بسم الله الرحمن الرحيم

PPU College of Engineering and Technology
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College of Engineering & Technology

Mechanical Engineering Department

Graduation Project

Assessing the climate in Palestine for air conditioning

Project Team

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Hebron-Palestine

Dec , 2011

Palestine Polytechnic University
(PPU)

Hebron-Palestine

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According to the project supervisor and according to the agreement of the Testing committee members, this project is submitted to the Department of Mechanical Engineering at college of engineering and technology in partial fulfillment of the requirements of (B.A) the bachelor's degree.

Department Head Signature   Supervisor Signature

Name: ______   Name: ______

Supervisor Signature

Name: ______

December - 2011

Dedication

To my friends ...
To my parents ...
To who love me ...

To whom help me...
To my parents...
To who love me ...

To all who find of his death a way of life to others.

To all martyrs who were killed by no fault of their own except wishing a flourishing future to their home.

To all who is troubled by his conscience and loyalty

To all who violently love their homes and whom swords was broken without touching their determination.

To all the mothers who bring, raise, and present obliged us to have an ever-increasing recognition of their greatness.

To our supervisor Eng. Kazem Osaly

To our country
To the souls of Palestine martyrs
To the freedom fighters
To whom their guidance and support made this work possible

Acknowledgments

Our thanks go first to our advisor Eng. Kazem Osaily. His guidance and support made this work possible. His constant encouragement, intuitive wisdom, and resolute leadership were instrumental in completing this work. And we thank other doctors who Work to help us throughout our work on this project, Dr. Imad Khatib. And we thank one of the brothers to the engineers who make every effort to help us engineer Omar Ash.

And, finally, our ultimate thanks go to all lecturers and doctors, engineers, and laboratories supervisors. Their efforts and their nice dealing with us improved our characters to become successful Engineers in the future.

Abstract:

In this study we will conduct a study and a comprehensive survey of the climate of Palestine , where the temperature wet and dry, humidity, and rate, and the value of heat content and wind speed, based on previous studies and meteorological stations extended in Palestine from north to south, as well as through the Software called Meteonorm, which contains readings historic for this area extends to tens of years, after which it will draw maps of the area of Palestine embodied in these values, so that if he wanted the student identify a specific property of these maps, it does not need the coordinates of the site and will receive this value.

After the mapping process we divide the area of Palestine into four climatic zones based on the information we have obtained, namely: the mountainous area, the coastal region, the Jordan Valley, and the desert. We find equations of thermal loads for air conditioning for each area, where we used equations of the adaptation and compensated values that we obtained for each region for the equations belonging to each region.

الملخص

في هذه الدراسة سوف نقوم بإجراء دراسة وعملية مسح شامل لمناخ منطقةِ من حيث دراسة درجة الحرارة الرطبة والجافة والرطوبة ونسبتها ، وقيمة المحتوى الحراري وسرعة الرياح، بالاستناد إلى دراسات سابقة ومن محطات الأرصاد الجوية الممتدة في فلسطين من الشمال إلى الجنوب ، وكذلك عن طريق برنامج سوفت وير يدعى متيونورم , والذي يحتوي قراءات تاريخية لهذه المنطقة تمتد إلى عشرات السنين ، وبعد ذلك سوف نقوم برسم خرائط لمنطقة فلسطين تظم هذه القيم ، بحيث إذا أراد الدارس تحديد خاصية معينة من هذه الخرائط فانه لا يحتاج إلا إلى إحداثيات الموقع وسيحصل على هذه القيمة .

بعد عملية رسم الخرائط قمنا بتقسيم منطقة فلسطين إلى أربع مناطق مناخية استنادا على المعلومات التي حصلنا عليها وهي : المنطقة الجبلية , المنطقة الساحلية , منطقة الأغوار , ومنطقة الصحراء . وقمنا بإيجاد معادلات الأحمال الحرارية للتكييف الخاصة بكل منطقة , حيث استعنا بالمعادلات العامة للتكييف وعوضنا القيم التي حصلنا عليها لكل منطقة للحصول على معادلات تخص كل منطقة.

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Chapter One

INTRODUCTION

1.1 Introduction

Air conditioning is a combined process that performs many functions simultaneously. It conditions the air, transports it, and introduces it to the conditioned space. It provides heating and cooling from its central plant or rooftop units. It also controls and maintains the temperature, humidity, air movement, air cleanliness, sound level, and pressure differential in a space within predetermined limits for the comfort and health of the occupants of the conditioned space or for the purpose of product processing.

The term HVAC&R is an abbreviation of heating, ventilating, air conditioning, and refrigerating.

The combination of processes in this commonly adopted term is equivalent to the current definition of air conditioning. Because all these individual component processes were developed prior to the more complete concept of air conditioning , the term HVAC&R is often used by the industry .

1.2 General Overview of Project

The area of Palestine of the most prominent areas that have experienced changes in climate great lately, so it was important to conduct a study climate for this region and to identify the climate factors in this region, due to its effect in the process of air conditioning and refrigeration, so we noticed that there is a Sevier shortage of many of the factors or parameters that we need to find loads of operations, and we resort to rounding.

The objectives of this project is to build maps for Palestine locations contain many of climate characteristics that is used in heating and air conditioning calculations, and using them in the development of energy programs besides this will help improving weather information and forecasting, then the equations of heating and air conditioning load for Palestine as special case are established for load calculation.

1.3 Importance of project.

The importance of this project is through the comprehensive study of the climate of Palestine, and build maps of the constants and the values that we need to calculate the thermal loads, so that we can do without reference to the Meteorological Department to obtain information necessary for the load, In addition that this project could be a reference for students and researchers in the climatic conditions in this region and the prediction.

1.4 Project Scope:

Historical climatologic data for the last 40 years were sleeked in the first place for a desired domain shown in Fg.1.1 below. The domain Features Palestine, part of the Mediterranean and Red seas, part of Lebanon, Syria, Jordan and Egypt. It extends 29-34 degrees north and 34-36 easts. The historical climatologically data identified for the study are:

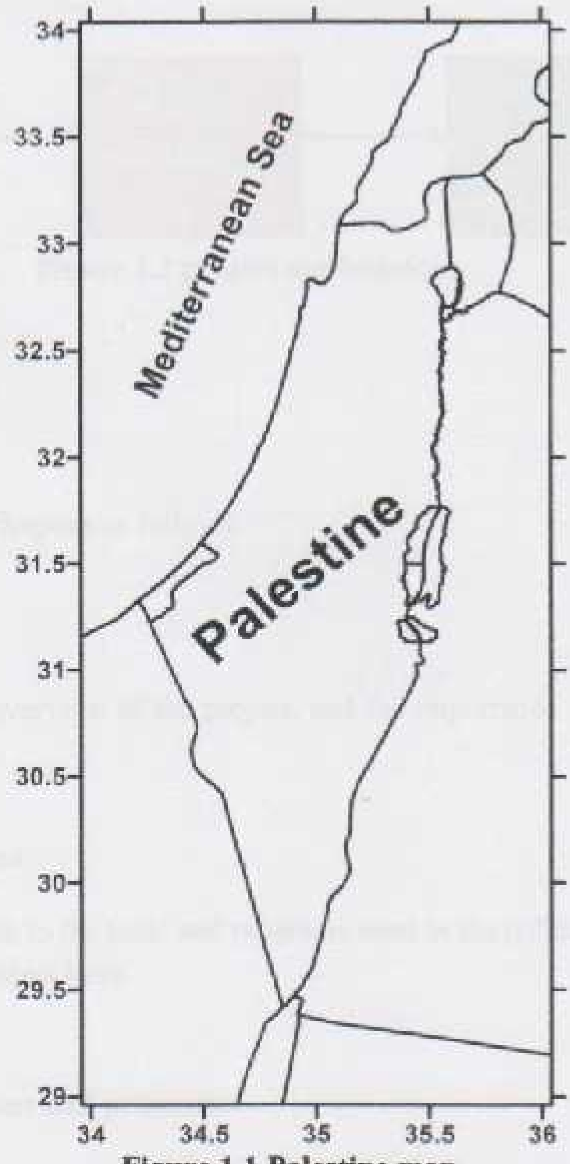


Figure 1.1 Palestine map

- relative humidity
- humidity ratio
- Temperature
- Enthalpy
- wind speed

In order to produce atlas data, the data should be representative to the relevant grids overlaying the domain chosen. In order to do so, climatologically data are identified on each station grid. The mean climatologically data representing the domain and distributed on the gridded area are the used to compute the wind speed and relative humidity, humidity ratio, enthalpy, temperature.

It is unfortunate that the Palestinian Meteorological Department did not provide us with the relevant data although such data are usually open for research institutions and even for public. The other option was to rely on available packages that have recorded climatologically data from associated stations, such as Meteonorm. The following block diagram illustrates the methodology adopted.

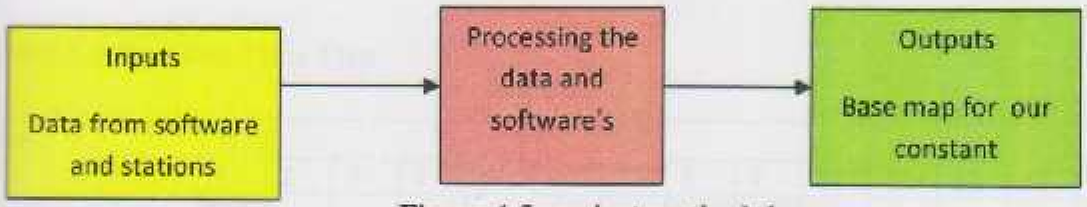


Figure 1.2 project methodology

1.5 Project Outline :

The proposal composed of four chapters as follows:-

Chapter one: - Introduction

This chapter includes an overview of the project, and the importance of this project. And the reason to work with it.

Chapter two: - Tools and Means

In this chapter we will look to the tools and programs used in the collection of information and mapping that aims of this project have.

Chapter three: - Basic definitions and properties

This chapter will talk about the parameters and characteristics that we will have a mapping, which we need in the calculations of thermal loads, and will be explained on the face of the shortcut and clarification.

Chapter four: Cooling load Calculation

This chapter we will look to talk and explain the equations of thermal loads that we have after dividing the region into four units based on climatic conditions.

1.6 Time planning:

The project plan follows the following time schedule, which includes the related task of study and system analysis.

1.6.1 The first semester time plan

Table 1.1 the First Time Plan

Process	Week														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Choosing group															
Project determination															
Understanding project concept															
Searching for Soft wares															
Getting started With soft wares															
Data collection															
Writing documentation															

1.6.2 The second semester time plan

Table 1.2 the second time plan

Process	Week														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Climate data Collection															
Constants and equation data calculation															
Using golden software to build maps															
Data analysis and relevant formatting															
Simulation software building															
Writing project document															

CHAPTER TWO
Tools And Means

2.1 Software Tools:

Two main software packages were used. The first is database software that represents meteorological stations associated with the software and located all over the world. The second software is the golden surfer used professionally to present meteorological data distributed over geographic domains as overlays. Both software are used together in this context.

2.1.1. METEONORM

It is a comprehensive meteorological reference, incorporating a catalogue of meteorological data and calculation procedures for solar applications and system design at any desired location in the world. It is based on over 20 years of historical data collection in the process of developing meteorological databases for energy applications. The software addresses engineers, architects, teachers, planners and those interested in solar energy and climatology.

The associated stations that have their historical data attached and updated in the software are more than 7'700 weather stations, with measured parameters of global radiation, temperature, humidity, precipitation, days with precipitation, wind speed and direction, sunshine duration, in addition to updated global radiation database for period (1981-2008), also it uses satellite data for areas with low density of weather stations, beside the Inclusion of climate change forecast.

The software has built in interpolation algorithms based on several interpolation methodologies. Data can be imported by users and can be obtained in different formats and in five languages; English, French, German, Italian and Spanish.

Data import:

The software offers 28 different predefined output formats that may be used for the calculation of hourly as well as monthly climatologically parameters values and can then be converted to ASCII formats" [1].

The following figures are examples of the software interface.

Example:

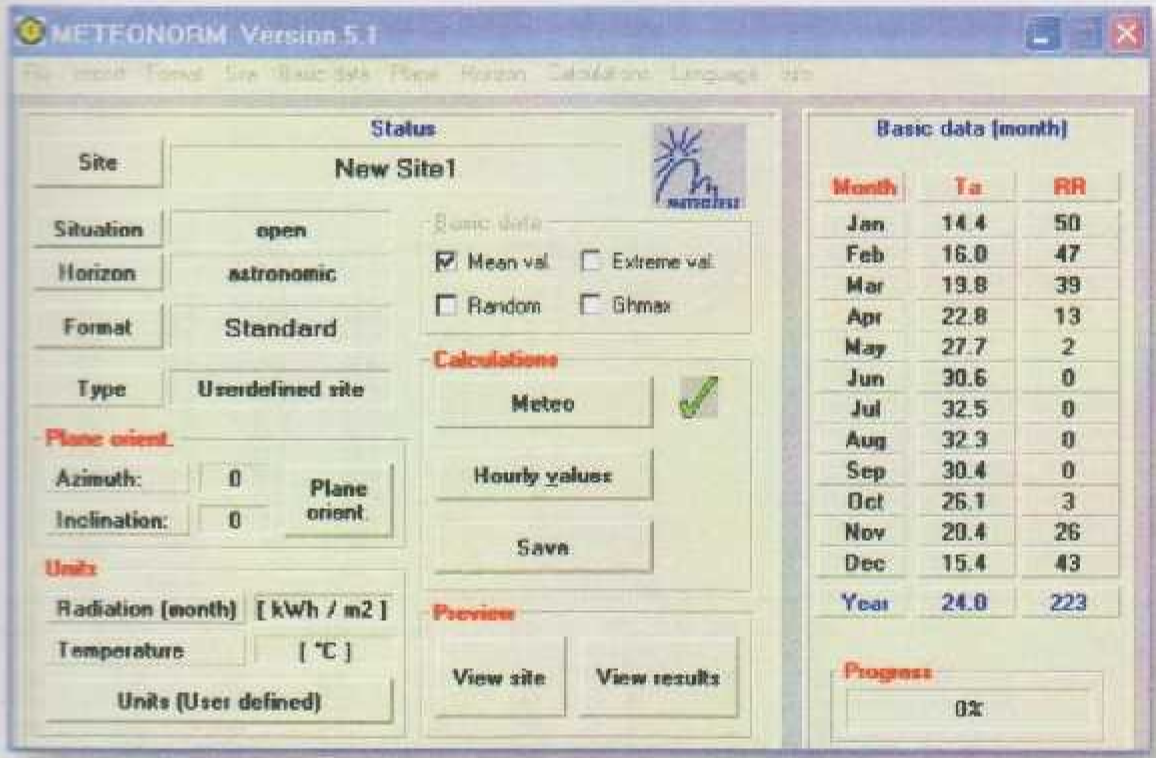


Figure (2.1): Meteonorm program

Calculation (hour)

10. 06. 2009 / 15:02

METEONORM Version 5.1

Site:	New Site1		
Situation:	open		
Horizon:	astronomic		
Type	Userdefined site	Format	METEO

Month	Ta	Ta min	Ta dmin	Ta dmax	Ta max	RH
Jan	14.4	2.7	8.7	19.9	24.4	64
Feb	16.0	4.3	10.3	21.2	26.8	58
Mar	19.8	6.4	13.8	25.2	31.0	51
Apr	22.8	9.6	16.0	28.5	34.6	47
May	27.7	13.9	20.6	33.9	39.8	42
Jun	30.6	17.4	23.0	36.2	40.6	43
Jul	32.5	18.1	26.3	39.1	42.9	43
Aug	32.3	19.0	25.7	38.1	41.5	46
Sep	30.4	16.5	23.9	35.6	40.2	49
Oct	26.1	15.2	20.6	31.4	35.5	54
Nov	20.4	8.8	14.2	25.9	32.3	57
Dec	15.4	3.6	9.7	21.2	26.2	63
Year	24.0					52

