THE ASSESSMENT OF WIND ENERGY IN INDONESIA BY USING SATELLITE DATA

Denny Widhiyanuriyawan[1], Nurkholis Hamidi[1], Sugiarto[1], Triyanna Widhiyaningtyas[2]
[1]Department of Mechanical Engineering, Brawijaya University
Jl. MT. Haryono 167 Malang East Java
E-mail: denny_malang2000@yahoo.com
[2]Department of Electrical Engineering, Malang University
JL. Semarang 5 Malang East Java, Indonesia

KEY WORDS: Wind Energy, QuikSCAT, Satellite data.

ABSTRACT: This research was to investigate on the potential offshore wind energy resources in Indonesia by using wind speed data from the microwave scatterometer SeaWinds onboard QuikSCAT. The 10m-height wind speed from QuikSCAT data which operated (during August 1999 to November 2009) used for assessment the potential of wind energy. Based on the satellite data, the mean of wind speed in Southern of Java and Arafuru Sea show 6–7 m/s, while the southern of Kalimantan, southern of Java, Bali, and Nusa Tenggara show 5–6 m/s. Based on the anomaly data from 11 years (operated time of QuikSCAT) the southern region of Indonesia Java to Nusa Tenggara, Arafuru Sea have a huge potential of wind energy. Indonesia hopes that wind energy power has an important role for renewable energy development.

INTRODUCTION

Right now, the population of Indonesia is more than 230 million. As a development country that have growth economic fasted, it will be impact on energy demand. The energy consumption of Indoneisa increased 5.7% during 2000~2030 (Santosa and Yudiartono, 2005). The consumption of fuel (gas, oil and coal) will increase, while sources of fuel are limited. The excessive of fuel consumption in Indonesia for energy resources has increasing environment pollution (Susandi, 2006). Rubianndini (2011) explained that consumption energy of Indonesia is 1.1 % from total energy consumption of the world (ranking 20), where the population of Indonesia reached number 4 in the world. The energy consumption is lower than China (reach 13.5%) and United State (reach 20.8 %) from total energy consumption in world.

Energy diversification is one of the solutions to fulfill of the energy demand and environment problem in Indonesia. Indonesia is the archipelago country, where 2/3 part of area is sea and has shoreline 80791.42 km. Based on this geographical condition, this research will study more detail to discuss on diversification of energy, particularly on wind energy in Indonesia. The assessment of wind energy power is using satellite data from QuikSCAT, where satellite data that better on spatial and temporal data than traditional data. The quantified of wind energy power will be described to know the areas that have potential for wind energy over Indonesia region.

In addition, the wind energy provides on the sources of electrical energy, reduce the fuel consumption and improve environment quality. The wind energy development promises to be a domestic significant energy resource in Indonesia.

DATA AND METHODS

The wind speed data from QuikSCAT during operate period Juli 1999~November 2009 that provided by Asia Pacific Data Research Center (APDRC) are used in this research. The outline of QuikSCAT data are shown in Table 1. QuikSCAT is a sun-synchronous polar orbiting satellite and observes 10m height wind speed. This satellite has global swath grid product 25 kmx25km and twice a day at an arbitrary area on the globe. All of the weekly data during July 1999~November 2009, approximately 574 data, are used in this study.

Table 1. Outline of Sea Winds sensor onboard QuikSCAT (Ohsawa et. Al 2009)

Platform	
Platform name	QuikSCAT
Operated Period	June 20, 1999 to November 23 2009
Orbit	Sun-synchronous polar orbit
Orbital Period	101 minutes (14.25 orbits/day)
Altitude	803 km
Inclination	98.6 degrees
Sensors	
Sensor name	Sea Winds
Microwave	13.4 GHz (Ku-band)
Spatial Resolution	25 km x 25 km
Coverage	90% of ice free ocean every day
Wind speed	RMSE 2 m/s (3 to 20 m/s) and 10% (20 to 30 m/s)
Wind direction	RMSE 20 degrees
Parameter data	Lon, lat, time, U and V component

The area study covers from 12° South to 7° North of latitude and from 91° to 142° East of longitude. Image processing is used for filling and smoothing pixels which are caused by blank and low spatial resolution of satellite data.

