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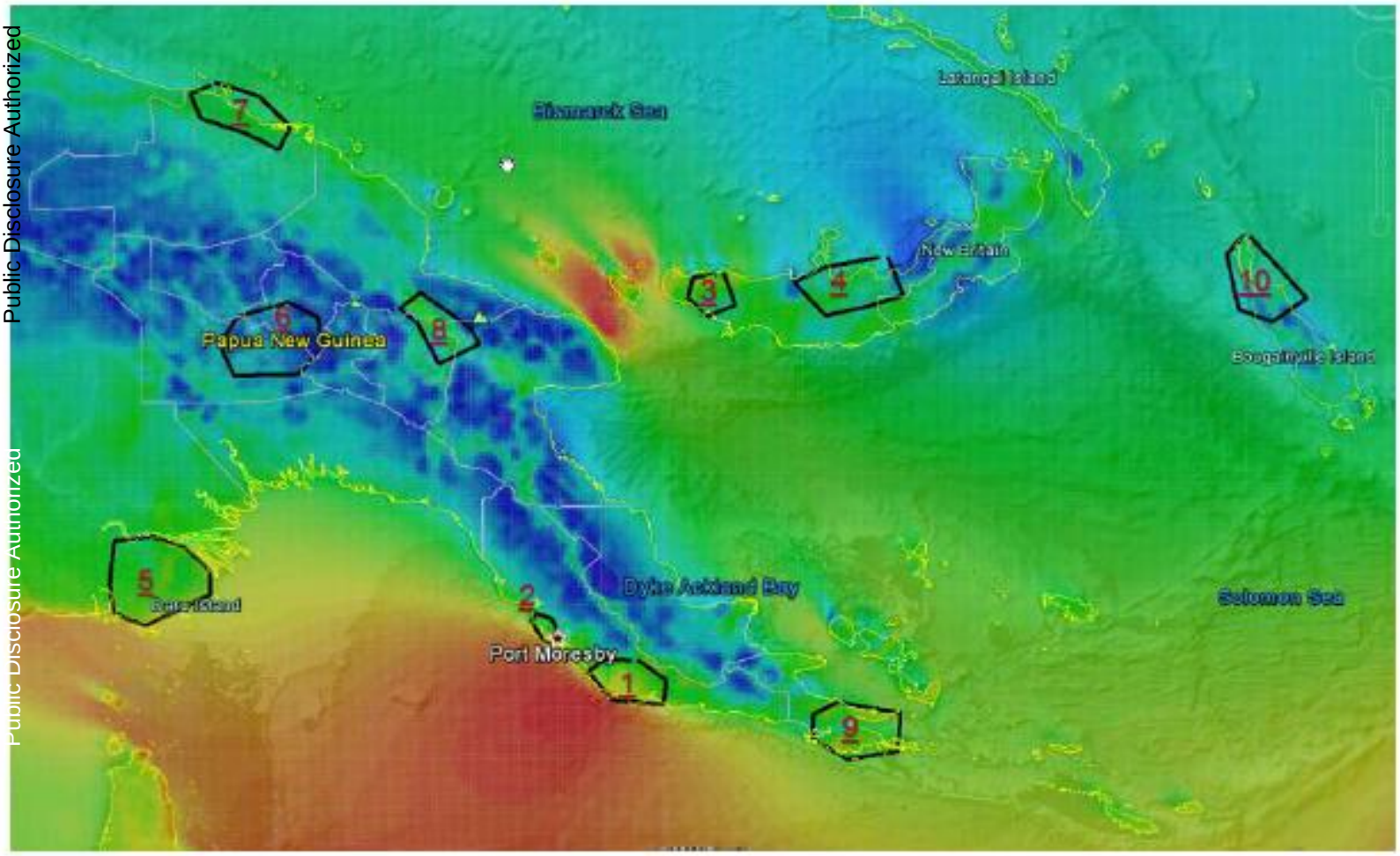
ESMAP
Energy Sector Management Assistance Program

Wind Resource Mapping in Papua New Guinea

SITE IDENTIFICATION REPORT

November 2015



This report was prepared by 3E, in association with DTU Wind under contract to The World Bank.