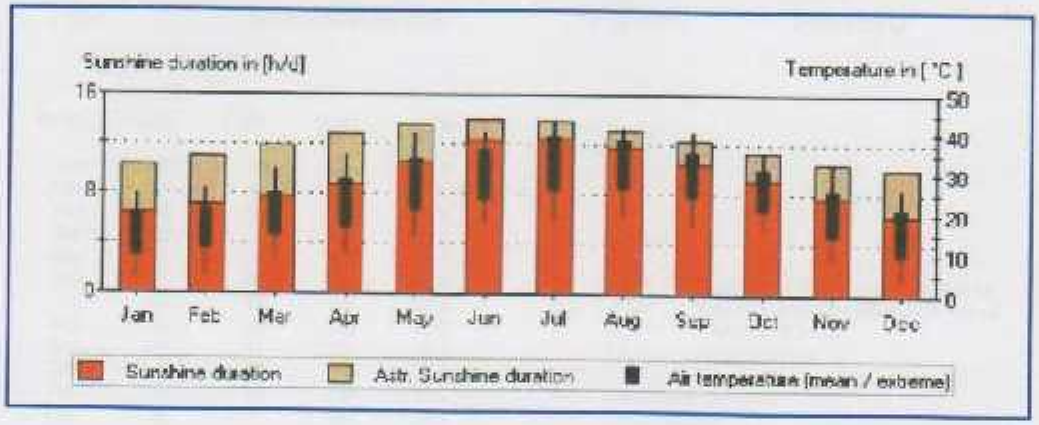
Month	H_Gh	SDm	SDd	SD astr.	RR	RD	FF	DD
Jan	103	197	6.4	10.2	50	6	1.5	90
Feb	111	198	7.1	11.0	47	5	1.6	90
Mar	165	240	7.7	11.9	39	4	1.8	90
Apr	190	261	8.7	12.8	13	2	1.9	338
May	229	326	10.5	13.5	2	1	1.7	338
Jun	243	368	12.3	14.0	0	0	1.7	315
Jul	250	385	12.4	13.8	0	0	1.7	315
Aug	228	365	11.8	13.1	0	0	1.5	315
Sep	194	313	10.4	12.2	0	0	1.4	338
Oct	169	281	9.1	11.3	8	1	1.4	338
Nov	118	232	7.7	10.4	26	3	1.6	90
Dec	96	195	6.8	10.0	43	5	1.4	90
Year	2081	3362	9.0		229	26	1.6	1

Legend:

Ta:	Air temperature	RH:	Relative humidity
Ta min:	10 y minimum (approx.)	Ta max:	10 y maximum (approx.)
Ta dmin:	Mean daily minimum Ta	Ta dmax:	Mean daily maximum Ta
SD:	Sunshine duration	RR:	Precipitation
RD:	Days with precipitation	FF:	Wind speed
SD astr.:	Sunshine duration, astronomic	DD:	Wind direction
H_Gh:	Irradiation of global radiation horizontal		

Temperature in: [°C]
Wind speed in: [m/s]
Sunshine duration in: [h/day]
Radiation in: [kWh/m²]

New Site1



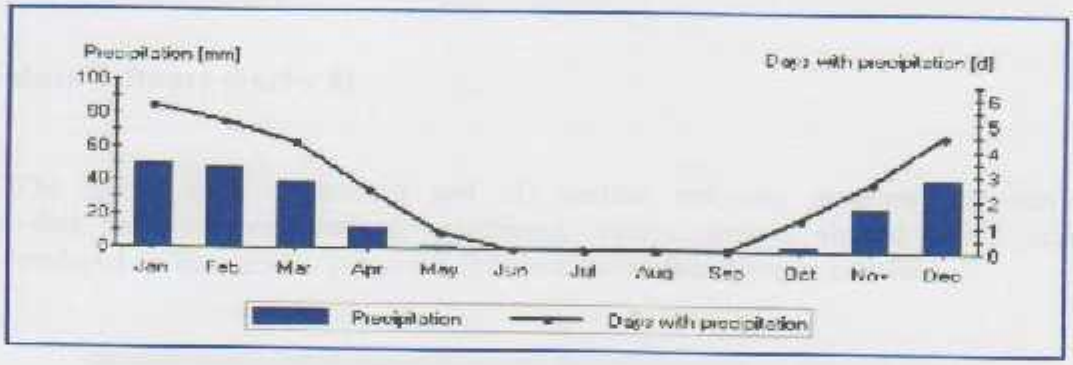


Figure (2.2): Meteonorm (monthly values diagram)

Calculation (hour) 10. 06. 2009 / 15:11

METEONORM Version 5.1

Site:	New Site1		
Situation:	open		
Horizon:	astronomic		
Azimuth:	0	Inclination:	0
Type	Userdefined site	Format	Standard

Month	H_Gh	H_Dh	H_Bn	Ta
Jan	103	49	138	14.4
Feb	111	44	128	18.0
Mar	165	50	169	19.8
Apr	190	74	186	22.8
May	229	73	218	27.7
Jun	243	60	268	30.8
Jul	250	57	262	32.5
Aug	228	56	258	32.3
Sep	194	47	221	30.4
Oct	169	42	199	26.1
Nov	116	36	161	20.4
Dec	96	37	151	15.4
Year	2081	639	2278	24.0

Legend:

H_Gh: Irradiation of global radiation horizontal
H_Dh: Irradiation of diffuse radiation horizontal
H_Bn: Irradiation of beam
Ta: Air temperature

Radiation in [kWh/m²]
Temperature in [°C]

2.1.2 Golden Software (Surfer 8)

"The Surfer is a contouring and 3D surface mapping program that can easily convert data into contour, surface, wireframe, vector, image, shaded relief, and post maps overplayed on base maps. (Figure 2.3) below shows the software interface.

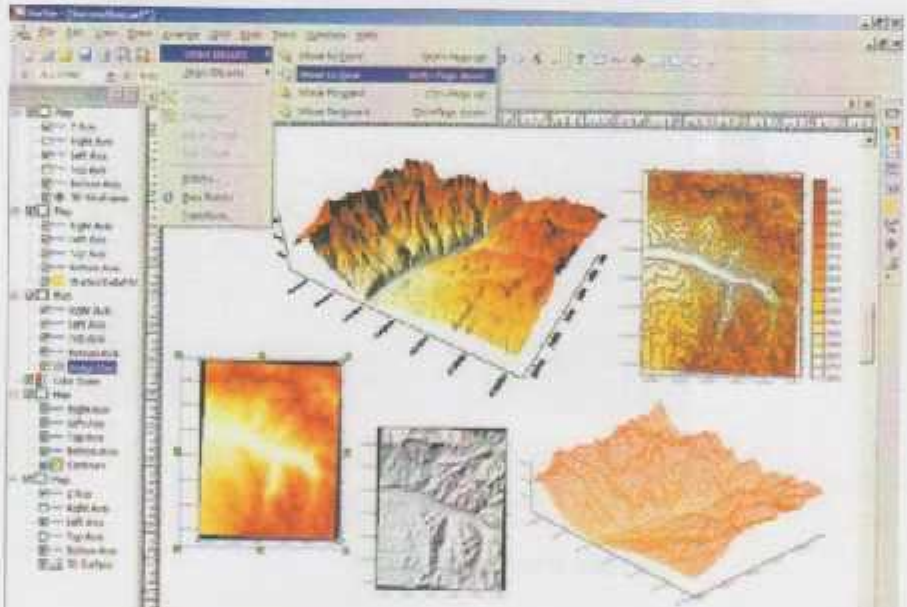


Figure (2.3): Golden software (Surfer 8)

Surfer contour maps could be easily customized with specific features that may illustrate the distributed parameters over the geographic areas.

An example map produced by the software is shown in (Figure 2.4) below.

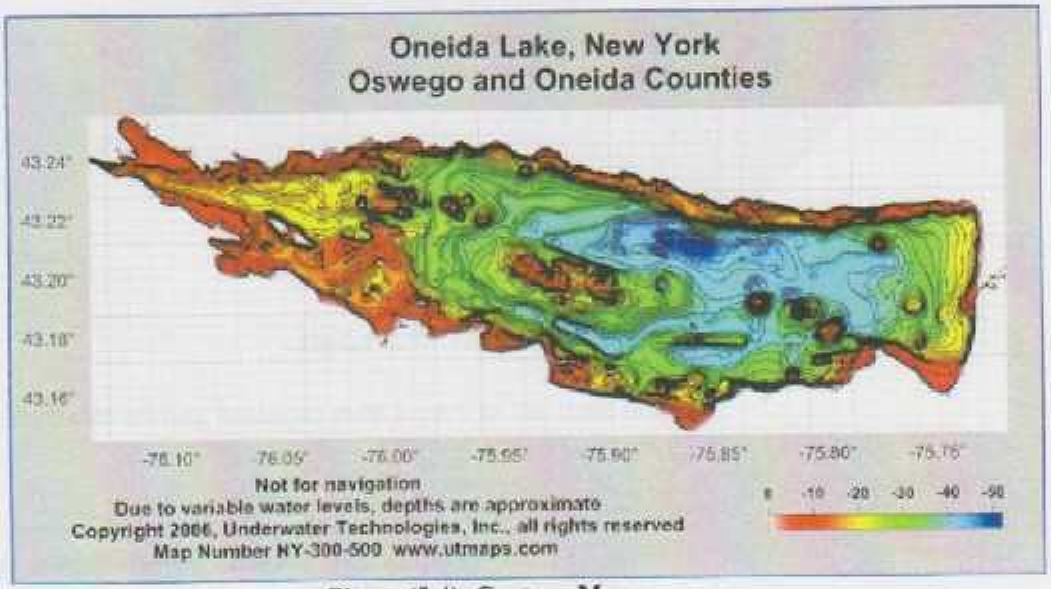
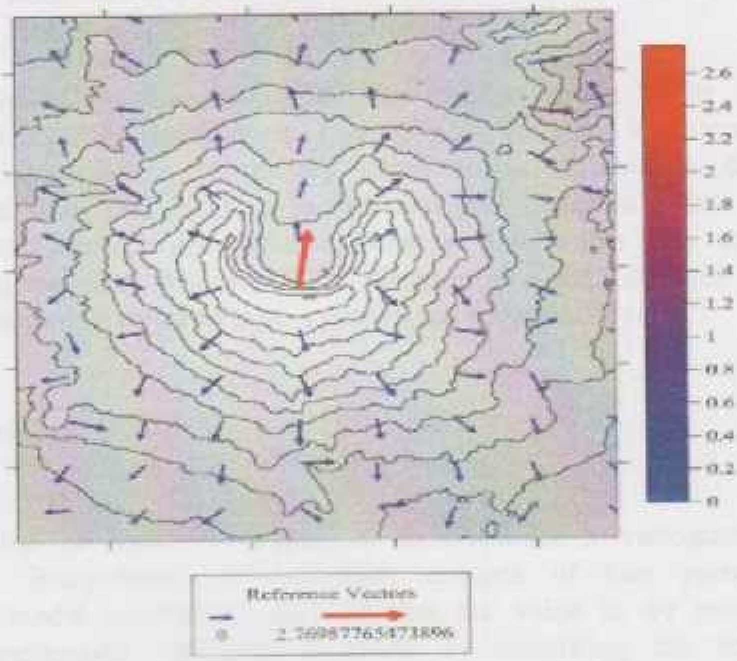


Figure (2.4): Contour Map

In addition to contour maps, software has the capability to produce vector maps presents the magnitude and directions of vectors, such as wind. As shown in (Figure 2.5 and 2.6)".



Figure(2.5): Vector map

Figure (2.6): Vector map

The capability includes adding multiple map layers to the base map

2.2 Method for interpolating climatological data:

The method used in this work is called the Kriging interpolation technique which is named after the South African mining engineer D. G. Kriging who developed the technique in an attempt to more accurately predict ore reserves. Over the past several decades Kriging has become a fundamental tool in the field of geo-statistics.

Kriging is based on the assumption that the parameter being interpolated can be treated as a regionalized variable. A regionalized variable is intermediate between a truly random variable and a completely deterministic variable in that it varies in a continuous manner from one location to the next and therefore points that are near each other have a certain degree of spatial correlation, but points that are widely separated are statistically independent (Davis, 1986). Kriging is a set of linear regression routines which minimize estimation variance from a predefined covariance model.

2.2.1 Ordinary Kriging

The first step in ordinary kriging is to construct a variogram from the scatter point set to be interpolated. A variogram consists of two parts: an experimental variogram and a model variogram. Suppose that the value to be interpolated is referred to as f. The experimental variogram is found by calculating the variance (g) of each point in the set with respect to each of the other points and plotting the variances versus distance (h) between the points. Several formulas can be used to compute the variance, but it is typically computed as one half the differences in f squared.

Once the experimental variogram is computed, the next step is to define a model variogram. A model variogram is a simple mathematical function that models the trend in the experimental variogram.

As can be seen in the above figure, the shape of the variogram indicates that at small separation distances, the variance in f is small. In other words, points that are close together have similar f values. After a certain level of separation, the variance in the f values becomes somewhat random and the model variogram flattens out to a value corresponding to the average variance.

Once the model variogram is constructed, it is used to compute the weights used in kriging. The basic equation used in ordinary kriging is as follows:

$$F(x,y) = \sum_{i=1}^{n} w_i f_i \tag{2.1}$$

Where n is the number of scatter points in the set, if are the values of the scatter points, and we are weights assigned to each scatter point. This equation is essentially the same as the equation used for inverse distance weighted interpolation except that rather than using weights based on an arbitrary function of distance, the weights used in kriging are based on the model variogram. For example, to interpolate at a point P based on the surrounding points P1, P2, and P3, the weights w1, w2, and w3 must be found. The weights are found through the solution of the simultaneous equations:

$$w_1 S(d_{11}) + w_2 S(d_{12}) + w_3 S(d_{13}) = S(d_{1p}) \tag{2.2}$$

$$w_1 S(d_{12}) + w_2 S(d_{22}) + w_3 S(d_{23}) = S(d_{2p}) \tag{2.3}$$

$$w_1 S(d_{13}) + w_2 S(d_{23}) + w_3 S(d_{33}) = S(d_{3p}) \tag{2.4}$$

Where S (dij) is the model variogram evaluated at a distance equal to the distance between points (i) and (j). For example, S (d1p) is the model variogram evaluated at a distance equal to the separation of points P1 and P.

Chapter Three

Basic properties and maps for Palestine

3.1 Introduction

In this chapter we will determine the general design parameters necessary for the design process; these parameters are the general outside condition. Such as the wind velocity, the average relative humidity, the outside temperature, the ground means temperature.

3.2 relative humidity:

They are many constants that are very important to study before we design the air conditioning for any space, and relative humidity is one of them. But what is relative humidity? And what is happened if we design at error relative humidity?

Relative humidity is defined as the ratio of the partial pressure of water vapor in a gaseous mixture of air and water vapor to the saturated vapor pressure of water at a given temperature [2]

If the percent of relative humidity increased or decreased at location that cause many of problems such as mold, corrosion, decay, etc. when it until to 70% . And when it reaches to 100% that cause condensation and at low relative humidity can lead to discomfort and shrinkage of wood floors and wood furniture.

From our study we see the difference in this percent from one location to another, so when we design the air conditioning we will understand this difference to decrease this percent at some location and increase it in anther.

