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Climate change impacts and public perceptions

- A study in Heraklion, Crete, Greece.

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ABSTRACT

The impacts of climate change in the environment are beginning to be apparent, not just affecting the natural environment but also human societies. In Crete, according to the IPCC projections, these effects are highly likely to intensify in the coming decades. The temperature will rise, the frequency of rainfall will decrease, and the sea level rise will affect numerous coastal areas. Extreme weather events now make their appearance more and more frequently, causing disasters such as floods and droughts. These changes represent a serious threat to human life, economic development and the natural world, from which humans are depending largely their prosperity.

Moreover, these changes affect in different levels and in different ways every society. In this thesis a general background will be provided regarding the climatic conditions and climate change future projections concerning the area of interest. The focal point of this work is to assess how the locals perceive, experience and understand climate change in the Heraklion regional unit. An attempt will be also made to analyze for the region the reasons that make basic domains of the society vulnerable to extreme weather events. The purpose of this is to understand to some level the reasons that increase the vulnerability of the local population when exposed to various stimuli, since the success of adaptation or mitigation strategies is subject to population dynamics along with other factors.

1. Introduction

1.1 Background

Mainly concerned about the consequences of climate change in the Mediterranean and more specifically in the island of Crete where I come from, I decided to base my master thesis on examining the indicators and effects of climate change at this region, but also the inhabitants perception on this matter and the measures taken by the authorities so far, and compare the facts.

Climate change is one of the most imminent global issues, (World Bank Group, 2014). Is the Heraklion prefecture in Crete immune to these changes? In this study the climate change scenarios (IPCC/Synthesis report, 2014) will form the base upon which i will study the impacts related to global warming due to anthropogenic activities. Accordingly, as a result to the human actions, there are possible events that arise when disturbing the fragile balance that exists between terrestrial, marine, riverine and atmospheric systems, and the impact these impose to economic activities, the environment, infrastructure, health etc could be tremendous (Ciscar, et al., 2009).

In a research study made by Blennow, et al., (2012), regarding factors that can predict and explain if adaptation measures should be taken, it was found that personal experience and belief in climate change must be taken into consideration for the better understanding of people's adaptive capacity and hence communicating and addressing climate change effects more effectively.

Moreover, a population's capacity to withstand the effects of environmental changes and its flexibility to readjust its way of living is a factor that can greatly influence the outcome of adaptive measures decided and vice versa. Thus, by understanding the level and reasons that make a population vulnerable we can better enhance its adaptive capacity. However, adaptive capacity is relative to scale, meaning that it can be applied in different levels with different ways, from the individual level to the regional, national and global and the same goes for risk management. As a consequence, decision makers and authorities can influence in a negative or positive way the individuals' adaptive capacity. It all lies on how risk management is applied and communicated (Daniell, et al, 2014), and also on bottom-up planning

strategies where the public's opinion is regarded as essential and thus it's participation will also guarantee in a way the acceptance of the decisions and policies that are decided, (Lubell, et al, 2007).

Climate change impacts not only have adverse effects on the physical environment and biodiversity but also pose challenges and put at risk people's activities and way of living. Can these challenges be met by bottom up planning approaches that will take into account people's understanding and opinions about how climate changes affect them? O'Brien et al., (2007) claim that the way we understand vulnerability, influences the adaptation strategies promoted. Top-down approaches are focusing between scientific projections and decision making, whereas, bottom-up approaches are focusing on addressing social vulnerability (Dessai, et al., 2004). Can factors related to social vulnerability like political economy and social capital act as barriers and prevent from choosing the best possible solutions? (Myers, 2009) Likewise since bottom up approaches can be described as people-centered another important factor that can interfere with whether actions should be taken or not to address the effects of global warming is personal belief in climate change.

1.2 Objective

The overall intention through this work is to contribute to a more sustainable development through a better understanding of the risks and social vulnerabilities that are related to climate change.

This thesis aims to study the potential impacts of climate change in the prefecture of Heraklion, through the data issued by the Intergovernmental Panel on Climate Change (IPCC) in the wider region of the Mediterranean. A pivotal role will also have the survey data collected in this study illustrating the relationship between climate change beliefs, risk perception, local/regional vulnerabilities, resilience and adaptive capacity. Hence, the local's population perception of climate change and strength of belief in global warming will be investigated on the question if it is required, and at what level, to address climate change impacts.

More specifically, other factors that could indicate the need of action will be covered, such as the inhabitants:

- Past experiences of extreme weather events, which they link to global warming.
- Which threat of climate change is more alarming and at what location.
- Which sectors are more vulnerable/ or resilient.
- The trust level regarding local authorities' preparedness to cope with climate change consequences.
- The level at which they believe adaptation measures can compensate for the losses resulting by climate change effects.

Other predictors such as age, gender, and level of education, will also be included in order to explore if there are significant differences between the different respondents groups and their belief in climate change due to anthropogenic reasons.

1.3 Research questions

In this thesis with the use of literature and the survey findings I will attempt to answer questions such as:

- What would be the impacts of climate change in this region for the local population according to the climate projections presented by the IPCC?
- Are the inhabitants skeptical about climate change or not? Have they noticed/ experienced changes?
- How prepared is the local society and what are the factors influencing its capabilities?
- What are the measures to adapt taken by the authorities so far?

1.4 Approach/Method

The methods used in this thesis were partially based on literature research along with the conduction of a survey and a further analysis and discussion of the findings. The procedure followed for completing this study, was broken down into 3 parts.

Initially, literature information was gathered regarding observed and projected climate changes concerning the Mediterranean region, from the Fifth Assessment Report (AR5) published by IPCC. At the second part, specific information about the area of study were gathered, from municipal records, journals, observation station data et cetera, regarding the observed changes on local climatic conditions and also on the existing environmental and socio-economic conditions. Thirdly, a survey was prepared and was carried out by the use of a landline telephone connection, in order to collect a sample of views from the inhabitants of Heraklion municipality on how they perceive climate change, and how they react upon it. On that account, it was considered necessary to collect an adequate random sample of views that would allow the survey results to be generalized for the population of Heraklion municipality, and also to perform a statistical analysis. The data will be described and statistical methods will be used to test for differences between groups of responses. Furthermore, the results will be used to discuss mitigation measures and adaptation strategies taken so far regarding their effectiveness and if alternative approaches can contribute in addressing climate change risks better.