It is one of several outputs from the wind resource mapping component of the activity " Renewable Energy Resource Mapping and Geospatial Planning – Papua New Guinea" [Project ID: P145864]. This activity is funded and supported by the Energy Sector Management Assistance Program (ESMAP), a multi-donor trust fund administered by The World Bank, under a global initiative on Renewable Energy Resource Mapping. Further details on the initiative can be obtained from the ESMAP website.

This document is an **interim output** from the above-mentioned project. Users are strongly advised to exercise caution when utilizing the information and data contained, as this has not been subject to full peer review. The final, validated, peer reviewed output from this project will be the Papua New Guinea Wind Atlas, which will be published once the project is completed.

WIND MAPPING PROJECT PAPUA NEW GUINEA

D1.5 SITE IDENTIFICATION REPORT

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1 INTRODUCTION

In the framework of the wind mapping exercise for Papua New Guinea, a mesoscale wind map has been computed over the whole country by the Technical University of Denmark (DTU) (cf. Figure 1).

The latest methodology developed at DTU Wind Energy uses the Weather Research and Forecasting (WRF) model in a dynamical downscaling mode to produce a mesoscale wind map.

3E carried out a preliminary desktop study of the country in order to identify potential areas where wind measurement masts could be installed within the perspective of the validation of the meso-scale wind map prepared by DTU.

The selection of measurement locations is taking into account existing constraints and information received from local partners, highlighting the challenging working environment in Papua New Guinea.

This report presents the methodology and the results of the preliminary desktop analysis of site selection.

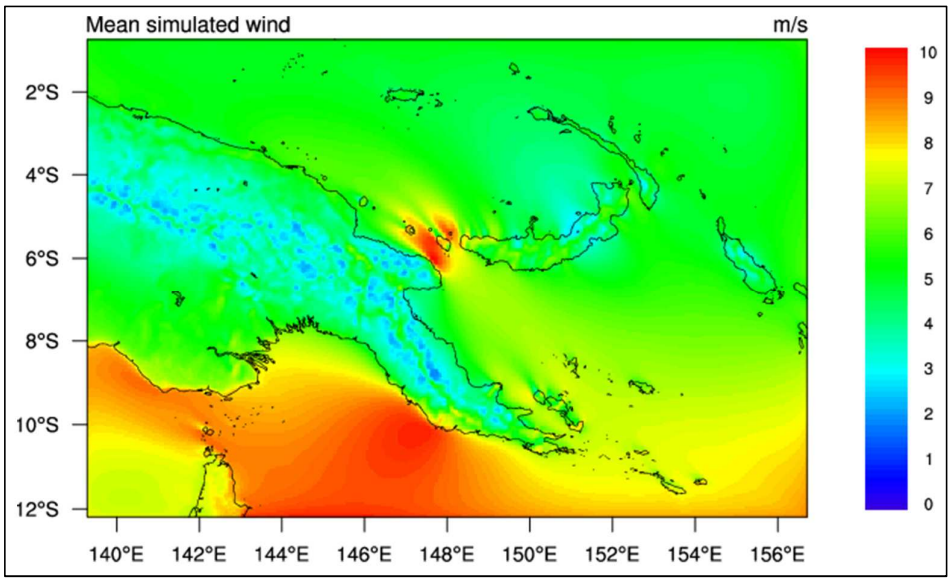

Figure 1: Mesoscale wind map calculated by DTU

2 METHODOLOGY

The pre-selection of areas, where ground based wind measurements could be envisaged for the wind map validation, is based on a desktop study that makes use of the meso-scale wind map calculated by the Technical University of Denmark (DTU), the satellite imagery of Google (indicating elevation, land cover, roads, waterways, villages etc.) and ground information received from the local partner.

