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Comparative study of meteorological data analysis tools based on Sousse climate

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Abstract

Due to lack of meteorological data of several locations, so designers select a Typical Year Weather data which is close to study location. But this method gives incorrect prediction of climatic design condition because; it not represents accurate weather of this location and not take account of climatic change. This paper aims in first step to evaluate conversion method of Real Time weather data using Ecotect Weather Manager. And in second step to evaluate efficiency of meteorological data analysis tools such as: Revit, Ecotect, GBS. For this study we opt for Sousse city location. The results for climatic design conditions show a great correlation between Revit and GBS tools but a difference in the results concerning Ecotect weather tool especially for distribution of wind frequency were also identified. Moreover, interaction of weather parameters is used to identify bioclimatic passive design strategies for sustainable construction.

Keywords: *Conversion; Passive design strategies; Meteorological data; Ecotect weather manager; Csv (Comma Separated Variable); Wea format*

Introduction

Climate is the first thing that architects and engineers should consider when designing a building. It dictates what passive design strategies are most suitable for the building site. They are two kinds of meteorological weather data: Real Time Weather Data and Typical Weather Data. The first one provides information of hourly weather data from stations across the world such as dry bulb temperature, dew point temperature, wind speed/direction, atmospheric pressure, visibility, cloud conditions, and precipitation type. But the second is derived from more than 10 year recorded meteorological data. It doesn't take account of climatic change. Pernigotto [1] specifies three kinds of data for dynamic simulation [2]:multi-year weather data; typical or reference years; representative days. Due to lack of meteorological data of several locations like Sousse city, so designer adopts available Typical Year Weather data which are close to his study location. Real Time weather data can give accurate climatic information for a specific location. This paper aims to evaluate a conversion method in order to convert Real Time Weather data in CSV weather file from Green Building Studio (GBS) to WEA format using Ecotect Weather Manager. This conversion allows us to meteorological data analysis using ECOTECT Weather tool. This method allows us to use WEA format which is legible with ECOTECT Weather tool. After that we can able to compare meteorological data analyses which are based on several tools as: Revit, Ecotect, GBS. Our comparison is based on hourly simulation of dry bulb temperature, percentage relative humidity and wind speed. Finally, we will identify passive design actions which represent climate responsive of Sousse region.

Study model

Sousse city is located exactly at 10.59°east longitude, 35.85°north latitude and an altitude of about 30 m above the sea level according internet mapping service from REVIT. Like seen above, weather data of Monastir is not accurate and it has missing data. So the weather data of closest station which is presented by 9km away of our study site such as 157077 from REVIT and GBS06M12-02-149005 from GBS is adopted. Regarding, REVIT, our study location is close 157077 station. This station is situated in **10° 59'** east longitude, **35° 85'** north. Then, Actual Year in CSV weather file is put into WEATHER MANAGER to convert it on WEA format which is legible with ECOTECT software.

Reference tools description

Green building studio GBS)

GBS can display all meteorological data analysis results of any location on one interface. According to GBS our study

site is located in 10° 59’ latitude; 35° 85’ longitude and altitude 30m. Station reference is GBS06M12-02-149005.

View of map localization for Sousse city close to Sousse medina using GBS (10° 59’ latitude and 35° 85’ longitude)

Revit

Ancient Sousse Medina has the same location as GBS. According to selected location Revit Manage coordinates with external database of 4400+ World Meteorological Organization (WMO) weather stations derived from the 2005 ASHRAE Handbook of Fundamentals [8]. Revit is a new tool for meteorological data analysis. It is able like GBS to expose all meteorological data analysis results of any location on one interface

Ecotect

ECOTECT, is a specialized tool for Meteorological data and environmental analysis with a highly visual and interactive display. Energy plus website source presents only TUN.IWEC station for Tunisia country. But it presents missing data on Real-Time Weather Data for Habib Bourguiba International station which corresponds to Monastir station. Moreover, lack of data concerning Sousse city.