The resulted map for relative humidity at summer season:

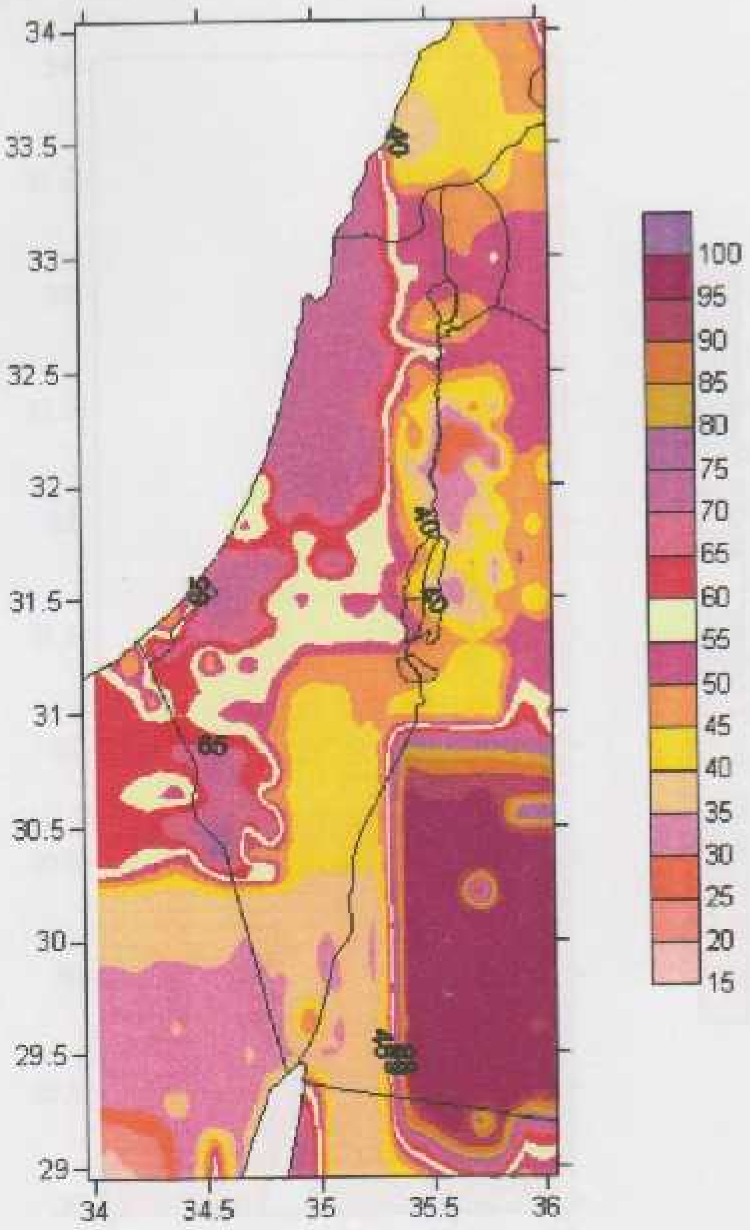


Fig (3.1) relative humidity map (summer)

The resulted map for relative humidity at spring season:

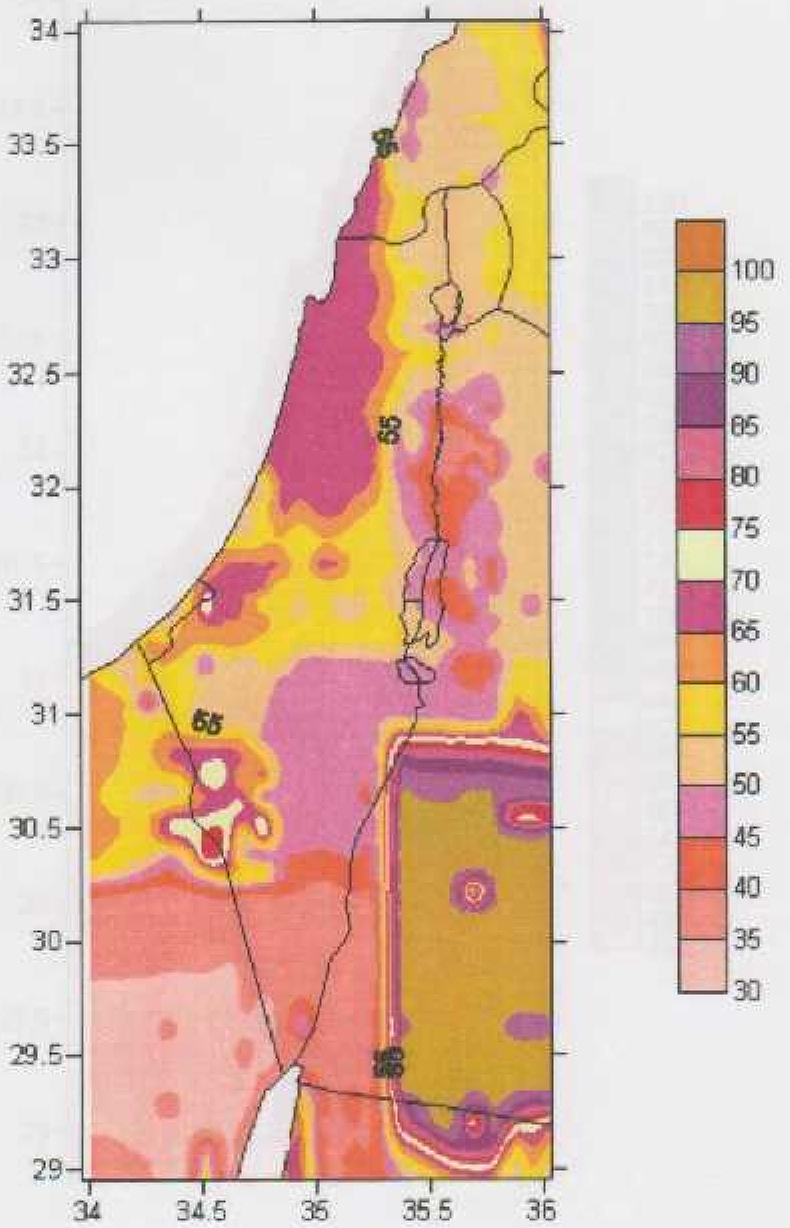


Fig (3.2) relative humidity map (spring)

The resulted map for relative humidity at winter season:

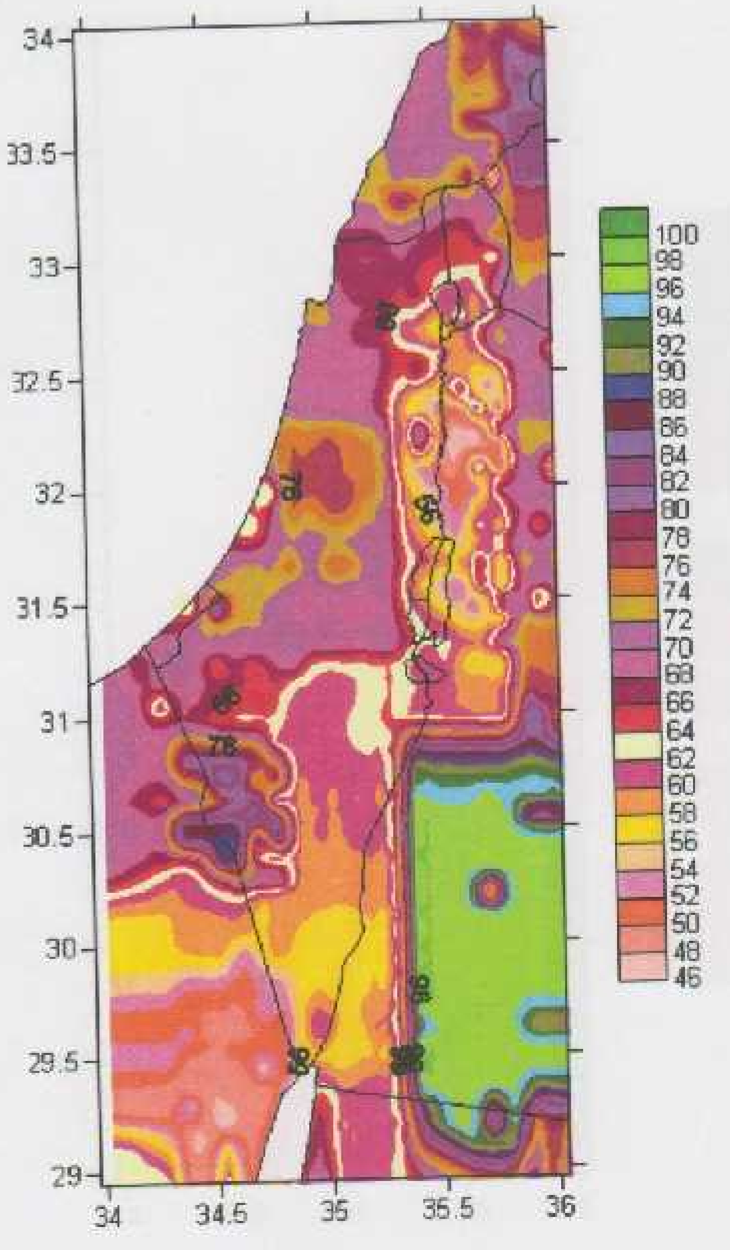


Fig (3.3) relative humidity map (winter)

The resulted map for relative humidity at autumn season:

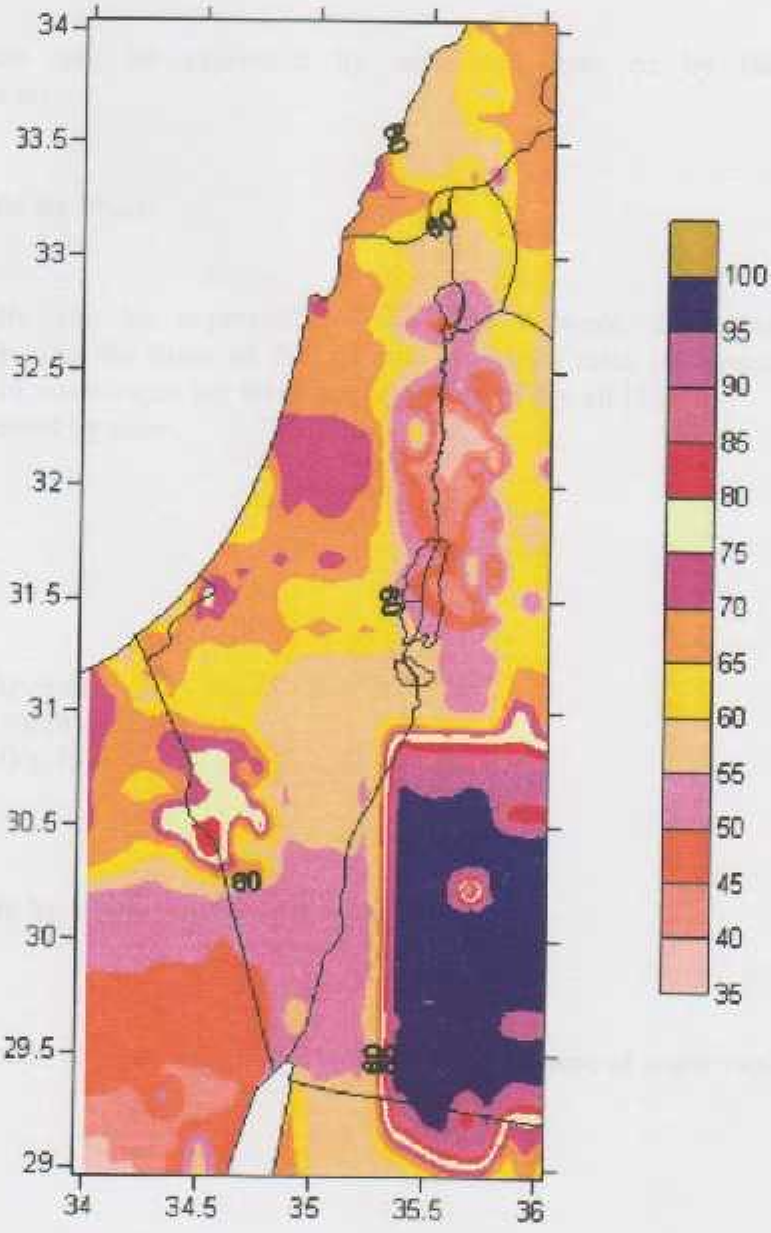


Fig (3.4) relative humidity map (autumn)

3.3 humidity ratio:

Humidity ratio can be expressed by mass of water or by the vapor partial pressure in the moist air.

3.3.1 Humidity Ratio by Mass:

Humidity ratio can be expressed as the ratio between the actual mass vapors present in moist air – to the mass of the dry air. Humidity ratio is normally expressed in kilogram or pounds of water vapor per kilogram or pounds of dry air [3].
Humidity ratio expressed by mass:

$$w = \frac{m_w}{m_a} \tag{3.1}$$

Where:

W= humidity ratio (kg water/kg dry air, lb water/lb dry air)
m_w= mass of water vapor (kg, lb)
m_a= mass of dry air (kg, Ib)

3.3.2 Humidity Ratio by Vapor Partial Pressure

Humidity ratio can also be expressed with the partial pressure of water vapor:

$$w = \frac{0.62198 p_w}{(p_a - p_w)} \tag{3.2}$$

Where:

pw = partial pressure of water vapor in moist air (Pa, psi)
pa = atmospheric pressure of moist air (Pa, psi)

The maximum amount of water vapor in the air is achieved when pw = pws the saturation pressure of water vapor at the actual temperature. Can be modified to:

$$w = \frac{0.62198 p_{ws}}{(p_a - p_{ws})} \tag{3.3}$$

Where:
ws = specific humidity at saturation
pws = saturation pressure of water vapor

Since the water vapor pressure is small regarding to the atmospheric pressure, the relation between the humidity ratio and the saturation pressure is almost linear.

Note that the saturation pressure of water vapor and the maximum humidity ratio increase dramatically with the air temperature. Which it important for the capacity of drying processes.

The resulted map for humidity ratio at summer season:

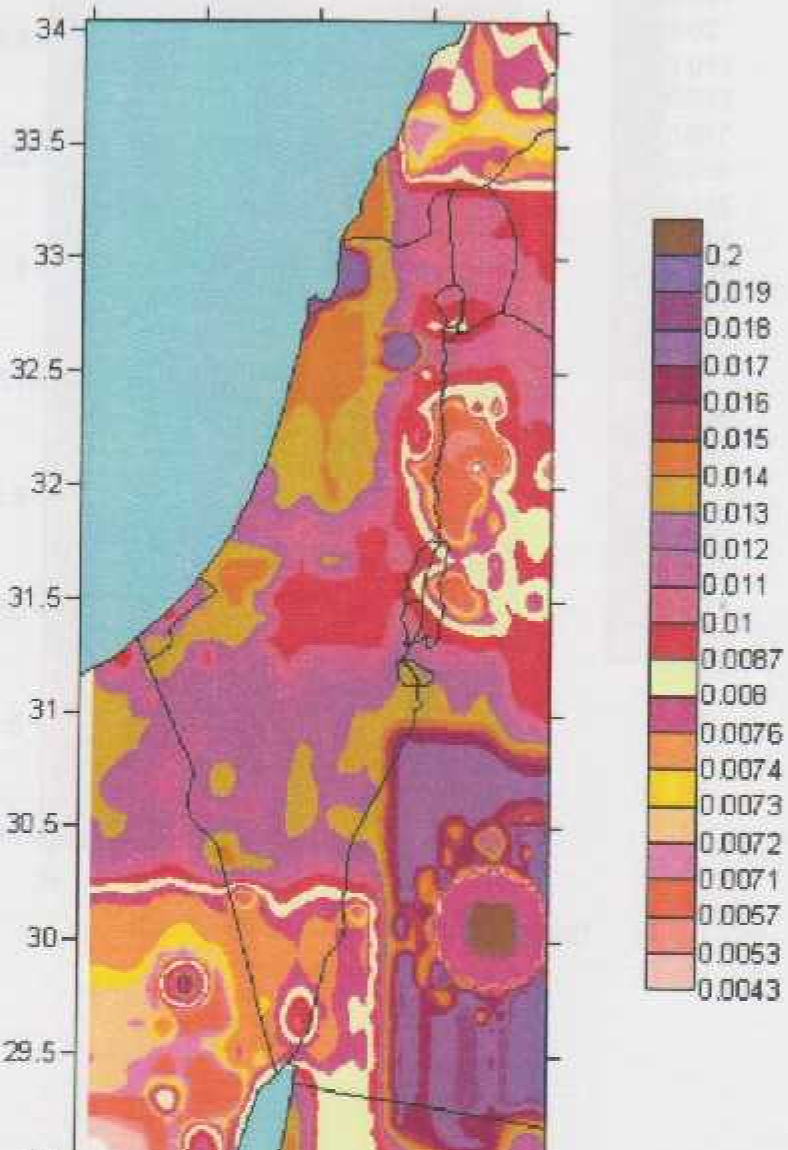


Fig (3.5) humidity ratio map (summer)

The resulted map for humidity ratio at spring season:

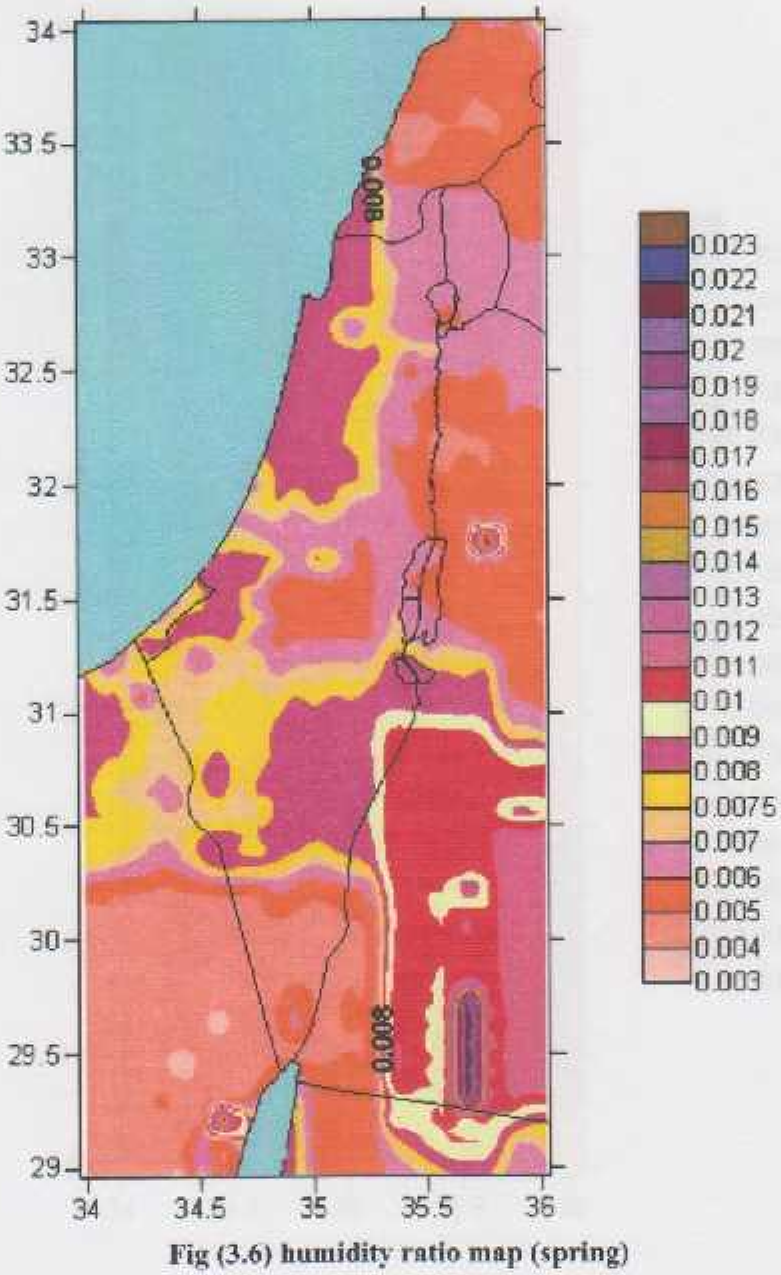


Fig (3.6) humidity ratio map (spring)

The resulted map for humidity ratio at winter season:

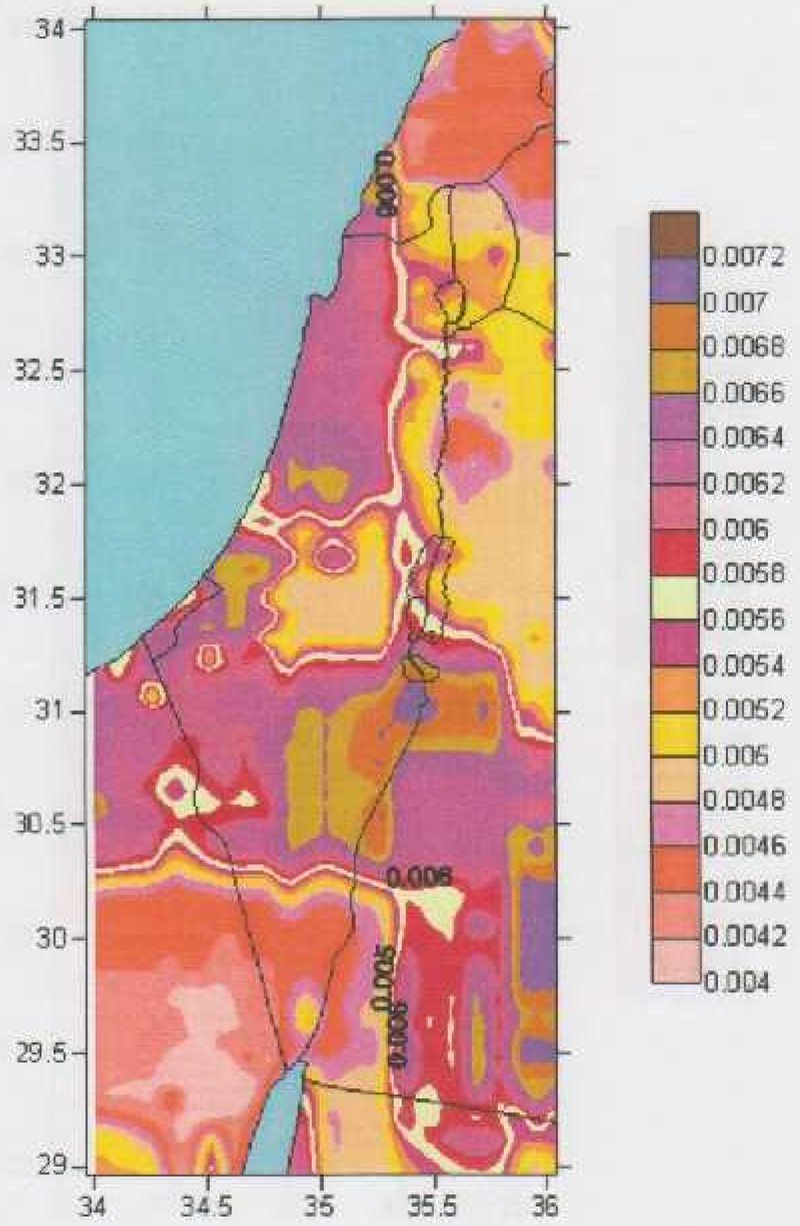


Fig (3.7) humidity ratio map (winter)

The resulted map for humidity ratio at autumn season:

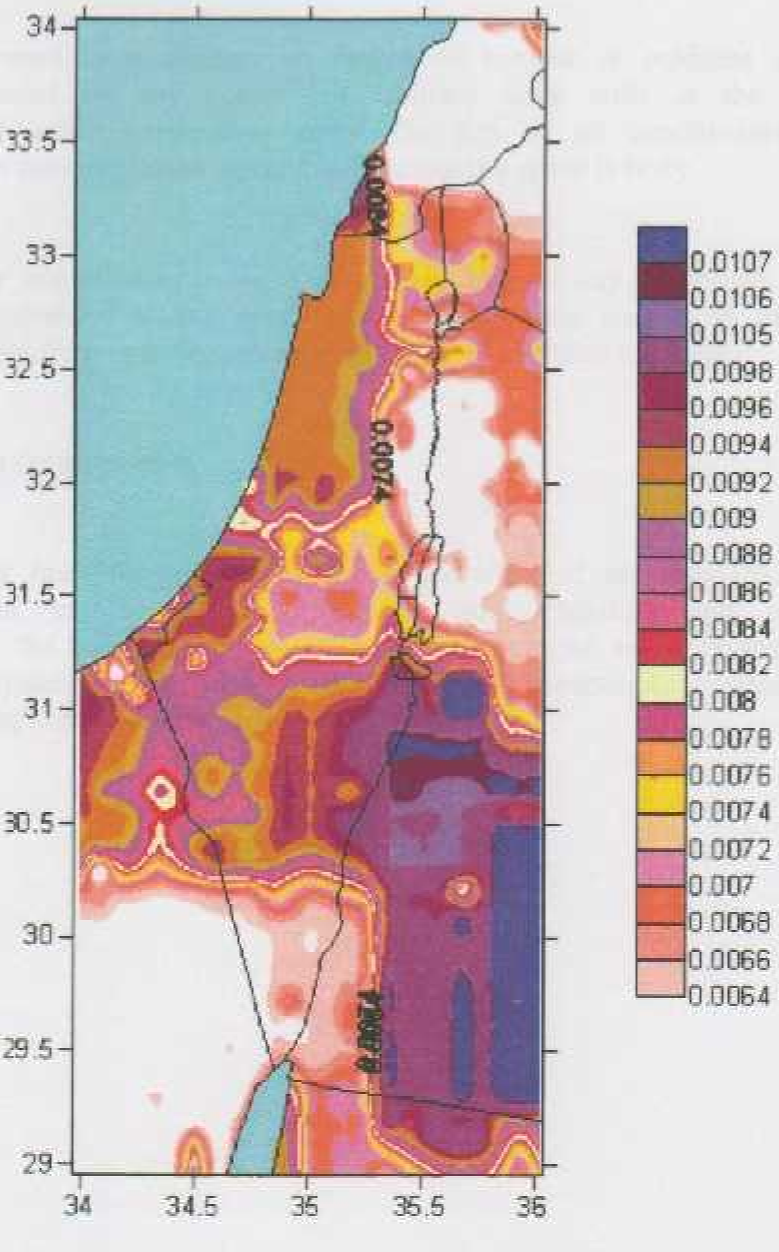


Fig (3.8) humidity ratio map (autumn)

3.4 Temperature:

Temperature is a measure of degree of hotness or coldness of any substance, it can be expressed on any convenient arbitrary scale such as the Celsius temperature scale and Fahrenheit temperature scale, the aim of air conditioning is to control the temperature, so the temperature in air conditioning is a spine in body.

Thus air conditioning is independent of time of day or season of the year. So we study the temperature relating many places or locations and at all time of year, and we so see it different from one place to another and from one time to another.

3.3.1 Dry bulb temperature:

The dry bulb temperature is the temperature of air measured by a thermometer freely exposed to the air but shielded from radiation and moisture. Dry bulb temperature is the temperature that is usually thought of as air temperature, and it is the true thermodynamic temperature. It is the temperature measured by a regular thermometer exposed to the airstream.

The resulted map for dry bulb temperature at summer season:

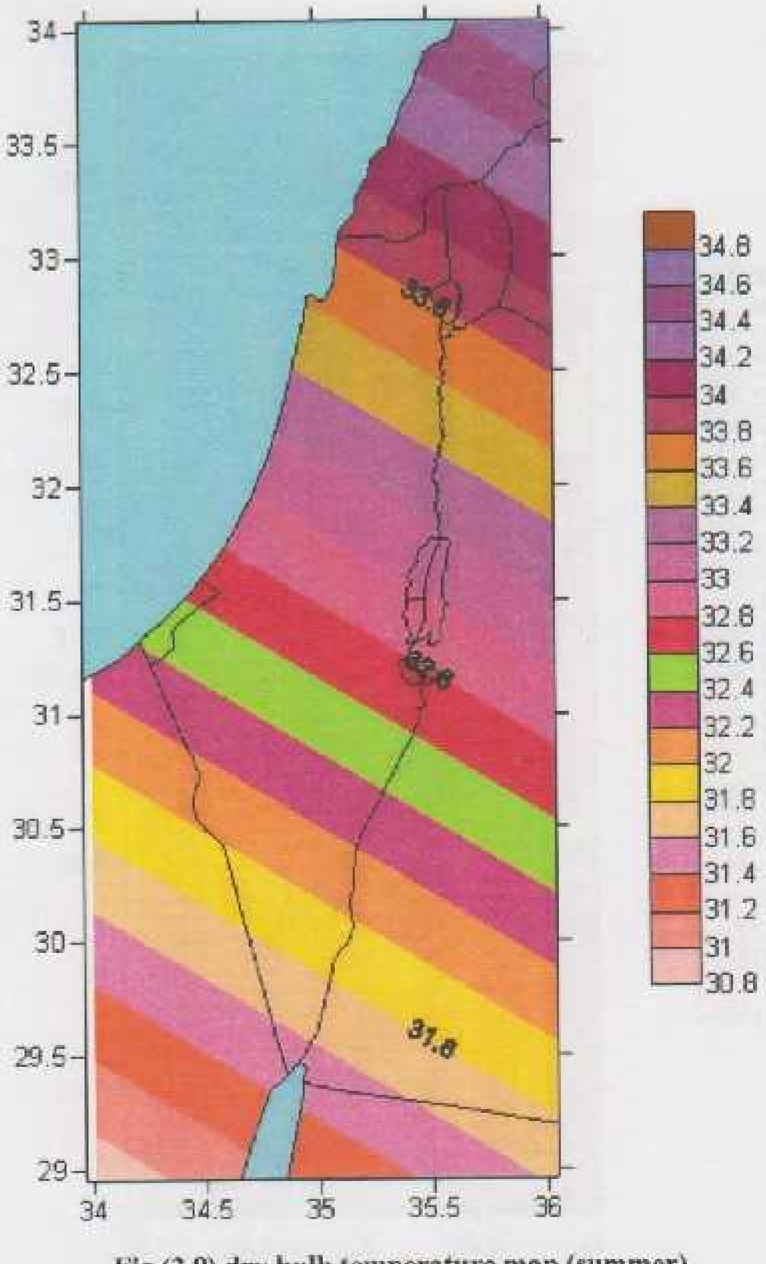


Fig (3.9) dry bulb temperature map (summer)

The resulted map for dry bulb temperature at spring season:

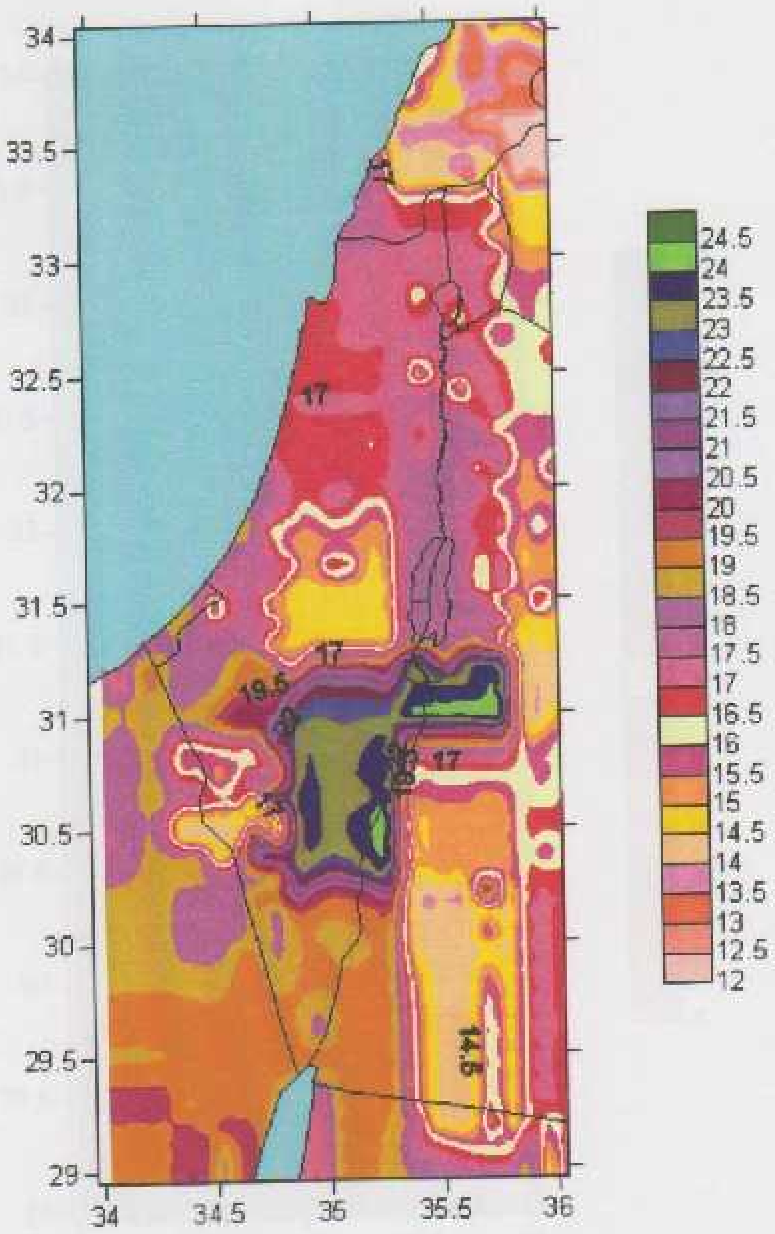


Fig (3.10) dry bulb temperature map (spring)