In this report, the word “area” is used to define a broad location on the map, whereas the word “site” is used to define a more precise location that can be clearly identified with geographical coordinates.

The first focus was to identify areas suitable for the wind map validation. These areas should comply with the following constraints:

- The areas should be well spread over the country, including some of the secondary islands, in order to capture as many potentially different wind regimes as possible.
- The selection is also based on the accessibility of the areas, which is a major challenge in this project.
- The areas are homogeneous in terms of terrain elevation. This means that ideally no elevation differences greater than 100 to 300 metres should be present in an area with a radius of at least 5 km.
- The areas are relatively homogeneous in terms of roughness. This means that large changes of surface roughness (or land covers type) should be avoided in an area with a radius of at least 5 km. This includes land-to-sea and open land-to-forest changes, which is a major challenge in Papua New Guinea composed by many islands and where forest occupies most of the country.
- The area is located inside or close to a region of interest for wind energy development:
  - High to moderate wind resource area
  - Close to electricity network and consumption centre (electrical load)

In a later phase of the project, site visits will be organised by 3E and/or their local partners, to identify within these areas suitable sites for the installation of wind masts. These sites should comply with the following criteria:

- The site is (almost) flat over an area of about 100m by 100m in order to fit the 80m mast and its guy-wires with anchor points no more than 1 to 2 m difference in elevation.
- The site is open (no trees or only few trees that can be cut down before installation)
- The site is easily accessible for trucks and heavy duty, and is also relatively easy to access from larger cities with airports (reduction of maintenance costs)
- The site is located close to dwellings in order to improve equipment security, but not closer than 300m from any construction/building.
- The ground conditions are adequate for easy installation of mast and anchors foundations.

Due to the very limited amount of geographical information at hand, some of above mentioned selection criteria and constraints couldn’t be properly evaluated from the desktop study. Site visits in pre-selected areas will help to assess the “suitability” of these areas for the validation. During these visits, potential sites for the installation of wind masts within these areas will be identified. A site visit

report will follow, detailing all visited sites and providing suggestions of the most relevant sites for mast installation.

The outcome of the present study is a preliminary list of validation areas and a long list of potential mast locations.

3 CONSTRAINT MAPPING

Besides the wind map calculated by DTU, several other maps of Papua New Guinea are used in order to identify areas throughout the whole country, taking into account different constraints as presented above:

- **Electrical network** map: several masts should be located in areas where the electrical grid is present, to facilitate wind farm development and grid integration. As can be seen from Figure 2, the grid is very much dispersed and not interconnected, except around Port-Moresby and in the region between Lae, Madang and the Highlands. A few interconnections are under construction around Wewak and on New Britain Island. Grid connection appears as a considerable constraint for wind farm development.
- **Orography** map: identification of regions with probably different wind regimes due to the presence of large orographic features like mountain ridges, sea or lakes. Suitable sites on both sides of the mountainous spine of PNG, in the central region, and also on some of the largest secondary islands like New Britain and Bougainville Islands should be investigated..
- **Population/cities** map: the electrical network and political maps are similar in density with most of the people living around Port-Moresby and the Lae-Madang-Highlands region. However, small villages are located almost everywhere over the country, so there should be no difficulty finding local villages inside most of the selected areas. It is however not possible to identify all of them with the current information at hand and this will be uncovered during the site visits.
- **Road network** map: accessibility of the areas is important to consider. As many roads are in difficult conditions areas with access on good sealed roads should be preferred.
- **Earth quake frequency** map: it is important to assess the risk of severe earthquake occurrences in places where wind turbines could be installed. It is not directly used for the siting of wind measurement mast, but this is an important factor to keep in mind in terms of risks for the project.
- Google Earth is also used as a complementary source of information, notably for the identification of large terrain **roughness** changes.