2. Observed and projected climate change

2.1 Intro

In the fifth assessment report of IPCC the relationship between regional climate and global mean change is described as complex. This is due to the large number of components that affect the climate globally and regionally. Accordingly the relations between these components seem to play a key role in climate change. The after effects arising from the interaction between the different scales of influence have been interpreted by the theory of chaos and the famous butterfly effect, where even the smallest disturbance of the initial conditions in the climate system can cause major changes in the long term. These relations are connecting global climate and the diverse regional climate responses. Furthermore, these responses are subject to the change of water cycle and atmospheric circulations that redistribute heat and moisture from one region to the other. Regional spatial surface conditions also affect these responses. Likewise, external forcings influence climate change, either due to physical (e.g. volcanic eruptions) or anthropogenic acts, where the latter are identified by the majority of the scientific community as the basic drivers of fast pace climate change.(Christensen, et al., 2013) & (Kirtman, et al., 2013)

2.2 Temperature

It is referred in SREX report of IPCC that since 1950, warm days and nights have increased annually, whereas the increasing temperature trends at global level have consequently increased the number of heat waves at regional level (IPCC, 2012). It is also reported that southern Europe is expected to be affected much more from drought in relation to the rest of the continent. Climate change is expected to affect many sectors. Though, due to the vast amount of climatic divergence in the Mediterranean, each region is expected to be more or less affected depending on the surrounding context. Mediterranean regions are characterised by a large amount of natural variability (Christensen, et al., 2013). This variability is a result of the local microclimates, which depend in various factors, such as latitude, elevation, topography, vegetation, nearby water, ocean currents, and prevailing winds.

Since microclimates resemble global climate they are also influenced by external forcing, such as solar radiation, emissions, land use, et cetera.

According to Kirtman et al. (2013), from 1880 till 2012 the average global land and surface temperature shows an increase of 0.85, ranging from 0.65 to 1.06°C. According to the reference period during 1850 to 1900, it is assumed for all scenarios of working group one of the fifth IPCC assessment report, except for RCP 2.6, that global surface temperature will exceed 1.5°C by the end of 21st century. It is also mentioned that if no major changes take place due to solar irradiance or volcanic eruptions the global mean surface temperature for the period 2016 to 2035 (relative to data from 1986 – 2005) will range from 0.3 to 0.7°C.

Furthermore, the model projections of the IPCC scenarios estimate with high confidence that temperatures will continue to increase over the 21st century at the Mediterranean region. It is mentioned though that summer mean temperatures are expected to increase more compare to winter mean temperatures, whereas north Europe will experience the opposite. As a result heat waves will increase in frequency and length, (IPCC, 2013, Annex I). Whereas in areas within the subtropical zone, such as the Heraklion prefecture, both seasonal and annual mean temperatures are expected to be larger than those in mid-latitudes. (Kirtman, et al., 2013)

2.3 Precipitation

In general the IPCC reports assess that precipitation in the subtropics' zone is expected most likely to decrease. At the regional level though, precipitation patterns are expected to be strongly influenced by internal variability and probably in a certain extend by anthropogenic aerosol emissions.

The range of projections about precipitation varies greatly, especially when focusing in the regional context. The observed data and the future projections show an inconsistency in trends across the different regions, this due to the many natural and anthropogenic factors but also due to unequal research attention, the poor quality data in some regions and monitoring and reporting issues. It is observed though that the difference between wet and dry regions is expected to increase, meaning that dry regions will become drier while wet

regions will have an increase in precipitation. Nevertheless, the above assumption is subject to regional exceptions.

The precipitation patterns for the next few decades are expected to be similar to those at the end of the 21st century, but will have smaller magnitude (IPCC, 2013 SPM). The precipitation trends for the Mediterranean region, according to the 39 CMIP5 model simulations, show a moderate reduction for the half year season (October to March) and a more great reduction during the rest of the year (April to September), for the last two decades of the 21st century. These projections are a result of the 39 CMIP5 model simulations for the RCP4.5 scenario, where 66% of the models had the same values with the ensemble mean changes (IPCC, 2013. Annex I).

It is stated though, by Christensen, et al. (2013), that even if model simulation has improved in many aspects regarding the regional climates, the projections still cannot be considered as de facto due to the large amounts of natural variability in the Mediterranean. This natural variability is particularly subject to weather phenomena produced by atmospheric systems such as the North Atlantic Oscillation (NAO) mode, and ocean currents such as the Atlantic Multi-decadal Oscillation (AMO) mode, that influence the weather and climatic patterns of the region. By definition, (IPCC, 2013, Annex III), the modes of variability are products of spatial climate patterns, which have traceable characteristics through time and specific regional effects. The NAO and AMO variability modes are the ones affecting most the Mediterranean basin, along with atmospheric blocking.

2.4 Sea level rise

As stated by Church, et al., (2013, pp.1150), the data derived from stations that measure tide gauge show a significant increase during the 20th century till today. According to this data global mean sea level (GMSL), between 1901 and 2010, ranged from 1.5 mm to 1.9mm with the average set at 1.7mm, and the sea level rise is estimated between 0.17m to 0.21m with the average set to 0.19m.

The sea level projections in the fifth assessment report of the IPCC imply that sea level could rise 40 to 65 centimetres or at the worst case to 1 meter by the end of the 21st century. The near term projections are described as highly

confident to happen and illustrate higher sea level changes in comparison to the 2007 assessment report. Nonetheless, it must be noted that regional sea level changes may vary considerably from the global average sea level rise. The regional sea level changes are subject to the ocean's dynamic processes, the movement of the sea floor and to the way the water mass is distributed spatially, (IPCC, 2013 SPM).

