REPORT

Development of Wind Power Projects in Albania

Wind Siting Study

Submitted to:

Ministry of Infrastructure and Energy (MIE)

Submitted by:

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1 copy to MIE

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Table of Contents

TABLES

FIGURES

APPENDICES

EXECUTIVE SUMMARY

Golder Associates was requested to carry out a high-level analysis of Albanian territory aimed to find potentially suitable areas to develop new Wind Projects.

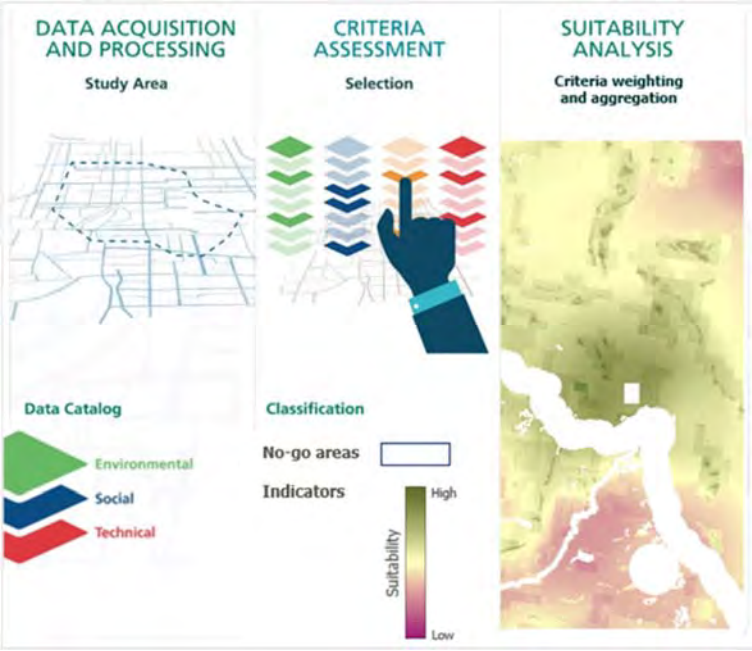
A Geographic Information System (GIS) was implemented to collect and manage relevant data describing physical, biological and social features that characterize the Country.

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 Wind Projects.

The criteria identified as either constraints or **no-go areas** (to identify exclusions) or **indicators** (to characterize a higher or lower suitability) were implemented in response to a series of sustainability goals. 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 large areas, presenting the higher values of suitability.

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

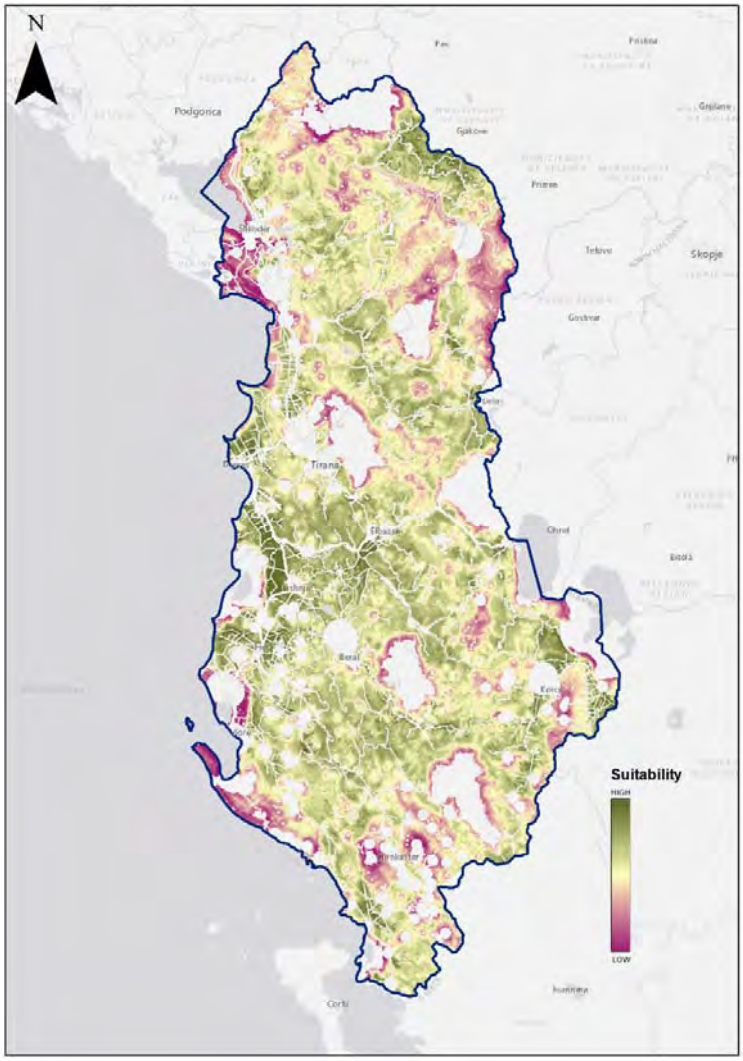


The suitability map has been reclassified using a quintile method to have a representation in slices of 20% of the suitable land available at country level. The best 20% corresponds to a total area of 350.000 hectares and has a suitability value greater than 70%.

The top quintile has been used to perform a selection and classification of areas of suitable land applying a minimum threshold of one hectare in size and classified according to the average wind speed at 150 m above ground/sea level, derived from the global wind atlas for Albania and used also as an indicator in the siting analysis.

The Suitability map and the complete set of indicators and no-go 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 Wind Project will ideally meet and best trade-off the goals of sustainability, according to the scale and consistency of available data sources considered.

The suitability framework adopted in this study and the deliverables produced m ay be leveraged at different stages and by multiple stakeholders involved in the wind 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 wind 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 sites and can contribute to streamlining the permitting process of development projects.

The present study is subject to the limitations listed in section 1.4.

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.

A Consultancy Team of experts in various disciplines was selected to provide technical and scientific support to the Government of Albania to promote and develop solar energy projects. In July 2020 their scope has been extended to the development of wind power projects.

Golder Associates ("Golder"), as part of the Consortium, was requested to assess the suitability of the entire Albanian territory, commissioning an analysis of suitable areas for the development of wind power plants (WPP).

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 Wind 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

1.4 Study limitations

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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 (no-go areas)** 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-

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

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 specific protected areas. 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.

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.).

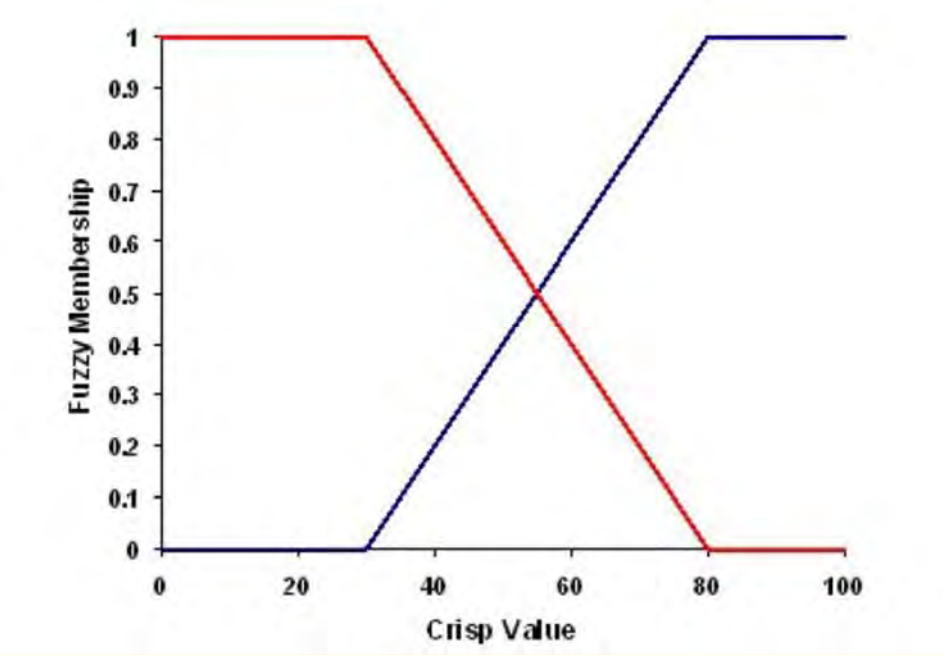


Figure 2: Direct (blue line) and inverse (red line) relationship between the indicators and the suitability scores

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.

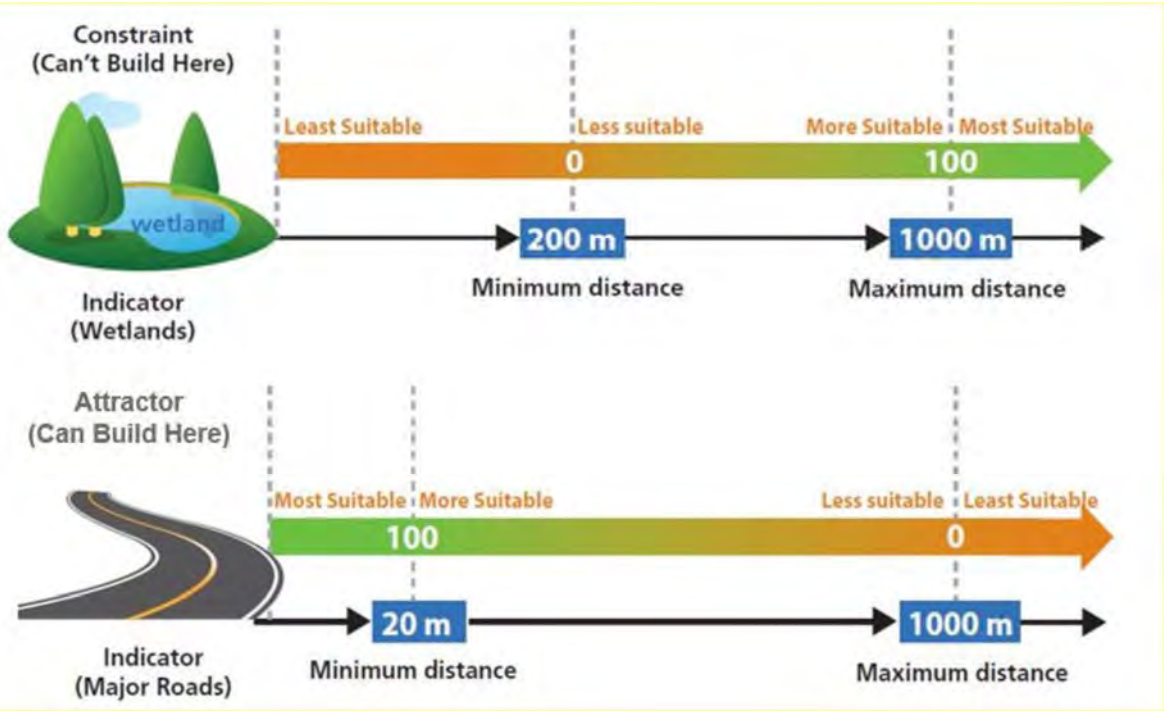


Figure 3: Criteria standardization between 0 (lowest suitability) and 100 (highest suitability), according to the proximity to existing features (Golder illustration).

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 "***No-go areas map***" (see Figure 8 and APPENDIX B). This surface is overlaid to the result of the aggregation of indicators to obtain the overall "***Suitability map***" (see Figure 9 and APPENDIX C) that is the basis to support the identification of the best locations that satisfy the goals of the study.

3.0 WIND SITING STUDY

This chapter illustrates the application of the GoldSET framework to support the definition of suitable areas for the projects of the Wind 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 began with a multi-stakeholder engagement carried out on September 10th and 11th, and October 23rd, 2020 involving representatives of institutions and subject matter experts, including from MIE and the Consortium. Study goals, the GoldSET approach and the list of criteria were shared and agreed with the stakeholders.

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 develop WPP was confirmed during the engagement and the following specific study goals were agreed upon:

- *Maximize wind energy production* (e.g., identify the areas with adequate average wind speed);
- *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 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, Important Birds Areas, etc.).

3.2 Data sources and data quality (WIND)

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 catalog of data sources used to develop the project database was the following:

- *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 Wind Atlas*
- *Integrated Biodiversity Assessment Tool (IBAT)*
- *OpenStreetMap/GeoFabrik*
- *World Database on Protected Areas (WDPA)*
- *Council of Europe – European Environmental Agency*
- *Joint Research Center (JRC)*
- *Transmission System Operator (OST)*
- *Agency of Territorial Development (ATD)*
- *Energy Regulatory Authority (ERE)*
- *World Karst Aquifer Map (WOKAM).*

The geoportal of the Albanian State Authority for Geospatial Information (ASIG), which allows the consultation of an exhaustive national geospatial database, did not allow the download of data. 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 Wind 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.Source consultation for data download: December 2019.

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

This is a source of topographic data used to define elevation and 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.

Source consultation for data download: December 2019.

- **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 wind project (such as dunes or beaches).

Source consultation for data download: December 2019.

- **Integrated Biodiversity Assessment Tool (IBAT)**

The Integrated Biodiversity Assessment Tool (IBAT) is a multi-institutional programme of work involving Bird Life International, Conservation International, IUCN and UNEP-WCMC. It compiles information on globally recognised biodiversity datasets derived from a number of IUCN's Knowledge Products: IUCN Red List of Threatened Species, Key Biodiversity Areas (priority sites for conservation) and Protected Planet/The World Database on Protected Areas (covering nationally and internationally recognised sites, including IUCN management categories I–VI, Ramsar Wetlands of International Importance and World Heritage sites). Each

dataset is updated at different frequencies. The World Database on Protected Areas is updated each month through web services, the World Database of Key Biodiversity Areas is updated twice a year, and the IUCN Red List is updated two to three times a year. IBAT was used to select IBAs areas from the KBA dataset and KBA which have a designation for migratory/resident birds.

Source consultation for data download: October 2020.

- **Global Wind Atlas**

The Global Wind Atlas provides access to wind resource data globally. The Global Wind Atlas is a joint initiative between the Technical University of Denmark (DTU) and the World Bank Group. The Global Wind Atlas helps policymakers, planners, and investors identify high-wind areas for wind power generation. The Global Wind Atlas primarily supports wind power development during the exploration and preliminary wind resource assessment phases prior to the installation of meteorology measurement stations on site. It also serves as a useful tool for governments to get a better understanding of their wind resource potential at provincial and local levels. Global Wind Atlas consists in a wind resource mapping at 10, 50, 100, 150 and 200 m above ground/sea level, with 250 m horizontal grid spacing.

Last released: October 2019 (based on 10 years of mesoscale time-series model simulations).

Source consultation for data download: March 2020.

- **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.

Source consultation for data download: December 2019.

- **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.

Source consultation for data download: December 2019.

- **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).

Source consultation for data download: September 2020.

- **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 in order 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.

Source consultation for data download: December 2019.

- **Transmission System Operator (OST)**

The transmission system of electricity in Albania is operated by the Transmission System Operator that provided detailed data about existing substations and transmission lines. Considering all technical and financial aspects connected to the choice of the best wind farm option in terms of the connection to transmission lines and substations, it was decided not to include these data in the suitability analysis. Instead, transmission lines and substations were overlapped to the suitability map as a post-processing information to further support the decision making.

This dataset had no associated metadata concerning accuracy, last update, and quality but the source can be considered consistent for the analysis considering that the data provider is the national transmission operator itself.

Data received in September 2020.

- **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 but also in this case the resource can be considered reliable for the scale of the analysis considering the standing of the data provider.

Data received in December 2019.

- **Albanian Energy Regulator Authority (ERE)**

The Energy Regulatory Authority is an independent public entity tasked to ensure a sustainable and secure electricity supply for the Albanian consumer by establishing an operational and competitive electricity market, taking into account the consumer's interest.

This source allowed the collection of information about wind farms, in terms of either footprint or wind turbines coordinates. However, these datasets are incomplete and the activity of collecting and process missing information is still ongoing. In addition to this, these data are not fully disclosed due to confidentiality reasons. Therefore, these data were not included in the analysis, but they could serve as post-processing indicators to better address the decision-making process.

Data received in September-October 2020.

- **World Karst Aquifer Map (WOKAM)**

The World Karst Aquifer Map (WOKAM) is intended to increase the awareness of these valuable but vulnerable freshwater supplies and to help address global water resources management. WOKAM was prepared in the framework of the World-wide Hydrogeological Mapping and Assessment Programme (WHYMAP). The digital Global Lithological Map (GLiM) by Hartmann and Moosdorf (2012) served as an important basis for WOKAM. Many other regional geological and hydrogeological maps, cross-sections and literature were consulted to improve the map, which was also validated by many regional experts. However, as the type and quality of information, as well as the availability of regional experts, is very different in different parts of the world, the reliability of WOKAM is spatially variable.

Source consultation for data download: August 2020.

3.3 Dimensions and criteria selection

The engaged stakeholders 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:

- *Obtain social consent and license to operate;*
- *Favor constructability.*

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 wind potential availability;*
- *Minimize construction delays;*
- *Minimize costs (capital, operational);*
- *Favor constructability – ensure ease of connectivity to the existing grid*.

As a result of the criteria selection, 24 criteria were selected (Table 1, Table 2 and Table 3), 7 belonging to the Environmental, 6 to the Social and 11 to the Technical dimension. Among these, a total of 10 constraints was identified, respectively 1 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 8).

Table 1: Selected indicators and constraints summary

Dimensions	Indicators no.	Constraints no.
Environmental	6	1
Social	3	3
Technical	5	6

The Indicators Workbook, reported in 0, 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.