The resulted map for dry bulb temperature at winter season:

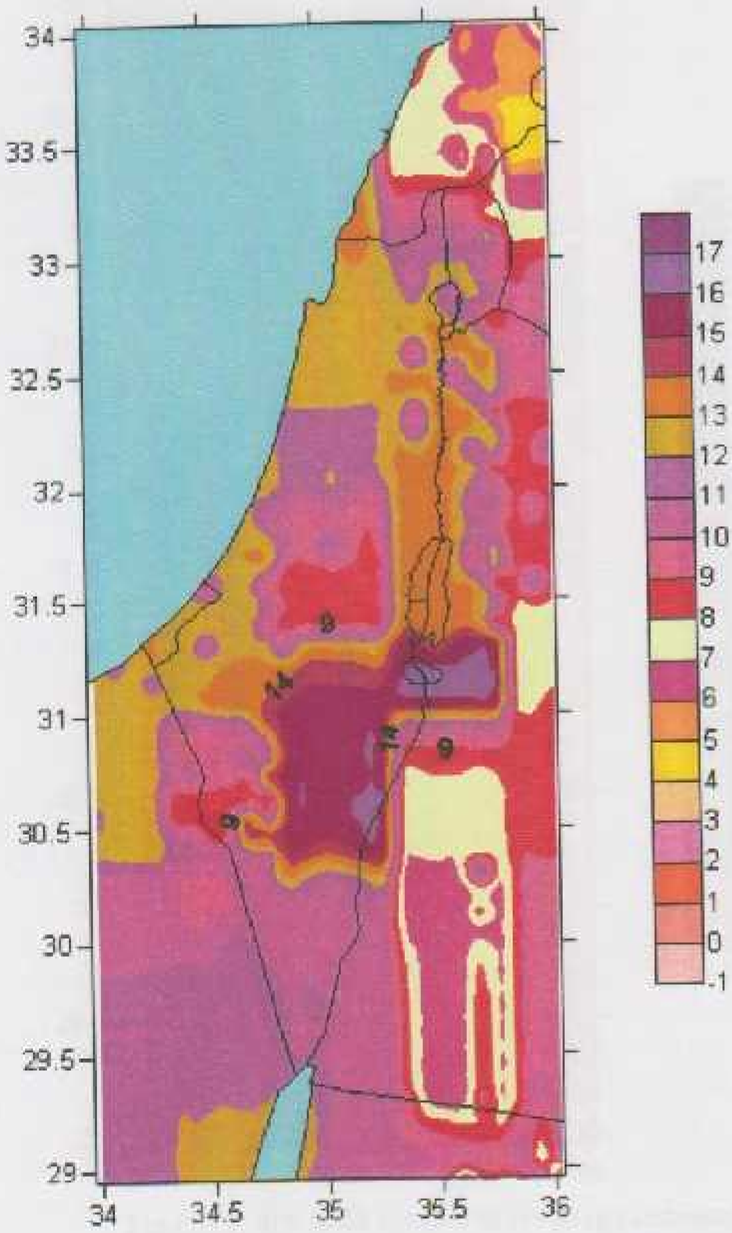


Fig (3.11) dry bulb temperature map (winter)

The resulted map for dry bulb temperature at autumn season:

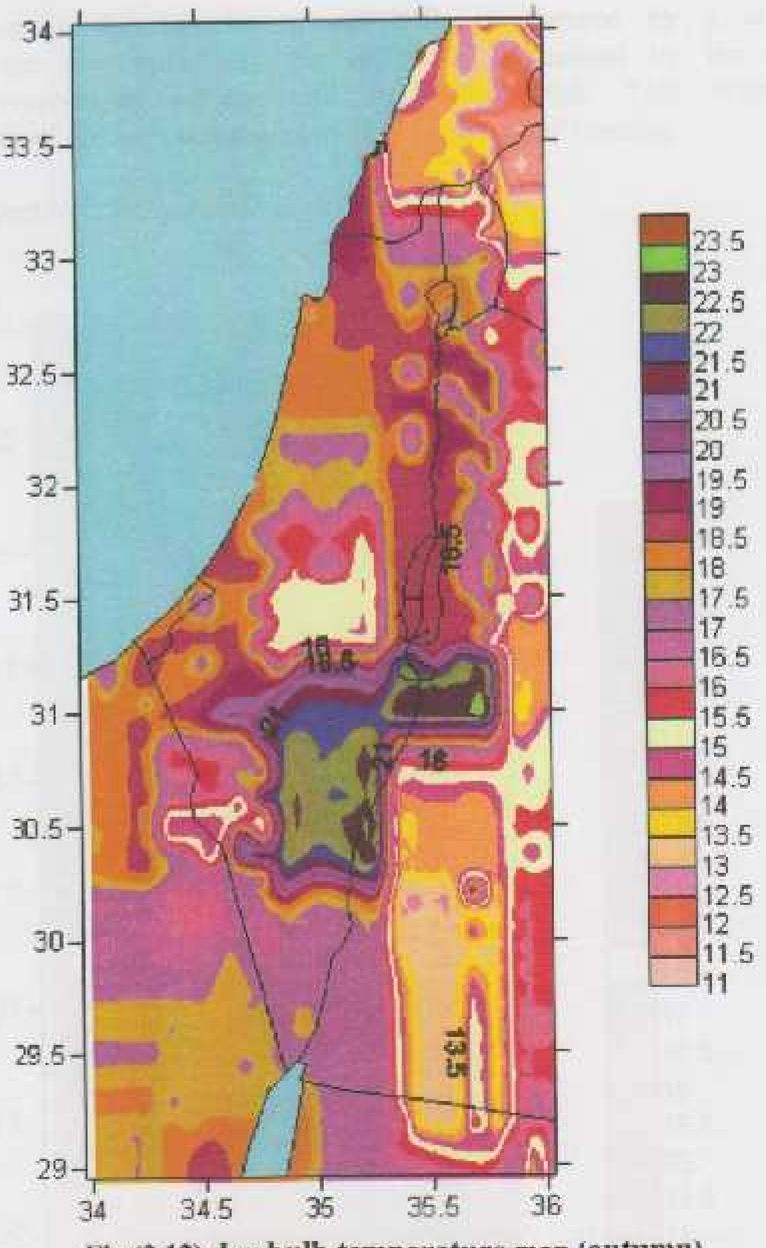


Fig (3.12) dry bulb temperature map (autumn)

3.4.2 Wet bulb temperature:

It is read from a thermometer whose bulb is covered by a wet wick. The difference between the wet bulb and the dry bulb is caused by the cooling effect produced by the evaporation of moisture from the wick. This evaporation effect reduces the temperature of the bulb and therefore the thermometer reading.

The resulted map for wet bulb temperature at summer season:

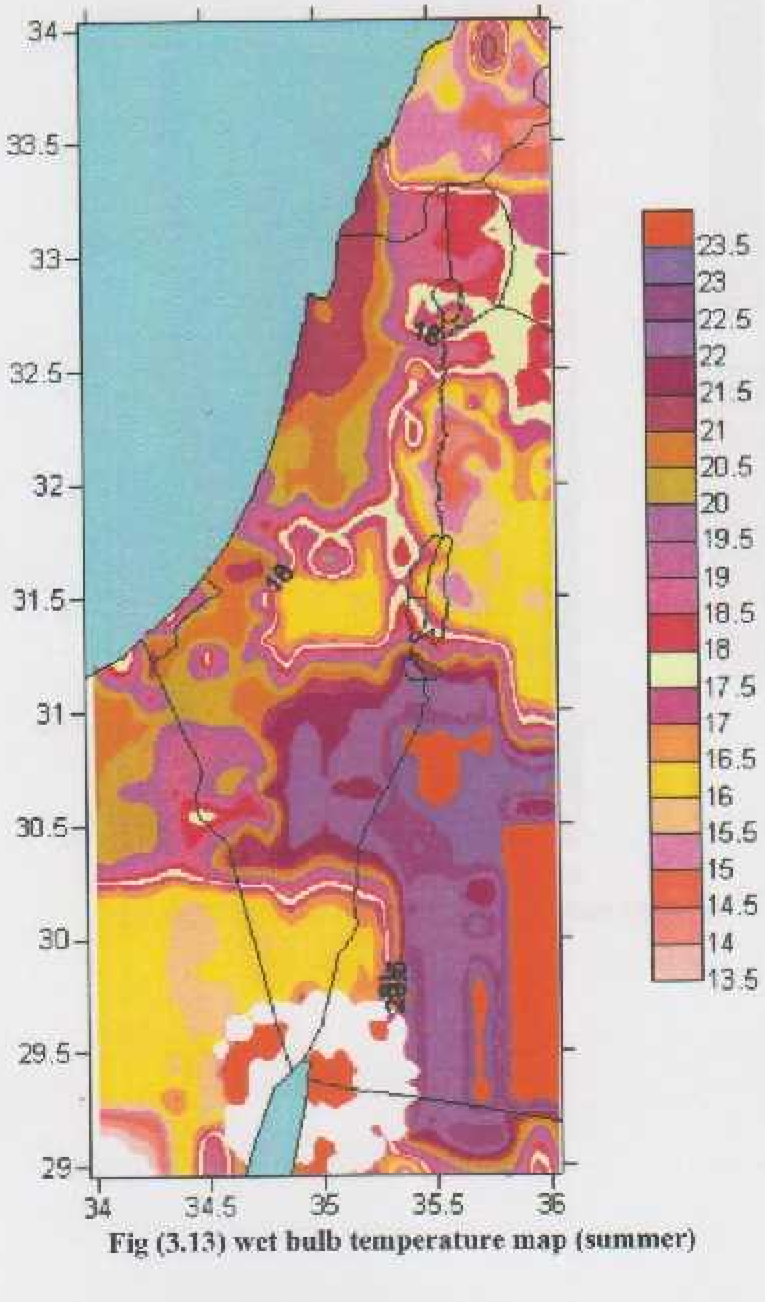


Fig (3.13) wet bulb temperature map (summer)

The resulted map for wet bulb temperature at spring season:

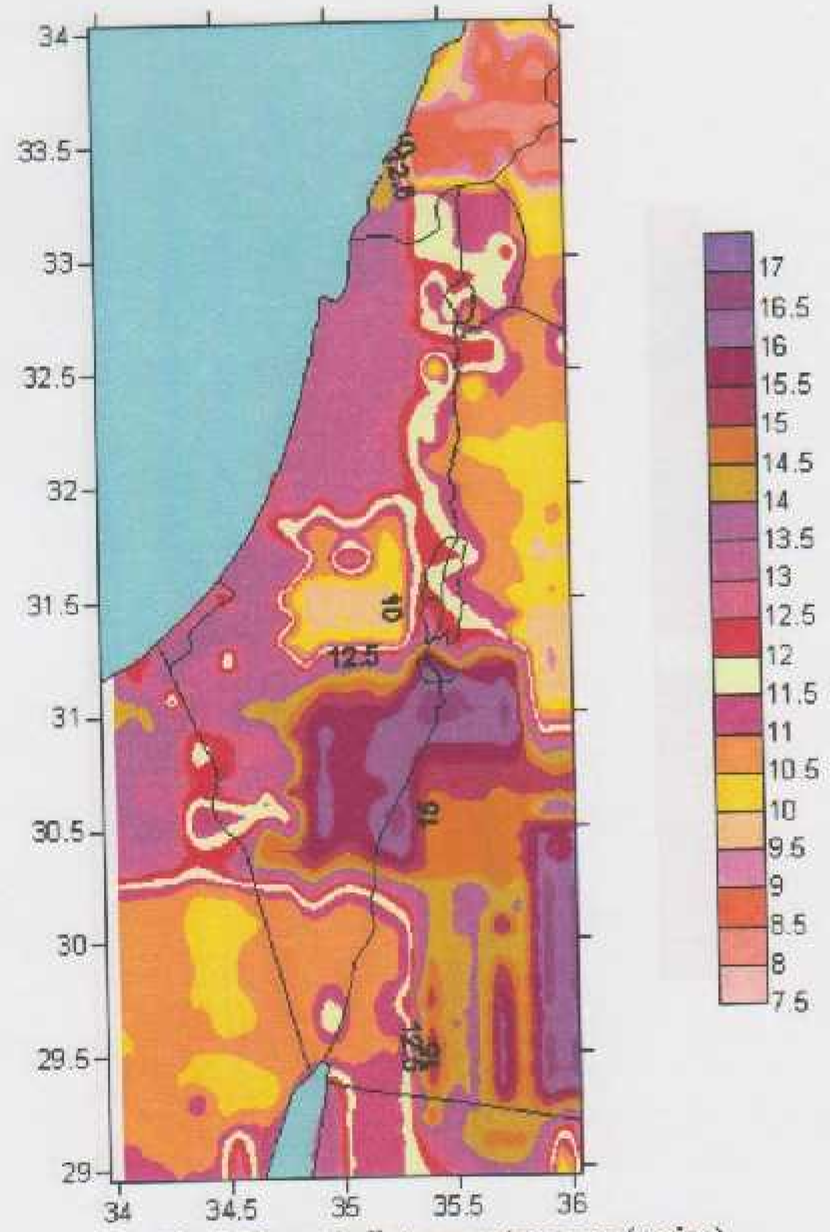


Fig (3.14) wet bulb temperature map (spring)

The resulted map for wet bulb temperature at winter season:

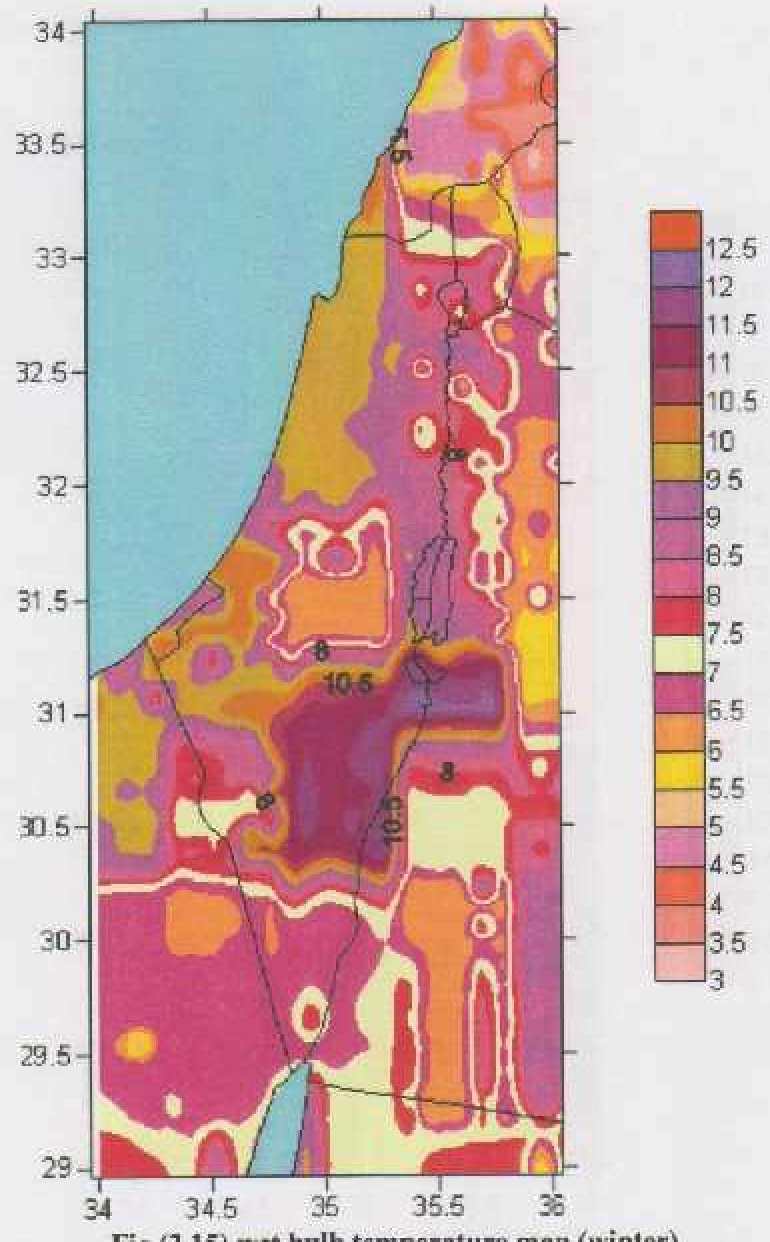


Fig (3.15) wet bulb temperature map (winter)