The possibility of higher sea levels, however, is not excluded, but there are no sufficient evidences to support this. According to Church, et al., (2013, pp.1153), higher levels of change than those estimated during the 21th century could take place if sections of the grounded Antarctic ice sheet were to collapse. The intrusion of warm water at the base of the ice sheet, could therefore, intensify both its melting and thinning, resulting thus to its mass loss at a fast pace. Since the ice sheet contribution for the 21st century and beyond remains uncertain it is difficult to project with confidence how sea level rise will be distributed regionally and what the storminess intensity will be at this scale.

Church, et al., (2013, pp.1150-1151)) states that thermal expansion is considered the major cause of sea level rise, followed by the glaciers meltdown. Human interventions in land water storage and the extraction of ground water also contribute to changes at the sea level rise, but to a small degree. It seems that not enough studies have taken place and those that exist are in conflict as to the extent of change imposed to sea level due to the direct human interventions on land water storage. Be that as it may, examples around the globe show that when land water storage temporally increased due to climate patterns (La Niña), global mean sea level decreased. In the same manner human activities, such as massive water storage in reservoirs, have an offset effect at sea level rise. According to Kirtman, et al., (2013, pp. 1008-1009), another factor influencing global mean temperature and sea level rise is volcanic activity. Volcanic eruptions produce a cooling effect that reduces ocean thermal expansion. This negative forcing depends on the magnitude of the eruption.

According to the multi-millennial projections of IPCC as stated by Church, et al., (2013, pp.1186) , if humanity manages to follow the low emission pathway the sea level rise during 2100 -2500 are estimated to range between 0.26 to 0.21 meters. In the case of the medium emission scenario are estimated to range

between 0.19 to 2.32 meters and in the worst conditions will range between 0.21 to 6.63 meters.

These projections were based on the contribution of several factors aside the emission scenarios, such as the melting progress of the glaciers, Greenland's and Antarctica's ice sheets, and the thermal expansion of sea. These projections, though, entail high uncertainty, since the models used had different spatial distribution of the warming and due to the fact that sea thermal expansion is also dependent to local temperature and salinity. (Church, et al., 2013, pp.1151-1153).

2.5 Extreme events

The occurrence of extreme climate events is expected to escalate according to the future projections of the IPCC. Events such as heavy precipitation, droughts, and heat waves are expected to affect at large the Mediterranean basin. These events are estimated to vary at each region. There are also differences at these projections with regards to each RCP emission pathway. Except from the temporal regional variations, hot days are expected to increase in the Mediterranean. As it is stated by Christensen, et al., (2013, pp.1266) since 1950 there is a strong increasing trend of hot days and warms nights in the region. In the same manner heat waves are expected to become more frequent in the future years. These temperature extremes result in a steady increase of dryness and in an increased number of the areas that will suffer from drought in the future. The IPPC report also points the necessity of better coastal planning (Church, et al., 2013, pp.1279-1280), where regional sea level rise and variability trends should be part of a risk management framework, since these factors are expected to exacerbate the impact of storminess at coastal areas.

3. Area of study

The regional unit of Heraklion is one of the four that constitute the prefecture of Crete, which covers an area of 2.641 km and has a population of 305.490 inhabitants. The Heraklion unit borders with the regional units of Rethymno and Lasithi, from west to the east respectively. The coasts of the north meet with the Cretan archipelago and the southern ones are facing the Libyan Sea. Heraklion is the most highly populated of all the regional units of Crete and its capital is the city of Heraklion (173.993 inhabitants). The region is divided by eight municipalities, as it can be observed from the map (Figure 1); the majority of the population resides at the three municipalities located at the north side.