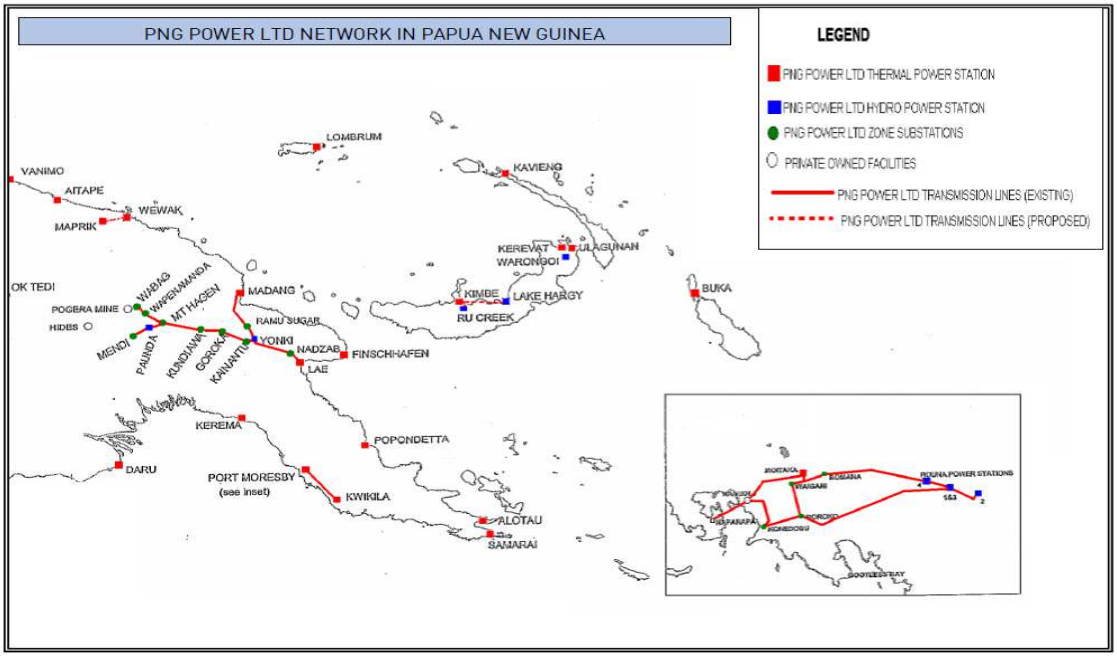

Figure 2: Electrical network map (Source: PNG Power Ltd, in *Fifteen Year Power Development Plan 2014 - 2028*)

