ENVIRONMENT & DEVELOPMENT GROUP

KOM OMBO 200MW PV PROJECT
ACWA Power

Baseline Survey – Climatic Profile

February 2020

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1. INTRODUCTION

This report presents the climatic profile of Kom Ombo region, in Aswan Governorate. The climatic data serves as baseline information for Kom Ombo PV Project. The climatic data covers aspects related to temperature, rainfall, humidity, relative humidity, solar insolation, wind speed, and wind direction. Climatological data of the area is available from the Kom Ombo meteorological station about 18 km southwest of the project site and is summarized below.

2. CLIMATE PROFILE

In the following section, an overview of the climatic profile of the Project area will be presented (Kom Ombo), covering the following elements:

- Temperature
- Rainfall
- Relative humidity and evaporation
- Solar insolation
- Wind speed and direction

2.1 TEMPERATURE

Temperature is high throughout most of the year (Figure 1 ; Table 1) averaging 24.7 °C. January is coldest month of the year with a mean daily average of 15.4°C and ranging from a mean minimum of 7.0°C to a mean maximum of 23.7°C. In June, the hottest month of the year, temperatures average 31.4°C, ranging from 22.1°C to 40.8°C. The absolute highest and lowest temperatures on record are 49.0°C (occurring in June) and – 2.0°C (occurring in February).

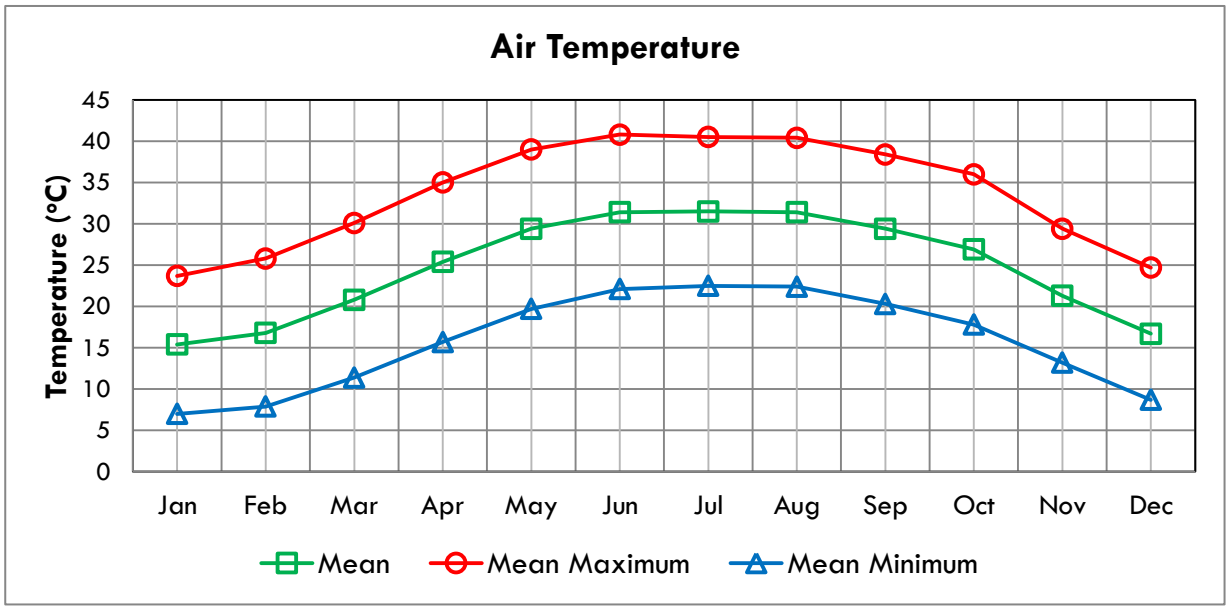

Figure 1: Monthly mean temperature and its range in Kom Ombo

Table 1: Maximum, minimum and monthly mean temperature at Kom Ombo

Month	Temperature (°C)				
	Daily Mean	Mean Maximum	Mean Minimum	Absolute Maximum	Absolute Minimum
Jan	15.4	23.7	7	35.0	-0.6
Feb	16.8	25.8	7.9	40.0	-2.0
Mar	20.8	30.1	11.4	47.1	1.5
Apr	25.4	35	15.7	46.0	5.6
May	29.4	39	19.7	48.3	9.2
Jun	31.4	40.8	22.1	49.0	15.0
Jul	31.5	40.5	22.5	47.2	16.0
Aug	31.4	40.4	22.4	48.8	13.8
Sep	29.4	38.4	20.3	47.0	12.8
Oct	26.9	36	17.8	44.8	9.0
Nov	21.3	29.4	13.2	39.2	2.4
Dec	16.7	24.7	8.7	35.6	-1.2
Annual Mean	**24.7**	**33.6**	**15.7**	**44.0**	**6.8**

2.2 RAINFALL

Upper Egypt, including the Kom Ombo area is typically hyper-arid with very scarce and highly irregular precipitation. According to the climatological records of Kom Ombo, the mean annual rainfall amounts to an average of 1.2 mm. Rainy days most frequently occur in spring months and to a lesser extent, in autumn and early winter months (Figure 2 and Figure 3). Rainfall usually occurs as squally highly irregular showers. Downpours equivalent to the average rainfall of a whole year or even several years can fall within few minutes during spring and autumn months. Figure 2 shows a downpour of 6.2 mm or the equivalent of the rain of 5 years falling in one day in Kom Ombo. Rain occurs at an average rate of 1.3 days per year (Figure 4) mostly of less than 0.1 mm (0.7 days per year). Forms of precipitation other than rain are insignificant.

