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THE CLIMATE OF THE MALTESE ISLANDS

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ABSTRACT: This article discusses a number of climate variables as measured over the Maltese Islands. This climatic information covers ambient air temperature, precipitation, atmospheric pressure, relative humidity, thunderstorms, cloud cover, duration of bright sunshine, solar radiation and wind. The understanding of the climate norm of the Maltese Islands is essential in order to detect local trends and anomalies.

Keywords: Climate, Maltese Islands.

1 INTRODUCTION

This article describes the climate of the Maltese islands based on the regular and standardised observations at Malta's climate station (WMO No. 16597) situated at Luqa Airport and managed by the Malta Airport MetOffice.

Global meteorological observations carried out during the 30-year period of 1961-1990 constitute the climate baseline. This climate period was used by the IPCC in the development of the Kyoto Protocol and is commonly used as a standard period to allow comparisons between different data sets collected from all over the world. The World Meteorological Organisation (WMO) upholds the use of this period as a long-term reference value or "normal" against which shorter-term (e.g. monthly) data can be compared [1].

The following *surface* and *upper-air* climate variables are presented in this article:

- ambient air temperature
- precipitation
- atmospheric pressure
- relative humidity
- occurrence of thunder and hail
- cloud cover
- duration of bright sunshine
- winds and gales.

2 CLIMATE VARIABLES

2.1 Ambient Air Temperature

This variable is based on the following temperature observations: (1) the daily mean, (2) the daily maximum, (3) the night minimum, and (4) the grass-height minimum.

Table 1 provides summary statistics for the climatic *mean* temperature. Figure 1 shows a plot of the monthly mean maximum and minimum air temperature as observed at Luqa airport.

Table 1: Summary statistics for the mean temperature (^{o}C). Based on the 30-year climate period 1961 – 1990

Average	18.6
Standard deviation	0.4
Coeff. of variation	2.1%
Minimum	17.9
Maximum	19.7
Range	1.8

The overall variation in temperature is to a large extent due to the regional weather patterns in the Central Mediterranean, and the influence from the surrounding sea, which has a warming (cooling) influence in winter (summer).

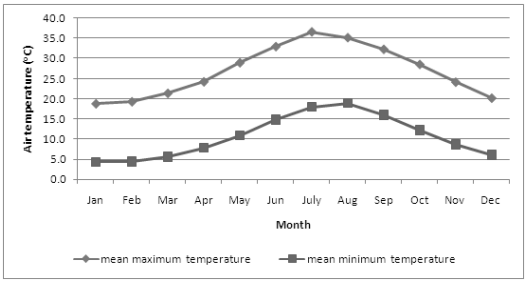

Figure 1: Monthly profiles of the mean *minimum* and *maximum* air temperature. Based on the 30-year climate period 1961-1990 (WMO Station: 16597)

With regard to extreme temperature events, data shows that while July shows the highest mean *maximum* temperature, the highest extreme temperature was registered on August 9th of 1999 with a temperature of 43.8 °C, making this the hottest day recorded in Malta since 1947. On average, the lowest winter temperatures occur in February. However, the lowest ever recorded temperature occurred on the 29th January 1981 when the minimum temperature fell to 1.4 °C.

The mean monthly temperature at grass-height follows the same pattern as that of the *minimum* air temperature. Since 1953, the lowest minimum grass-height temperature was recorded on February 4th, 1983 when the temperature dropped to -5.1 °C. Data collected since 1953 show that the average lowest grass temperature is -1.3 °C with a standard deviation of ±1.4 °C.

2.2 Precipitation

Local precipitation is in the form of rain, hail, dew and soft rime. Malta's climate has an average precipitation of the Maltese Islands is 553.1 mm with a standard deviation of 157.0 mm (table 2).

Table 2: Summary of Statistics for precipitation (mm). Based on a 30-year climate period 1961 – 1990

Average	553.1
Standard deviation	157.0
Coeff. of variation	28.4%
Minimum	274.2
Maximum	874.1
Range	599.9

The frequency of the total annual precipitation during 1961-1990 has a main distribution lying within the 400-800 mm range. During this period, the lowest total precipitation recorded was 274.2 mm (measured in 1961) while the highest total rainfall was 874.1 mm (measured in 1976).

