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Solar measurements in the Maldives

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# Introduction

When doing a data exploration it is somewhat important to enjoy the data you are exploring. In this project we are given the liberty to choose a dataset from:

* United Nations datasets
* South African open data
* World bank data

The data set I chose was from the world bank data called Solar Measurements Maldives Malé WB ESMAP Satellite TS (Schnierer, 2017). It basically describes the data collected from the Maldives with respect to the solar radiation that the Hulhule airport experiences every hour since 1999 to 2018. Data calculated from Meteorsat MSG IODC and Meteosat MFG IODC satellite data ((c) 2018 EUMETSAT) and from atmospheric data ((c) 2018 ECMWF, NOAA and NASA) by Solargis method (solargis.com/, 2018). The data collected from the place has these parameters, define in the Index: 'Date', 'Time', 'GHI', 'DNI', 'DIF', 'GTI', 'flagR', 'SE', 'SA', 'TEMP', 'WS', 'WD', 'RH', 'AP', 'PWAT' . These parameters work as columns to define our data.

The date column was not in the correct type so I had to change it into a datetime type so that I could use the information in that column well. After some preliminary inspection I chose to separate the date into year, month and day columns so that there could be a better way to work with the data, or rather more efficiently. The data did not have any missing values.

# DATA CLEANING

There was no data cleaning necessary.

# MISSING DATA

They described the missing values to be at -9 but after checking using some code I wrote it showed a 0 % data loss in all the columns which is quite fantastic because there is nothing more daunting than having to decide what to do with missing data. It usually means having to either impute values or having to get rid of rows or columns.

# DATA STORIES AND VISUALIZATIONS

## Preliminary Inspections

Background pattern

Description automatically generatedJumping into a data set is weird because you don’t know what type of information you are going to get unless you have the specific data gathered to prove a hypothesis or show hyper specific information and other uses of specific data. My first thought when exploring this data was to see how the year, months, days and time of day were affected by these different values. So I made heat maps to describe the distribution of information on the data. They were grouped by the parameters I listed before and they showed some interesting information.

The figure on the left describes the heatmap of the basic statistics for the temperature of the year. The mean temperature seems to fluctuate between 27.5 and 28.5. It seems to have been more hot at the beginning of the measurements and stay consistent around those temperatures till 2018. The height of the heat, though seems to also fluctuate during the years but between 29 and 30 degrees Celsius. This is a fascinating piece of information I wonder what affects the temperature. The graph below corroborates the Chart

Description automatically generated with medium confidenceanalysis.

For the Months of the year it seems that the average temperature peaks around April and doesn’t show an average below 27 degrees Celsius for the entire year. This makes the Maldives a very temperate area. On average when visiting one could get a very hot day and in April on average they could be very warm. The maximum temperature per month is also quite annoyingly close with lower maximum temperatures at the beginning and the end of our survey’s measurements. The minimum temperatures were as low as the 25 degrees Celsius In the months this also being the case at the beginning of the measurements. It is quite a fascinating distribution.

Shape, background pattern

Description automatically generated

Background pattern

Description automatically generatedChart, line chart

Description automatically generatedFor the days of the month it is quite a normal distribution of temperatures. The mean temperatures per month are so close with a slight change per day where the beginning of the month is moderately colder than when the month ends. It’s as though the peaks on the fifth day of the month and then does a steady decline until the 13 where it then stays the same till month ends. The max heat on average is about the between the 13th to the 17th . This is an interesting take. The distribution of minimum temperatures has a greater range than the other values, this make things more exciting. The height of the lowest temperature seems to be the day before the highest maximum of the temperatures. This makes it seem like during the beginning of the month is the hottest time in that area.

Chart, line chart

Description automatically generated

For the times in the day, it follows a pretty uninteresting normal distribution, where heat peaks around noon and dips around the morning. It is the same everywhere in the world.

Background pattern

Description automatically generated with medium confidence

Based on the analysis the best time to visit the Maldives for a warm day would be in August to September at the beginning of the month!

## A picture containing shape Description automatically generated

# What affects temperature ?

With a basic understanding of physics we know that temperature is affected by that pressure and volume of certain gasses. I expect atmospheric temperature is affected by the Irradiation and atmospheric pressure and wind speed and humidity so maybe we find that out.

## GHI - Global horizontal irradiation [Wh/m2]

The effect of irradiation is obvious. Irradiation is the process or fact of irradiating or being irradiated.

Chart

Description automatically generatedThe sun irradiates the earth at every moment in time and this affects the temperature of the earth. The greater the amount irradiation, the greater the temperature. The graph is also erratic and looks like a cardiograph but has an increasing shape as the temperature increases. It is weird though that the peak irradiation shows a low temperature though.