RESULT AND DISCUSSIONS

The mean 10m height wind speed during July 1999 to November 2009 is shown in Figure 1. Wind speed 5~7 m/s based on QuikSCAT satellite (Figure 1 left side) shown in Southern of Java Island to Nusa Tenggara, Southern of Kalimantan to South Sulawesi, and East of Nusa Tenggara Timur to Arafuru Sea. The mean of wind speed reanalysis data from Jan 1948 to Des 2010 (Figure 1 right side) estimate less wind speed 3~5 m/s in same area.

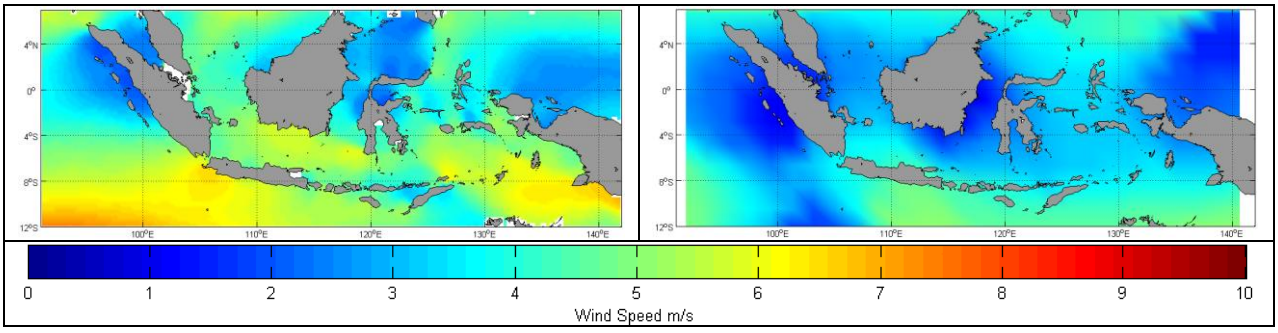

Figure 1. The mean of wind speed during QuikSCAT period from July 1999 to November 2009 (left side) and the mean of wind speed reanalysis data from Jan 1948 to Des 2010 (right side).