The resulted map for wet bulb temperature at autumn season:

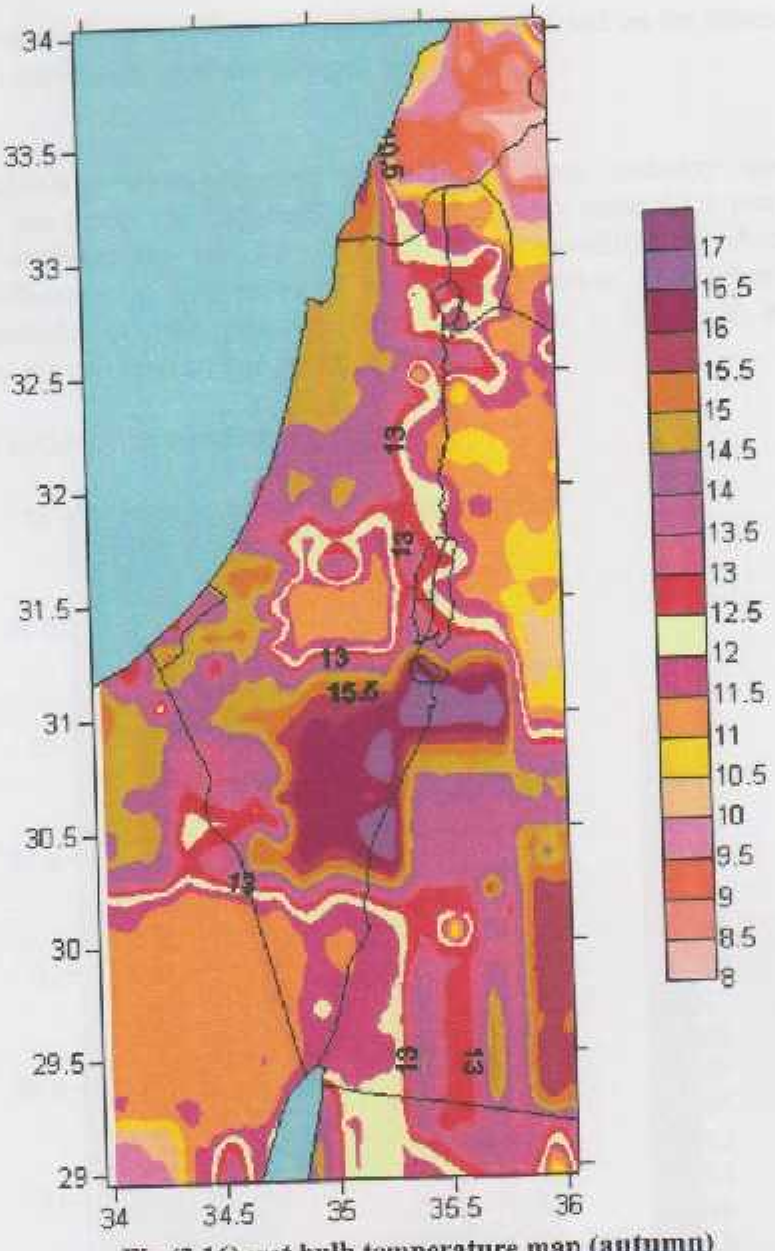


Fig (3.16) wet bulb temperature map (autumn)

Consequently, the difference between dry bulb and wet bulb temperature reading is a measure of the dryness of air. The drier the air, the greater the difference between the dry bulb and wet bulb readings.

3.5 enthalpy:

Enthalpy defined as a heat content it contains is a system based on the internal energy of the system, based on temperature changes changes this values.

From this definition we understand the relation from enthalpy and temperature, and from our study we know the air conditioning aim is to control of temperature, so if we can control of enthalpy we can take to aim of air conditioning. According to our study we see the difference of this property from one location to another , and we can determine the magnitude of this property from this map , where it effected at the system or process that we can used in this position .

The resulted map for enthalpy at summer season:

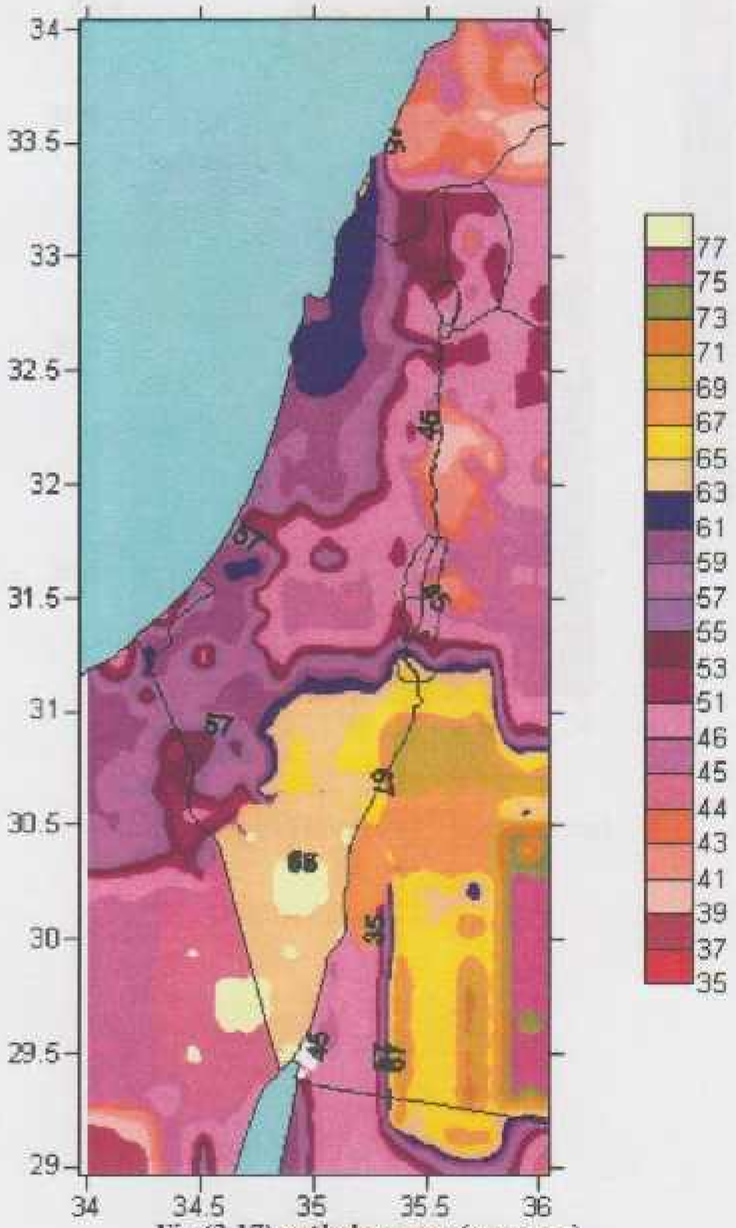


Fig (3.17) enthalpy map (summer)

The resulted map for enthalpy at spring season:

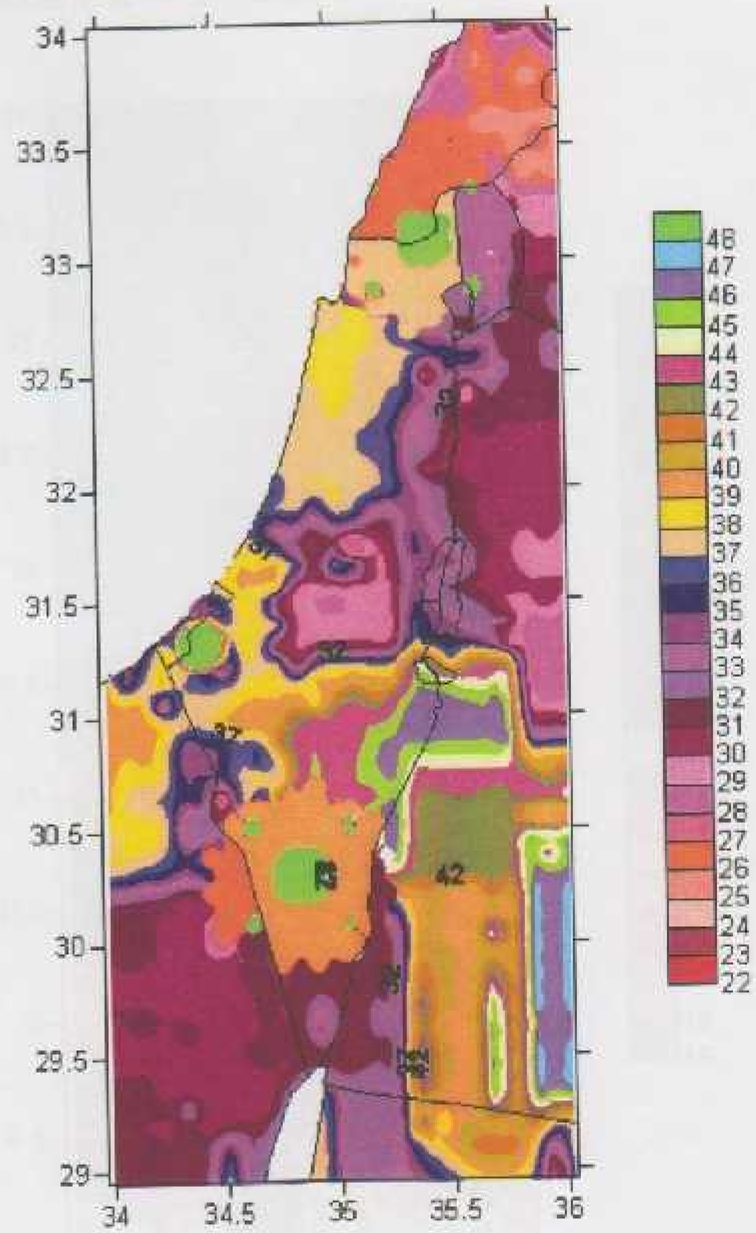


Fig (3.18) enthalpy map (spring)

The resulted map for enthalpy at winter season:

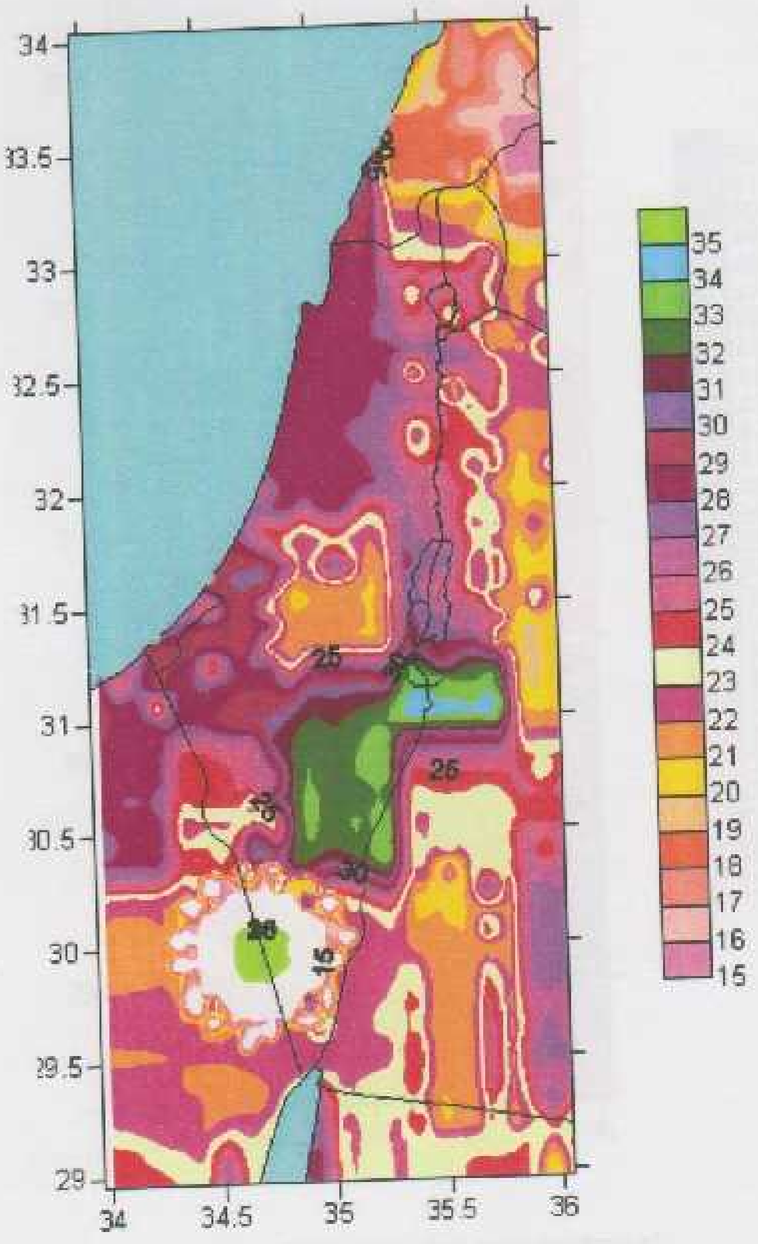


Fig (3.19) enthalpy map (winter)

The resulted map for enthalpy at autumn season:

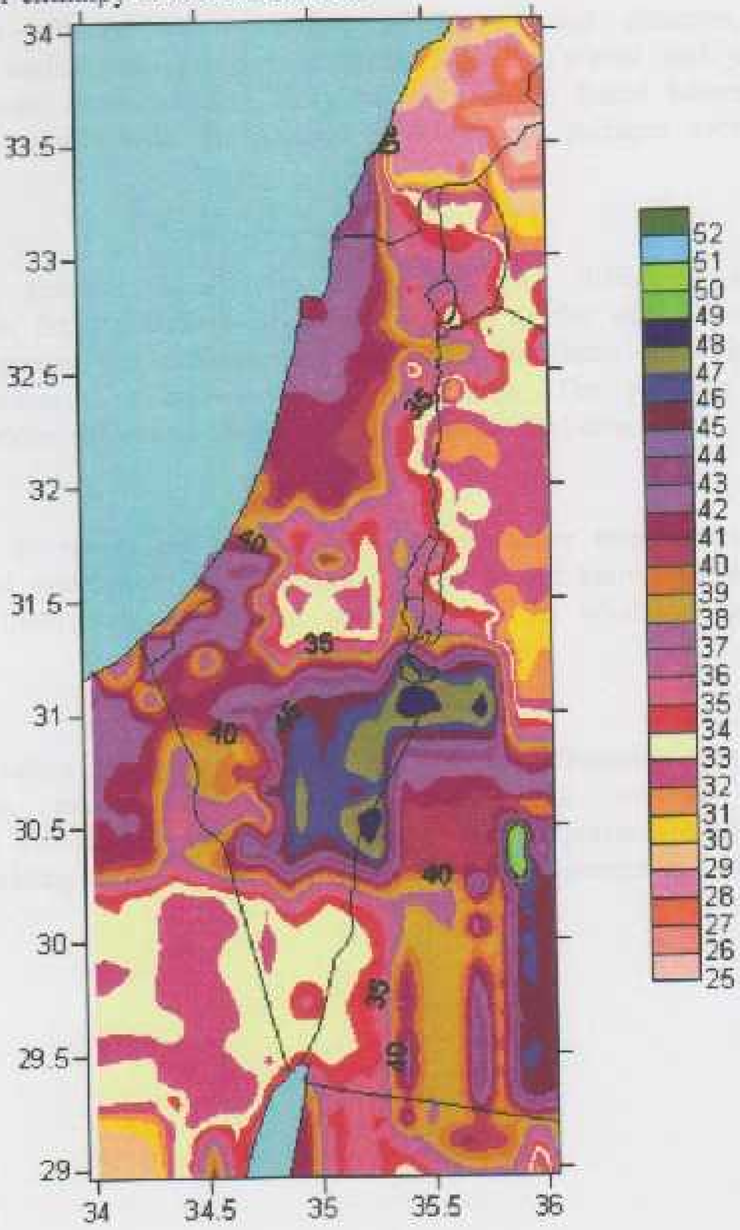


Fig (3.20) enthalpy map (autumn)

3.6 wind speed:

Wind speed is affected by a number of factors and situation, operating on varying scales, these include the pressure gradient, Ross by waves and jet streams, and local weather conditions, there are also links to links to be found between wind speed and wind direction , notably with the pressure gradient and surfaces over which the air is found.