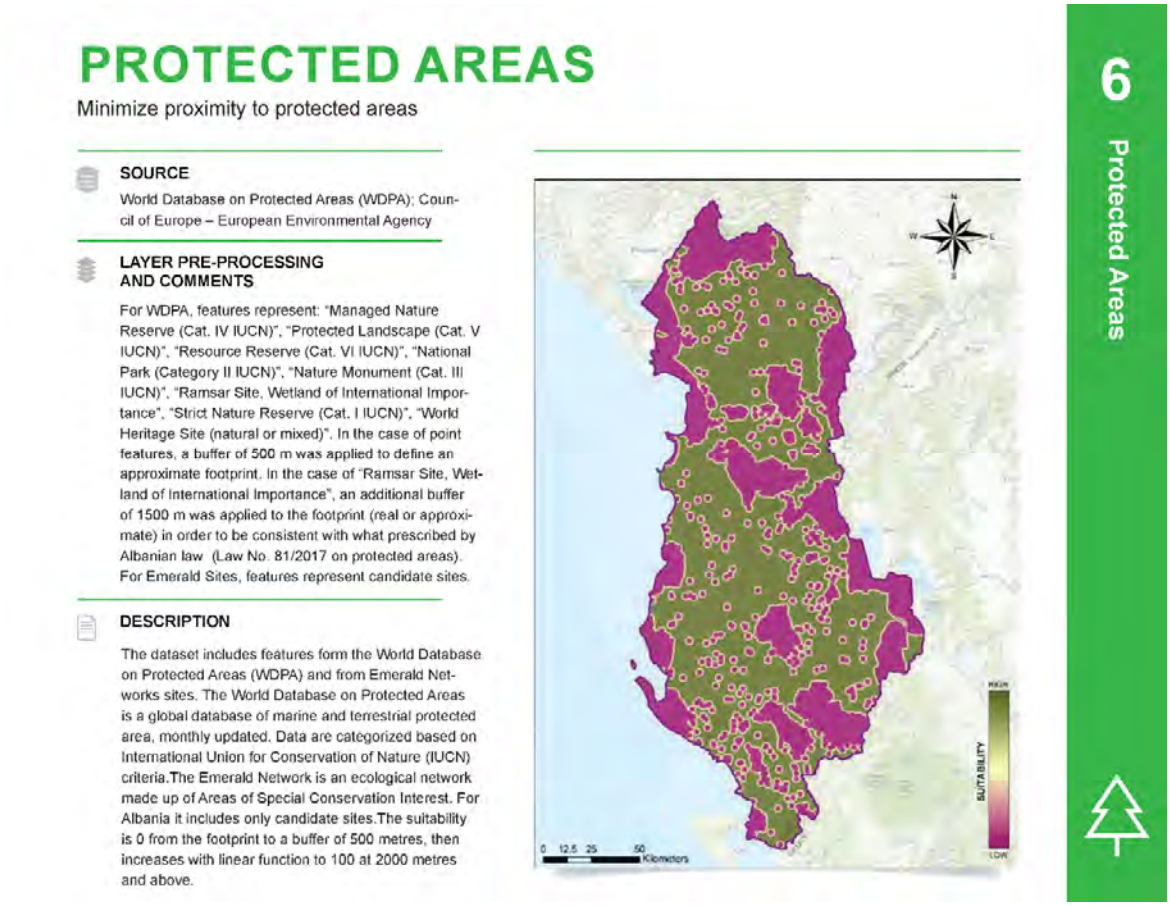


Figure 4: Indicators workbook sample page

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

Dimensions	Constraints (NO-GO areas)
ENVIRONMENTAL	**Protected Areas Constraint**[2] Avoid protected areas (footprint, Ramsar sites footprint +1500m)
SOCIAL	**Historic Resources Constraint** Avoid historic resources sites (footprint + buffer 2km)
	Recreation Areas Constraint Avoid green urban areas and leisure centres (footprint + buffer 2km)
	Urban Constraint Avoid built-up areas (footprint)
TECHNICAL	**Airports Constraint** Avoid airports (footprint + buffer 5km)
	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 + buffer 250m)
	Railway Constraint Avoid railway tracks (footprint + buffer 500m)
	Unsuitable Areas Constraint Avoid difficult terrain
	Water Surface Constraint Avoid water surfaces (footprint + buffer 50m)

[2] Protected areas considered as NO-GO-areas are those of IUCN Categories: “Strict Nature Reserve (Category I IUCN), “National Park” (Category II IUCN), “Nature Monument” (Category III IUCN), along with the “Ramsar Site, Wetland of International Importance” and “World Heritage Site (natural or mixed)”. Protected areas considered as indicator are all of the above plus the following IUCN Categories: “Managed Nature Reserve” (category IV IUCN), “Protected Landscape” (Category V IUCN), “Resource Reserve” (Category VI IUCN),” and the Emeralds Sites. The selection criteria are largely aligned with the Albanian legislation (see APPENDIX G).

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

Dimensions	Indicators
ENVIRONMENTAL	**Birds** Minimize proximity to birds' areas
	Critical Habitat Minimize proximity to Critical Habitats
	Geohazard Minimize use of areas potentially affected by geohazards
	Potential Karstic Areas Minimize proximity to potential karstic areas
	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
	Elevation Prefer areas at lower altitude
	Major Transport Service Prefer proximity to major transportation routes
	Unsuitable terrain (slope) Avoid steep slopes
	Wind speed Prefer areas characterized by optimal average wind speed

3.4 Weight assignment

The weighting process of the selected criteria was carried out in September and October 2020, as 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" and Birds indicator are valued the most important with an average score of respectively 95.2 and 95. The "Population density" criterion has the highest value within the Social group, while the most influential criterion within the Technical group is the "Wind speed" with an average score of 97.6. On the other hand, the indicators based on proximity to respectively "Water surface", "Critical facilities" and "Airports" are the least influential criteria, for Environmental, Social, and Technical dimension.

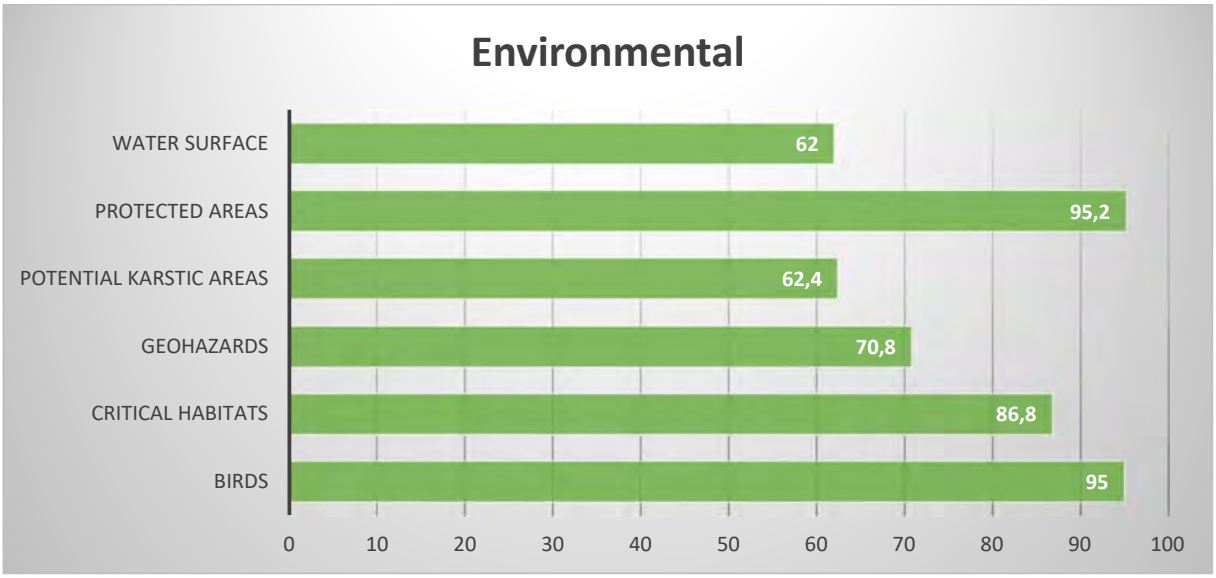


Figure 5: Environmental indicators weights

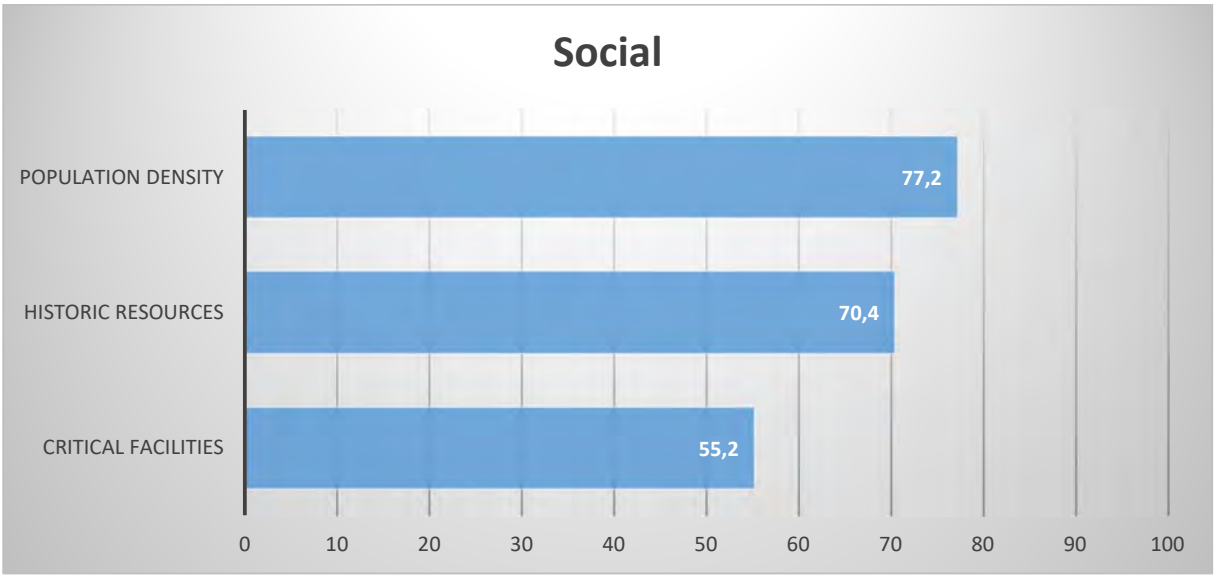


Figure 6: Social indicators weights

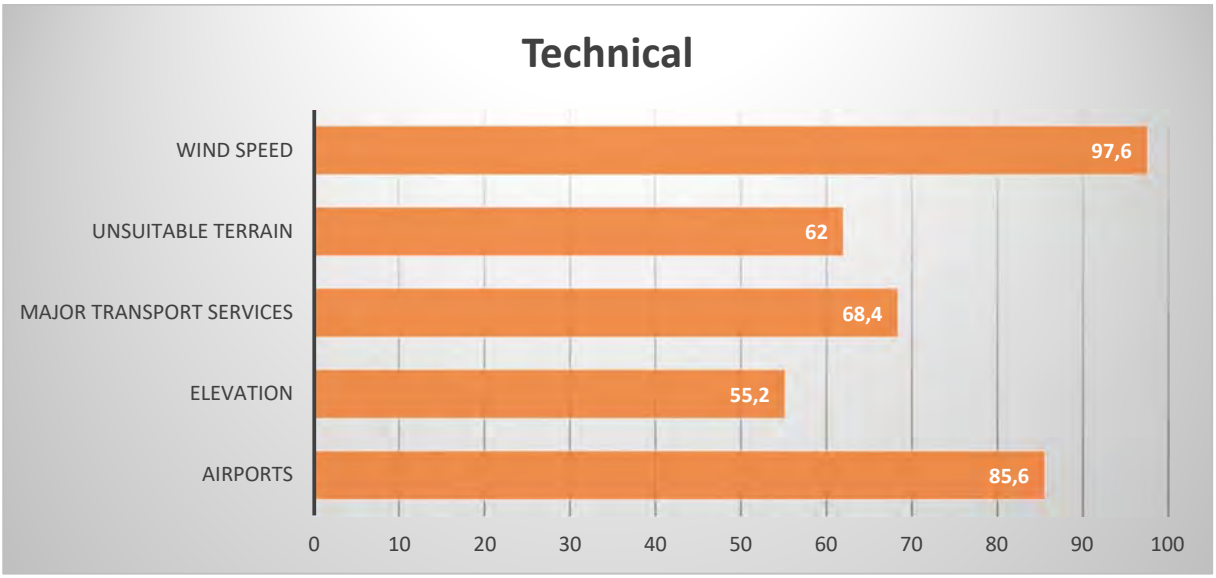


Figure 7: Technical indicators weights

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 8) and subtracted from the result of the aggregation of indicators to obtain the overall "***Suitability Surface***" (Figure 9).

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 to develop WPP.

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 wind speed indicator was transformed by a linear stretch function between the minimum feasible (5 m/s) and the maximum available average wind speed 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 virtual workshop using a derived relative weight that sums up to 100 within each dimension.

The dimensions have been considered to have a relative importance proportional to the number of indicators, hence the weight assigned is different for environmental, social and technical. A higher dimension weight will factor in the lower average weight shared between a higher number of indicators within the dimension. 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 (stakeholders)	Relative WEIGHT	Final weight
Environmental	0.43	BIRDS	95.0	20.1	8.62
		CRITICAL HABITATS	86.8	18.4	7.88
		GEOHAZARDS	70.8	15.0	6.43
		POTENTIAL KARSTIC AREAS	62.4	13.2	5.66
		PROTECTED AREAS	95.2	20.2	8.64
		WATER SURFACE	62.0	13.1	5.63
Social	0.21	CRITICAL FACILITIES	55.2	27.2	5.83
		HISTORIC RESOURCES	70.4	34.7	7.44
		POPULATION DENSITY	77.2	12.7	8.16
Technical	0.36	AIRPORTS	85.6	23.2	8.29
		ELEVATION	55.2	15.0	5.35
		MAJOR ROADS	68.4	18.5	6.62
		SLOPE	62.0	16.8	6.00
		WIND SPEED	97.6	26.5	9.45

3.6 Suitable areas identification

The final suitability surface and its set of underlying criteria are tools to support in the identification and characterization of the suitable areas for the objective of developing a wind farm.

Setting up a wind farm is quite a complex task to accomplish because many factors are involved in the feasibility study. The starting point is finding a suitable area where evaluating the wind potential to support the minimum amount of electricity required in megawatt. Wind speed is a crucial variable but as highlighted by the indicators list, it is only one of the factors contributing to a final site selection. Looking at the final set of weights, wind

speed has the highest influence, nonetheless its contribution to the overall suitability is a little bit less than 10% because other factors, not only technical, need to be considered.

The suitability map has been reclassified using a quintile method (Figure 10 and APPENDIX D) to have a representation in slices of 20% of the suitable land available for the country. The best 20% corresponds to a total area of 350,000 hectares and has a suitability value greater than 70%.

The top quintile has been converted in polygonal shapes to perform a selection and classification of areas of suitable land. A 2009 report from the National Renewable Energy Laboratory (NREL, United States Department of Energy) studied land area uses for operating wind farms and provided statistics showing that the average area densities ranged from about 12 to 100 ha/MW with an average extension of 35 hectares per megawatt.

Therefore, the top quintile polygons have been classified and symbolized according to the size, in defined intervals of 1,000 hectares (Figure 11 and APPENDIX E) to help identify an adequate area depending on the megawatts to be developed for a single plant. The total area requirement of a WPP is the area within a perimeter surrounding all the turbines planned within a specific project. A wind farm has a fairly variable range of total area requirements (different from the permanently occupied land) due to the fact that wind turbines need to be spaced hundreds of meters apart so that the turbulence of one turbine does not interfere with another, reducing the overall power generation. The distance to be applied is correlated with the wind farm configuration (string, multiple or parallel strings, clusters depending on sites morphology) and with the size of the turbines (megawatts and rotor diameter).

The top quintile areas have also been classified and represented on the map (Figure 12 and APPENDIX F) according to the average wind speed at 150 m above ground/sea level, derived from the global wind atlas for Albania and used also as an indicator in the siting analysis. Due to the small scale of the global wind Atlas, no constraint has been applied to locations below a minimum speed threshold to start a wind turbine, leaving the assessment of wind suitability to detailed studies that can be performed at later stages. As a preliminary guidance, the wind speed map can assist in prioritizing the WPP detailed feasibility studies in the most suitable areas where other technical, social or environmental factors achieve the best results.

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.

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

Land ownership, for instance, is 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. If land ownership map is not available, as in this study, the Suitability map can still drive a hypothetical identification of sites.

In addition, the information of the plant size and geometric configuration, can help identify a site that trades off those spatial requirements (size, shape and configuration) with the highest suitability.

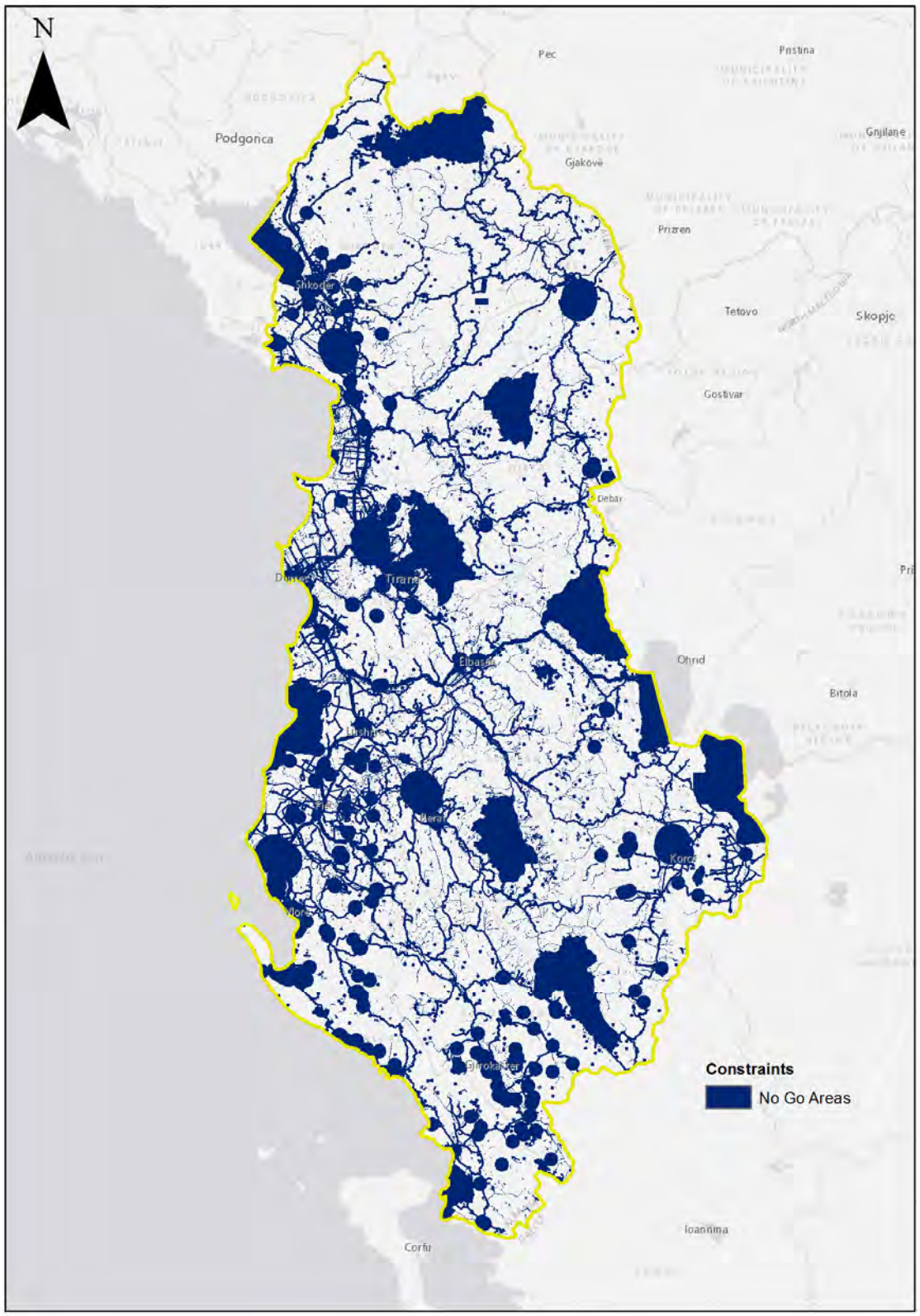


Figure 8: No-go areas map for WPP siting.

