Call: H2020-EE-2016-2017
Topic: EE-11-2016-2017
Type of Action: CSA

Project Acronym: HAPPEN
Project Title: Holistic APproach and Platform for the deep renovation of the Med residential built Environment
Grant Agreement: 785072

D3.1 – Report on Representative Climates and Zoning

DOCUMENT CONTROL	
Deliverable No.	3.1
Related WP	3
Related Task	3.1
Deliverable Title	Representative Climate Zoning
Deliverable Date	M3
Deliverable Type	Report
Dissemination level	PU
Author(s)	Chrysanti Efthymiou, Margarita Assimakopoulou, Theoni Karlessi (NKUA)
Reviewed by	José Salmeron Lissen (USE), Luca Laghi (Certimac)
Approved by	Marco Padula (ITC-CNR)
Status	FINAL

TABLE OF CONTENTS

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement n. 785072

PUBLISHABLE EXECUTIVE SUMMARY

This deliverable has two main objectives.
The first one is the climatic zoning and identification of representative climates in MED Area using the CSI methodology.
The second one is to classify the MedZEB pilot areas in more detailed subcategories, using the effect of land use, and to evaluate the effects that future climate change scenarios would have on the energy consumption of the retrofitted MedZEB buildings.

ACRONYMS AND ABBREVIATIONS

All acronyms and abbreviations (AAs) used in the report should be listed in alphabetical order in the table below (other than symbols for units of measurement) in the following way:

CSI	Climate Severity Index
DD	Degree Days
MED	Mediterranean

AAs must be defined the first time they are used in the text of the report, and AAs should not be introduced if they are not used again in the document.

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement n. 785072

1 MED ZONING

1.1 Introduction

Climate classifications are orderly arrangements of data dealing with climatic controls and elements. The purpose of such schemes is to identify climate types and subtypes. The classifications typically identify climate regions and subregions that cover broad areas that are subcontinental in size.

The display of climate regions on maps helps us understand the location of other environmental features that climate influences. Such climate-related features include water, vegetation, soils, landforms, and wildlife. They also help us understand the influence of climate on distributions of things important to humans, such as agriculture, tourism, living comfort, and climate-related natural hazards.

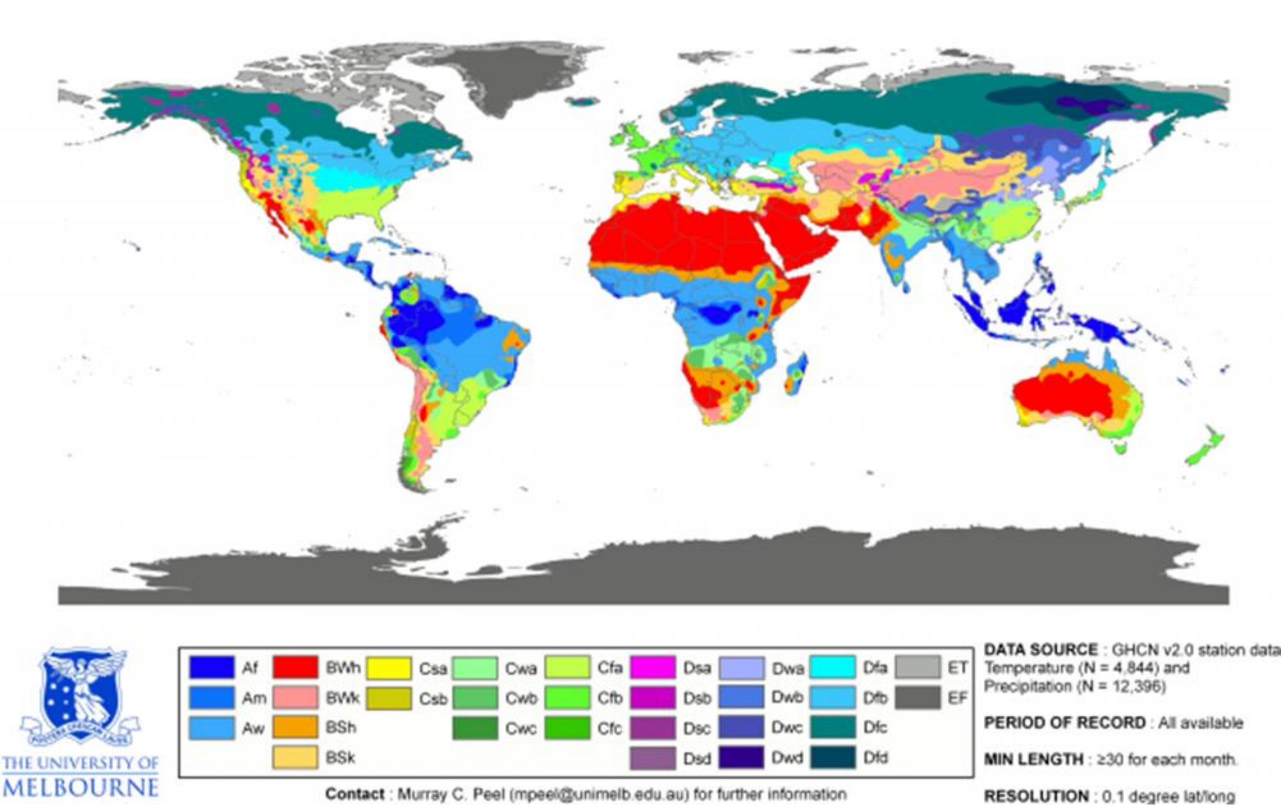


Figure 1: World map of Koppen-Geiger climate classification

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement n. 785072

Climate has also a major impact on the energy use of most commercial and residential buildings. Characterization of climate zones is a useful tool and can be used for various objectives, for example:

- To orient the design process of low energy buildings by suggesting the suitability of certain techniques to various certain climatic zones,
- To normalise energy consumption to a limited number of variables in order to make possible (to some degree) extrapolation of performances calculated for one climate zone and building to other climate zones.

Within the methods suited, especially to the second objective one can enumerate e.g. the Degree-Day (DD) method, the Climate Severity Index (CSI) method developed by Markus et al. [Markus et al. 1984], Keller's method [Keller et al. 2004] and others. The definition for relevant climates by using degree-days has the advantage of being relatively simple and the disadvantage of considering only air temperature as driving force and disregarding all the others (solar radiation, wind). Caution should be used since the value of degree-days depends on the assumed indoor reference or base temperature.