With regards to the periodicity of the monthly precipitation, observations show that the annual pattern of rainy winters is followed by dry and generally rainless summers. In figure 2, the month with the highest precipitation is December, which accounts for 20.3% of the total annual precipitation. The summer period between June and August barely comprises 2% of the total rainfall. Conversely over half the total annual precipitation has been recorded between October and December.

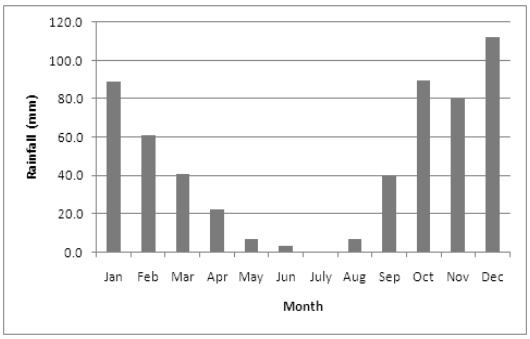

Figure 2: Monthly periodicity of the total annual precipitation (in mm). Based on the 30-year climate period 1961-1990

Moreover, climate data shows that the month of November gives the highest precipitation variability throughout the year, ranging from a minimum of 2.6 mm to a maximum of 297.0 mm.

Extreme precipitation events at Luqa Airport show that the driest year was 1947 with just a total of 228.4 mm of precipitation. Four years later, in 1951, a record maximum of 955.6 mm was registered at the same site. The highest precipitation ever recorded on a monthly basis over the Maltese Islands since 1922 was 476.5 mm registered in October 1951.

The total amount of precipitation recorded in 24 hours is a good indicator of the vigour and duration of storms. November shows the greatest variability, which is very often attributed to convective storms triggered by the movement of cooler air mass flowing over the still warmer central Mediterranean region.

2.3 Atmospheric Pressure

This section refers to the analysis of the surface air pressure which is measured or estimated at an elevation equal to mean sea level. An understanding of pressure is very important in the consideration of wind and storm patterns since variations in horizontal atmospheric pressure lead to the development of winds that play a significant role in shaping the local weather.

Figure 3 shows the mean monthly sea level pressure and its variability during the period 1961-1990. This data shows that the yearly mean sea level pressure over the Maltese Islands is 1016.5 hPa and ranges from 1014.9 hPa to 1018.3 hPa. During this period the highest variation is observed during January. The months of June, July and August show very similar averages and variability in the sea level pressure, which is related to the stable weather conditions during the summer months. The lowest air pressure values are observed during March and December, while the highest value of 1029.1 hPa is reached during January.

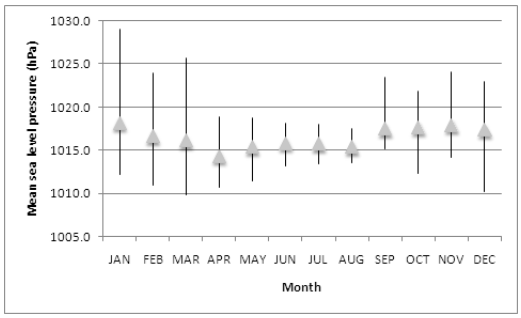

Figure 3: Monthly means and variability of the sea level pressure (in hPa). Based on the 30-year climate period 1961-1990

2.4 Relative Humidity

Air humidity is a good indication of how much the atmosphere is close to saturation by water vapour. This information can anticipate, as well as explain the formation of clouds and fog.

Observations show that the mean relative humidity varies from a minimum of 61% in July to a maximum of 87% in January. The transition between July and August shows the highest gradient in both the mean and maximum relative humidity. The highest monthly variability occurs during the months of January and June.

Ancillary observations indicate that during the summer season the degree of physiological stress caused by heat seems to be more dependent on the temperature rather than on humidity, which has the lowest percentage value during the summer period. On the contrary, humidity seems to play a greater role in weather discomfort during the cold winter months.

Records from the Malta Airport MetOffice show that the extreme monthly values of relative humidity occurred in December 1993 and June 2006, when the mean monthly values were 89% and 54% respectively.

2.5 Thunderstorm and Hail

Thunderstorms are storms produced by the formation of convective, turbulent clouds that are often accompanied by lightning and thunder. Over the Maltese islands, they are usually of short duration but are able to produce strong wind gusts and heavy rainfall, and which may be accompanied by hail.