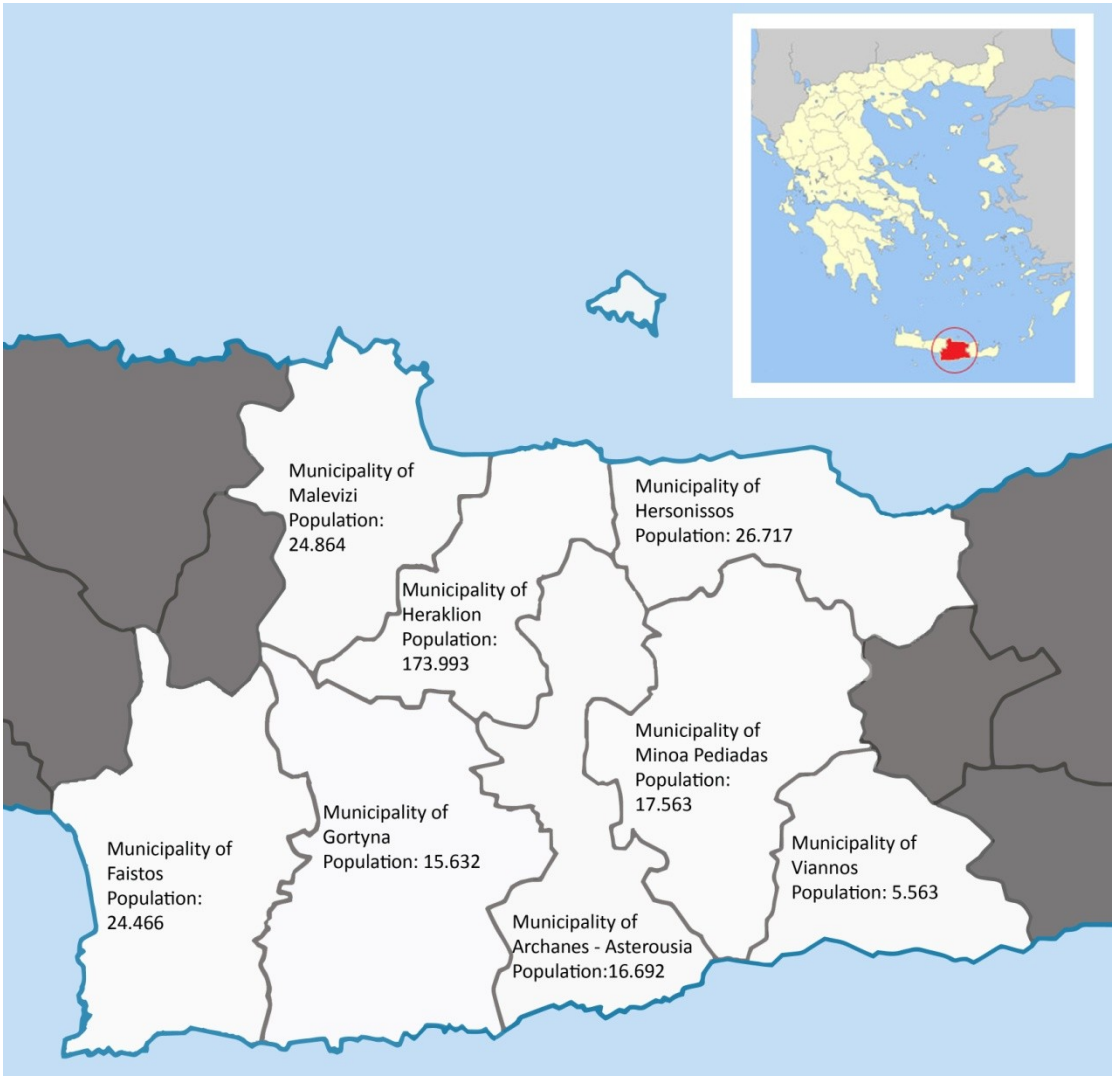

Figure 1: Map of the regional unit of Heraklion in Crete, Greece, illustrating demographic distribution along with the municipalities as established according to the decentralized administration plan Kallikratis in 2010. (Illustration made by the author)

A vast number of the European cities, from major ones to settlements, are located at coastal zones. In the fifth IPCC report Kovats, et al. (2014), recognize the risk these areas are to face in the near future, especially from 2070 and beyond, from extreme climate events (coastal flooding), due to sea level rise. Most of these cities located at coasts play a major role in local and global economy, since they function as hubs of transportation for goods and people. While the services, amenities and job opportunities provided attract more dwellers from the suburbia and other regions. Future projections of the IPCC show that the southern parts of Europe (Mediterranean region) will be affected in great extend. Moreover, if no adaptation measures take place a large number of the population living in these coastal zones will be affected.

In Crete the majority of the population resides near the coast. The capital city of the regional unit of Heraklion is located at the north coast of the island, as are all of the five major cities on the island, with the exception of Ierapetra city, which is located at the south-east coast. The inhabitants' life at the Heraklion region is mainly focused on tourism and the agriculture sector, which are greatly dependent on the changes that occur due to climate change.

3.1 Morphology

The landscape of the region is mainly characterized by lowlands and semi-mountainous areas (Figure 2). Though, the mountains occupy much of the island area. Morphologically, the mountains volumes generate three major zones: the mountainous with an altitude of 400 meters and above, the semi-mountainous (200-400 meters), and the lower zone which extends from the coast up to 200 meters. The first two areas occupy 3/5 of the island and are parts of a continuous mountain range, from west to east, while separate the region's northern and southern parts. The main mountainous ranges, at the region of Heraklion, are those of mountain Dikti (2.148m) to the east, and the mountain of Idi or Psiloritis (2.456) to the west, which is the highest on the island.

The majority of agricultural land is located at valleys at the mainland of the region and also at the plains of north coast. The region has two major plains, that of Messara in the south-west part, which is the largest in area, and that of Minoa Pediadas (Kastelli), located in the northeast.