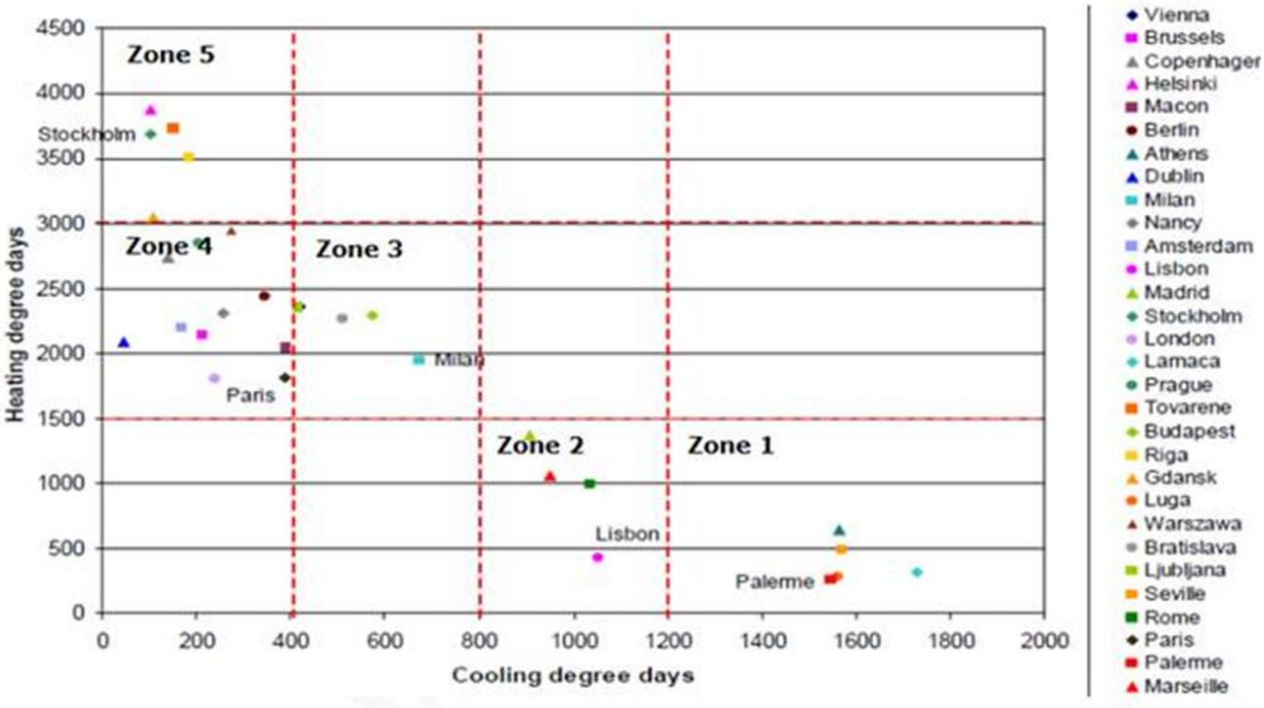


Figure 2: European climate zones defined by heating and cooling degree days

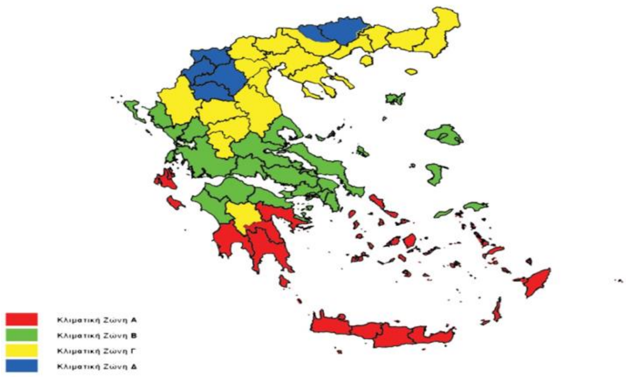
The Climate Severity Index, developed at the University of Strathclyde in the 80s [Markus 1982, Markus et al. 1984] originally proposes ways to derive, via detailed simulations of a defined building, a correlation between the energy demand of that building, three climatic variables and three physical parameters describing the building itself. It is hence not only a description of the climate but a description of the behaviour of a certain building within a range of climates. It has been subsequently used to propose correlations between the average consumption of a mix of building prototypes and two or three climatic variables. Caution should be used in the choice of the building prototypes, since buildings with poor or advanced envelope features will result in quite different values of this aggregated index. A better level of correlation might be achieved for smaller regions that the entire EU, e.g. at national level with relatively homogeneous construction traditions.

1.2 Mediterranean Climate

The Mediterranean climate is characterized by dry and hot summer and cold and rainy winter. The regions are located in the western parts of the continent between 30 and 45 degrees north and south of the equator. The climate zone is linked to the five large subtropical high-pressure belts of the oceans. These pressure belts include Azore, South Atlantic, Noth Pacific, South Pacific, and Indian Ocean High. The pressure belts are also called anticyclone and rotate clockwise in the Northern Hemisphere and anticlockwise in the Southern Hemisphere. The anticyclones cause the surrounding air to diverge and descend leading to a clear sky. Climatic changes are profound in the Mediterranean climatic region with rains alternating with warm sunny days during the winter seasons. Rainfall varies from year to year and does not fall evenly. The rains do not arrive yearly at the same time or within the same interval. Temperatures also vary from year to year with winter temperatures falling to as low as zero and may rise to as high as over 50 degrees °C in arid areas.

The Mediterranean Region has many morphologic, geographical, historical, and societal characteristics, which make its climate scientifically interesting.

Despite the similar climate characteristics of MED countries, the specific topographical characteristics of each country and the synoptic systems lead to significant extremities even within a country itself.
For example, Greece, according to the National Regulation on the Energy Performance of Buildings (K.EN.A. K), is divided into four climatic zones



A) The Marine Mediterranean type (red)

B) The Land Mediterranean type (green)

C) The Continental type (yellow)

D) The Mountainous type (blue)

Figure 3: Climate zones of Greece according to national regulation

1.3 Methodology

Different methods are widely used for climatic zoning in urban areas (e.g. Ren et al., 2011; Matzarakis, 2005; de la Flor et al., 2008), taking into account different climatic parameters. In general, all climatic zoning schemes divide the examined area into homogenous regions with scope to characterize energy partitioning. A complete scheme should take under consideration the climate properties, the physical properties of surface structure, the building characteristics, land use types and activities.