Table 1 Sousse city based on different reference tool Conversion method

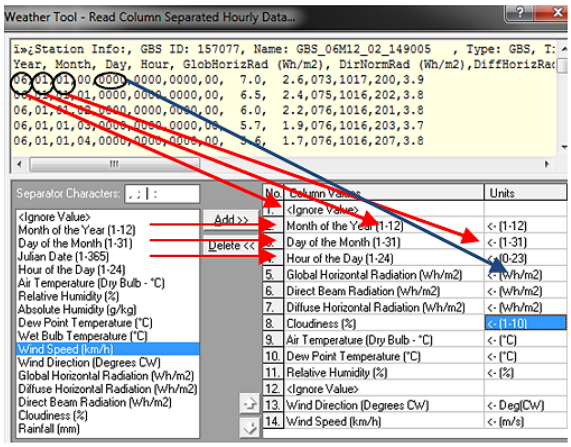
Reference source/format	Recorded period	Latitude N°	Longitude E°	Elevation	Distance to study localization
GBS Weather data.csv	2006	35.83	10.53	30m	6.18 km
Revit (WMO station)	-	35° 85’	10° 59’	30m	9km
Ecotect (EnergyPlus Weather data.wea)	Real time weather data 2002-2004	35° 45’	10° 45’	25m	20km

We assign the following step and finally we validated conversion results. First, we open the ECOTECT WEATHER MANAGER. Second, we open the GBS.CSV file for our location and we specify ‘Separated Value Files’ concerning file type. Third operation consists to provide a translation for this file. The WEATHER MANGER dialog box emphasizes a necessity to add from left column each weather parameters that correspond respectively to the following parameters:

Year
Month (1-12)
Day (1-31)
Hour (0-23)
GlobHorizRad(Wh/m2)
DirNormRad (Wh/m2)
DiffHorizRad (Wh/m2)
TotalSkyCover (tenths covered)
DryBulbTemp (deg C)
DewPointTemp (deg C)
RelHumidty (%)
Pressure (mb)
WindDir (degrees)
WindSpeed (m/s)

Fourth, import File to load this data into the Weather Tool. Further that user need to add precipitation data on the ‘Monthly Data’ panel selector concerning rainfall. Then, import file into Ecotect Weather Tool. The last operation consist to add a location: Fill in the Location Data Fields latitude, longitude, altitude and time zone. And finally save as weather data file on WEA format.

The figure 3 exposes temperatures from 10:00 hours to 20:00 hours on CSV (comma. delimited) file download from GBS and related to Sousse city. These data are similar to output conversion data taken from ECOTECT WEATHER tool as displayed in figure 5. Then, we can validate conversion operation from GBS to ECOTECT WEATHER tool that corresponds to Sousse region weather data. In the next parts, these data will be used for meteorological data comparison which corresponds to Ecotect weather data analysis results in format WEA format.



Dialog box Weather Tool- Read Column Seperated Hourly Data

06,07,21	10,0699,0742,0091,00,	30.1,	11.8,031,1013,347,2.5
06,07,21	11,0810,0786,0092,00,	31.4,	12.0,029,1013,004,2.7
06,07,21	12,0865,0805,0093,00,	32.3,	12.8,029,1013,021,2.7
06,07,21	13,0859,0803,0092,00,	33.0,	15.5,034,1013,047,2.9
06,07,21	14,0793,0779,0092,00,	33.3,	15.7,033,1013,067,3.7
06,07,21	15,0672,0731,0091,00,	33.1,	15.4,033,1013,071,4.3
06,07,21	16,0509,0647,0087,00,	32.5,	14.7,033,1013,068,5.2
06,07,21	17,0324,0511,0080,00,	31.8,	13.8,032,1012,069,5.5
06,07,21	18,0147,0298,0062,00,	30.8,	14.2,035,1012,071,5.2
06,07,21	19,0032,0008,0023,00,	29.3,	16.1,044,1012,071,4.2
06,07,21	20,0000,0000,0000,00,	27.7,	18.2,055,1012,073,3.3

CSV (comma. delimited) file download from GBS related to Medina Sousse city

Hour	00:00	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00
Temp	22.8	22.2	21.6	21.1	20.6	20.2	20.3	24.4	26.8	28.5	30.1	31.4	32.3	33.0	33.3	33.1	32.5	31.8	30.8	29.3	27.7

