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Strategic Environmental and Social Assessment of Renewable Energy Projects (Wind and Solar PV) in the East Nile Region (Arab Republic of Egypt)

Final Recommendation Report

September 2018

Strategic Environmental and Social Assessment of Wind Energy Projects in the East Nile Region (Arab Republic of Egypt)

Final Recommendation Report

Prepared for:

New and Renewable Energy Authority (NREA), Egypt

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02	25.09.2018	Matthias Drosch	Dr. Frank Bergen	Matthias Drosch Dr. Frank Bergen	Final Recommendation Report

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List of Abbreviations

a.g.	Above Ground Level
EBRD	European Bank for Reconstruction and Development
EEHC	Egyptian Electricity Holding Company
EETC	Egyptian Electricity Transmission Company
ESIA	Environmental and Social Impact Assessment
FDI	Foreign Direct Investors
FiT	Feed-in Tariff
JICA	Japan International Cooperation Agency
JV	Joint Venture
GHI	Global Horizontal Irradiation
GIS	Geographic Information System
GoE	Govern
NREA	National Renewable Energy Authority
RANS	Reynolds Averaged Navier Stokes
RE	Renewable Energy
SESA	Strategic Environmental and Social Assessment

0 Executive Summary – English

0.1 Objectives and Scope of the overall SESA Process

The Government of Egypt (GoE) has identified three large areas suitable for development of Renewable Energy (RE) farms for both wind and solar energy projects in Egypt. Among these, an area of 2,200 km^2 with a usable area of 1,725 km^2 (425 km^2 were excluded due to military height limitations, see section 2) located to the east of the Nile River across three Governorates – Beni Suef, El Minya and Assiut, which have been identified based on existing data on solar and wind potential and existing land-use (the "Project Area", see section 1.2). To ensure a strategic level assessment of potential environmental and social issues associated with the development of such projects and to inform the decision-making process for project development, two Strategic Environmental and Social Assessments (SESAs) have been conducted. A SESA is a systematic decision-support process that helps to ensure that environmental, social and other sustainability aspects are considered effectively in policy, planning and programme making. The SESA process for the Project area has the following objectives:

- To provide a reliable source of environmental and social data for the Project Area to inform RE development plans, environmental permitting and project financing.
- To identify eventually existing zones of technical or social constraints for RE development within the Project Area.
- To identify and assess potential environmental and social impacts associated with RE project development and operation in the Project Area and define mitigation and management measures to address these potential impacts, including recommendations on arrangement of plots for individual wind or solar power projects.
- To identify zones in the Project Area, which are suitable for RE development based on the outcome of the environmental and social impact assessment.
- To engage with stakeholders, including members of the public on the planned development of RE projects in the Project Area.
- To develop a Geographic Information System ("GIS") database, which will be used to inform future RE projects.
- To determine the spatial distribution of wind and solar power potential of the area.
- To identify and outline the best possible areas for wind power and solar power development considering technical, environmental and social RE power potential aspects.
- To identify eventually existing further requirements (data procurement/measurements, studies, administrative) for RE development on the identified areas.

In addition, during the SESA course, the SESA consultant provided training to the staff of the New and Renewable Energy Authority (NREA) on SESA, Environmental and Social Impact Assessment (ESIA) and GIS.

Major elements of the assessment were field surveys such as general area reconnaissance, ornithological field monitoring over three migration periods (spring 2016, autumn 2016 and spring 2017) and other surveys (e.g. flora and fauna, land-use and other social aspects).

0.2 Final Recommendation Report – Objectives and Approach

In addition to the physical, environmental and social assessment conducted in the SESA Wind Power and the SESA Solar Power Reports, in this Final Recommendation Report the spatial wind and solar power distribution is determined to identify the best possible areas for RE power development and to inform and facilitate future projects, and investment decisions and project financing for the development of individual investment projects of 50 MW each within these areas.

This Final Recommendation Report, focusses on

- Determination of the spatial distribution of the wind and solar power potential.
- Identification and outline of the best possible areas (most suitable plots) for wind power and solar power development considering in addition to the technical, social, and environmental aspects the spatial distribution of the wind and solar power potential.
- Proposal of 50 MW plots and a development sequence according to the suitability of areas in the East Wind and East Solar subareas respectively, starting with the most favourable areas.
- Identification of eventually existing further requirements (data procurement/measurements, studies, administrative processes) for RE development in the identified areas.
- Definition of any limitations and conditions to be considered in the tender and/or permitting process.

The Final Recommendation Report shall inform NREA how to best develop wind power and solar power projects in the relevant East Wind and East Solar subareas by selecting plots, which

- are physically and technically suitable for installing wind power and PV solar power respectively;
- show no or low social and environmental constraints (impacts); and finally
- show high wind power and solar power potential.

At the same time the Final Recommendation Report, together with the GIS data base, shall serve as an information tool and shall list outstanding activities and requirements for realisation of individual projects, thus facilitating later investments.

The Final Recommendation Report is based on the SESA Wind Power Report and the SESA Solar Power Report, which identified and already pre-classified zones according to their physical suitability and environmental and social compatibility. The final suitability of areas will be defined by the additional consideration of the spatial power potential. The plots for wind/solar power development will be prioritised according to the following criteria:

- The area is not classified as preclusive due to physical or social criteria such as soft soils, rough terrain, competing land use, etc. (see SESA Reports).
- The area is not classified as preclusive or less favourable as a result of impact assessment (e.g. habitat protection, heritages, high risk, accessibility, etc.); i.e. the area is classified to be favourable from the social and environmental point of view (see SESA Reports).
- The area shows the most favourable wind/solar power potential compared to other portions of the overall area.

0.3 Spatial Distribution of RE Power Potential

For each subarea, the wind respectively solar resources have been calculated by use of international standard software and tools. The results indicated a homogenous distribution of the solar resources in the overall region. As a consequence, all three solar subareas can be considered as very promising for the development of PV solar power plants with an average annual potential of between 2,200 and 2,300 kWh/m^2. Therefore, no ranking of (parts of the) subareas can be undertaken on the basis of solar power potential.

The predicted wind resource are in a range between 7.3 and 9.8 m/s for the two wind-subareas whereas the highest wind speeds can be expected in in the northern part of the East Wind-1 subarea and on top of the cliff in the East Wind-2 subarea.

0.4 Subarea Classification

The suitability of the RE potential (wind and solar developments) of each subarea has been analysed on basis of various factors, taking into account the suitability on basis of the environmental and social constraints as elaborated in the SESA Wind and SESA Solar Reports. From environmental point of view, the assessment mainly focusses on constrains such as geomorphology and important habitats (mainly Wadis). Regarding the social constrains, areas involved by economic factors, like farming, mining or other important activities are the main constraints. Thus, areas which have been identified as preclusive or unfavourable as a result of the SESAs have not been considered.

As defined in the Terms of Reference, the typical size of an individual wind power or PV solar power project is defined as 50 MW. Thus, it is necessary to define plots which can accommodate 50 MW wind / solar PV capacity (individual 50 MW plots).

On basis of the resource maps presented in section 2 and in consideration of areas which are defined as preclusive or unfavourable, zones which are in general suitable for wind energy and solar PV power planning are identified on basis of their RE. The results are presented in Zonation maps, included under section 4. The results for each subarea are as follows:

0.4.1 Wind Subareas

East Wind-1

Three different wind farm layout scenarios have been considered for the East Wind-1 subarea:

- Scenario 1 reflects a resource optimized zonation map aiming for optimizing the energy yield for each 50 MW plot.
- Scenario 2 is a capacity optimized zonation map, considering two rows of turbines in each plot to minimize wake losses.
- The zonation map for Scenario 3 is also capacity optimized but considers up to three rows of turbines for each plot which will maximise the capacity for the whole East Wind-1 subarea, but will at the same time cause higher wake losses compared to Scenario 2.

To classify the plots and propose an adequate development sequence, an exemplary energy production calculation has been performed for each scenario, taking into account a generic wind turbine type (Gamesa G114, 2.5 MW) which is considered as suitable for the East Wind-1 subarea. Afterwards, each plot has been ranked depending on the calculated energy yield:

- Category 1 (recommended for implementation in the first phase): Energy yield > 103% of the average energy yield for the whole East Wind-1 subarea.
- Category 2: (recommended for implementation in the subsequent phase): Energy yield between 95% and 103% of the average energy yield for the whole East Wind-1 subarea.
- Category 3: (recommended for implementation in the last phase): Energy yield lower than 95% of the average energy yield for the whole East Wind-1 subarea.

This categorization has been performed for each scenario.

As a result of the resource assessment, the northern part of the East Wind-1 subarea is characterised by higher wind speeds compared to the southern portion of the area. Thus, a development sequence should logically start in the northern part of the East Wind-1 area. The initial average energy yield per plot is in a range between 250 and 269 GWh/a, depending on the scenario. A ranking of each plot in accordance with its energy yield results in the following recommended development sequence:

Table 0-1: Development sequence in the East Wind-1 subarea

	Scenario 1 [no. of Plots]	Scenario 2 [. of Plots]	Scenario 3 [no. of Plots]
Development Phase 1	3	8	8
Development Phase 2	14	17	15
Development Phase 3	5	9	15

East Wind-2

Due to restriction defined in the SESA Wind Report, wind farm development is restricted to the southern part of the East Wind-2 subarea. For this portion, only one scenario (base scenario) has been developed, comprising of two 50 MW plots which cover the whole usable area.

Due to the homogenous wind conditions in the southern portion of the East Wind-2 subarea, a similar energy yield for both plots can be expected which is about 234 GWh in average. As this energy yield is lower compared to the results obtained for the East Wind-1 subarea and due to the fact that only a small portion of the East Wind-2 subarea is usable for wind farm planning, it is recommended to implement wind power projects in the last phase (i.e. after all plots in the East Wind-1 subarea are used).

0.4.2 Solar Subareas

As the solar potential of the solar subareas is uniform, establishing a ranking / development sequence on basis of the solar resources is considered as not applicable. Thus, it is considered as more reliable to benchmark the solar PV plots against the available infrastructure (i.e. accessibility) to judge on ranking. The following criteria have been defined:

- Category 1: (recommended for implementation in the first phase): solar PV plots which are at maximum distances of 2,000 m from existing roads infrastructure.
- Category 2: (recommended for implementation in the subsequent phase): solar PV plots which are located at distances between 2,000 and 3,500 m from existing roads infrastructure.
- Category 3: (recommended for implementation in the last phase): solar PV plots which are located at distances of more than 3,500 m from existing roads infrastructure.

East Solar-1

The East Solar-1 subarea is characterized by several zones that are currently used or under development for economic activities such as farming or mining activities. These zones have been considered to be preclusive for the development of photovoltaic plants in the SESA Solar Report. The farms represent one of the sensitive receptors to be considered during developmental activities in the East Solar-1 subarea. Therefore, no PV plots are foreseen to be on or next to (100 m buffer) farming areas.

In addition, the important Wadi Ibadah and Wadi al-Birshawi complex has been assessed as less favourable for PV solar power developments in the SESA Solar Report. Thus, construction works in this Wadi complex (plus 100 m buffer zone) shall be excluded.

The following table summarizes the potential for implementation of PV solar plots in the East Solar-1 subarea.

Table 0-2: Summary of PV solar plots in the East Solar-1 subarea

Scenario	Number of plots	Accumulated capacity	Initial annual cross energy yield whole East Solar-1 subarea	Approximately average cross annual energy production per plot
Base Scenario	100	5 GW	1,820-1,930 kWh/kWp	95 GWh

East Solar-2

As no preclusive or unfavourable zones have been identified in the East Solar-2 subarea and a homogenous solar potential can be expected, the whole subarea can theoretical utilized. Plot size and distance between individual plots are the same as assumed for the East Solar-1.

The following table summarizes the potential for implementation of solar PV plots in the East Solar-1 subarea.

Table 0-3: Summary of PV solar plots in the East Solar-2 subarea

Scenario	Number of plots	Accumulated capacity	Initial annual cross energy yield whole East Solar-2 subarea	Approximately average cross annual energy production per plot
Base Scenario	53	2.6 GW	1,820-1,930 kWh/kWp	95 GWh

East Solar-2

As a conclusion of the SESA Solar Report, the whole East Solar-3 subarea has been defined as unfavourable due to geomorphic conditions and the difficult accessibility, requiring the construction of an access road of at least 30 km length. Thus, no PV solar power development is recommended in this subarea.

0.5 Measures and Conditions Recommended for Future Development by Private Investors,

0.5.1 Further required specialist studies

The following further (detailed) specialist studies are considered as necessary for further planning stages:

- Power Grid Expansion Studies and Power Grid Expansion

- Geotechnical Investigations at individual WTG Sites
- Wind Measurement Programmes
- Project Individual Resource Studies

0.6 Environmental and Social Management Issues to be Mandatory for Future Investors

0.6.1 Proposed Procedures to make Issues Contractual Binding for Investors

It is understood that NREA or an alternative Egyptian Authority (e.g. EETC) will launch tenders for the selection of private investors for the individual 50 MW wind and solar PV power plots and will supervise the investors during the life time of the projects. It is therefore essential that the ESMP obligations (please refer to section 8 of the SESA Wind and SESA Solar Reports) and mitigations measures developed during the SESA and during project-specific ESIA are properly reflected in the Tender Documents and in the later contracts with the private investors.

0.6.2 Stakeholder engagement, information disclosure and grievance management

Together with the SESAs for wind and solar power a Stakeholder Engagement Plan (SEP) has been developed which sets out how, during the development and operation of wind and solar resources in the East Nile area, potential stakeholders will be engaged and information about the projects will be shared. The SEP further sets out a grievance mechanism. The SEP will be implemented by NREA, with the support of individual developers where necessary."

0.6.3 Monitoring

The purpose of environmental monitoring is to ensure that the designed mitigation measures are implemented on the ground.

The environmental monitoring follows the E&S management plan and shall be carried out in four phases:

1. The bidding and planning phase
2. The implementation and operation phase
3. The checking and corrective actions phase
4. The management review phase

This compliance monitoring provides for the control of keeping the requirements defined in the ESMP. The responsibility for the overarching monitoring must lie with the Competent Authority, which was already entrusted with the tendering but projects should also monitor their own E&S impacts and performance, executed by the Project Companies and Contractors. This authority needs to guide and

supervise the individual project investors (if necessary by subcontracting these monitoring services). Moreover, the financing institutes may make keeping the monitoring and a corresponding reporting a condition in the financing agreements.

Two extensive bird surveys have been conducted in the wider region of El Minya west and east of the Nile Valley. Both investigations clearly revealed that the desert located at minimum distances of 10 km west and east to the Nile Valley has no particular importance for bird migration – neither in spring nor in autumn. As this conclusion can be regarded as well-founded and finally verified, sufficient baseline data is available for future impact assessments and no further baseline studies are required when developing wind power or PV solar power in the East Nile region.

1 General

1.1 Introduction

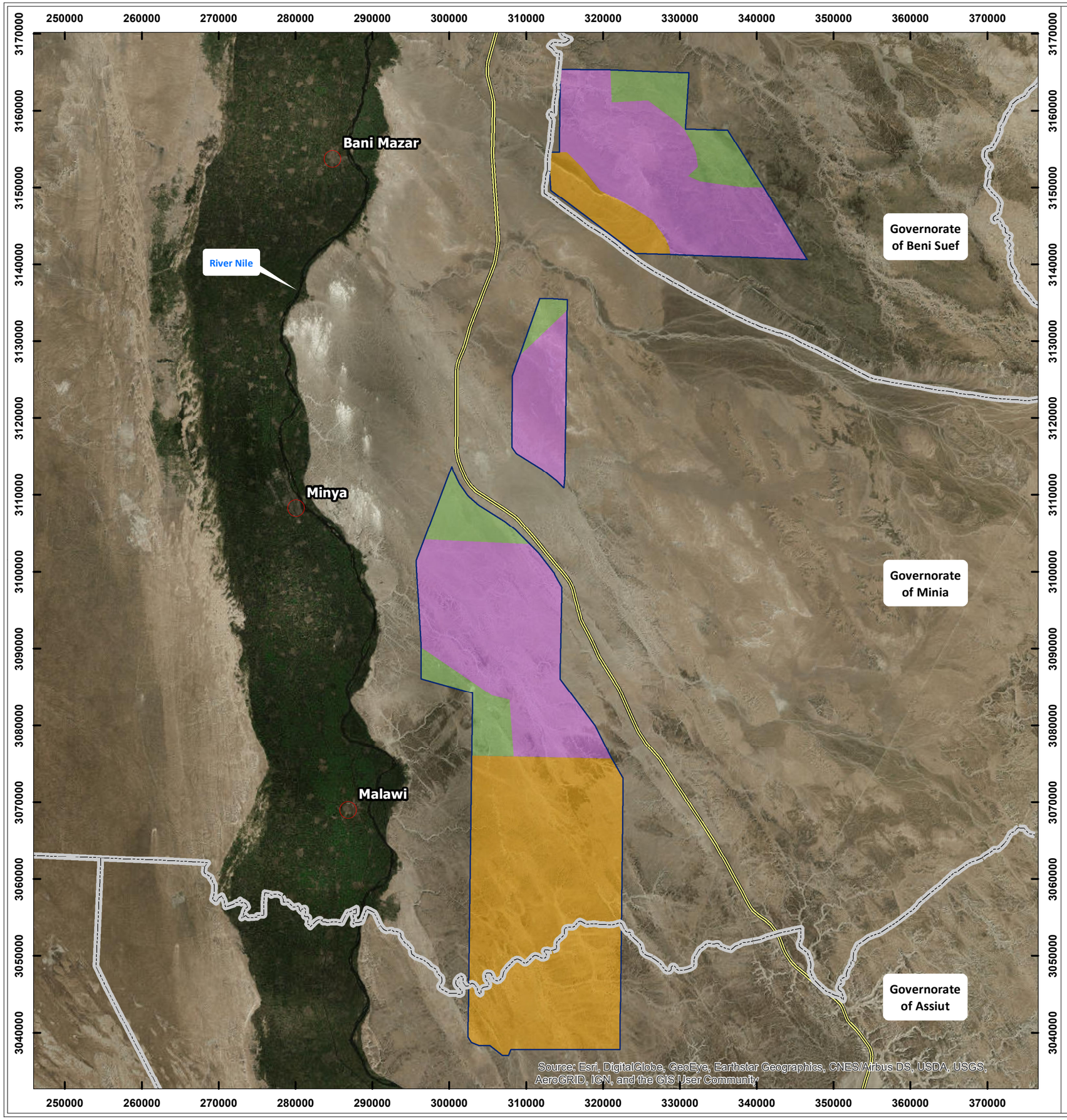
A Strategic Environmental and Social Impact Assessment (SESA) for the development of renewable energy (RE) projects in a 1,725 km² area (2,200 km² during the proposal stage and before modification of the area by the Government of Egypt –GoE, see section 1.2) located to the east of the Nile River in Egypt across three Governorates Beni Suef, El Minya and Assiut has been carried out by the Joint Venture of Lahmeyer International and ecoda Environmental Consultants on behalf of the New Renewable Energy Authority (NREA) in Egypt.

Following the issuance of the Renewable Energy (RE) Feed-in Tariff (FiT) presidential law in Egypt in December 2014, the European Bank for Reconstruction and Development (EBRD) has been engaged in partnership with the Government of Egypt (GoE) to identify a portfolio of RE projects (from wind and solar sources) to be financed by prequalified Foreign Direct Investors (FDIs). It is expected that each project will be of 50 MW capacity.