The analysis of the exterior conditions over the cooling and heating demands of a giving building could be studied in an easy and clear way using the concept of climatic severity index (de la Flor and Dominguez, 2004). Climate Severity Index (CSI) is generally used to predict the climate-dependent energy requirements of a building in a given period of time (Akander et al., 2005).

In this work, the method of CSI is employed, considering TMY data for whole Europe as well as existing climatic observations in MED countries. From the spatial distribution of CSI values, a climatic classification is derived.

1.3.1 Data

The data required are values of temperature and sunshine duration for all the countries participating in the project (Greece, Cyprus, Italy, Spain, Croatia, France, and Slovenia). Table 1 summarises the cities included in calculations. The time span of data series is different for each meteorological station, thus for the following calculations TMY data were used, while the provided ones only for the validation of our results.

Number	Cities	Number	Cities
01	Lyon	17	Kerkyra
02	Strasbourg	18	Athens
03	Marseille	19	Larissa
04	Paris	20	Thessaloniki
05	Grenoble	21	Pazin
06	Bordeaux	22	Rijeka
07	Tarbes	23	Gospic
08	Clermont-Ferrand	24	Dubrovnik
09	Tours	25	Zadar
10	Besancon	26	Varazdin
11	Lille	27	Zagreb
12	Nantes	28	Durdevac
13	Rouen	29	Bologna
14	Saint-Brieuc	30	Monte Cimone
15	Heraklion	31	Venice
16	Kalamata	32	Trieste

33	Genova	53	Salamanca
34	Milan	54	Cordova
35	Ancona	55	Granada
36	Pisa	56	Seville
37	Naples	57	Ibiza
38	Pescara	58	Menorca
39	Capo Palinuro	59	Paphos
40	Cagliari	60	Nicosia
41	Messina	61	Larnaca
42	Alicante	62	Limassol
43	Lleida	63	Tolmin
44	Barcelona	64	Radovijica
45	Bilbao	65	Ljubljana
46	Saragossa	66	Koper
47	Pamplona	67	Maribor
48	Lugo	68	Celje
49	Pontevegra	69	Brezice
50	Santiago de Compostela	70	Novo Mesto
51	Burgos	71	Cerknica
52	Madrid		

Table 1: MED cities with TMY data

1.3.2 Heating and Cooling Degree Days

A common basis for the climatic zoning are the indices of heating and cooling degree days (HDD and CDD, respectively) that are designed to reflect the demand for energy needed to heat/cool a building and are commonly used for the estimation of the normalized energy consumption for heating/cooling in public, residential, commercial and industrial buildings as well as in greenhouses, livestock facilities, storage facilities and warehouses, (Gaitani et al., 2010).
These indices can be derived from daily temperature observations and are defined relative to a base temperature, i.e. the outside temperature above/below which a building needs no heating/cooling. Particularly for Greece, the default degree days are set in the Technical Directive TOTEE 20701-3/2010 (Technical Chamber of Greece, 2010). According to this, the base temperature is set to 18 °C for the heating degree days and 26 °C for the cooling degree days.
More specifically, for the calculation of the number of heating/cooling degrees in a day, the difference between the base temperature and the outside temperature for that day is considered. For example, using a cooling base temperature of 26 °C and considering a day with a mean temperature of 30 °C, a value of 4-degree cooling days is obtained for the given day. Then, the daily values of degree days are summed to calculate the total number of degree days over a period in question to provide a rough estimate of seasonal heating/cooling, as described in Equations 1 and 2.

According to their definition, cooling and heating degree-days are calculated as:

$$HDD = \sum_{days}(THDDbase - Tout) \quad (1)$$
$$CDD = \sum_{days}(Tout - TCDDbase) \quad (2)$$

Where, T_{HDD} and T_{CDD} are the base temperatures and T_{out} is the mean daily outdoor temperature. In these summations only positive values are counted.

1.3.3 Climate Severity Index

It should be mentioned that energy requirements are not linearly related with temperature and heavily insulated buildings have a lower "balance point". For this reason, the amount of heating/cooling required depends on several factors besides the outdoor temperature, such as the amount of solar radiation reaching the interior of a building and the outdoor wind speed and direction. One of the ways to effectively characterize the climatic dependency of the heating or cooling requirements of buildings is the Climatic Severity Index (CSI), by providing a comparison of the "severity" between different climatic conditions. The more severe the climate is, the bigger the energy requirements and, consequently, the bigger the value of CSI (Akander et al., 2005).
Using the CSI concept, the influence of a climatic variable change over the cooling and heating demands of a certain building can be estimated, assuming that this change affects in the same way the whole building (de la Flor and Domínguez, 2004).
Therefore, for the purposes of the present study, the CSI approach was preferred against the simpler HDD/CDD approach.
CSI is calculated following the methodology described in Akander et al., (2005); in Section HE-1 of the Spanish Technical Building Code (Appendix 2 "determination of climatic zones based on climatic records"); and by Salmeron et al., (2012). The climate severity index combines the cooling/heating degree-days and the solar radiation in a way that it can be demonstrated that when two localities exhibit the same climatic "severity", the energy demands of same buildings situated in both localities are equal.

The Climatic Severity Index (CSI), is a single number on a dimensionless scale which is specific for each building and location.
The equation for winter is formulated as follows:

$$WCSI = a \times HDD + b \times \frac{n}{N} + c \times HDD^2 + d \times \left(\frac{n}{N}\right)^2 + e \quad (3)$$

And the respective for summer:

$$SCSI = a \times CDD + b \times \frac{n}{N} + c \times CDD^2 + d \times \left(\frac{n}{N}\right)^2 + e \quad (4)$$

where HDD and CDD are the degree days for heating/cooling using the same base temperature of 20°C for both the winter months (October to May) and summer months (June to September), while $\frac{n}{N}$ is the ratio of the actual insolation hours (n) and the maximum insolation hours (N) for that latitude and for the respective months. These set of inputs have been obtained from typical meteorological year for each location.