First: Pressure gradient is a term to describe the difference in air pressure between two points in the atmosphere or on the surface of the earth. It is vital to wind speed, because the greater the difference in pressure, the faster the wind flows (from the high to low pressure) to balance out the variation. The pressure gradient when combined with the Coriolis Effect and friction also influences wind direction.

Second : Ross by waves are strong winds in the upper troposphere these operate on a global scale and move from west to east (hence being known as westerlies) , the Ross by waves are themselves a different wind speed from what we experience in the lower troposphere.

Third: local weather conditions play a key role in influencing wind speed, as the formation hurricanes, monsoons and cyclones as freak weather conditions can drastically affect the velocity of the wind, so it is very important to study the velocity of air around the building that we work in it to chose the systems and devices to use in air conditioning [4].

The resulted map for wind speed at summer season:

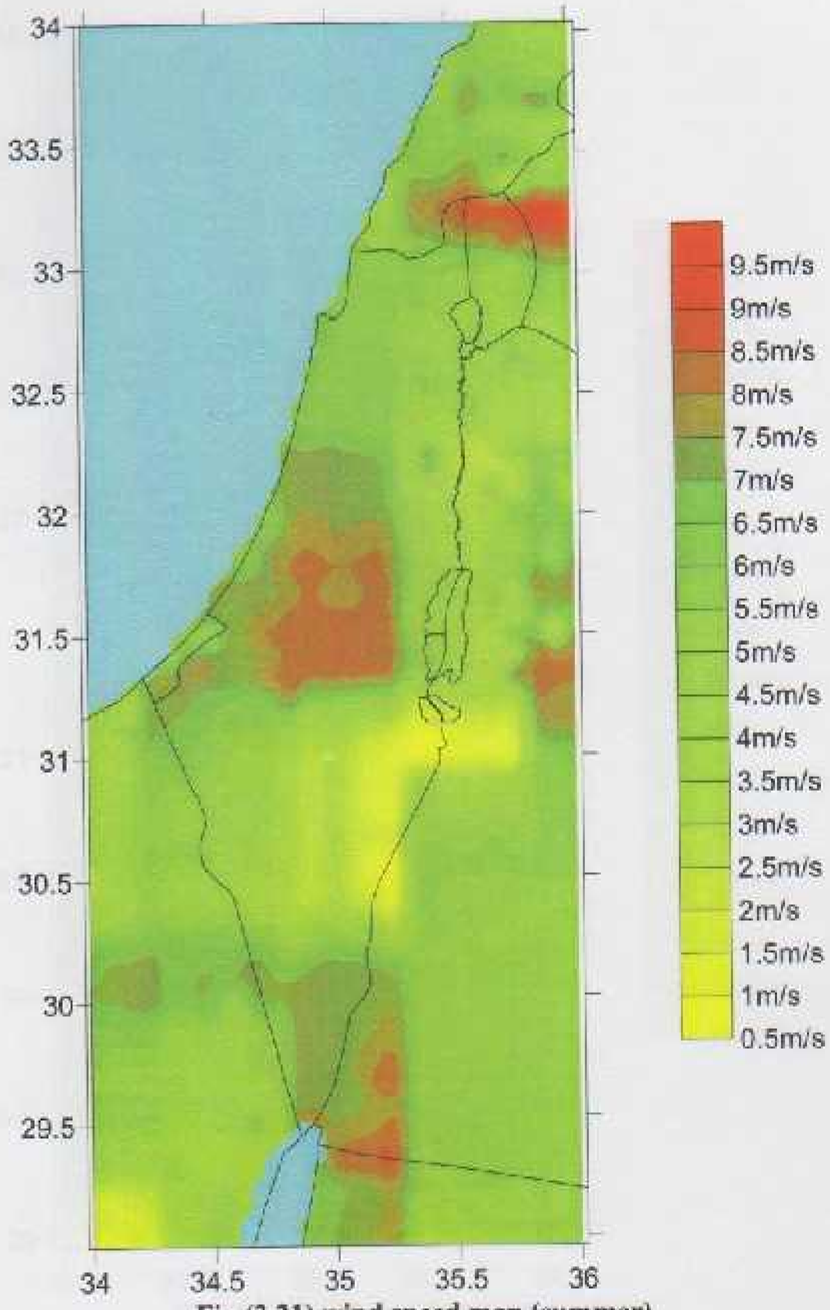


Fig (3.21) wind speed map (summer)

The resulted map for wind speed at spring season:

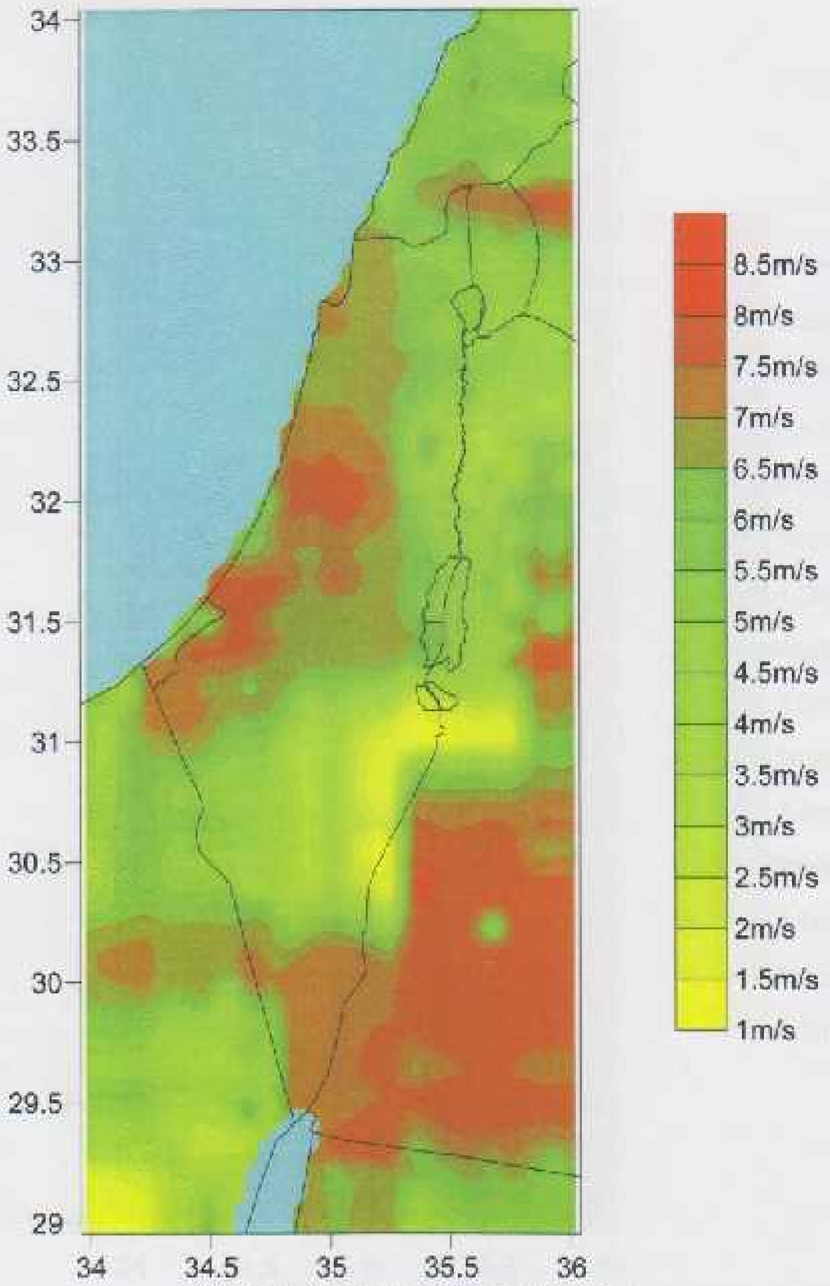


Fig (3.22) wind speed map (spring)

The resulted map for wind speed at winter season:

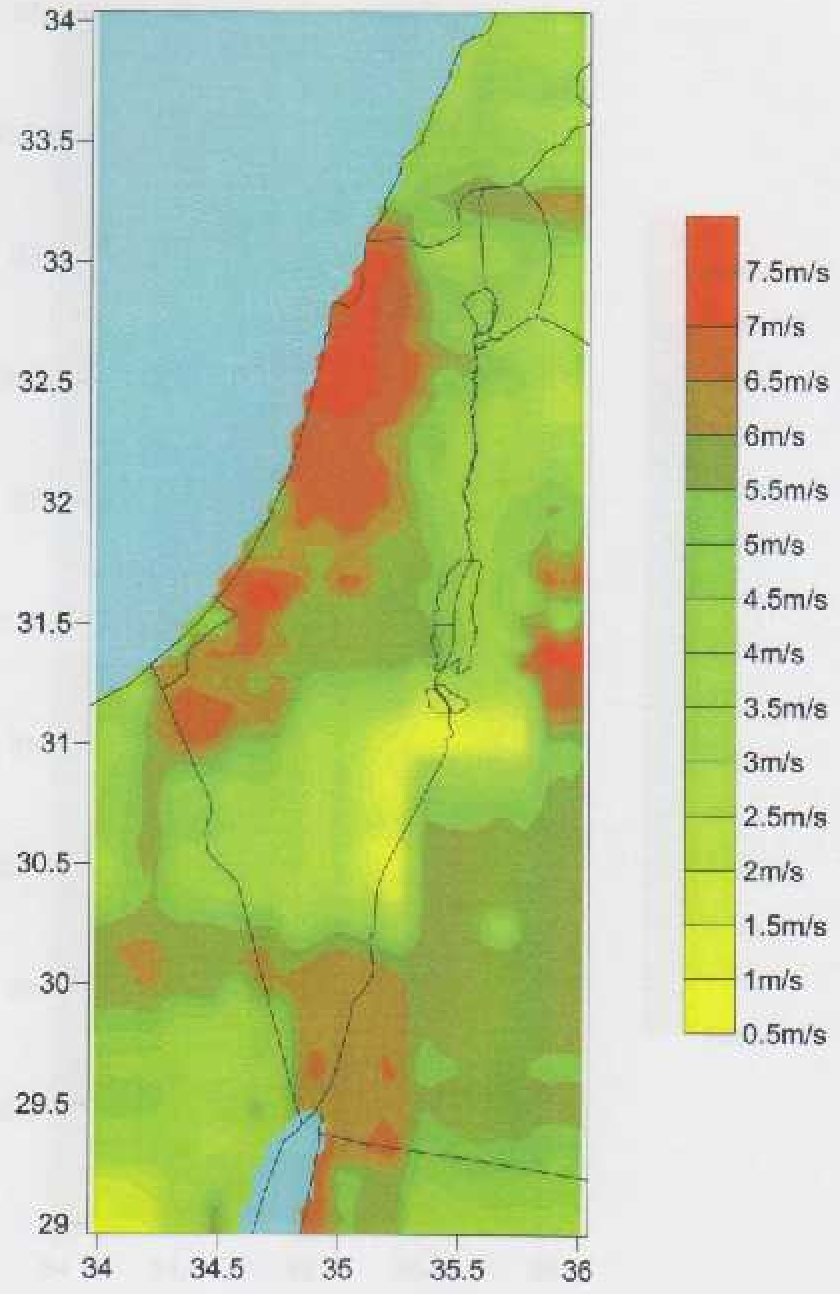


Fig (3.23) wind speed map (winter)

The resulted map for wind speed at autumn season:

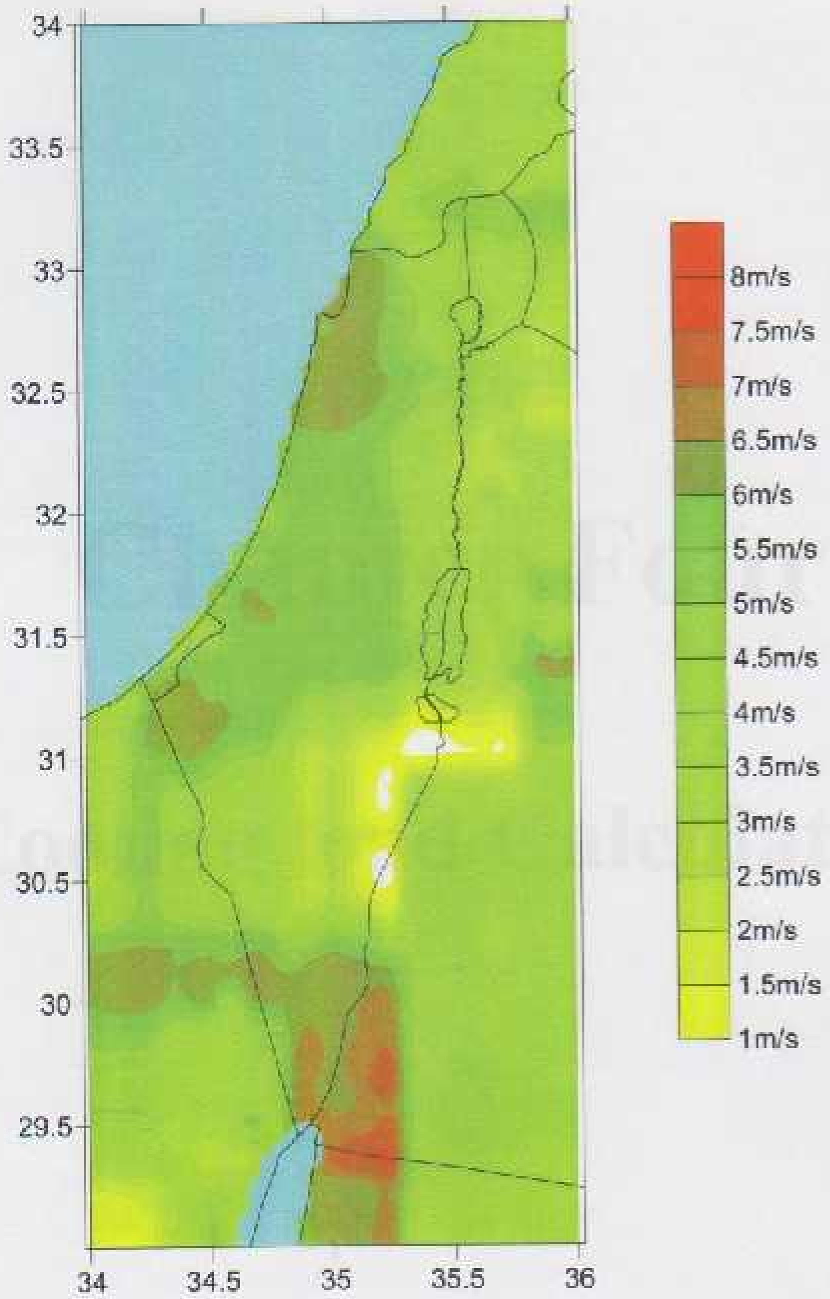


Fig (3.24) wind speed map (autumn)

Chapter Four

Cooling load Calculation

4.1 Introductions:

The main objective of air conditioning is to maintain the environment in enclosed spaces at conditions that induce the feeling of comfort to all occupants of the spaces. This feeling of comfort is influenced by a number of air related parameters which are inside space temperature, humidity, air motion and its speed and the air purity. The purity of the air and its quality include the absence of odors, toxic fumes and suspended particles, such as dust and dirt.

4.2 Cooling load equation:

The cooling load of a building consists of the following components:

1- Heat gain transmitted through building structure such as walls, floor and ceiling that are adjacent to unconditioned spaces. That heat transmitted is by temperature difference that exists on both sides of structures.