The GoE has identified three large areas suitable for development of RE mega farms for both wind and solar projects under the newly issued FiT law including a 1,725 km² area (East Wind-1 and East Wind-2 with building height limit of 150 m and the three East Solar areas with building height limit of 5 m) located to the east of the Nile River (the "Project Area"). These areas were identified by the GoE based on existing data on solar and wind potential and existing land use. To ensure a strategic level assessment of the potential environmental and social issues associated with the development of RE projects in this area, and to inform the decision-making process for project development, the GoE, together with the NREA, has undertaken a Strategic Environmental and Social Assessment (SESA) Study for the Project Area. A SESA is a systematic decision-support process that helps to ensure that environmental, social and other sustainability aspects are considered effectively in policy, plan and programme making. The SESA is supported by the EBRD.

1.2 The Project Area

The East Nile Area of 2,200 km^2 with a useable area of 1,725 km² (East Wind-1 and East Wind-2 as well as East Solar-1, East Solar-2 and East Solar-3 subareas) was allocated by Presidential Decree No 456 of 2014, which was modified by the Decree No 116 of 2016 for the development of wind and solar energy projects. Most of the area is located in the El Minya Governorate. Smaller portions are extending to the Assiut Governorate in the South and to the Beni Suef Governorate in the North. With the modification in 2016 three subareas with a total of 425 km^2 were excluded from further RE developments due to military height limitations (“zero height”, see Map 1-1). Thus, East Nile RE power development is limited to wind power (maximum building height of 150 m) in the subareas East Wind-1 and East Wind-2 and solar power (photovoltaic) in the subareas East Solar-1, East Solar-2 and East Solar-3 (maximum building height 5m).



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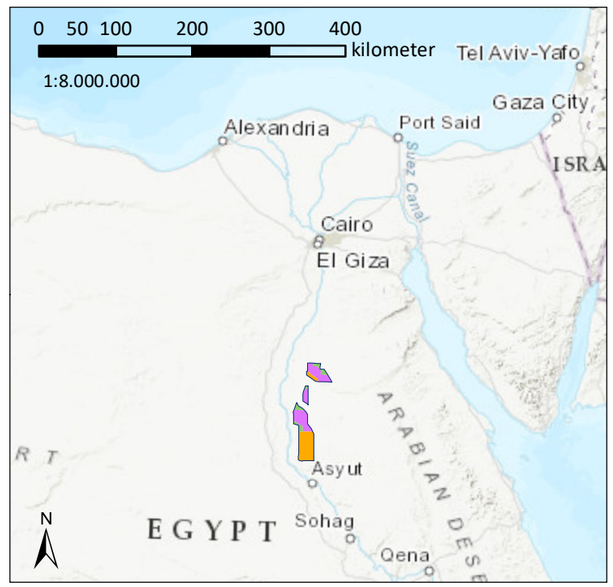
Strategic Environmental and Social Assessment of Renewable Energy Projects in the East Nile Region (Arab Republic of Egypt)
Draft Final Recommendation Report

client:
New and Renewable Energy Authority (NREA),
Ministry of Electricity and Renewable Energy

Map 1-1:
Project Area, including initial RE development areas and height restrictions for developments in the Project Area

Bordering of project area and subareas

- project area
- subarea not useable for RE developments (due to height restrictions "Zero")
- subarea usable for PV solar power projects (due to height restrictions "5 m")
- subarea usable for wind power projects (due to height restrictions "150 m")
- borders between governorates
- Assiut - Cairo Desert Road (motorway)



Coordinate System: WGS 1984 UTM Zone 36N

0 25.000 Meter
1:500.000

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1.3 SESA Process and Objectives

The SESA has the following objectives:

- To provide a reliable source of environmental and social data for the Project Area to inform RE development plans, environmental permitting and project financing.
- To identify eventually existing zones of technical or social constraints for RE development within the Project Area.
- To identify and assess potential environmental and social impacts associated with RE project development and operation in the Project Area and define mitigation and management measures to address these potential impacts, including recommendations on arrangement of plots for individual wind or solar power projects.
- To identify zones in the Project Area, which are suitable for RE development based on the outcome of the environmental and social impact assessment.
- To engage with stakeholders, including members of the public on the planned development of RE projects in the Project Area.
- To develop a Geographic Information System ("GIS") database, which will be used to inform future RE projects.
- To determine the spatial distribution of wind and solar power potential of the area.
- To identify and outline best possible areas for wind power and solar power development considering technical, environmental and social RE power potential aspects.
- To identify eventually existing further requirements (data procurement/measurements, studies, administrative) for RE development on the identified areas.

In addition, during the course of the SESA, the SESA consultant provided training to the staff of NREA on SESA, Environmental and Social Impact Assessment (ESIA) and GIS.

The SESA has adopted a typical SESA process to inform project development over a large area.

It includes the following key stages and reports:

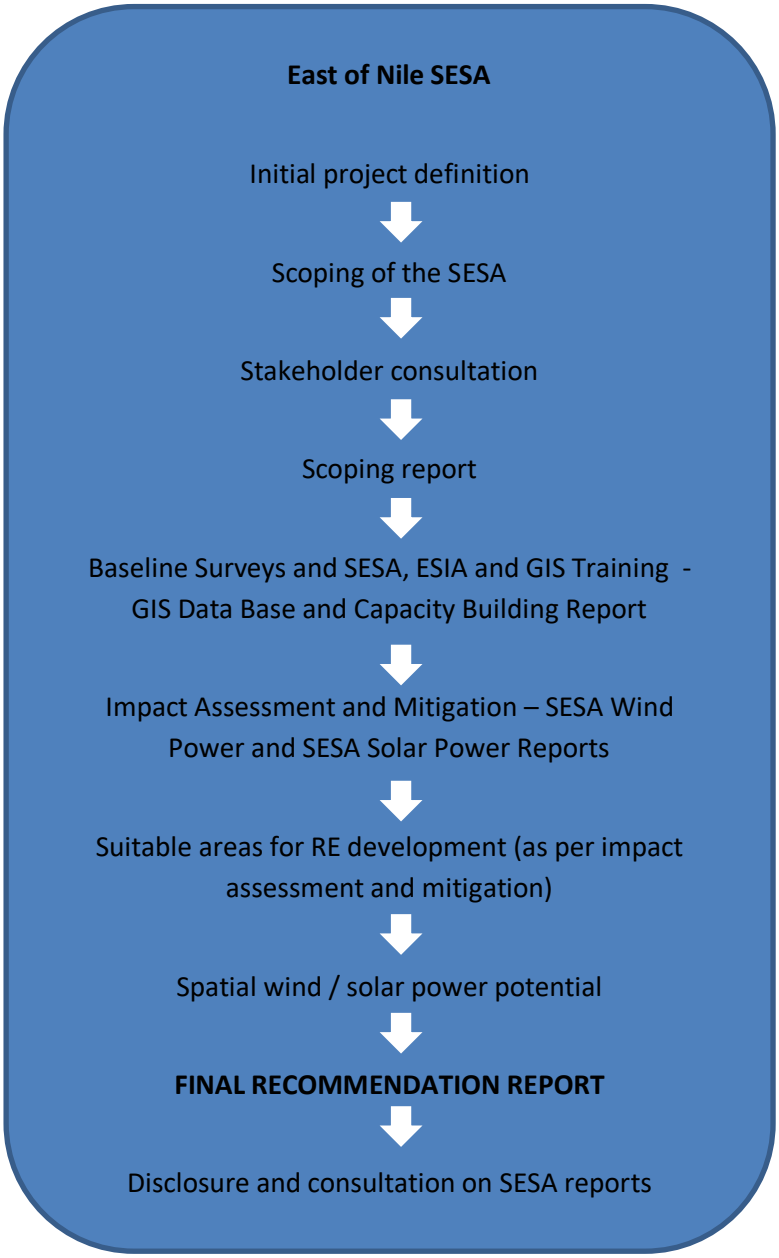


Figure 1-1: Overview of the SESA stages and reports

1.4 Final Recommendation Report – Objectives and Approach

In addition to the physical, environmental and social assessment conducted in the SESA Wind Power and the SESA Solar Power Reports, in this Final Recommendation Report the spatial wind and solar power distribution is determined to identify the best possible areas for RE power development and to inform and facilitate future projects, and investment decisions and project financing for the development of individual investment projects of 50 MW each within these areas.

This Final Recommendation Report, focusses on

- Determination of the spatial distribution of the wind and solar power potential.
- Identification and outline of the best possible areas (most suitable plots) for wind power and solar power development considering in addition to the technical, social, and environmental aspects the spatial distribution of the wind and solar power potential.
- Proposal of 50 MW plots and a development sequence according to the suitability of areas in the East Wind and East Solar subareas respectively, starting with the most favourable areas.
- Identification of eventually existing further requirements (data procurement/measurements, studies, administrative processes) for RE development in the identified areas.
- Definition of any limitations and conditions to be considered in the tender and/or permitting process.

The Final Recommendation Report shall inform NREA how to best develop wind power and solar power projects in the relevant East Wind and East Solar subareas by selecting plots, which

- are physically and technically suitable for installing wind power and PV solar power respectively;
- show no or low social and environmental constraints (impacts); and finally
- show high wind power and solar power potential.

At the same time the Final Recommendation Report, together with the GIS data base, shall serve as an information tool and shall list outstanding activities and requirements for realisation of individual projects, thus facilitating later investments.

The Final Recommendation Report is based on the SESA Wind Power Report and the SESA Solar Power Report, which identified and already pre-classified zones according to their physical suitability and environmental and social compatibility. The final suitability of areas will be defined by the additional consideration of the spatial power potential. The plots for wind/solar power development will be prioritised according to the following criteria:

- The area is not classified as preclusive due to physical or social criteria such as soft soils, rough terrain, competing land use, etc. (see SESA Reports).
- The area is not classified as preclusive or less favourable as a result of impact assessment (e.g. habitat protection, heritages, high risk, accessibility, etc.); i.e. the area is classified to be favourable from the social and environmental point of view (see SESA Reports).
- The area shows the most favourable wind/solar power potential compared to other portions of the overall area.

2 Spatial Distribution of RE Power Potential

As part of the scope of services, the Consultant has elaborated the wind and solar potential in the area under investigation to identify subareas which are on basis of their wind and solar potential usable for wind and solar PV applications.

2.1 Spatial Distribution of the Wind Power Potential

As the wind measurement campaign in the East Nile Project Area has not been completed at the time of the assessment of the wind potential, the calculation of the wind resources is inter alia based on information from a wind measurement campaign in the Western Nile region, which was executed from September 2010 to October 2011. As main meteorological input data, reanalysis data from the EMD-WRF -Middle East database were used. These data are available in a 3 x 3 km grid space and in 60 min. resolution. After simulation of the wind flow, the data from the West Nile measurement campaign were used for the synthesis of the model.

This measurement campaign comprised of 10 wind measurement stations which were procured under the “Preparatory survey on the Project to establish a wind farm in the West Nile Valley” financed by the Japan International Cooperation Agency (JICA) and executed under the umbrella of NREA. The obtained data were already processed and evaluated by the Lahmeyer International within this previous study (“Interim Report for the preparatory survey on the Project to establish a wind farm in the West Nile Valley”).

Based on these wind data and other information available, the Consultant performed preliminary wind resource calculations with the computer software MeteodynWT.

MeteodynWT is a three-dimensional computational fluid dynamics (CFD) model which solves the full RANS (Reynolds Averaged Navier Stokes) equations with a one-equation turbulence model adapted to the atmospheric boundary layer. The model allows simulating wind conditions over terrain for a predefined area and to derive site specific wind conditions and statistics at any given target point within the three-dimensional wind farm domain.

The following figure shows the general simulation approach of MeteodynWT.

With the results of these calculations an initial wind resource map with a spatial resolution of approximately 50 m x 50 m showing mean annual wind resource for the East Wind-1 and East Wind-2 subareas was calculated.

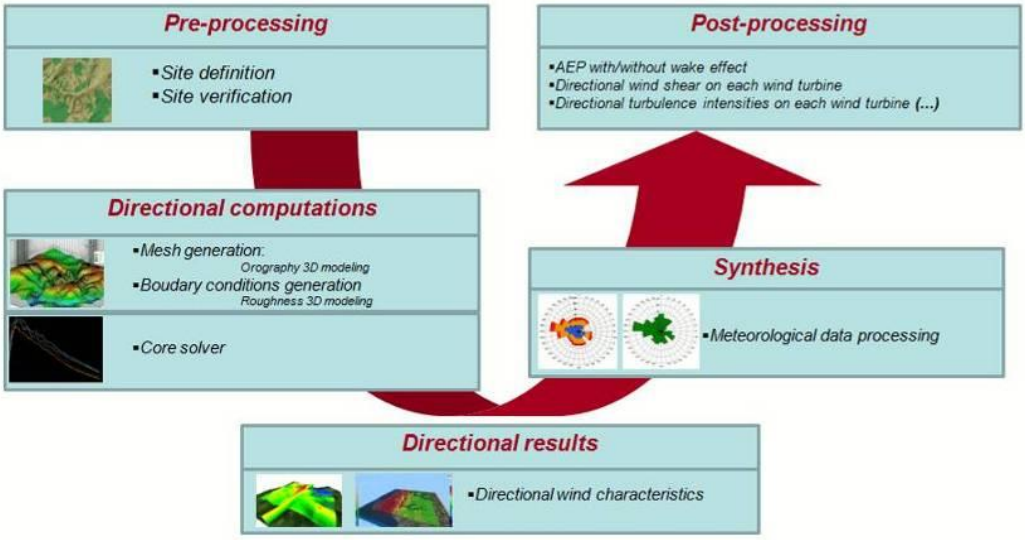
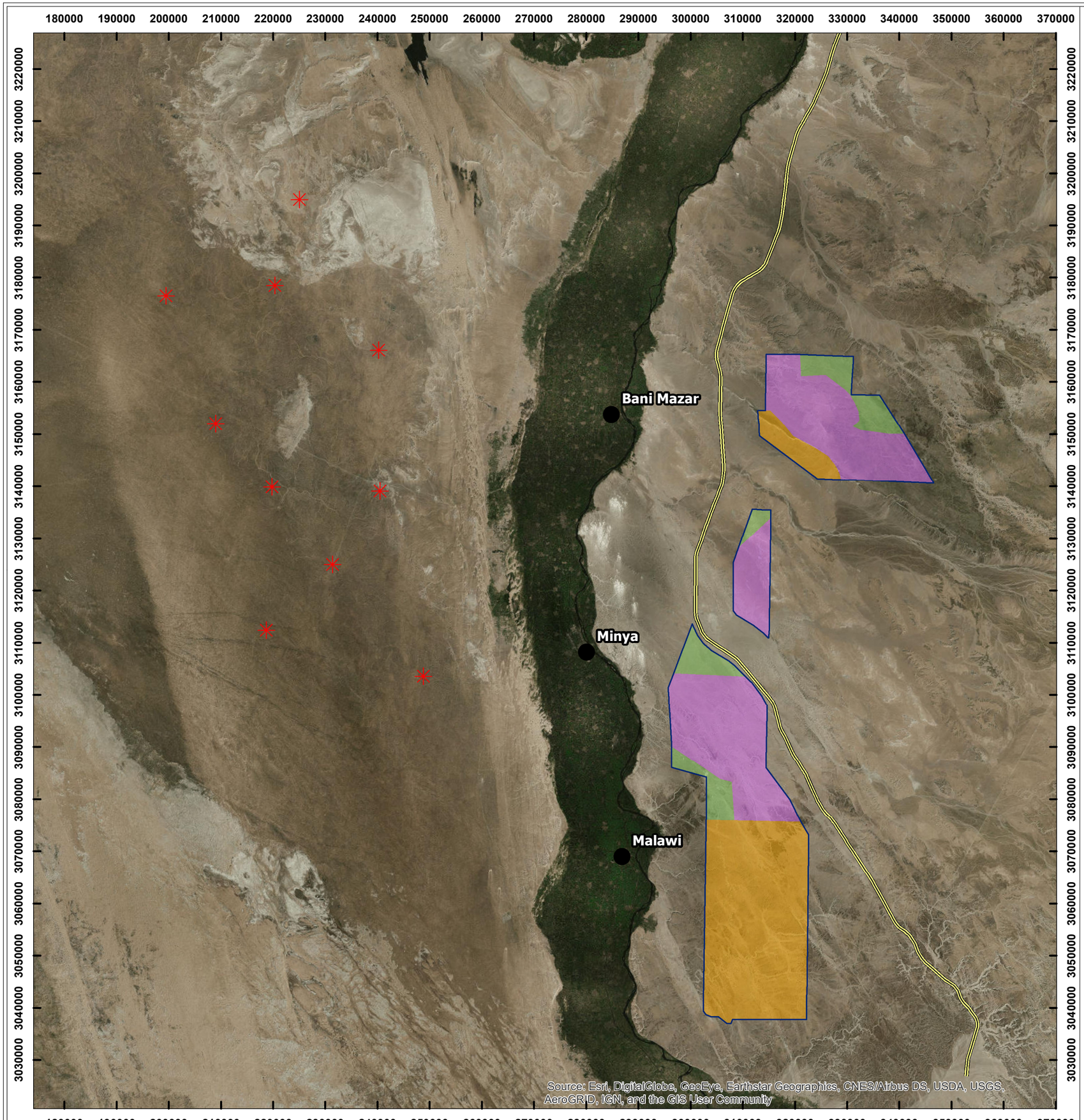


Figure 2-1: Simulation method of the model MeteodynWT



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Map 2-1:
Location of the ten wind measurement stations in the west Nile region

Bordering of project area and subareas

- project area
- subarea not useable for RE developments (due to height restrictions "Zero")
- subarea usable for PV solar power projects (due to height restrictions "5 m")
- subarea usable for wind power projects (due to height restrictions "150 m")

Roads

- Assiut - Cairo Desert Road (motorway)

Location of the ten wind measurement stations in the west Nile region

- wind measurement station

Coordinate System: WGS 1984 UTM Zone 36N

0 37.500 Meter

1:750.000

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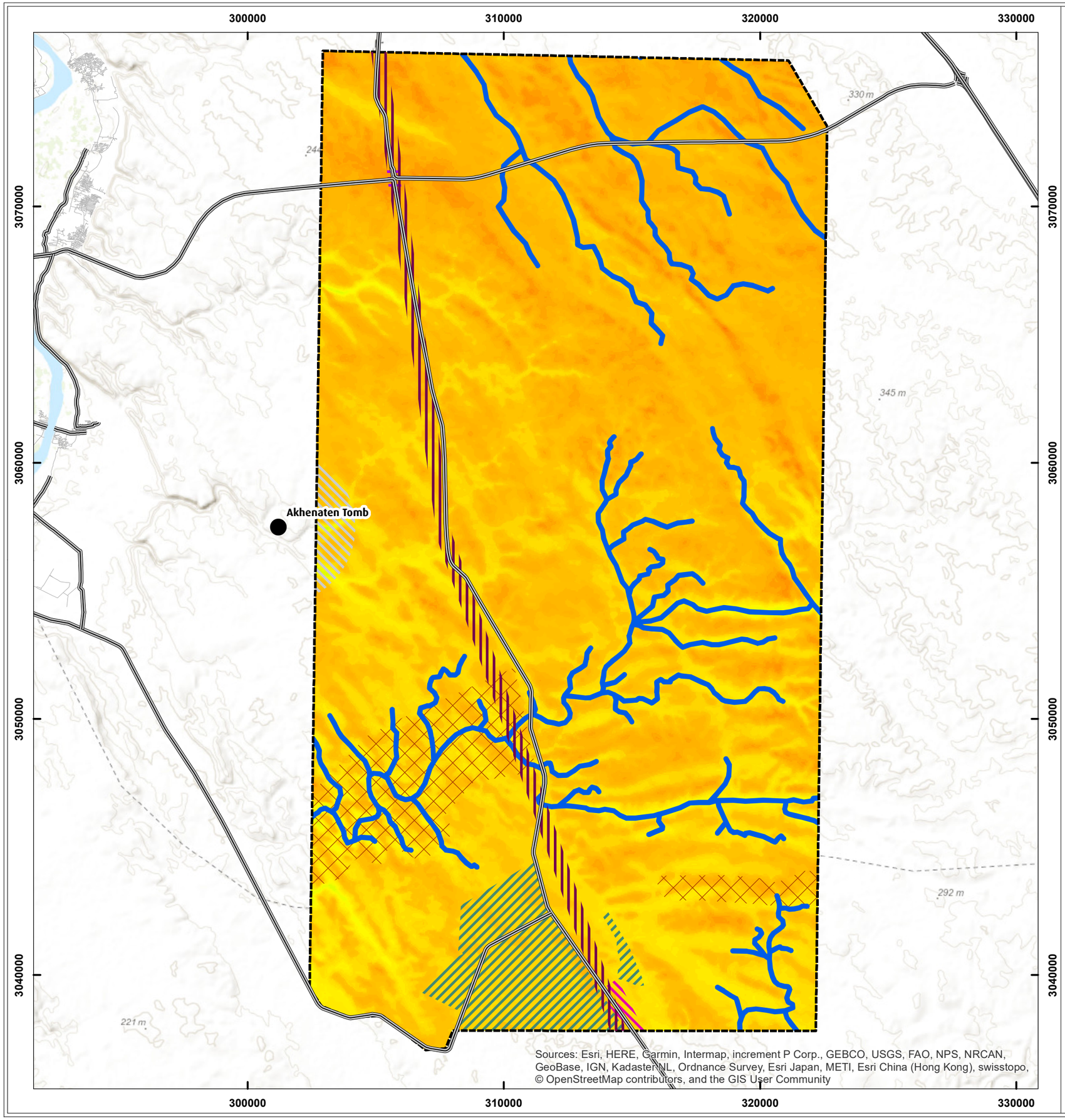
2.1.1 East Wind-1 Subarea

The East Wind-1 subarea has a rectangle shape with lateral lengths of about 20 km (west to east) and 38 km (north to south). Most of the subarea falls within to the El Minya Governorate. The southern portion is part of the Assiut Governorate. The subarea is located more than 7 km away from the Nile Valley, but has good accessibility via well dimensioned asphalt roads next to or even crossing the subarea. In general, the subarea is common non-vegetated desert ground with a quite homogeneous geology. The southern half of the East Wind-1 subarea partly contains more complex terrain which is crossed by Wadi systems. Economic activities such as farming and mining can only be found in the southern part of the subarea.