Winter		**Summer**	
a	$3.546\ 10^{-3}$	a	$3.052\ 10^{-3}$
b	$-4.043\ 10^{-1}$	b	$1.784\ 10^{-1}$
c	$8.394\ 10^{-8}$	c	$-1.343\ 10^{-7}$
d	$-7.325\ 10^{-2}$	d	$-2.339\ 10^{-1}$
e	$-1.137\ 10^{-1}$	e	$-2.041\ 10^{-1}$

Table 2: Coefficients for the winter and summer Climate Severity Index equations

The climatic classification based on the resulted winter and summer CSI values follow the thresholds described in Table 3. These thresholds have been obtained starting from the limits used by Briggs et al., 2002 for the climatic classification of the United States of America. First, the bin boundaries that occur at 500 degree-days Celsius have been converted to climate severity units using the equations (3) and (4) respectively. Later the limits have been fine-grained corrected in order to include within the same climatic zone locations that in their respective buildings technical codes are considered of equal intensity.

Winter				
Winter 0	Winter 1	Winter 2	Winter 3	Winter 4
CSI < 0	0 ≤ CSI < 0.522	0.522 ≤ CSI < 1.52	1.52 ≤ CSI < 2.77	2.77 ≤ CSI
Summer				
Summer 0	Summer 1	Summer 2	Summer 3	Summer 4
CSI < 0	0 ≤ CSI < 0.508	0.508 ≤ CSI < 1.34	1.34 ≤ CSI < 2.00	2.00 ≤ CSI

Table 3: Intervals for winter and summer zoning

In order to create the climatic zones for the selected region, the numbers are combined, thus resulting in 25 different zones, as maximum, as shown in table below.

	S0	**S1**	**S2**	**S3**	**S4**
W0	W0S0	W0S1	W0S2	W0S3	W0S4
W1	W1S0	W1S1	W1S2	W1S3	W1S4
W2	W2S0	W2S1	W2S2	W2S3	W2S4
W3	W3S0	W3S1	W3S2	W3S3	W3S4
W4	W4S0	W4S1	W4S2	W4S3	W4S4

Table 4: Climate zones according to CSI values

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement n. 785072

1.3.4 Results

The resulting climatological CSI values for the 71 cities are presented in Figure 4. It can be seen that for winter, the values of CSI range from -0.14 to 3.95, the lowest severity being observed at Paphos –Cyprus- (59) and the highest at Monte Cimone –Italy- (30). Regarding the summer period, the CSI values range from -0.12 (30) to 2.59 (62). Monte Cimone as expected has the highest value of WSCI and the lowest SCSI. On the other hand, in Cyprus presented some of the lowest WSCI values and and highest SCSI values.

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement n. 785072

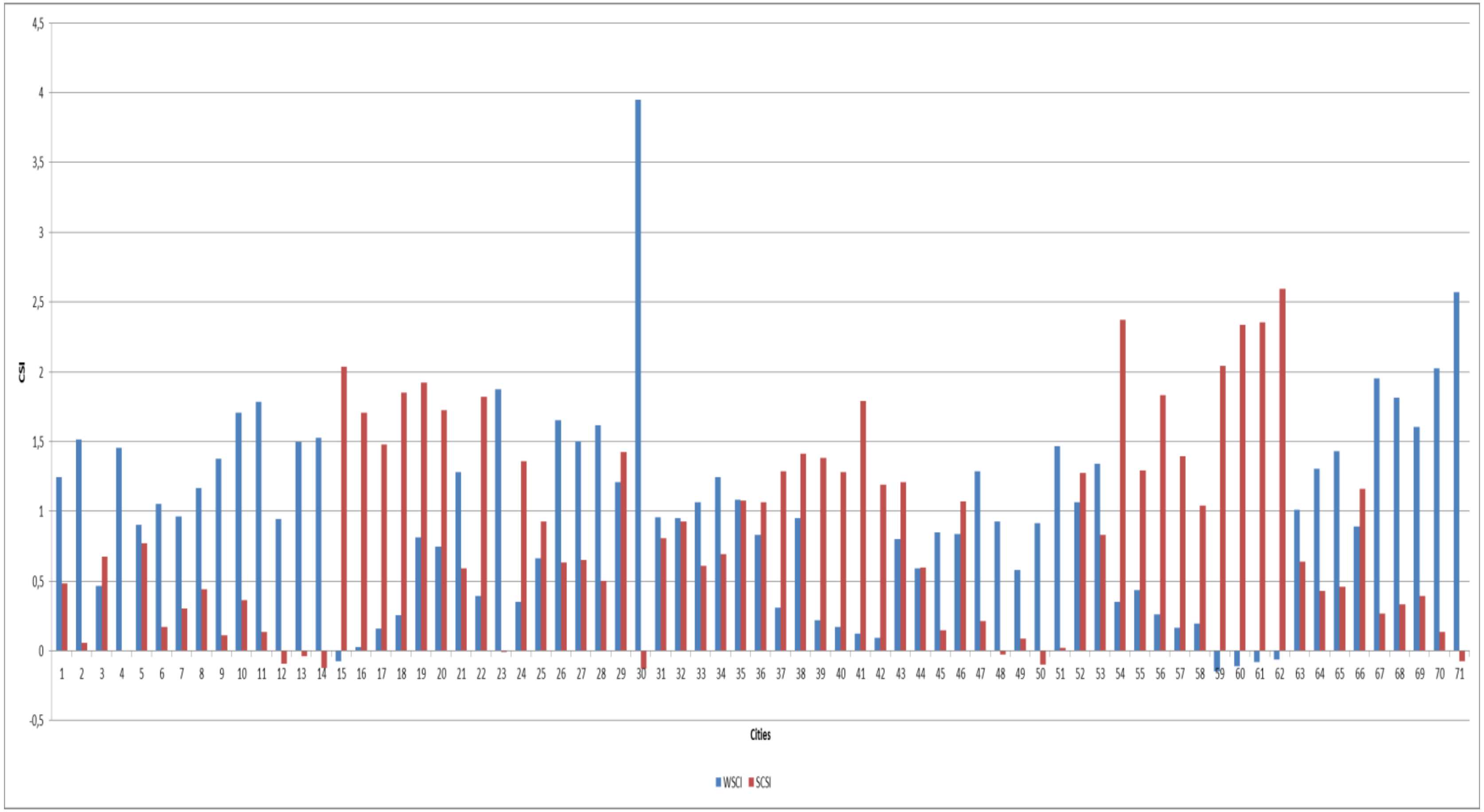


Figure 4: Winter and summer CSI climatological values for the 71 MED cities

The distribution of CSIs for the whole Europe as well as only for the MED countries is presented in figures 5 and 6 respectively.

