École Polytechnique de Tunisie

Data Science Project Report

The Impact of the global warming in the south of Tunisia by the end of 2030

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Table des matières

Introduction

Climate change deals with the global phenomenon of climate transformation that significantly impacts the earth's usual climatic conditions (temperature, precipitation, wind, etc.). They are mainly caused due to human-made activities. Still, many people were unaware of the actual impacts of climate change, and they greatly enhance its risk through their day to day activities.

The major source of climate change is global warming, which is primarily caused by the greenhouse effect. The emission of greenhouse gases from everyday human activities results in an unprecedented rise in earth temperature, and it is predicted to nurture even more in the future if left unaddressed. Rapid urbanization and industrial revolution are the other main causes that lead to the risk of climate change with increased energy demand and production, especially in the form of fossil fuels.

The growing risk of climate change has a disastrous impact on earth organisms, including human beings and earth's flora and fauna. It further leads to the destruction of the food chain and economic resources. The impacts will be more crucial in developing and under-developed countries in comparison to the developed countries.

While there exist possible literature to adapt to mitigate the impacts of climate change, these may become ineffective and obsolete over time as the severity may increase. Hence finding more advanced ways to predict, analyze, monitor, and mitigate climate change impacts has become crucially unavoidable.

Artificial Intelligence (AI) is a disruptive paradigm that has greater potential to assess, predict, and mitigate the risk of climate change with efficient use of data, learning algorithms, and sensing devices. It performs a calculation, makes predictions, and take decisions to mitigate the impacts of climate change. By developing effective models for weather forecasting and environmental monitoring, AI makes us better understand the impacts of climate change across various geographical locations.

It interprets climatic data and predicts weather events, extreme climate conditions, and other socio-economic impacts of climate change and precipitation. From a technical perspective, AI offers better climatic predictions, shows the impacts of extreme weather, finds the actual source of carbon emitters and includes numerous other reasonable contributions. This enables the policymakers to be aware of the rising sea levels, earth hazards, hurricanes, temperature change, disruption to natural habitats, and species extinction.

Nevertheless, the research community and experts have already started focusing on climate informatics with AI paradigms. The predictive models are more appropriate to short-term forecasting models and diverge from the long-term prediction, assessment, and mitigation. To get the maximum benefit from AI for climate change mitigation, more advanced researches are necessitated towards this domain.

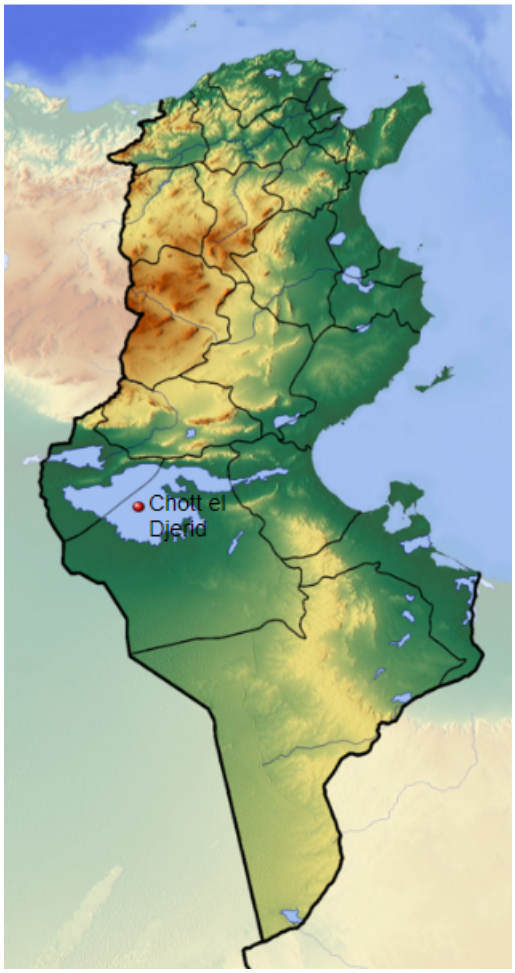
In this project we will be trying to forecast weather till the year 2030. first by analysing and cleaning the Data provided for the last 30 years such as temperature, wind speed and direction ,humidity levels at different altitudes.second, Modeling in which we will be training the model using LSTM based models.third, we will use said model to forecast the weather till 2030 and analysing the results.

1 Data Presentation

1.1 Chott El Jerid

Chott el Djerid is a large endorheic salt lake in southern Tunisia. The name can be translated from the Arabic into English as "Lagoon of the Land of Palms".It is the largest salt pan of the Sahara Desert, with a surface area of over 7,000 km2 (some sources state 5,000 km2). The site has a typical hot desert climate. Due to the harsh climate with mean annual rainfall of below 100 mm and daytime temperatures sometimes reaching 50 °C (122 °F) or more during summer with dense solar radiation, water evaporates from the lake. In summer Chott el Djerid is almost entirely dried up, and numerous fata morganas occur. Situated at 33 ° 42'N 8 ° 26'E in the center-west of the country, between the cities of Tozeur and Kebili.

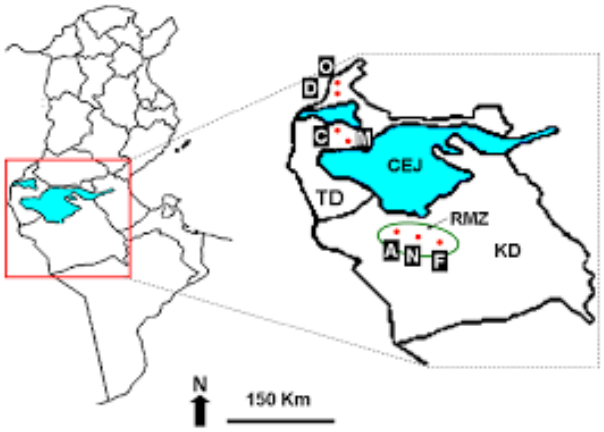
The Chott El Jerid plays an essential role in the hydrological regime of the entire surrounding region. Indeed the oases of Degache, Tozeur, Neha, as well as the group of oases of Nefzaoua, are fed by the waters of the underground artesian aquifers. This water supply was once done naturally through artesian springs ; today it is done by survey. During the rare wet winters, the surface of the Chott can be covered by a thin sheet of water. So we can see here the importance of the hydrological characteristics of Chatt El Jerid.



Furthermore, the fauna and flora of chott el jerid is also threatened by climate change. Indeed, currently, this area is home to vegetation dominated by periplocus which is threatened by erosion by high thermal amplitudes. The Retama raetam plants are also found in this area and are threatened by sand encroachment.

1.2 The source of our data

ERA5 is the latest climate reanalysis produced by ECMWF, providing hourly data on many atmospheric, land-surface and sea-state parameters together with estimates of uncertainty. Quality-assured monthly updates of ERA5 (1979 to present) are published within 3 months of measurement. Preliminary daily updates of the dataset are available to users within 5 days of the measurement. The used data were the average data for an area of radius of 32 km in the heart of Chott El Djerid. Dr. ATTIG Faten was in charge to providing us with data using ERA5. Ref :Reliability of the ERA5 in Replicating Mean and Extreme Temperatures across Europe.



2 Exploratory Data Analysis

Data visualisation

In order to analyze the data and try to understand the evolution of weather in the period from 1990 to 2020, we have visualized the temperature of the past 30 years as well as the solar radiation.