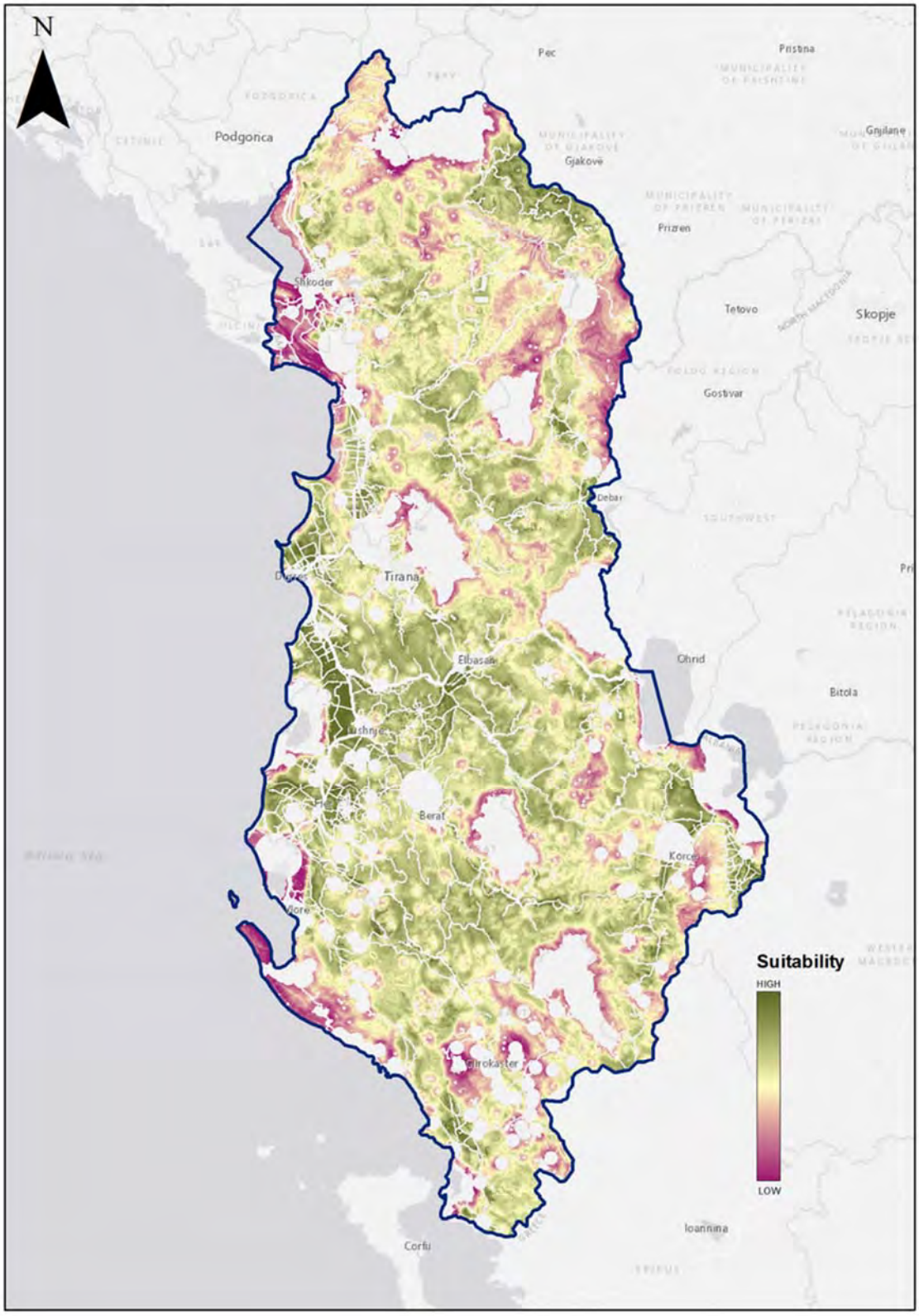


Figure 9. Suitability map for WPP siting.

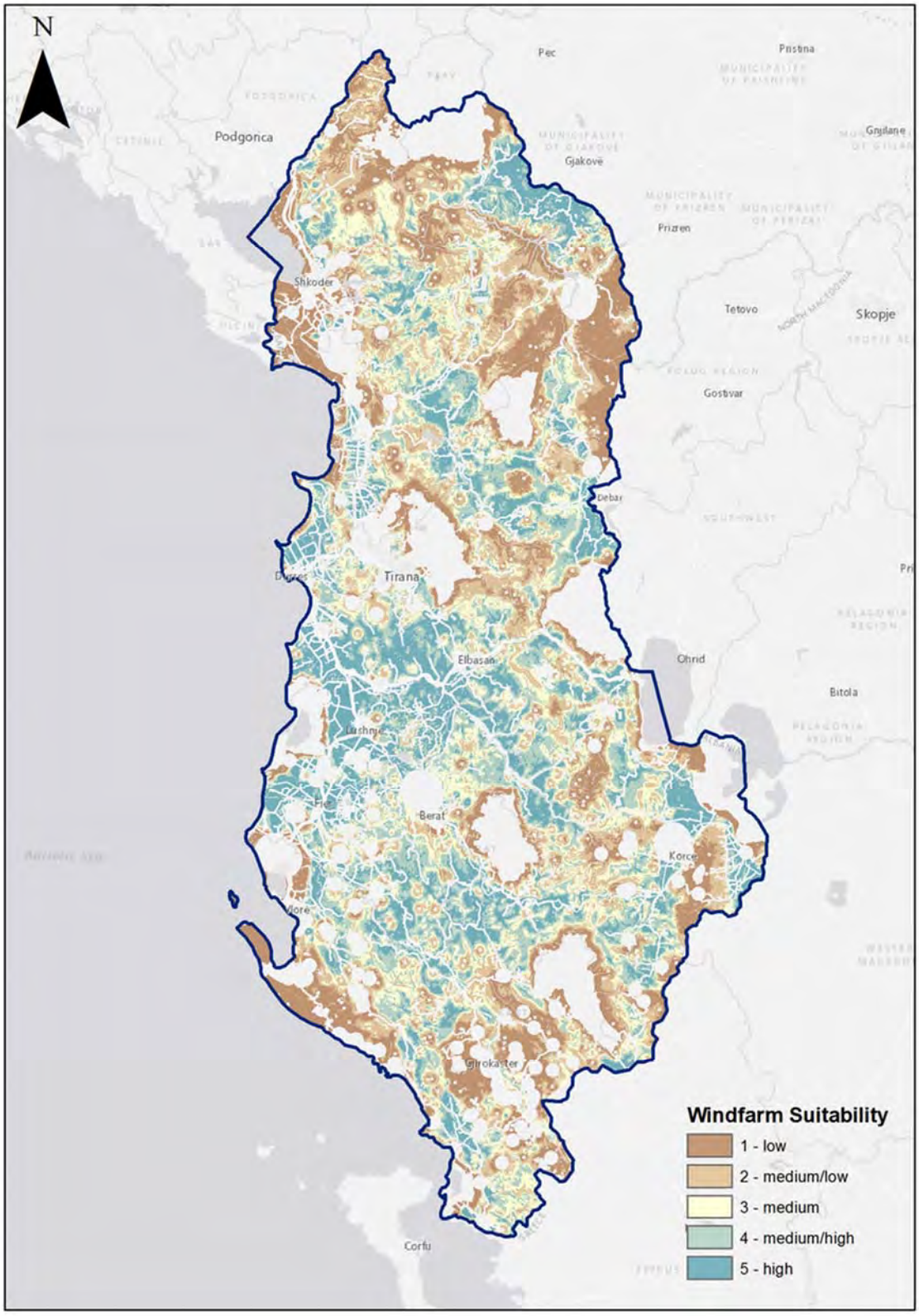


Figure 10. Suitability classes (quintiles) for WPP siting.

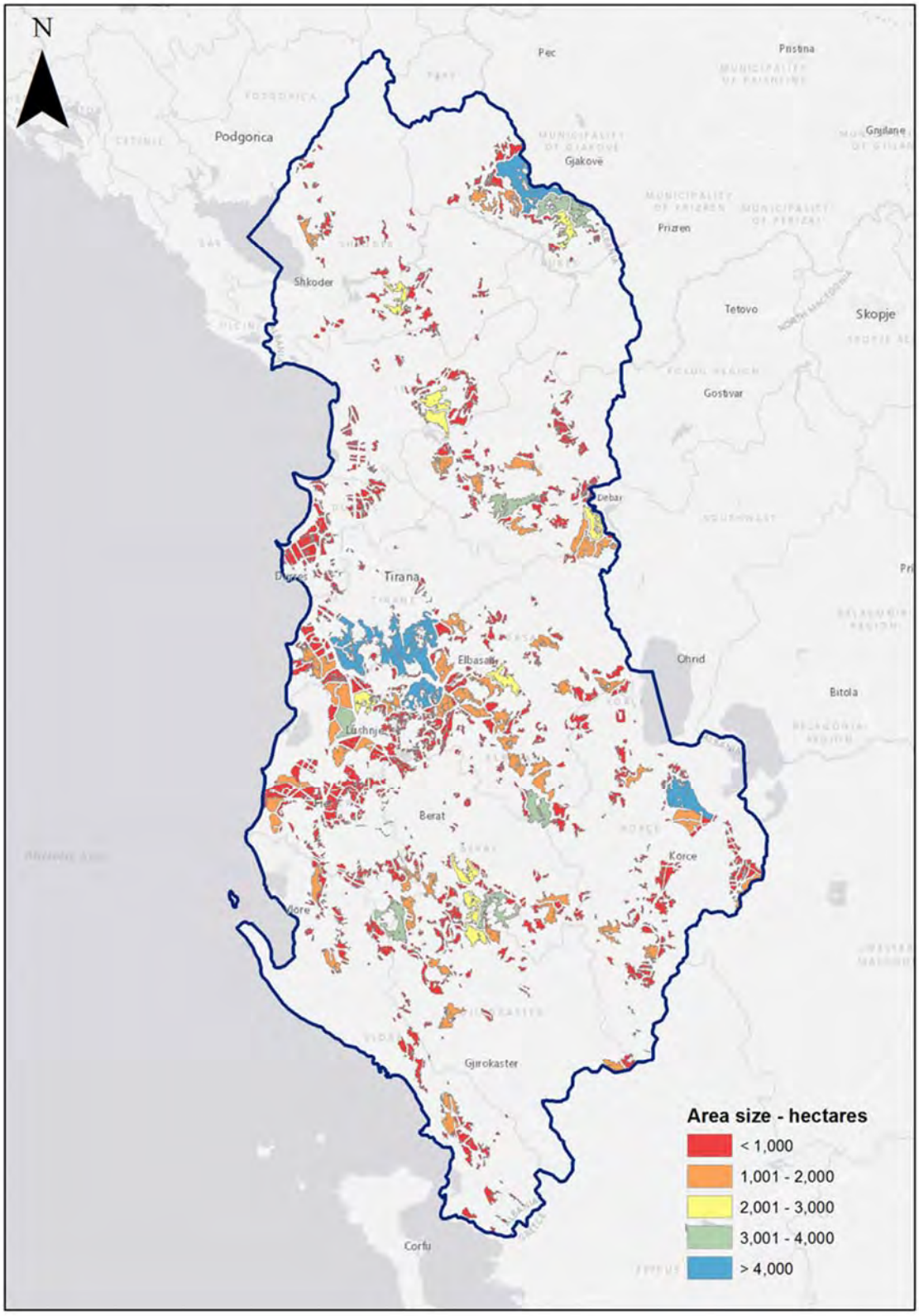


Figure 11: Most suitable areas classified according to size in hectares

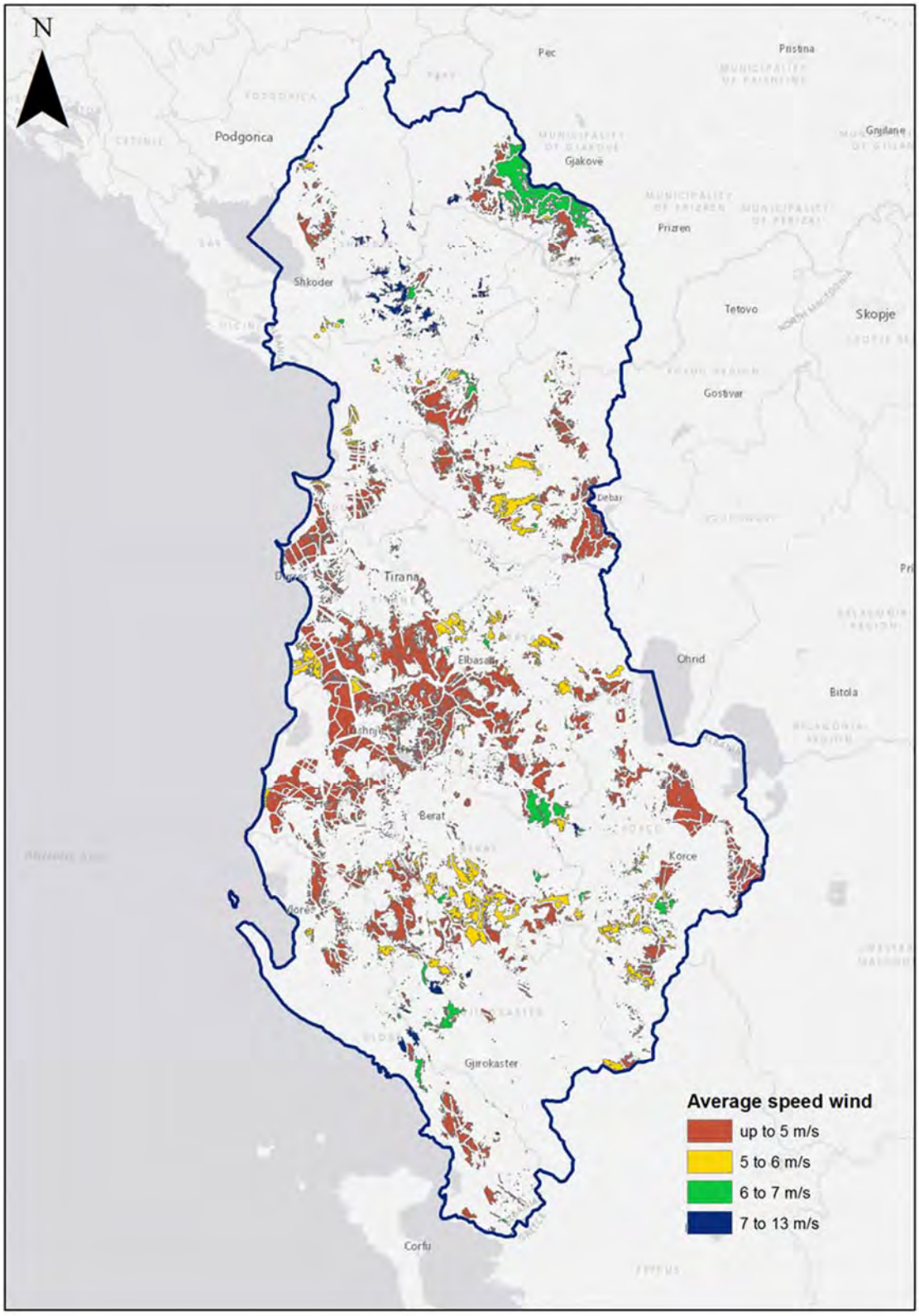


Figure 12: Most suitable areas classified according to average wind speed

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 wind 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 wind 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

Setting up a wind farm is quite a complex task to accomplish because many factors are involved in the feasibility study. The starting point is finding a suitable area where evaluating the wind potential to support the minimum amount of electricity required in megawatt. Wind speed is a crucial variable but as highlighted by the indicators list, it is only one of the factors contributing to a final site selection.

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 catalogue of indicators (Indicator Workbook), documenting the data source and its usage to derive decision criteria included in the analysis process.

The GoldSET methodology was applied to derive a suitability map for wind projects development. The map has been reclassified using a quintile method (Figure 10) to have a representation in slices of 20% of the suitable land available at country level.

The top quintile has been used to perform a selection and classification of areas of suitable land applying a minimum threshold of one hectare in size and classified according to the average wind speed at 150 m above ground/sea level, derived from the global wind atlas for Albania and used also as an indicator in the siting analysis.

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 WPP 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.

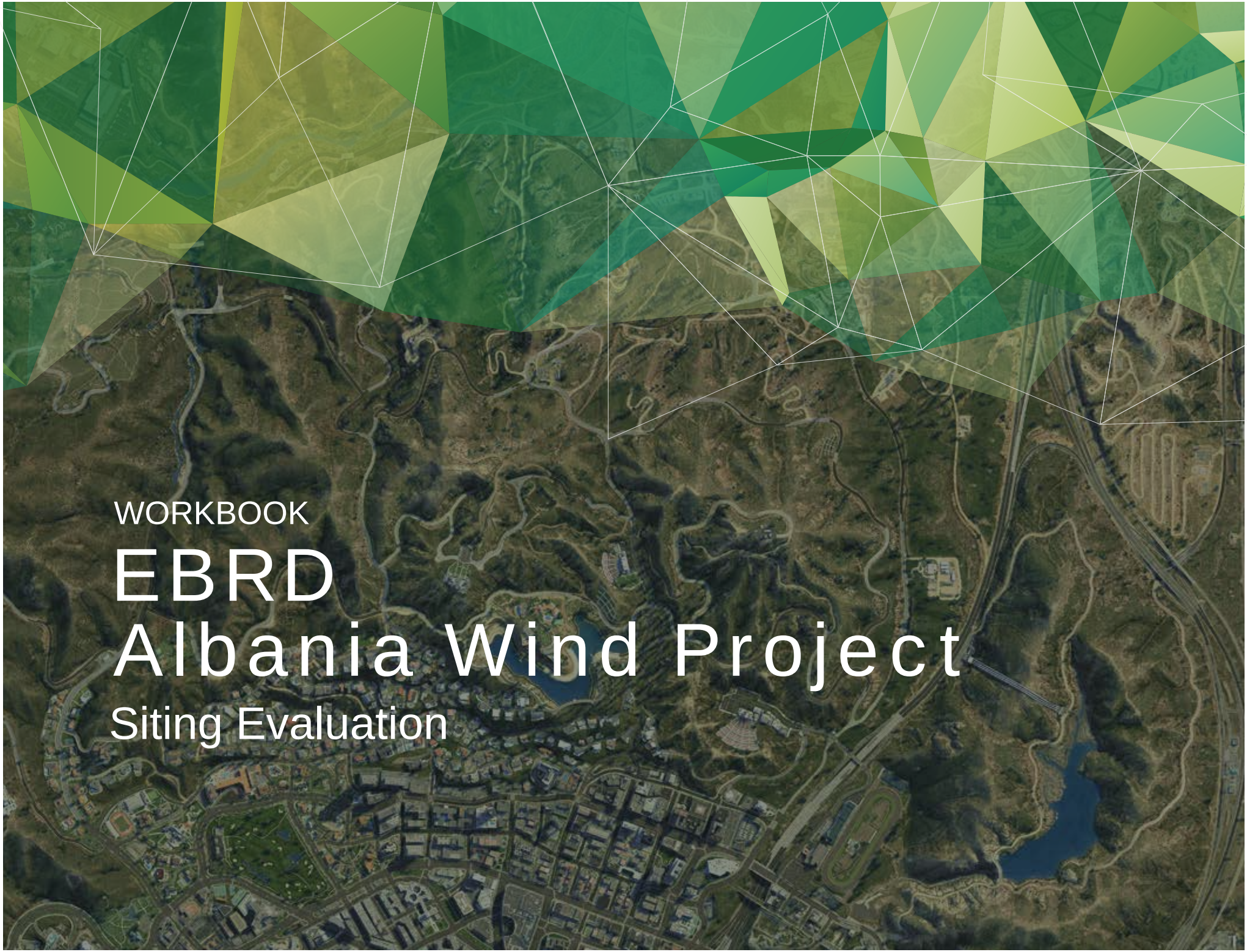
The adopted criteria are deemed adequate for the scale of the Study so that the suitable areas proposed can be considered a reliable screening to guide the initial bidding process, considering that detailed site selection and wind resource availability studies will be required.