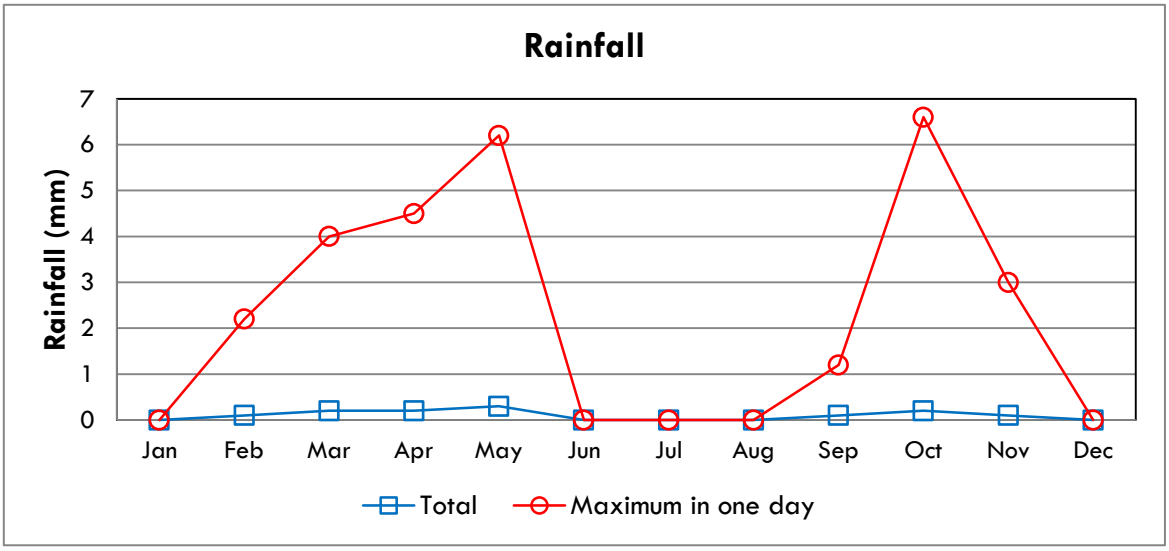

Figure 2: Mean monthly precipitation and maximum rainfall in one day in Kom Ombo

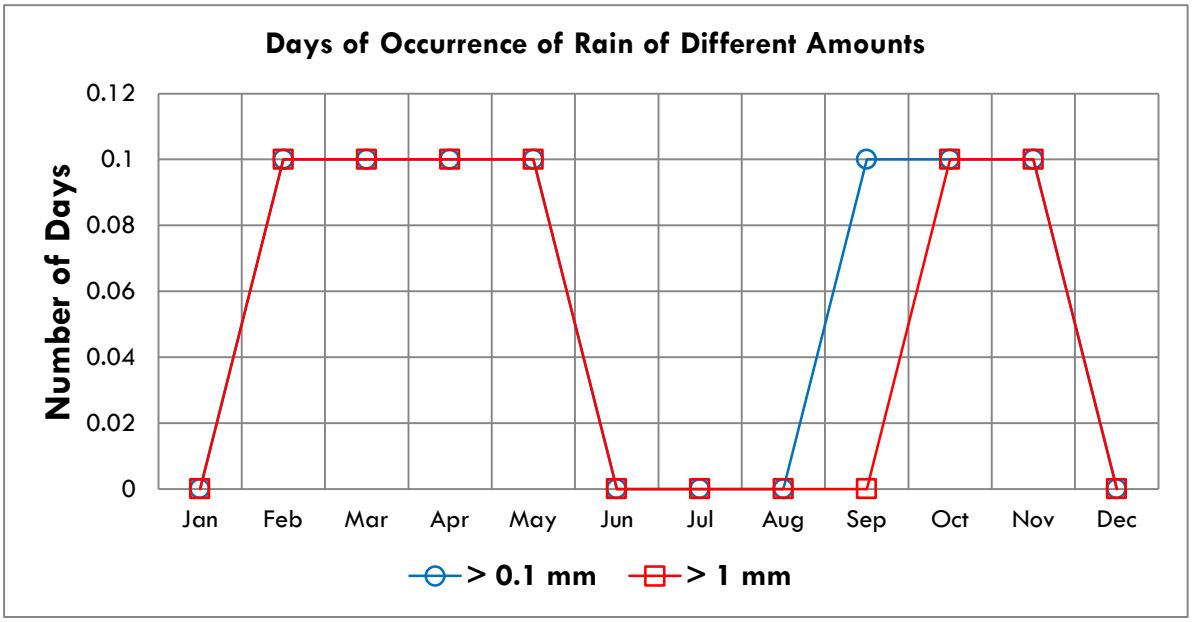

Figure 3: Monthly average number of rainy days in Kom Ombo

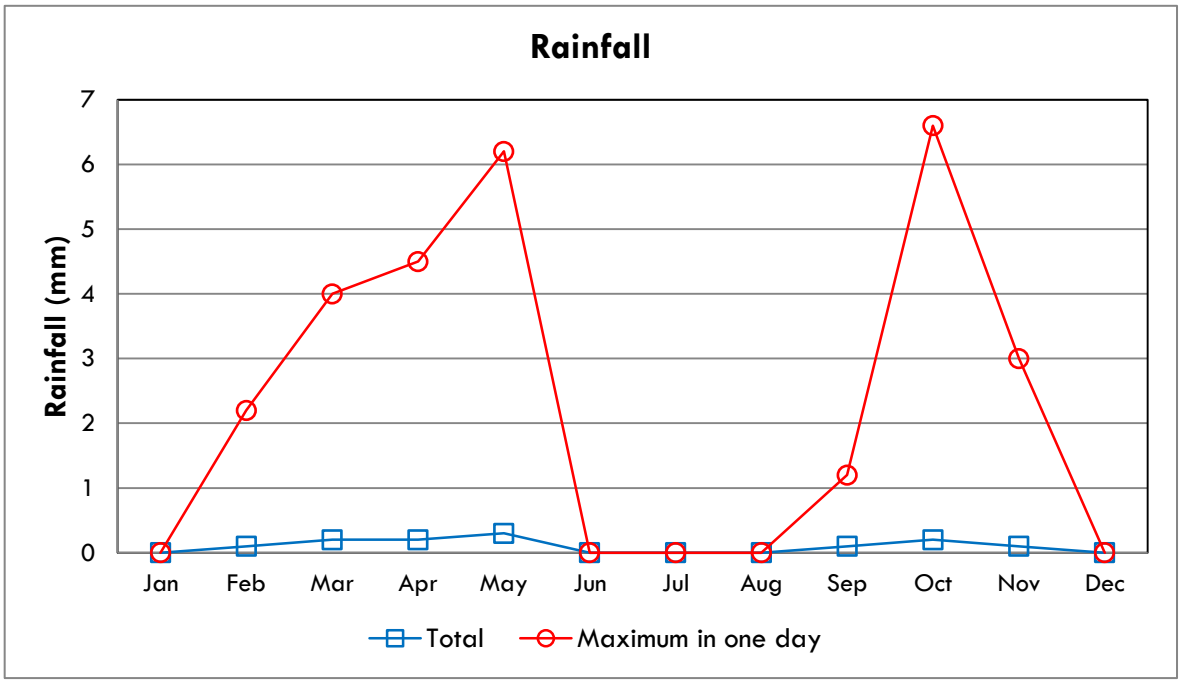

Figure 4: Mean total rainfall per day and maximum rainfall per day in Kom Ombo

2.3 Relative Humidity and Evaporation Rate

Relative humidity is generally low (Figure 5; Figure 6), with an average of 30.9% throughout the year, with the highest humidity levels are reported during winter months. Relative humidity is generally lower during midday, with an average of 19%.Like other hyper-arid areas, evaporation rate at the project site is extremely high, averaging at 11 mm per day. Higher evaporation rates occur in summer. The monthly rate of evaporation ranges between 5.4 mm in December to 16.1 mm in June. This high evaporation rate compared to the low precipitation rate (about 1.2 mm per year) makes the Kom Ombo area in general one of the driest areas on earth.