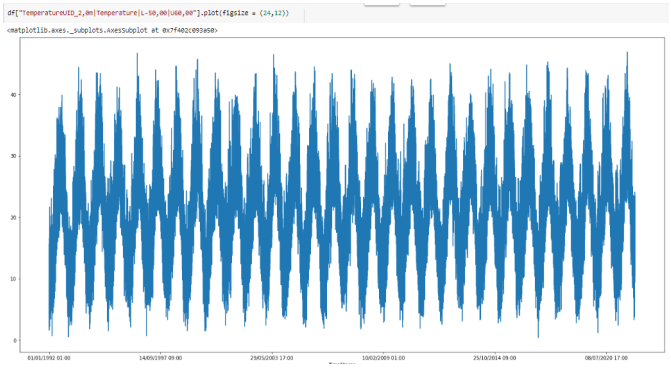


FIGURE 1 – Temperature

As one can notice no conclusion can be made even by seeing the average of the

evolution. this is expected given the strong variation of our parameters between night and day. to remedy this, we will break down the data. For the temperature we will take two values, that of maximum and minimum weekly. The choice of weekly values is chosen to reduce the temperature fluctuation and to harmonize the radiation values which vary a lot from day to day.

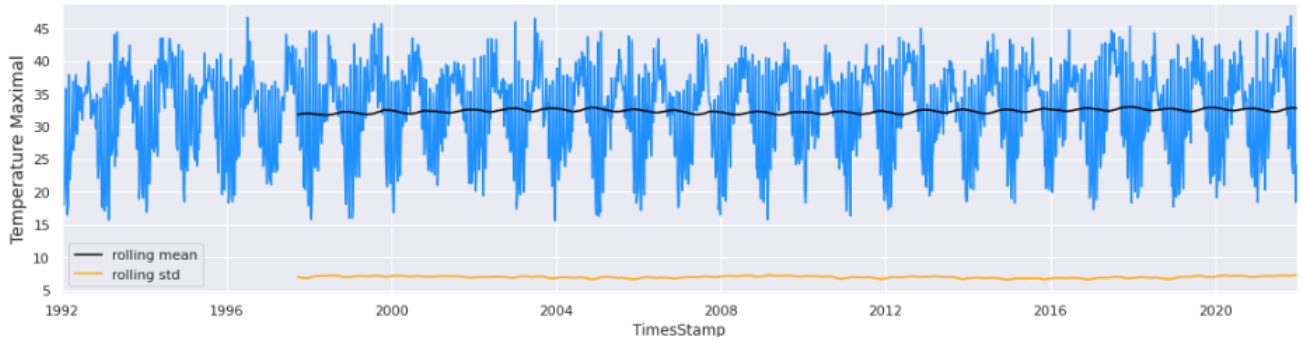


FIGURE 2 – Maximal Temperature

FIGURE 3 – Minimal Temperature

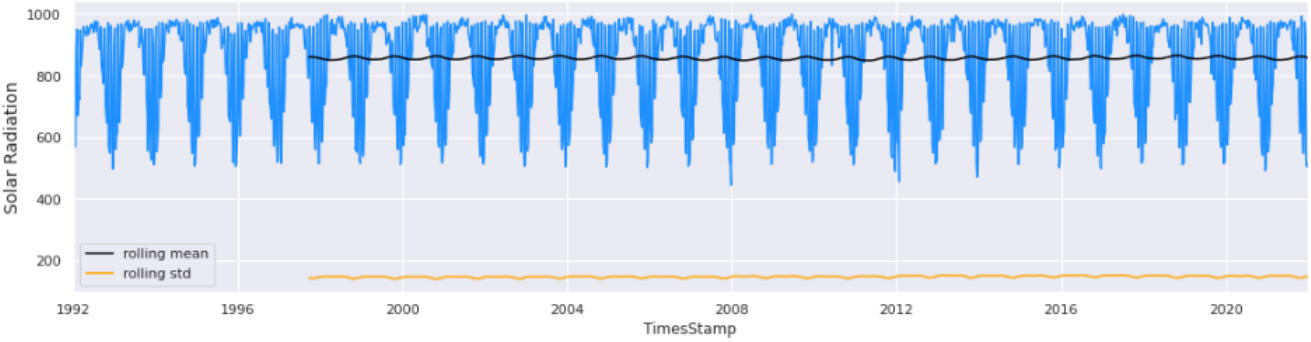


FIGURE 4 – Solar radiation

The curves obtained show that the temperature has increased from XX to YY degree during the specified period. Solar radiation shows a significant increase also from 1990 to 2020.

Time Series Decomposition

Time series decomposition involves thinking of a series as a combination of level, trend, seasonality, and noise components.

These components are defined as follows :

- Level : The average value in the series.

- Trend : The increasing or decreasing value in the series.

- Seasonality : The repeating short-term cycle in the series.

- Noise : The random variation in the series

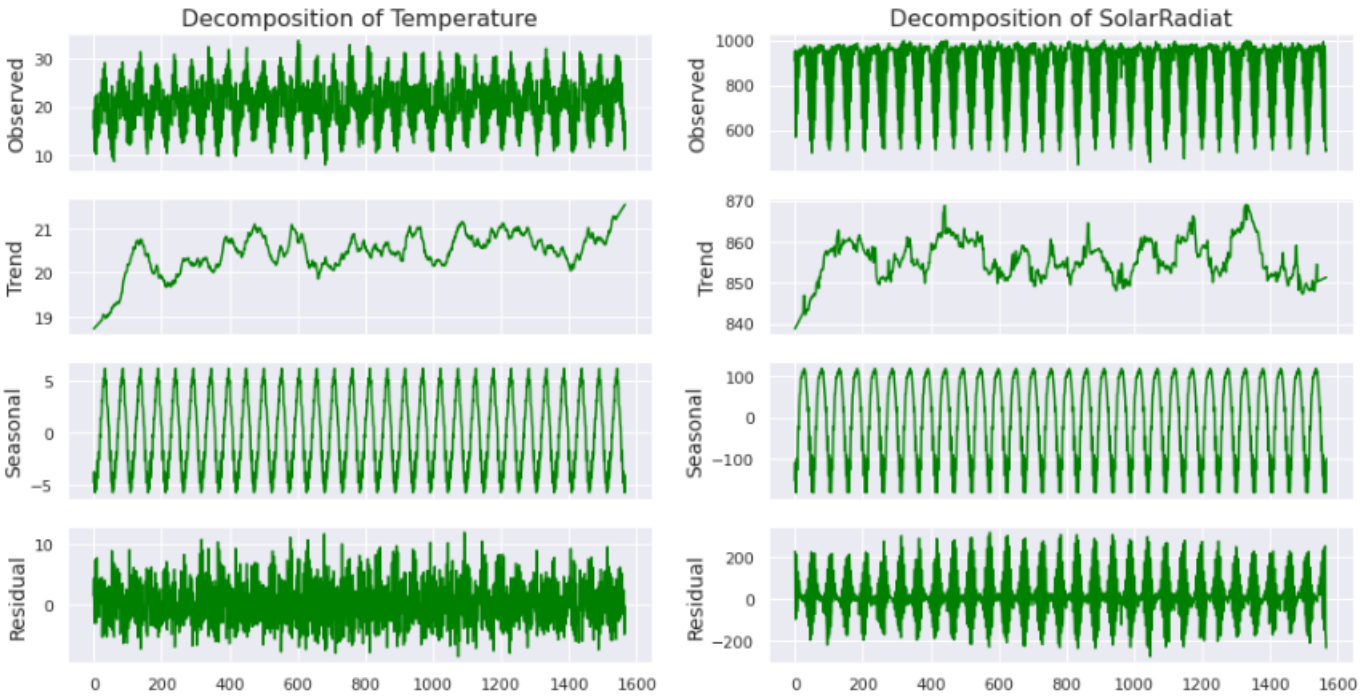


FIGURE 5 – Decomposition of Temperature and Solar Radiation

Stationarity

Stationarity describes that the time-series has :