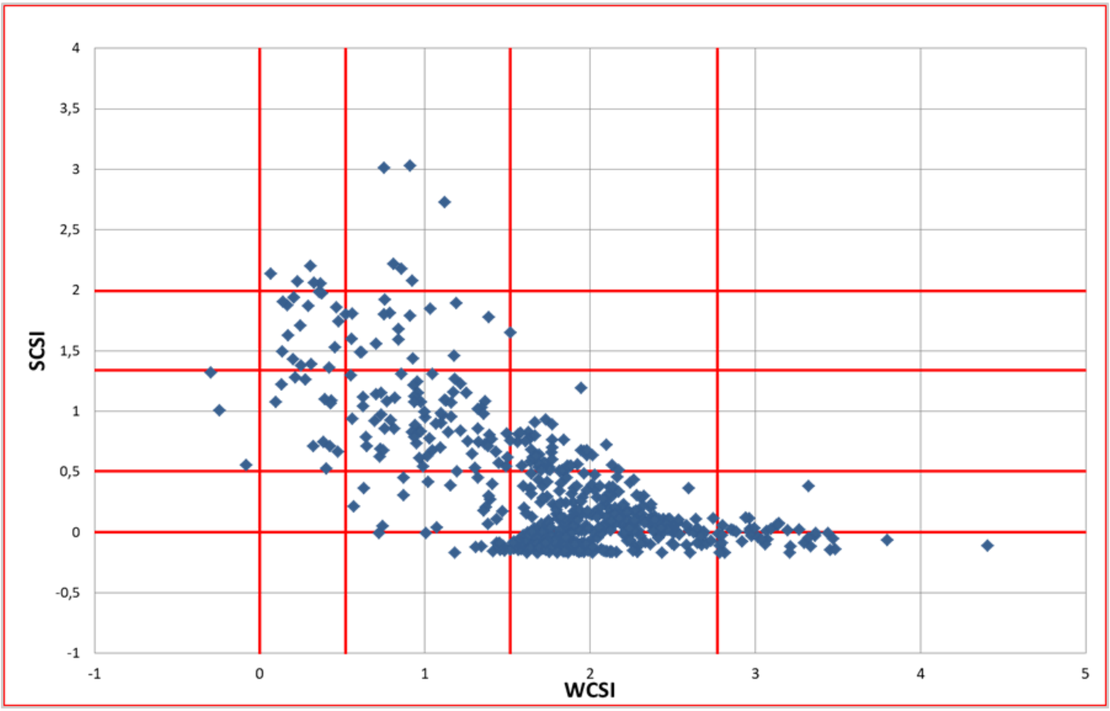


Figure 5: Distribution of CSI values for whole Europe

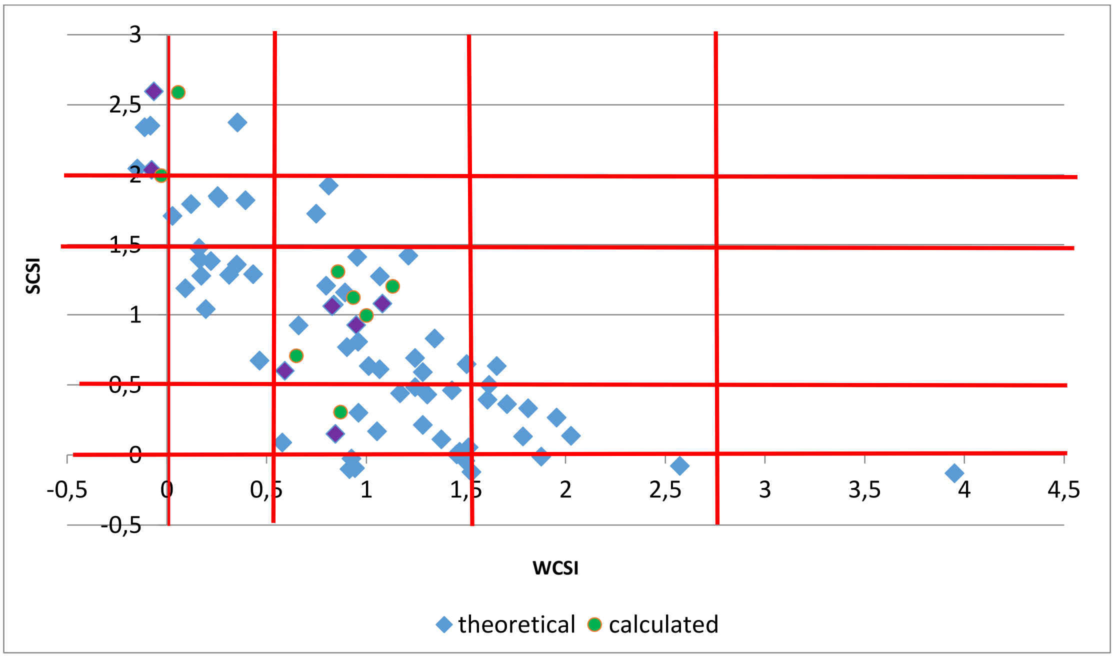


Figure 6: Distribution of CSI values for MED cities

In figure 6, the climatic severity indexes for some specific locations –those of the partners in the HAPPEN project- have been assessed in order to compare the actual values, provided by the partners, for actual years to the standards TMY climatic years. It is observed that the results are really comparable and significant correlated.

From these results, it is derived that the climatic classification presented in Table 3, leads finally to 13 feasible climatic zones in MED region. The next table shows these zones as well as the representative city in each zone. The selection of a representative city has been done to facilitate use of the classification in code development and for other type of analyses, like for instance the identification of the optimal energy rehabilitation set of measures for each climate zone that will be carried out in the task 3.3. In choosing representative cities we sought to satisfy two criteria. First, it is desirable that the representative city be similar to the "average" weather conditions within a zone, not favouring either mild or harsh climates and preferably located somewhat centrally within the zone's geographic extent. Second, a representative city should, to the extent possible, favour weather conditions where buildings are predominantly located. The set we have chosen represents a compromise that facilitates a reasonable intuitive understanding of the climate zones, and can be used to make reasonable assessments of energy performance of buildings within the climate zone. Also we have taken into account the location of the pilot buildings in order to consider them in the final selection of the representative cities.