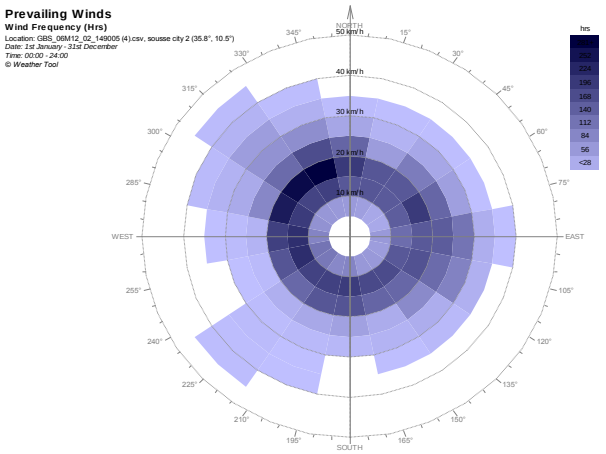
Outpout file from Weather tool Ecotect that correspond to input .CSV file

Result for climatic data analysis

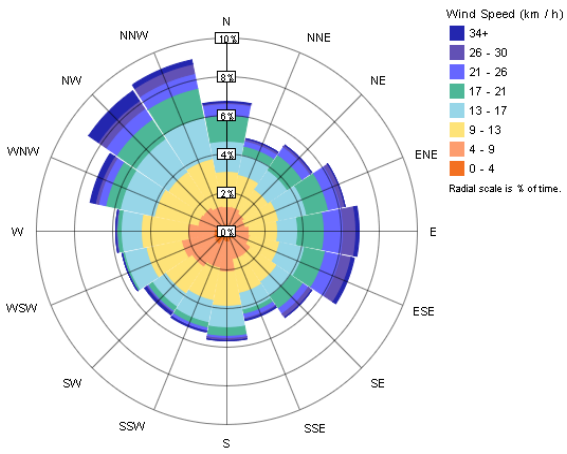
Our location is limited in Sousse city of Tunisia. Data is put into Weather Tool of ECOTECT which could automatically output the analysis results of GBS ID157077. As seen above, there are several softwares which are able to analysis weather data related to study location as Revit, Ecotect, GBS.

Wind

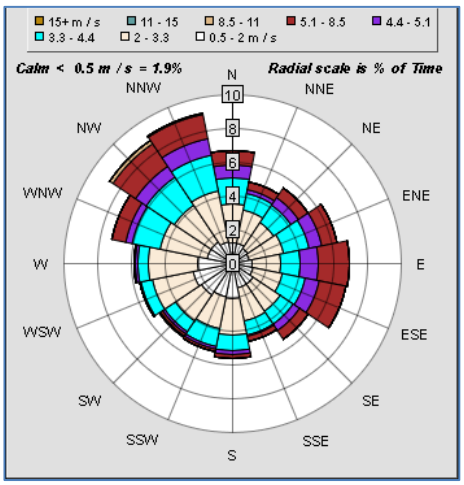
Figure 6 from REVIT displays annual winds speed as a function of time percentage in radical scale for Sousse location. As well as, figure 5 from ECOTECT WEATHER tool shows an annual frequency and the speed of prevailing winds. Interpolated results correspond to last figures show that REVIT and ECOTECT WEATHER tool has almost the same finding results as displayed in figure (IV-18, IV-6, and IV-7).