- Constant mean and mean is not time-dependent

- Constant variance and variance is not time-dependent

- Constant covariance and covariance is not time-dependent

We are going to check if our data is stationary or not

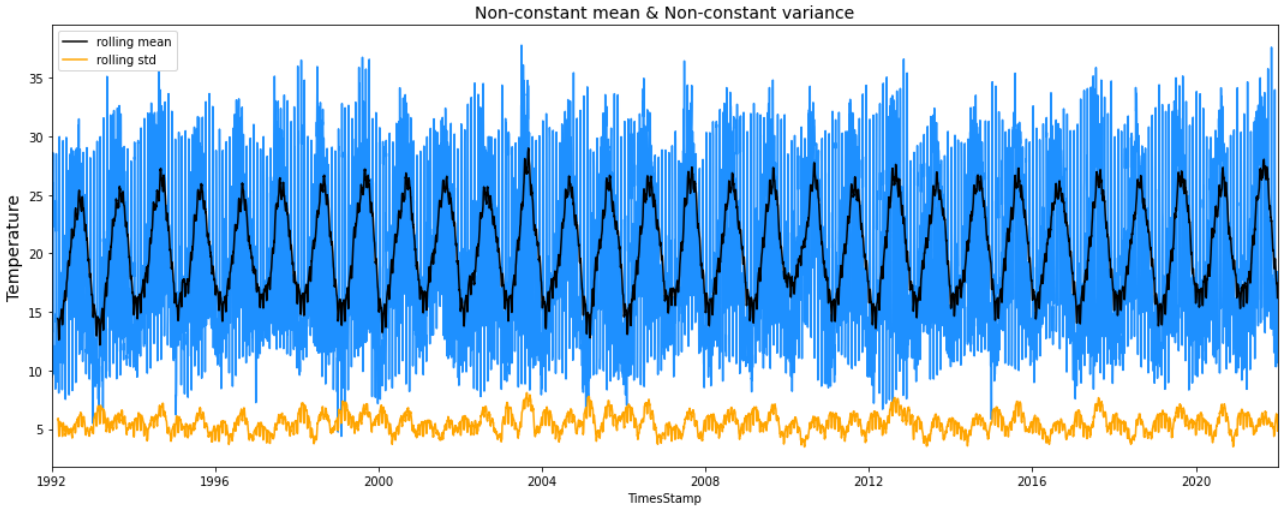


FIGURE 6 – Temperature mean and standard deviation

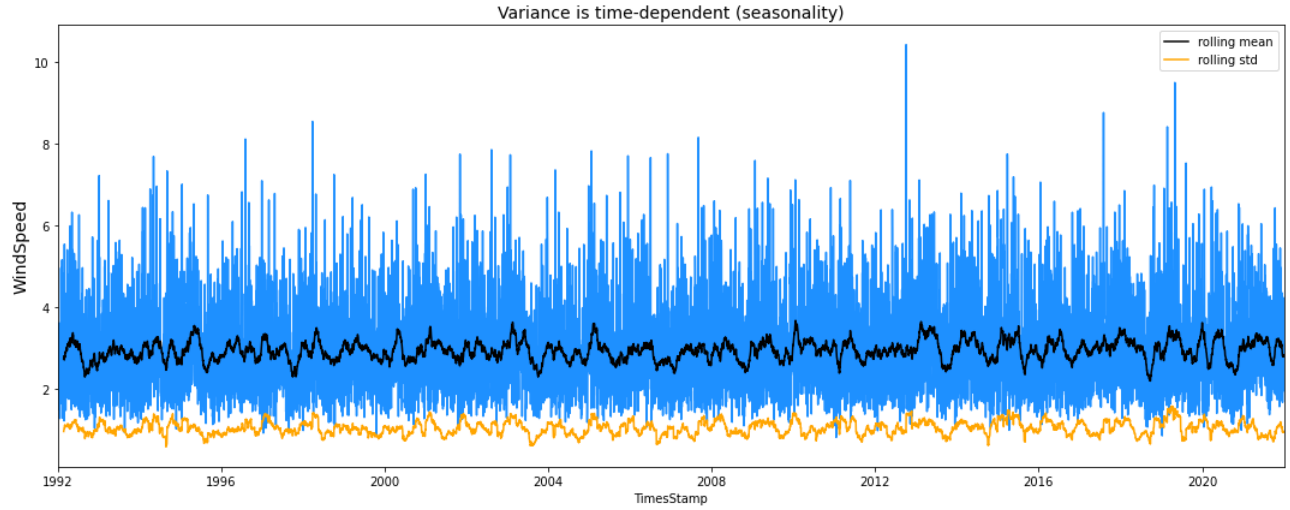


FIGURE 7 – Wind speed mean and standard deviation

We can see clearly that the features don't have constant mean and std.

Data Visualization

Data Visualization is an approach for data analysis that employs a variety of techniques (mostly graphical) to :

1. Maximize insight into a data set
2. Uncover underlying structure
3. Extract important variables
4. Detect outliers and anomalies
5. Test underlying assumptions
6. Develop parsimonious models

7. Determine optimal factor settings

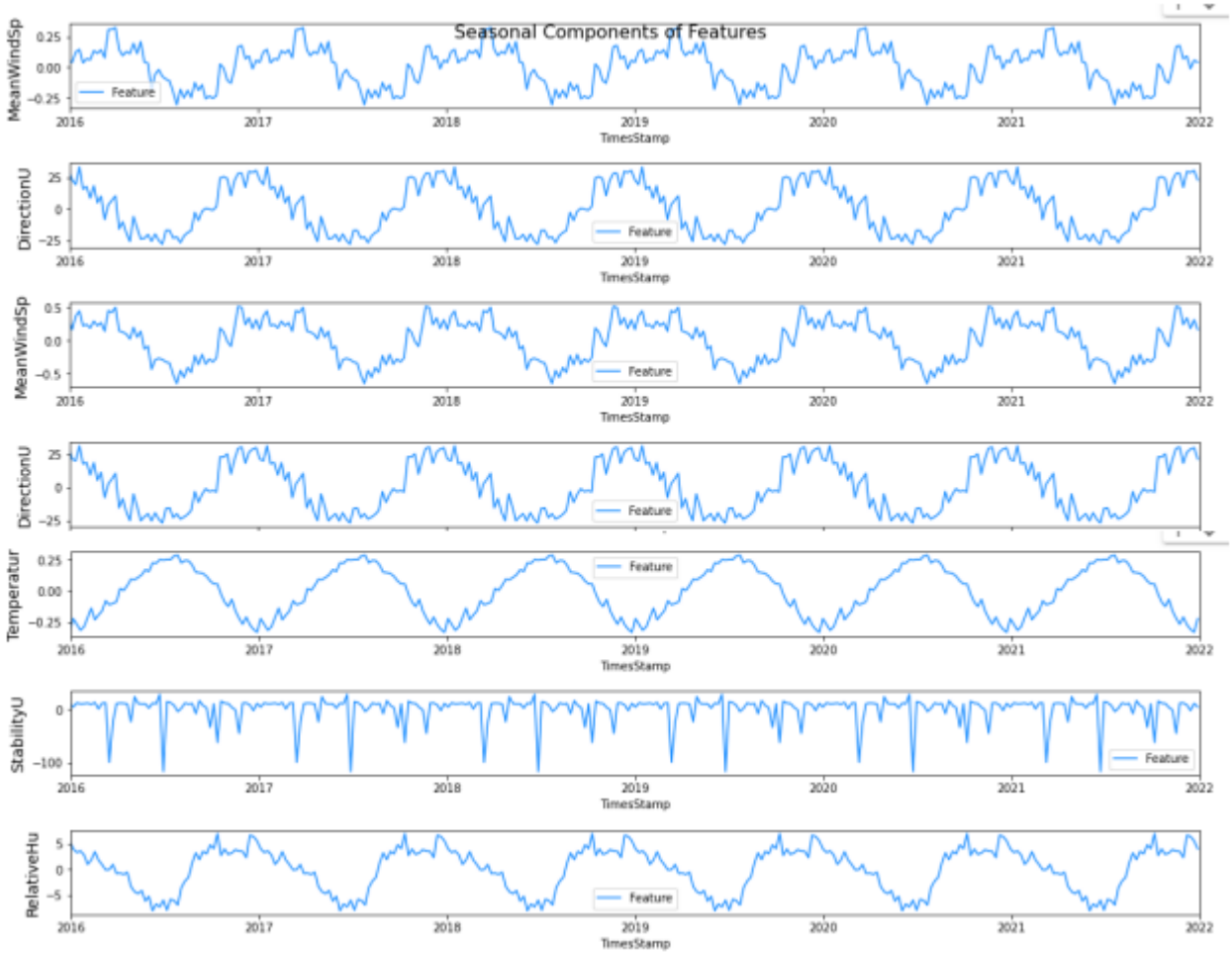


FIGURE 8 – The values of the different climatic variables during the last 8 years

As we can see :

- Temperature : reaches its maximum around June/July and its minimum around January

- Wind Speed 100m altitude : reaches its maximum around November and March and its minimum around May/June

- Wind Speed 10m altitude : reaches its maximum around March and its minimum around August/September

- Relative Humidity : reaches its maximum around December and October and its minimum around April.