	S0	S1	S2	S3	S4
W0	W0S0	W0S1	W0S2	Larnaca_CY	Limassol_CY
W1	W1S0	W1S1	Marseille_FR	Athens_GR	Cordova_SP
W2	Nantes_FR	Bilbao_SP	Milano_IT	Larissa_GR	W2S4
W3	Cerknica_SL	Maribor_SL	Varazdin_CR	W3S3	W3S4
W4	Monte Cimone_IT	W4S1	W4S2	W4S3	W4S4

Table 5: Climatic classification based on winter and summer CSI values for the MED region

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement n. 785072

1.3.5 Mapping

A map of Europe showing the WCSI, another showing SCSI and the last one with the climate zones are presented below. Void zones are countries that are not member states.

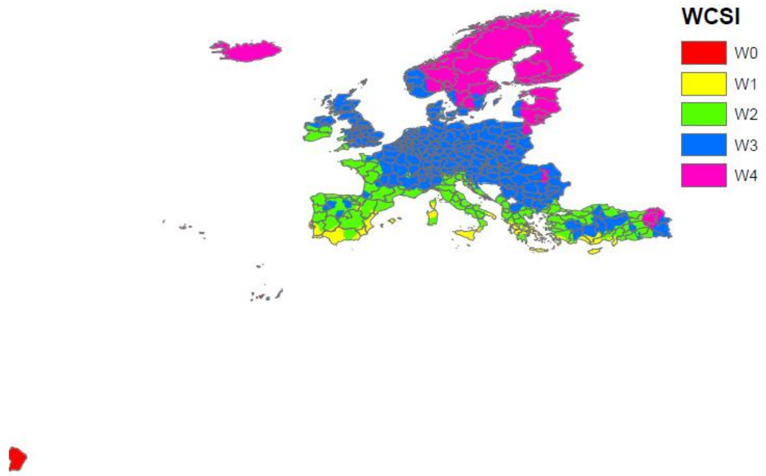


Figure 7: WSCI Europe map

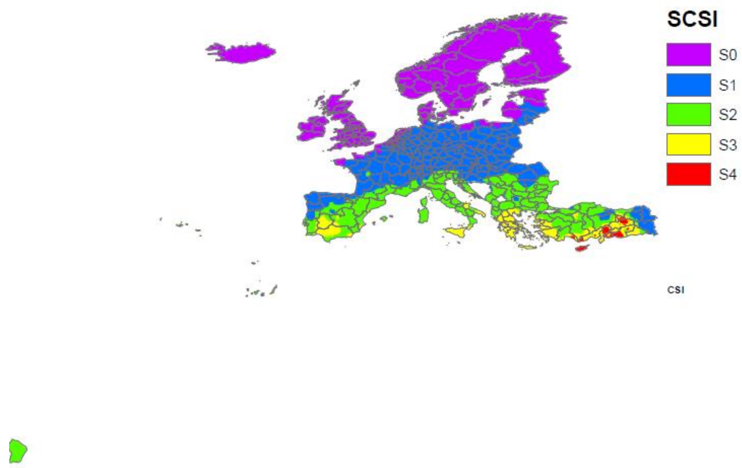


Figure 8: SCSI Europe map

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement n. 785072

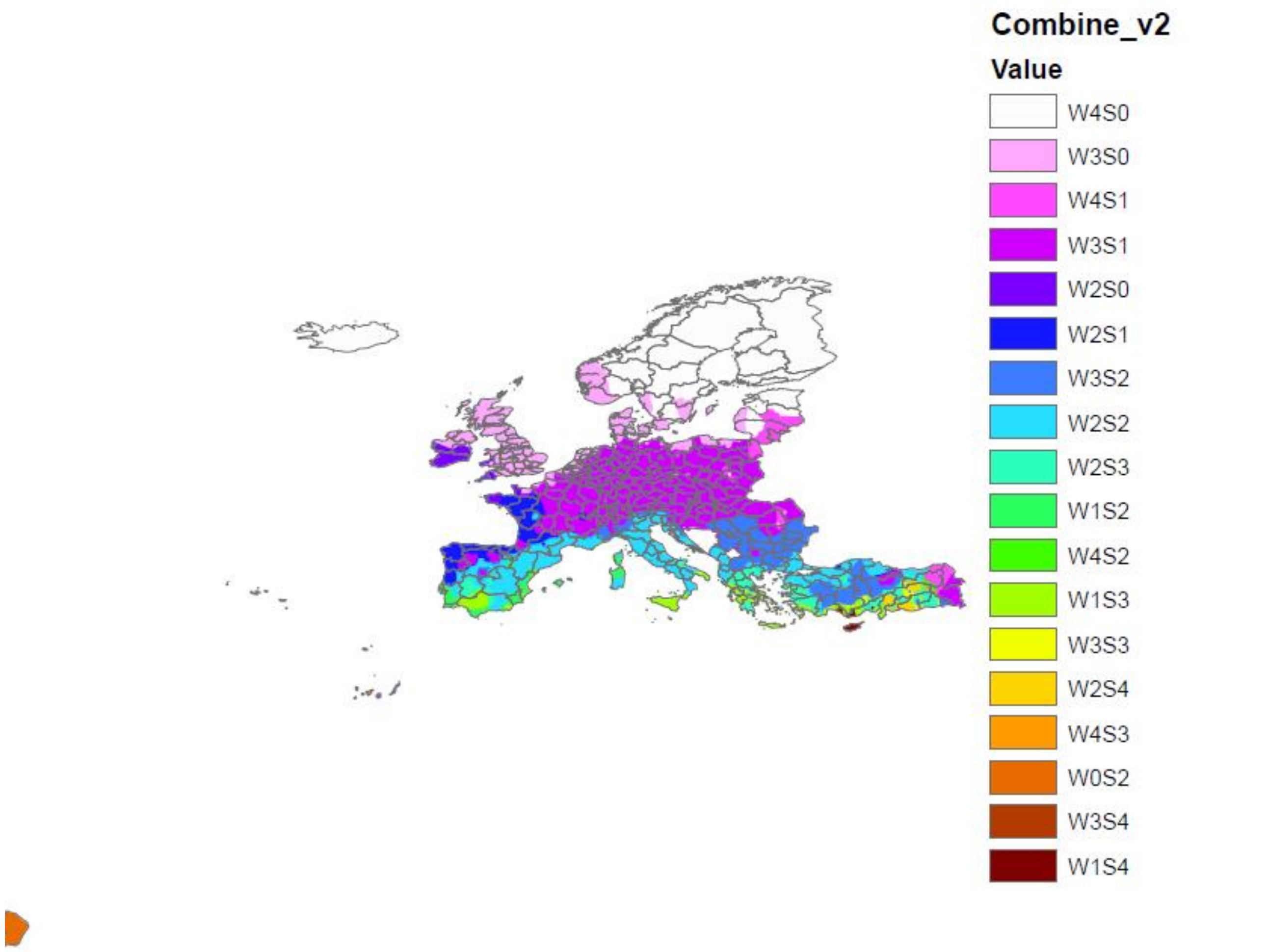


Figure 9: European climatic zones

2 URBAN ZONING

2.1 Introduction

The built environment is greatly affected by the surrounding meteorological conditions in terms of the energy needed to heat and cool domestic (not only) buildings. Global climate change, the thermal deterioration of the urban climate because of the rapid alteration of land use (replacement of free spaces with buildings) and poor urban planning have led to unfavourable environmental conditions. Building energy consumption and urban climate are related and need to be considered simultaneously for urban planning purposes, especially when facing significant climatic changes that could worsen thermal comfort in urban areas (European Environmental Agency, 2012).

It has been found that buildings dated before 1980, which account to 65% of the building stock, are not thermally insulated with wall insulation, double glazed windows etc. Moreover, the indoor space square meters per person and the penetration of A/C have increased leading to higher energy demands during peak hours. According to Eurostat, Greek buildings consume 30% more energy than Spanish and twice as much as Portuguese do.

2.2 The Urban Climate

Anthropogenic activities can alter the local atmospheric conditions in urban areas and consequently lead to the formation of the so called "urban climate". The factors that affect its characteristics are: a) land use and land cover change (e.g., urbanisation, deforestation, drainage of surface water etc.), b) release of energy to the atmosphere (industrial units, domestic heating, consumption of electricity etc), c) emission of air pollutants and aerosols. Moreover, other parameters that have a direct effect on the urban climatic conditions are the size of the area, its population, the ratio of built to green spaces, the construction materials, the urban planning, the industrial and other anthropogenic activities. The urban air is generally warmer than its surroundings because of the thermal energy released from all activities and the alteration of the radiation balance from the buildings and streets that absorb and re-emit heat at a different rate compared to a rural area, thus leading to a further temperature increase. This phenomenon is called the urban heat island, it appears both in summer and winter and Athens is a typical example with a densely built centre and less dense suburbs.

Due to different local characteristics within a Greater Urban Area (or a metropolitan area) such as land use type, anthropogenic heat and micrometeorological conditions there exist temperature differences even among the different municipalities that range from 0 to 13^{0}C. Therefore, climatic zoning is required to better represent the energy performance requirements which buildings in the localities should comply with, (Zoulia et al., 2008; Santamouris et al., 2001; Mihalakakou et al, 2004).