The following map shows the calculated wind potential for the East Wind-1 subarea for an elevation of 80 m above ground level (a.g.). As indicated in the following map, the highest wind potential with wind speeds above 9.5 m/s at 80 m a.g. is expected in the northern part of the East Wind-1 subarea whereas in its southern part simulated wind speeds are predicted to be lower (7.3-8.0 m/s), which is however still a suitable range for wind power development. In general, the distribution of the wind speed can be considered as homogenous without extreme changes in the wind speed. Considering modern wind turbines in the multi MW range (e.g. Gamesa G114, 2.5 MW), the gross annual energy production (including considering wake losses from neighbouring wind turbines) would be in a range from 10-15 GWh/a per turbine, depending on location and wake losses.



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Map 2-2:
Wind Resources and preclusive / unfavorable zones for the East Wind-1 Area

Bordering of East Wind-1 subarea

East Wind-1 subarea

Roads

road

Calculated wind potential for an elevation of 80 m above ground level

10 m/s
9 m/s
8 m/s
7 m/s
6 m/s

Zones preclusive for wind power development

due to farming area
due to industrial area
due to service buildings
due to transmitter corridor
due to Royal Tombs

Zones unfavourable for wind power development

wadis of importance as habitat
due to geomorphology

Coordinate System: WGS 1984 UTM Zone 36N

0 7.500 Meter

1:150.000

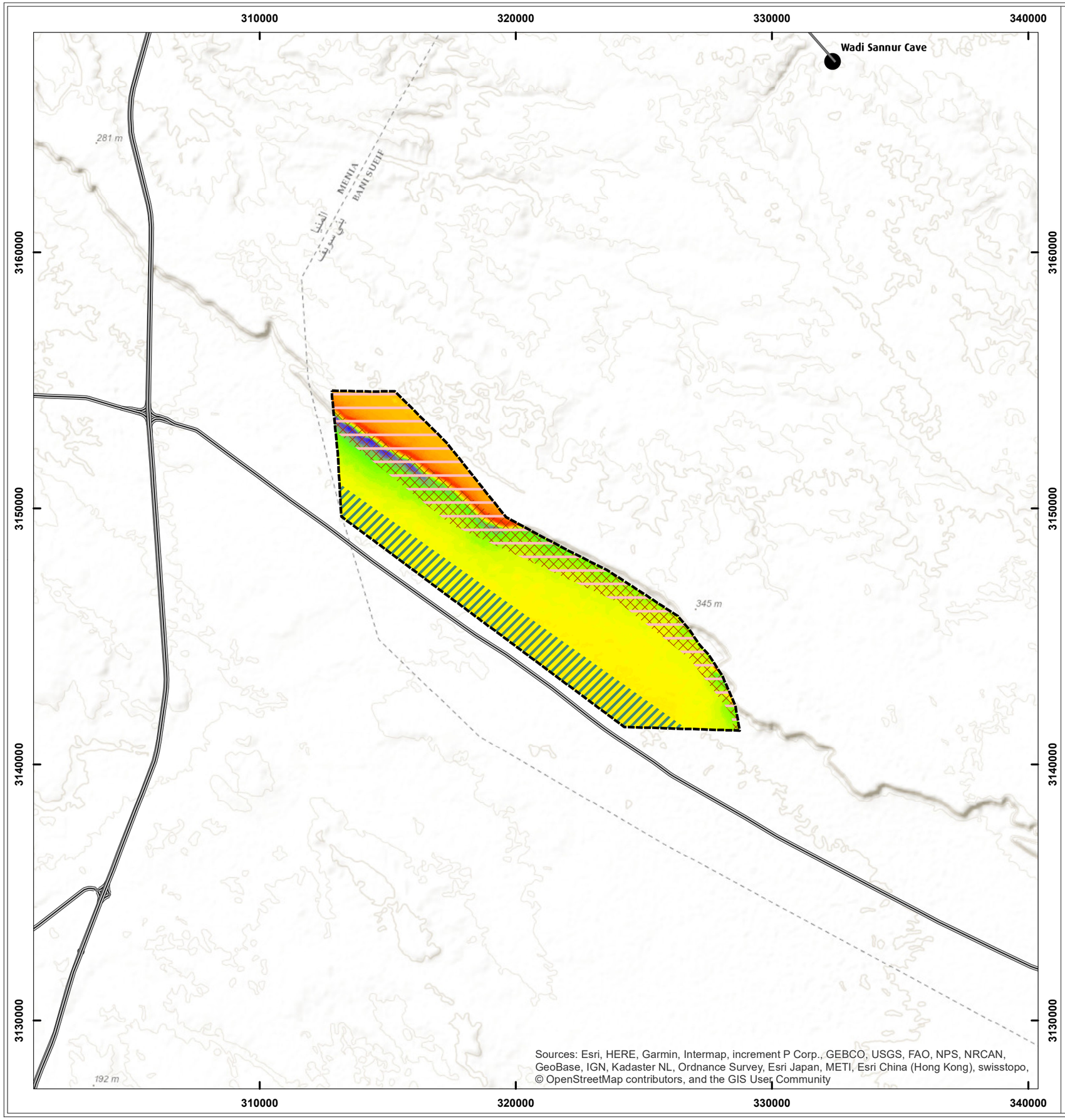
N

2.1.2 East Wind-2 Subarea

The East Wind-2 subarea comprises about 79 km² and is located north of the old Ras Ghareb – El Sheik Fadl Road (its southern boundary is located distances of about 500 m to the road). The subarea can be divided into two portions: Most of the subarea is located at the base of a 100 m high fault line (cliff) with a mostly homogeneous relief and slightly sloping towards the South. The cliff itself is considered as unstable and prone to continuous erosion. A smaller portion of the subarea is located on a plateau on top of the cliff. There is no possibility to access the upper area from the South. In the southern part of the East Wind-2 subarea farming activities have been identified.

Unlike the East Wind-1 subarea, the East Wind-2 subarea is characterised by height wind speeds on top of the cliff (9.0-9.8 m/s) whereas the southern part of the subarea indicates only wind speeds below 6.5 m/s as indicated in the following map. This can be explained by the dominant wind direction of north-east which is perpendicular to the alignment of the cliff (form Northwest to Southeast). The predicted annual energy potential for a modern wind turbine would be in the range of 10-12 GWh/a.

The following map shows the calculated wind power potential in the East Wind-2 subarea.



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Map 2-3:
Wind Resources and preclusive / unfavorable zones for the East Wind-2 area

Bordering of East Wind-2 subarea

East Wind-2 subarea

Roads

road

Calculated wind potential for an elevation of 80 m above ground level

10 m/s
9 m/s
8 m/s
7 m/s
6 m/s

Zones preclusive for wind power development

due to farming area

due to geomorphology

Zones unfavourable for wind power development

due to accessibility

Coordinate System: WGS 1984 UTM Zone 36N

0 7.500 Meter

1:150.000

N

2.2 Spatial Distribution of the solar power potential

Unlike wind potential, a uniform distribution of the solar potential can be expected as its potential mainly depends on the solar radiation which is mainly proportional to the degree of latitude and the cloudiness. Both parameters can be considered as stable for the region under reference with slightly higher cloudiness in the Nile Valley due to the evaporation of water.

The following map indicates the regional Global Horizontal Irradiation (GHI) which is derived from the SolarGIS database. On this basis, the annual long-term average sum of the GHI has a minimum value of 2,160 kWh/m² in the northwest and in the Nile Valley and the maximum GHI value of 2,360 kWh/m² is predicted in the Eastern Dessert and east of the city of Assiut. The solar potential in the three East Solar subareas can be considered as very high and, thus, suitable for development of photovoltaic projects.

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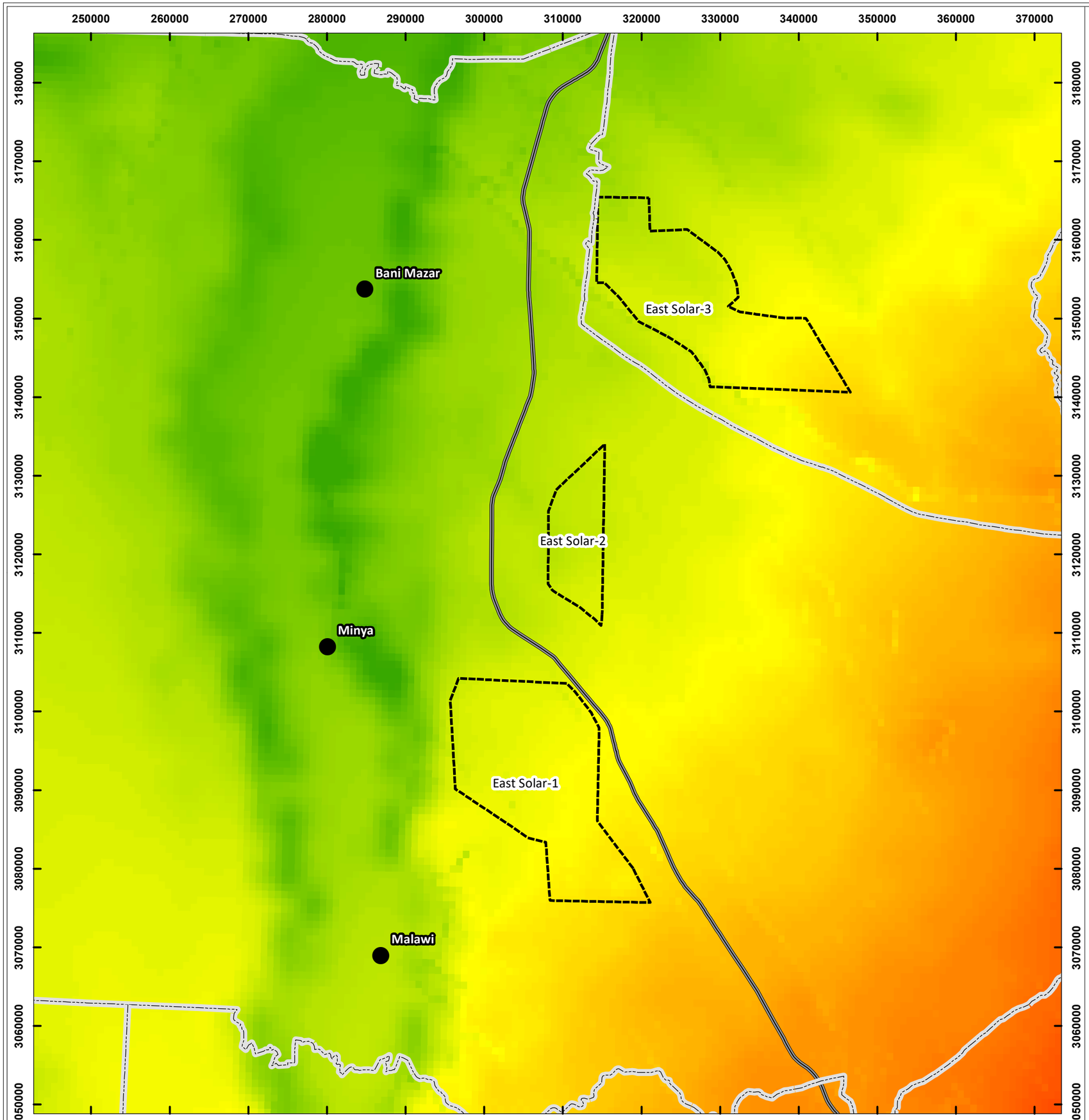
Map 2-4:
Annual long-term average sum of Global Horizontal Irradiation (GHI), period 1994-2015 in the region (source: SolarGis)



Bordering of project area and subareas

- East Solar subareas
- borders between governorates
- Assiut - Cairo Desert Road (motorway)

Annual long-term average sum of Global Horizontal Irradiation (GHI), period 1994-2015 in the region (source: SolarGis)

- 2320 kW/m²
- 2160 kW/m²

Coordinate System: WGS 1984 UTM Zone 36N

0 25.000 Meter

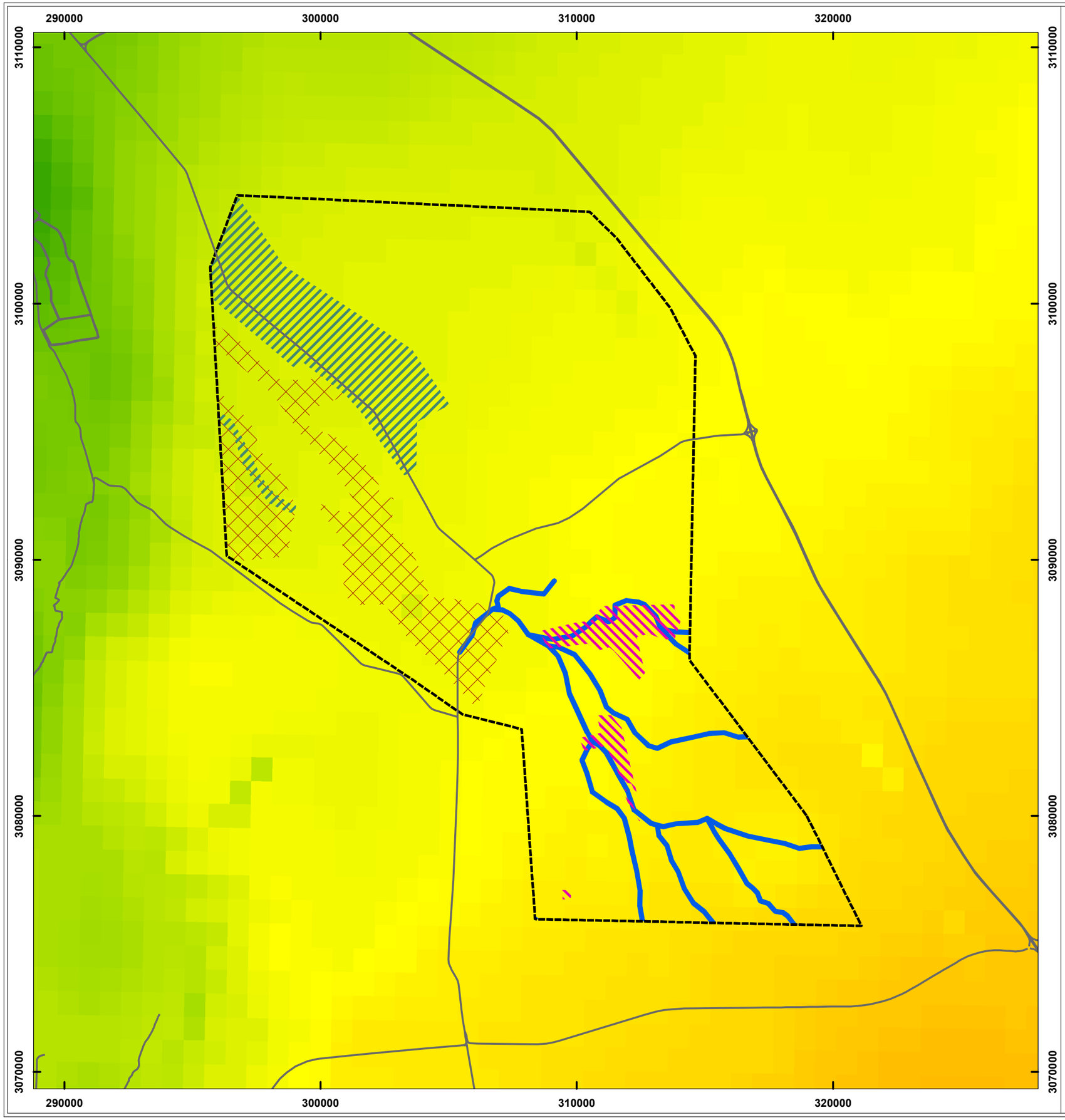
1:500.000

N

2.2.1 East Solar-1 Subarea

The East Solar-1 subarea is the largest (416 km²) and the most southern of the three solar subareas. It has an extension of 28 km from North to South and lateral lengths of about 18 km (West to East) in the North and 11 km in the South. The subarea is located in the Governorate of El Minya. The most western part is located about 5 km away from the Nile Valley. It starts about 10 km south of the East Solar-3 subarea and is directly connected to the East Wind-1 subarea further to the South. The north-eastern part of the East Solar-1 subarea can be described as flat or gently rolling dessert land whereas its southern half partly contains more complex terrain. In the north-western part of the East-Solar-1 subarea farming areas dominate the landscape, whereas the southern part of the subarea is penetrated with Wadi valleys and some sporadic mining activities.

Based on the following map, the annual long-term average sum of GHI ranges from about 2,200 kWh/m^2 in the north-west up to 2,280 kWh/m2 in the south-easterly region of the area. Compared to the highest solar irradiation in the region (Map 2-4), the overall solar power potential the East Solar-1, area can be characterized as medium high but still very favourable for development of solar PV projects.