Now lets look to the correlation between our features.

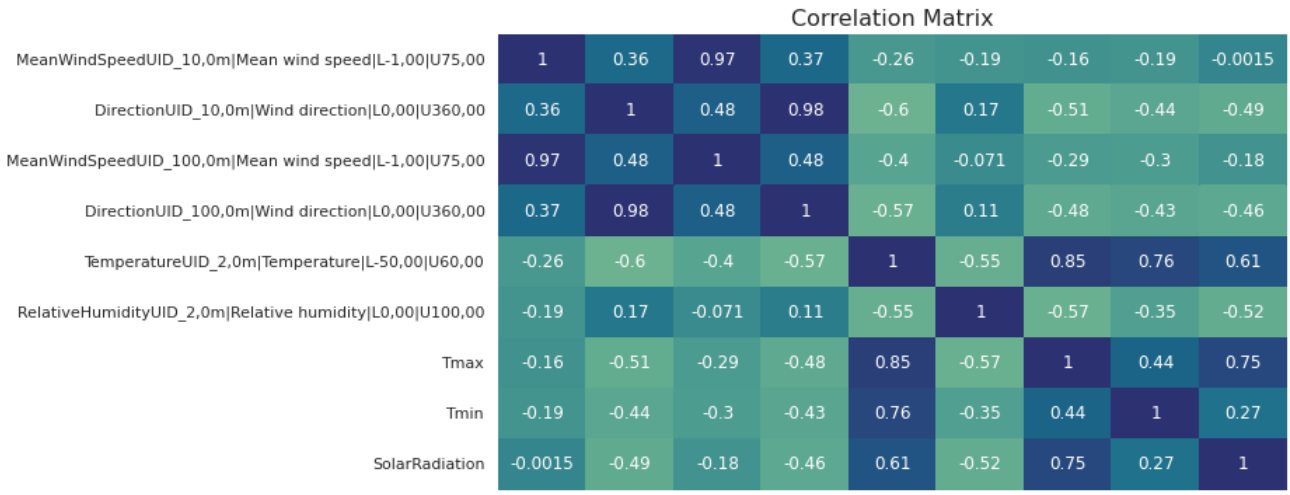


FIGURE 9 – Correlation Matrix

As we can see, there is not a strong correlation between temperature and the remaining features.

3 Data Cleaning

Data cleaning is the process of preparing data for analysis by removing or modifying data that is incorrect, incomplete, irrelevant, duplicated, or improperly formatted.

Data cleaning includes more actions than removing data, such as fixing spelling and syntax errors, standardizing data sets, and correcting mistakes such as empty fields, missing codes, and identifying duplicate data points. Data cleaning is considered a foundational element of the data science basics, as it plays an important role in the analytical process and uncovering reliable answers.

The goal of data cleaning is to create data sets that are standardized and uniform to allow business intelligence and data analytics tools to easily access and find the right data for each query

We received the data in csv file (24.5 Mo).

```
df.head()
```

	TimeStamp	MeanWindSpeedUID_10,0m|Mean wind speed|L-1,00|U75,00	DirectionUID_10,0m|Wind direction|L0,00|U360,00	Comment_10,0m	TimeStampStatus_10,0m	SampleStatus_10,0m	DataStatus_MeanWindSpeedUID_10,0m	D
0	NaN	[m/s]	[Degrees]	NaN	NaN	NaN	NaN	
1	01/01/1992 01:00	2,11	290,9	NaN	0.0	0.0	0.0	
2	01/01/1992 02:00	1,72	281,2	NaN	0.0	0.0	0.0	
3	01/01/1992 03:00	1,71	276,7	NaN	0.0	0.0	0.0	
4	01/01/1992 04:00	1,77	276,1	NaN	0.0	0.0	0.0	

5 rows × 27 columns

FIGURE 10 – Initial data samples

By opening the data using Google Colab (for interactive cooperation between the team's members) we can see that we have some empty cases and 'inappropriate' format

for some data.

For instance, temperature's type is object. This error happened because the floats are writhing with a comma and not a simple point as we used to manipulate data with.

Many features have one value (NaN or 0) such as "TimeStampStatus_10,0m", so we're going to delete them because they will not provide us with further information about our target which is temperature.

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 262993 entries, 0 to 262992
Data columns (total 27 columns):
 #   Column                                                Non-Null Count   Dtype
---  ------                                                --------------   -----
 0   TimeStamp                                             262992 non-null  object
 1   MeanWindSpeedUID_10,0m|Mean wind speed|L-1,00|U75,00  262993 non-null  object
 2   DirectionUID_10,0m|Wind direction|L0,00|U360,00       262993 non-null  object
 3   Comment_10,0m                                         0 non-null       float64
 4   TimeStampStatus_10,0m                                 262992 non-null  float64
 5   SampleStatus_10,0m                                    262992 non-null  float64
 6   DataStatus_MeanWindSpeedUID_10,0m                     262992 non-null  float64
 7   DataStatus_DirectionUID_10,0m                         262992 non-null  float64
 8   MeanWindSpeedUID_100,0m|Mean wind speed|L-1,00|U75,00 262993 non-null  object
 9   DirectionUID_100,0m|Wind direction|L0,00|U360,00      262993 non-null  object
 10  Comment_100,0m                                        0 non-null       float64
 11  TimeStampStatus_100,0m                                262992 non-null  float64
 12  SampleStatus_100,0m                                   262992 non-null  float64
 13  DataStatus_MeanWindSpeedUID_100,0m                    262992 non-null  float64
 14  DataStatus_DirectionUID_100,0m                        262992 non-null  float64
 15  TemperatureUID_2,0m|Temperature|L-50,00|U60,00        262993 non-null  object
 16  SolarRadiationUID_2,0m|Solar irradiation|L-10,00|U2000,00 262993 non-null  object
 17  StabilityUID_2,0m|Stability (1/L)                     262993 non-null  object
 18  RelativeHumidityUID_2,0m|Relative humidity|L0,00|U100,00 262993 non-null  object
 19  Comment_2,0m                                          0 non-null       float64
 20  TimeStampStatus_2,0m                                  262992 non-null  float64
 21  SampleStatus_2,0m                                     262992 non-null  float64
 22  DataStatus_TemperatureUID_2,0m                        262992 non-null  float64
 23  DataStatus_SolarRadiationUID_2,0m                     262992 non-null  float64
 24  DataStatus_StabilityUID_2,0m                          262992 non-null  float64
 25  DataStatus_RelativeHumidityUID_2,0m                   262992 non-null  float64
 26  Unnamed: 26                                           0 non-null       float64
```

FIGURE 11 – Initial climatic variables