European Commission

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement n. 785072

2.3 Methodology

The next step is to combine the derived climatic zoning with the land use distribution in selected regions (MedZEB pilot areas) in order to produce a more concise climatic zoning.

Several interpolation methods have been employed to predict the spatial variation of climatic parameters in smaller-scale areas, using climatic data from official networks. Here, the kriging method was chosen, as it has been proven to be effective in geostatistical applications (e.g. Delfiner and Delhomme, 1975). The interpolation procedure was applied separately on the winter and summer CSI data series of the selected regions, producing square grid boxes covering the whole examined area.
Sensitivity tests were performed to decide the partitioning of the area. The size of the grid boxes was gradually reduced checking for possible distortion at the spatial distribution of the initial CSI values of the stations.

2.3.1 Data

Data are currently being collected and analysed and the results will soon be incorporated into the revised report.

3 CONCLUSIONS AND RECOMMENDATIONS

This report deals with two different scales of climatic zoning. The first scale, is a general one and concerns the climatic zoning of Europe with a specific interest/focus on MED countries, while the second concerns a more regioning scale (urban zoning).

The derived climatic zoning can allow estimations of energy demand in localities with no meteorological data. Moreover, based on future climate projections, possible changes in the climatic zones distribution can provide estimation for changes in energy demand for specific localities, as well as for the whole examined area.

Also the climatic zoning can help in identification of the best renovation solutions for a specific area or/and a specific type of building in different regions.

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement n. 785072

4 REFERENCES

Akander J., Alvarez S., and Johannesson G., 2005: Chapter 3. Energy normalization techniques. In: Santamouris M. (ed.), Energy performance of residential buildings. A practical guide for energy rating and efficiency. James & James/Earthscan, UK, 64–67.

Assimakopoulos M.N, Assimakopoulos V.D, 2014: The square mile retrofit project, WP4, D4.1.2 '' Report on the climatic regioning and sub-regioning methodologies for building energy – The Attica case''.

Assimakopoulos M.N, Assimakopoulos V.D, 2014: The square mile retrofit project, WP4, D4.1.1 '' Report on the land use profiles of the square mile project areas''.

de la Flor F.J.S. and Domnguez S.A., 2004: Modelling microclimate in urban environments and assessing its influence on the performance of surrounding buildings. Energy and Buildings, 36, 403–413.

de la Flor F.J.S., Domnguez S.A., Felix J.L.M., and Falcon R.G., 2008: Climatic zoning and its application to Spanish building energy performance regulations. Energy and Buildings, 40, 1984–1990.

Briggs R.S., Lucas R.G., Taylos Z.T., 2003: Climate Classification for Buildings Energy Codes and Standards: Part 1: Development Process. ASHRAE transactions (1): 4610-4611.

Delfiner P. and Delhomme J.P., 1975: Optimum interpolation by kriging. In: Davis J. C., McCullagh M.J. (eds), Display and Analysis of Spatial Data. John Wiley, New York, 96–119.

Ecofys, 2013: Towards nearly zero-energy buildings, ''Definition of common principles under the EPBD''

European Environmental Agency, 2012: Urban adaptation to climate change in Europe, Copenhagen.

