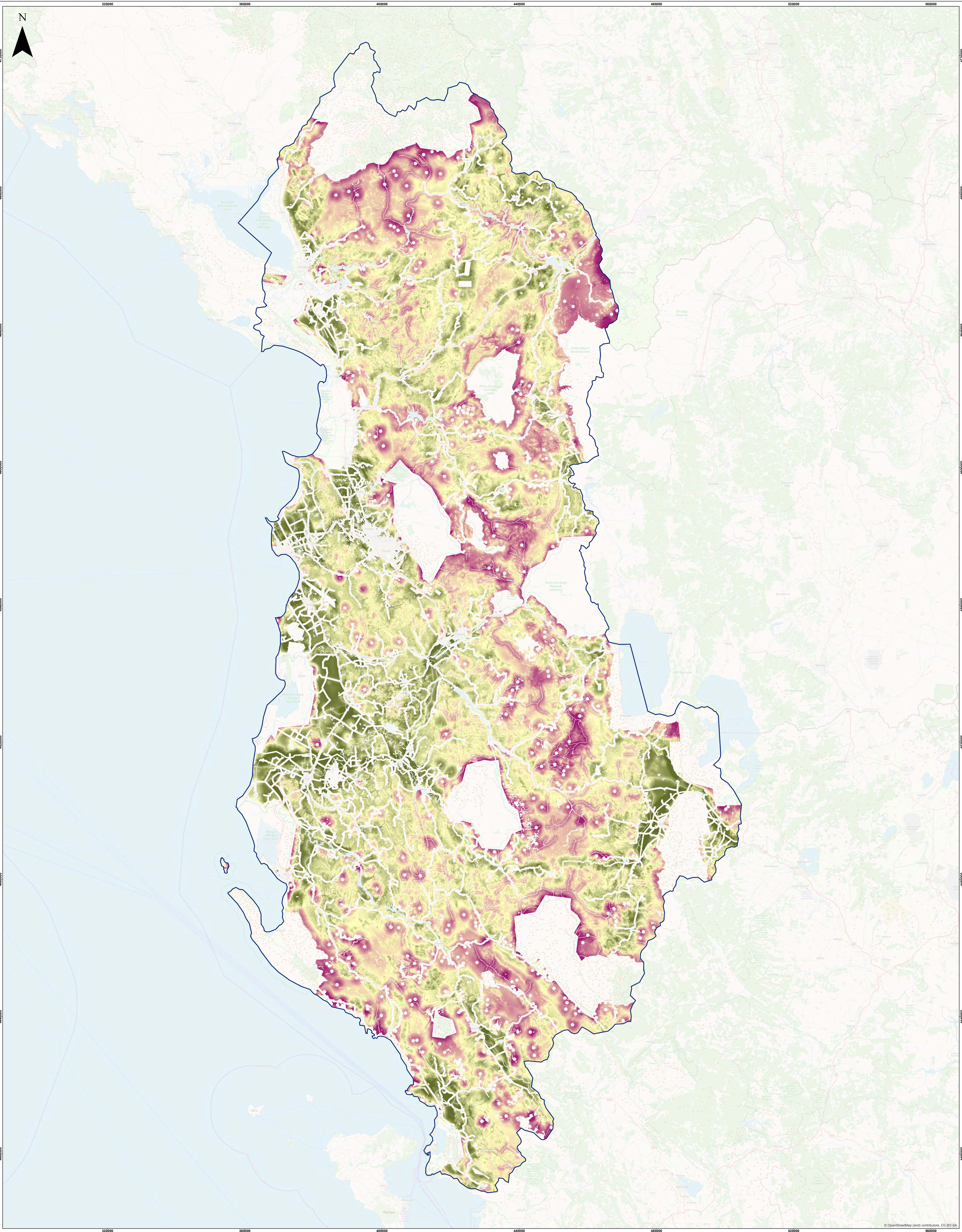
DESCRIPTION

Global Surface Water provides information on data collected over 35 years period, using remote sensing tools. Dataset includes rivers and lakes. Data provided by ATD consists of 50 metres buffer around waterways and include: streams, rivers, canals, ditches, drains, dams, weirs, trickles, ponds.