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Map 2-5:
Annual long term average sum of Global Horizontal Irradiation (GHI), period 1994-2015 (source: SolarGis) and preclusive / unfavorable zones for the East Solar-1 area

Bordering of East Solar-1 subarea

East Solar-1 subarea

Roads

road

Annual long-term average sum of Global Horizontal Irradiation (GHI), period 1994-2015 in the region (source: SolarGis)

2320 kW/m²

2160 kW/m²

Zones preclusive for PV solar power development

due to economic activities (farming)

due to economic activities (mining)

Zones less favourable for PV solar power development

due to geomorphology

distance of 100 m to wadis of importance

Coordinate System: WGS 1984 UTM Zone 36N

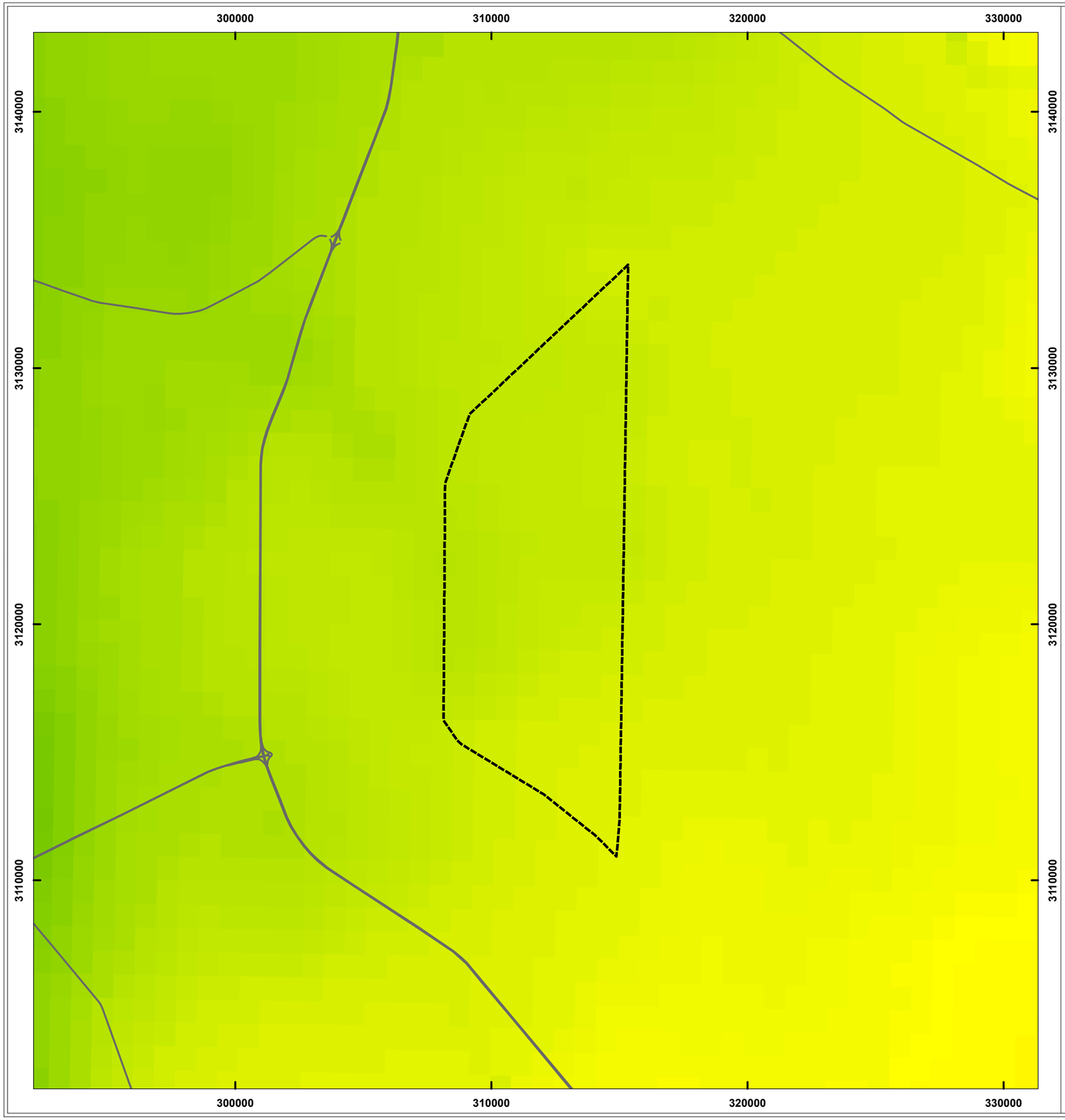
0 7.500 Meter

1:150.000

N

2.2.2 East Solar-2 Subarea

The East Solar-2 subarea amounts to 179 km² and is located in the East of El Minya Governorate. It starts about 15 km south of the East Solar-3 subarea. The subarea is crossed in the South by the new Highway from El Minya to Ras Ghareb. The whole subarea can be considered as flat without any penetration by Wadis or economic activities such as farming or mining. As indicated in the following Map 2-6, the area has a uniform annual GHI distribution of approximately 2,220 to 2,260 kWh/m2. Compared to the East Solar-1 subarea, the solar potential is slightly lower, but can still be considered as very suitable for development of PV solar projects.



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Map 2-6:
Annual long term average sum of Global Horizontal Irradiation (GHI), period 1994-2015 (source: SolarGis) and preclusive / unfavorable zones for the East Solar-2 area

Bordering of East Solar-2 subarea

East Solar-2 subarea

Roads

road

Annual long-term average sum of Global Horizontal Irradiation (GHI), period 1994-2015 in the region (source: SolarGis)

2320 kW/m²

2160 kW/m²

No restrictions exists for PV solar power development in the East Solar-2 subarea!

Coordinate System: WGS 1984 UTM Zone 36N

0 7.500 Meter

1:150.000

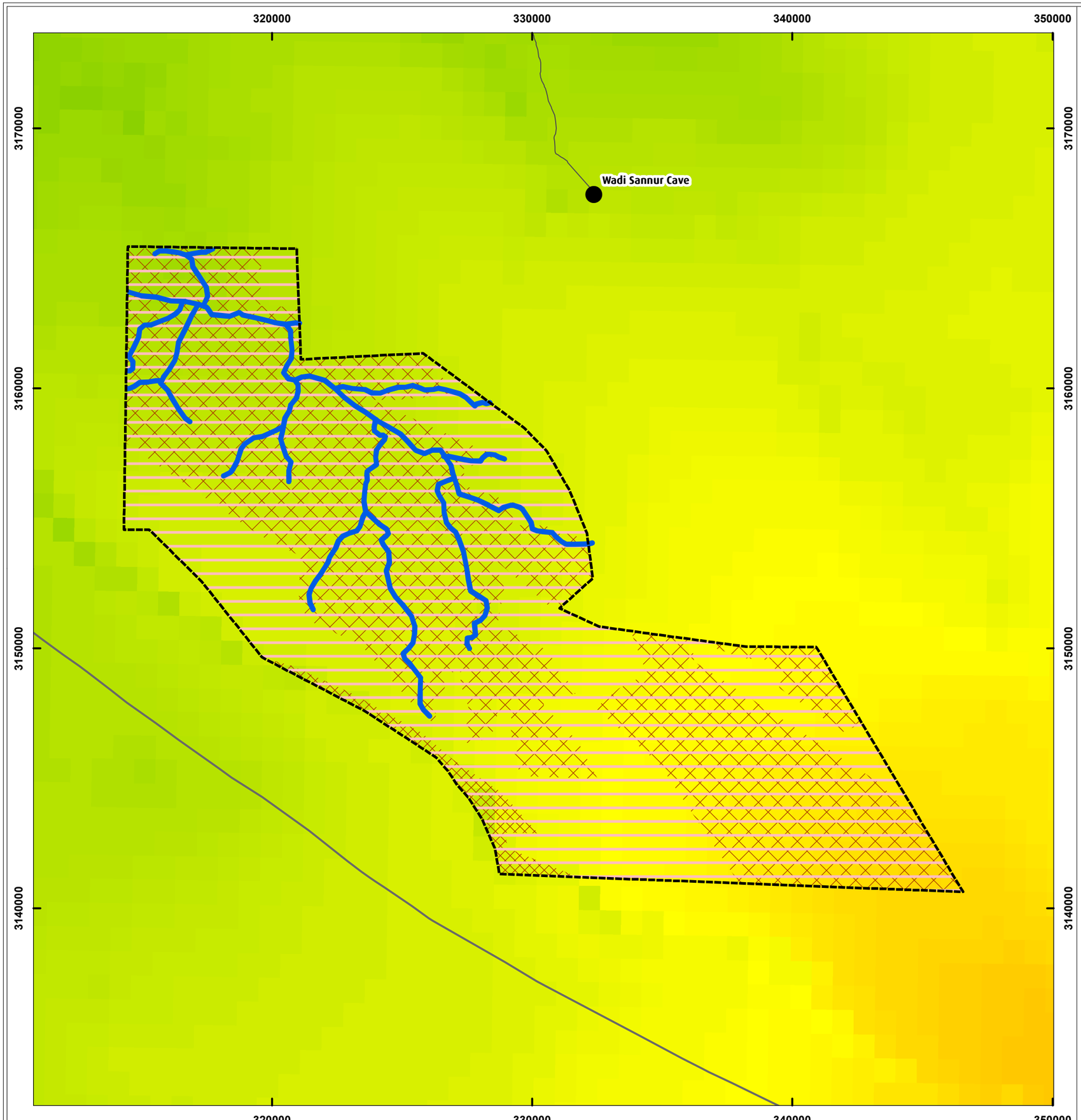
N

2.2.3 East Solar-3 Subarea

The northern border of the most northern East Solar-3 subarea of 363 km² is located in the South of Cairo at about 160 km linear distance and at 60 km linear distance to Beni Suef. It is located north-east of the cliff, the south-eastern part is even at the cliff's edge, which extends to about 70 km to the East in parallel to the old Ras Ghareb road. The major portion of the subarea consists of complex terrain with deep valleys and Wadis.

The East Solar-3 subarea has an annual GHI distribution in a range from 2,200 kWh/m^2 in the Northwest and 2,300 kWh/m^2 in the Southeast (see

Map ***2-7***). Like the East Solar-1 and East Solar-2 subareas, the GHI range for this subarea is also suitable for development of PV solar projects.



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Map 2-7:
Annual long term average sum of Global Horizontal Irradiation (GHI), period 1994-2015 (source: SolarGis) and preclusive / unfavorable zones for the East Solar-3 area

Bordering of East Solar-3 subarea

East Solar-3 subarea

Roads

road

Annual long-term average sum of Global Horizontal Irradiation (GHI), period 1994-2015 in the region (source: SolarGis)

2320 kW/m²

2160 kW/m²

Zones preclusive for PV solar power development

due to geomorphology

Zones unfavourable for PV solar power development

due to geomorphology

due to accessibility

distance of 100 m to wadis of importance

Coordinate System: WGS 1984 UTM Zone 36N

0 7.500 Meter

1:150.000

N

2.2.4 Conclusion

To conclude, due to the homogenous distribution of the solar power potential, all solar subareas can be considered as very promising for the development of PV solar power plants. Therefore, no ranking of (parts of the) subareas can be undertaken on the basis of solar power potential.

3 Subarea Classification

Within this section, the suitability of the RE potential (wind and solar developments) of each subarea will be analysed on basis of various factors. In particular, the suitability on basis of the environmental and social constraints as elaborated in the SESA Wind and SESA Solar Reports will be considered. From environmental point of view, the attention will be focussed on constrains such as geomorphology and important habitats (mainly Wadis). Regarding the social constrains, the attention will be addressed to the areas involved by economic factors, like farming, mining or other important activities.

As per the Terms of Reference, the size of an individual wind power or PV solar power project is defined to be a maximum of 50 MW. Thus, it is necessary to define plots which can accommodate 50 MW wind / solar PV capacity (individual 50 MW plots).

As mentioned before, areas which have been identified as preclusive or unfavourable as a result of the SESAs have not been considered. However, as wind farm construction works typically cover only 6% to 8% of the overall required plot, wind farm planning in zones of important Wadi systems (defined as unfavourable as per SESA Wind and SESA Solar) was considered as acceptable, provided that no turbines or wind farm infrastructure (roads or cable trenches) will be installed inside or next to (buffer of 100 m) Wadis beds. This limitation is also logical from technical point of view as the Wadi beds are characterized by lower wind resources, partly difficult access and potential water impact from rain.

Unlike wind energy, PV solar utilizes the majority of the land inside each plot (70-90% of the overall plot during the construction and operation phases) and so zones with important Wadis have been generally considered as not usable.

3.1 East Wind-1 Subarea

3.1.1 Identification of Subareas according to overall Suitability

On basis of the wind resource maps presented in Map 2-2, zones which are in general suitable for wind energy planning are identified on basis of their wind resources. As mentioned under section 2.1, the whole East Wind-1 subarea is, suitable for wind power development when taking into account the wind resources (minimum wind speeds above 7.0 m/s at 80 m above ground). Thus, no zones apart from the preclusive and unfavourable zones as already mentioned in the SESA Wind Report, have been excluded due to insufficient wind resources. As the East Wind-1 subarea is well connected to the Egyptian road network (El Minea - Asyut Road and the road connecting the El Minea - Asyut road with the Cairo - Aswan highway), all wind farm plots can be accessed without major difficulties. Thus, no zones have to be excluded due unfavourable accessibility. However, as wind potential varies within the East Wind -1 subarea, it is necessary to distinguish the respective zones pursuant to their wind resources.

To allocate different zones within the East Wind-1 subarea, three scenarios have been considered:

- Scenario 1 reflects a resource optimized zonation map aiming for optimizing the energy yield for each 50 MW plot.
- Scenario 2 is a capacity optimized zonation map, considering two rows of turbines in each plot to minimize wake losses.
- The zonation map for Scenario 3 is also capacity optimized but considers up to three rows of turbines for each plot which will maximise the capacity for the whole East Wind-1 subarea, but will at the same time cause higher wake losses compared to Scenario 2.

To classify the plots and propose an adequate development sequence, an exemplary energy production calculation has been performed for each scenario, taking into account a generic wind turbine type (Gamesa G114, 2.5 MW) which is considered as suitable for the East Wind-1 subarea. Afterwards, each plot has been ranked depending on the calculated energy yield:

- Category 1 (recommended for implementation in the first phase): Energy yield > 103% of the average energy yield for the whole East Wind-1 subarea.
- Category 2: (recommended for implementation in the subsequent phase): Energy yield between 95% and 103% of the average energy yield for the whole East Wind-1 subarea.
- Category 3: (recommended for implementation in the last phase): Energy yield lower than 95% of the average energy yield for the whole East Wind-1 subarea.

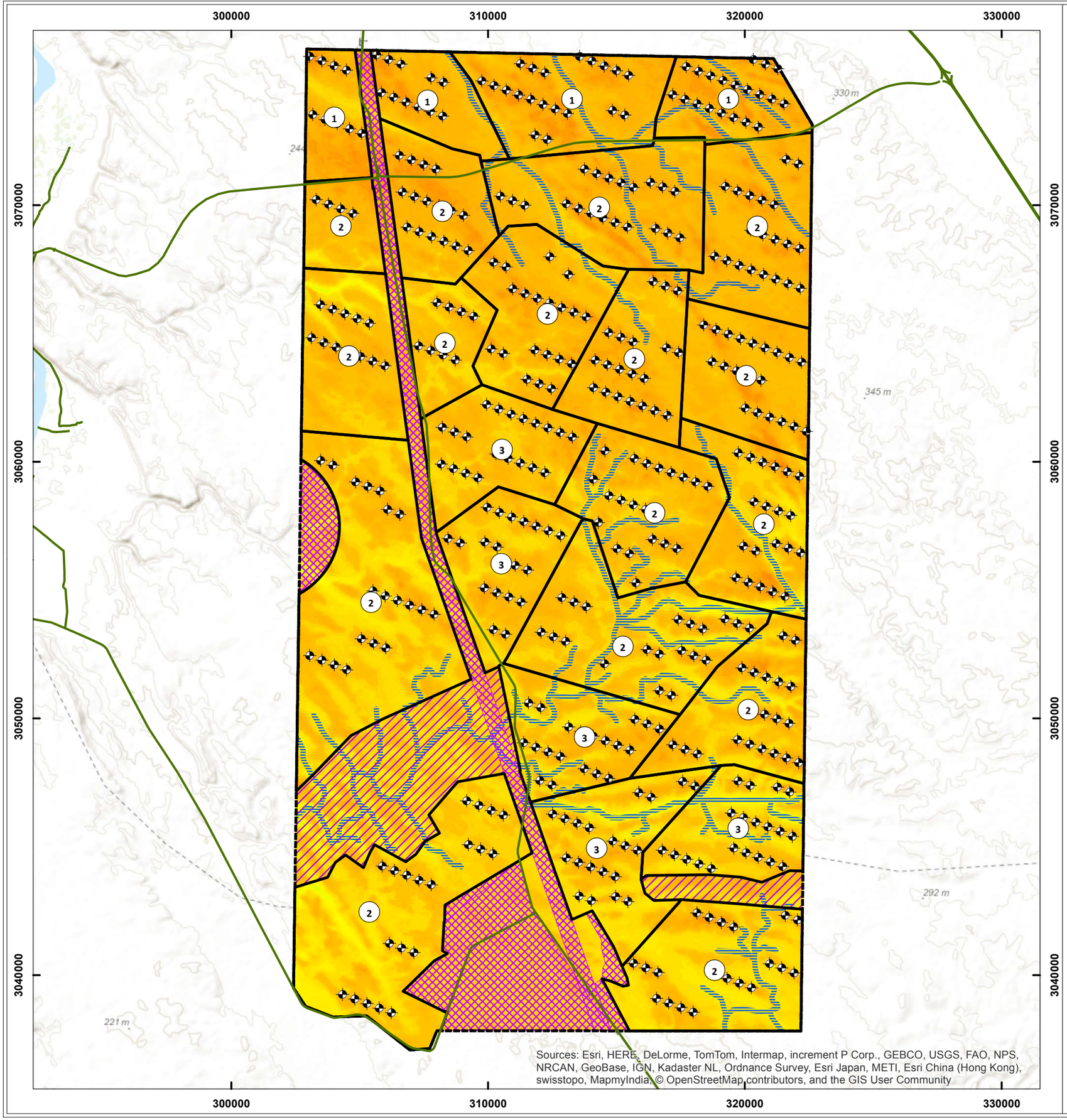
This categorization has been performed for each scenario.

3.1.2 Zonation maps for 50 MW Plots and Proposal of Development Sequence

The following maps (Map 3-1 - Map 3-3) shows the elaborated zoning for the East Wind-1 subarea which results in the following number of 50 MW plots. Further, Table 3-1 indicates the predicted cross energy yield which is calculated by the wind farm planning tool WindPRO on basis of the wind resources map. It must be noted that these figures only represent the cross energy yield, considering wake losses as calculated by WindPRO but no additional technical losses such as electrical losses, availability of the wind turbine as well as curtailment - although curtailment is not expected due to low importance of the area for migrating birds. Further, uncertainties in the calculation process are also not reflected at this stage.