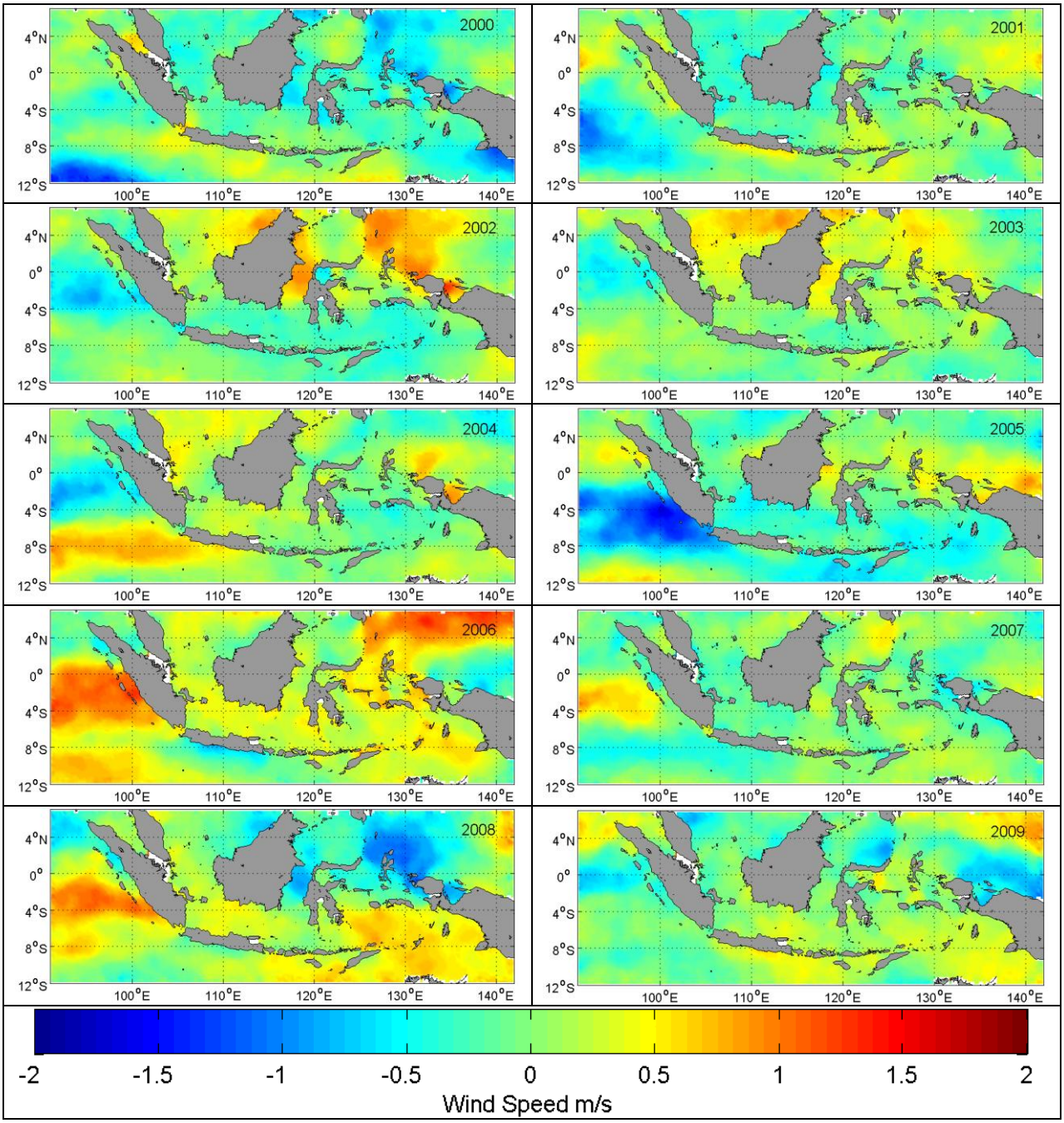

Figure 2. The Anomaly wind speed during 2000~2009 based on operate period of satellite.

Figure 2 shows the annual anomaly wind speed from the operated period of QuikSCAT (10 years) average. From Figure 2, it is found areas have range anomaly -0.5 to 0.5 m/s. This indicates that the annual wind speed not extreme year in term of wind speed around Indonesia based on operated period of QuikSCAT.

Potential wind energy estimate by using formulation of power density (IOWA Energy Center, 2006). The formula to calculate a wind power density:

$P = 0.625\ w^3$

Where P = Power density (W/m^2)

w = wind speed (m/s) ; $w = (U^2 + V^2)^{0.5}$

The annual power density based on satellite data are shown in Figure 3. The high power density more than 150 W/m^2 are shown in Southern of Java and Arafuru Sea. The middle power density (75~150 W/m^2) are shown in Nusa Tenggara Barat, Nusa Tenggara Timur, Southern Kalimantan to Southern of South Sulawesi.