APPENDIX B

Suitability map

PATH: D:\lavori\Albania\Suitability_Map_Solar.mxd PRINTED ON: 2020-09-24 AT: 4:07:07



LEGEND

Suitability

HIGH

LOW

0 25 50

Kilometers

NOTE(S)

1. LINE NOTES
2. LINE NOTES

REFERENCE(S)

1. PROJECTION: UTM ZONE: 34 DATUM: WGS84

CLIENT

MINISTRY OF INFRASTRUCTURE AND ENERGY

PROJECT

DEVELOPMENT OF SOLAR POWER PROJECTS IN ALBANIA

TITLE

SUITABILITY MAP

CONSULTANT

GOLDER

YYYY-MM-DD	2020-09-11
DESIGNED	CVI
PREPARED	CVI
REVIEWED	LMA
APPROVED	LMA

PROJECT NO.	DOCUMENT NO.	CONTROL	REV.	FIGURE
19133659	12733	0001	0	APPENDIX B

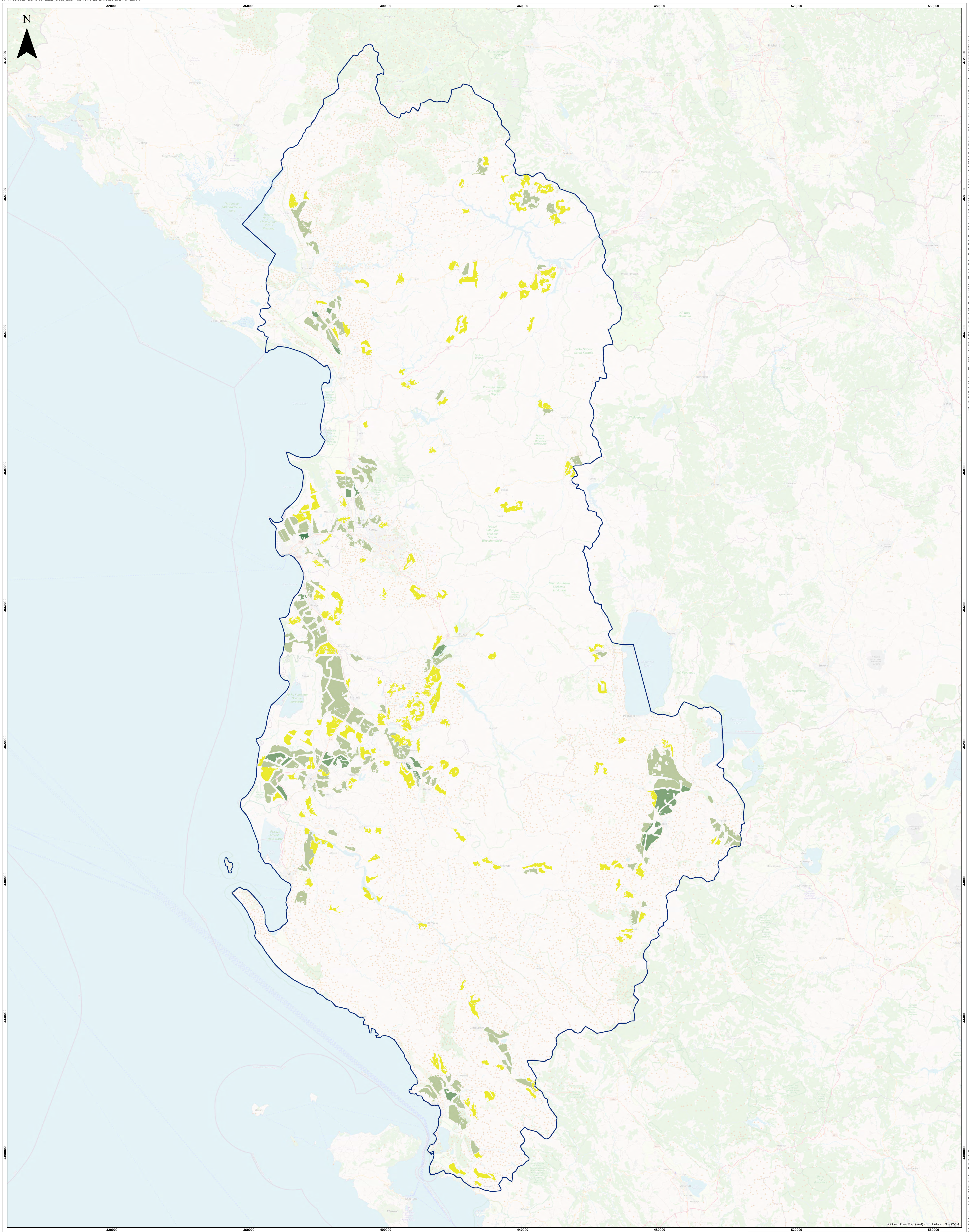
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A1