Leveraging this analysis framework both on the side of authorities as well as by the developers has the potential of streamlining the wind 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 WPP, policy makers, professionals and financial institutions in the comparison and ranking of selected sites and ultimately streamlining the permitting process of development projects.

APPENDIX A

WORKBOOK - Albania Wind Project - Siting Evaluation



WORKBOOK

EBRD
Albania Wind Project

Siting Evaluation

GOLDER

European Bank
for Reconstruction and Development

GoldSETSpatial

ENVIRONMENTAL

Indicators

01 . Birds

02 . Critical Habitat

03 . Geohazard

04 . Potential Karstic Areas

05 . Protected Areas

06 . Protected Areas Constraint

07 . Water Surface

BIRDS

Minimize impacts to birds

SOURCE

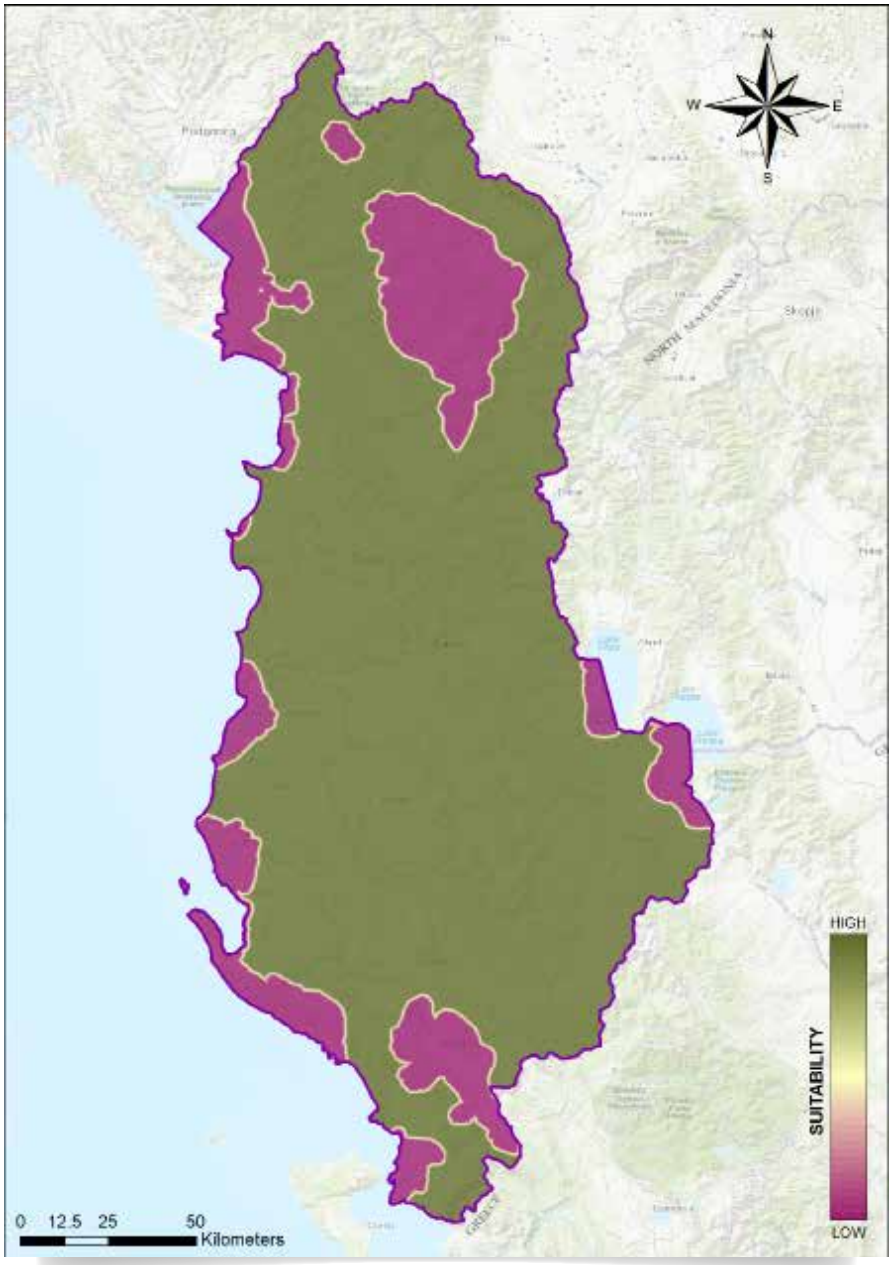
Integrated Biodiversity Assessment Tool (IBAT)

LAYER PRE-PROCESSING AND COMMENTS

Select IBAs areas from the KBA dataset (ibastatus = “confirmed”) and KBA which have a designation for migratory/resident birds.

DESCRIPTION

The dataset includes features form the Key Biodiversity Areas (KBA) database: Important Bird Areas (IBA) and other KBA which have a designation for migratory/resident birds. IBA are identified using an internationally agreed set of criteria as being globally important for the conservation of bird populations. IBA was developed and sites are identified by Bird Life International.
The suitability is 0 from the footprint to a buffer of 500 metres, then increases with linear function to 100 at 2000 metres and above.



CRITICAL HABITAT

Minimize impact on Critical Habitat

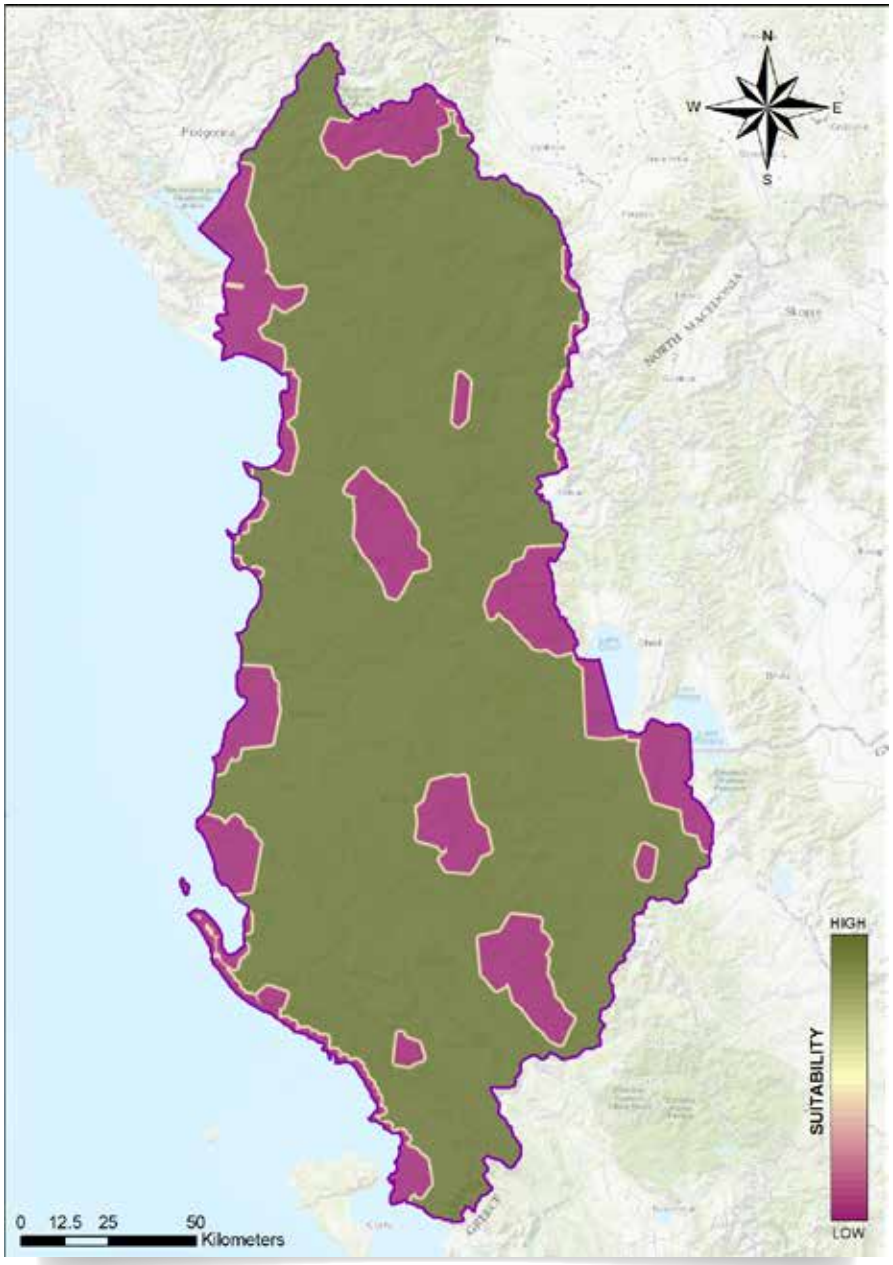
SOURCE

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 features. The suitability is 0 at a buffer of 500 metres from the footprint, then increases with linear function to 100 at 2000 metres and above.



GEOHAZARD

Minimize proximity to areas potentially affected by landslide

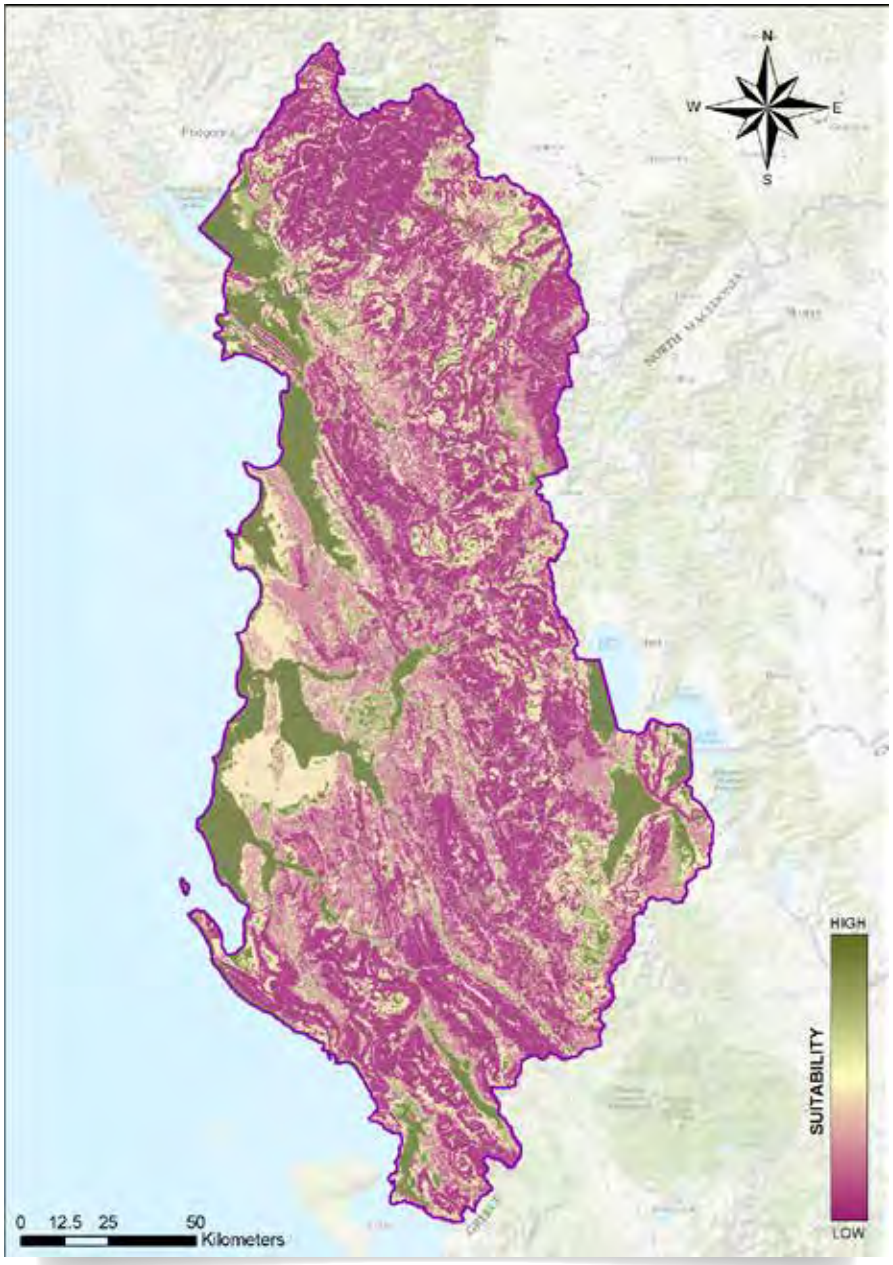
SOURCE

Joint 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.



POTENTIAL KARSTIC AREAS

Minimize proximity to potential karstic areas

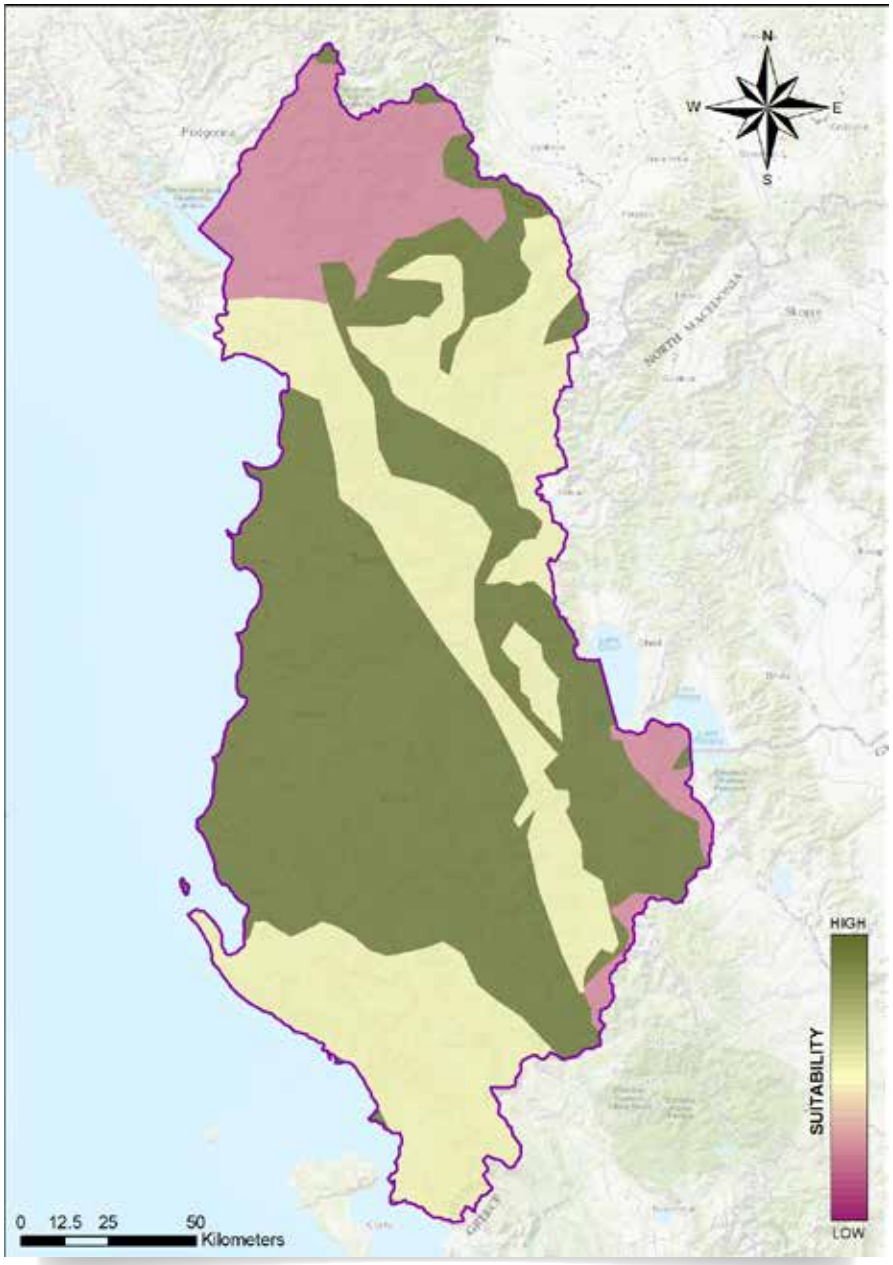
SOURCE

World Karst Aquifer Map (WOKAM)

LAYER PRE-PROCESSING AND COMMENTS

DESCRIPTION

Potential karstic areas are part of the World Karst Aquifer Map which is intended to increase the awareness of these valuable but vulnerable freshwater supplies and to help to address global water resources management. The dataset includes Continuous carbonate rocks and Discontinuous carbonate rocks. Continuous carbonate rocks are more likely to host karstic areas (that can cause a litany of problems for a windpower project) so suitability = 30. Discontinuous carbonate rocks are less likely to host karstic areas and so suitability = 60.