Table 3-1: Summary of wind farm plots in the East Wind-1 subarea

Scenario	Number of plots	Accumulated capacity	Number of turbines	Initial annual cross energy yield whole East Wind-1 subarea	Average cross annual energy production per plot
Scenario 1 – resource optimized	22	1.1 GW	440	5.9 TWh	269 GWh
Scenario 2 – capacity optimized – 2 rows	34	1.7 GW	680	8.5 TWh	251 GWh
Scenario 3 – capacity optimized – 3 rows	38	1.9 GW	760	9.5 TWh	250 GWh



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Map 3-1a:
Zoning Map East Wind-1 Resource optimized

Bordering of East Wind-1 subarea

East Wind-1 subarea

Roads

road

Calculated wind potential for an elevation of 80 m above ground level

10 m/s
9 m/s
8 m/s
7 m/s
6 m/s

Zones preclusive or unfavorable for wind power development

zones preclusive for wind power development

zones unfavorable for wind power development (due to geomorphology)

zones unfavorable for wind power development (due to habitat protection)

Zoning East Wind-1 Resource optimized

① Category 1: Energy yield > 103% of the average energy yield for the whole East Wind-1 area

② Category 2: Energy yield between 95% and 103% of the average energy yield for the whole East Wind-1 area

③ Category 3: Energy yield lower than 95% of the average energy yield for the whole East Wind-1 area

exemplar location of a wind turbine (WTG)

Coordinate System: WGS 1984 UTM Zone 36N

0 7.500 Meter

1:150.000

N

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Map 3-1b:
Zoning Map East Wind-1 Resource optimized

Bordering of East Wind-1 subarea

East Wind-1 subarea

Roads

road

Zones preclusive or unfavorable for wind power development

zones preclusive for wind power development

zones unfavorable for wind power development (due to geomorphology)

zones unfavorable for wind power development (due to habitat protection)

Zoning East Wind-1 Resource optimized

Category 1: Energy yield > 103% of the average energy yield for the whole East Wind-1 area

Category 2: Energy yield between 95% and 103% of the average energy yield for the whole East Wind-1 area

Category 3: Energy yield lower than 95% of the average energy yield for the whole East Wind-1 area

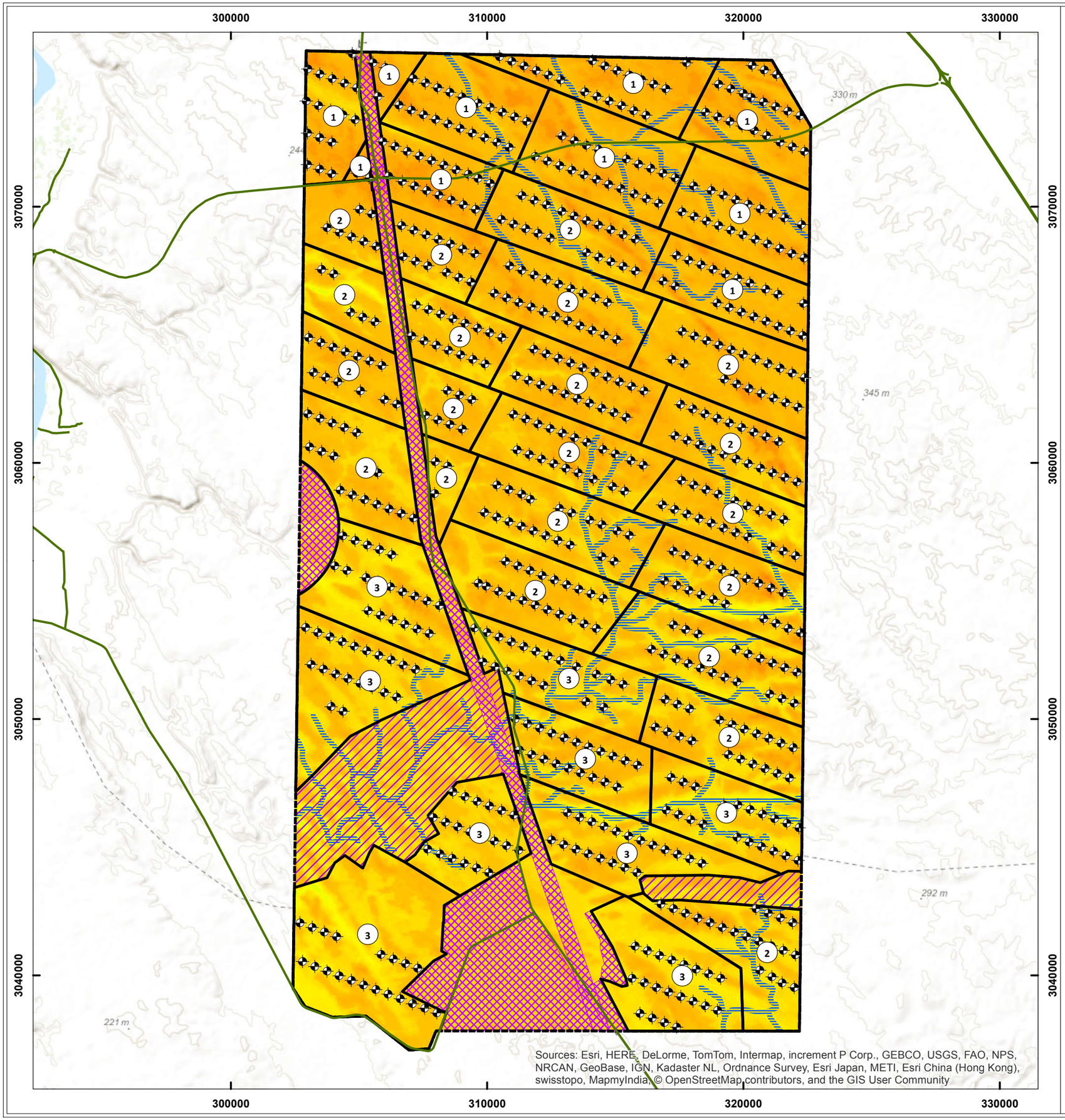
exemplar location of a wind turbine (WTG)

Coordinate System: WGS 1984 UTM Zone 36N

0 7.500 Meter

1:150.000

N



Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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Map 3-2a:
Zoning Map East Wind-1 Capacity optimized – 2 rows

Bordering of East Wind-1 subarea

East Wind-1 subarea

Roads

road

Calculated wind potential for an elevation of 80 m above ground level

10 m/s
9 m/s
8 m/s
7 m/s
6 m/s

Zones preclusive or unfavorable for wind power development

zones preclusive for wind power development

zones unfavorable for wind power development (due to geomorphology)

zones unfavorable for wind power development (due to habitat protection)

Zoning East Wind-1 Capacity optimized (2 rows)

① Category 1: Energy yield > 103% of the average energy yield for the whole East Wind-1 area

② Category 2: Energy yield between 95% and 103% of the average energy yield for the whole East Wind-1 area

③ Category 3: Energy yield lower than 95% of the average energy yield for the whole East Wind-1 area

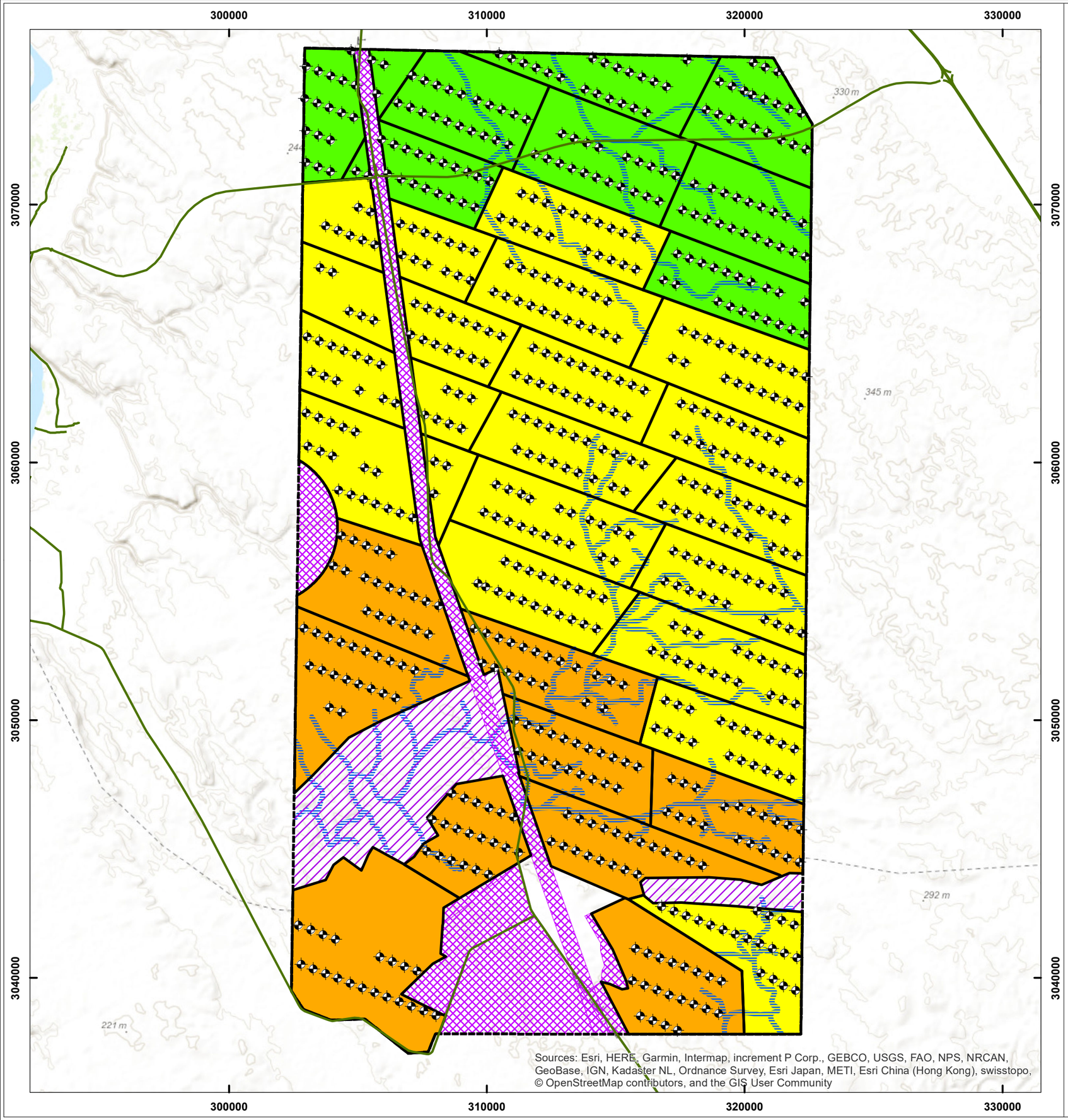
exemplar location of a wind turbine (WTG)

Coordinate System: WGS 1984 UTM Zone 36N

0 7.500 Meter

1:150.000

N



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Map 3-2b:
Zoning Map East Wind-1 Capacity optimized – 2 rows

Bordering of East Wind-1 subarea

East Wind-1 subarea

Roads

road

Zones preclusive or unfavorable for wind power development

zones preclusive for wind power development

zones unfavorable for wind power development (due to geomorphology)

zones unfavorable for wind power development (due to habitat protection)

Zoning East Wind-1 Capacity optimized (2 rows)

Category 1: Energy yield > 103% of the average energy yield for the whole East Wind-1 area

Category 2: Energy yield between 95% and 103% of the average energy yield for the whole East Wind-1 area

Category 3: Energy yield lower than 95% of the average energy yield for the whole East Wind-1 area

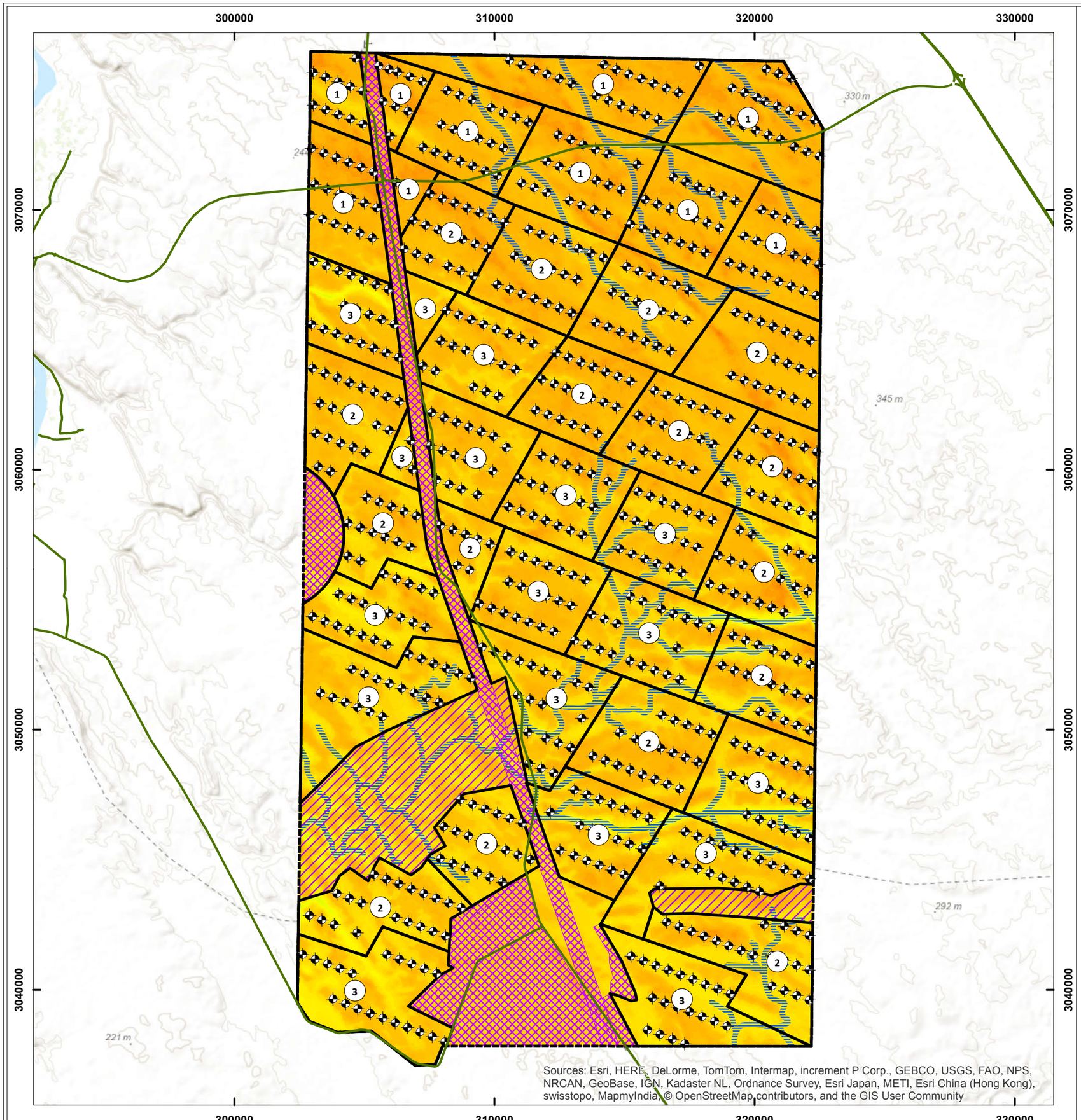
exemplar location of a wind turbine (WTG)

Coordinate System: WGS 1984 UTM Zone 36N

0 7.500 Meter

1:150.000

N



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Map 3-3a:
Zoning Map East Wind-1 Capacity optimized – 3 rows

Bordering of East Wind-1 subarea

East Wind-1 subarea

Roads

road

Calculated wind potential for an elevation of 80 m above ground level

10 m/s
9 m/s
8 m/s
7 m/s
6 m/s

Zones preclusive or unfavorable for wind power development

zones preclusive for wind power development

zones unfavorable for wind power development (due to geomorphology)

zones unfavorable for wind power development (due to habitat protection)

Zoning East Wind-1 Capacity optimized (3 rows)

① Category 1: Energy yield > 103% of the average energy yield for the whole East Wind-1 area

② Category 2: Energy yield between 95% and 103% of the average energy yield for the whole East Wind-1 area

③ Category 3: Energy yield lower than 95% of the average energy yield for the whole East Wind-1 area

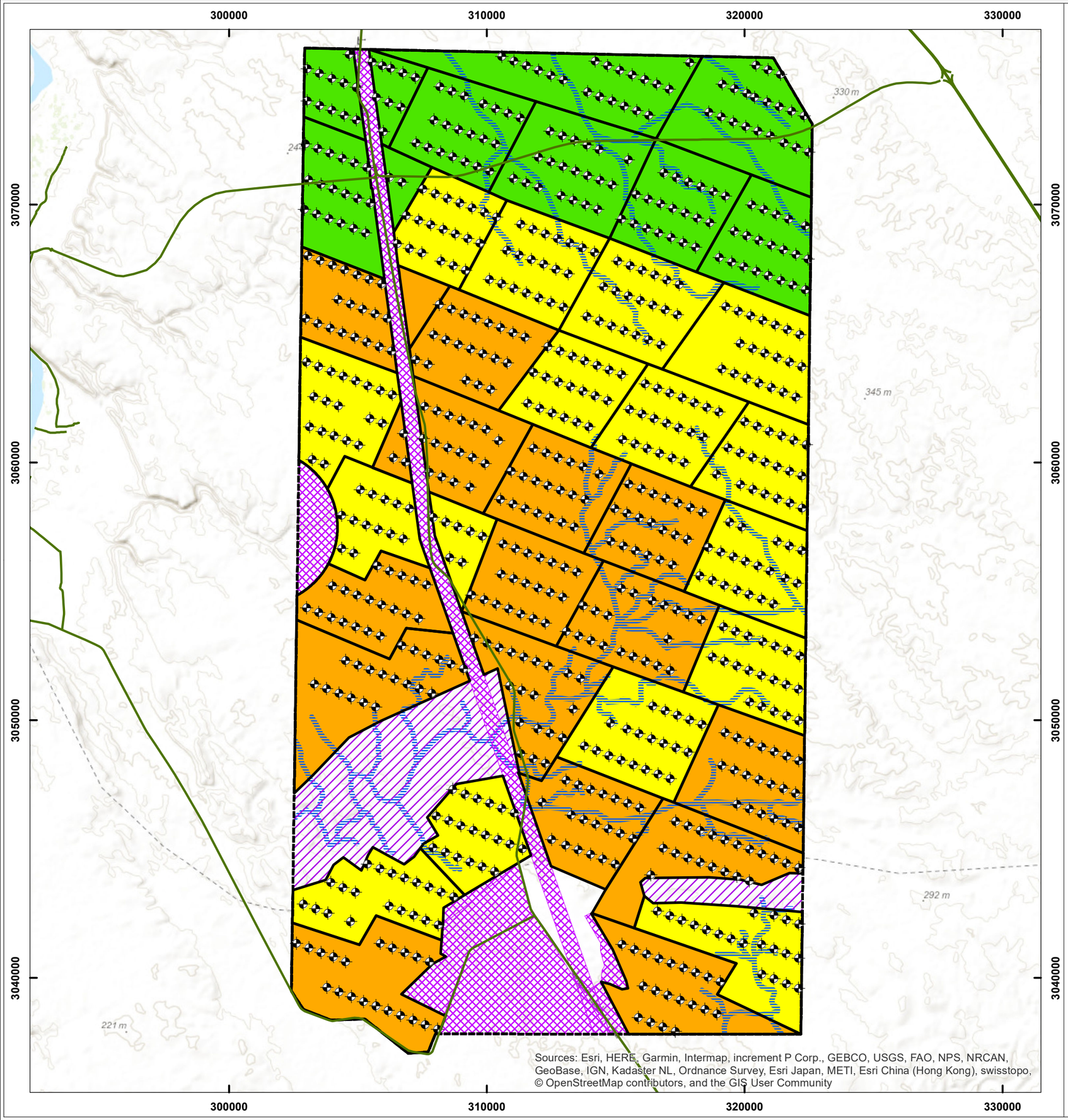
exemplar location of a wind turbine (WTG)

Coordinate System: WGS 1984 UTM Zone 36N

0 7.500 Meter

1:150.000

N



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Map 3-3b:
Zoning Map East Wind-1 Capacity optimized – 3 rows

Bordering of East Wind-1 subarea

East Wind-1 subarea

Roads

road

Zones preclusive or unfavorable for wind power development

zones preclusive for wind power development

zones unfavorable for wind power development (due to geomorphology)

zones unfavorable for wind power development (due to habitat protection)

Zoning East Wind-1 Capacity optimized (3 rows)

Category 1: Energy yield > 103% of the average energy yield for the whole East Wind-1 area

Category 2: Energy yield between 95% and 103% of the average energy yield for the whole East Wind-1 area

Category 3: Energy yield lower than 95% of the average energy yield for the whole East Wind-1 area

exemplar location of a wind turbine (WTG)

Coordinate System: WGS 1984 UTM Zone 36N

0 7.500 Meter

1:150.000

N

In the resource optimized Scenario 1, it is assumed that turbines are placed on positions with the best wind condition. In the capacity optimized scenarios, fix distances between turbines (10 times the rotor diameter in main wind direction and 4.5 times the rotor diameter in cross wind direction) are assumed. As a consequence, the resource based Scenario 1 requires more space per plot in comparison with Scenario 2 and Scenario 3, resulting in fewer plots. As the routing of future transmission lines is not know yet, each plot is of sufficient size to consider buffer zones between each plot of about 1.5 km in main wind direction to allow the wind speed to increase again and to reduce the wake losses (maximum 10%) for the southern plots and to provide space for required transmission lines and road corridors for site access.