25mm

APPENDIX C

Candidate areas map

PATH: D:\lavori\Albania\Candidate_areas_Solar.mxd PRINTED ON: 2020-09-24 AT: 3:57:48



LEGEND

CANDIDATE AREAS

Mean Suitability

- 90.1 - 95.0
- 85.1 - 90.0
- 80.1 - 85.0
- 76.4 - 80.0

0 25 50
Kilometers

NOTE(S)
1. LINE NOTES
2. LINE NOTES

REFERENCE(S)
1. PROJECTION: UTM ZONE: 34 DATUM: WGS84

CLIENT
MINISTRY OF INFRASTRUCTURE AND ENERGY

PROJECT
DEVELOPMENT OF SOLAR POWER PROJECTS IN ALBANIA

TITLE
CANDIDATE AREAS MAP

CONSULTANT
GOLDER

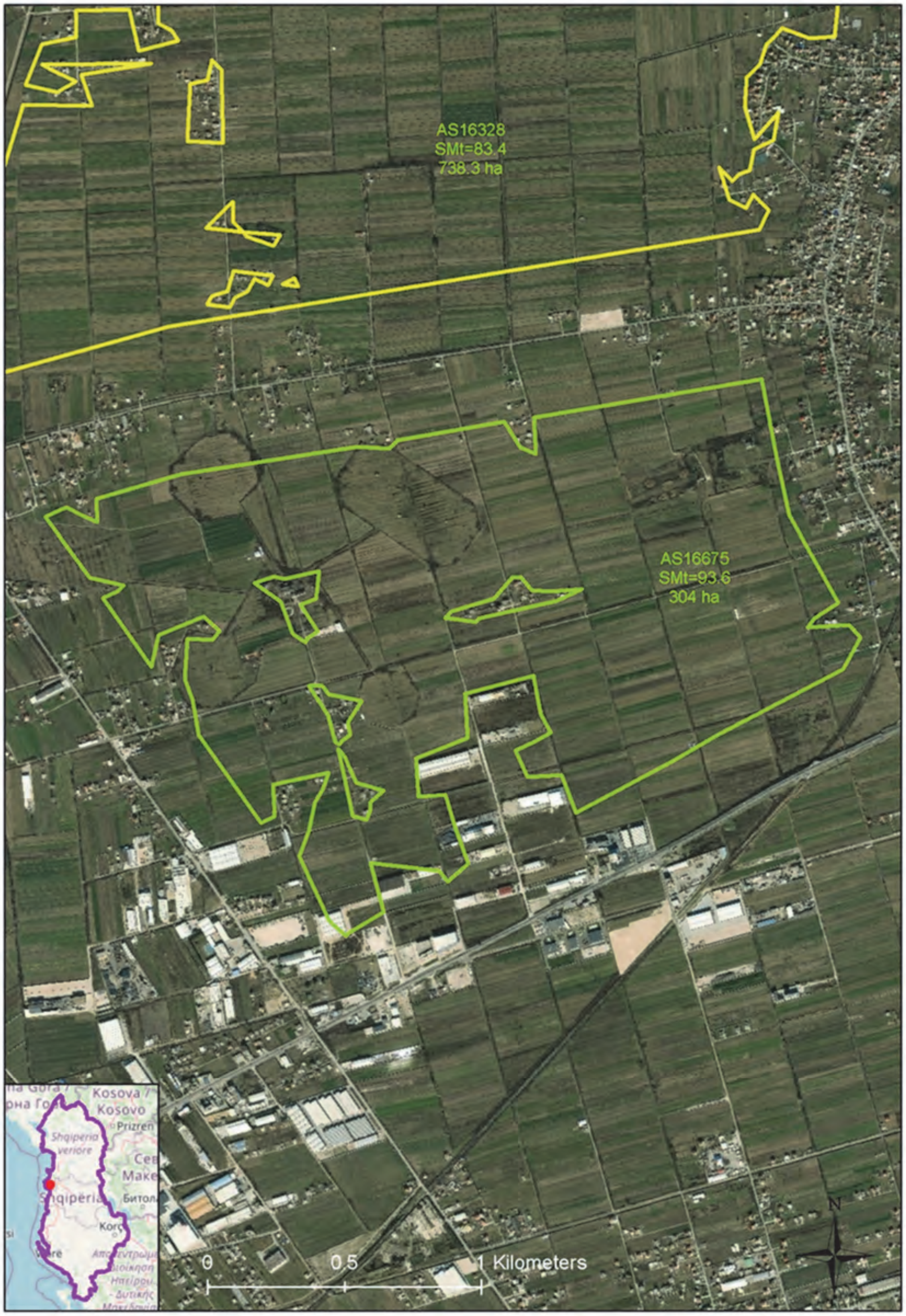
YYYY-MM-DD	2020-09-11
DESIGNED	CVI
