

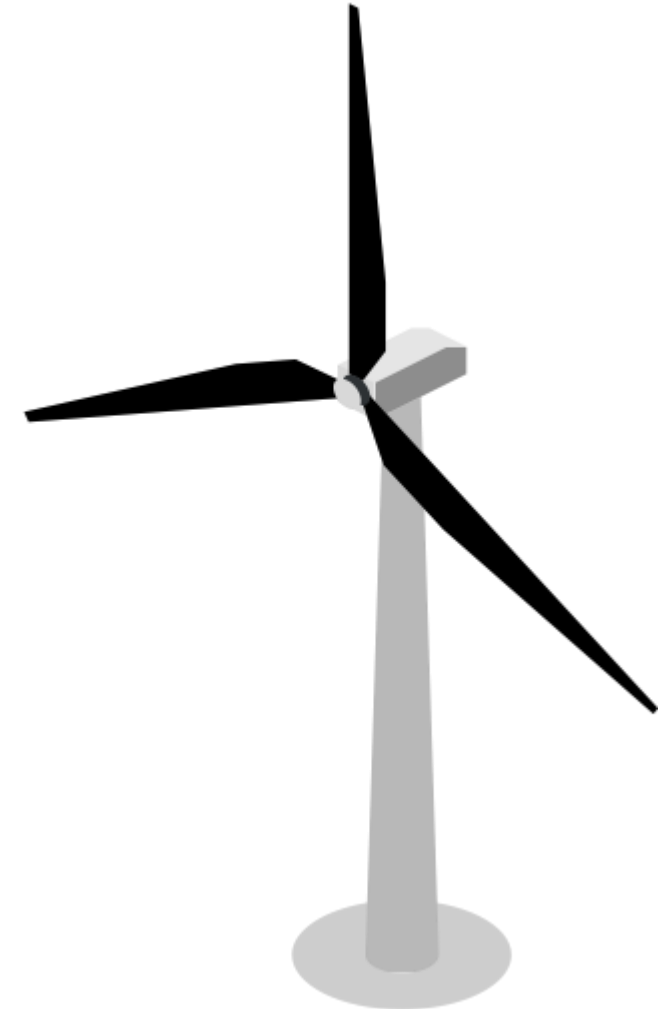


The Lebanese
Foundation *for*
Renewable Energy



National Council for Scientific Research

Potential Regions for Wind Energy

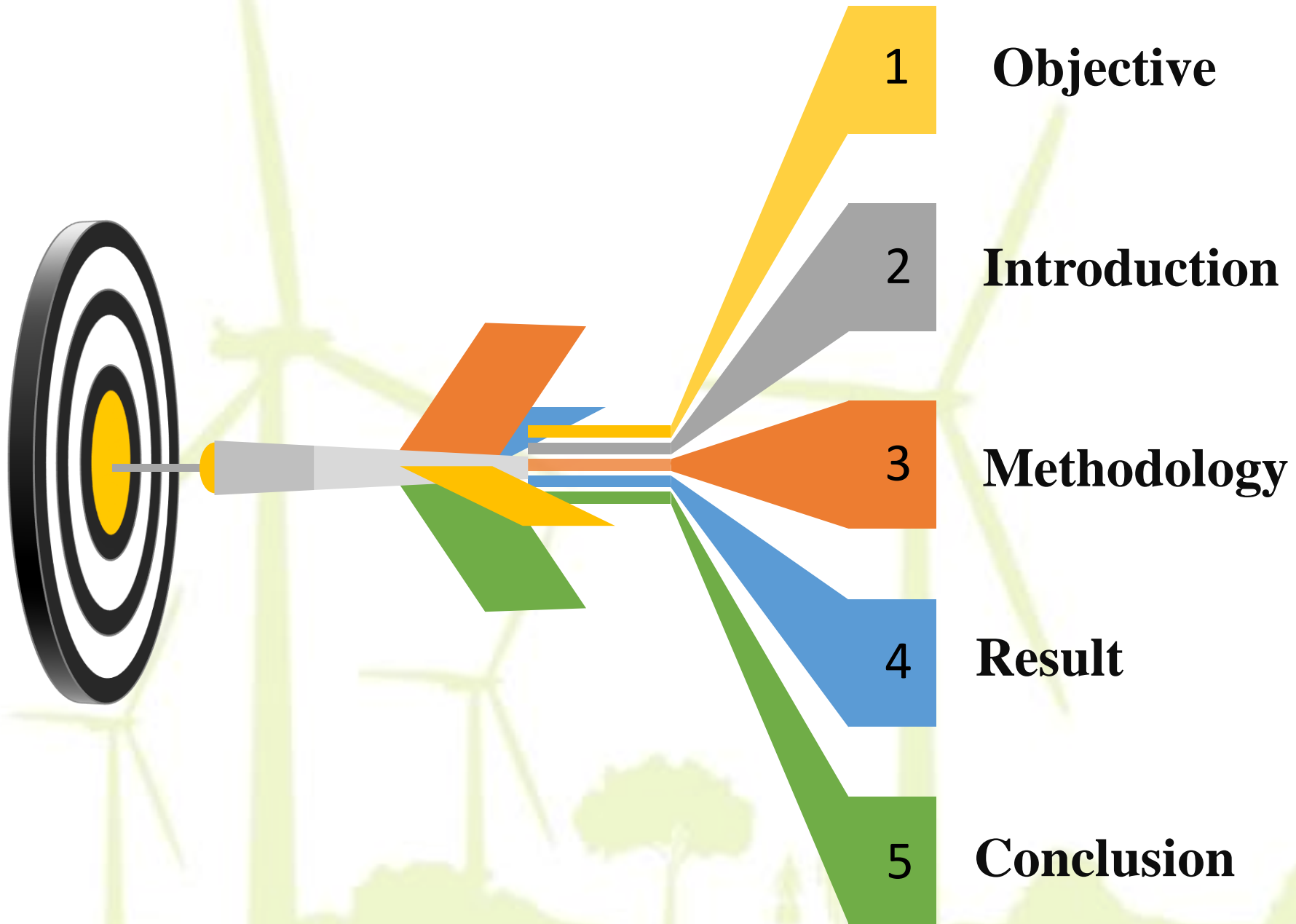


Prepared by: Ali Dawi and Jaafar Serhan



OUTLINE

00





Objective

01

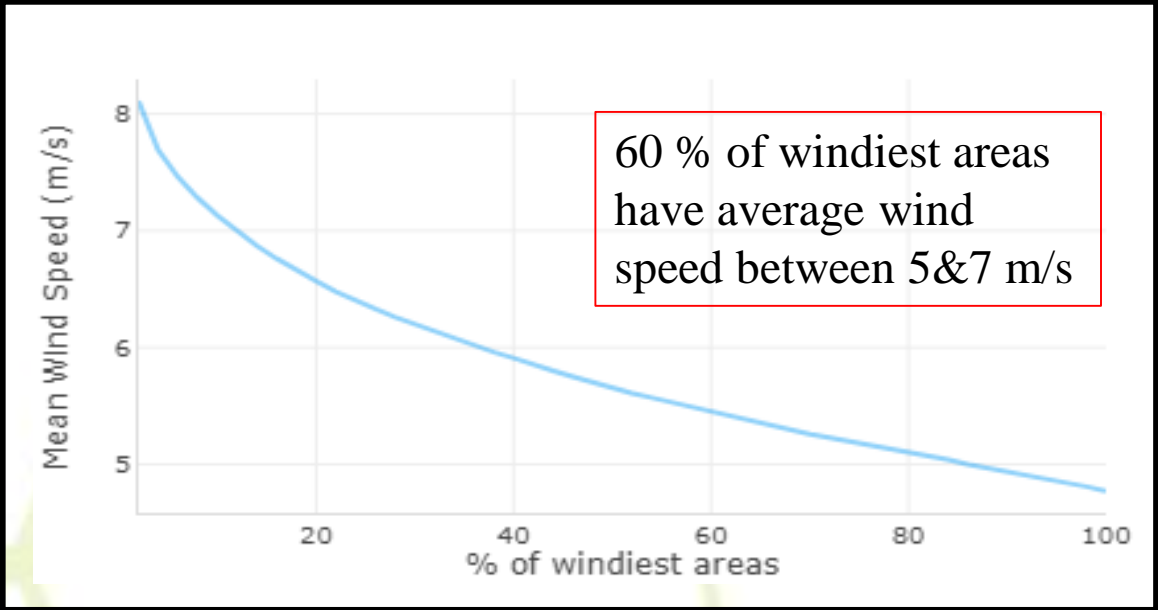
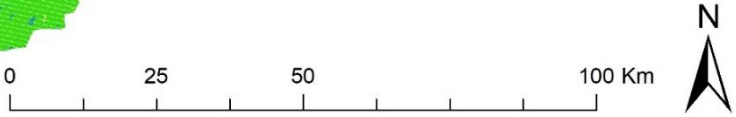
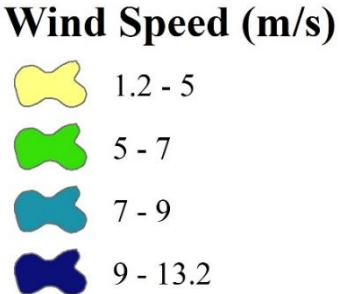
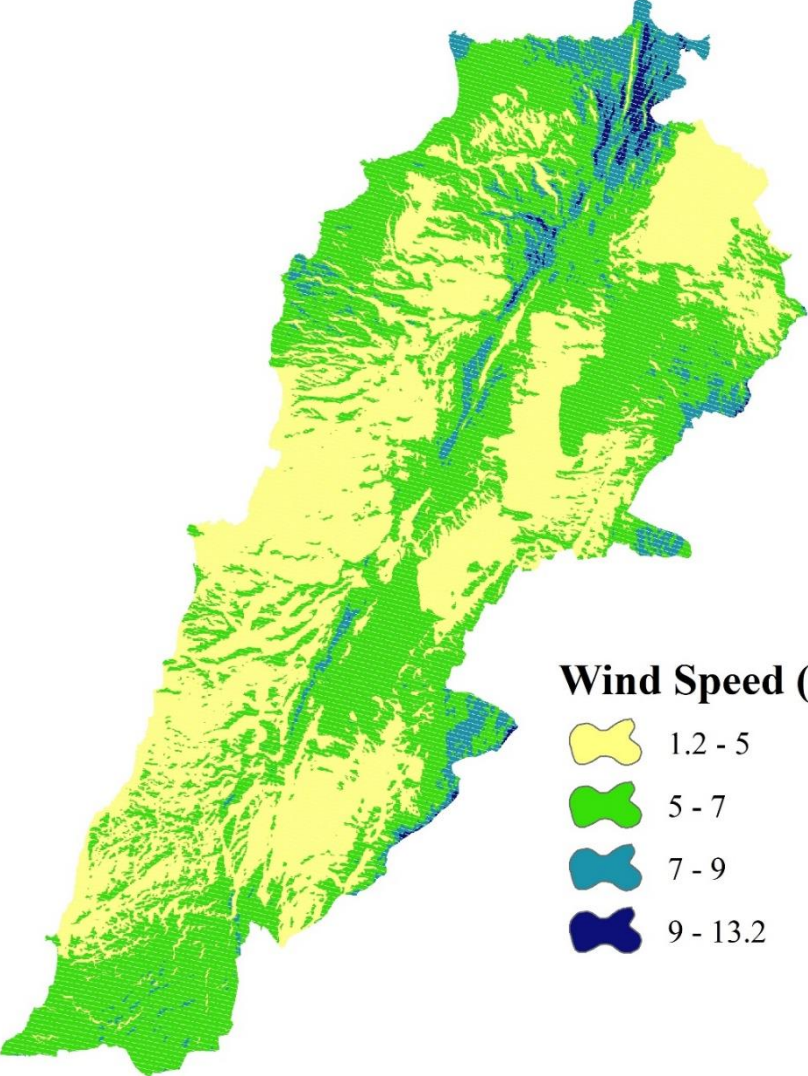
This study aims to analyze the wind speed in Lebanon based on a data collected from **WIND ATLAS** and selects the suitable lands for installing wind turbines according to geographic, climatic and spatial conditions.