As indicated in the maps, the northern part of the East Wind-1 subarea shows higher wind speeds compared to the southern portion of the area. Thus, a development sequence should logically start in the northern part as indicated by the green plots (energy yield higher than 103% of the overall average for the East-Wind-1 subarea). The following table summarizes the number of plots for each development sequence.

Table 3-2: Development sequence in the East Wind-1 subarea

	Scenario 1 [no. of Plots]	Scenario 2 [. of Plots]	Scenario 3 [no. of Plots]
Development Phase 1	3	8	8
Development Phase 2	14	17	15
Development Phase 3	5	9	15

As indicated in Table 3-1, Scenario 1 indicates the lowest estimated energy yield for the whole subarea due to lowest number of plots. On the other hand, the average energy yield per plot is significantly higher due to the resource optimization. This can result in lower energy generation costs for each wind farm plot and can make the plots more attractive for project investors. From an economic point of view, Scenario 2 and 3 will produce the highest energy yield due to the larger number of plots. As the average energy yield per plot is quite similar, Scenario 3 is the preferred Scenario due to the larger number of plots compared to Scenario 2.

3.2 East Wind-2 Subarea

3.2.1 Identification of Subareas according to overall Suitability

The wind resources in the East Wind-2 subarea are mainly dominated by the impact of the cliff which separates the area in a smaller northern portion located above the cliff and a larger portion in the South. The majority of the southern portion is however defined as preclusive due to the geomorphic conditions at the bottom of the cliff and farming activities. Due to the topographic impact of the cliff, the average annual wind speed decreases from about 9.5 m/s on top of the cliff to 6.0 m/s at the

bottom. After some hundred meters distance, the wind speeds increase again to about 7.3 m/s which can be considered as suitable for wind energy planning.

3.2.2 Zonation map in 50 MW Plots and Proposal of Development Sequence

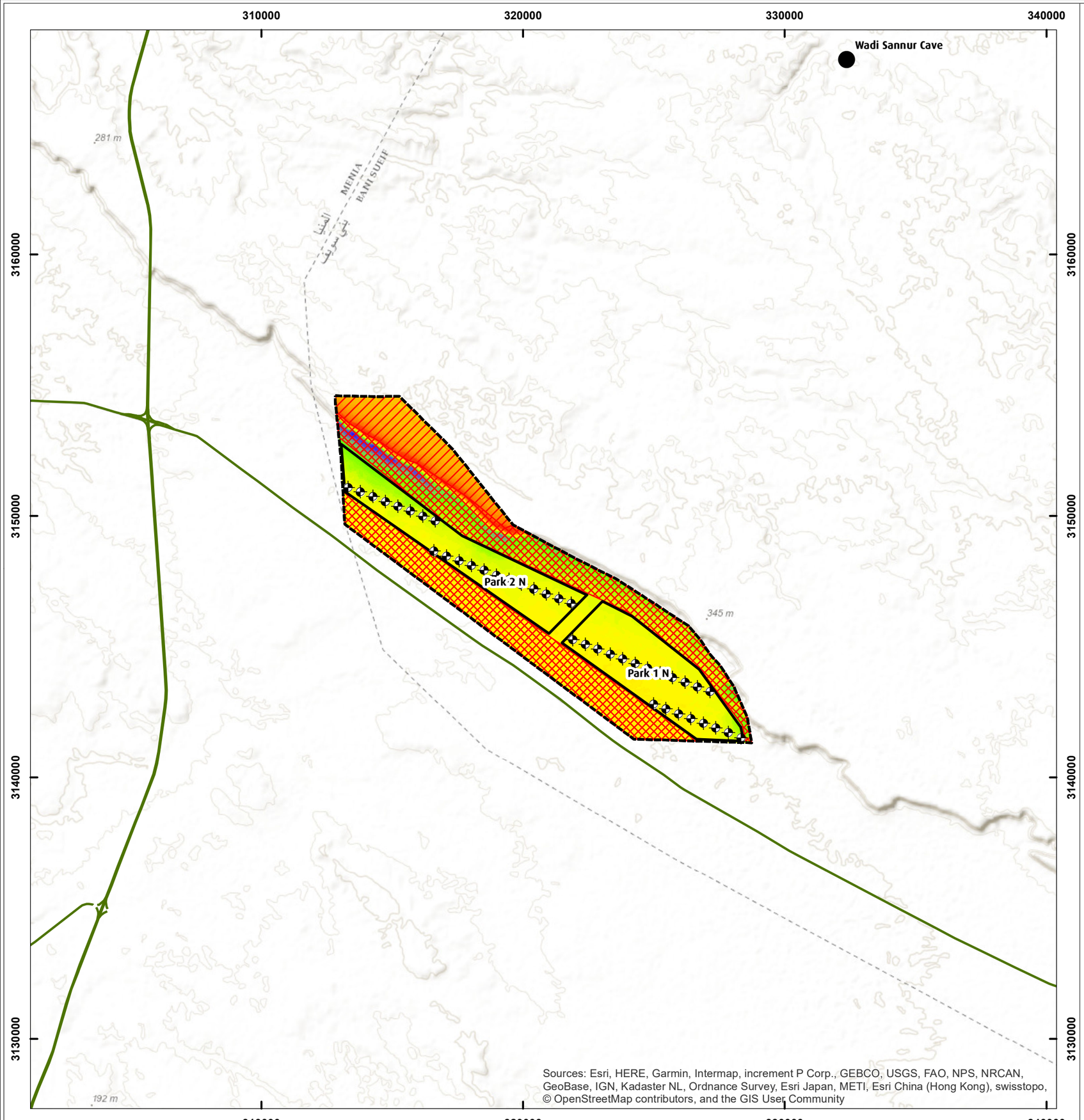
As most of the northern portion of the East Wind-2 subarea have been defined as preclusive due to geomorphic conditions (area along the cliff), the remaining area of this portion is not sufficient to accommodate a 50 MW plot and, in addition, is difficult to access. Consequently, wind farm development is restricted to the southern part of the East Wind-2 subarea. For this portion only one scenario (base scenario) has been developed, comprising of two 50 MW plots which cover the whole usable area.

The following Map 3-4 shows the zoning of the two wind farm plots. Due to the homogenous wind conditions in the southern portion of the East Wind-2 subarea, a similar energy yield for both plots can be expected. The results are summarized in the following table.

Table 3-3: Summary of wind farm plots in the East Wind-2 subarea

Scenario	Number of plots	Accumulated capacity	Number of turbines	Initial annual cross energy yield whole East Wind-2 subarea	Average cross annual energy production per plot
Base Scenario	2	0.1 GW	40	0.57 TWh	234 GWh

As indicated in Table 3-3, the estimated annual energy yield is lower compared to the results obtained for the East Wind-1 subarea. Due to this and due to the fact that only a small portion of the East Wind-2 subarea is usable for wind farm planning, it is recommended to implement wind power projects in the last phase (i.e. after all plots in the East Wind-1 subarea are used).



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Draft Final Recommendation Report

client:
New and Renewable Energy Authority (NREA),
Ministry of Electricity and Renewable Energy

Map 3-4:
Zoning Map East Wind-2

Bordering of East Wind-2 subarea

East Wind-2 subarea

Roads

road

Calculated wind potential for an elevation of 80 m above ground level

10 m/s
9 m/s
8 m/s
7 m/s
6 m/s

Zones preclusive or unfavorable for wind power development

zones preclusive for wind power development

zones unfavorable for wind power development (due to geomorphology)

Zoning East Wind-2

zonation (50 MW plots)

exemplary location of a wind turbine (WTG)

Coordinate System: WGS 1984 UTM Zone 36N

0 7.500 Meter

1:150.000

N

3.3 East Solar-1 Subarea

3.3.1 Identification of Subareas according to overall suitability

The East Solar-1 subarea is characterized by several zones that are currently used or under development for economic activities such as farming or mining activities. These zones have been considered to be preclusive for the development of photovoltaic plants in the SESA Solar Report. The farms represent one of the sensitive receptors to be considered during developmental activities in the East Solar-1 subarea. Therefore, no PV plots are foreseen to be on or next to (100 m buffer) farming areas.

In addition, the important Wadi Ibadah and Wadi al-Birshawi complex has been assessed as less favourable for PV solar power developments in the SESA Solar Report. Thus, construction works in this Wadi complex (plus 100 m buffer zone) shall be excluded.

The following figure shows the general layout of a PV solar plot which comprises 50 x 1 MW clusters plus a temporary laydown area, substation and O&M buildings. A fence surrounding each PV solar plot will be placed at a distance of about 10 meters from the PV modules rows to allow the normal circulation of machinery during the construction and O&M activities. Space for internal roads allowing the regular O&M activities are foreseen as well. PV solar plants also include medium voltage cabinets housing inverters, transformers and control panels.

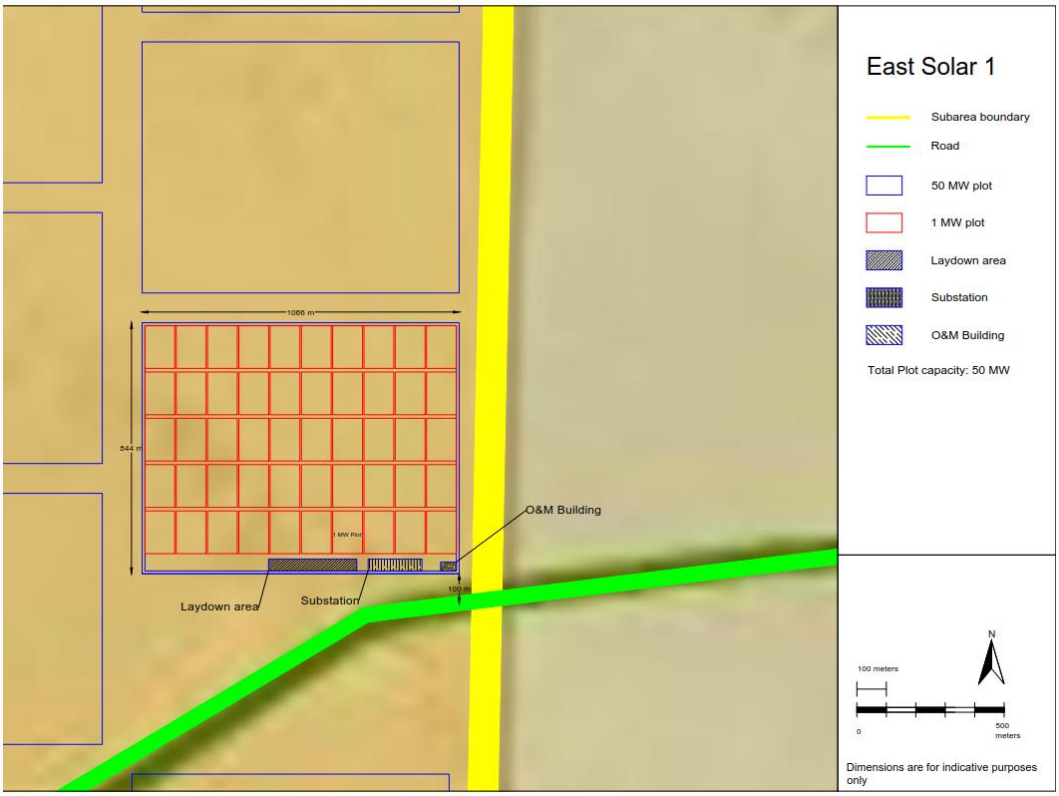


Figure 3-1: General layout of a 50 MW PV solar plot

3.3.2 Zonation maps in 50 MW Plots and Proposal of Development Sequence

Map 3-5 shows the distribution of the 50 MWp solar PV blocks within the usable East Solar-1 subarea. The installation of a single 50 MWp block requires an area of about 150 ha which can be considered as a conservative value, as the overall area can be reduced during the detailed planning phase. Thus, the considered 150 ha still provides sufficient space for routing of transmission lines, if required. The total theoretical capacity which can be accommodated in the suitable zones is estimated to be 5 GW, with a total installed capacity of around 100 plots. The distance between two neighbouring plots has been defined as 150 m to allow sufficient space for accessing all plots.

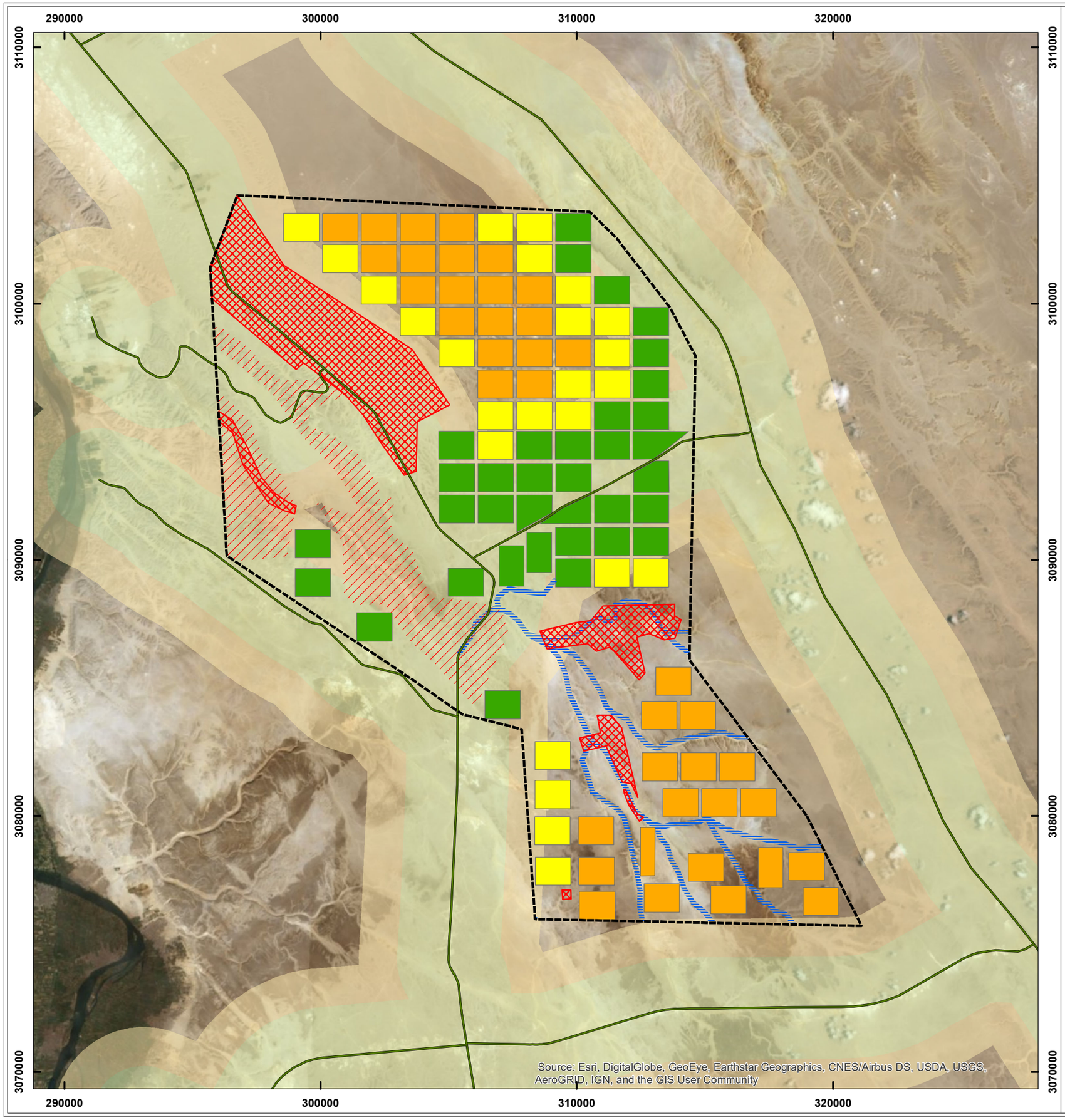
As the solar potential of the East Solar-1 subarea is uniform, establishing a ranking / development sequence on basis of the solar resources is considered as not applicable. Thus, it is considered as more reliable to benchmark the solar PV plots against the available infrastructure (i.e. accessibility) to judge on ranking. The following criteria have been defined:

- Category 1: (recommended for implementation in the first phase): solar PV plots which are at maximum distances of 2,000 m from existing roads infrastructure.
- Category 2: (recommended for implementation in the subsequent phase): solar PV plots which are located at distances between 2,000 and 3,500 m from existing roads infrastructure.
- Category 3: (recommended for implementation in the last phase): solar PV plots which are located at distances of more than 3,500 m from existing roads infrastructure.

The following table summarizes the potential for implementation of PV solar plots in the East Solar-1 subarea.

Table 3-4: Summary of PV solar plots in the East Solar-1 subarea

Scenario	Number of plots	Accumulated capacity	Initial annual cross energy yield whole East Solar-1 subarea	Approximately average cross annual energy production per plot
Base Scenario	100	5 GW	1,820-1,930 kWh/kWp	95 GWh



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Map 3-5:
Zoning map East Solar-1 area

Bordering of East Solar-1 subarea

East Solar-1 subarea

Roads

asphalt road

Distance to existing roads

2,000 m buffer to asphalt roads

3,500 m buffer to asphalt roads

Zones preclusive or unfavorable for PV solar power development

zones preclusive for PV solar power development

zones unfavorable for PV solar power development (due to geomorphology)

zones unfavorable for PV solar power development (due to habitat protection)

Distribution of the 50 MWp photovoltaik (PV) blocks and proposal of development sequence

Category 1: PV blocks which are in a maximum distance of 2.0 km to existinge roads

Category 2: PV blocks which are in a distance between 2.0 and 3.5 km to existing roads

Category 3: PV blocks which are in a maximum distance more than 3.5 km to existing roads

Coordinate System: WGS 1984 UTM Zone 36N

0 7.500 Meter

1:150.000

N

3.4 East Solar-2 Subarea

3.4.1 Identification of Subareas according to overall Suitability

As no preclusive or unfavourable zones have been identified in the East Solar-2 subarea and a homogenous solar potential can be expected, the whole subarea can theoretical utilized. Plot size and distance between individual plots are the same as assumed for the East Solar-1 subarea (see section 3.3).