PREPARED	CVI
REVIEWED	LMA
APPROVED	LMA

PROJECT NO.	DOCUMENT NO.	CONTROL	REV.	FIGURE
19133659	12733	0001	0	APPENDIX C

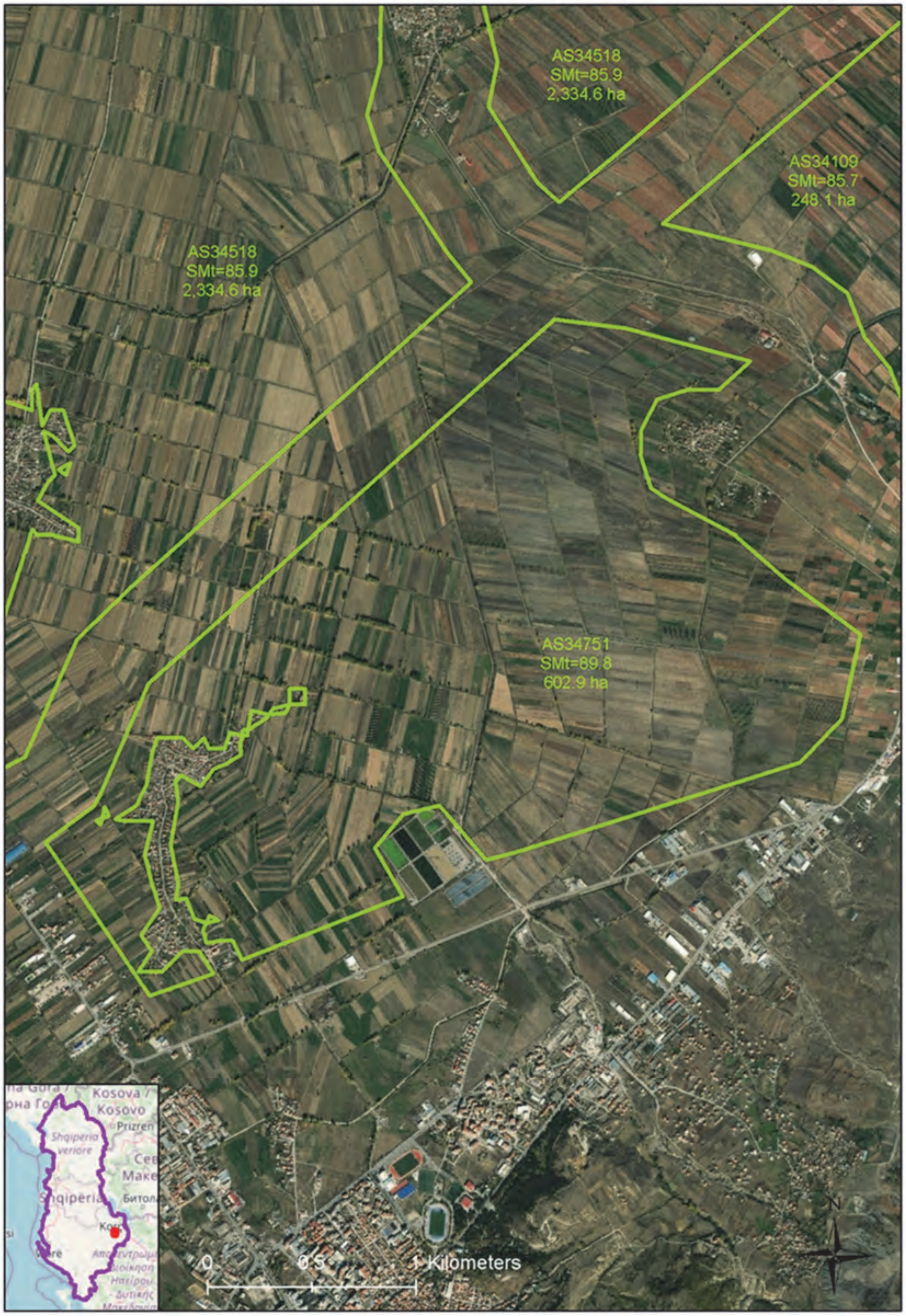
25mm

APPENDIX D

Sample candidate areas



Candidate Area 16675



Candidate Area 34751

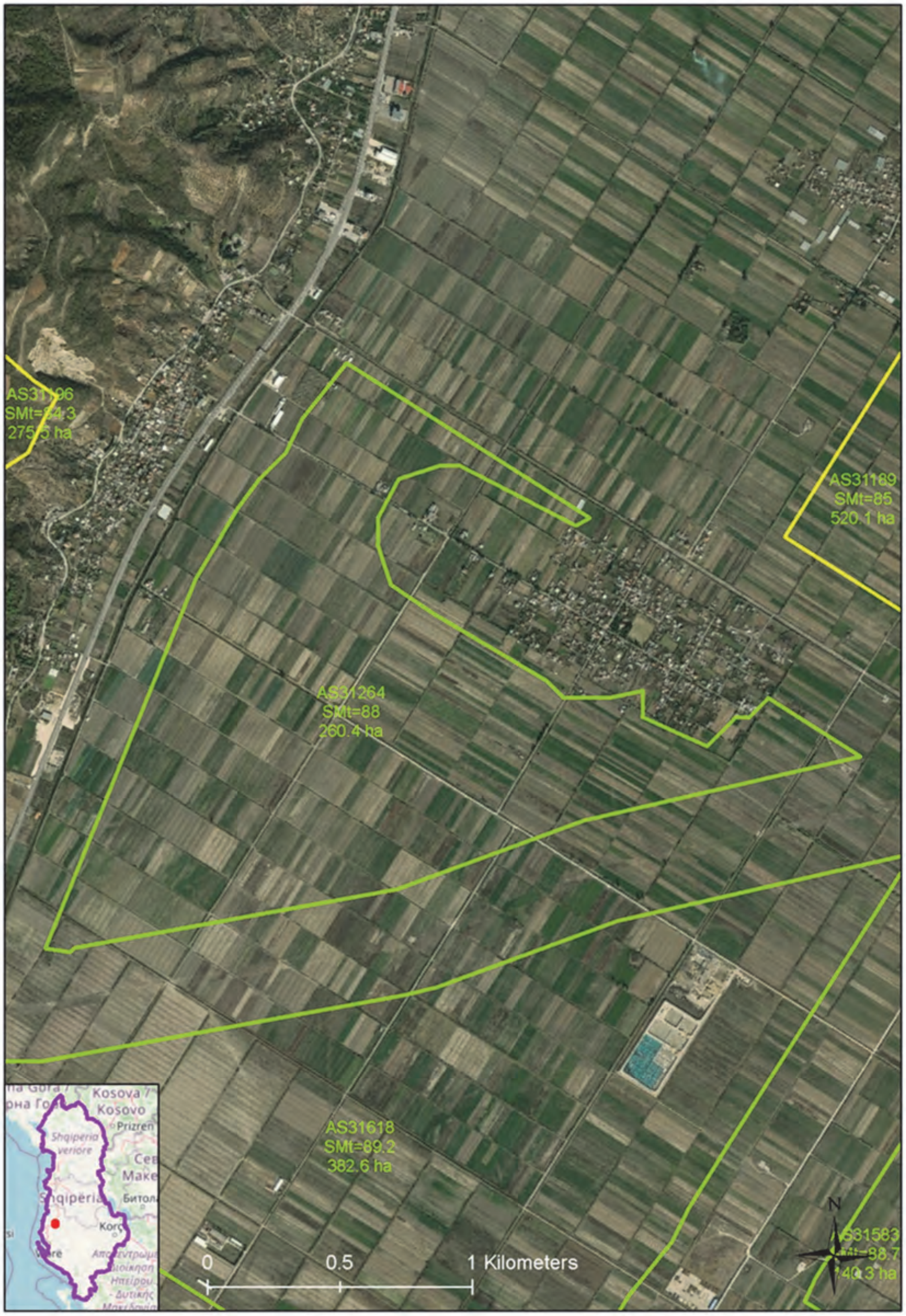