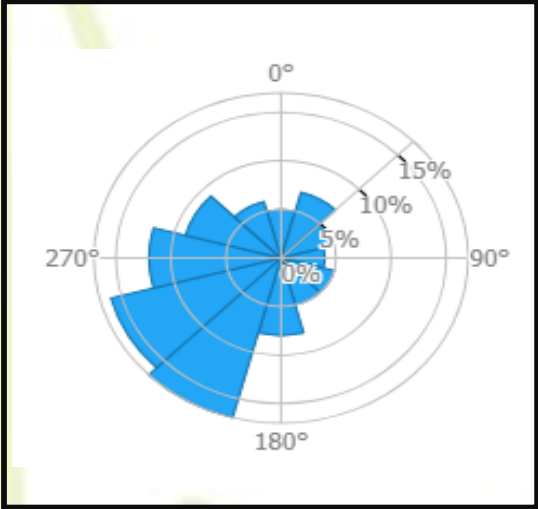


Introduction 02

Lebanon Wind Speed



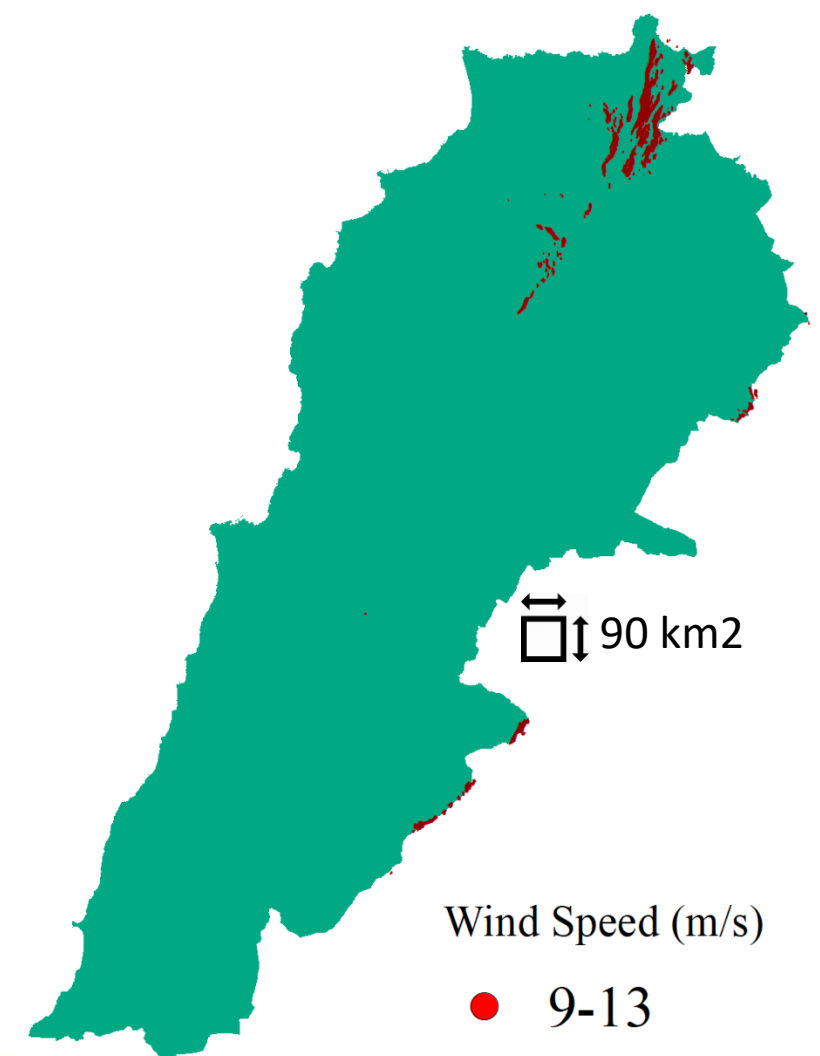
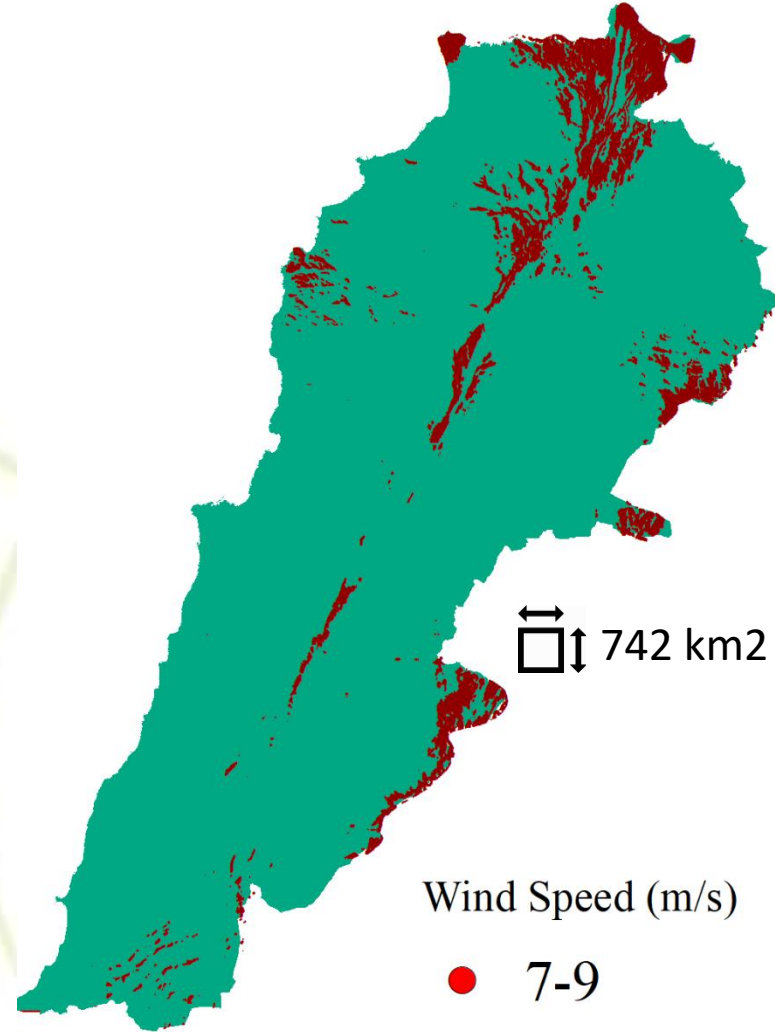
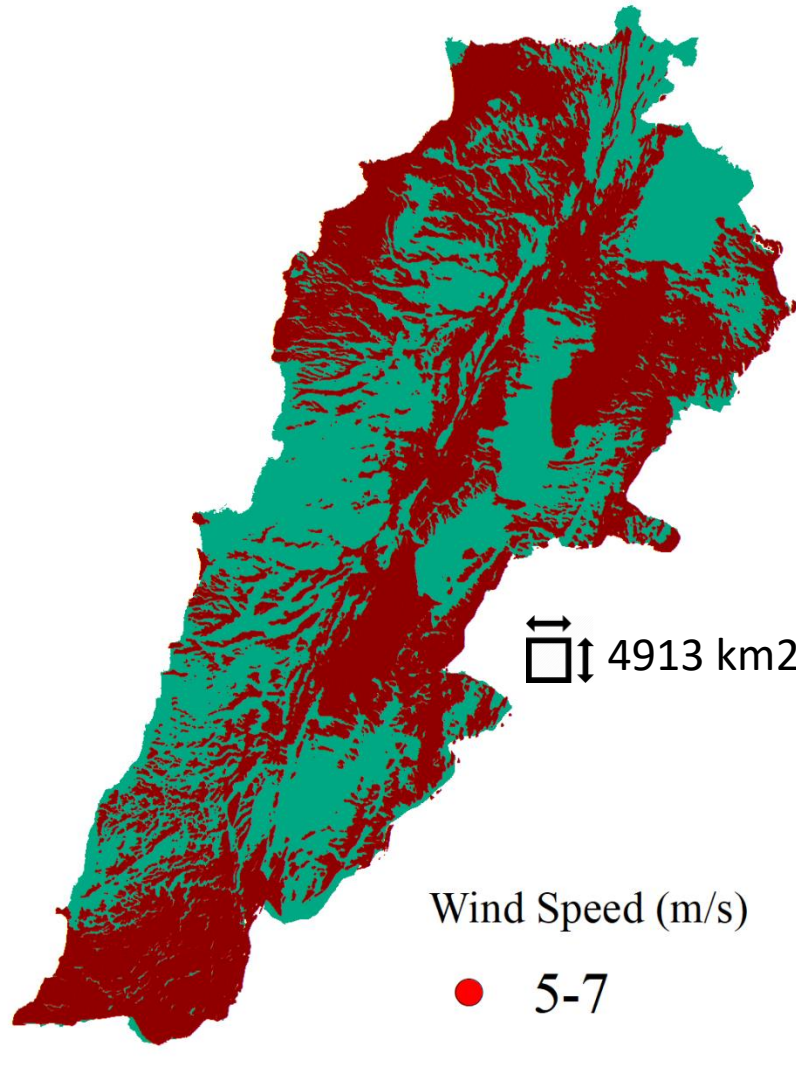
Mean Wind Speed in Lebanon



Wind Direction in Lebanon

The average wind direction in Lebanon is **SW**

Different Distribution of Wind Speed in Lebanon



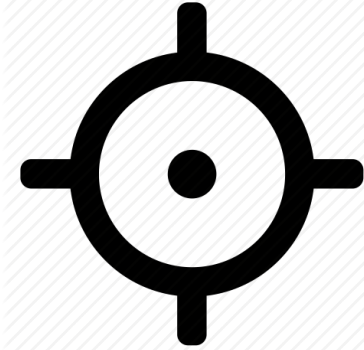
After our meeting with Mr. Guy (Wind Specialist) and Mr. Joseph El Hachem (Head of Engineering in PD&P), We derived out the criterions in order to select the potential land for installing and distributing wind turbines:

01

Elevation must not exceed 2500 m

04

Land must be Natural Land (Scrub land, Bare Rock, Bare Soil, Grass Land...)