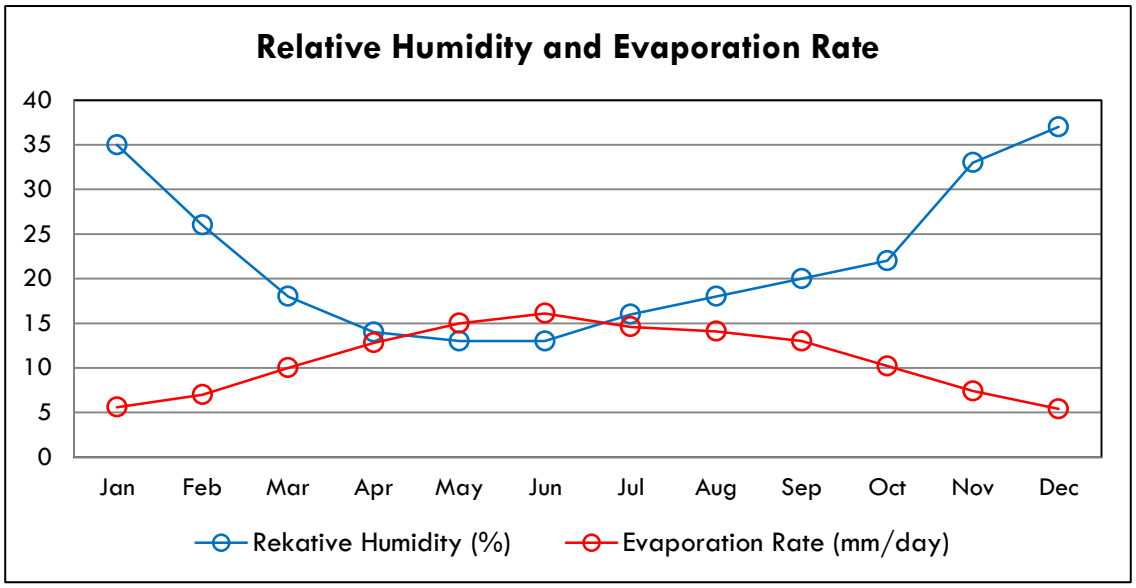

Figure 5: Mean monthly relative humidity and evaporation rate in Kom Ombo

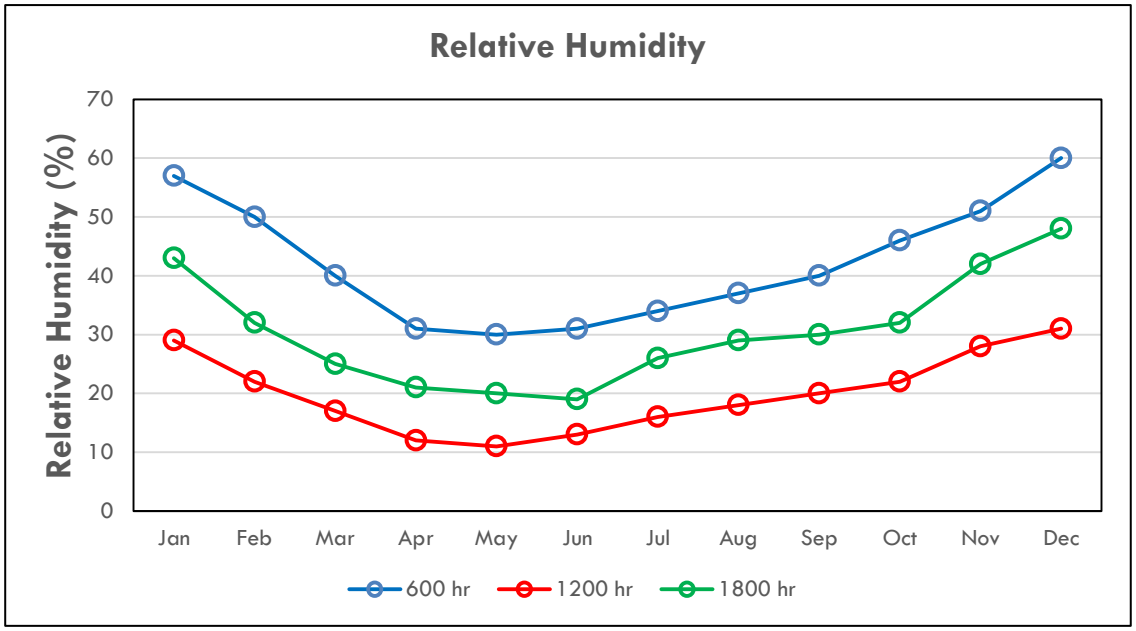

Figure 6: Mean monthly daily evaporation rates at different time of day in Kom Ombo.

2.4 SOLAR INSOLATION

Egypt receives more direct solar insolation than most other areas on the globe. In desert areas such as the Kom Ombo project site, solar insolation is extremely high. The sky is usually cloudless during most of the year. Bright sunshine occurs at an average of 76% of potential daytime hours and ranges from a minimum of 67 % in December to a maximum 82.9 in August (Figure 7). Related to this, is the prevailing clear sky conditions, which characterize the region (Figure 8).

The intensity of solar insolation is also affected by other weather conditions such as the occurrence of fog, mist, haze, dust or sand rising. **Figure** 9 shows the number of days of occurrence of fog, mist or haze with visibility of less than 1000 meters. The figure shows that fogy days do not occur in the area or are extremely rare. Haze is also very rare but occurs mostly in winter and spring. Days with mist are very rare and can occur any time of the year.