Figure 3: Google terrain map

Figure 4: Google topography map with main roads

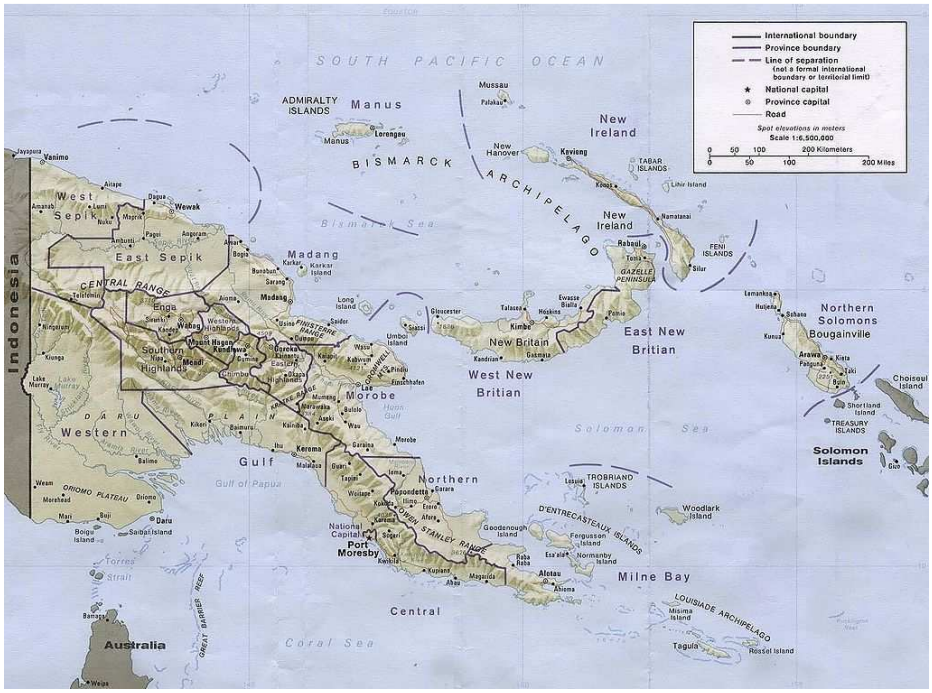

Figure 5: Political map with cities and provinces

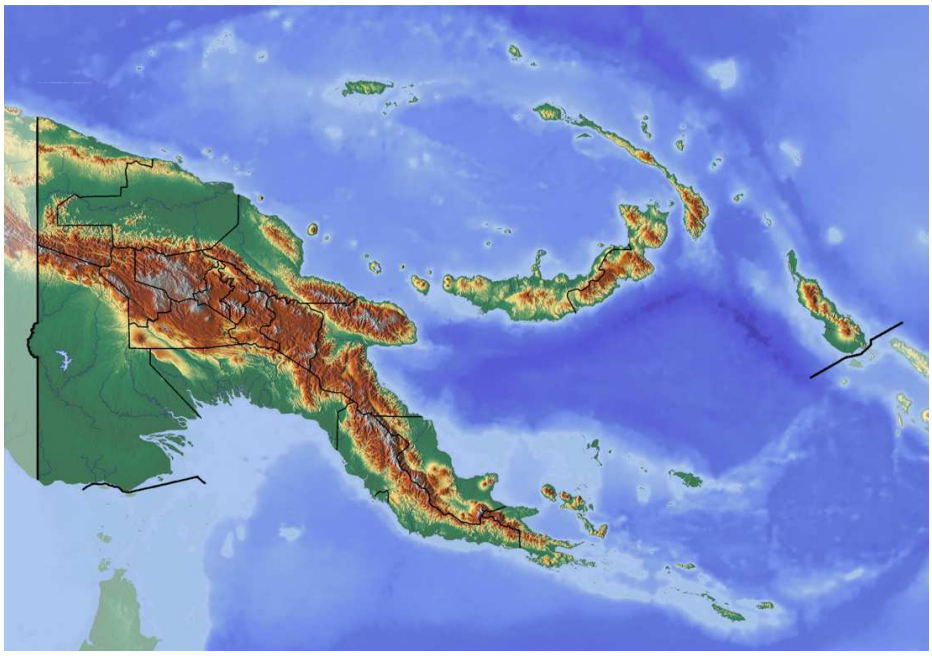

Figure 6: Elevation map with provinces

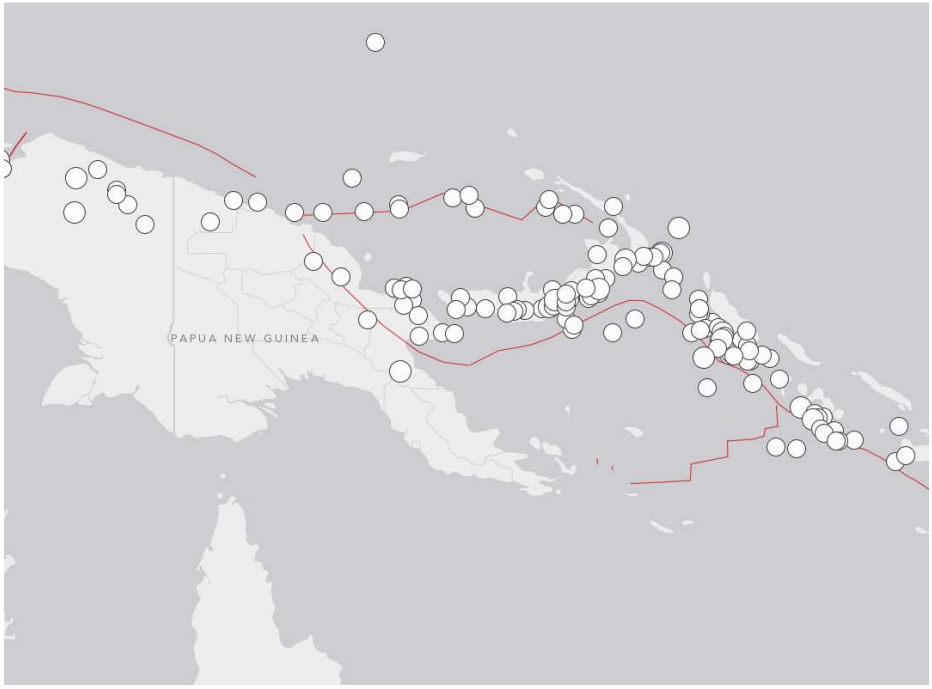

Figure 7: Map of earthquakes of magnitude > 6 over the last 10 years (Source: USGS)

4 RESULTS

Based on the combination of constraints and criteria, as presented above, 3E selected 10 areas where ground-based measurements could serve for the validation of the mesoscale model (cf. Table 1 Figure 8). These areas, identified as potential validation sites, are illustrated in figure below (polygons).

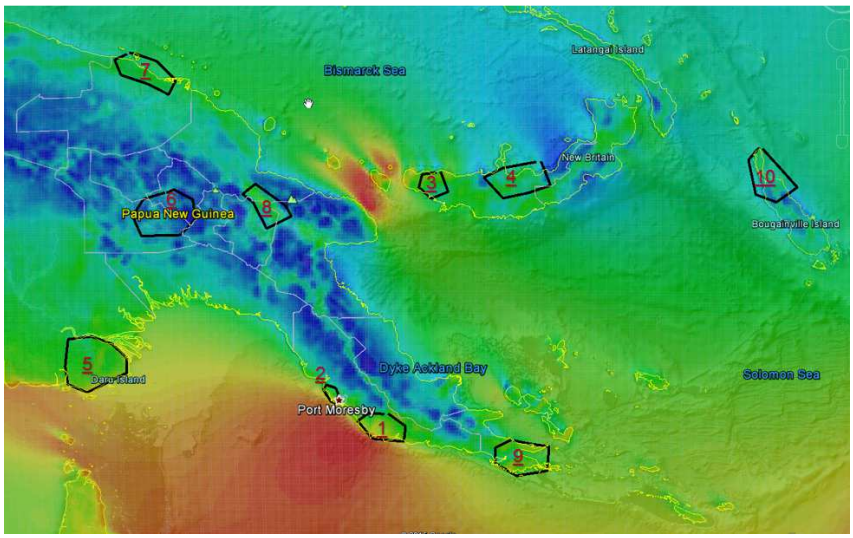

Figure 8: Mesoscale wind map calculated by DTU, and suggested validation areas (10 black polygons)

Within these areas, a first list of potential sites for the installation of wind masts was identified, through desktop analysis (cf. Table 1). Site visits will be organized in order to asses suitability of the areas and identify most relevant sites for mast installation.

Table 1: Proposed validation areas and identified locations from desktop analysis

	Province	Area
1	Central	Kamali Village and Launakalana Agricaltural Station
2	Central	LNG plant
3	West New Britain	Bagai and Kakumo villages
4	West New Britain	NBPOL plantations
5	Western	Ture-Ture, Oriomo and Mabaduan villages
6	Highlands	Ponowi Village
7	East Sepik	Tring, Yawasoro – Wewak Town and Angoram Villages
8	Morobe	UMI Station, Markham Valley
9	Milne Bay	Siasiada and Kaigulan Villages, Nube Village and Oil Palm Nursery
10	Bougainville	Buka and Bougainville islands

QUALITY INFORMATION

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