02

Slope must not exceed 8.5 degree

05

Minimum Clear Distance = 3 x (diameter of blade) between each wind turbine

03

Wind Turbine must be located at minimum distance 400 m from urban settlement.

06

Wind Speed must be minimum 7 m/s.

We suggested to use E-160 EP5 wind turbine manufactured by ENERCON and will be available in 2020.

Rated power	4,600 kW
Rotor diameter	160 m
Hub height in meter	120 / 143 / 166
Wind class (IEC)	IEC IIIA
WEC concept	Gearless, variable speed, full power converter





Methodology 03



PHASE 01

Preparation of data required in our study.
(Elevation, Public Lands, Wind speed, Land cover, Road , High Voltage)

E
Set Null for elevation above 2500 meter.

S
Slope is calculated from the resultant elevation (E)

S1
Set Null for Slope above 8.5 degree for the resultant slope (S)

S1NW
Intersection between resultant wind speed and Resultant intersection(S1N)

W
Delete Wind Speed below 7 m/s

S1N
Intersection between resultant Natural lands (N) and Slope 8.5 degree(S1)

N
Delete all Land cover type except natural land.

U
Delete all Land Cover types except Urban Settlement

BU
400 meter Buffer zone from Urban Settlement (U)

S1NBU
Intersection between the buffer (BU) and resultant intersection (S1NW)

Finally, the remained lands are the land that meet our conditions.



PHASE

02

Unlike phase 01 which performed by modeling in GIS, Phase 02 was done manually.

The result obtained from phase 01 is 12583 point are not distributed according to our condition (3 x diameter between two points).

So the location and distribution of wind turbines is related to two conditions :

01

Must be located on
the resultant points.

02

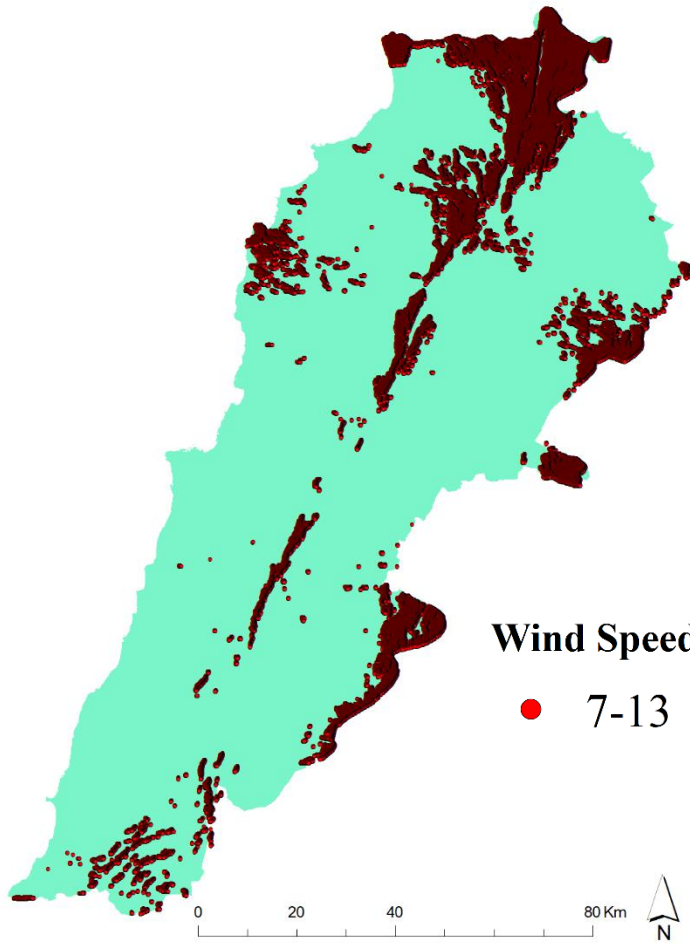
Distance between
each turbine
 $= 3 \times 160 = 480 \text{ m}$

The background features a stylized illustration of a landscape with several wind turbines of varying heights and orientations. In the foreground, there are silhouettes of trees and two small human figures walking. The overall color palette is light green and yellow, suggesting a clean, natural environment.

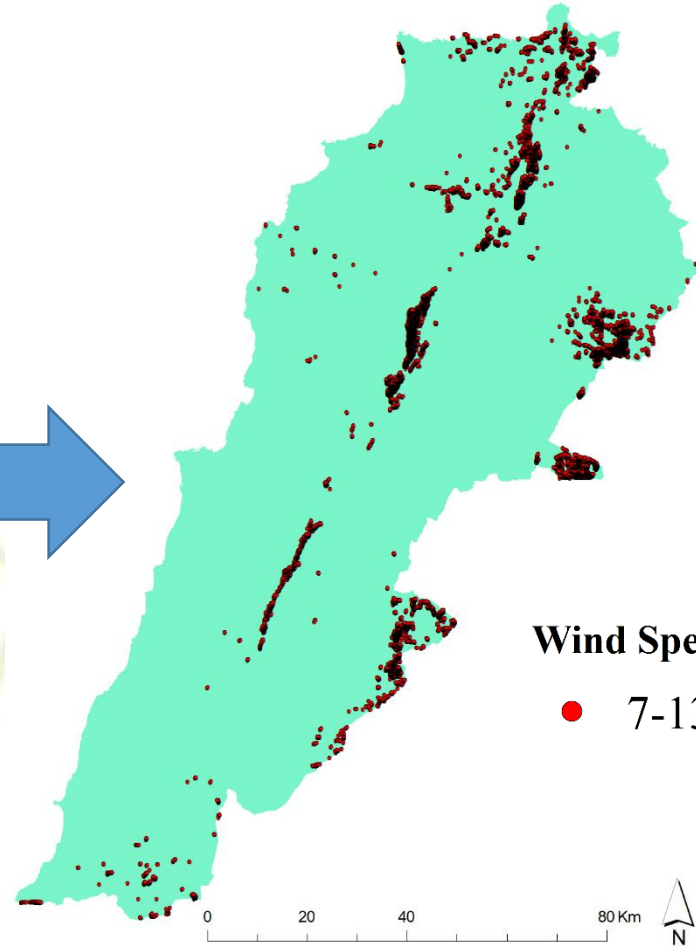
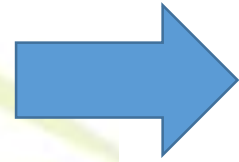
Result

04

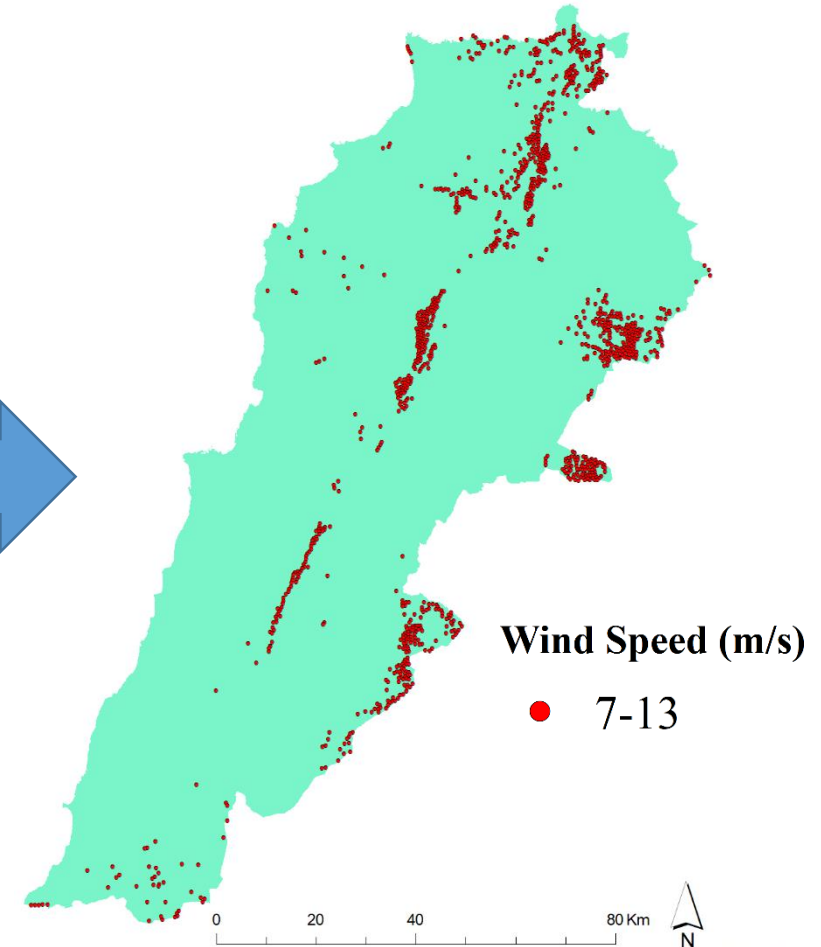
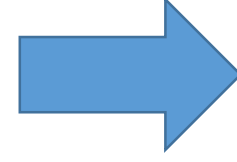
Resultant of the methodology



All points with wind speed between 7 and 13 m/s. (156785 point).