Founda, D., and Giannakopoulos, C. (2009) "The exceptionally hot summer of 2007 in Athens, Greece – A typical summer in the future climate?", Global and Planetary Change, 67, pp. 227-36.

Founda, (2011) "Evolution of the air temperature in Athens and evidence of climatic change: a review", Advances in Building Energy Research.

Gaitani N., Lehmann C., Santamouris M., Mihalakakou G., and Patargias P., 2010: Using principal component and cluster analysis in the heating evaluation of the school building sector. Applied Energy, 87 (2010) 2079–2086.

Giorgi, F. and Lionello, P. (2008) "Climate change projections for the Mediterranean region", Global and Planetary Change, 63, 90-104.

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement n. 785072

Hassid S., Santamouris M., Papanikolaou N., Linardi A., Klitsikas N., Georgakis C., and Assimakopoulos D.N., 2000: The effect of the Athens heat island on air conditioning load. Energy and Buildings, 32(2), Pages 131–141.

Kostopoulou, E and Jones, P. (2005) "Assessment of climate extremes in the Eastern Mediterranean", Meteorology and Atmospheric Physics, 89, pp.69-85.

Matzarakis, A., 2005: Country Report: Urban Climate Research in Germany. IAUC Newsletter 11.

Mihalakakou, G., Papanikolaou, N., Santamouris, M. and Cartalis C. (2004), "Simulation of the urban heat island phenomenon in Mediterranean climates", Pure and applied Geophysics, 161, 429-51.

Nastos, P. and Zerefos, C.S. (2007) "On extreme daily precipitation totals at Athens, Greece", Advances in Geosciences, 10, 59-66.

Ren C., Ng Yan-yung E., and Katzschner L., 2011: Urban climatic map studies: a review. Int, J. Climatol., 31, 2213–2233.

PVSITES project report, 2016: European climate zones and bio-climatic design requirements

Salmeron J.M., Alvarez S., Molina J.L., Ruiz A., Sanchez F.J, 2013: Tightening the energy consumptions of buildings depending on their typology and on Climate Severity Indexes. Energy and Buildings, 58, 372-377.

Santamouris M., Papanikolaou N., Livada I., Koronakis I.,Georgakis C.,Argiriou A., and Assimakopoulos D.N, 2001: On the impact of urban climate on the energy consumption of buildings. Solar Energy, 70(3), 201–216.

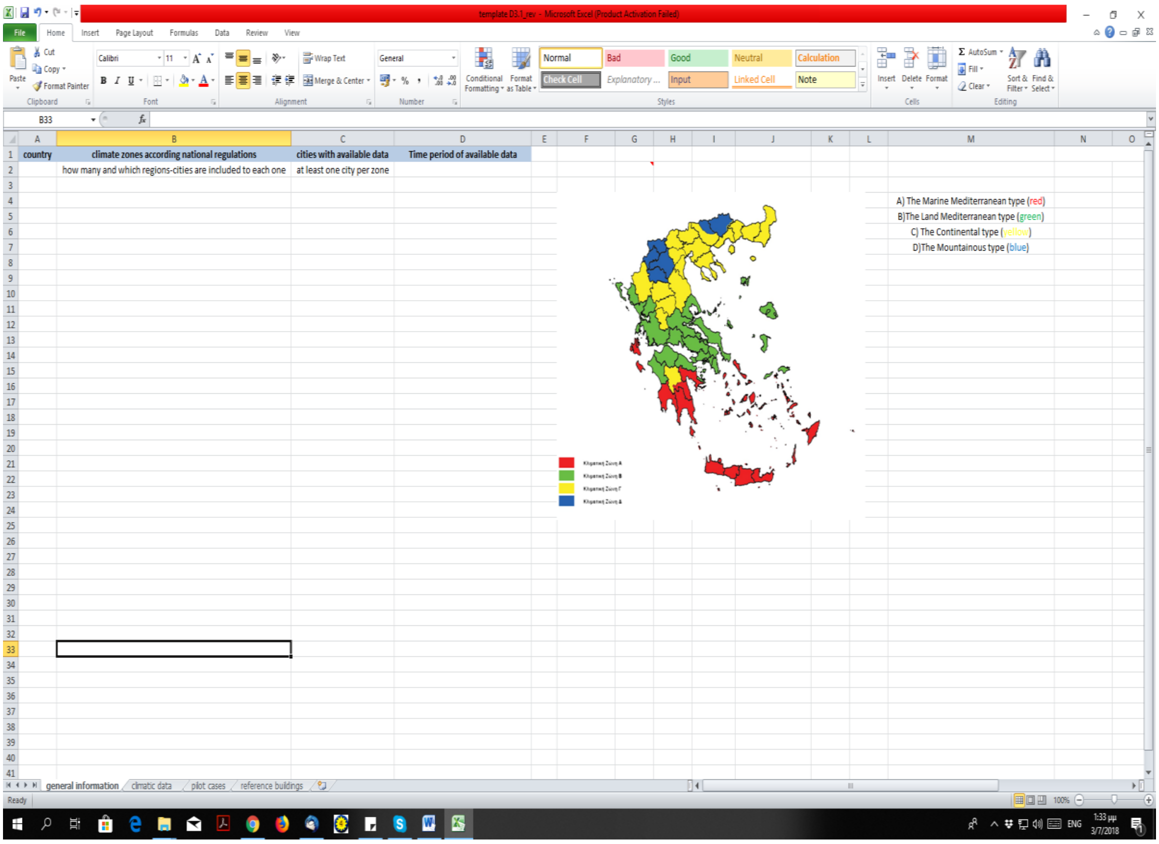
Technical Chamber of Greece, 2010: Technical Directive—Technical Chamber of Greece T.O.E.E. 20701-3/2010 Climatic Data of Greek Regions.

Tsikaloudaki K., Laskos K., Bikas D., 2012: On the establishment of climatic zones in Europe with regard to the energy performance of buildings. Energies, 5, 32-44.

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement n. 785072

APPENDIX A: TEMPLATE D3.1

All partners provided data according to the template below. The first two sheets were adressed to all the participant countries, while the third one only to pilot cases partners. The data concerns meteorological data of at least one city per climatic zone according to national regulations and land use data and images for areas close to pilot cases.



This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement n. 785072