Prevailing annual wind speed using Ecotect Weather Tool



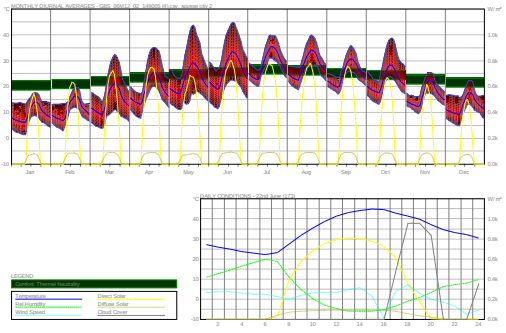
Revit chart annual wind rose



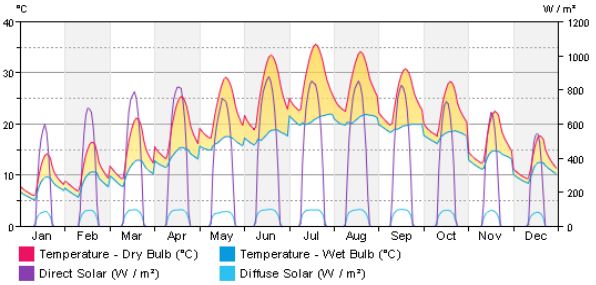
GBS chart annual wind rose

Temperature

Temperature data can be represented in a various way. According to Ecotect Weather tool analysis for Sousse weather data, fig 8 displays a maximal dry bulb temperature is 45°C on 15 June. Minimal temperature is 1.4°C exhibits on 7 January. By against, according to Revit tool a maximal dry bulb temperature is 36°C on 15 July and a minimal temperature is 5°C on 8 January as displayed in figure 9.



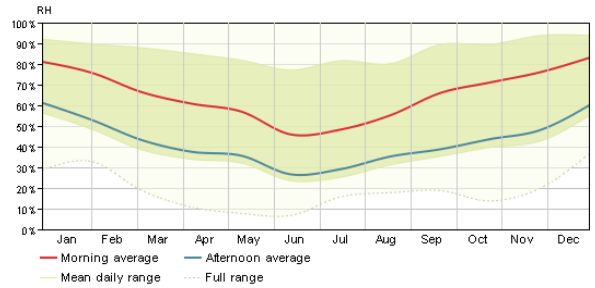
Monthly Diurnal Averages using Ecotect Weather tool



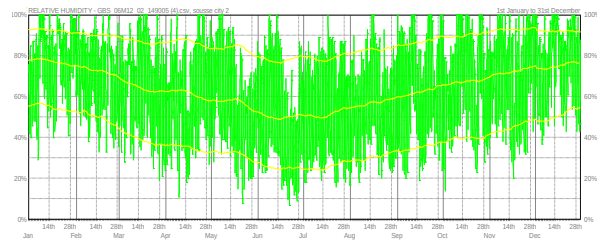
Monthly Diurnual Averages using Revit weather data analysis

Humidity

Using Revit for weather data analysis displays a minimum relative humidity (RH) 28% in June and 93% of maximal RH on December in figure 10. By against, Ecotect Weather tool exhibits 25% of minimal RH in July and it show 93% of a maximum RH on January in figure 11.



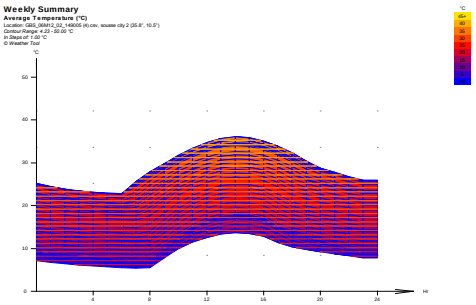
Monthly relative humidity using Revit weather data analysis



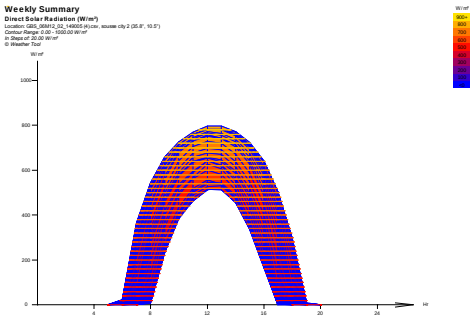
Monthly relative humidity using Eotect weather tool