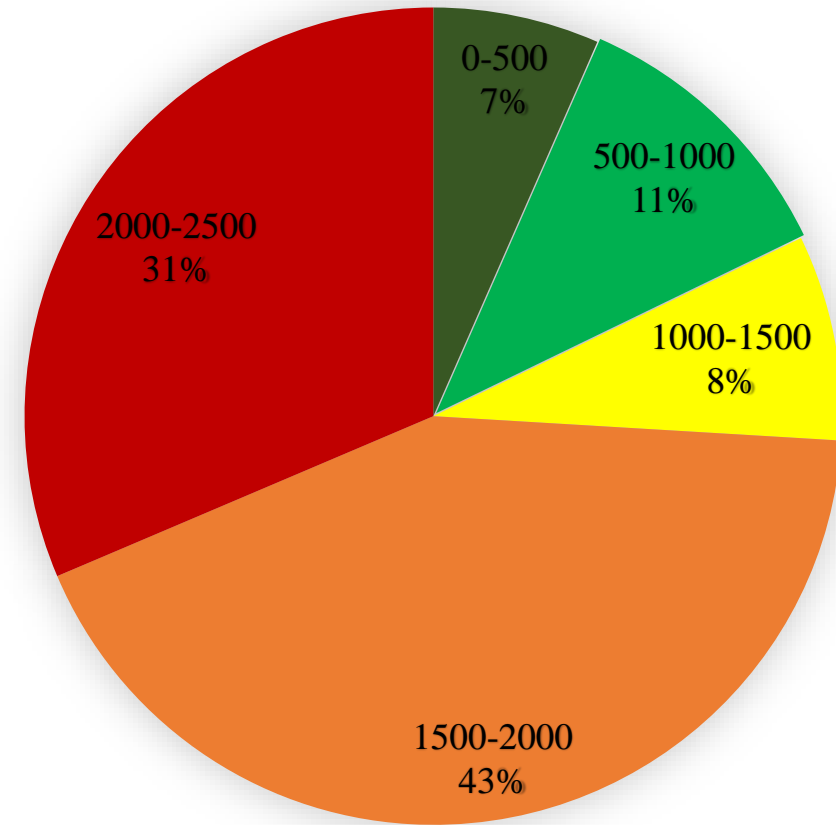
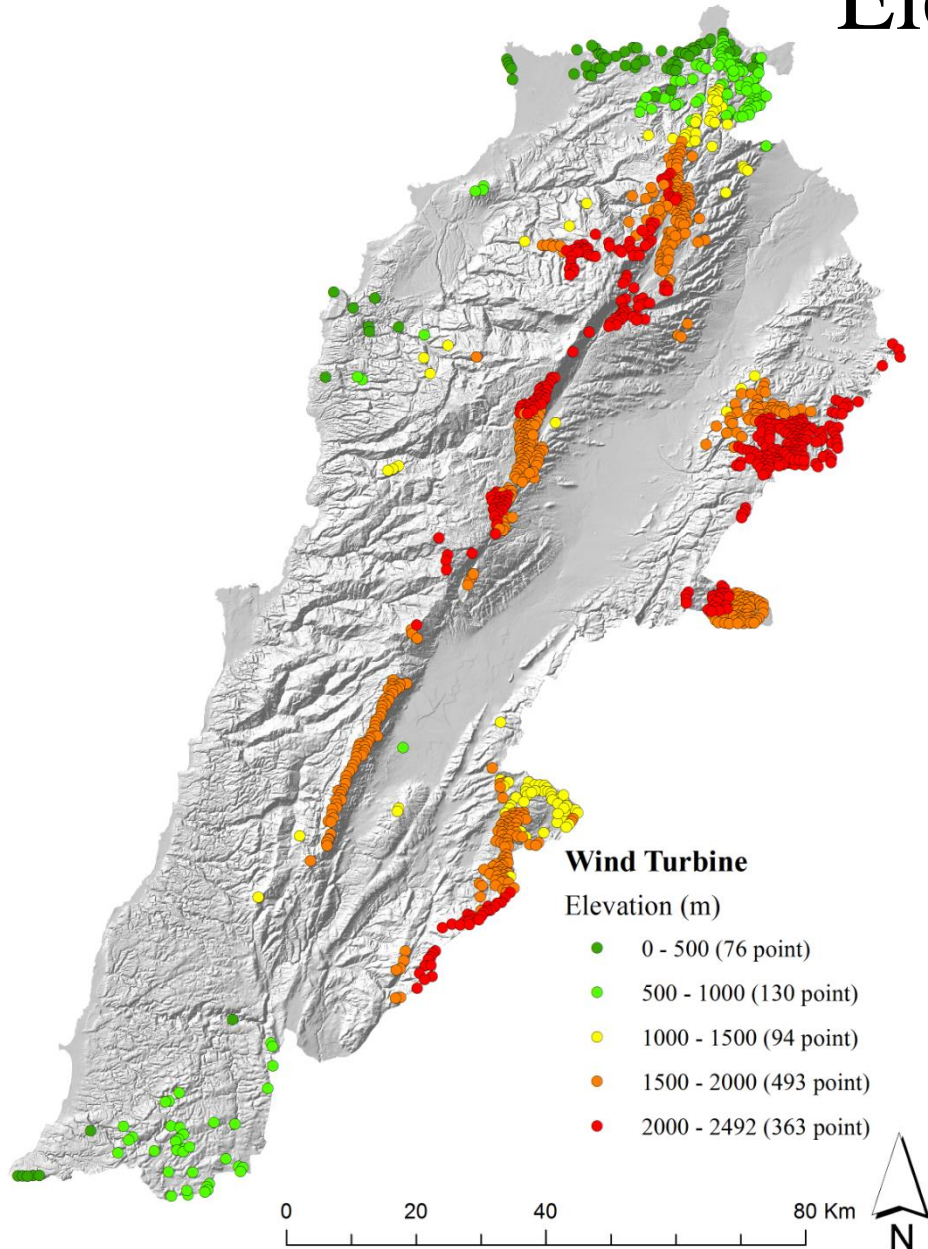


The resultant of **Phase 01**. Points represent the location that meet our condition mentioned in phase 01. (12583 point)

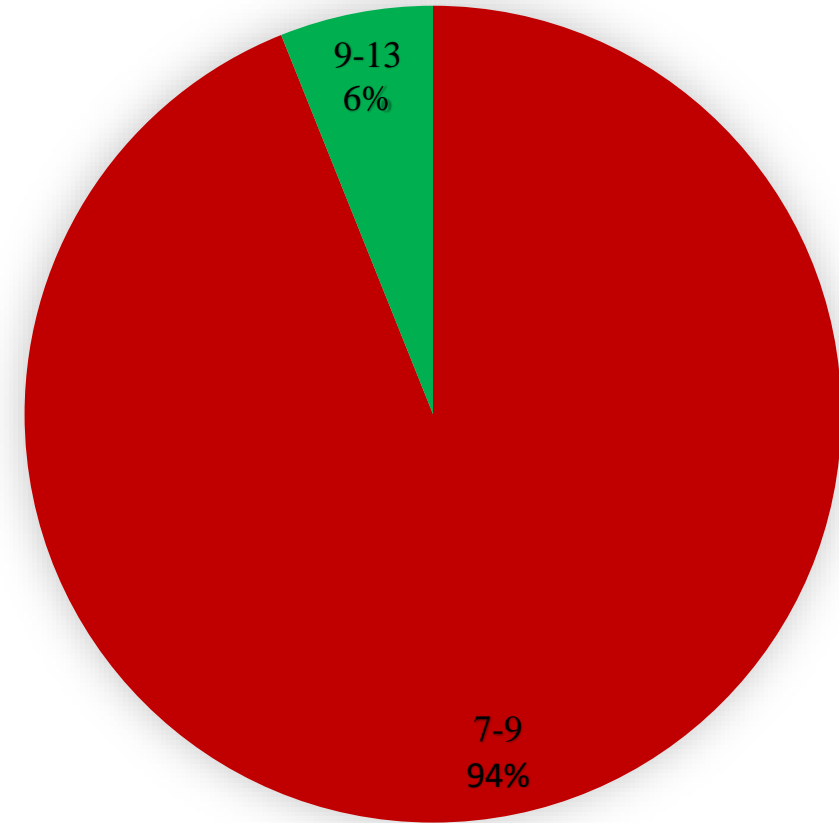
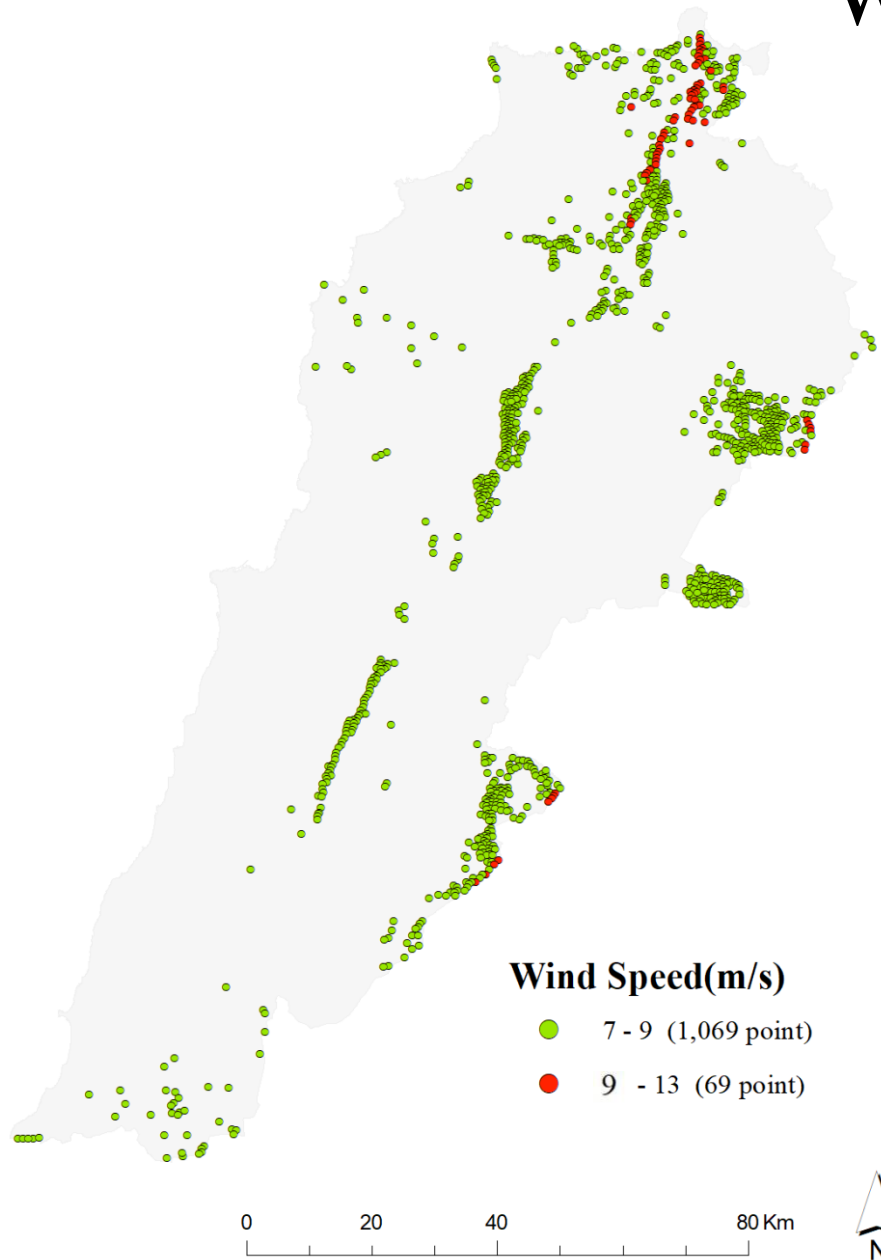