Candidate Area 33651

Candidate Area 31618

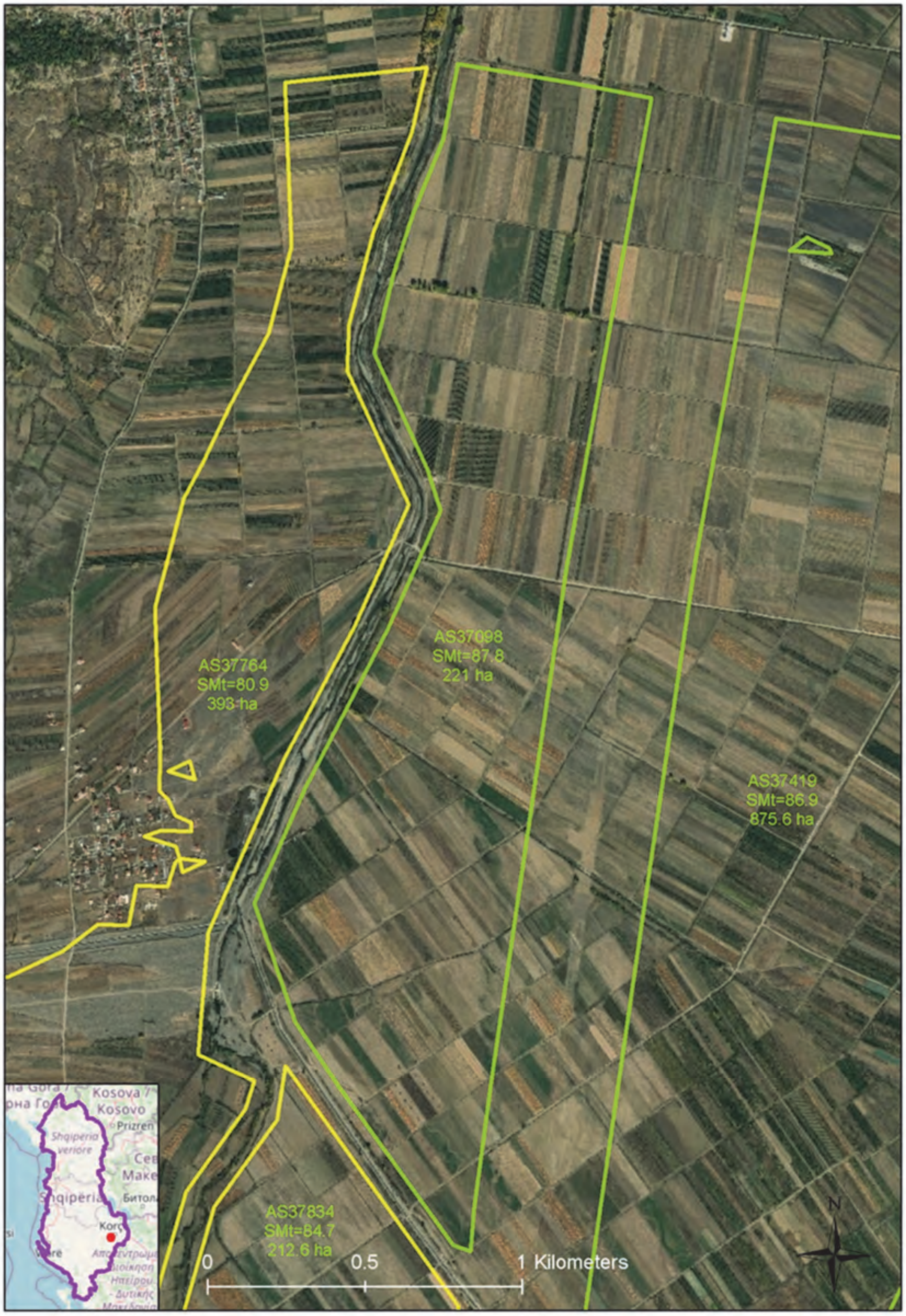
Candidate Area 31583

Candidate Area 7465

Candidate Area 35840



Candidate Area 31264



Candidate Area 37098

Candidate Area 31790

GOLDER

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