PROTECTED AREAS

Minimize proximity to protected areas

SOURCE

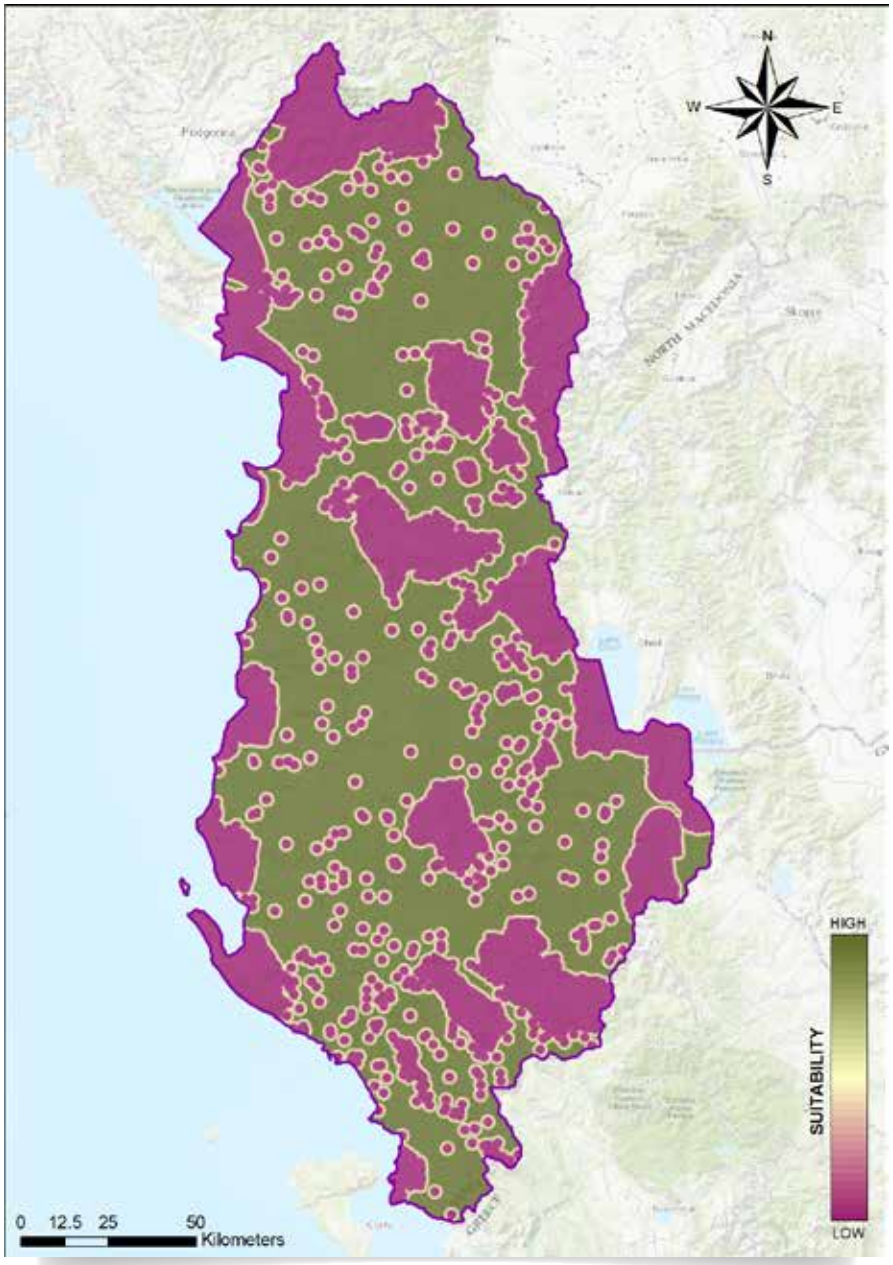
World Database on Protected Areas (WDPA); Council of Europe – European Environmental Agency

LAYER PRE-PROCESSING AND COMMENTS

For WDPA, features represent: “Managed Nature Reserve (Cat. IV IUCN)”, “Protected Landscape (Cat. V IUCN)”, “Resource Reserve (Cat. VI IUCN)”, “National Park (Category II IUCN)”, “Nature Monument (Cat. III IUCN)”, “Ramsar Site, Wetland of International Importance”, “Strict Nature Reserve (Cat. I IUCN)”, “World Heritage Site (natural or mixed)”. In the case of point features, a buffer of 500 m was applied to define an approximate footprint. In the case of “Ramsar Site, Wetland of International Importance”, an additional buffer of 1500 m was applied to the footprint (real or approximate) in order to be consistent with what prescribed by Albanian law (Law No. 81/2017 on protected areas). For Emerald Sites, features represent candidate sites.

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 2000 metres and above.



PROTECTED AREAS CONSTRAINT

Avoid protected areas

SOURCE

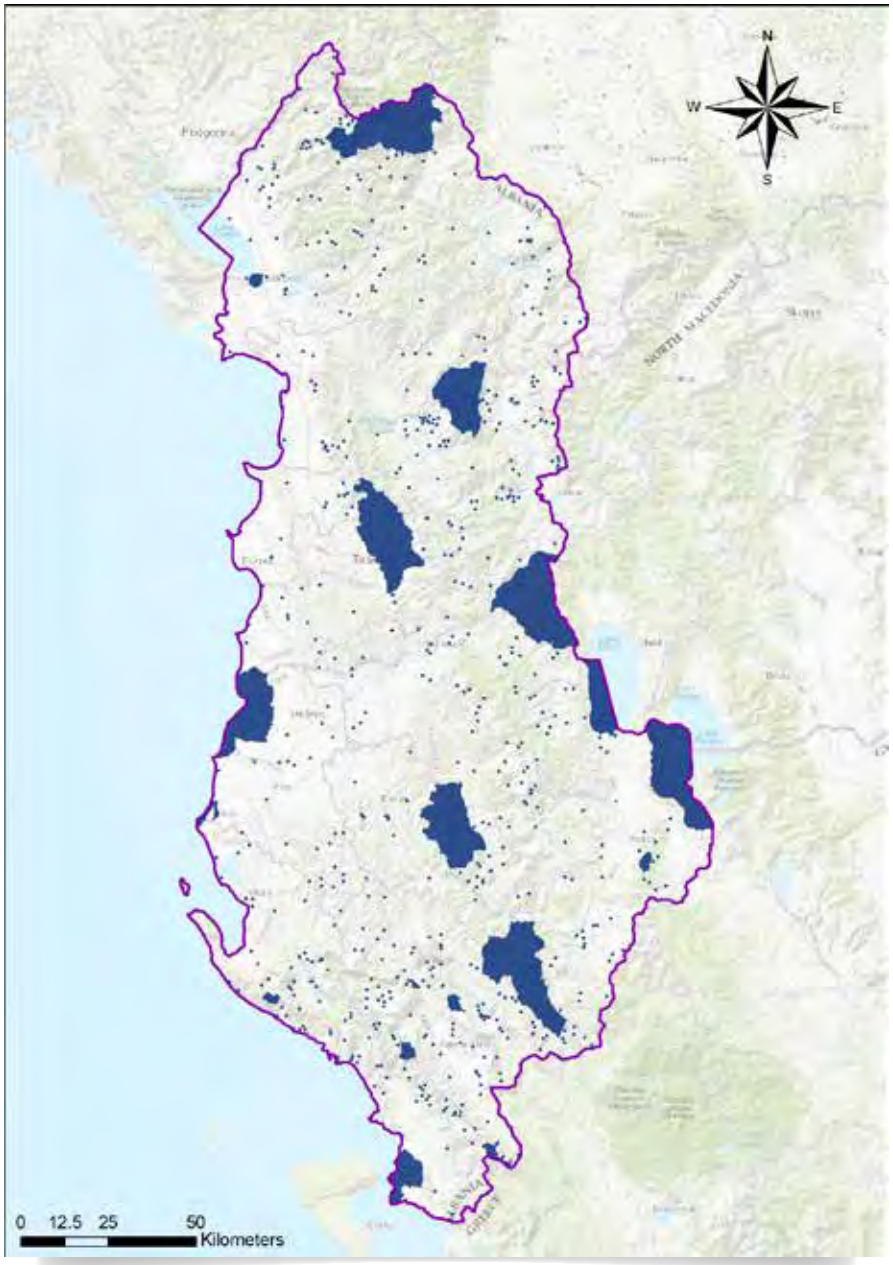
World Database on Protected Areas (WDPA)

LAYER PRE-PROCESSING AND COMMENTS

Features representing “National Park (Category II IUCN)”, “Nature Monument (Category III IUCN)”, “Ramsar Site, Wetland of International Importance”, “Strict Nature Reserve (Category I IUCN)” and “World Heritage Site (natural or mixed)” are considered as constraint. The selected feautures identify the more articulate and complex areas, with elaborated interactions. In the case of point features, a buffer of 500 m was applied to define an approximate footprint. In the case of “Ramsar Site, Wetland of International Importance”, an additional buffer of 1500 m was applied to the footprint (real or approximate) in order to be consistent with what prescribed by Albanian law (Law No. 81/2017 on protected areas).

DESCRIPTION

The dataset includes features form the The World Database on Protected Areas (WDPA). 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.
Protected areas are identified by either a polygon or a representative point.



WATER SURFACE

Minimize proximity to water surface

SOURCE

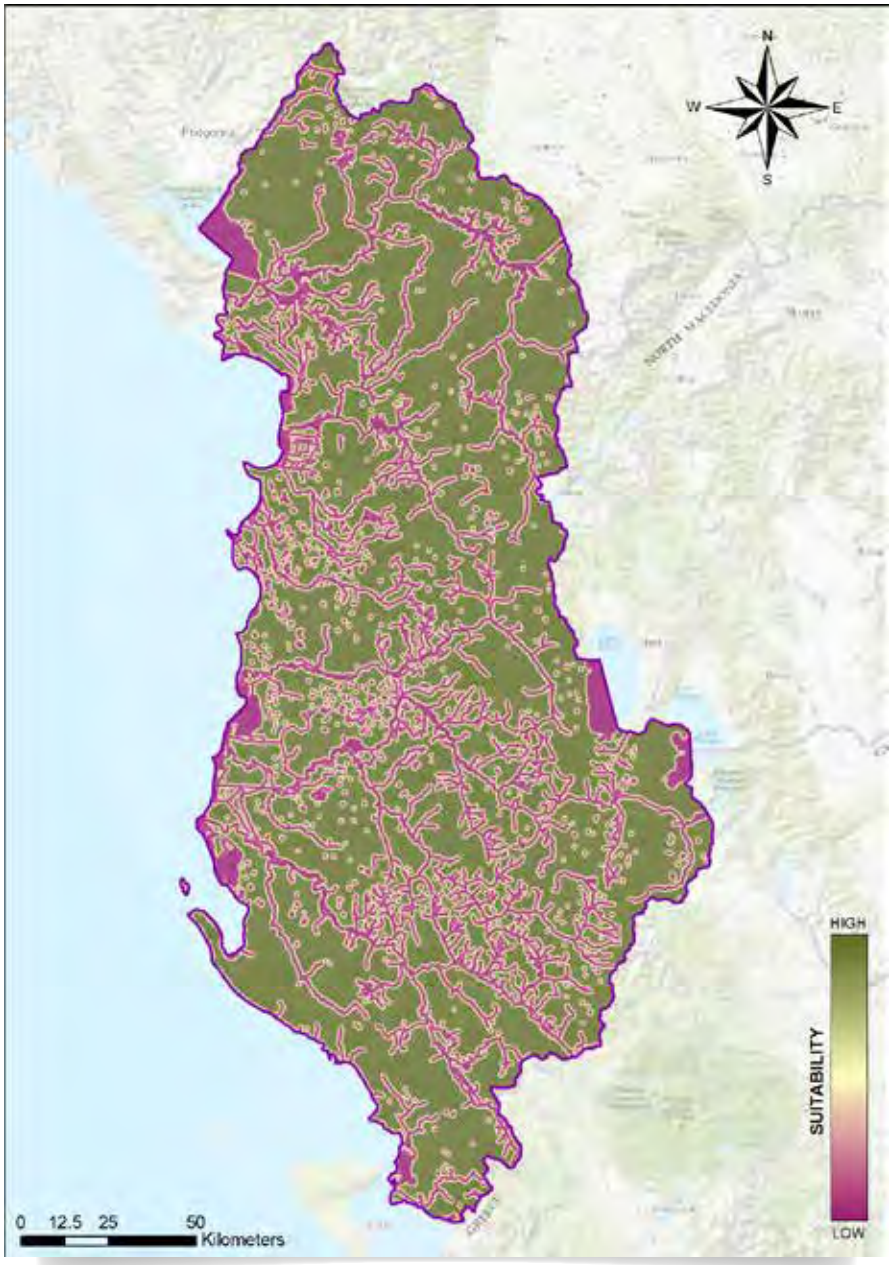
Joint Research Centre - Global Surface Water; Agency of Territorial Development (ATD)

LAYER PRE-PROCESSING AND COMMENTS

Convertion of Global Surface Water data from raster type to vector type. Merge 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 consist of 50 metres buffer around waterways and include: streams, rivers, canals, ditches, drains, dams, weirs, trickles, ponds. Suitability is 0 from the footprint to 100 metres distance, then increases (in linear function) to 100 at a distance of 1000 metres.



SOCIAL

Indicators

08 . Critical Facilities

09 . Historic Resources

10 . Historic Resources Constraint

11 . Population Density

12 . Recreation Areas Constraint

13 . Urban Constraint

CRITICAL FACILITIES

Prefer proximity to critical facilities areas

SOURCE

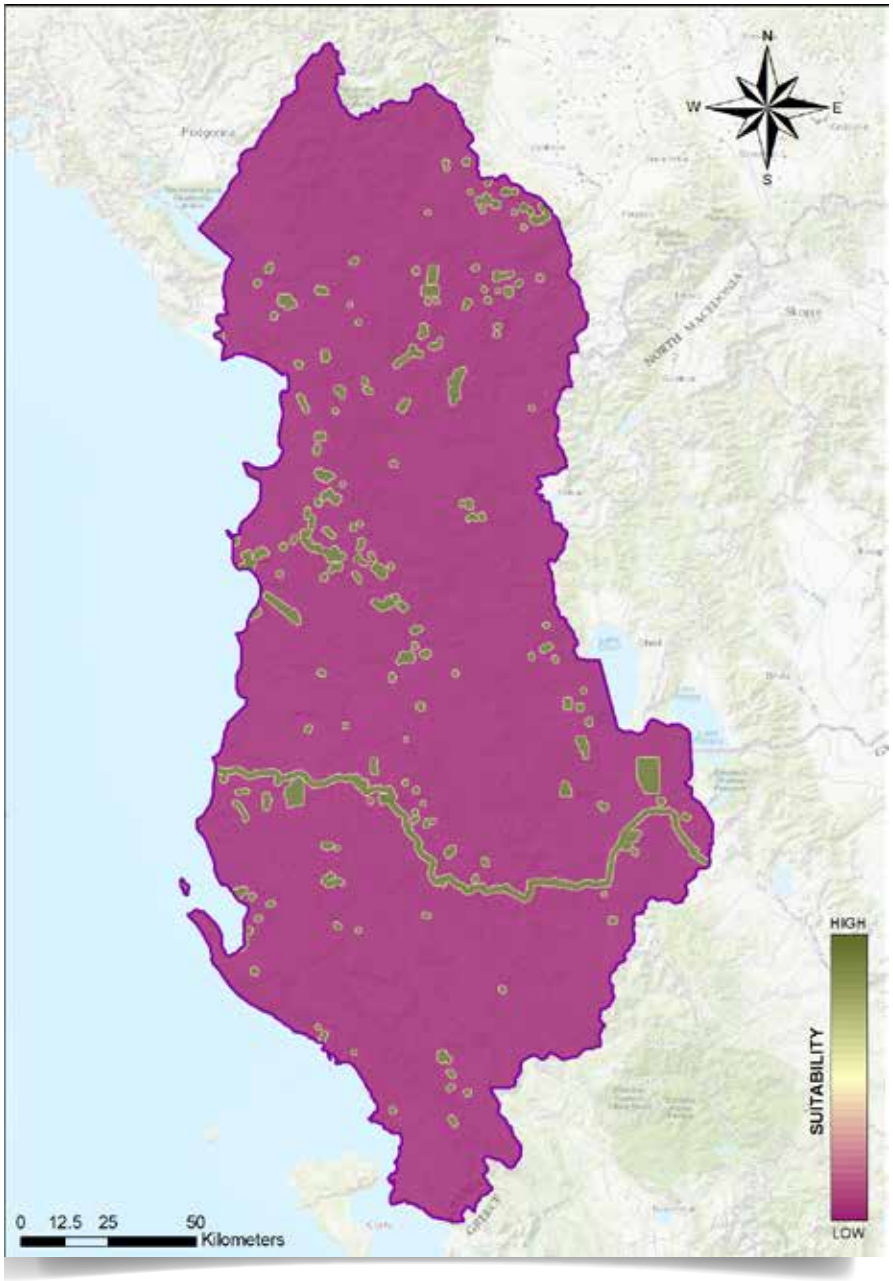
Copernicus Land Monitoring Service (CLMS) - Corine Land Cover; Agency of Territorial Development (ATD)

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, industrial areas from ATD. Suitability value is maximum from the footprint to 500 metres. The suitability decades between 500 and 1000 metres from the footprint. Above 1000 metres the suitability is 0.



HISTORIC RESOURCES

Minimize proximity to historic resources areas

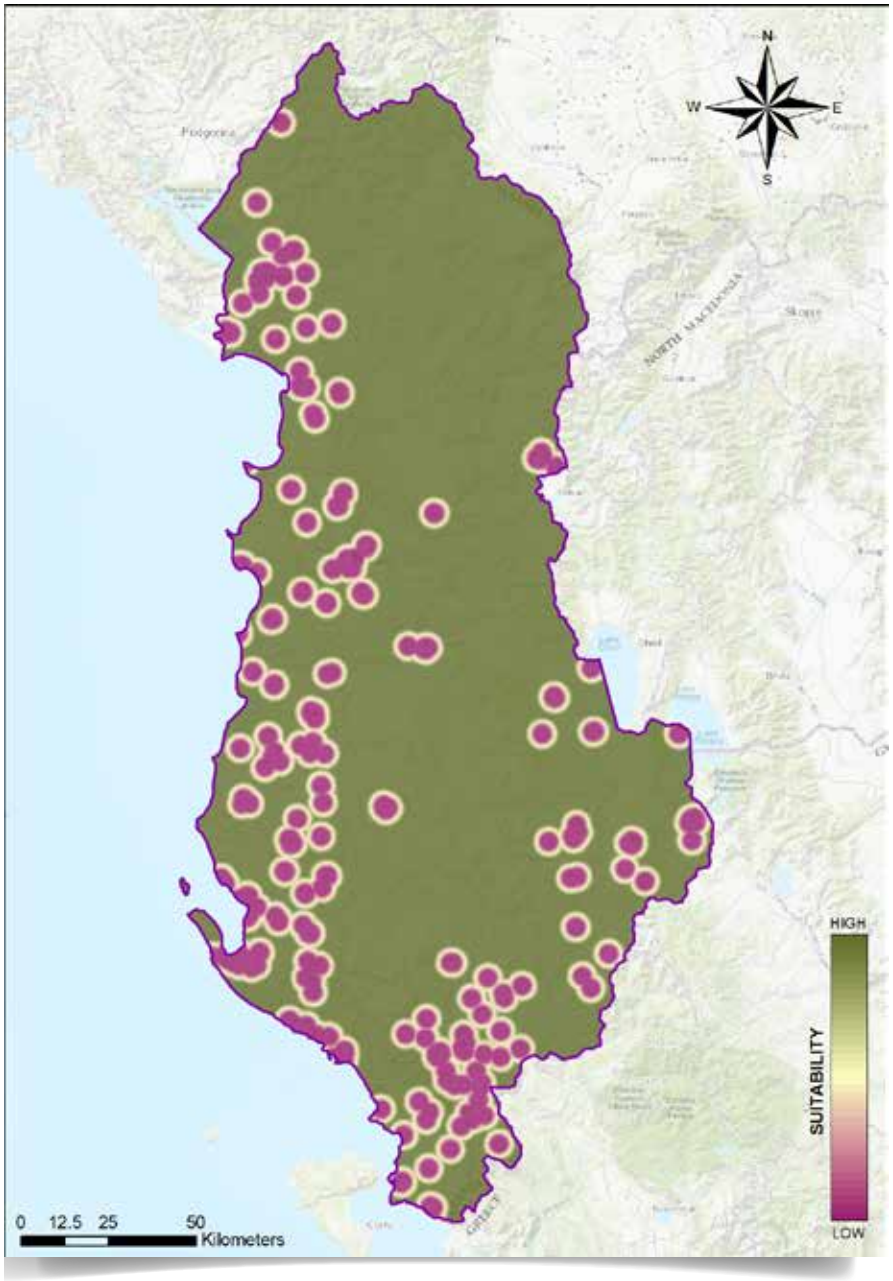
SOURCE

Agency of 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. The suitability is 0 at a buffer of 2000 metres from the footprint, then increases with linear function to 100 at 5000 metres and above.