The resultant of **Phase 02**. Points represent the location of **wind turbines** that meet our condition mentioned in phase 02. (1156 point)

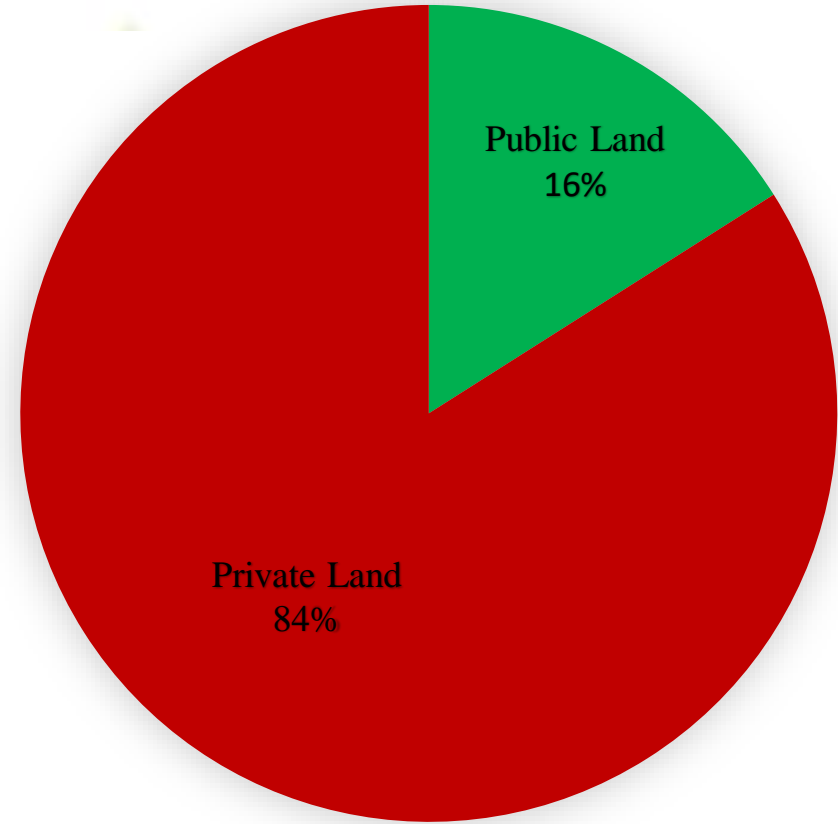
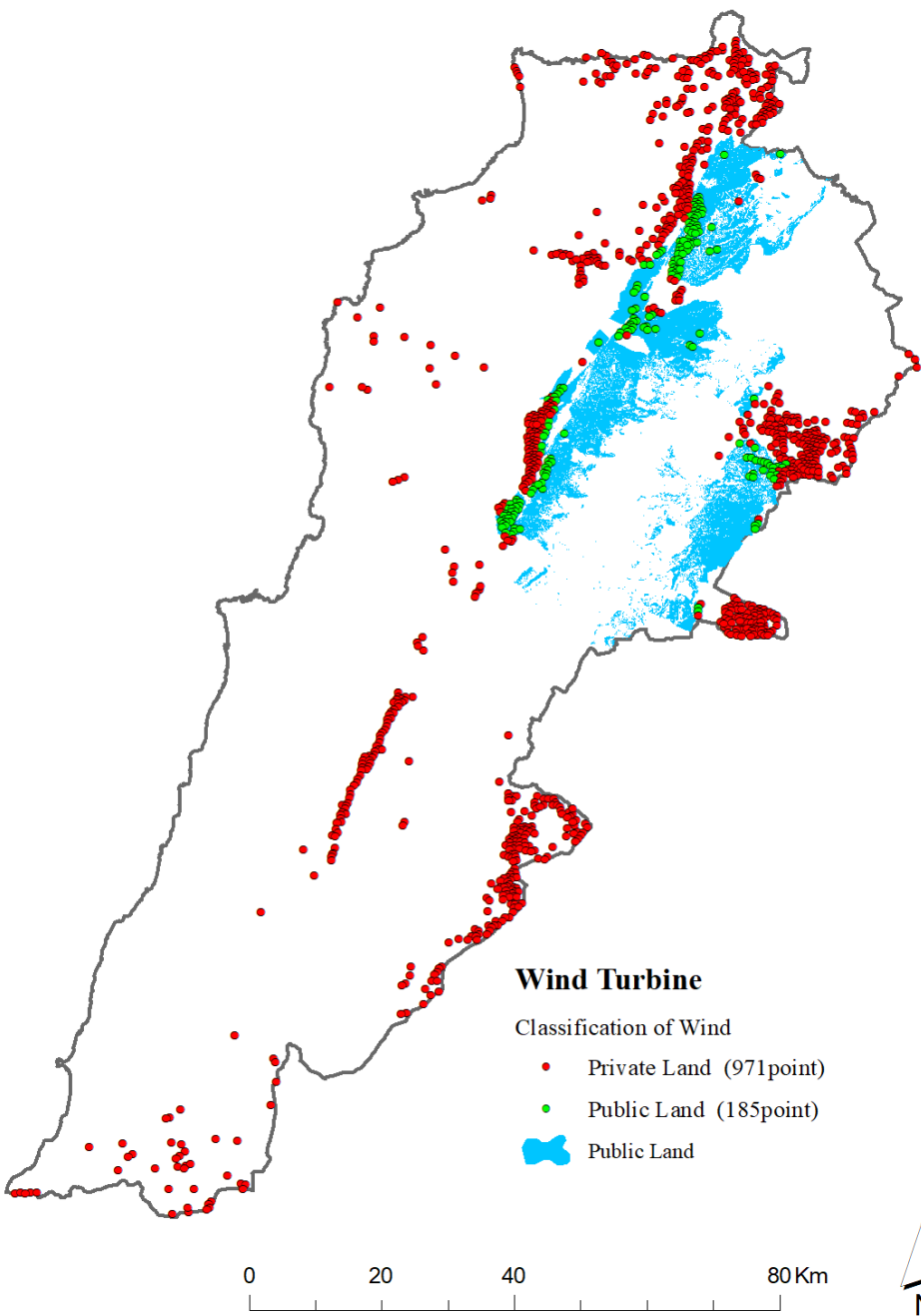
Elevation for Wind Turbines