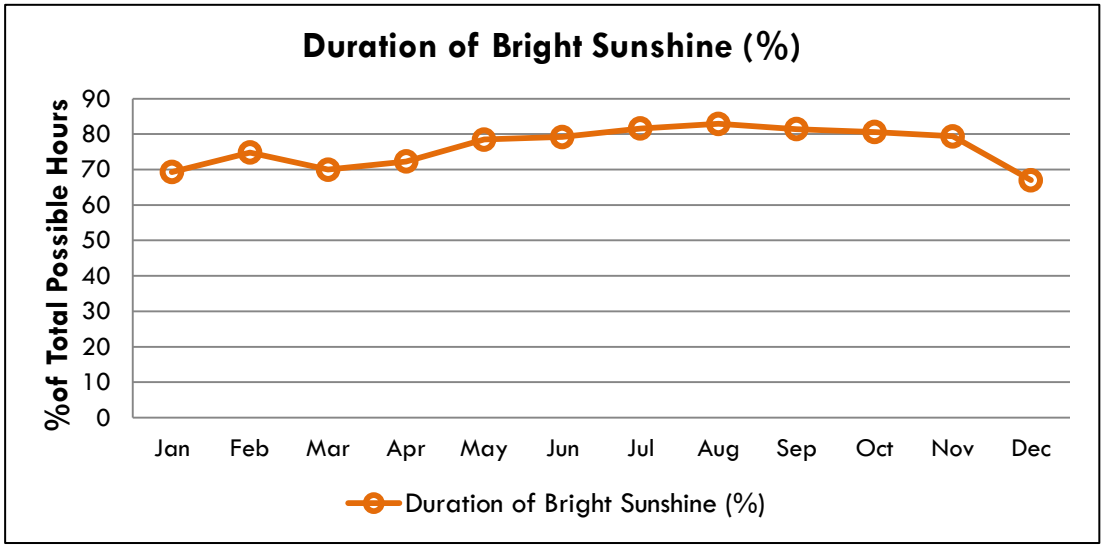

Figure 7: Average monthly duration of bright sunshine in Kom Ombo

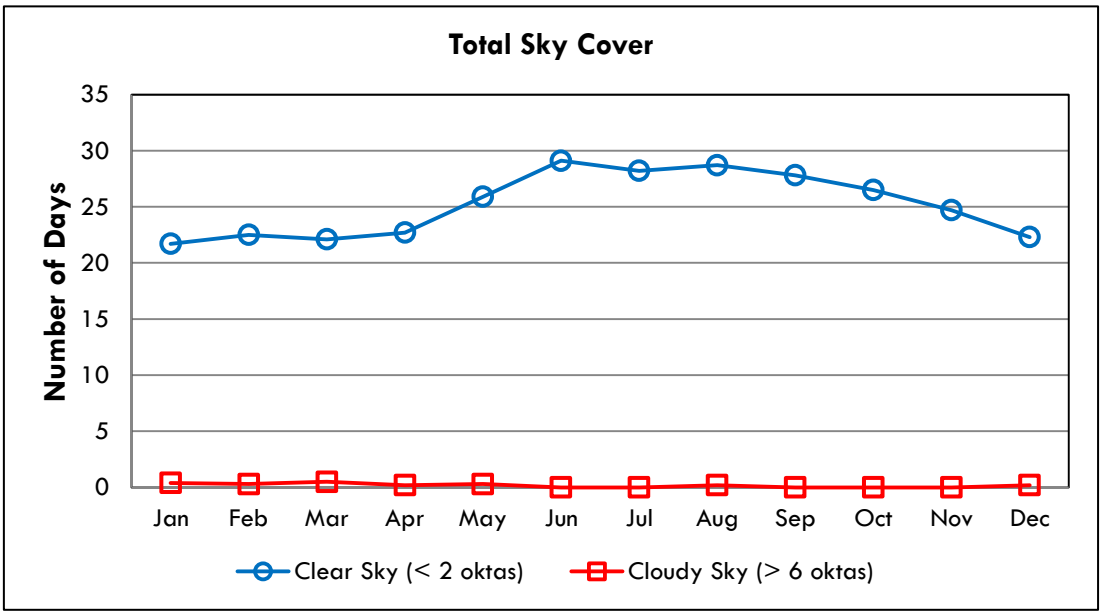

Figure 8: Monthly average total sky cover at different time of day in Kom Ombo

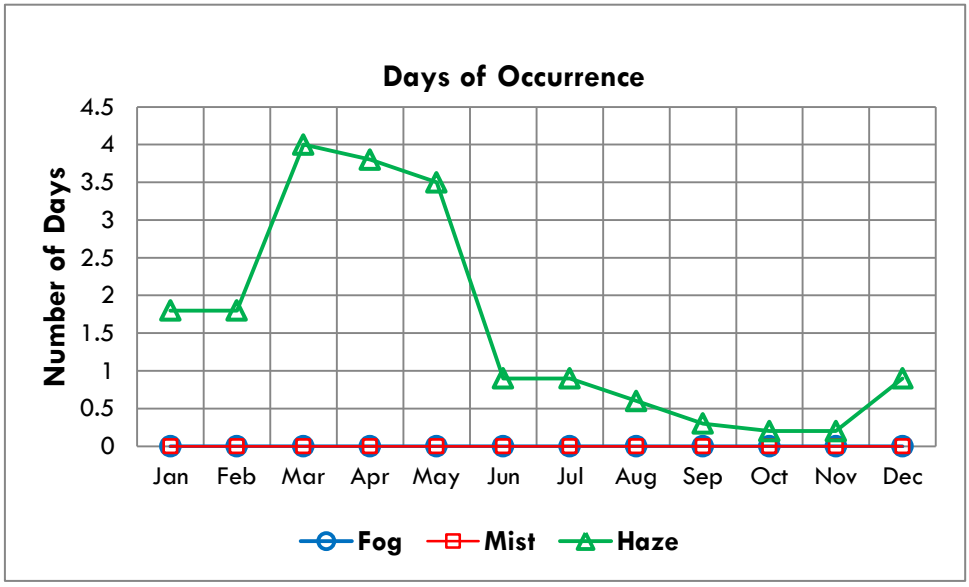

Figure 9: Days of occurrence of fog, mist and haze in Kom Ombo.

2.5 Wind Speed and Direction

Wind regime is highly uniform throughout Egypt and is dominated by northwesterly and northerly winds most of the year. In Kom Ombo, the prevailing wind blows during most of the year, from the northwest, north, or northeast, with a moderate speed averaging 3.6 knots, with March being the windiest month of the year (Figure 10). For only a few days during the spring months, transient changes in this rather stable wind pattern occur, with hot desert wind blowing from south, southeast or southwest. This wind, which is known as the *Khamasin* wind, often blows as sand storms of hot desert wind and covering vast areas of Egypt.

In most months, wind speeds of 4 knots or less occur between only 2.2 and 9% of the time. Winds of 7-10 knots is much more common and account for 33.2-44.3% of the observations (**Figure 11**). Occasional gals occur throughout the year with isolated instances of 28 to 33 knots being on record in spring.

Wind-driven dust and sand rising is more frequent during spring months, totaling 32 days per year (**Figure 12**). Dust or sand storms occur at a mean frequency of 6.4 days per year mostly during spring months. Gales with surface wind speed of 34 knots or more occur at a frequency of one day per year.

Kom Ombo is subject to wind blowing predominantly from north to south, throughout much of the year (**Figure 13**). **Error! Reference source not found.** shows the monthly wind roses of Kom Ombo. The figure shows that westerly winds prevail during December, January and, representing 40.1, 54.1 and 36.4 %of the wind during that period, respectively.