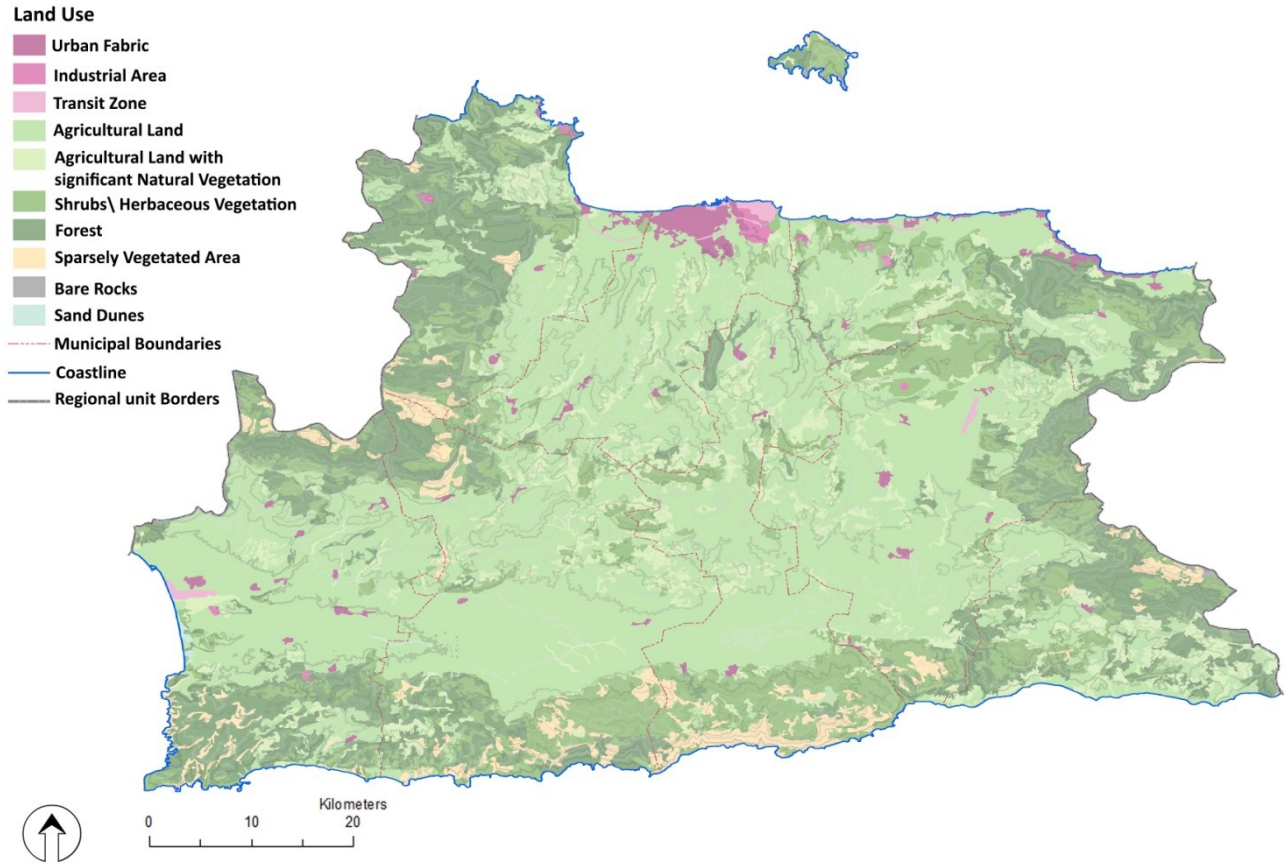

Figure 2: Map illustrating the land uses types in the region of Heraklion. (Data derived from Land Cover Corine 2000, map made by author in ArcGIS)

Moreover, according to figures from local authorities the regional unit of Heraklion holds the majority (44%) of agricultural land on the island. The number of rivers in the region is low. The largest by volume of water and length are two, Geropotamos that stems from Mount Dikti and flows at the Gulf of Messara, and Giofyros that stems from Psiloritis Mountain and flows into the Cretan archipelago. Fortunately a noticeable percent of the water poured during the rainy season ends up in the many subterranean karstic basins of the island, which can be then extracted. (National Technical University, 2010)

3.2 Geological features

Crete has a complex geological structure and this is due to its geotectonic position, above the point where the lithospheric plates of Africa and Eurasia converge. Several scientists have different views on its structural content and this can be seen from the numerous geological maps that reveal this confusion the (I.G.M.E, 1967) & (Bonneau, 1973).

A key feature of its geological structure is, nevertheless, the successive tectonic covers, which are deposited on limestone slabs (dolomites, schists) by different indigenous systems and zones. On top of these rock formations are found sediments of the Neogene (Miocene and Pliocene epoch) and the Quaternary (Pleistocene and Holocene epoch). This complex structure results in each system to behave and move in a different way during seismic excitation. The region of Heraklion, for its most part is covered by alluvium marls, limestone, and Neocene sediments. (National Technical University, 2010) & (Fassoulas, 2000).

3.3 Seismic activity

Crete is situated on the juncture that forms the trench, where the Eurasian lithospheric plate clashes with the African plate. The movements of these two lithospheric plates are the main cause of the intense seismic activity that is observed on the island and the surrounding marine region. The tectonic movements do not influence uniformly the island, on the ground that the plate of the Crete is composed of many tectonic segments separated by a number of fractures, which move independently. More specifically between 2020 BC to 280 AD western Crete had 10 subductions that the size of each reached up to 0.25 meters, while since 430 AD has begun to emerge once again (National Technical University, 2010). In the same manner, it has been observed, due to these particular geological conditions, that in the region of Heraklion the central north coast shows subduction trends, which constitutes the area more vulnerable in the case of sea level rise, whereas parts of the south coast of the region are prone to emerge. (Fassoulas, 2000)

3.4 General climatic conditions

The island of Crete has a temperate Mediterranean climate, which however is characterized by a number of variations depending on the geomorphology of each location. More specifically, according to Bleta, et al. (2014) the climate, of the regional unit of Heraklion, is semi-arid with mild winters and a relatively cool summer at the north coast, because of the northern winds – Etesians- that inhibit the heat feeling in the summer. On the other hand, the mainland has hotter summers and colder winters.

While the southern coast have warmer winter and summer, as the mountains cease the north winds that prevail on the other side of the island. As for the mountainous zones the climate differs dramatically and tends towards the continental type.

In general, according to the information provided by the Hellenic National Meteorological Service (HNMS), the sunshine rate in Crete is particular high. In the northern areas of the Heraklion region, the number of sunshine hours is around 2700 hours, while in the southern areas is 10% higher, reaching approximately 3000 hours. The summer season lasts just about four months, from June to September. The warmest month is July, while the coldest is February with little differentiation from January. The average monthly temperature varies from 12.1 °C in January to 26.1 °C in July. The absolute monthly maximum temperature in July and August can reach up to 41°C and 42 °C respectively, the absolute monthly minimum temperature occurs during the months of January and February reaching 0.2 °C.

The maximum rainfall rate is observed in December and January, while the minimum in July and August, especially in the lowlands, where the percentage of drought is high. Similarly, the monthly number of days with precipitation ranges between 15-16 in December and January, and 0.3 in July and August.

The average number of days of precipitation is approximately 90, taking up for the 25% of the year. The least wet month is August while January is the rainiest with mean value at 90.1 mm. The total annual rainfall in the region stands at 481.3mm according to the meteorological station of Heraklion. Main constituent snow is uncommon phenomenon in the lowlands, but not so the hail-storms that occur during December till March. Additionally, the humidity rates are relatively high, ranging from 56.3% in June to 68% in January.

The prevailing winds in the region are northwesterly, except from the winter months when their main direction is to be from the south. The average monthly intensity of the winds varies from 3.1 m/sec in May to 5.1 m/sec in February.

4. Regional observed changes on climatic conditions

For this part of my thesis it was not possible to find coherent data for the most part of the 20th century. Many of the data sources had gaps between certain periods of time. This is due to a variety of reasons (low quality data due to outdated equipment use, unavailability of data for the public, loss of data during WW2 and several years after due to political instability). It was possible though to find a number of data for later years published on the web from local stations that measure climatic conditions and also through the research work that has taken place so far by several scientists on this field.