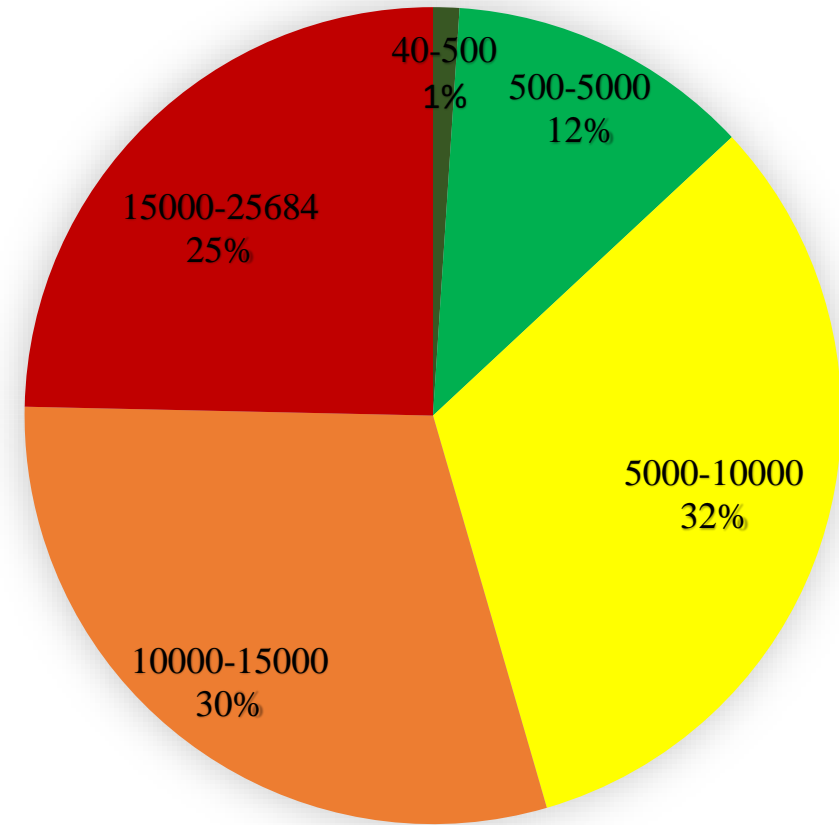
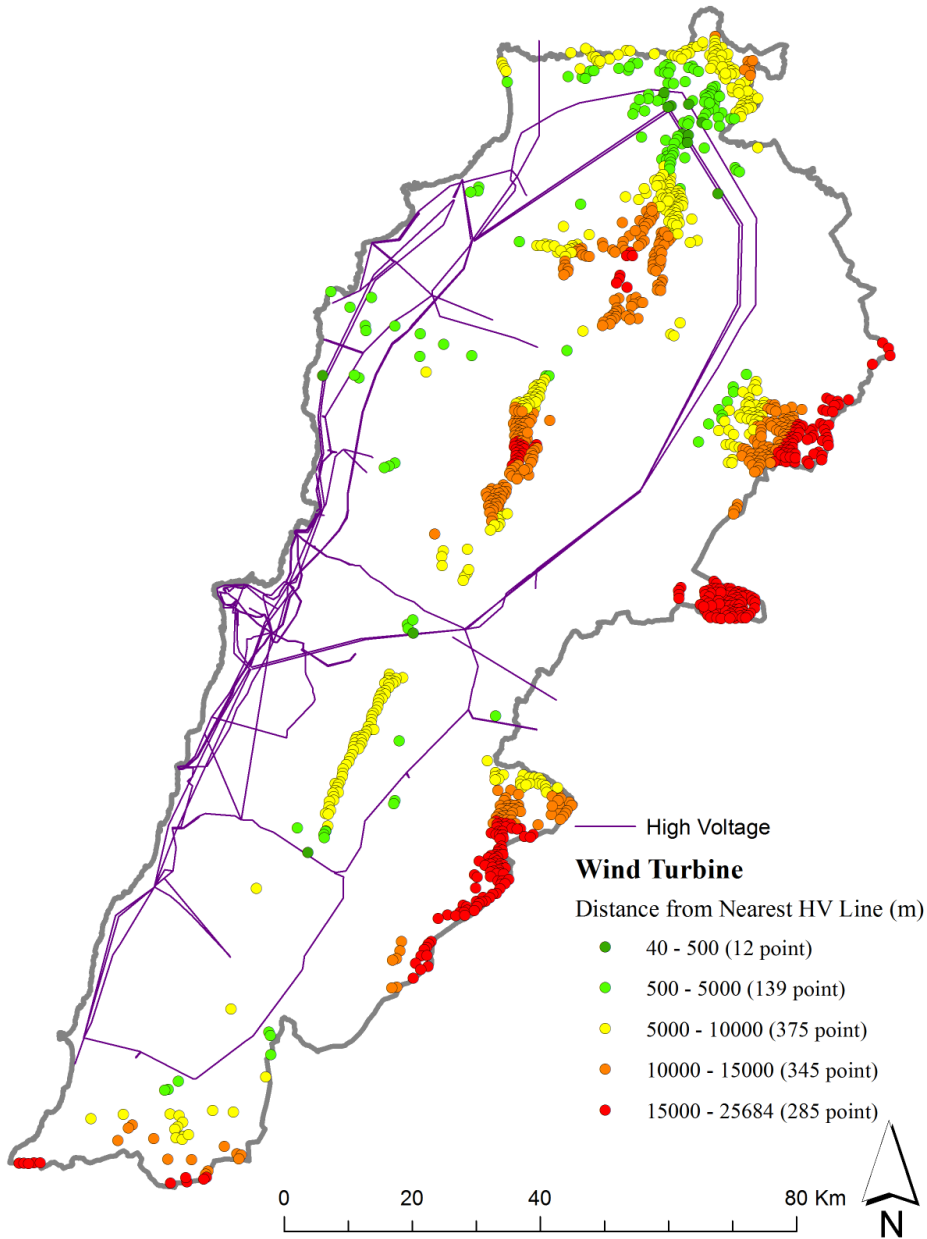
Wind Speed at Wind Turbines



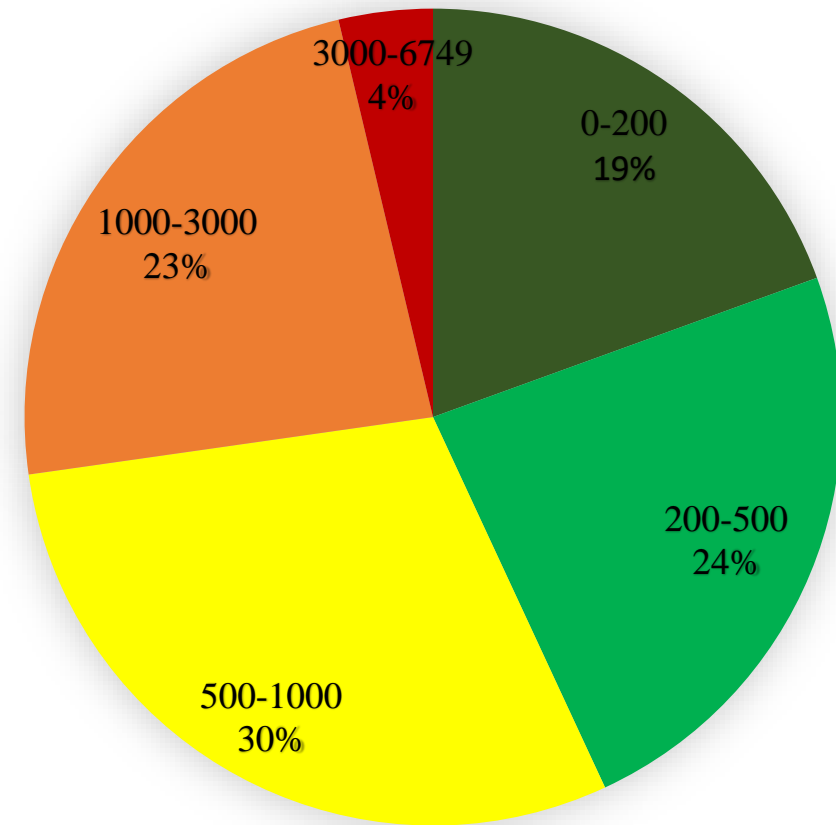
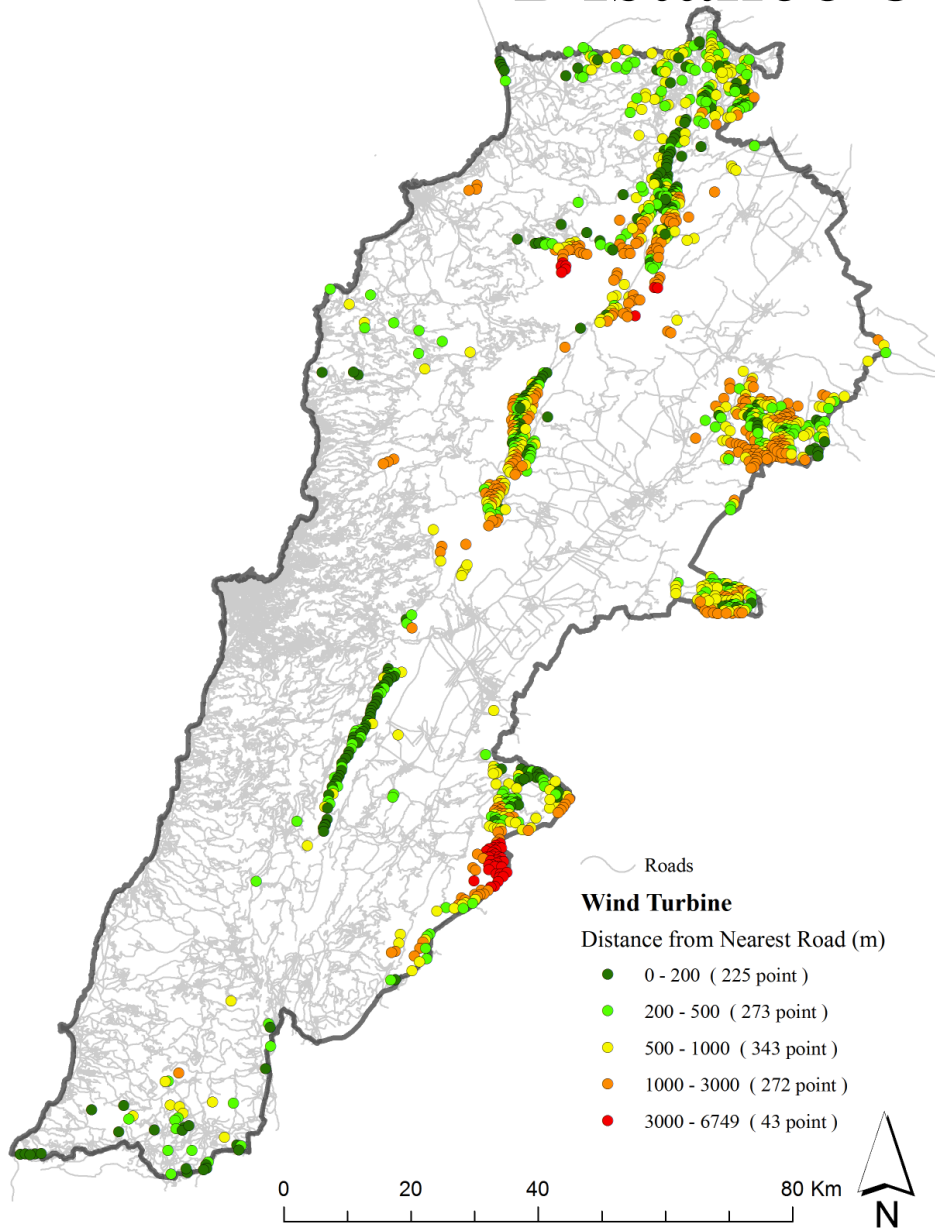
Public Lands Availability