2-heat gain due to solar effect which includes:

a) Solar radiation transmitted through the glass and absorbed by inside surface and furniture.

b) Solar radiation absorbed by walls, glass windows, glass doors, and roofs that are exposed to solar radiation.

3) Sensible and latent heat gain brought into the space as a result of infiltration of air through windows and doors.

4) Sensible heat produced in space by lights, appliances, motors and other miscellaneous heat gains.

5) Latent heat produced from cooking, hot baths, or any other moisture producing equipment

6) Sensible and latent heat produced by occupants.

The quantity of heat transmitted through the walls, doors, floor, and roof of space per unit of time is the function of three factors whose relationship is expressed in the following equation:

$$Q = U A \Delta T \qquad (4.1)$$

Where Q: the rate of heat transferred in watt (W).

U: the overall coefficient of heat transmission in $W/m^2.C$.

A: the outsides surface area of the wall (m^2).

ΔT : total equivalent temperature difference (C°) .

But ΔT which takes into consideration the increase of wall temperature due to absorption of solar radiation, so ΔT is called corrected cooling load temperature differences $CLTD_{corr}$.

4.2.1 Overall heat transfer coefficients

A Wall could be made of several numbers of layers such as a wall is called composite wall. Figure 4.1 shows that

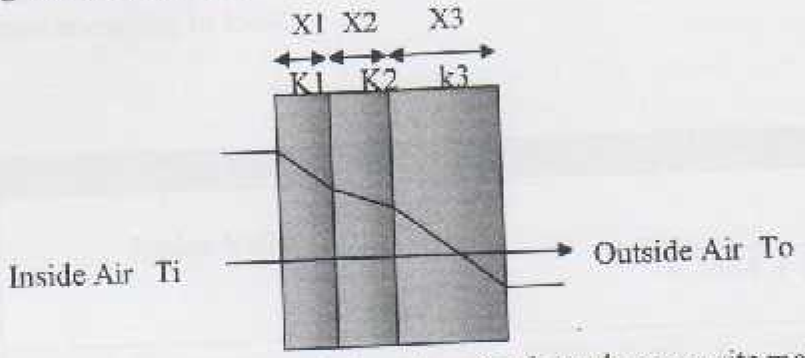


Figure 4.1: heat transfer through composite material

Overall heat transfer coefficients (U) are identified in the following equation:

$$U = \frac{1}{Rth} = \frac{1}{\frac{1}{hin} + \frac{X1}{K1} + \frac{X2}{K2} + \frac{X3}{K3} + \frac{1}{hout}} \tag{4.2}$$

Where:

→ h_{out}: Convection coefficient (surface Conductance) of Outside wall, floor, or ceiling.

→ h_{in} : Convection coefficient (surface conductance) of Inside wall, floor, or roof.

→ X: Thickness of constructing material.

→ K : Thermal conductivity of material.

Through our knowledge of the climate and the area of Palestine, because of the change in climatic conditions from region to region, convection coefficient varies depending on the circumstances, and we came to these values for the region.

location	h_{out}
Jordan Valley	22
The coastal region	32
Region of the desert	28
The mountainous region	22

Table 4.1: Convection coefficient of outside

Overall heat transfer coefficient for walls, roofs, glass, and floors calculated from equation according to location :

location	U
Jordan Valley	$U = \frac{1}{0.0454 + \sum R_{cond} + R_i}$
The coastal region	$U = \frac{1}{0.03125 + \sum R_{cond} + R_i}$
Region of the desert	$U = \frac{1}{0.03571 + \sum R_{cond} + R_i}$
The mountainous region	$U = \frac{1}{0.0454 + \sum R_{cond} + R_i}$

Table 4.2: over all heat transfer coefficient

4.2.2 Corrected cooling load temperature differences $CLTD_{corr}$

The CLTD values vary with hour of the day and it is function of environmental conditions and building parameters. The CLTD tables are derived from computer solutions using the transfer function method.

The value of CLTD extracted from Table 9-1 needs to be corrected so that the actual value is found for different cases, and hence it will be called corrected CLTD and can be calculated from the following equation:

$$CLTD_{corr} = (CLTD + LM)k + (25.5 - T_i) + (T_{O,M} - 29.4)f \quad (4.3)$$

Where LM is latitude correction factor, which can be obtained from table 9-2 for horizontal and vertical surfaces. The factor k is color adjustment factor such that k = 1.0 for dark colored roof, and k = 0.5 for permanently light colored roofs.

If the roof construction details are not specified or the construction is different from that specified in Table 9-1, approximate cooling load temperature differences can be obtained from Table 9-3. This simplified table gives the CLTD for sunlit roofs of light, medium and heavy constructions.

The temperature difference (25.2-Ti) is a correction value for indoor design temperature where Ti is the room or inside design temperature. On the other hand, the temperature difference (To.m-29.4) is a correction factor for outdoor mean temperature To,m . It is related to the outdoor design temperature To, according the relation:

$$T_o, m = T_o - \frac{DR}{2} \quad (4.4)$$

DR: the daily temperature range which equal to the difference between the Average maximum and Average minimum temperature for the warmest month of the summer season.

f: attic or roof fan factor such that f=1.0 if there is no attic or roof fan & f = 0.75 if there is an attic or roof fan [5].

Then the magnitude of outdoor mean temperature for our regions:

location	T_{om}
Jordan Valley	23
The coastal region	19
Region of the desert	20
The mountainous region	16

Table 4.3: outdoor mean temperature

4.2.3 Equation of load:

After the analysis of the climate of the area, and find all the constants and the values that underlie the process of carrying air-conditioning account for any region, we achieved the following equations of convection, each according to the expense of the area to be carried :

location	Cooling load equation
Jordan Valley	$Q = U * A * ((CLTD + LM) * K + (25 - T_i) - 6.4 * f)$
The coastal region	$Q = U * A * ((CLTD + LM) * K + (25 - T_i) - 10.4 * f)$
Region of the desert	$Q = U * A * ((CLTD + LM) * K + (25 - T_i) - 6.4 * f)$
The mountainous region	$Q = U * A * ((CLTD + LM) * K + (25 - T_i) - 13.4 * f)$

Table 4.4: equation of load

4.3 Cooling load due to Infiltration:

Infiltration is the flow of outdoor air into a building through cracks and other unintentional openings and through the normal use of exterior doors for entrance and egress. Infiltration is also known as air leakage into a building.

They are many ways to find or calculating the magnitude of infiltration, one of them is could cracking method, where is based on length of the crack or the perimeter of the window or the door, so we use this way because it is very accurate.

The heat loss due infiltration Qt. f , is calculated as follows:

$$Qt.f = \left(\frac{V_{inf}}{v_o}\right) * (h_i - h_o) \qquad (4.5)$$

Where is:

h_i: Inside enthalpy of infiltrated air in $\left(\frac{kJ}{kg}\right)$

h_o: outside enthalpy of infiltrated air in $\left(\frac{kJ}{kg}\right)$

V_{inf} :The volumetric flow rate of infiltrated air in $\left(\frac{m^3}{s}\right)$

v_o : Specifics volume in$\left(\frac{m^3}{kg}\right)$

Then we can find the magnitude of V_{inf} by using the equation:

$$V_{inf} = V_f * L \tag{4.6}$$

Where is :

L: crack length of meter.

location	Infiltration
Jordan Valley	$Qt.f = \left(\frac{V_{inf}}{v_o}\right) * (h_i - 38.25)$
The coastal region	$Qt.f = \left(\frac{V_{inf}}{v_o}\right) * (h_i - 41.5)$
Region of the desert	$Qt.f = \left(\frac{V_{inf}}{v_o}\right) * (h_i - 35.5)$
The mountainous region	$Qt.f = \left(\frac{V_{inf}}{v_o}\right) * (h_i - 35.875)$

Table 4.5: equation of Infiltration load

4.4 Cooling load due to ventilation:

Ventilation air is air used to provide acceptable indoor air quality. It may be composed of forced or natural ventilation, suitably treated re circulated air, transfer air, or an appropriate combination. Ventilation includes the international introduction of air from the outside into a building ; it is further subdivided into natural ventilation and forced ventilation ; Natural ventilation is the flow of air through open windows , doors grilles , and other planned building envelope penetrations , and it is driven by natural and/or artificially produced pressure differentials Forced ventilation , is the intentional movement of air into and out of a building using fans and intake and exhaust vents, it is also called mechanical ventilation.

We can find the magnitude of ventilation by determining type space such as bathrooms , kitchens, etc. then from table (4-6) in heating and air conditioning we can find number of air change per hour , then use equation :

$$Q = \left(\frac{V*N}{3600}\right) * \rho * cp * \Delta T \tag{4.7}$$

Where is :

V: volume of room.
N: number of air change per hour.
ρ: Density of air
Cp : specific heat at constant pressure
ΔT:difreence in temperature.

Through our study , and after conducting the tests and calculation crisis , we were able to reach the following equations :

Table 4.6: equation of ventilation load:

location	ventilation
Jordan Valley	$Q = V * N * 3.472 * 10^{-4} * (23 - T_i)$
The coastal region	$Q = V * N * 3.472 * 10^{-4} * (19 - T_i)$
Region of the desert	$Q = V * N * 3.472 * 10^{-4} * (20 - T_i)$
The mountainous region	$Q = V * N * 3.472 * 10^{-4} * (16 - T_i)$

Conclusion:

Solar and wind energy is available in most of Palestine , and the process of creating maps of of the area of Palestine are very important and effective tools to evaluate the potential use of solar energy , wind speedmaps are very important for planning future strategies on the best use of available resources , and efforts in the graduation project is the first step in the development of reliable solar and wind energy resource map of Palestine . Effort should be made to include additional data available to Palestinian meteorically department in order to increase accuracy . In addition , it can provide data and maps available to the internet using a software user interface that enables users to the official transfer of power to evaluate the proposed system be installed in any location .

Through this project it was possible to build maps of climate that can be utilized to determine areas with high temperatures in order to be used in many ways to save energy, most notably the abuse for heating using solar energy, in addition to its use in providing hot water for buildings .

The maps of wind speeds that were obtained indicate that there are large areas of Palestine of the wind speeds fast enough to generate electrical energy , and it is recommended to exploit these resources.

Appendix

Table 4-6 Number of air change per hour in residences and commercial application

Type of Room or Building	No .of Air Change per Hour
Rooms with no windows or exterior doors	0.5
Rooms with windows or exterior doors on one side only	1
Rooms with windows or exterior doors on two sides	1.5
Rooms with windows or exteriors doors on three sides	2
Entrance halls	2-3
Factories , machine shops	1-1.5
Recreation rooms , assembly rooms , gymnasium	1.5
Homes , apartments , offices	1-2
Classrooms , dining rooms , lounges , hospital rooms , kitchens , laundries ballrooms , bathrooms	2
Stores, public buildings	2-3
Toilets , auditorium	3

Table 9-3 Approximate CLTD values for sunlit roofs:

Solar Time	Roof Construction		
	Light	Medium	Heavy
10:00	5		
11:00	12		
12;00	19	3	0
13:00	25	8	2
14:00	29	14	5
15:00	31	19	8
16:00	31	23	10
17:00	29	25	12
18:00	24	26	14
19:00	19	25	15
20:00	11	22	16

TABLE 9-1 cooling load temperature difference (CLTD) for sunlit roofs C

Roof Description no Construction	U	Solar time, h																							
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Without suspended ceiling																									
1) Steel sheet with 25.4 mm (or 50.8mm) insulation	1.209 0.704	0	-1	-2	-2	-3	-2	3	11	19	27	34	40	43	44	43	39	33	25	17	10	7	5	3	1
2) 25mm wood with 25.4mm insulation	0.903	3	2	0	-1	-2	-2	-1	2	5	15	22	29	35	39	41	41	39	35	29	21	15	11	8	5
3) 101.6mm L.W. concrete	1.209	5	3	1	0	-1	-2	-2	1	5	11	18	25	31	36	39	40	40	37	32	25	19	14	10	7
4) 50.8mm H.W. concrete 25.4mm (or 50.8mm) insulation	1.17 0.693	7	5	3	2	0	-1	0	2	6	11	17	22	28	33	36	37	37	34	30	25	20	16	12	10
5) 25.4mm wood with 50.8 insulation	0.619	2	0	-1	-3	-4	-4	-4	-2	3	9	15	22	27	32	35	35	35	32	27	20	14	10	6	3
6) 152.4mm L.W. concrete	0.897	12	10	7	5	3	2	1	0	2	4	8	13	18	24	29	33	35	36	35	32	28	24	19	16
7) 63.5mm wood with 25.4mm insulation	0.738	16	13	11	9	7	6	4	3	4	5	8	11	15	19	23	27	29	31	31	30	27	25	22	19
8) 203.4mm L.W. concrete	0.715	20	17	14	12	10	8	6	5	4	4	5	7	11	14	18	22	25	28	30	30	29	27	25	22
9) 101.6mm H.W. concrete with 25.4mm (or 50.8mm) insulation	1.136 0.681	14	12	10	8	7	5	4	4	6	8	11	15	18	22	25	28	29	30	29	27	24	21	19	16
10) 63.5mm wood with insulation	0.528	18	15	13	11	9	8	6	5	5	5	7	10	13	17	21	24	27	28	29	29	27	25	23	20
11) Roof terrace system	0.602	19	17	15	14	12	11	9	8	7	8	8	10	12	15	18	20	22	24	25	26	25	24	22	21
12) 152.4mm H.W. concrete with 25.4 mm (or 50.8mm) insulation	0.664	18	16	14	12	11	10	9	8	8	9	10	12	15	17	20	22	24	25	25	25	24	22	20	19
13) 101.6 mm wood with 24.4 mm (or 50.8mm) insulation	0.602 (443)	21	20	18	17	15	14	13	11	10	9	9	9	10	12	14	16	18	20	22	23	24	24	23	22

Without suspended ceiling																									
1) steel plate with 25.4mm(or50.8mm) insulation	0.761 0.522	1	0	-1	-2	-3	-3	0	5	13	20	28	36	42	48	48	42	37	32	22	15	10	7	5	3
2) 25.4mm wood with 25.4mm insulation	1.653	11	8	6	5	3	2	1	2	4	7	12	17	22	27	31	33	35	34	32	28	24	19	17	14
3) 101.6mm L.W. concrete	0.751	10	8	5	4	2	1	0	0	2	5	10	16	21	27	31	34	36	36	34	30	26	21	17	13
4) 50.8mm H.W. Concrete 25.4mm insulation	0.744	16	14	13	11	10	8	7	7	8	9	11	14	17	19	22	24	25	26	26	25	23	21	20	18
5) 25.4mm wood with 50.8 insulation	1.471	14	12	9	7	5	4	3	3	4	5	10	14	18	23	27	30	31	32	31	29	26	22	19	16
6) 152.4mm L.W concrete	0.819	15	15	13	11	9	7	6	4	3	4	6	9	12	16	20	24	27	29	30	30	28	26	23	20
7) 63.5mm wood with 25.4mm insulation	1.545	19	18	16	14	13	12	10	9	8	8	9	10	12	14	17	19	21	23	24	25	24	23	22	21
8) 203.2mm L.W. concrete	0.528	22	20	18	16	15	13	11	10	9	8	8	9	9	11	14	16	19	22	23	25	25	25	24	23
9) 101.6mm H.W. with 25.4mm (or 50.8mm)	0.227 0.511	17	16	15	14	13	13	12	11	11	11	12	13	15	16	18	19	20	21	21	21	21	20	19	18
10) 63.5mm wood With 50.8mm insulation	0.409	19	18	17	16	14	13	12	11	10	10	10	11	12	14	16	18	19	21	22	23	23	22	22	21
11) roof-terrace system	0.466	17	16	16	15	15	14	13	13	13	12	12	13	13	14	15	16	16	17	18	18	19	18	18	18
12) 152.4mm wood Concrete with 25.4 mm (or 50.8mm) insulation	0.71 0.449	16	16	15	15	14	13	13	12	12	12	12	13	14	15	16	17	18	18	19	19	19	18	18	18
13) 101.6mm wood With 25.2mm (or 50.8mm) insulation	0.455 0.363	20	19	19	18	17	16	15	14	14	13	12	12	12	12	13	14	15	16	18	19	20	20	20	19

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