Weather parameters interaction

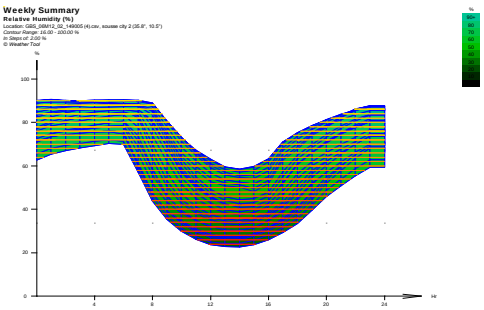
Many types of weather data are very dynamic, varying not just seasonally but daily and hourly. Figure12 shows that a maximal dry bulb temperature occurs between 12am hour and 2pm hour in summer period. The time lag of 2hours occurs after the sun reaches its maximum altitude at 12 noon ("fig13") and when the absolute solar radiation intensity is maximal. Figure 12 displays the lowest temperatures are appear before sunrise. Figure 14 exhibits that lowest RH% correspond to maximal dry bulb temperature and solar radiation. Figure 15 and 17 exhibit a maximal dry bulb temperature and stronger wind occurs in summer period (24 to 32 weeks). Figure 16 displays a trend towards stronger winds during 16h-18h in summer. Then, Sousse location is suitable for a night-purge ventilation system. According prior figure 5, a quick wind located in North-West direction is beneficial for night-purge ventilation system and natural ventilation. By consequent, designer needs to exploit the previous direction for passive design strategy.



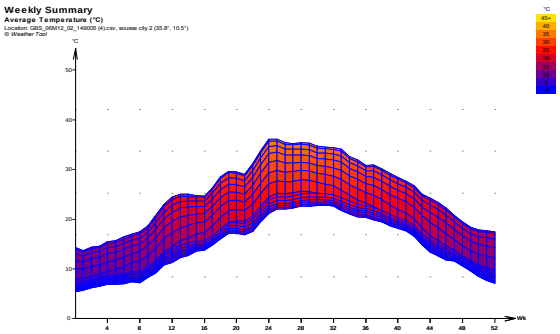
Avearage weekly dry bulb temperature (maxT°, 12h-16h)



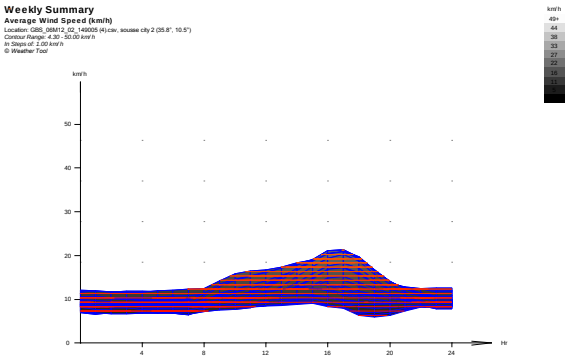
Avearage weekly direct solar radiation (max solar radiation at 12h)



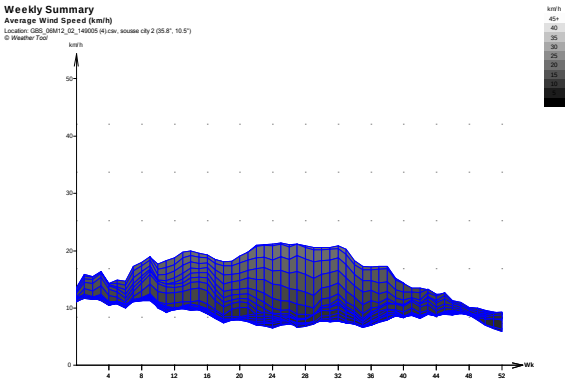
Average weekly relative humidity in summer (maxRH%, 12h-16h)



Avearage weekly dry bulb temperature (max on 24 to32 weeks)



Average Weekly wind speed (max 16h-18h)



Average Weekly wind speed (max max on 24 to32 weeks)

Conclusion

There are several tools allow to analyse weather data but the designer need to identify input data and location before analysis weather data. Like shown previsiouly GBS and Revit software have a same results for meteorological data analysis. Ecotect have almost the same RH percentage as REVIT. By against, Revit predict incorrect prediction of dry bulb temperature compared to Ecotect Weather tool.

Interpolated results from wind speed figures show that REVIT and ECOTECT WEATHER tool has almost the same finding results. We can resume that Sousse region has a typical hot and dry summer moreover mild and wet winter climate. Meteorological weather data analysis shows that a passive strategy as thermal mass, purge ventilation and envelope insulation are suitable for Sousse climate.

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