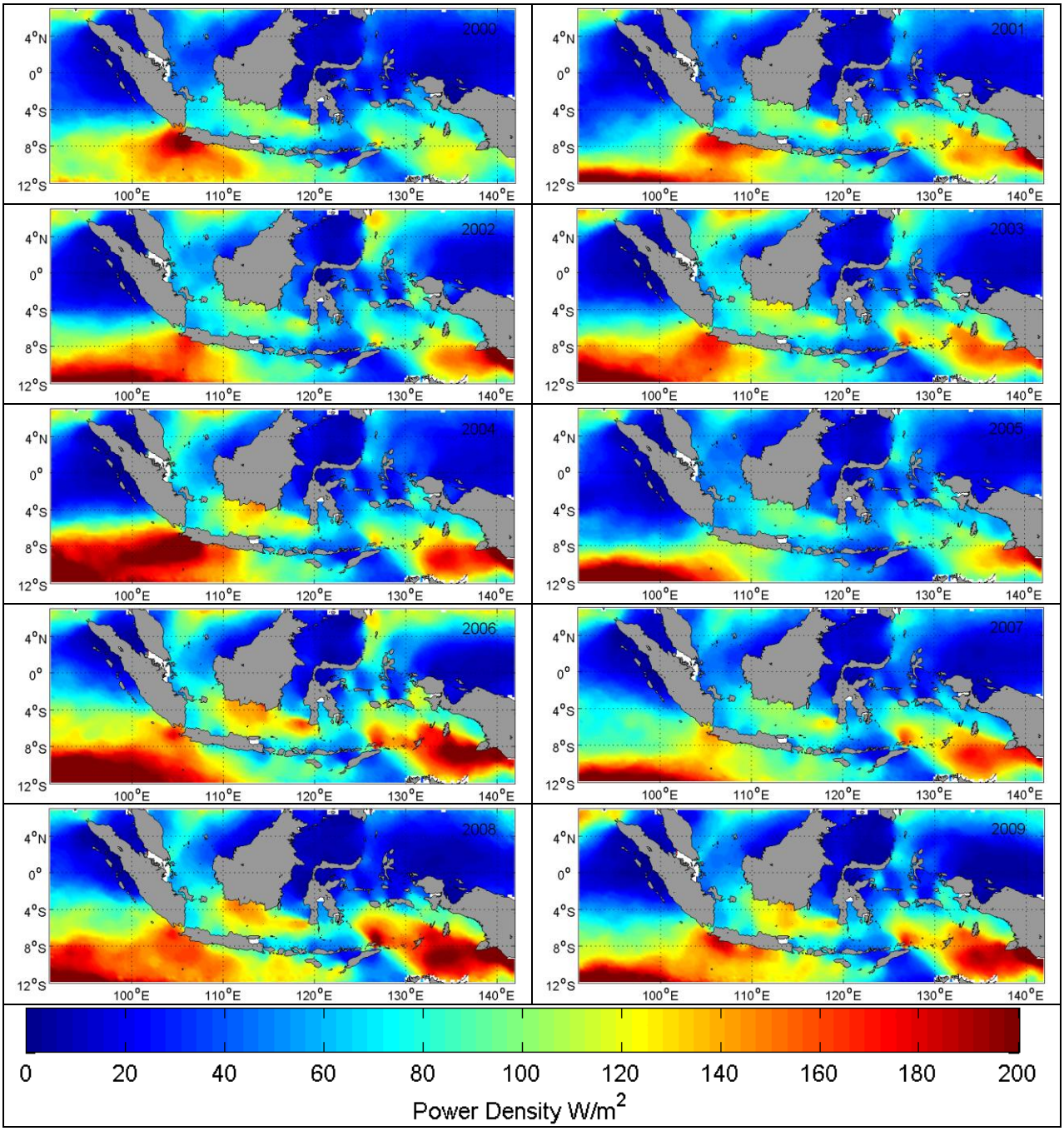

Figure 3 Power density during 2000~2009 based on QuikSCAT satellite.

CONCLUSSIONS

The mapping of wind energy resources based on QuikSCAT satellite data have studied. The assessment of wind energy using power density is categorized in two parts. The power density

75~150 W/m^2 is shown in Nusa Tenggara Barat, Nusa Tenggara Timur, Southern of Kalimantan and Southern of South Sulawesi, where the mean wind speed are 5~6 m/s. The high power density more than 150 W/m^2 is shown in Southern of Java and Arafuru Sea, where mean wind speed 6~7 m/s.

ACKNOWLEDGEMENTS

I would like to say thank for Asia Pacific Data Research Data Center (APDRC) and NCEP/NCAR reanalysis data that provided data, Brawijaya University that financial support in my research.

REFERENCES

IOWA Energy Center, 2006. Iowa Energy Manual. Iowa, USA

Ohsawa T, Tanaka M, Shimada S,Tsubouchi N. and Kozai K, 2009., Assessment of Offshore Wind Resources Within Japan's EEZ Using QuikSCAT Data. *Journal of the Environmental Sciences, pages* 841~845.

Rubindini, R.RS. 2011, http://metrotvnews.com/read/analisdetail/2011/07/02/177/Strategi-Meningkatkan-Ketahanan-Energi accessed on August , 27, 2011.

Santoso. Joko and Yudiartono., 2005, Analisis Prakiraan Kebutuhan Energi Nasional Jangka Panjang di Indonesia, Strategi Penyediaan Listrik Nasional Dalam Rangka Mengantisipasi Pemanfaatan PLTU Batubara Skala Kecil, PLTN, Dan Energi Terbarukan.

Susandi, A ,2006., Impacts of International Greenhouse Gasses Emmisions Reduction on Indonesia. Max Planck Institute for Meteorology. Germany.