Distance between High Voltage and Wind Turbines



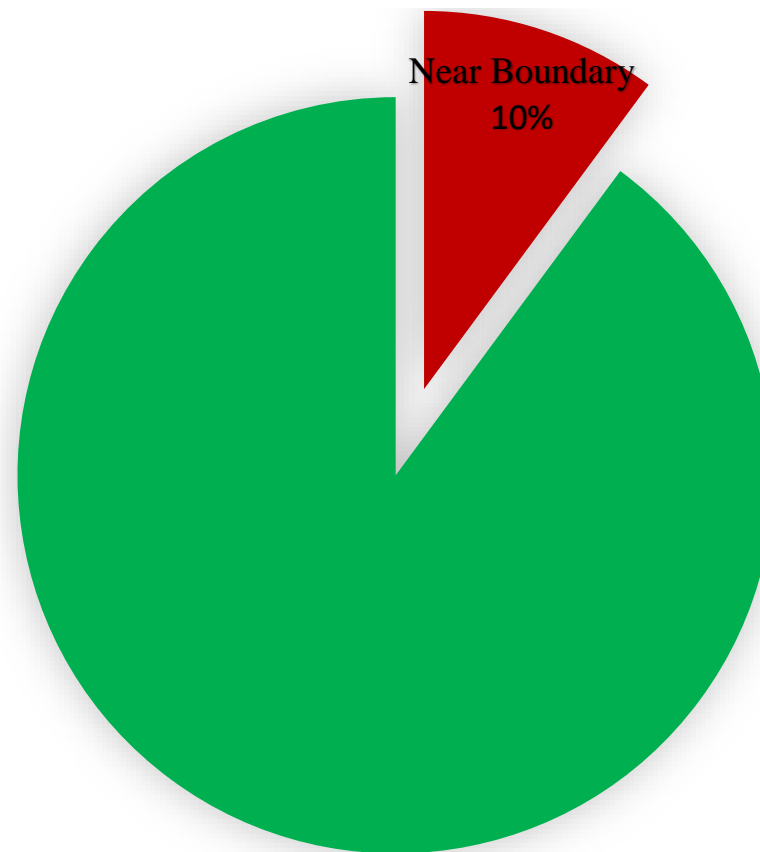
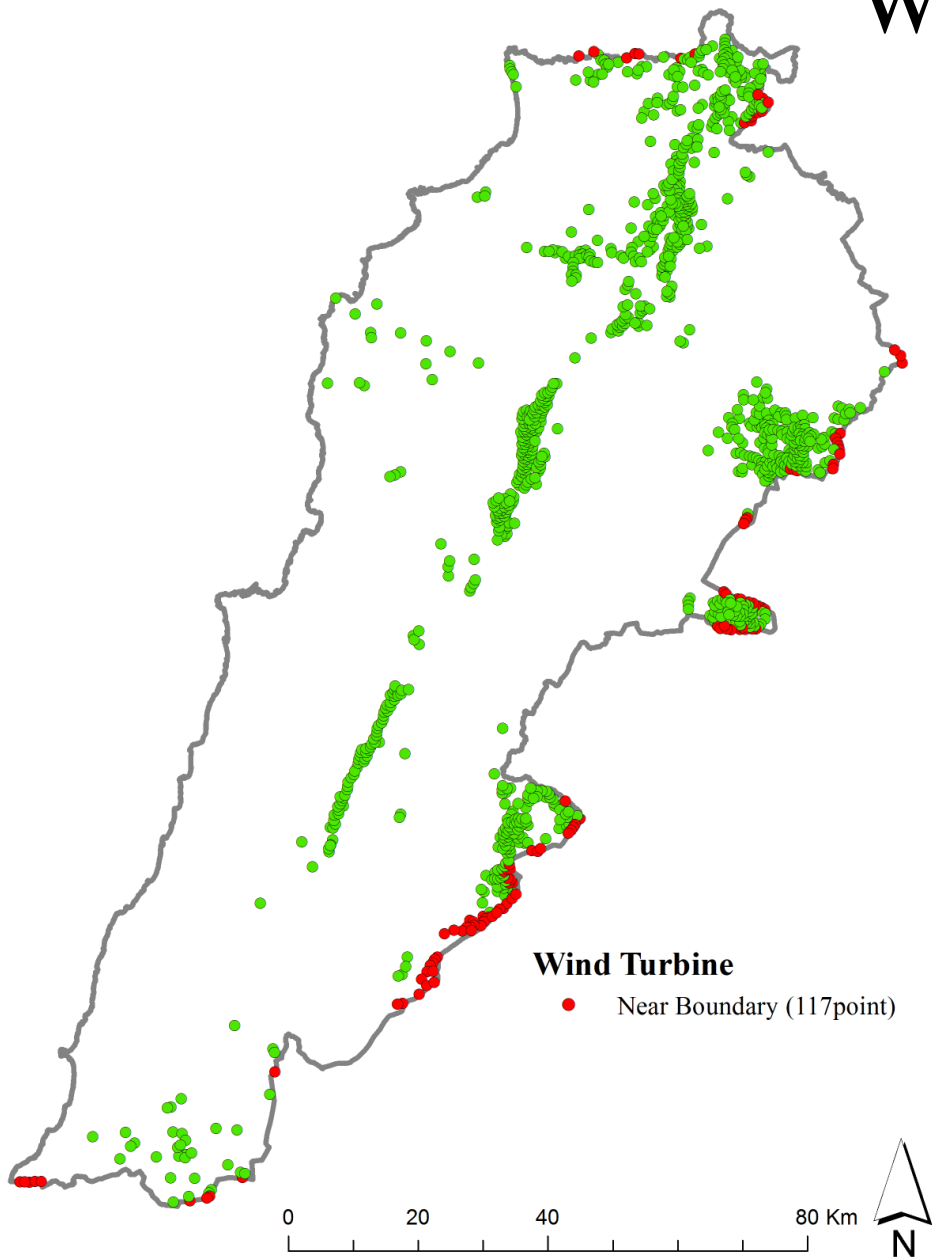
Distance between Road and Wind Turbines



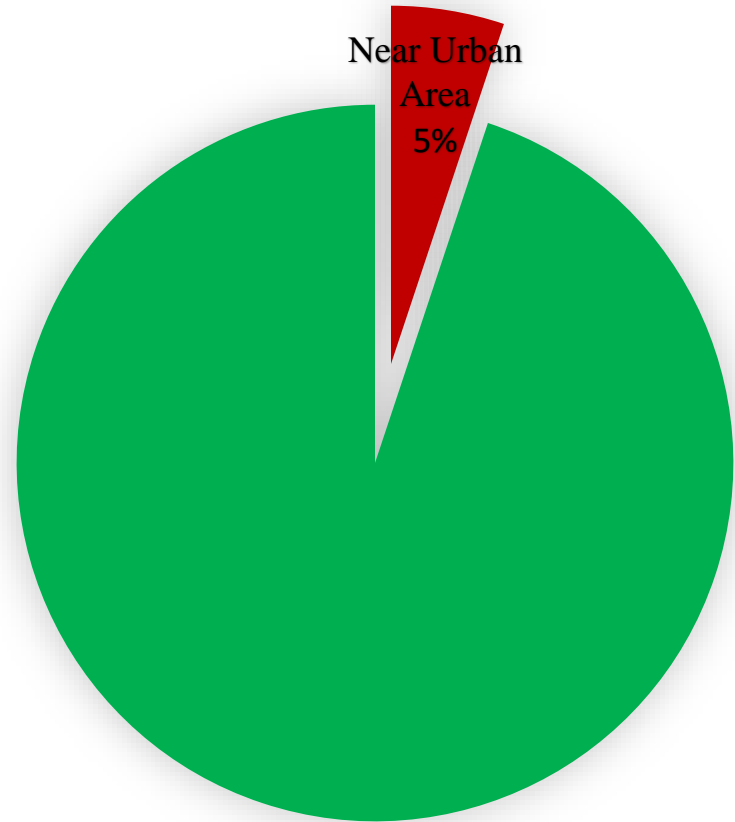
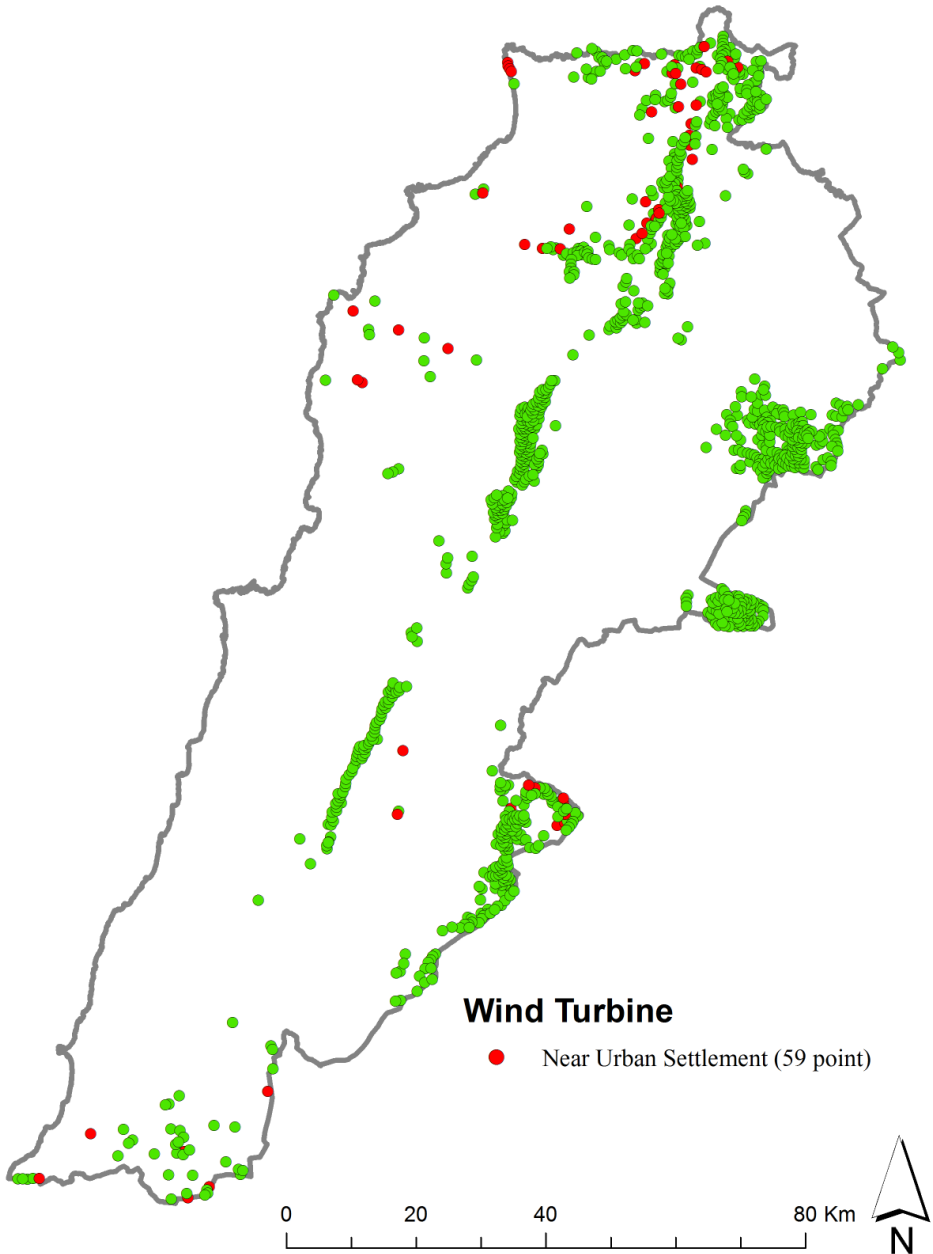
Note