HISTORIC RESOURCES CONSTRAINT

Avoid historic resources sites

SOURCE

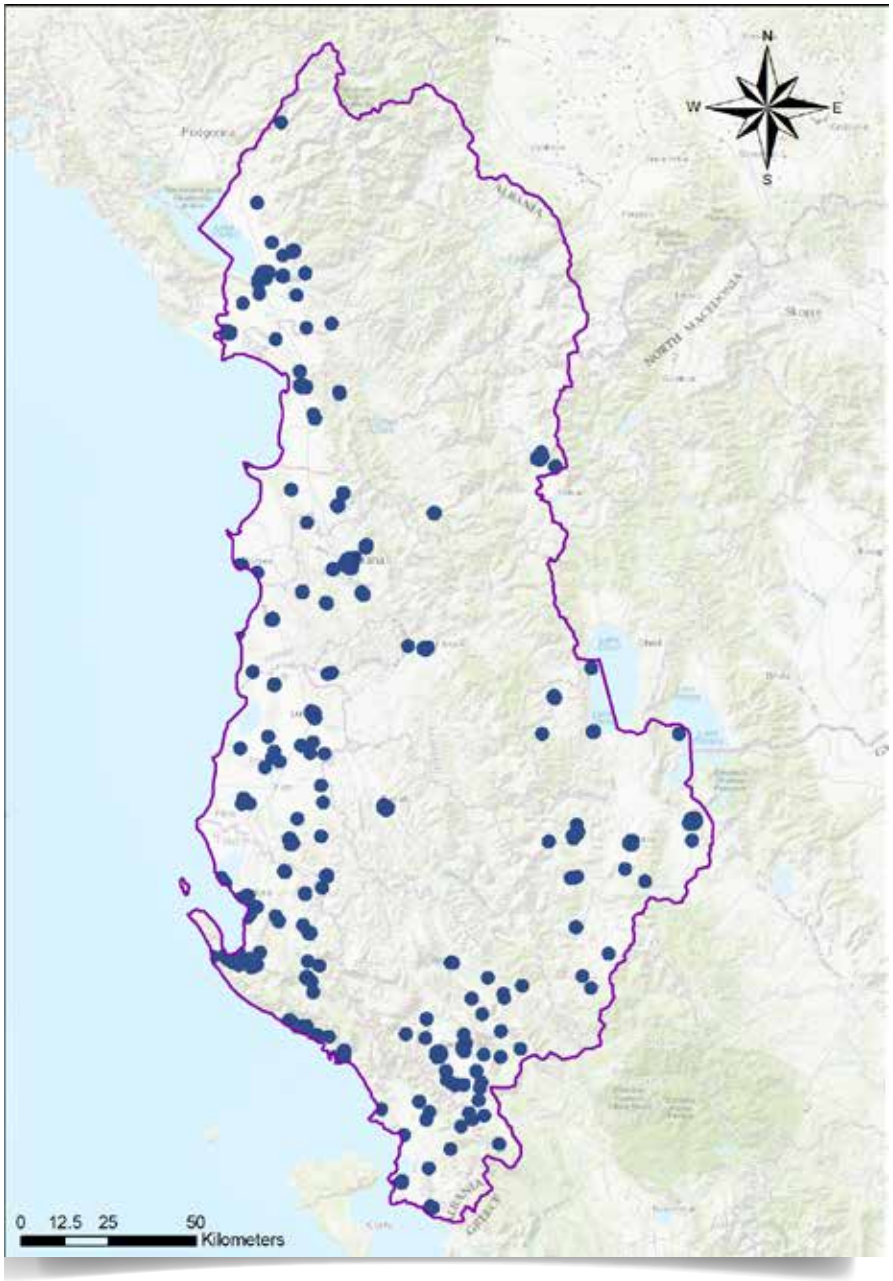
Agency of Territorial Development (ATD)

LAYER PRE-PROCESSING AND COMMENTS

Calculate 2000 metres buffer around polygons in order to create constraint areas.

DESCRIPTION

The dataset includes: archaeological parks, castles, towers, monumental areas, museums, art galleries, historic buildings, churches, mosques, bridges, necropolis. A buffer of 2000 metres is established as an exclusion.



POPULATION DENSITY

Avoid highly populated areas

SOURCE

Joint 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

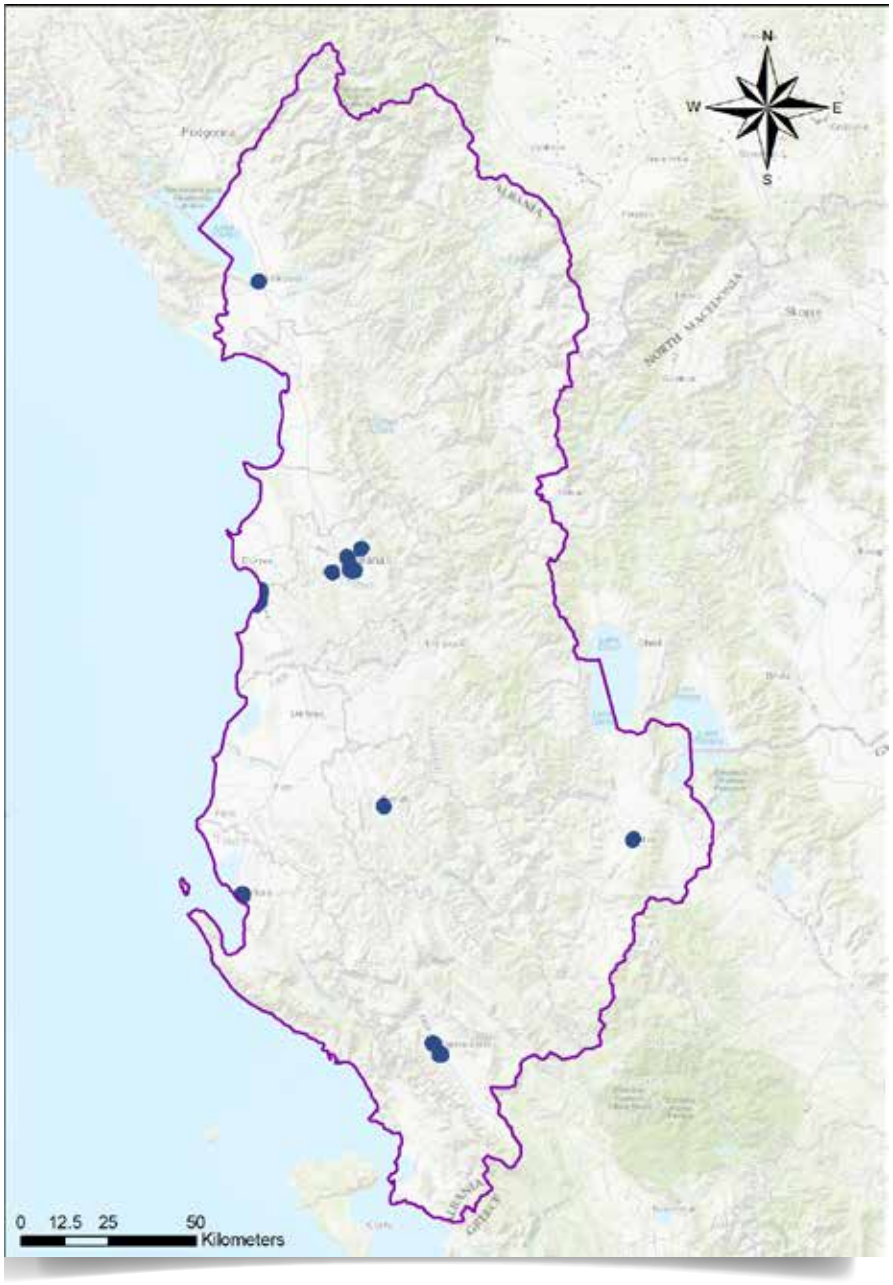
Copernicus Land Monitoring Service (CLMS) - Corine Land Cover

LAYER PRE-PROCESSING AND COMMENTS

Select Corine Land Cover areas. Calculate 2000 metres buffer.

DESCRIPTION

The dataset includes: Green urban areas (CLC 141), Sport and leisure facilities (CLC 142). A buffer of 2000 metres is established as an exclusion.



URBAN CONSTRAINT

Exclude built areas

SOURCE

Agency of Territorial Development (ATD)

LAYER PRE-PROCESSING AND COMMENTS

DESCRIPTION

Data represent urban and build-up zones.

TECHNICAL

Indicators

14 . Airports

15 . Airports Constraint

16 . Critical Facilities Constraint

17 . Elevation

18 . Major Transport Service

19 . Major Transport Service Constraint

20 . Railway Constraint

21 . Unsuitable Areas Constraint

22 . Unsuitable Terrain (Slope)

23 . Water Surface Constraint

24 . Wind Speed

AIRPORTS

Minimize proximity to airports

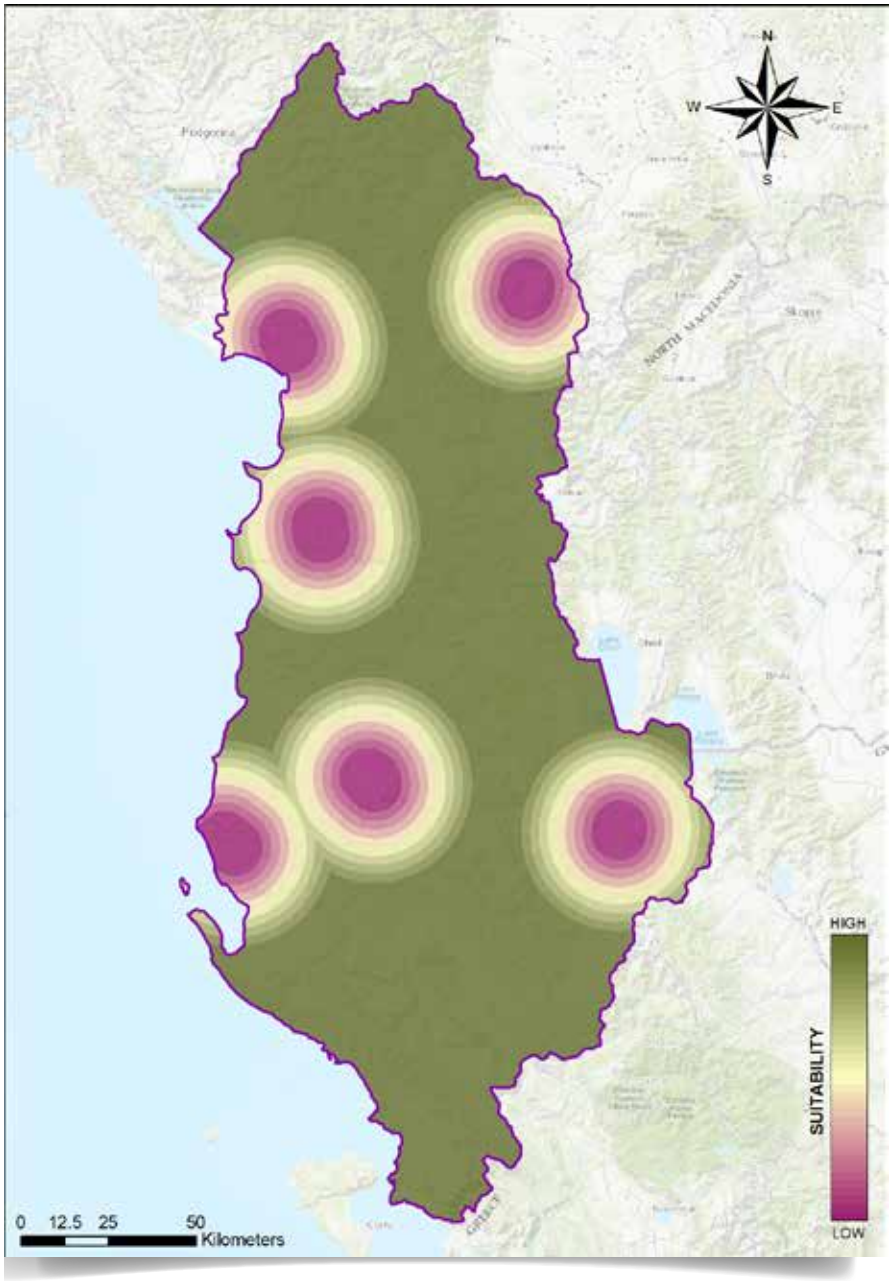
SOURCE

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. The suitability is 0 at a buffer of 5000 metres from the footprint, then increases with linear function to 100 at 30 kilometres and above.



AIRPORTS CONSTRAINT

Avoid airports

SOURCE

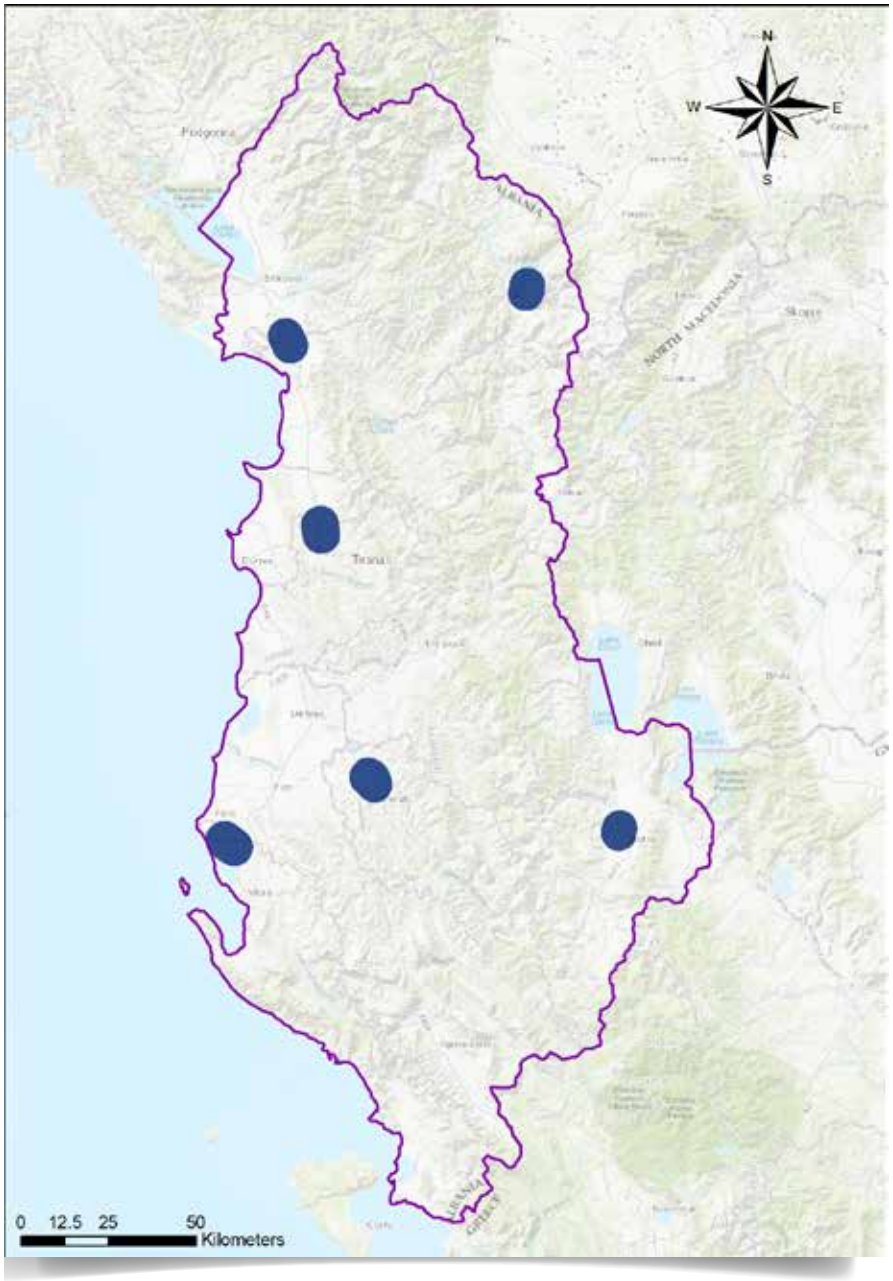
Agency of Territorial Development (ATD)

LAYER PRE-PROCESSING AND COMMENTS

Calculate 5000 metres buffer around lines in order to create constraint areas.

DESCRIPTION

Data represent the footprint of airports all over the country. Airports present several constraints due to navigation safety rules. A buffer of 5000 metres is established as an exclusion.



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.

ELEVATION

Prefer areas at lower altitude

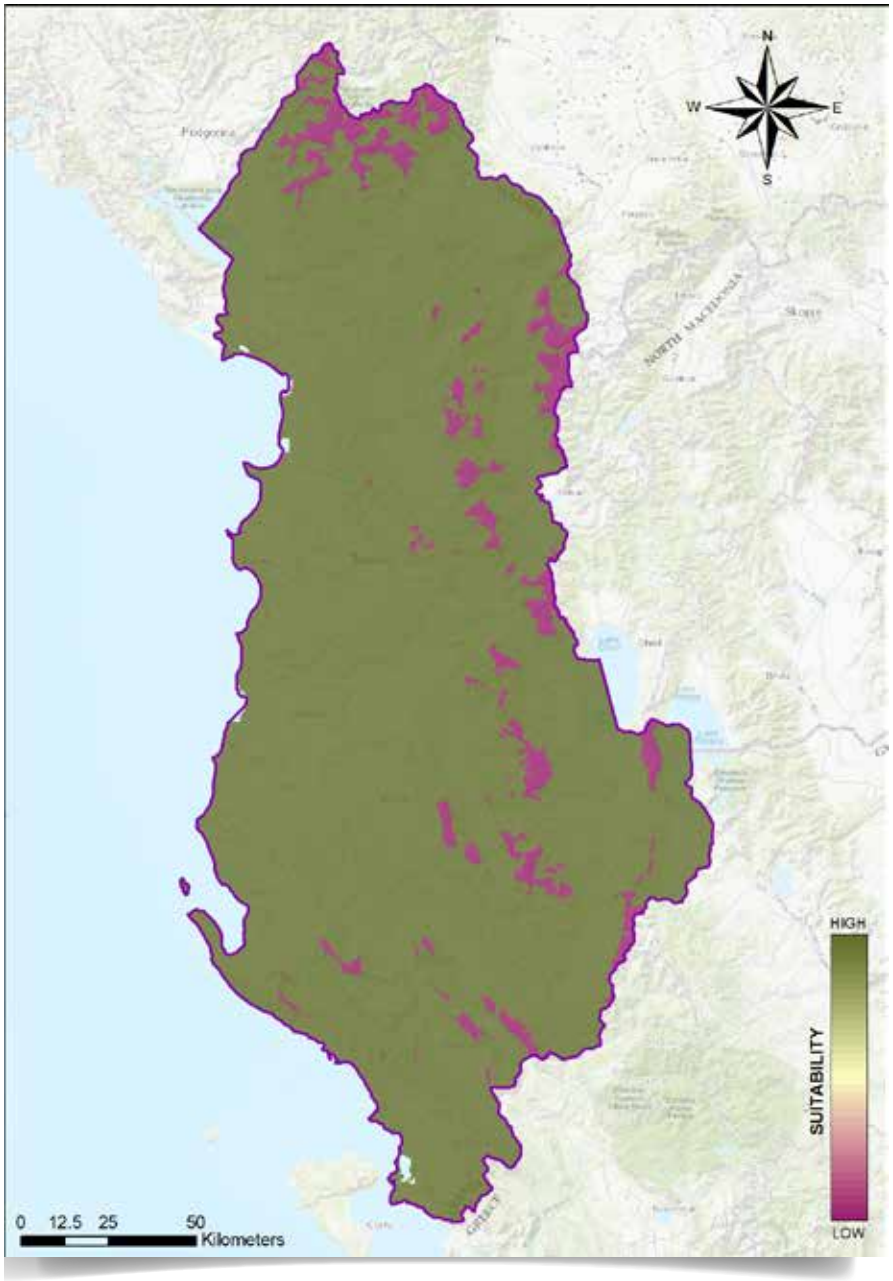
SOURCE

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

LAYER PRE-PROCESSING AND COMMENTS

DESCRIPTION

Areas lower than 1600 m height are assigned highest suitability (100). At altitudes greater than 1600 m, suitability is considered the lowest (0).