4.2 Temperature

According to the data provided by the local weather station at Heraklion airport (Berkeley Earth, 2013), a trend of increasing positive anomaly can be observed around 2005 towards higher temperatures. Additionally, it shows that the intensity of extreme cold weather events during winter time has also increased dramatically. The temperature anomaly average, regarding the data from the local station, shows an increase of 1°C especially at the end of 20th century and beyond.

4.3 Precipitation

It has been observed that there may be a trend of decreasing rainfall in Crete (Sauter, et al., 2013). According to a study made by Pnevmatikos & Katsoulis, (2006), there is an evident shift in the rainy season, which has become shorter in duration across the whole Greek peninsula over the last 20 years. Until the 1980, data show that the rainy season would start early in October and would end at late April. The last few decades though the precipitation regime comes at late October and ends at late March.

4.4 Sea Level Rise

The gauge station of Heraklion presents an increasing trend of sea level rise according to the monthly measurements through the years, whereas it is noticeable a dramatic change after 2008. Unfortunately, it was not possible to obtain information regarding the mean sea level anomalies, and so the range of the average anomaly trend is not illustrated here. However, according to Alexandrakis & Poulos, (2008), the data within the period 1979-2007 from the Heraklion gauge station present a rise of 12cm, with a mean rate of sea level rise of 2,2mm/year. Additionally, satellite data indicate that the sea level in the Mediterranean has risen by 2.6cm during the period 1992-2008 (Sauter, et al., 2013).

4.5 Extreme Events

Extreme events of precipitation entail a number of consequences for the urban and rural landscape. According to research studies, by Koutroulis, et al. (2012), rain intensity is found to be more severe in summer and fall than during winter or spring. Especially during fall, when thunderstorms and cyclones tend to occur more often, inducing thus flash flood phenomena (Kambezidis, et al, 2010). The overall decrease of annual precipitation leads to events of heavy precipitation outside of the range of the rainy season. Hence, result in floods in the urban and rural environment that test human efficacy in managing such situations. Heavy rainfall and intense storms also contribute to a large extend on soil loss and erosion. In Crete severe storms threaten the mainland and the coastal areas in various ways such as: increased mortality and injuries, agricultural losses, soil erosion and degradation, coastal erosion, infrastructure damages.

The negative trend of the annual average precipitation increases environment's vulnerability during extreme hot conditions. The decline of duration of the rainy season lengthens the duration of the dry and warm period. Within the summer season the occurrence of heat-waves, that become all the more frequent exacerbate the impacts of the dry periods, thus influencing the daily activities and human health. Additionally, fire events tend to occur more often, while the strong winds that prevail during summer enhance fire's spreading ability, leaving large patches of land barren.

According to studies, a vast number of locations in the Heraklion regional unit are threatened by desertification (Hellenic Ministry for the Environment, Physical Planning and Public Works, 2008). As a result extreme drought conditions threaten the land, the environment, the water resources but most importantly life in all its forms.

Moreover, the increasing climate anomalies create many problems in various sectors. These different sectors, including by name, tourism, agriculture, environment, health and the energy sector occupy a dominant role in how a society functions. The above-mentioned sectors possess precisely this role in the Heraklion regional unit. The way they function and their response to possible climate changes, might present serious consequences in the daily lives of the inhabitants, especially since these sectors are inextricably linked, and accordingly, influencing one another's performance. By this logic the degree of response in these sectors regarding climate change can act as a meter factor of adaptability.

5. Sectors and climate change implications

5.1 Agriculture

In Crete is expected, according to the observed data and future projections of Kovats, et al. (2014), that droughts and desertification will be aggravated. It is also stated, that southern Europe will experience more losses, in comparison to the north, with yield losses up to 25% by 2080, if temperatures rise as high as 5.4 ˚C that the IPCC projections suggest. Abnormalities in precipitation and temperature will cause serious effects on the agricultural sector, especially if there is no proper management of the water resources. What is more, the agriculture production that so far has been dependent on seasonal precipitation, as a result to the warmer and drier conditions, will increase the water demand for crop irrigation (Savé, et al., 2012). The farmers coping ability will be very much dependent on how possible future water- shortages are assessed, in order to protect their plant production from dry spells. Likewise, the increased occurrence of intense storms could also threaten crop production, especially the sensitive crop species. On this ground, it is highly likely that climate change impacts will result to agricultural production losses. Though, the regional distribution of these impacts is expected to vary, due to the temperature and precipitation variability.

5.2 Tourism

It is expected according to Kovats, et al. (2014), that after 2050, summer light outdoor activities will decline due to the climatic conditions. Yet, it is also highly possible that temperature will rise during spring and autumn. Thus, it can be argued that this change will, somehow, compensate for the possible reduction of tourism in Mediterranean during the summer period. In other words, a time-length change of the tourism season will possibly take place in the region.

On the occasion of the upcoming climate impacts, if someone follows the changes that have taken place in the past will observe that the last three decades a major shift has occurred, towards an economy all the more dependent on tourism. Consequently, this shift has increased the demand on

the energy sector and on water resources. The once agrarian land has been covered with cement (urban sprawl), especially across the north coastline of the prefecture where small accommodation units but also large resorts have been built. As a consequence and having in mind the projections of the IPCC reports, the future increase of summer temperature peeks, will test the energy sector response to the higher electricity demands (cooling)of the future, while it will increase also water consumption and irrigation needs (Giannakopoulos, et al., 2009).

5.3 Environment

The observed declining trends of precipitation have a subsequent effect on the total runoff water and the precious, for the Heraklion regional unit, groundwater resources. According to studies made by Koutroulis, et al. (2012) and Tsanis, et al. (2011), the regions' water resources are affected largely because of the irresponsible extraction and misuse of underground water basins, which are the main source of providing potable water at the prefecture. Excessive water extraction has also led to the influx of saltwater into these basins, thus degrading the quality of the water. In addition, it has been found that excessive use of pesticides in agriculture has led to further contamination. Considering, that during winter time when heavy rain falls occur after long periods of drought, a large portion of pesticide residues leak to the aquifers.