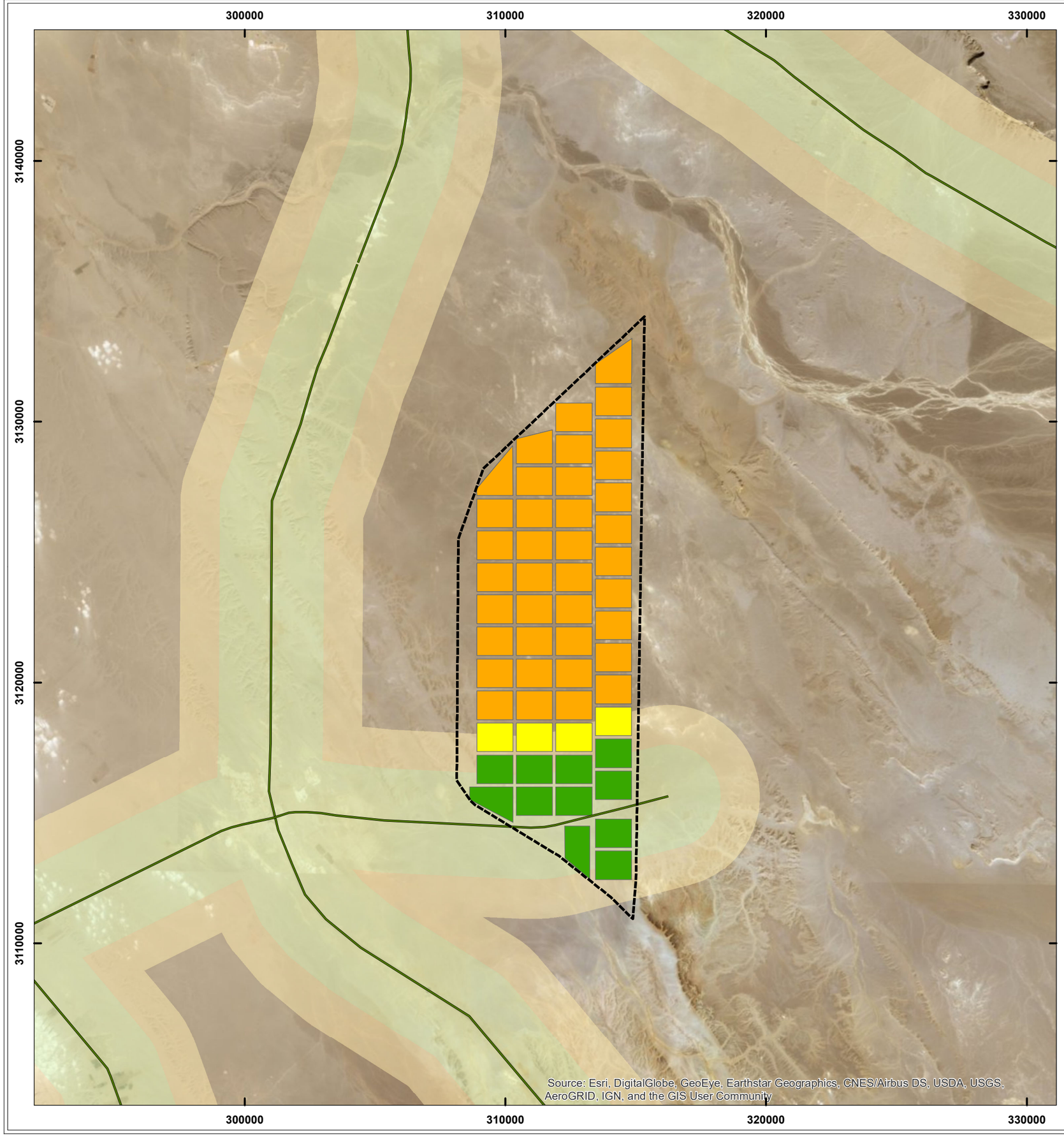
3.4.2 Zonation Maps in 50 MW Plots and Proposal of Development Sequence

Similar as for the East Solar-1 subarea, a development sequence is recommended on basis of the available infrastructure (i.e. accessibility). Plots in the southern part of the East Solar-2 subarea can be easily accessed by the new road connection to the El Minea - Ras Garib Highway. Consequently, it is recommended to start PV solar development in the South of the subarea, followed by the central and the northern part which also show less favourable soil conditions compared to the southern part (please refer to the SESA Solar report section 5.1.3.1). The following map shows the potential solar PV plots in the East Solar-2 subarea and the recommended development sequence.

The following table summarizes the potential for implementation of solar PV plots in the East Solar-1 subarea.

Table 3-5: Summary of PV solar plots in the East Solar-2 subarea

Scenario	Number of plots	Accumulated capacity	Initial annual cross energy yield whole East Solar-2 subarea	Approximately average cross annual energy production per plot
Base Scenario	53	2.6 GW	1,820-1,930 kWh/kWp	95 GWh



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Map 3-6:
Zoning map East Solar-2 area

Bordering of East Solar-2 subarea

East Solar-2 subarea

Roads

asphalt road

Distance to existing roads

2,000 m buffer to asphalt roads

3,500 m buffer to asphalt roads

Distribution of the 50 MWp photovoltaik (PV) blocks and proposal of development sequence

Category 1: PV blocks which are in a maximum distance of 2.0 km to existinge roads

Category 2: PV blocks which are in a distance between 2.0 and 3.5 km to existing roads

Category 3: PV blocks which are in a maximum distance more than 3.5 km to existing roads

Coordinate System: WGS 1984 UTM Zone 36N

0 7.500 Meter

1:150.000

N

3.5 East Solar-3 Subarea

As already mentioned in the SESA Solar Report, the whole East Solar-3 subarea has been defined as unfavourable due to geomorphic conditions and the difficult accessibility, requiring the construction of an access road of at least 30 km length. Thus, no PV solar power development is recommended in this subarea.

4 Measures and Conditions Recommended for Future Development by Private Investors

4.1 Specialist Studies required

The following sub-sections describe recommendations for further (detailed) specialist studies which are considered as necessary for further planning stage.

4.1.1 Power Grid Expansion Studies and Power Grid Expansion

In Egypt, the national electrical grid is planned and developed by the Egyptian Electricity Holding Company (EEHC) and operated and maintained by the Egyptian Electricity Transmission Company (EETC), under the jurisdiction of the Ministry of Electricity and Energy.

On basis of the results from previous studies (e.g. study on "Preparatory survey on the Project to establish a wind farm in the West Nile Valley") it is known the existing transmission capacity in the region and the current high voltage grid does not have sufficient carrying capacity to accommodate large amount of wind and solar PV power. Thus, a grid extension master plan must be studied and implemented to allow power evacuation up to the load centres in the north. This study shall include as a minimum:

- Planning of grid extension, including routing of required new transmission lines. As indicated under section 3.1.2, buffer zones within and around each wind and solar power plot have already been considered to allow sufficient flexibility for planning of transmission line routing.
- Location of collector substation(s) to gather the power from individual wind and solar PV projects and to step-up the voltage to the voltage of the transmission system (step-up of the voltage to 500 kV and connection to new 500 kV transmission line(s) is considered as the most realistic scenario).
- Determination of maximum capacity which can be accommodated from the projects.

4.1.2 Geotechnical Investigations at individual WTG Sites

During the site reconnaissance conducted in October 2016, and as part of the baseline assessment, the subareas have been screened regarding the geological conditions. However, it is common practise to perform additional geotechnical investigations on a project individual basis to obtain information on the subsoil which are required for the foundation design. This is of particular importance, as parts of the area consist of thick marine limestone, which at some locations is strongly weathered (please refer to section 5.1.2.1 of the SESA Wind Report). Furthermore, the investigations carried out in the context of the SESAs concluded that some locations in the subareas contain highly permeable aquifers respective the existence of some spots where flowstone caves may exist. To cope with these difficulties

with regards to foundations, a basic study is usually performed in the early planning stage of every single project, comprising of sample drillings on-site, followed by laboratory analysis. During the detailed design stage, drilling at all wind turbine sites are common practise.

4.1.3 Wind Measurement Programmes

Financing institutions usually require expert opinion on wind resources which must be based on wind measurements. For the East Nile region, a wind and solar measurement campaign, comprising of nine wind measurement stations and three solar measurement stations, is currently ongoing and shall provide basic information on the wind and solar potential in the region. However, as on-site wind measurements are a basic requirement of financing institutions, it can be expected that additional wind measurements must be performed by the project investors at each individual wind farm plot. Two measurement masts are estimated to be required per 50 MW plot for this purpose.

4.1.4 Project Individual Resource Studies

One requirement for an investment decision is a sound prediction of the wind and solar energy yield on a project specific basis. This calculation must be performed once the detailed project definition (WTG and PV-module type, project layout) are available and in accordance with international standards.

4.2 Facilitation of Social and Environmental Permitting Process

On basis of the "Egyptian Guidelines of Principles and Procedures for Environmental Impact Assessment ("EIA Guidelines", 2nd edition (2009)), projects are categorized as follows:

- Category A: Projects which expect no or insignificant negative impacts on the environment, therefore ESIA is not required.
- Category B: Projects which may result in significant negative impacts, therefore it must be determined if a partial ESIA study is required.
- Category C: Projects which are likely to cause substantial impacts on the environment, so that a complete ESIA study is required.

These Guidelines contain a provision regarding projects in a development, for which an integrated EIA has been prepared (e.g. for a cluster of foundries or tourist centres; in analogy for a cluster of wind or PV solar power projects). In this case the individual projects of similar nature will be required to abide by the requirements of the category that is less strict than its original category. Accordingly, once an integrated ESIA (also designated as regional or strategic ESIA/SESA) was prepared and approved for a cluster development of wind or PV solar power according to Category C requirements, for later

individual investment projects out of the cluster the ESIA will have to follow the requirements of Category B, making use of the assessment results of the integrated ESIA/SESA and applying any measures, restrictions, etc. defined in the E&S action or management and monitoring plan. The SESA facilitates and informs the later ESIA and environmental approval process for individual RE projects. As the SESA considered the requirements of these EIA-guidelines in Egypt, a partial (simplified) ESIA ("scoped ESIA" for category B projects) is required for each future wind and solar PV project.

During the preparation of these project-specific ESIAs, the following shall be considered:

- Performance of an additional land use assessment, to update the extent of known land-use and to reflect additional economic areas which might have been established in the period between the finalization of the SESA and the start of a project-specific ESIA.

- Simplified baseline study (site visit) to collect additional data on areas/habitats affected by construction works to avoid any impact on vegetated areas.

  Two extensive surveys on local and migrating birds have been conducted west and east of the Nile Valley (ecoda 2012, JV LI & ecoda 2017). The obtained results clearly show that the desert located at minimum distances of 10 km west and east to the Nile Valley has no particular importance for local or migrating birds. As this conclusion can be regarded as well-founded and finally verified, sufficient baseline data is available for the impact assessment to be conducted in the context of project-specific ESIAs. Consequently, no further baseline studies on local or migrating birds are required when developing wind power or PV solar power in the East Nile region.

- Preparation of a project-specific Environmental and Social Management Plan (ESMP).

4.3 Environmental and Social Management Issues to be mandatory for Future Investors

4.3.1 Proposed Procedures to make Issues Contractual Binding for Investors

It is understood that NREA or an alternative Egyptian Authority (e.g. EETC) will launch tenders for the selection of private investors for the individual 50 MW wind and solar PV power plots and will supervise the investors during the life time of the projects. It is therefore essential that the ESMP obligations (please refer to section 8 of the SESA Wind and SESA Solar Reports) and mitigations measures developed during the SESA and during project-specific ESIA are properly reflected in the Tender Documents and in the later contracts with the private investors.

4.3.2 Stakeholder engagement, information disclosure and grievance management

Together with the SESAs for wind and solar power a Stakeholder Engagement Plan (SEP) has been developed which sets out how, during the development and operation of wind and solar resources in the East Nile area, potential stakeholders will be engaged and information about the projects will be

shared. The SEP further sets out a grievance mechanism. The SEP will be implemented by NREA, with the support of individual developers where necessary."

4.3.3 Monitoring

The purpose of environmental monitoring is to ensure that the designed mitigation measures are implemented on the ground.

The environmental monitoring follows the E&S management plan and shall be carried out in four phases:

5. The bidding and planning phase
6. The implementation and operation phase
7. The checking and corrective actions phase
8. The management review phase

This compliance monitoring provides for the control of keeping the requirements defined in the ESMP. The responsibility for the overarching monitoring must lie with the Competent Authority, which was already entrusted with the tendering but projects should also monitor their own E&S impacts and performance, executed by the Project Companies and Contractors. This authority needs to guide and supervise the individual project investors (if necessary by subcontracting these monitoring services). Moreover, the financing institutes may make keeping the monitoring and a corresponding reporting a condition in the financing agreements.

Two extensive bird surveys have been conducted in the wider region of El Minya west and east of the Nile Valley. Both investigations clearly revealed that the desert located at minimum distances of 10 km west and east to the Nile Valley has no particular importance for bird migration – neither in spring nor in autumn. As this conclusion can be regarded as well-founded and finally verified, sufficient baseline data is available for future impact assessments and no further baseline studies are required when developing wind power or PV solar power in the East Nile region.

Accordingly, no significant impact on migrating birds must be expected when installing and operating multiple wind power projects in the East Nile subareas. From a strict technical point of view, this assessment can be regarded as well-founded, and hence no post-construction monitoring is required to verify this assessment. However, if post-construction monitoring is regarded as good international practice by international financing institutes, carrying out such monitoring at individual operational wind farms might be required to double-check the findings of this SESA. The precise approach and the scope of such post-construction monitoring should be defined on a case-by-case basis in the context of project-specific ESIAs. Post-construction monitoring might, for example, include visual observations of migrating birds and carcass surveys at individual wind farms and associated power lines.

5 Executive Summary – Arabic Version / الملخص التنفيذي

0-1- أهداف ونطاق عملية التقييم الاستراتيجي البيئي الاجتماعي:

حددت الحكومة المصرية ثلاث مناطق كبيرة مناسبة لتطوير مزارع الطاقة المتجددة لمشروعات طاقة الرياح والطاقة الشمسية في مصر، ومن بين هذه المناطق تم تخصيص مساحة تبلغ 2200 كيلومتر مربع بمساحة صالحة للاستعمال قدرها 1725 كيلومتر مربع (تم استبعاد 425 كيلومتر مربع بسبب قيود الارتفاع العسكرية - أنظر القسم 2) واقعة شرق نهر النيل عبر ثلاث محافظات هي بني سويف والمنيا وأسيوط وقد تم تحديدها استنادًا إلى البيانات الموجودة عن الطاقة الشمسية وطاقة الرياح واستخدام الأراضي الحالية ("منطقة المشروع" - انظر القسم 2). ولضمان إجراء تقييم على المستوى الاستراتيجي للأمور البيئية والاجتماعية المحتملة المرتبطة بتطوير هذه المشاريع وإخطار متخذي القرار لتطوير المشروع، فقد تم إجراء عمليتين للتقييم الاستراتيجي البيئي والاجتماعي. والتقييم الاستراتيجي البيئي الاجتماعي هو عملية منهجية منظمة لدعم اتخاذ القرار تساعد على ضمان اعتبار الجوانب البيئية والاجتماعية وغيرها من جوانب الاستدامة بشكل فعال في السياسة والتخطيط وصنع البرامج، وتتضمن عملية التقييم الاستراتيجي البيئي الاجتماعي لمنطقة المشروع الأهداف التالية:

- توفير مصدر موثوق للبيانات البيئية والاجتماعية لمنطقة المشروع تفيذ خطط تنمية الطاقة المتجددة وللحصول على الموافقات البيئية ولتمويل المشاريع المتعلقة.

- تحديد المناطق التي بها حاليا قيود تقنية أو اجتماعية لتطوير مشروعات الطاقة المتجددة داخل منطقة المشروع.

- تحديد وتقييم الآثار البيئية والاجتماعية المحتملة المرتبطة بتطوير وتشغيل مشروعات الطاقة المتجددة في منطقة المشروع وتحديد تدابير التخفيف والإدارة لمعالجة هذه الآثار المحتملة بما في ذلك التوصيات المتعلقة بترتيب قطع الأراضي لمشاريع طاقة الرياح أو الطاقة الشمسية.

- تحديد الأماكن في منطقة المشروع المناسبة لتنمية الطاقة المتجددة على أساس نتائج تقييم الأثر البيئي والاجتماعي.

- المشاركة مع أصحاب المصلحة بما في ذلك الجمهور في التخطيط المزمع لمشاريع الطاقة المتجددة في منطقة المشروع.

- إنشاء قاعدة بيانات لنظام المعلومات الجغرافية (GIS) يتم استخدامها في اقامة مشاريع الطاقة المتجددة المستقبلية.

- تحديد التوزيع المكاني لمشاريع طاقة الرياح والطاقة الشمسية المحتملة للمنطقة.

- تحديد وتحديد أفضل المجالات الممكنة لتطوير طاقة الرياح والطاقة الشمسية مع الأخذ في الاعتبار الجوانب التقنية والبيئية والاجتماعية المحتملة لمشاريع الطاقة المتجددة.

- تحديد المتطلبات الإضافية الراهنة (الحصول على مزيد من البيانات / اجراء قياسات، دراسات، إدارة) لتنمية موارد الطاقة المتجددة في المناطق المحددة.

وبالإضافة إلى ذلك ، خلال عملية التقييم الاستراتيجي البيئي الاجتماعي قام استشاري الدراسة بتدريب موظفي هيئة الطاقة الجديدة والمتجددة على عملية التقييم الاستراتيجي البيئي الاجتماعي وعلى عملية تقييم الأثر البيئي الاجتماعي وعلى نظام المعلومات الجغرافية.

وكانت العناصر الرئيسية للتقييم هي عميلات المسح الميداني مثل الاستطلاع الميداني العام ورصد ميداني للطيور خلال ثلاث فترات هجرة (ربيع 2016 وخريف 2016 وربيع 2017) أعمال مسح أخرى (على سبيل المثال للنباتات والحيوانات واستخدام الأراضي وغيرها من الجوانب الاجتماعية).

0-2- تقرير التوصيات النهائي - الأهداف والمنهجية:

بالإضافة إلى التقييم الفيزيائي والبيئي والاجتماعي الذي تم تقديمه في التقييم الاستراتيجي البيئي والاجتماعي لمزارع الرياح والتقييم الاستراتيجي البيئي والاجتماعي للطاقة الشمسية فإننا نقدم في تقرير التوصيات النهائي هذا التوزيع المكاني لمشروعات طاقة الرياح والطاقة الشمسية لتحديد أفضل المناطق الممكنة لتطوير الطاقة المتجددة وتيسير المشاريع المستقبلية والقرارات الاستثمارية وتمويل المشاريع لتطوير مشاريع استثمارية فردية بواقع 50 ميجاوات لكل منها في هذه المناطق.

وتقرير التوصيات النهائي هذا يركز على:

- تحديد التوزيع المكاني لمشروعات طاقة الرياح والطاقة الشمسية.