MAJOR TRANSPORT SERVICE

Prefer proximity to major transportation routes

SOURCE

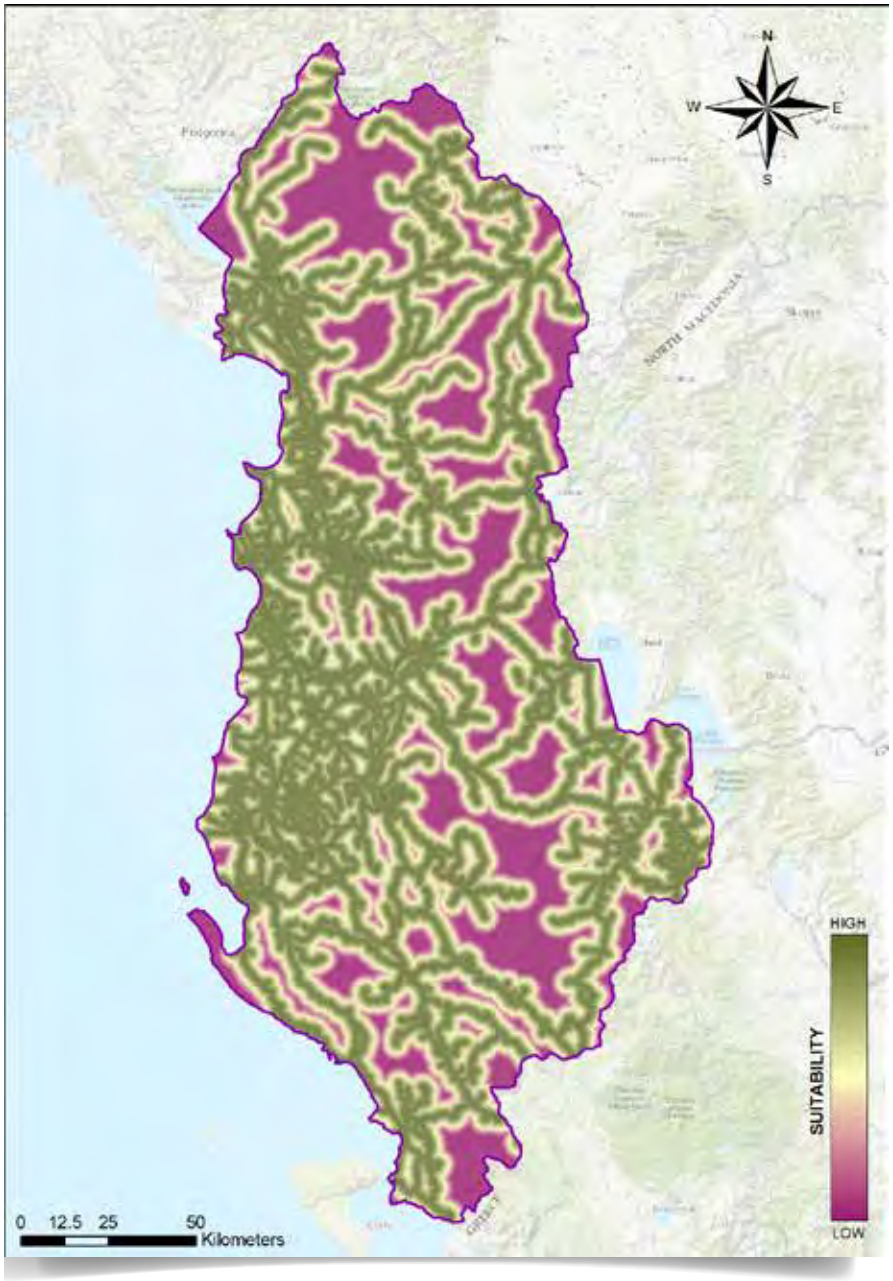
GeoFabrick - Open Street Map

LAYER PRE-PROCESSING AND COMMENTS

Calculate 25 metres buffer around lines in order to create indicators 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 250 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. A buffer of 250 metres is established as an exclusion.

RAILWAY CONSTRAINT

Avoid railway tracks

SOURCE

GeoFabrick - Open Street Map

LAYER PRE-PROCESSING AND COMMENTS

Calculate 500 metres buffer around lines in order to create constraint areas.

DESCRIPTION

A buffer of 500 metres is established as an exclusion.

UNSUITABLE AREAS CONSTRAINT

Avoid difficult terrain

SOURCE

Copernicus Land Monitoring Service (CLMS) - Corine Land Cover

LAYER PRE-PROCESSING AND COMMENTS

Select Corine Land Cover polygons.

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

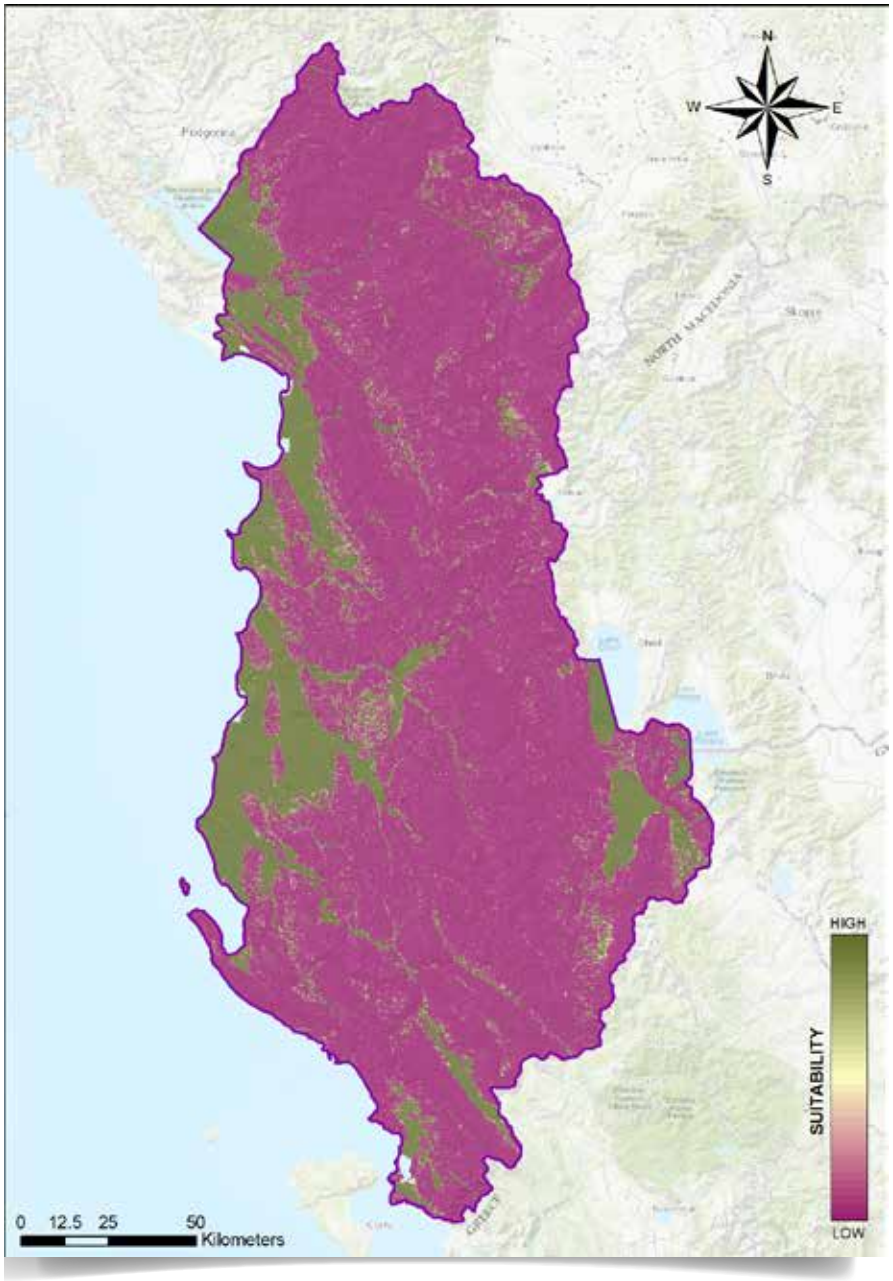
Copernicus Land Monitoring Service (CLMS) - European Digital Elevation Model(EU-DEM)

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. Values from 0 to 5% are identified as most suitable. Suitability decreases between 5% and 10%. Slope values higher than 10% 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 consist of 50 metres buffer around waterways and include: streams, rivers, canals, ditches, drains, dams, weirs, trickles, ponds.

WIND SPEED

Prefer areas charactetized by optimal average wind speed

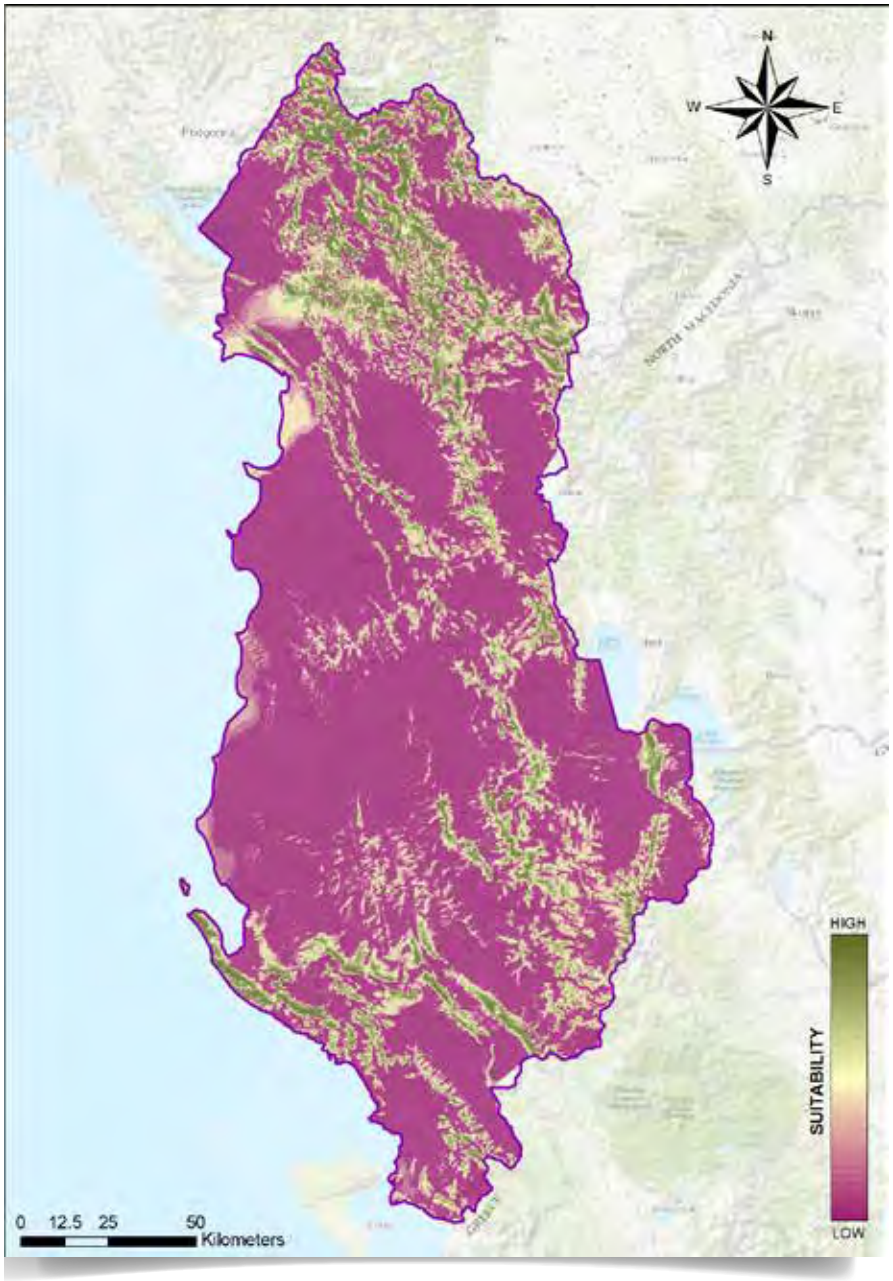
SOURCE

Global Wind Atlas

LAYER PRE-PROCESSING AND COMMENTS

DESCRIPTION

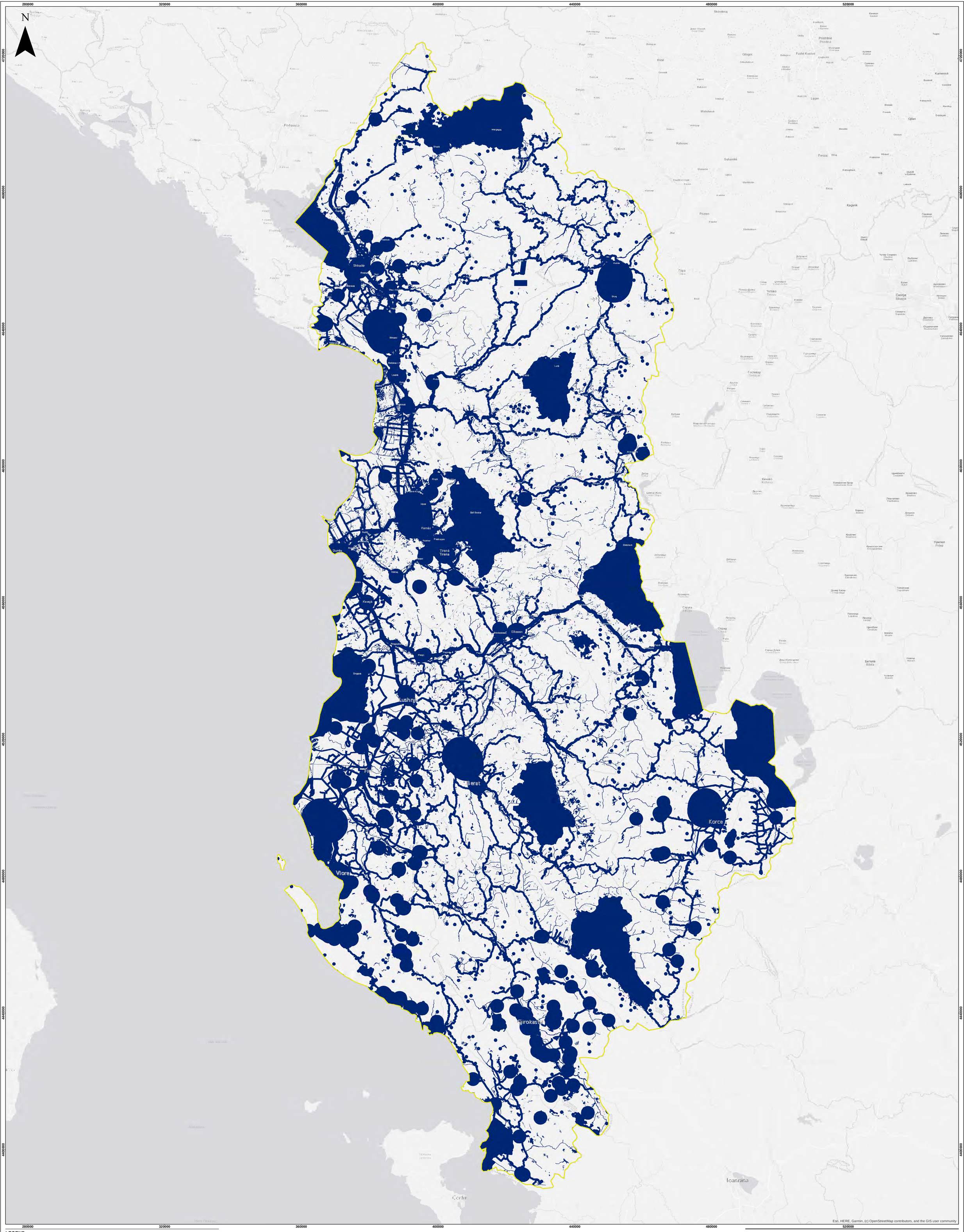
Data represent the average wind speed at 100 m height. Data are derived from large-scale wind climate data provided by European Center for Medium-Range Weather Forecasts (ECMWF). Suitability is considered the lowest (0) for average wind speed < 5 m/s. From 5 m/s the suitability increases with linear function to the highest (100) at 13 m/s and above (maximum average value for Albania is 14.4 m/s).