I was also curious how the values are distributed via the year, month, day, time of the day but some of them are more awkwardly visualized. You cannot really see much but it is very normal.

A screenshot of a video game

Description automatically generated with medium confidence

## A screenshot of a computer Description automatically generated with low confidenceA picture containing text Description automatically generatedA screenshot of a computer Description automatically generated with low confidence

## Chart, line chart Description automatically generatedAP - Atmospheric pressure [hPa]

As we can see, based on the graph we have below the atmospheric pressure increases as the temperature decreases. The graph is more erratic because it looks like a cardiograph, with the values decreasing in small ways.

## WS - Wind speed at 10 m [m/s]

Chart, line chart

Description automatically generated

The windspeed affects the temperature in almost a linear way. As the wind speed rises it seems that the temperature also rises, which is fascinating. But the temperature becomes erattic as we reach greater wind speeds. It is quite inconsistent but rather interesting data.

## RH - Relative humidity [%]

The relative humidity seems to follow a more interesting path than the other graphs. As the relative humidity progresses the temperature seems to look like a cardiograph arch that peaks at lower humidity values and seems to decrease more generally as the humidity rises. This is a fascinating graph of temperature to relative humidity.

Chart

Description automatically generated with medium confidence

# Conclusion

There is a lot more information to glean from this data set but from what we learnt so far we know what to expect from Malé. If there is information on the wind speed, humidity, atmospheric pressure and global horizon irradiation we can approximate the temperature for that day. We also know when to go to the Maldives for any temperature we want. We also know that the area we have the data set on, Malé is always a warm and temperate place, year-round.

# Bibliography

(2018, 05 29). Retrieved from solargis.com/.

Schnierer, B. (2017, April 13). *Maldives - Solar Radiation Measurement Data*. Retrieved from https://datacatalog.worldbank.org/dataset/maldives-solar-radiation-measurement-data.

Wikipedia. (n.d.). *Malé*. Retrieved from https://en.wikipedia.org/wiki/Mal%C3%A9.

# Index A

HOURLY VALUES OF SOLAR RADIATION AND METEOROLOGICAL PARAMETERS

Customer name: ESMAP

Issued: 2018-05-29 14:20

Site name: Hulhule, Airport, Male, Maldives (MV)

Latitude: 4.192733

Longitude: 73.528000

Elevation: 2.0 m a.s.l.

http://solargis.info/imaps/#tl=Google:satellite&loc=4.192733,73.528000&z=14

Output from the climate database Solargis v2.1.19, adapted

## Solar radiation data

Description: data calculated from Meteosat MSG IODC and Meteosat MFG IODC satellite data ((c) 2018 EUMETSAT) and from atmospheric data ((c) 2018 ECMWF, NOAA and NASA) by Solargis method

Summarization type: hourly

Summarization period: 01/01/1999 - 30/04/2018

Spatial resolution: 250 m

## Meteorological data

Description: spatially disaggregated from CFSR, CFSv2 and GFS ((c) 2018 NOAA) and MERRA2 ((c) 2018 NASA) by Solargis method

Summarization type: hourly

Summarization period: 01/01/1999 - 30/04/2018

Spatial resolution: temperature 1 km, other meteorological parameters 33 km to 55 km

Service provider: Solargis s.r.o., M. Marecka 3, Bratislava, Slovakia

Company ID: 45 354 766, VAT Number: SK2022962766

Registration: Business register, District Court Bratislava I, Section Sro, File 62765/B

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## Disclaimer:

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Columns:

* Date - Date of measurement, format DD.MM.YYYY
* Time - Time of measurement, time reference UTC+0, time step 60 min, time format HH:MM, center of the averaging interval
* GHI - Global horizontal irradiation [Wh/m2], no data value -9
* DNI - Direct normal irradiation [Wh/m2], no data value -9
* DIF - Diffuse horizontal irradiation [Wh/m2], no data value -9
* GTI - Global tilted irradiation [Wh/m2] (fixed inclination: 6 deg. azimuth: 180 deg., rel. row spacing: 2.6), no data value -9
* flagR - Cloud identification quality flag: 0: sun below horizon, 1: model value, 2: interpolated <=1hour, 3: extrapolated <=1hour, 4: interpolated/extrapolated >1hour, 5: long term monthly median or persistence, 6: synthetic data, 11:NWP forecast
* SE - Sun altitude (elevation) angle [deg.]
* SA - Sun azimuth angle [deg.]
* TEMP - Air temperature at 2 m [deg. C]
* WS - Wind speed at 10 m [m/s]
* WD - Wind direction at 10 m [deg.]
* RH - Relative humidity [%]
* AP - Atmospheric pressure [hPa]
* PWAT - Precipitable water [kg/m2], no data value -99