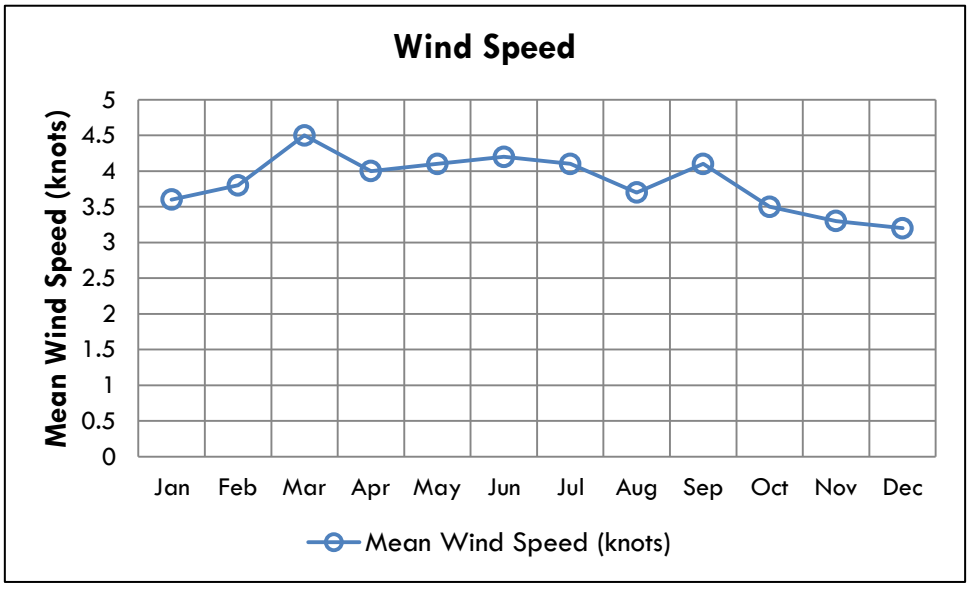

Figure 10: Monthly mean wind speed in Kom Ombo

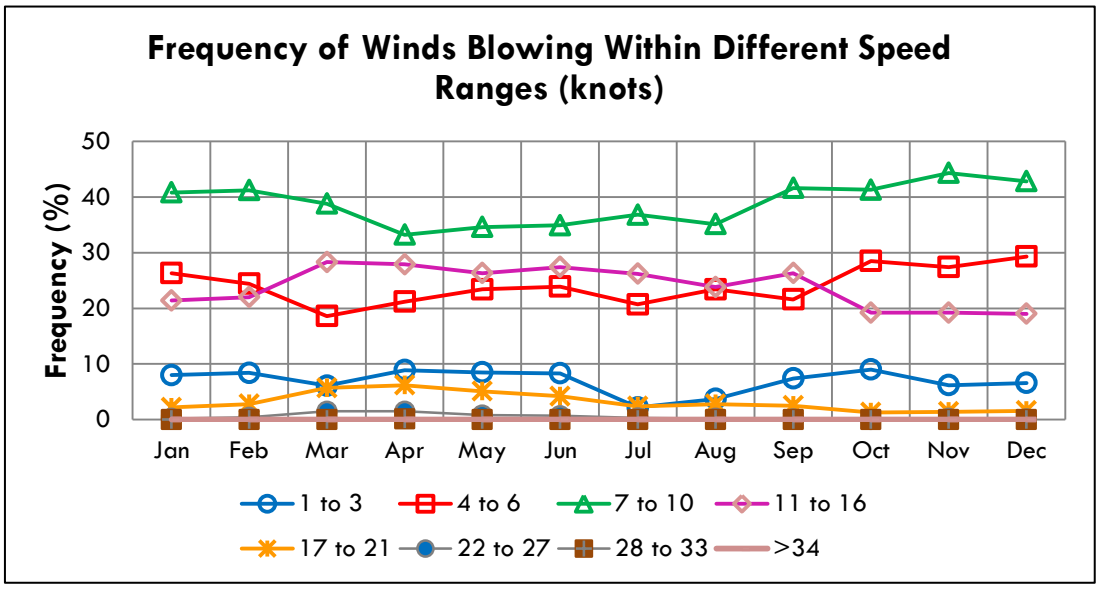

Figure 11: Frequency of occurrence of wind speeds ranges occurring in Kom Ombo

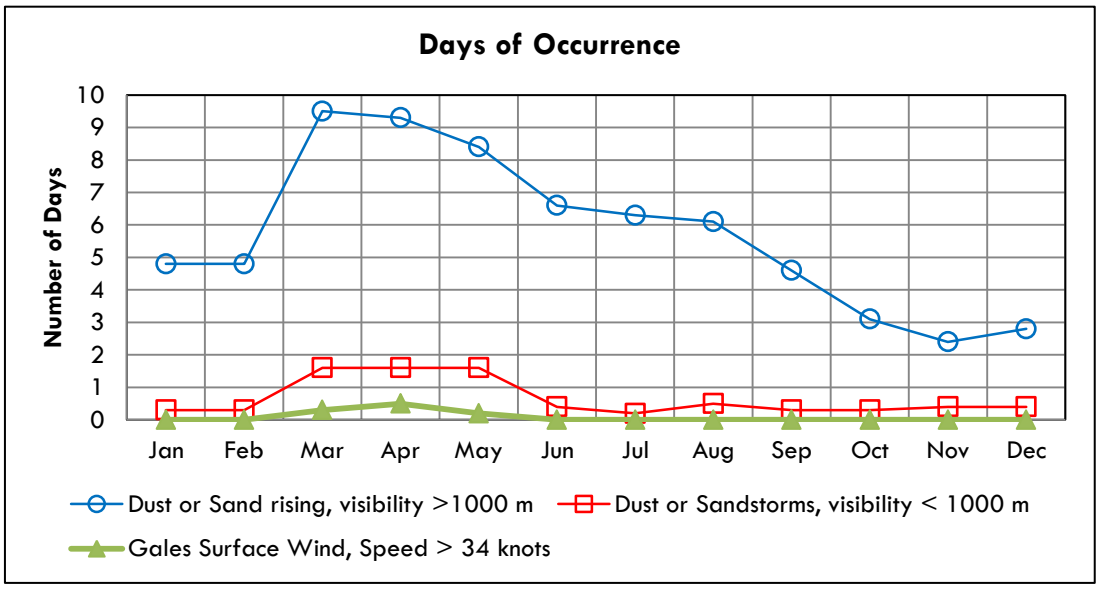

Figure 12: Monthly means of number of days of dust and sand rising affecting visibility in Kom Ombo