APPENDIX B

No-Go Areas Map

PATH: W:\471_EBRD\Albania\99_PROJECTS\XXXXX_ECE_Wind\GoldSET_Siting_Wind\02_PRODUCTION\MXD\Contraint_Map_Wind.mxd PRINTED ON: 2020-10-29 AT: 5:10:43 PM



LEGEND

No-go areas

0 25 50

Kilometers

1:350,000

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 WIND POWER PROJECTS IN ALBANIA

TITLE
NO-GO AREAS MAP

CONSULTANT
GOLDER

YYYY-MM-DD	2020-10-29
DESIGNED	SST
PREPARED	SST
REVIEWED	LMA
APPROVED	LMA

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

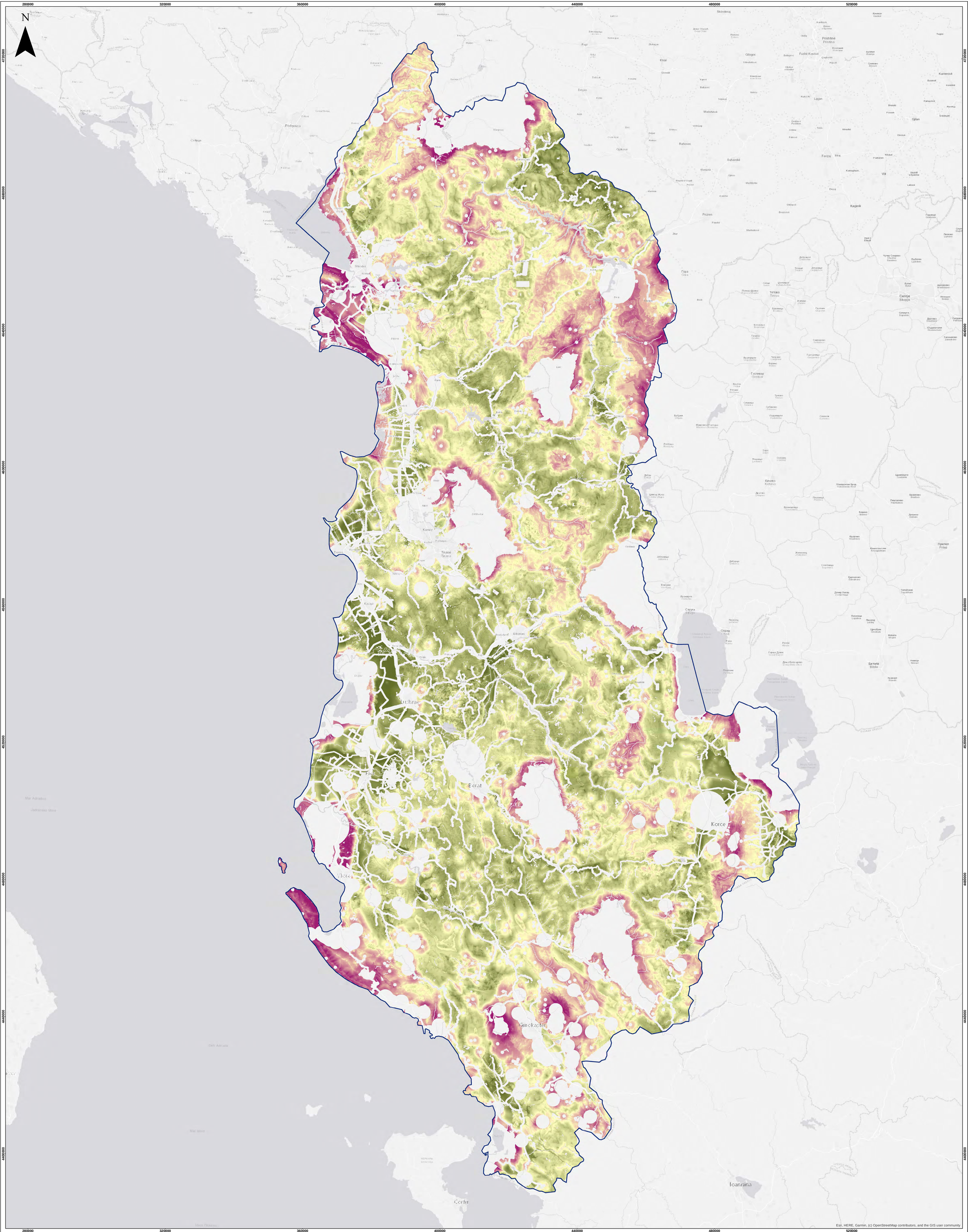
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A0

0 25mm

APPENDIX C

Suitability Map

PATH: W:\471_EBRD\Albania\99_PROJECTS\XXXXX_ECE_Wind\GoldSET_Siting_Wind\02_PRODUCTION\MXD\Suitability_Map_Wind.mxd PRINTED ON: 2020-10-29 AT: 5:16:30 PM



LEGEND

Suitability

HIGH

LOW

0 25 50

Kilometers

1:350,000

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 WIND POWER PROJECTS IN ALBANIA

TITLE
SUITABILITY MAP

CONSULTANT

GOLDER

YYYY-MM-DD	2020-10-29
DESIGNED	SST
PREPARED	SST
REVIEWED	LMA
APPROVED	LMA

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

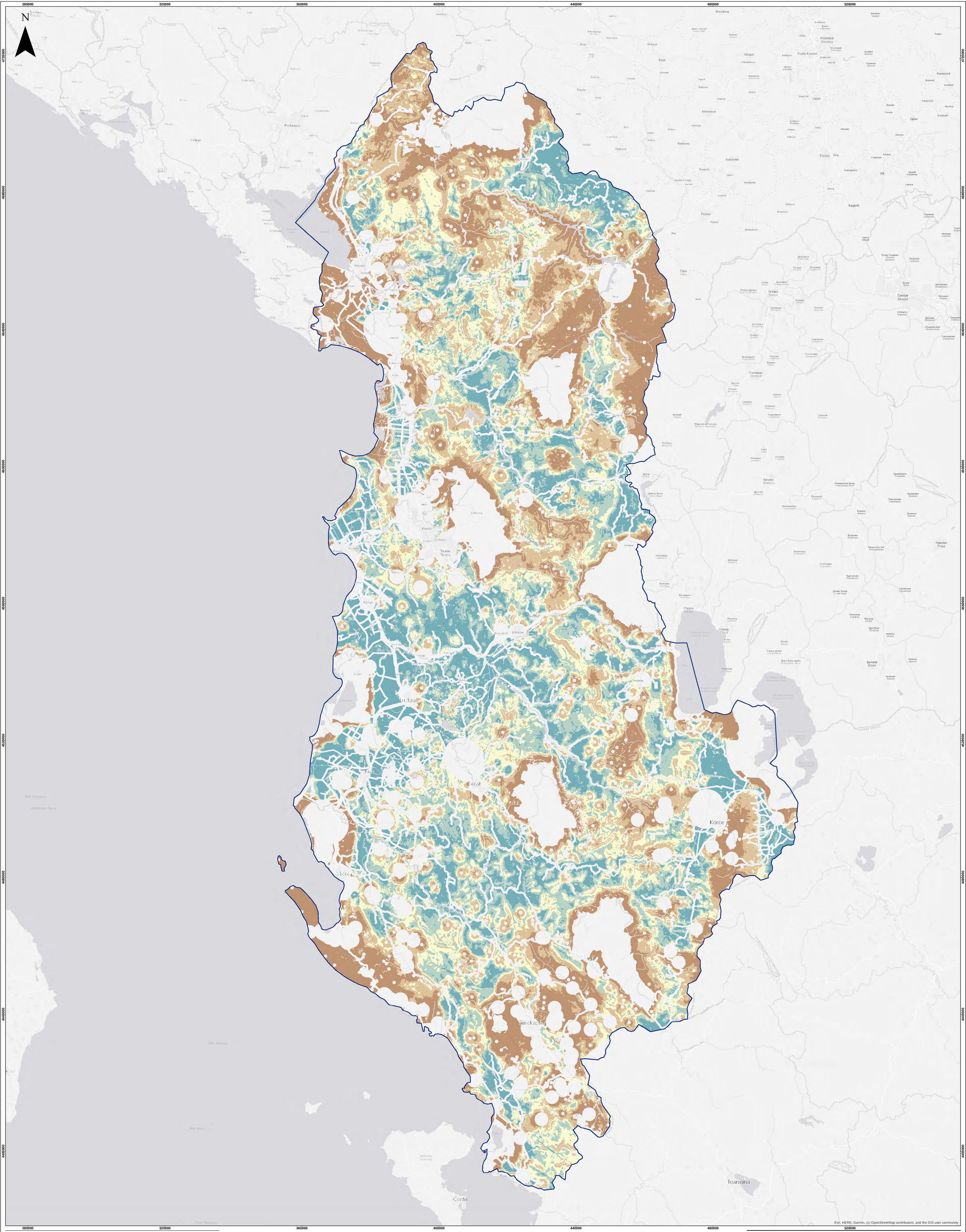
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A0

0 25mm

APPENDIX D

Suitability Classes Map

PATH: W:\471_EBRD\Albania\99_PROJECTS\XXXXX_ECE_Wind\GoldSET_Siting_Wind\02_PRODUCTION\MXD\Suitability_classes_Map_Wind.mxd PRINTED ON: 2020-10-29 AT: 5:19:11 PM



LEGEND

Windfarm Suitability Classes

- 1 - low
- 2 - medium/low
- 3 - medium
- 4 - medium/high
- 5 - high

0 25 50

Kilometers

1:350,000

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 WIND POWER PROJECTS IN ALBANIA

TITLE
WINDFARM SUITABILITY CLASSES

CONSULTANT
GOLDER

YYYY-MM-DD	2020-10-29
DESIGNED	SST
PREPARED	SST
REVIEWED	LMA
APPROVED	LMA

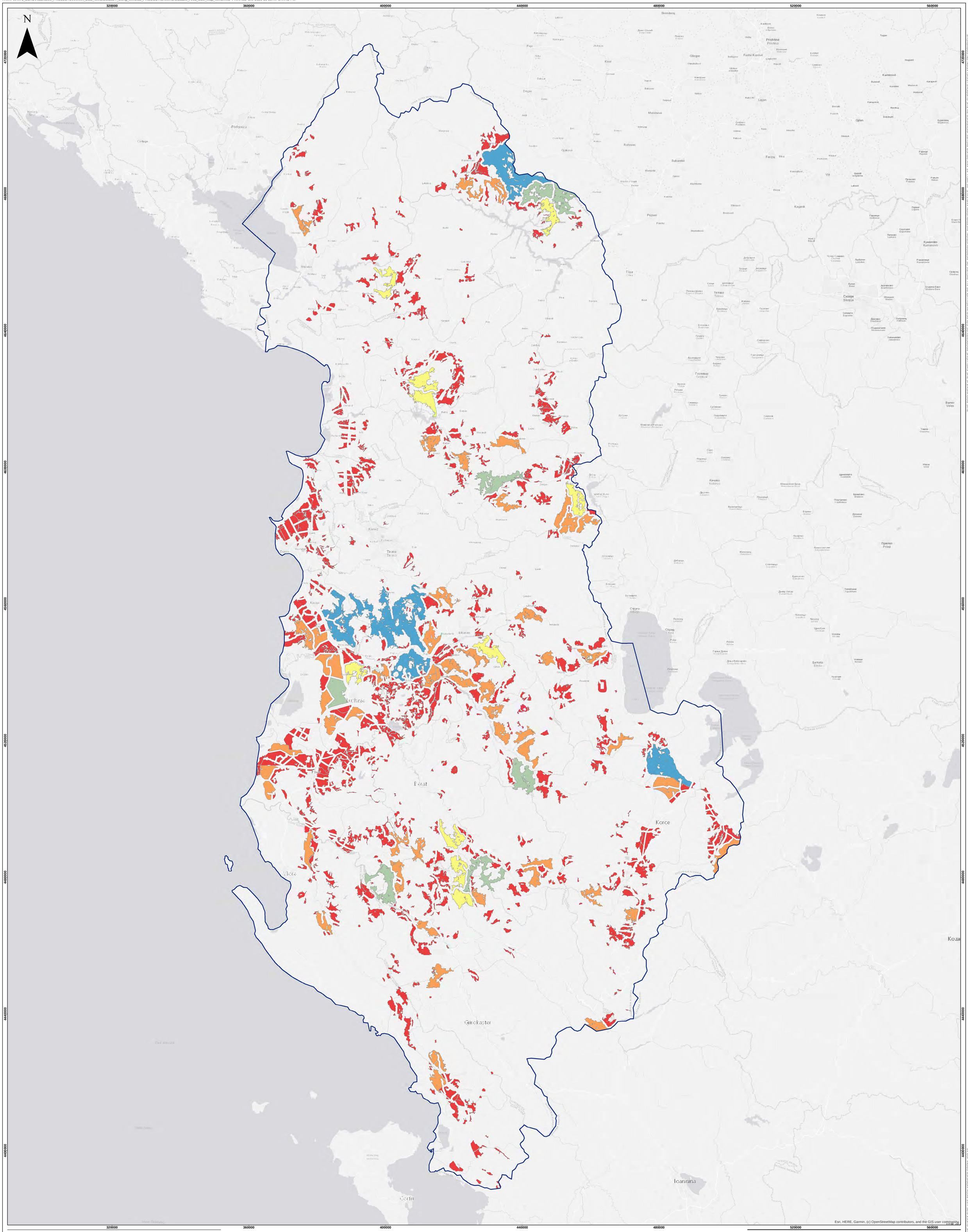
PROJECT NO.	DOCUMENT NO.	CONTROL	REV.	FIGURE
19133659	12733	0001	0	APPENDIX D

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A0

0 25mm

APPENDIX E

Suitable Areas Size Map



Legend

Area size - hectares

- < 1,000
- 1,001 - 2,000
- 2,001 - 3,000
- 3,001 - 4,000
- > 4,000

0 25 50
Kilometers

1:350,000

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 WIND POWER PROJECTS IN ALBANIA

TITLE
SUITABLE AREAS SIZE

CONSULTANT
GOLDER

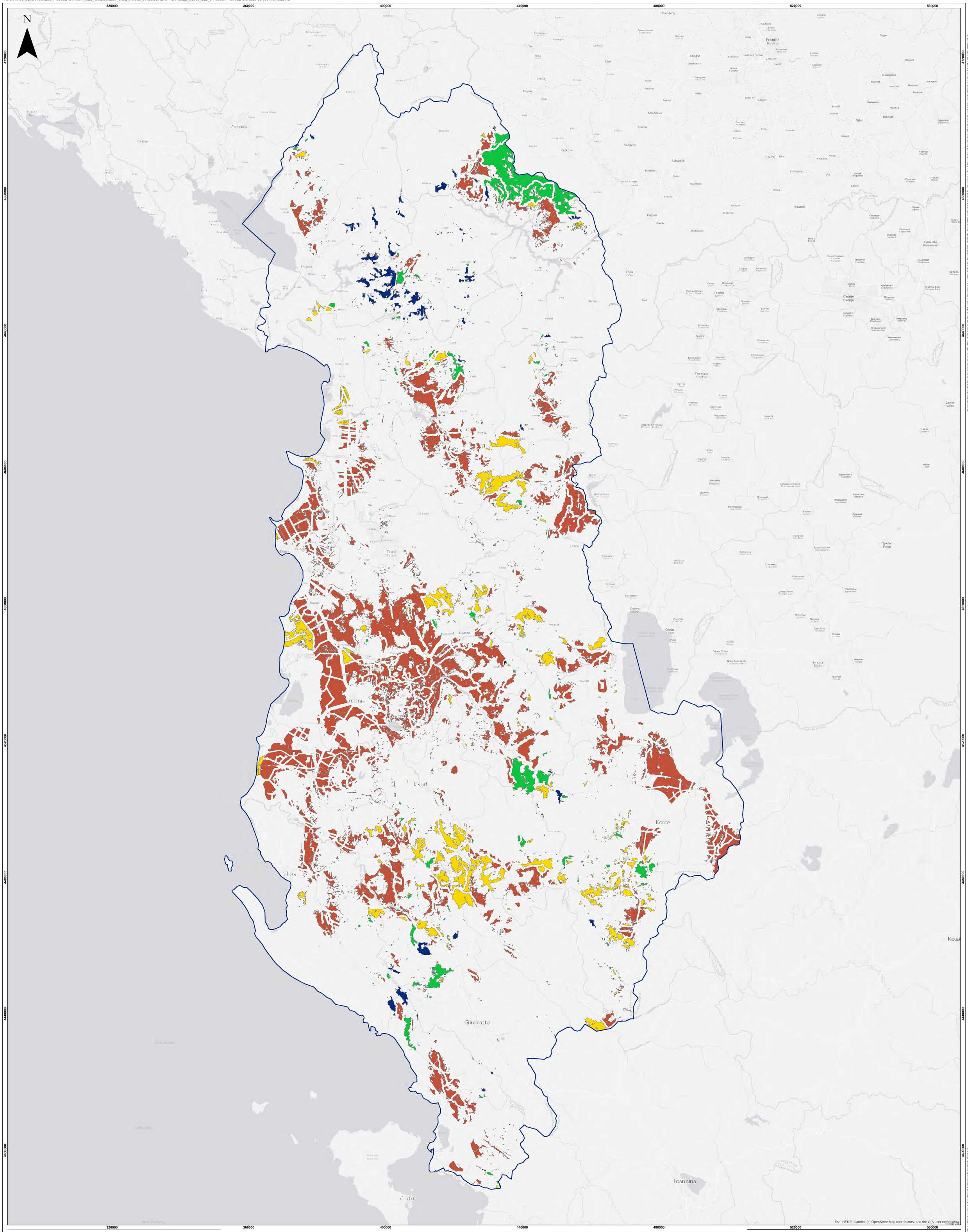
YYYY-MM-DD	2020-10-30
DESIGNED	SST
PREPARED	SST
REVIEWED	LMA
APPROVED	LMA

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

APPENDIX F

Suitable Areas Wind Speed Map

PATH: W:\471_EBRD\Albania\99_PROJECTS\XXXXX_ECE_Wind\GoldSET_Siting_Wind\02_PRODUCTION\MXD\Average_Speed_Map_Wind.mxd PRINTED ON: 2020-10-30 AT: 5:43:21 PM



Legend

Average wind speed

- up to 5 m/s
- 5 to 6 m/s
- 6 to 7 m/s
- 7 to 13 m/s

0 25 50
Kilometers

1:350,000

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 WIND POWER PROJECTS IN ALBANIA

TITLE
AVERAGE WIND SPEED

CONSULTANT
GOLDER

YYYY-MM-DD	2020-10-30
DESIGNED	SST
PREPARED	SST
REVIEWED	LMA
APPROVED	LMA

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

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A0

0 25mm

APPENDIX G

Protected Areas and Albanian Legislation

Law No. 81/2017 “On Protected Areas” defines the different categories of the PAs in Albania and their management prescriptions. Albanian Law No. 81/2017 defines 8 categories of PA plus one including several forms, each with varying degrees of protection that have been found to be present in the study area

- Strict Nature Reserve (Category I)
- National Park (Category II)
- Natural Monument (Category III)
- Natural Park (Category IV)
- Protected Landscape (Category V)
- Protected Area of Managed Resource (Category VI)
- Municipal Park (Category IV)
- Green belt (Category V)
- Protected areas of international interest (SAC, RAMSAR) – no specific category assigned.

The process of integrating the Albanian legal requirements is reflected in the way different categories of protected areas from international sources (World Database on Protected Areas plus the Emerald Sites from the Council of Europe – European Environmental Agency) were considered and whether to apply a buffer around the protected areas footprint or not.

The table below shows in detail: the categories considered as no-go areas and as indicator, the assigned spatial coverage (footprint or footprint plus a certain buffer) and the reference to the legal requirements (in italics an excerpt from the relevant article).

No-go area	**Spatial Coverage**	**National legal requirements**
Protected Areas		
Strict Nature Reserve (Category I IUCN)	Footprint	Strictly protected under national legislation *(“Strict protection, first level of protection”).*
National Park (Category II IUCN)		Strictly protected under national legislation *(“The current law on protected areas forbids these activities within NP:… - Intensive use of land with technologies that leads to irreversible biodiversity loss, ecosystem damages and destruction of soil..”.)*
Nature Monument (Category III IUCN)		Strictly protected under national legislation

		("Strict protection, first level of protection").
World Heritage Site (natural or mixed)		Not mentioned among the national legal requirements. Included as part of international obligations.
Ramsar Site, Wetland of International Importance	Footprint + 1500 m buffer	International obligation ("*The law on PA stipulates that (article 25/5) in such area are not allowed: all types of construction in distance of 1,500m from the water table perimeter, from this are excluded light construction with wood or environmentally friendly materials...").*
Indicators	**Spatial Coverage**	**National legal requirements**
Protected Areas – Areas above plus:		
Managed Nature Reserve (category IV IUCN)	The suitability is 0 from the footprint to a buffer of 500 metres, then increases with linear function to 100 at 2 km and above	Not strictly protected under national legislation.
Protected Landscape (Category V IUCN)		Not strictly protected under national legislation
Resource Reserve (Category VI IUCN)		Not strictly protected under national legislation *("The law does not list any forbidden activity but stipulates that in this protected area the protection level shall be set to ensure these objectives").*
Candidate Emerald Sites		Not mentioned among the national legal requirements. Included as part of international obligations. Considered just as indicator (not no-go areas) considering the state of "candidate" sites.

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