In this analysis, a day with thunderstorm refers to one during which thunder has been heard at Luqa Airport. Figure 4 shows that during the period 1961-1990, the month with the highest mean number of thunderstorm days is October (5.6 days), compared to lowest value in July (0.2 days). On average there are 29.3 days with thunderstorms spread out throughout the year.

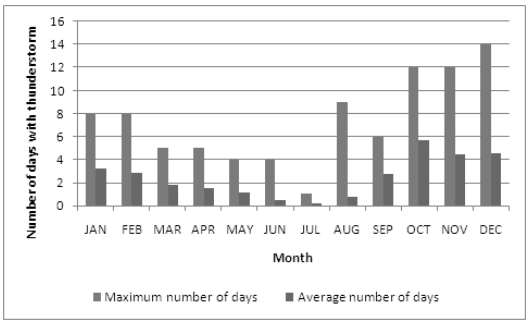

Figure 4: Monthly average and maximum number of days with thunderstorms. Based on the 30-year climate period 1961-1990

In thunderstorm clouds, accretion processes lead to the formation of hail. Over Luqa Airport, the yearly average number of days with hail is 6.3 days. During the period 1961-1990, December exhibits the highest mean number of days with hail (1.4 days), whilst no days with hail have been registered from June till August.

Annual extremes range from just 2 days with hail in 1977 to a maximum of 15 in 2005.

2.6 Cloud Cover

The term 'cloud cover' refers to the amount of sky covered by specific cloud layers. Cloud cover is recorded in line with the WMO-approved standard practice of dividing the full sky hemisphere into eight virtual sectors. Cloud coverage is observed and reported by trained meteorological observers at the Malta Airport MetOffice.

The monthly trend in cloud cover during the 30-year climate period of 1961-1990 is shown in figure 5. The pattern shows a decrease from a maximum in January to a minimum in July, which increases again towards December.

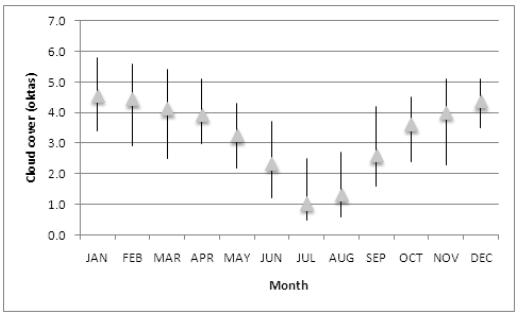

Figure 5: Monthly means and variability of the cloud cover. Based on the 30-year climate period 1961-1990

2.7 Total duration of bright sunshine

The Malta Airport MetOffice measures the number of hours with bright sunshine using a Campbell-Stokes recorder.

The climate norm for this variable shows that

much of the variability occurrs during August, possibly due to the local weather transition that starts to occur during this month (figure 6).

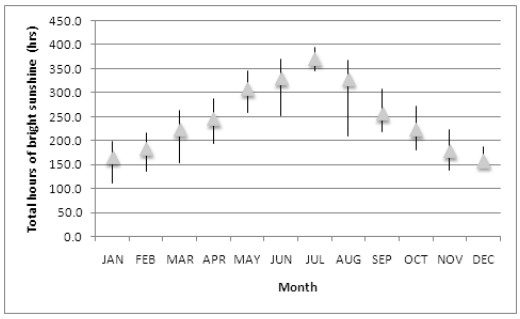

Figure 6: Monthly means and variability of the total hours of bright sunshine (in hours). Based on the period 1995-2008

Local knowledge of the climatic solar radiation values over the Maltese islands is strategically important. The most important climate variable to understand the availability of solar energy is the mean daily global solar radiation; however, local measurements of this variable during the 30-year climate period are not available at Malta Airport MetOffice. This situation can be circumvented using correlations which estimates solar radiation from the available parameter of monthly mean duration of bright sunshine hours. Applying McCulloch's relationship to measure the local solar radiation falling on a horizontal surface [2], for example, provides an approximate local climate maximum of 8.1 kWh/m^2/day during July and a minimum of 2.3 kWh/ m^2/day during December. Figure 7 shows a plot between the climatic ratio of monthly mean daily solar global radiation, H_1 and the monthly mean extrasolar radiation, H_o, with month, based on the McCulloch regression.