Projections also show a decrease in summer soil moisture in the Mediterranean region. It is expected and observed that precipitation trends and anomalies show an extension of the dry periods, resulting in fewer rainfall events which are highly intense, though. Consequently, according to Kovats, et al. (2014), the extended dry periods could increase soil erosion which can be exacerbated due to the heavy rain falls. Additionally, coastal erosion, due to intense storms as well as the sea level rise, is highly possible to put at risk the dune systems. The last existing dune systems, which are already depreciated and shrank by the spread of the built environment and infrastructure close to the shoreline. Also, due to the livestock extreme numbers on the island, overgrazing also contributes to soil erosion. Since, poor vegetation cover reduces the water infiltration capacity of the soil, resulting thus to land degradation (Kairis, et al., 2015).

More specifically, according to a research study by Panagos, et al. (2014), that mapped the 77% of the total area of Crete with the use of the G2 soil erosion model on a monthly basis revealed an annual mean soil loss rate of 8.123 tha^{-1}. The soil loss rate was found, logically, to be dependent on the annual climatic variations and also the type of vegetation and land use. The most erosive period was found to be between October and January was characterized as of high risk representing 80% of the annual erosion. Furthermore, it was found that natural grasslands, shrub lands, and sparsely vegetated areas were the landscapes in higher risk. This can be explained by the overwhelming numbers of livestock that overgraze these areas. Though, in the case of the sparsely vegetated areas, which are mainly located at the mountainous zones, soil erosion is induced even more due the fact that the terrain is characterized by many steep slopes.

It goes without saying, that the possible higher demands posed by tourism, energy, and agricultural sector will put a strain on the environment's resources in the future. At the same time the increasing urbanization leads to a reduction of biodiversity and degradation of the natural resources of the region, due to the increased environmental pollution, of the ecosystems disruption and the land use changes. Overall, the possible lack of sustainable measures will, therefore, have a negative impact at the inhabitants' way of living, in the same manner it will have for the environment as a whole.

5.4 Energy

Regarding the implications posed on the energy sector, the projections of the IPCC report by Kovats, et al. (2014), for the southern part of Europe, particularly in Greece, with relation to the temperatures increasing trend, estimate a decrease in electricity production by 5% during the winter season. On the contrary, during the summer season the demand could increase by 15 to 20%, according to a study made by Mirasgedis, et al. (2013). More specifically, according to publicly available data from the Regional authority of Heraklion (National Technical University, 2010), about the current state of the environment report in the year 2012, the electricity production is based on 75% in thermal power plants, gas turbines and diesel units. The first two of which are operated with the use of mazut and the last mentioned, with diesel

as its name implies. While on the other hand the proportion of wind-derived energy is up to 25%.

Suffice to say, that energy production dependent on oil, in such a high proportion, creates many problems, both in the environment where hazardous waste are discharged as well as at the health sector. Namely it leads to direct degradation of the areas and ecosystems that are in proximity to the energy production factory. While the atmosphere of the city of Heraklion and the surrounding areas are burdened with air contaminants that put in risk the health of the inhabitants, not to mention that they contribute to global warming. It should be also noted, that the energy generating factory is located at the west boundaries of the city of Heraklion and next to the sea.

There were also plans the factory to be relocated within 2015 but due to unspecific reasons this has not been realised yet. An upgrade with better design and planning, which considers the environmental risks and hazards, would be beneficial to some degree, since it could also mean that the energy production could adequately meet the needs of demand especially during the summer season.

5.6 Health

Climate change affects humans both directly and indirectly (Figure 10). The direct effects could be described by the way we experience climatic conditions (e.g. thermal stress, injure/death caused by flood or heavy storms), while indirect are those affecting our environment and consequently our way of life (e.g. changes in the disease spectrum, in water quality, food quality and availability). In general terms the IPCC and the World Health Organization (WHO) are recognizing three kinds of health impacts regarding climate change. Those related to extreme events (direct), those resulting from the various-complex processes of environmental change and ecological disturbance (indirect), and finally those occurring due to the low coping capacity of the demoralised/displaced/poorer populations at the climax of extreme climate events (World Health Organization, 2003).