```
[60] df.head()
```

TimeStamp	MeanWindSpeedUID_10,0m|Mean wind speed|L-1,00|U75,00	DirectionUID_10,0m|Wind direction|L0,00|U360,00	MeanWindSpeedUID_100,0m|Mean wind speed|L-1,00|U75,00	DirectionUID_100,0m|Wind direction|L0,00|U360,00	TemperatureUID_2,0m|Temperature|L-50,00|U60,00
01/01/1992 01:00	2.11	290.9	3.79	324.1	4.6
01/01/1992 02:00	1.72	281.2	3.62	321.1	4.7
01/01/1992 03:00	1.71	276.7	3.92	311.5	4.6
01/01/1992 04:00	1.77	276.1	4.27	307.2	4.3
01/01/1992 05:00	1.75	279.6	4.47	310.3	4.1

FIGURE 12 – Final data samples

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 262992 entries, 01/01/1992 01:00 to 01/01/2022 00:00
Data columns (total 10 columns):
 #   Column                                                Non-Null Count   Dtype
---  ------                                                --------------   -----
 0   MeanWindSpeedUID_10,0m|Mean wind speed|L-1,00|U75,00  262992 non-null  float64
 1   DirectionUID_10,0m|Wind direction|L0,00|U360,00       262992 non-null  float64
 2   MeanWindSpeedUID_100,0m|Mean wind speed|L-1,00|U75,00 262992 non-null  float64
 3   DirectionUID_100,0m|Wind direction|L0,00|U360,00      262992 non-null  float64
 4   TemperatureUID_2,0m|Temperature|L-50,00|U60,00        262992 non-null  float64
 5   SolarRadiationUID_2,0m|Solar irradiation|L-10,00|U2000,00 262992 non-null  float64
 6   StabilityUID_2,0m|Stability (1/L)                     262984 non-null  float64
 7   RelativeHumidityUID_2,0m|Relative humidity|L0,00|U100,00 262992 non-null  float64
 8   DataStatus_StabilityUID_2,0m                          262992 non-null  float64
 9   TimesStamp                                            262992 non-null  datetime64[ns]
dtypes: datetime64[ns](1), float64(9)
memory usage: 22.1+ MB
```

FIGURE 13 – Final climatic variables

Now, we need statistical information about the data so we used df.describe() :

```
[ ] df.describe()
```

	MeanWindSpeedUID_10,0m|Mean wind speed|L-1,00|U75,00	DirectionUID_10,0m|Wind direction|L0,00|U360,00	MeanWindSpeedUID_100,0m|Mean wind speed|L-1,00|U75,00	DirectionUID_100,0m|Wind direction|L0,00|U360,00	TemperatureUID_2,0m|Temperature|L-50,00|U60,00
count	262992.000000	262992.000000	262992.000000	262992.000000	262992.000000
mean	2.946974	181.425148	4.878747	182.786023	20.454083
std	1.539129	110.790483	2.385734	112.384618	7.789131
min	0.000000	0.000000	0.010000	0.000000	0.400000
25%	1.800000	83.000000	3.080000	81.200000	14.300000
50%	2.640000	179.700000	4.770000	182.200000	20.100000
75%	3.870000	287.700000	6.440000	293.600000	25.900000
max	13.030000	359.900000	20.200000	359.900000	46.900000

FIGURE 14 – Characteristics of climatic variables

4 Modeling

4.1 LSTM

The Long Short-Term Memory (LSTM) is an improved Recurrent Neural Network (RNN) to solve the problem of vanishing gradient and exploding gradient. The LSTM was designed by Hochreiter and Schmidhuber (1997) to solve the problem of long-term RNN dependence.

The RNN cannot predict the input data stored in long-term memory but can provide more accurate predictions based on the latest knowledge. The LSTM architecture can store information for a long time. They are used for processing, forecasting, and classification based on time series data. The main part of the LSTM architecture is the memory cell and gate units.

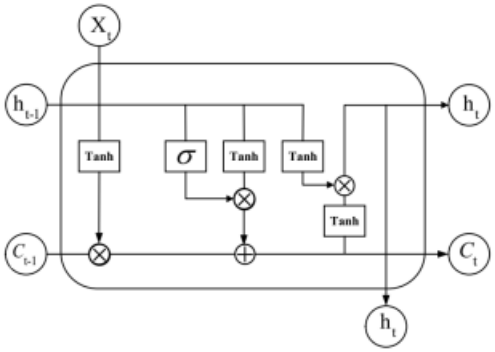


FIGURE 15 – LSTM Model

Each line transfers the complete vector output of one node to the input of other nodes. The X and + symbols represent point-wise operations, while the tanh and sigma symbols are the type of activation functions that are used in the trained layers of the neural network.

The merging lines indicate concatenation, while a forking line denotes copying its content, then the copies go to various places. The cell condition, which crosses the horizontal line at the bottom of the graph, is the key to LSTM. Here, Ct is a cell state or memory cell that passes straightforward information to flow unchanged. It is denoted by the horizontal line running across the bottom of the diagram.

Another key of LSTM is a sigmoid gate, which controls how much information can get through. In this process, the sigmoid neural net layer, which ranges from zero to one, determines the proportion of information to be passed. A value of zero indicates that nothing is passing through. Meanwhile, a value of one implies that everything is passed.

4.2 Our Approach

The backbone of our model is based on LSTM layers as it is able to learn non-linear and non stationary forecasting nature of time series which reduces error in forecasting.

Our model contains 3 stacked LSTM layers each one has 128, 256, 128 units respectively and 2 Dense layers with 10 and 1 units. In addition, We have used Batch Normalization layers to stabilize the learning process and Dropout layers to prevent over-fitting.

1st Approach Our first approach was based on using previous $n_{lookback}$ weeks to predict the following week. After a lot of experimentation, we found out that this approach wasn't the best for forecasting as it leads to either constant or erroneous values even if it produces a small error during evaluation.

2nd Approach The second method, which gave us the best forecasting results, consisted of using previous $n_{lookback}$ datapoints to predict the following $n_{forecast}$ sequence of points.

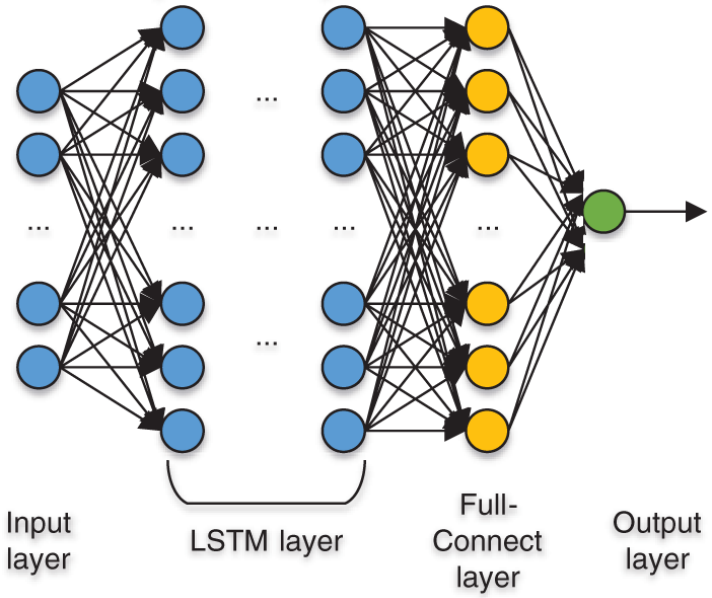


FIGURE 16 – Our LSTM-Based Architecture

In the end, we have used in total 3 models following the same architecture described previously to predict the following variables : T_{max}, T_{min} and $SolarRadiation$.

5 Performance Evaluation

Criteria : Mean Squared Error The mean squared error (MSE) tells you how close a regression line is to a set of points. It does this by taking the distances from the points to the regression line (these distances are the "errors") and squaring them. The squaring is necessary to remove any negative signs. It also gives more weight to larger differences. It's called the mean squared error as you're finding the average of a set of errors. The lower the MSE, the better the forecast.

$$\text{MSE} = \frac{1}{n}\sum_{i=1}^{n}\left(Y_i - \hat{Y}_i\right)^2$$

MSE = mean squared error
n = number of data points
Y_i = observed values
$\hat{Y}_i$ = predicted values

$Models' Evaluation$

In the following plots we can see the evolution of both the training and the evaluation error for each one of the 3 models.