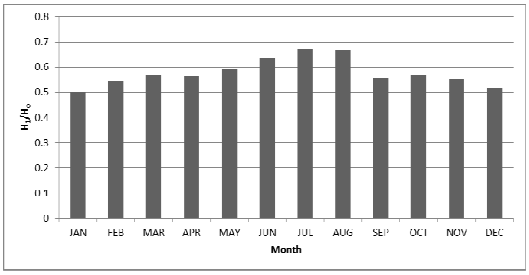

Figure 7: Ratio of the monthly mean daily solar global radiation, H_1 and the monthly mean extrasolar radiation, H_o, versus month. Based on the 30-year climate period 1961-1990

2.8 Surface wind speed and direction

Surface wind speed and direction during the 30-year period are based on measurements using cup anemometers and wind vanes. Observations show that the mean annual wind speed during the period 1961-1990 is 8.8 knots or 16.3 km/hr (figure 8). However, data shows considerable variation in the monthly averages, where January gives both the highest mean monthly wind speed of 14.1 knots, or 26.1 km/hr, as well as the highest variability.

During 1965 a record yearly average wind speed of 10.3 knots (or 19.1 km/hr) was registered at Luqa Airport. On the other end, the lowest yearly average wind speed was recorded in 2003 that measured 7.1 knots (13.2 km/hr).

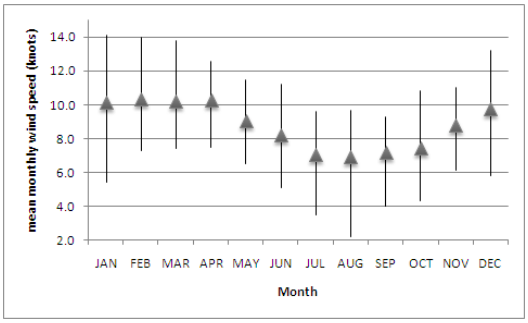

Figure 8: Monthly means and variability of the wind speed. Based on the 30-year climate period 1961-1990

As to the incidence of peak gusts during the 30-year climate period, January shows the highest average wind gust with a speed of 47 knots (87 km/hr). The highest variability in wind gusts at Luqa Airport occurs during October, ranging from 24 knots (or 44.5 km/hr) up to 72 knots (or 133.4 km/hr).

Figure 9 shows the occurrence of gale events reaching Beaufort scale Force 8 or more (a scale that is equivalent to 34 to 40 knots or 62 to 74 km/hr). During the climate period 1961-1990 the highest wind gust to be registered at Luqa Airport occurred on October 11, 1982. On this day gale force winds from the northwest reached a speed of 72 knots (133.4 km/hr). Malta's climatology shows that both March and December have the highest frequency of gale force winds with a total of 14 days, while the lowest frequency occurs during the summer month of July, with a total of 3 days.

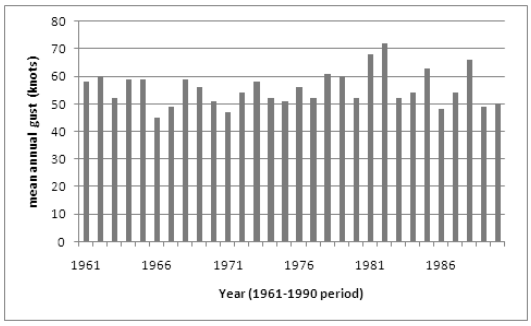

Figure 9: Mean annual wind gusts (in knots). Based on the 30-year climate period 1961-1990

Since 1961, there were two years – 1962 and 1978 – with a record total of 68 days when wind gusts exceeded 34 knots (63 km/hr). During 2002 a total of just 5 days with gale force winds were recorded.

The most common wind direction is the North-westerly which blows on an average of 20.7% days in a year. Next in frequency is the wind blowing from the West followed by winds blowing from West Southwest (8.9%), the South Southwest (7.8%) and North Northwest (7.4%). The other wind directions show no dominance. The North wind constitutes around 3% of the total days, making it the least dominant wind over the Maltese islands.

3 CONCLUSION

This article describes the climate of the Maltese islands based on observations made during the standard 30-year period of 1961-1990. A more lengthy assessment of the Maltese climate, trends and anomalies during the period 1951-2010, has been published by the National Statistics Office [3].

4 ACKNOWLEDGEMENTS

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5 REFERENCES

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