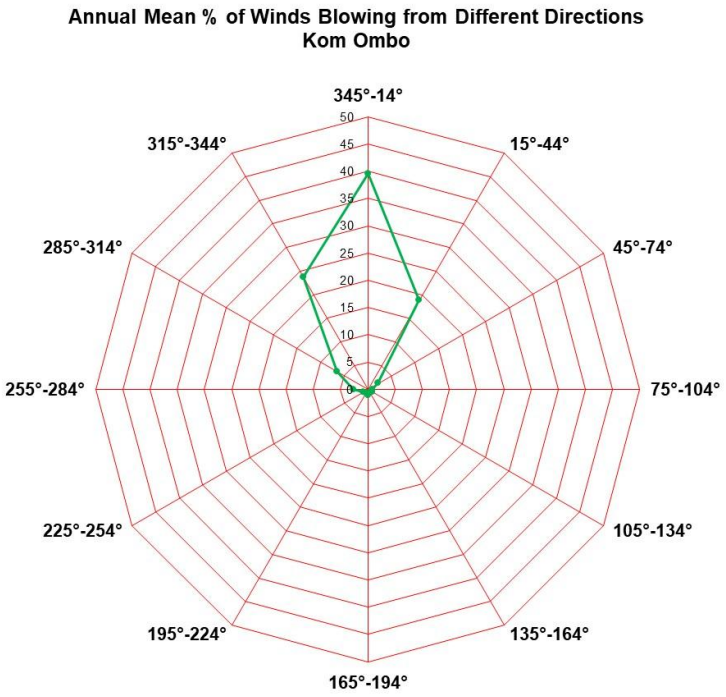

Figure 13: Annual Wind Rose of Kom Ombo

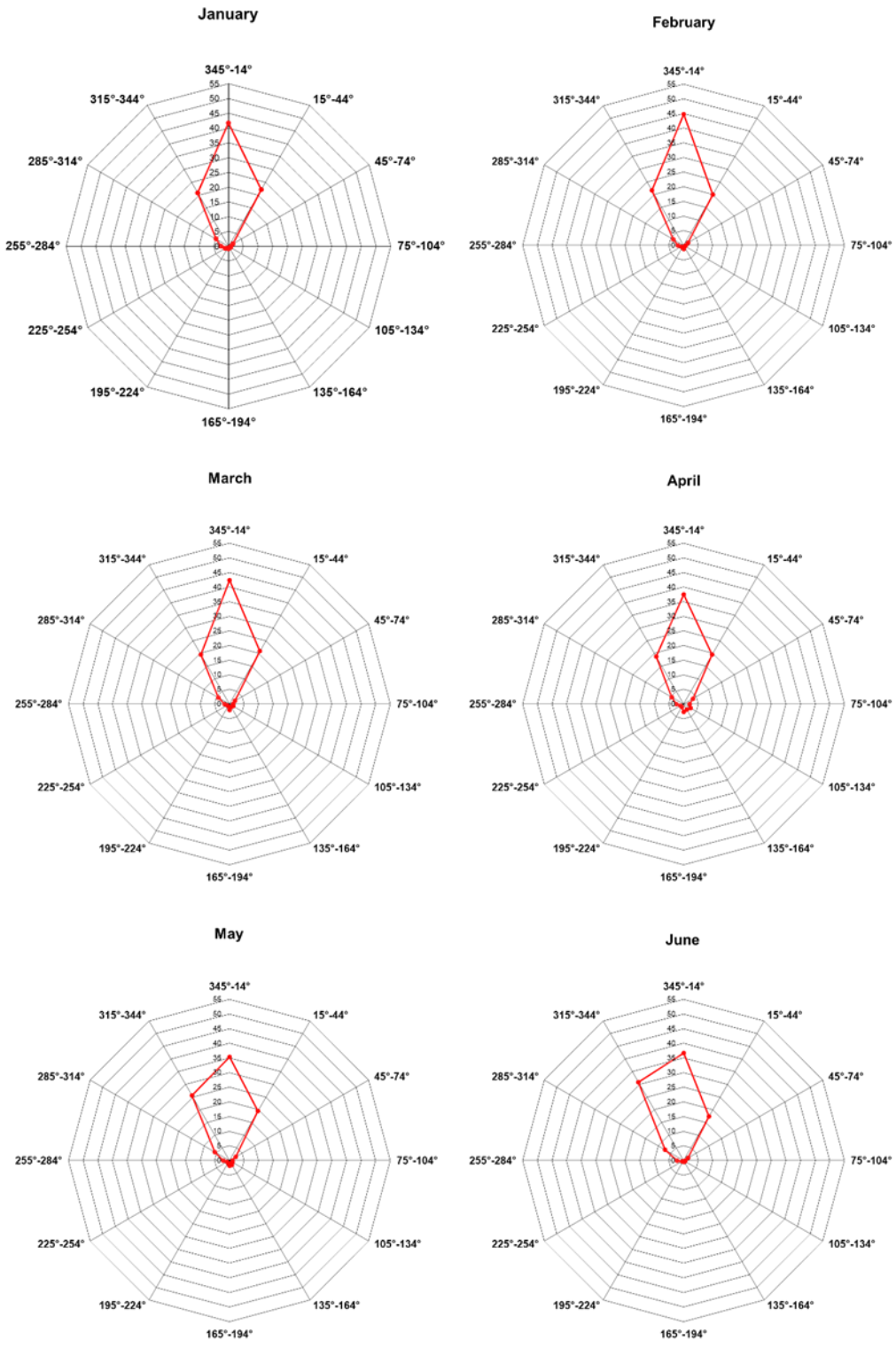