The input to the model was scaled to ensure numerical stability and faster convergence and thus the really small values of error despite the original ranges of the different variables. As a result, the values on the figures represent a percentage MSE out of the original range of the variables.

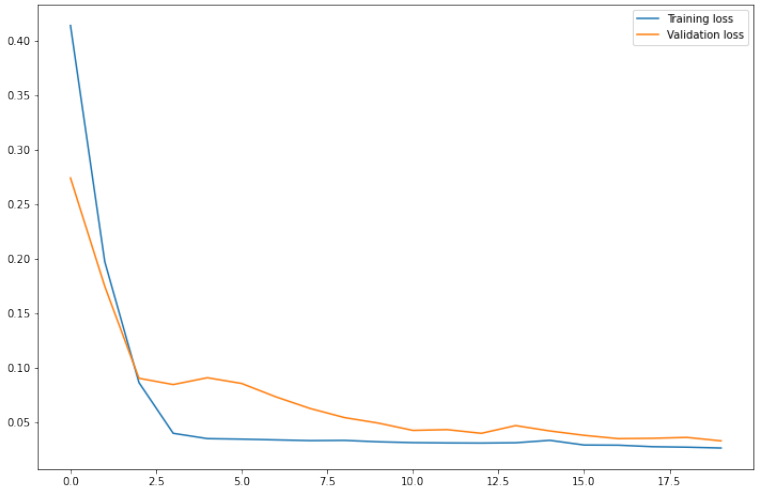


FIGURE 17 – Error Evolution of the Tmin Model

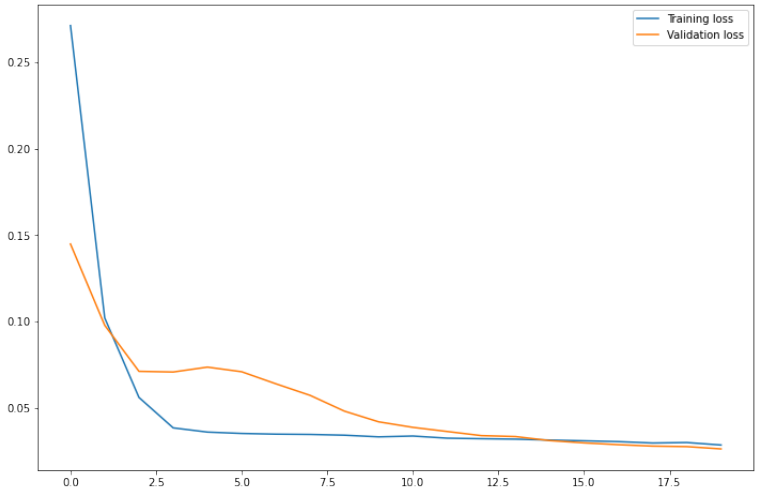


FIGURE 18 – Error Evolution of the Tmax Model

We fine-tuned the models' hyperparameters to obtain optimal models that are not over-fitting the data as can be seen from the previous figures.

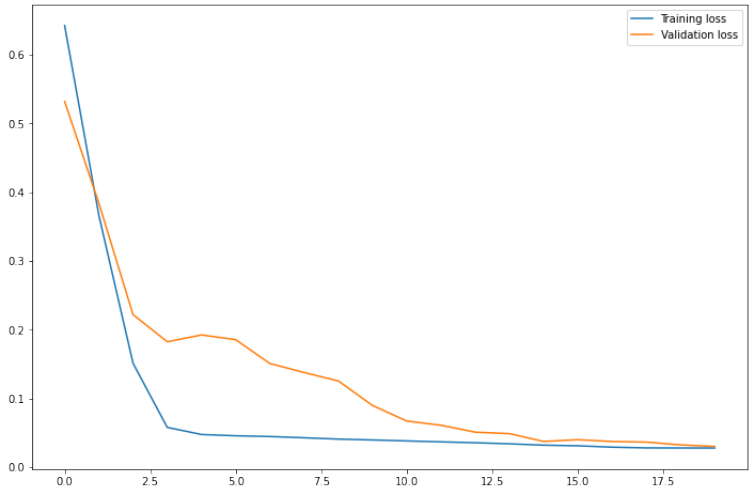


FIGURE 19 – Error Evolution of the Solar Radiation Model

6 Forecasting Results

6.1 The temperature

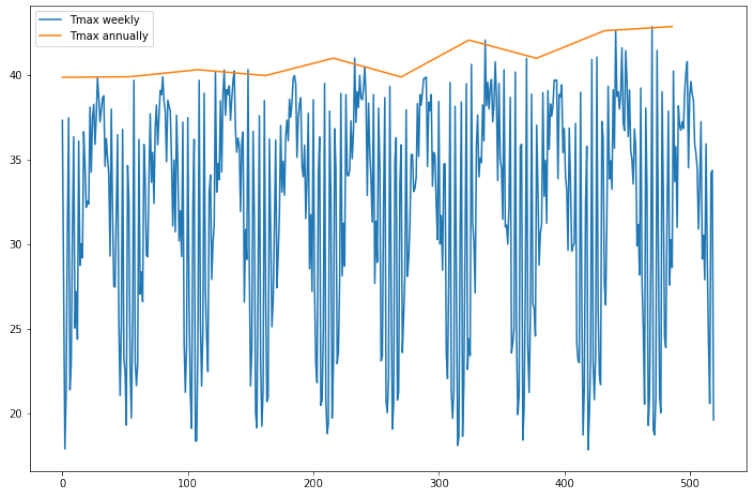


FIGURE 20 – Maximum Temperature Forecast for 10 years

We can see that the our forecast of the maximum temperature aligns with the trend which exists in the original data and is in accord with the most probable scenario in real life. We have an ever increasing maximum temperature and the number of hot days also increasing. our prediction shows that the maximum temperature is 42.0°C Which is logical as the days with extreme temperature above this degree are very rare and the model when training does not take into consideration the rare events.

The minimum temperature has also increased to reach 9.84 in 2030 compared to 8.56 in 1990

6.2 The Solar Radiation

Since 2020, the amount of solar radiation the sun emits, during the day, will increase by nearly 5. percent per decade(between 1990 and 2022 it was 10 per cent per decade)