- تحديد الخطوط العريضة لأفضل المناطق الممكنة (قطع الأراضي الأكثر ملاءمة) لمشروعات طاقة الرياح والطاقة الشمسية مع مراعاة الجوانب التقنية والاجتماعية والبيئية للتوزيع المكاني لمشروعات طاقة الرياح والطاقة الشمسية.

- اقتراح مناطق تصلح لمشروعات الطاقة المتجددة بقدرة 50 ميجاوات وتسلسل تطويرها وفقا لمدى ملاءمة المناطق الشرقية الفرعية للرياح والطاقة الشمسية بدءا بأكثر المناطق مواتاة.

- تحديد المتطلبات الإضافية الراهنة (الحصول على مزيد من البيانات / اجراء قياسات، دراسات، إدارة) لتنمية موارد الطاقة المتجددة في المناطق المحددة.

- تحديد أية قيود وشروط يجب مراعاتها في عملية المناقصة و / أو الحصول على التصاريح.

وسيخطر تقرير التوصيات النهائي هيئة الطاقة الجديدة والمتجددة بأفضل طريقة لتطوير مشاريع طاقة الرياح والطاقة الشمسية في المناطق الشرقية الفرعية للرياح وللطاقة الشمسية من خلال اختيار قطع أراضي مناسبة ماديا وفنيا لتركيب مشاريع طاقة الرياح والطاقة الشمسية الكهروضوئية.

- أثبات عدم وجود قيود أو آثار اجتماعية وبيئية ذات أهمية.

- إثبات وجود إمكانات كبيرة لطاقة الرياح والطاقة الشمسية.

وفي نفس الوقت سيكون تقرير التوصيات النهائي هذا إلى جانب قاعدة بيانات نظم المعلومات الجغرافية بمثابة أداة معلومات تحدد الأنشطة والمتطلبات اللازمة لتحقيق المشاريع الفردية مما ييسر الاستثمارات المستقبلية فيها.

ويستند تقرير التوصيات النهائي إلى تقرير طاقة الرياح للتقييم الاستراتيجي البيئي والاجتماعي وتقرير الطاقة الشمسية للتقييم الاستراتيجي البيئي والاجتماعي اللذان يحددان المناطق المصنفة مسبقًا بالفعل وفقًا لمدى ملائمتها الفيزيائية والتوافق البيئي والاجتماعي وسيتم تحديد مدى الملاءمة النهائية للمناطق من خلال اعتبار إمكانيات الطاقة المكانية وسيتم تحديد أولويات مشاريع طاقة الرياح / الطاقة الشمسية وفقًا للمعايير التالية:

- لم يتم تصنيف المنطقة على أنها مستبعدة نظرا لمعايير مادية أو اجتماعية مثل التربة الرخوة والتضاريس الوعرة واستخدام الأراضي المتنافس وما إلى ذلك (انظر تقارير التقييم الاستراتيجي البيئي والاجتماعي).

- لا تصنف المنطقة على أنها مستبعدة أو أقل تفضيلاً نتيجة لتقييم الأثر (مثل حماية الموائل والتراث والمخاطر العالية وسهولة الوصول وما إلى ذلك) ؛ أي أن المنطقة مصنفة على أنها مناسبة من الناحية الاجتماعية والبيئية (انظر تقارير التقييم الاستراتيجي البيئي والاجتماعي).

- تقدم المنطقة إمكانات طاقة الرياح / الطاقة الشمسية أكثر ملاءمة مقارنة بأجزاء أخرى من المساحة الكلية.

3-0- التوزيع المكاني لإمكانات الطاقة المتجددة:

بالنسبة لكل منطقة فرعية يتم حساب موارد طاقة الرياح / الطاقة الشمسية باستخدام برامج وأدوات قياسية دولية وتشير النتائج إلى توزيع متجانس للموارد الشمسية في المنطقة ككل، ونتيجة لذلك يمكن اعتبار جميع المناطق الفرعية الثلاثة انها واعدة جدا لإقامة محطات الطاقة الشمسية الكهروضوئية بمتوسط سنوي محتمل يتراوح بين 2200 و 2300 كيلو واط في الساعة / متر مربع ولذلك لا يمكن إجراء أي ترتيب المناطق الفرعية على أساس الطاقة الشمسية المتوفرة.

وتتراوح مصادر الرياح المتوقعة بين 7.3 و 9.8 متر / ثانية في منطقتي الرياح الفرعيتين بينما يمكن توقع أعلى سرعات الرياح في الجزء الشمالي من منطقة الرياح الشرقية الفرعية 1 وعلى قمة الجرف في منطقة الرياح الشرقية الفرعية 2.

4-0-تصنيف المناطق الفرعية:

تم تحليل مدى ملاءمة إمكانات الطاقة المتجددة (الرياح والطاقة الشمسية) لكل منطقة فرعية على أساس عوامل مختلفة مع الأخذ في الاعتبار مدى الملاءمة على أساس القيود البيئية والاجتماعية كما هو موضح في تقارير التقييم الاستراتيجي البيئي والاجتماعي لمشاريع طاقة الرياح والطاقة الشمسية ومن وجهة نظر بيئية يركز التقييم بشكل رئيسي على القيود مثل الجيومورفولوجيا والموائل الهامة (بشكل رئيسي الأودية)، وفيما يتعلق بالقيود الاجتماعية تعتبر المناطق التي تشملها العوامل الاقتصادية مثل الزراعة والتعدين أو

الأنشطة الهامة الأخرى هي القيود الرئيسية. وبالتالي لم يتم اعتبار المناطق التي تم اعتبارها مستبعدة أو غير مناسبة نتيجة لنتائج التقييم الاستراتيجي البيئي والاجتماعي.

وكما هو محدد في الشروط المرجعية فإن القدرة النموذجية لمحطة طاقة الرياح أو الطاقة الشمسية الكهروضوئية هو 50 ميجاوات. وبالتالي فمن الضروري تحديد المواقع التي يمكن أن تستوعب محطات رياح أو شمسية بقدرة 50 ميجاوات.

وعلى أساس خرائط الموارد الواردة في القسم 2 وبالنظر إلى المناطق التي يتم تعريفها على أنها غير ملائمة أو مستبعدة يتم تحديد المناطق الملائمة عمومًا لطاقة الرياح وللطاقة الشمسية على أساس الطاقة المتجددة، ويتم عرض النتائج في خرائط مناطق Zonation مدرجة في القسم 4، ونتائج كل منطقة فرعية هي كما يلي:

0-4-1- مناطق الرياح الفرعية:

<u>منطقة الرياح الشرقية الفرعية 1:</u>

تم اعتبار ثلاثة سيناريوهات مختلفة لتصميم منطقة الرياح الشرقية الفرعية 1:

- يعكس السيناريو 1 خريطة مرجعية للمنطقة تهدف إلى تحسين عائد الطاقة المتولدة من المحطات بقدرة 50 ميجاوات.

- السيناريو 2 عبارة عن خريطة لامكانات القدرات مع تركيب صفين من التوربينات في كل مزرعة للحد من فقد الطاقة.

- خريطة السيناريو 3 هي أيضاً خريطة لامكانات القدرات ولكنها تعتبر تركيب ثلاثة صفوف من التوربينات لكل قطعة من الأرض مما سيزيد من قدرة كل مزرعة ولكنه سيتسبب في فقد لطاقة الرياح مقارنة بالسيناريو 2.

لتصنيف المواقع واقتراح تسلسل مناسب للتطوير تم إجراء حساب نموذجي لإنتاج الطاقة لكل سيناريو مع الأخذ في الاعتبار نوع توربينات الرياح (Gamesa G114، 2.5 MW) الذي يعتبر مناسبا لمنطقة الرياح الشرقية الفرعية 1 وبعد ذلك تم تصنيف كل موقع عتمادًا على إنتاجية الطاقة المحسوبة:

- الفئة 1 (موصى بها للتنفيذ في المرحلة الأولى): عائد الطاقة> 103% من متوسط إنتاجية الطاقة لكل منطقة الرياح الشرقية 1

- الفئة 2 (موصى بها للتنفيذ في المرحلة اللاحقة): إنتاجية الطاقة بين 95% و 103% من متوسط إنتاجية الطاقة لكل منطقة الرياح الشرقية 1.

- الفئة 3 (موصى بها للتنفيذ في المرحلة الأخيرة): إنتاجية الطاقة أقل من 95% من متوسط إنتاجية الطاقة لكل منطقة الرياح الشرقية 1.

وقد تم إجراء هذا التصنيف لكل سيناريو.

وكنتيجة لتقييم الموارد فإن الجزء الشمالي من منطقة الرياح الشرقية الفرعية 1 يتميز بسرعات رياح أعلى مقارنة بالجزء الجنوبي من المنطقة، وبالتالي ينبغي أن يبدأ التسلسل المنطقي للتنفيذي في الجزء الشمالي من هذه المنطقة، ويتراوح المتوسط الأولي لإنتاج الطاقة لكل قطعة بين 250 و 269 جيجاوات / ساعة حسب السيناريو. ويؤدي ترتيب كل موقع وفقًا لعائدات الطاقة إلى التسلسل التالي المقترح:

الجدول0-1- تسلسل التطوير في منطقة الرياح الشرقية الفرعية 1

	السيناريو 1	السيناريو 2	السيناريو 3
مرحلة التطوير 1	3	8	8
مرحلة التطوير 2	14	17	15
مرحلة التطوير 3	5	9	15

<u>منطقة الرياح الشرقية الفرعية 2:</u>

بسبب القيود المحددة في تقرير التقييم الاستراتيجي البيئي والاجتماعي لمشاريع طاقة الرياح سيقتصر تطوير مزارع الرياح على الجزء الجنوبي من هذه المنطقة وبالنسبة لهذا الجزء تم إعداد سيناريو واحد فقط (السيناريو الأساسي) يتكون من منطقتين بقدرة 50 ميجاوات تغطيان كامل المساحة الصالحة للاستخدام.

ونظرًا لظروف الرياح المتجانسة في الجزء الجنوبي من منطقة الرياح الشرقية 2 يمكن توقع إنتاج طاقة مماثلة لكلتا القطعتين يبلغ حوالي 234 جيجاوات في الساعة في المتوسط، وبما أن إنتاجية الطاقة هذه أقل مقارنةً بالنتائج التي تم الحصول عليها في حالة منطقة الرياح الشرقية الفرعية 1 وبسبب أن جزءًا صغيرًا فقط من منطقة الرياح الشرقية الفرعية 2 يمكن استخدامه في مزرعة الرياح فمن المستحسن تنفيذ مشروعات طاقة الرياح في المرحلة الأخيرة (أي بعد استخدام جميع المواقع في منطقة الرياح الشرقية الفرعية 1).

0-4-2- المناطقة الشمسية الفرعية:

بما أن الطاقة الشمسية للمناطق الفرعية متماثلة فإن إعداد تسلسل للتطوير على أساس الموارد الشمسية يعتبر غير مناسب، وبالتالي فإنه من الأفضل تقييم مشروعات الطاقة الشمسية على أساس البنية التحتية المتاحة (أي إمكانية الوصول للمواقع) وقد تم تحديد المعايير التالية:

- الفئة 1: (مقترح تنفيذها في المرحلة الأولى): محطات الطاقة الشمسية الكهروضوئية التي تقع على مسافات قصوى تبلغ 2000 متر من البنية التحتية للطرق القائمة.

- الفئة 2: (مقترح تنفيذها في المرحلة اللاحقة): محطات الطاقة الشمسية الكهروضوئية التي تقع على مسافات تتراوح بين 2000 و 3500 متر من البنية التحتية للطرق القائمة.

- الفئة 3: (مقترح تنفيذها في المرحلة الأخيرة): مخططات الطاقة الشمسية الكهروضوئية التي تقع على مسافات تزيد عن 3500 متر من البنية التحتية للطرق القائمة.

المنطقة الشمسية الشرقية الفرعية 1:

تتسم المنطقة الشمسية الشرقية الفرعية 1 بالعديد من المناطق المستخدمة حاليًا أو قيد التطوير للأنشطة الاقتصادية مثل أنشطة الزراعة أو التعدين، وقد تم اعتبار هذه المناطق غير ملائمة لتطوير محطات الطاقة الشمسية في تقرير التقييم الاستراتيجي البيئي الاجتماعي وذلك لأن المزارع من المستقبلات الحساسة التي يجب مراعاتها أثناء تخطيط محطات الطاقة الشمسية في الشمسية الشرقية الفرعية 1، لذلك فمن غير المتوقع أن تكون هناك أية محطات شمسية على مسافة تقل عن 100 من المناطق الزراعية.

وبالإضافة إلى ذلك تم تقييم مناطق وادي العبادية ووادي البرباشي على أنها أقل ملاءمة لمشاريع الطاقة الشمسية الكهروضوئية في تقرير التقييم الاستراتيجي البيئي الاجتماعي، وبالتالي فلن يتم بناء محطات شمسية في هذه المناطق وأيضا على مسافة 100 متر بعدها كمنطقة عازلة.

ويلخص الجدول التالي إمكانية تنفيذ محطات الطاقة الشمسية الكهروضوئية في المنطقة الشمسية الشرقية الفرعية 1.

جدول 0-2- ملخص المحطات الشمسية الكهروضوئية في المنطقة الشمسية الشرقية 1

السيناريو	عدد القطع	القدرة الكلية	القدرة المبدئية السنوية من المنطقة الشمسية الشرقية الفرعية 1 كلها	متوسط القدرة المنتجة من كل قطعة سنويا
سيناريو الأساس	100	5 جيجاوات	1820-1930 ك وات ساعة /	95 جيجاوات ساعة

المنطقة الشمسية الشرقية الفرعية 2:

بما أنه لم يتم تحديد أية مناطق غير مواتية في المنطقة الشمسية الشرقية الفرعية 2 وإمكانية الطاقة الشمسية متجانسة فيها، فإنه يمكن استخدام كل هذه المنطقة الفرعية ومساحة كل قطعة والمسافة فيما بينها هي نفسها كما هو مفترض في المنطقة الشمسية الشرقية الفرعية 1.

ويلخص الجدول التالي إمكانية تنفيذ محطات الطاقة الشمسية الكهروضوئية في المنطقة الشمسية الشرقية الفرعية 2.

جدول 0-3- ملخص المحطات الشمسية الكهروضوئية في المنطقة الشمسية الشرقية 2

السيناريو	عدد القطع	القدرة الكلية	القدرة المبدئية السنوية من المنطقة الشمسية الشرقية الفرعية 2 كلها	متوسط القدرة المنتجة من كل قطعة سنويا
سيناريو الأساس	53	2ر6 جيجاوات	1820-1930 ك وات ساعة /	95 جيجاوات ساعة

المنطقة الشمسية الشرقية الفرعية 3:

في ختام تقرير التقييم الاستراتيجي البيئي الاجتماعي للطاقة الشمسية ، تم تحديد هذه المنطقة الفرعية بالكامل على أنها غير مواتية بسبب الظروف الجيومورفولوجية وصعوبة الوصول إليها مما يتطلب إنشاء طريق وصول بطول 30 كم على الأقل، وبالتالي لا يوصى بإقامة محطات الطاقة الشمسية الكهروضوئية في هذه المنطقة الفرعية.

0-5- الإجراءات والشروط المقترحة للتطوير المستقبلي من قبل المستثمرين:

0-5-1- الدراسات المتخصصة المطلوبة:

تعتبر الدراسات المتخصصة الإضافية (التفصيلية) التالية ضرورية لمراحل التخطيط اللاحقة:

- دراسات توسيع شبكة الكهرباء.
- الدراسات الجيوتقنية في مواقع WTG الفردية
- برامج قياس الرياح.
- مشروع دراسات الموارد.

0-6- أمور الإدارة البيئية والاجتماعية الالزامية للمستثمرين في المستقبل:

0-6-1- الإجراءات المقترحة لجعل الأمور البيئية الزامات تعاقدية للمستثمرين:

من المفهوم أن هيئة الطاقة الجديدة والمتجددة أو أية هيئة مصرية بديلة (على سبيل المثال الشركة القابضة لكهرباء مصر) سوف تطرح مناقصات لاختيار المستثمرين من القطاع الخاص لطاقة الرياح والطاقة الشمسية الكهروضوئية التي تبلغ قدرتها 50 ميجا وات وستشرف على المستثمرين خلال مدة عمر المشاريع لذلك فمن الضروري مراعاة توصيات الادارة البيئية الاجتماعية لهذه المشاريع (يرجى الرجوع إلى القسم 8 من تقارير التقييم الاستراتيجي البيئي الاجتماعي لمشاريع طاقة الرياح والطاقة الشمسية)

وتدابير التخفيف التي تم اقتراحها في التقييم الاستراتيجي البيئي والاجتماعي وفي دراسة تقييم الأثر البيئي والاجتماعي الخاصة بالمشروع بشكل مناسب في مستندات المناقصة وفي العقود اللاحقة مع المستثمرين من القطاع الخاص.

0-6-2- إشراك أصحاب المصلحة والإفصاح عن المعلومات وإدارة التظلمات:

بالتزامن مع التقييم الاستراتيجي البيئي والاجتماعي تم وضع خطة لإشراك أصحاب المصلحة توضح كيف سيتم أثناء تطوير وتشغيل محطات الرياح والطاقة الشمسية في منطقة شرق النيل إشراك أصحاب المصلحة المحتملين ويتم الافصاح لهم عن معلومات حول هذه المشاريع، كما تحدد هذه الخطة آلية التظلم، سيتم تنفيذ خطة إشراك أصحاب المصلحة بواسطة هيئة الطاقة الجديدة والمتجددة بدعم من المطورين الفرديين عند الضرورة. "

0-6-3- المراقبة البيئية:

الغرض من المراقبة البيئية هو ضمان تنفيذ تدابير التخفيف المصممة على أرض الواقع.

وتتبع المراقبة البيئية خطة إدارة بيئية اجتماعية تنفذ على أربع مراحل:

1- مرحلة تقديم العطاءات والتخطيط.
2- مرحلة التنفيذ والتشغيل
3- مرحلة التدقيق والإجراءات التصحيحية
4- مرحلة مراجعة الإدارة

وتوفر المراقبة البيئية الامتثال للحفاظ على المتطلبات المحددة في خطة الإدارة البيئية والاجتماعية ويجب أن تقع المسؤولية عن المراقبة الشاملة على عاتق السلطة المختصة التي يتم تكليفها بطرح المناقصات، ولكن يجب على المشاريع أيضًا رصد آثارها وأداءها البيئي والاجتماعي التي تنفذها شركات المقاولات وتحتاج هذه السلطة إلى إرشاد المستثمرين والإشراف عليهم (إذا لزم الأمر عن طريق التعاقد من الباطن على خدمات المراقبة هذه)، وعلاوة على ذلك فقد تتطلب الجهات الممولة الحفاظ على المراقبة وتقديم تقارير متعلقة بها من شروط اتفاقيات التمويل.

وقد تم إجراء مسحين كبيرين للطيور في منطقة المنيا الواقعة في غرب وشرق وادي النيل وكشفت كلتا الدراستين بوضوح أن الصحراء الواقعة على مسافة 10 كيلومترات إلى الغرب والشرق من وادي النيل ليس لها أهمية خاصة لهجرة الطيور - لا في الربيع ولا في الخريف، وحيث أن هذه النتيجة تعتبر نهائية فإن هناك بيانات أساسية كافية متاحة لتقييم الأثر البيئي المستقبلي ولا يلزم إجراء المزيد من الدراسات عند اقتراح انشاء محطات طاقة الرياح أو الطاقة الشمسية الكهروضوئية في منطقة شرق النيل.

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