Figure 14: Monthly Wind Roses of Kom Ombo

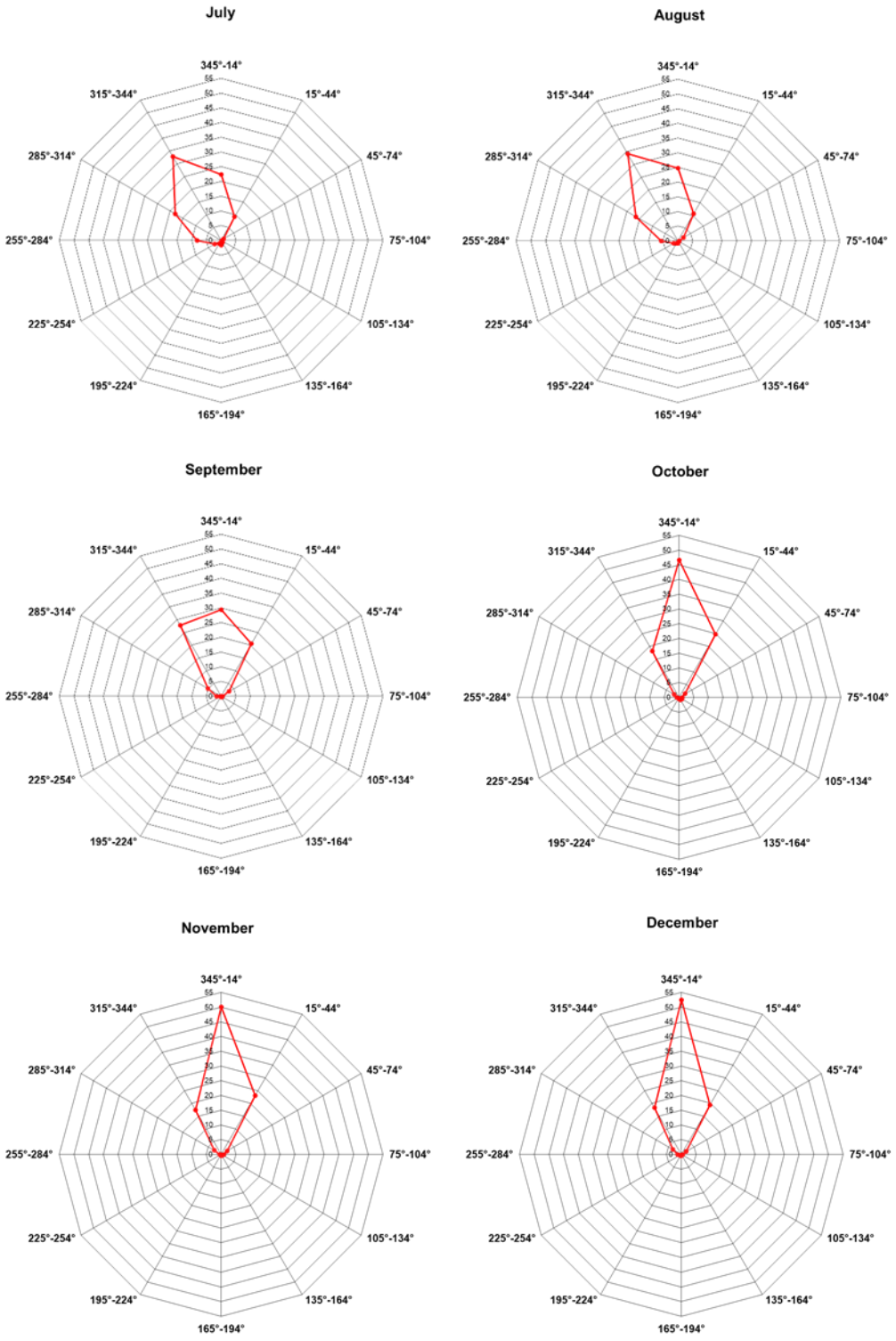

Figure 15: Monthly Wind Roses of Kom Ombo - Continued