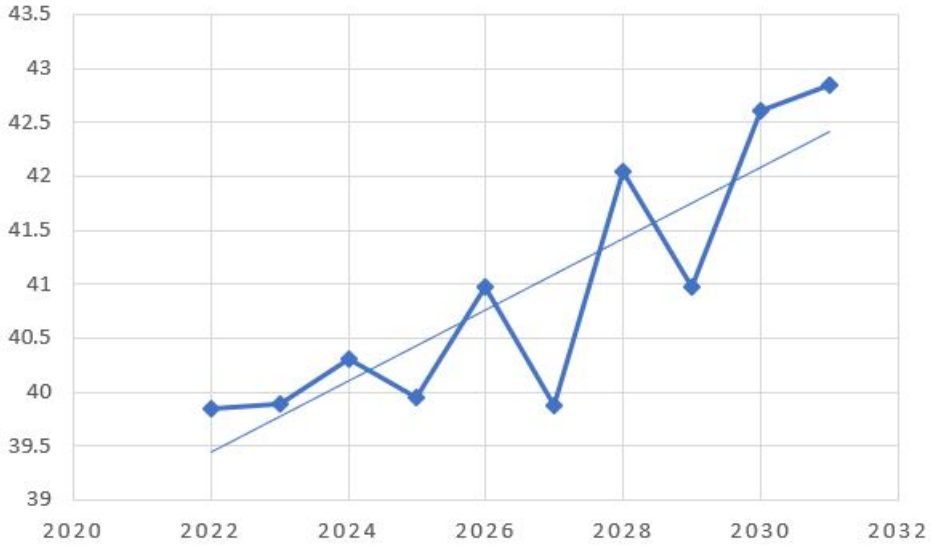


FIGURE 21 – Maximum Temperature Annual Forecast

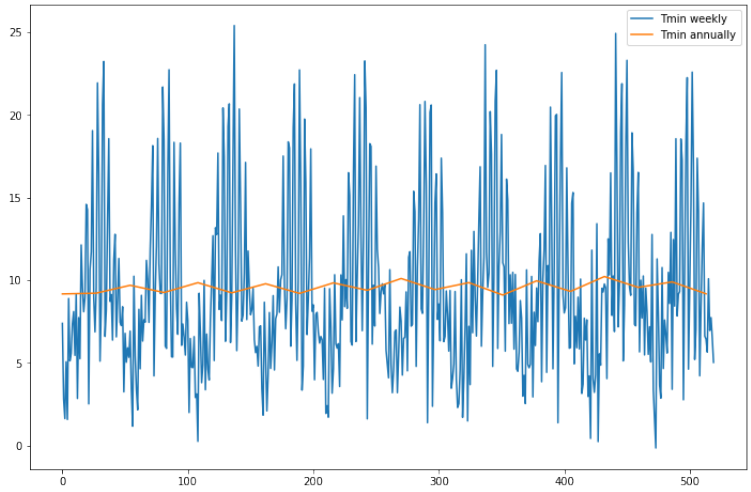


FIGURE 22 – Minimum Temperature Forecast for 10 years

7 Analysis

As we have seen in the data visualisation and Forecasting Results the temperature keeps rising. from 1990 to 2030 the temperature has increased by 3 to 4 degrees.This is quite predictable given the global warming that threatens humanity. This increase in temperature, accompanied by an increasingly critical solar radiation affects the region of Chott El Djerid in several aspects. In this report we will focus on the most significant indicators for the region.

7.1 Health

the increasing temperature has a major impact on the health of the citizens of the area on several levels which we will discuss apart

Increased appearance of heart and Respiratory System climate change will affect air pollution, vector-borne diseases, allergens, water quality, water and food supply, en-

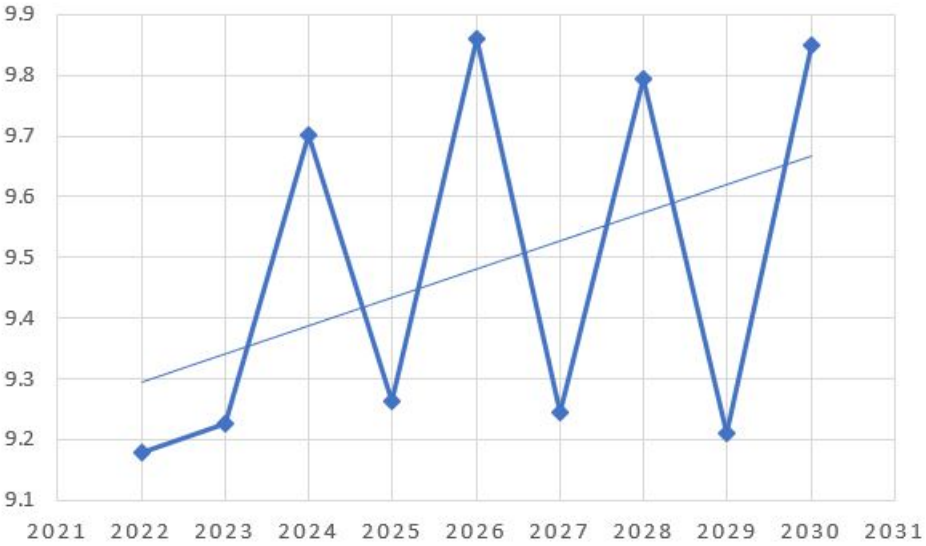


FIGURE 23 – Minimum Temperature Annual Forecast

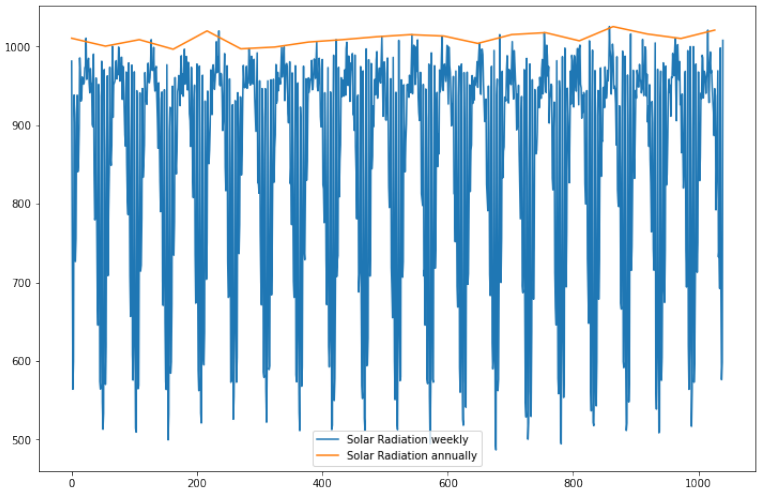


FIGURE 24 – Solar Radiation Forecast for 20 years

vironmental deterioration, extreme heat and severe weather. All of these changes are a serious threat to health.According to the Environmental Protection Agency (EPA), warmer temperatures could increase the concentrations of unhealthy air and water pollutants. Along with these, the environmental consequences of climate change, which are already occurring, include heat waves, changes in precipitation (flooding and drought), more intense storms, and worsening air quality. Extreme heat and poor air quality increase complications from underlying heart and respiratory conditions like asthma, renal failure, and pre-term birth, and as temperatures rise, there will be more heat-related illness and deaths.

Increased of insect transmitting diseases Environmental temperature is an overriding factor defining the geographic distribution range limits of many organisms, in particular ectotherms. Mosquitoes can only survive and reproduce in suitable environments that depend on the ecological characteristics of the mosquito species. Many studies have used temperature to map global or regional suitability and distribution of mosquito species. For

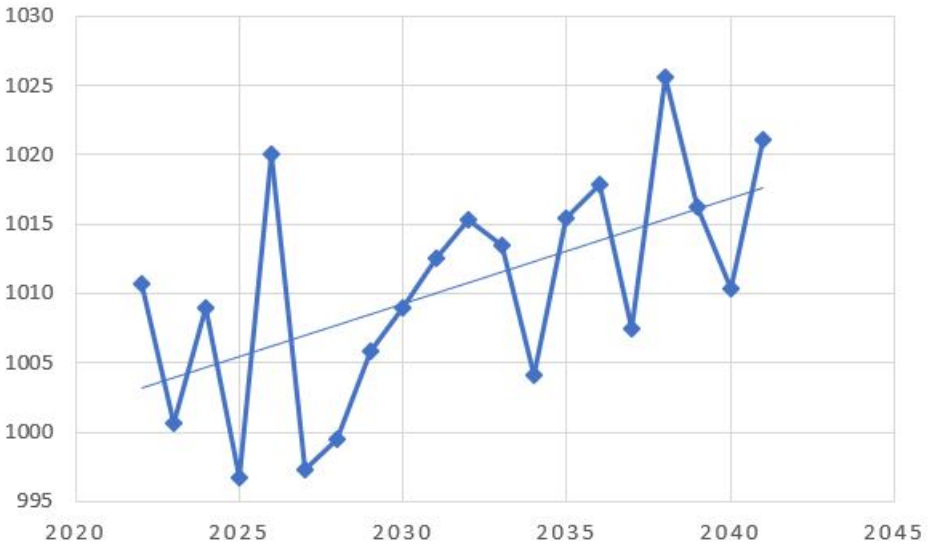


FIGURE 25 – Solar Radiation Annual Forecast

both species, the most important predictor of distribution was temperature. Sensitivity of mosquitoes to temperature reflects the effects of temperature on the main mosquito physiological processes.More precisely, in the past 30 years, mosquito-borne viruses (MBVs) have dramatically expanded their distribution range within increasingly frequent and large epidemics . MBVs such as Zika virus (ZIKV ; Flaviviridae, Flavivirus), dengue virus (DENV ; Flaviviridae, Flavivirus), yellow fever virus (YFV ; Flaviviridae, Flavivirus), West Nile virus (WNV ; Flaviviridae, Flavivirus), and chikungunya virus (CHIKV ; Togaviridae, Alphavirus) have been responsible for millions of human cases with significant morbidity and mortality over the last decade .