Wind Turbines near Boundary



Wind Turbines near Urban

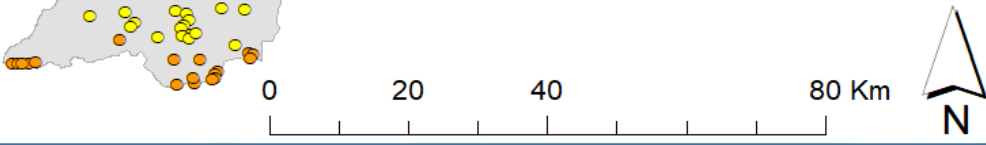
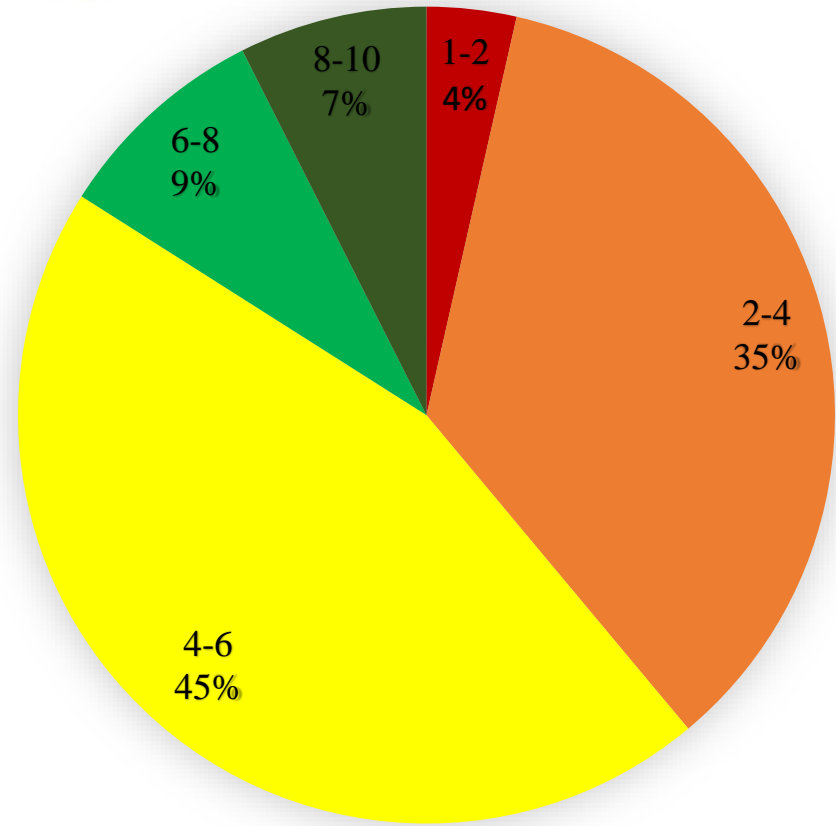
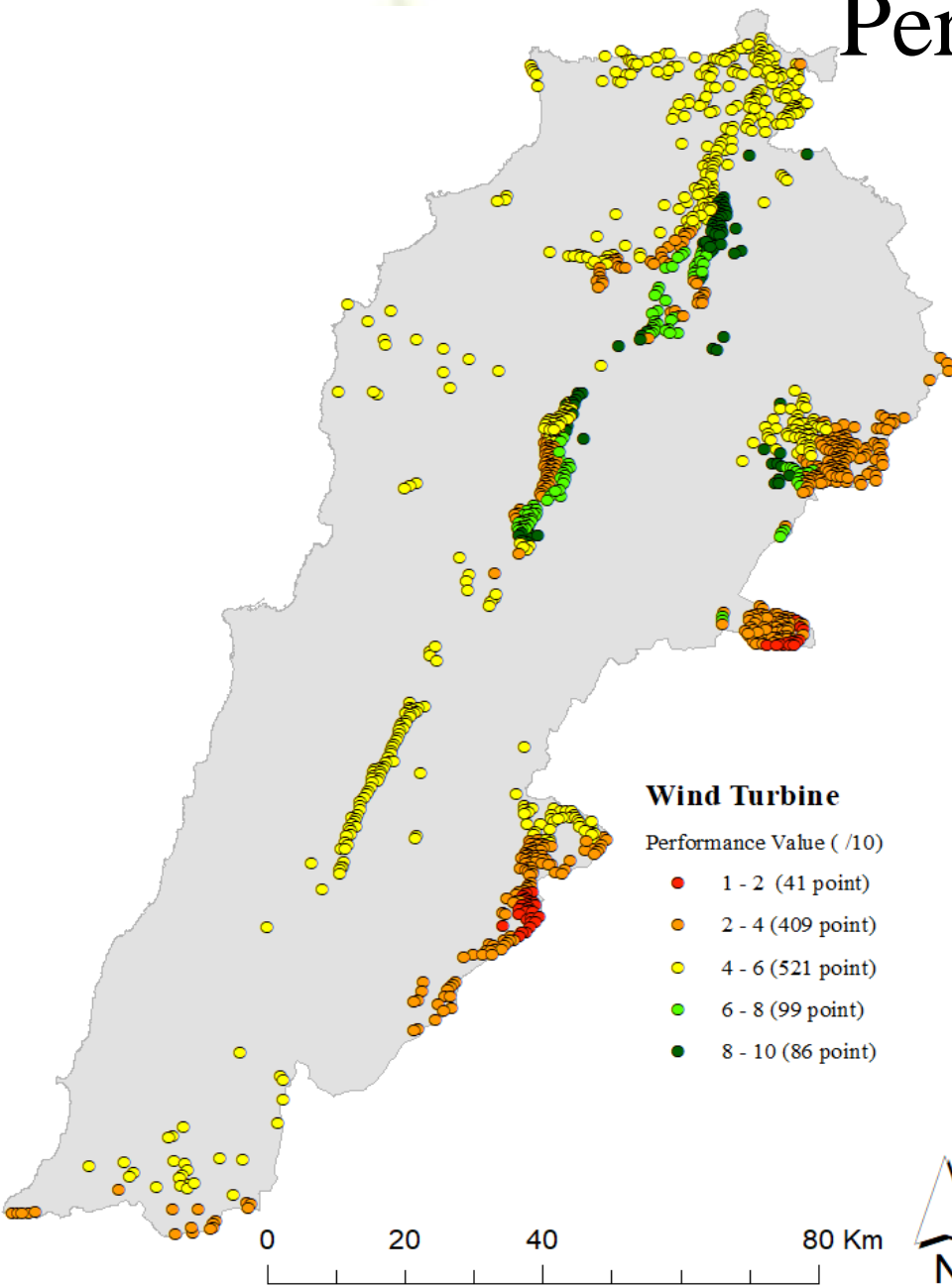


Data available of the urban settlement is at year 2017. So each turbine was checked in google earth pro if there is newly constructed building within 400 meter from wind turbine



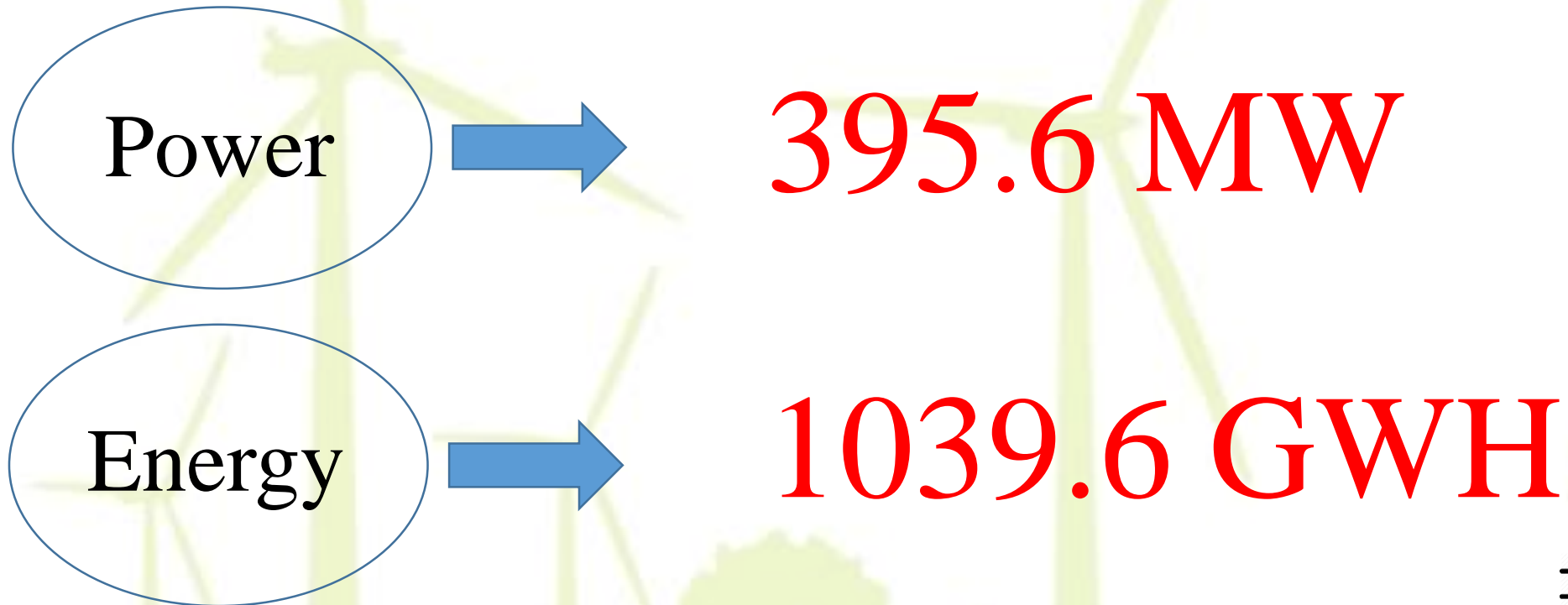
Conclusion 05

Performance for Wind Turbines



Energy and Power Production

According to the performance evaluation, we can determine that 86 Wind Turbine have the highest performance (between 8 and 10).



Note:
Capacity factor
is considered
30 %