7.2 Environment

The Flora is heavily impacted as only trees such as cacti and Palm trees are resistant to high temperature and lack of water the rest of the flora is heavily impacted by first the increasing temperature and second by the side effects such as the increased erosion and desertion that would lead some trees even to going locally extinct.

The Fauna is equally damaged because of the chain reaction of the ecosystem first and lack of food resources and water for the animals to survive.second the temperature itself is lethal to most domesticated animals so we will see a huge reduction to the cattle and sheep population and the current population is already scarce with 1740 head of cattle,65000 sheep,31000 goat and 32000 chicken.however,Drought-like conditions and increased precipitation will induce negative impacts on the desert ecosystem. These pressures will reduce soil moisture, resulting in the reduction of desert vegetation cover and thus a decline in higher populations on the food chain. Consequently the desert biodiversity will plummet at a significant rate and eventually become extinct.

7.3 Agriculture

this sector is a crucial part of both food security and economical security of the region as the dates are the primary product of this area we will analyse the effect first on the dates industry and second on the rest of crops

Dates are the most important but not the most impacted as the total number of Palm trees is around 1.6 million tree among which we have the much desired "deglet nour" with a huge 950 thousand even the effect of climate change is not direct . climate change could increase the number of pests and lead to changes in the critical flowering and pollination periods. There is no analysis specific to Tunisia, but based on estimates of impacts in similar countries, 20-26 million in exports could be at risk in 2050 and $72-85 million in 2100.

the rest of the crops as the rest of the crops are not as resistant to lack of water. the effect was devastating on most of them and it even led to some types of crops being removed completely from the area..

7.4 Energy

the energy consumption is expected to explode during the next years due to a substantial increase in temperature.

Increasing temperatures and the increased frequency and intensity of aridity and drought are expected to further increase energy demand. Changes in demand are likely to be through the expansion of peak-hour patterns, air conditioning intensity needs and the increased need for water desalination (used in processing and station cooling). The existing infrastructure and generation capabilities are ill-prepared to cope with the projected effects of climate change and the increased demand. Existing energy systems are at risk of system failures and increased/ expanded energy outages.Additionally, the projected decrease in precipitation and change in seasonal rainfall patterns are likely to reduce hydro power generation potential as well as the potential for revenue loss due to overbuilt hydro power, which may be under supplied. Increased evaporation rates from existing water storage facilities will also increase production costs, resulting in increased prices for consumers. Increased temperatures and changing rainfall patterns may also alter the seasonal demand for energy, increasing demand during peak loads with a projected increase in net electricity usage.While Tunisia has planned to increase its renewable energy consumption by up to 30% by 2030, infrastructure and investment have yet to keep pace with these goals. according to a study done in France, an increase of 1°C creates a 500MW demand which is a huge number.and measures have to be took to support the rising demand.

photovoltaic and the rising solar radiation As concentrating the solar radiation over a single cell is now a proven technology, so attempt has been made in this article to extend this concept over PV module. High irradiation intensity from 1000 to 3000 W/m2 has been investigated to measure the power and energy of PV cell. At 3000 W/m2 irradiation, the electrical power increases by about 190 W compared with 63 W at irradiation level of 1000 W/m2. At the same time, at 3000 W/m2 irradiation, the thermal energy increases by about 996 W compared with 362 W at 1000 W/m2 irradiation. Electrical power and thermal energy are enhanced by about 6.4 and 31.3 W, respectively, for each 100-W/m2 increase of solar radiation. The overall energy is increased by about 179.06% with increasing irradiation level from 1000 to 3000 W/m2. It is concluded that the effect of high solar radiation using concentrator can significantly improve the overall output of the PV module.so STEG could use this as an opportunity to generate enough to support not only Tunisia but even export to other countries.

7.5 Economics and Tourism

Climate Change will decimate the desert tourism Aridity, higher evaporation rates, an increase in thermal discomfort for humans and thermal stress for plants and animals, change in precipitation patterns, and land degradation are the most significant impacts that climate change entails for Tozeur. Climate simulations show a continuous expansion of aridity from south towards the north (Institut National de la Météorologie). The tourism sector will be affected by these impacts, either directly due, for instance, to diminishing water resources and increasing costs for water supply, or indirectly due to the degradation of the oasis, one of the main attractions for tourists in Tozeur.

7.6 Recommendations

7.6.1 Saving the environment

Protection of soils from hydromorphy and salinization are necessary to limit the loss of agricultural land. It implies measures to slow down the abandonment of cultivated land and the and the realization of actions and projects of valorization of the abandoned lands and maintenance and improvement of drainage networks.

Preservation of soil quality is advocated for cultivated land. It will be necessary to to ensure a continuous supply of organic fertilizers (manure, plants) and mineral mineral supplements (sand).

The mobilization and sustainable exploitation of conventional and non-conventional water resources It will be done by the realization of replacement drillings in the deep and the exploitation of groundwater, in parallel with the fight against illicit drilling.

Improving the efficiency of irrigation systems It will ensure regular supply to the plots and provide water according to the needs of the crops while reducing crops while reducing water losses and waste.

7.6.2 Biodiversity

Safeguarding and conservation of the arboricultural market gardening and forage biodiversity of oases. This conservation will be in situ through the establishment of living collections and also ex situ via the national gene bank and the various seed banks of the research institutes' seed banks

Valorization of the oasis biodiversity through processing labeling (of quality products, but which are quality products, but which are only very little cultivated) or genetic improvement (based on quality quality, precocity and resistance to diseases)

Establishment of an observatory of phytosanitary monitoring relating to oases This observatory will allow the early detection of diseases and pathogens before their spread, especially since the oases are adjacent to the Algerian borders and the borders and that the risk of disease transfer is high

Establishment of an observatory of phytosanitary monitoring relating to oases This observatory will allow the early detection of diseases and pathogens before their spread, especially since the oases are adjacent to the Algerian borders and the borders and that the risk of disease transfer is high

Creation of a center specialized in the breeding of biological control agents particularly trichogrammes (against the pyralid moth) and which will allow their release on a large scale.

Support for the creation of a unit (microenterprise) of micro propagation of palm trees, with a commercial vocation. Indeed, the new plantations require the search for rejects which are becoming rare and the in vitro culture is imposed as a means of propagation of varieties.

7.7 Socio-economic

Improvement of the productivity of oasis crops Margins of technical progress and productivity gains are still possible in terms of of oasis agriculture. It is necessary to set up training programs to allow the expression of such potential. to allow the expression of such a potential. This requires the improvement of techniques, crop management at the different levels, better use of inputs and the use of inputs and the intensification of the use of some of them

The development of tourism of the natural and cultural oasis heritage in order to valorize and of the wealth and potentialities that are the basis of a sustainable oasis tourism strategy of sustainable oasis tourism development

8 Conclusion

This project was a perfect opportunity for us to get acquainted with the practical side of data science.
The beginning consists in understanding the data and trying to come out with the best solution to estimate the temperature as well as the solar radiation.
Due to the chaotic nature of the system, and in the absence of a single agent controlling the climate system and the non-correlation of the different parameters, modeling and forecasting has taken on great importance in order to have good results whether minimizing errors and to have a forecasting that follows trends without taking into account external parameters.
The results, although it does not give an exponential increase in the various parameters, but this evolution really threatens the ecosystem of Chott El Djerid as well as the well-being of its native inhabitants.
the goverment must take any necessary measure to safeguard this location as it is not only valuable to our people and an amazing resource but it is regarded highly by the UNESCO and it is classified as world heritage.