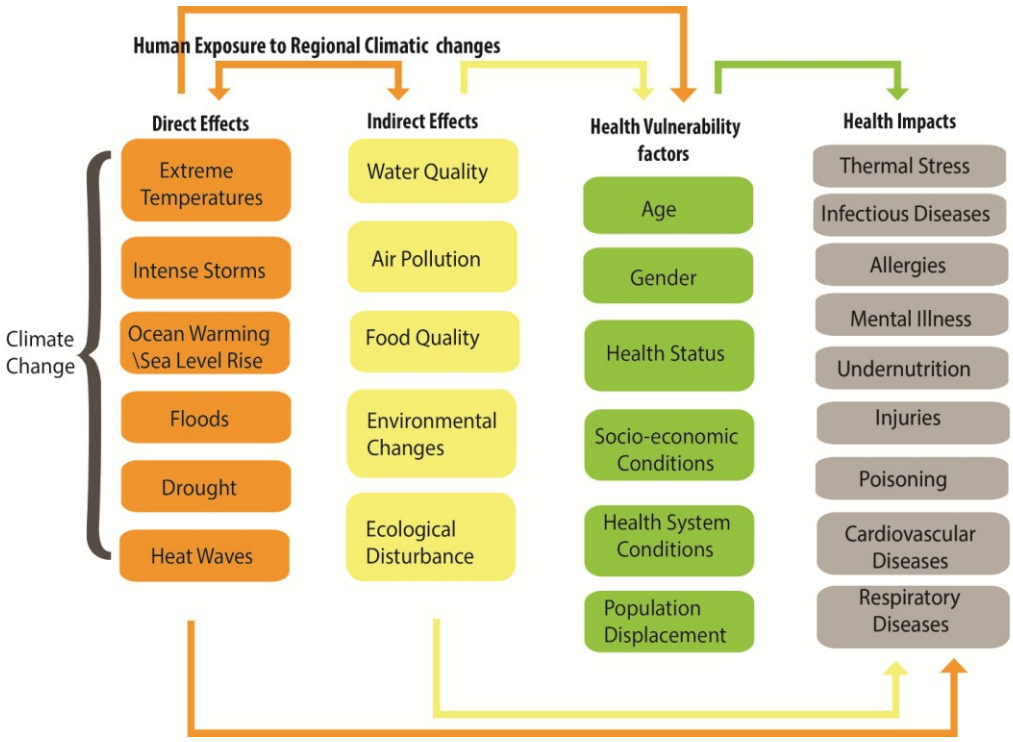

Figure 10: Direct and indirect climate effects influencing health.
(Info graphic created by the author)

Therefore, in the health sector is expected an increase of the morbidity and mortality due to climate change effects. In a study made by Papagiannaki, et al. (2013), the number of fatalities for the period 2001–2011 in Greece shows that the mortality rates due to extreme weather events are attributed by order of risk to flash floods, lightning occurrences, windstorms, heat waves, tornadoes, and lastly snow/frost events.

For southern Europe, cold related mortality is not so much of an issue as heat related mortality. According to Kovats, et al. (2014), high risk groups such as the elderly, children and those who are already experiencing chronic health issues. The increased anomaly trends of climate change will affect the health of the inhabitants, so much due to the increased occurrence of extreme heat events and in view of their increased duration.

In the Heraklion regional unit the occurrence of phenomena such as the Saharan dust storms exacerbate atmospheric particle pollution. Moreover, it has become evident from observed data that the frequency of Saharan dust episodes in Crete is very high, since the island is located at the south-eastern region of Mediterranean. The Saharan episodes lead to especially high particulate matter (PM) concentrations. Whereas the long term exposure of the inhabitants to such high PM concentrations affects their health a great

deal. Thus, resulting in an increased rate of respiratory and eye infection cases, such as glaucoma, inflammation, asthma, pulmonary and systemic oxidative stress, chronic inflammatory lung injury, etc (Nastos, et al., 2011).

Further implications of the climatic conditions are inflated due to human interventions. Namely, the unsustainable energy production methods, the over-exploitation of natural resources, and the tactics of development growth based only on profit, in all sectors, harm the environment adversely. And not only that, but such tactics fail to respect both the environment and the role that ecosystems hold, and therefore endanger the health of local population.

5.7 Infrastructure

The built environment is consisted by many different components, such as transportation (roads, highways, paths, ports, airports, public transit, etc), buildings and land use. Humans are highly affected in various ways by the built environment, since it represents, in essence, how the society's structure functions. It represents the many possible services that the society offers but also the population's dependency from those, and the humans' contribution as well as their vulnerability towards climate change.

It is a fact, that the buildings electricity consumption, the transportation infrastructure and the mobility patterns influence GHG emissions. Since, the use of motor vehicles increases air pollution and thus promotes climate change. As natural environments (ecosystems) provide their services to humans, in the same manner our built environment provides a number of services. The man made environment, though, hasn't yet reach equilibrium with its surroundings or with its core as healthy ecosystems do. Sustainable planning strategies of infrastructure, as a result, can mitigate society's emission footprint and increase its adaptive capacity to climate change. On the other hand the absence of sustainable planning in the built environment increases humans' vulnerability to future climatic conditions. Under these circumstances, the way the built environment responds to climate change and extreme climate events is of high importance and should be considered when planning. (Younger, et al., 2008)

In the Heraklion regional unit, the effects of climate change on the built environment will be particularly significant, in the case that the projected scenario simulations by the IPCC are materialized in the near future and no measures are taken. Accordingly, due to the gradual sea level rise the occurrence of intense storms could more and more threat the coastal areas of the Heraklion region, particularly those located in the northern zone of the region, since, according to Monioudi, et al. (2014), it has been observed a gradual subsidence of sedimentary layers in that area. As a consequence, the basic public infrastructure, the road network, private and public property will be in immediate risk. Critical will also be the implications for human activities along the northern coastline, where exists a significant number of populous settlements, tourism infrastructures and cultural monuments.

Another factor that could directly affect the life of the inhabitants is the reduced use of greenery and the lack of green spaces in the urban fabric. That fact, due to the growing trend of warmer temperatures and the increased number and length of the imminent heat wave events, especially during the summer months, could exacerbate the phenomenon of the "heat island effect".

In 2012, the Directorate of Regional Planning submitted a suggestive framework for the island of Crete regarding the future spatial planning and sustainable development of the island (Hellenic Republic Ministry of the Environment, Energy and Climate Change, 2014). From the day of submission of this proposal until the 31 of May 2015, a series of revision consultations began with the society and local stakeholders. Soon, is expected the publication of the development framework and its further final approval by the authorities. Although, public participation was initiated, as the European legal institutions require, the local community and several local organizations in the region of Heraklion, as well as those of remaining regions of the island, are quite skeptical as to the outcome of the consultations, since they believe that their views and recommendations for the revision of the proposals were not taken seriously into consideration by the planning agencies responsible.

According to their suggestions, submitted for the revision of the development framework, which are accessible to the public through the website of local authorities (Region of Crete, 2015. *Public consultation*), there are references to a

lack of knowledge of the current situation of the built environment and infrastructure by the responsible engineers in charge of the drafting proposals. To name but a few, they report that the framework's proposals include grandiose plans based primarily on the geopolitical position of the island and the exploitation of its resources by external players with the sole purpose of profit and not sustainable development. In simple words, the plans that make up the proposal do not have as a first driven the sustainable development to the benefit of the inhabitants neither upgrade the urban environment.

Moreover, they do not smooth the spatial anarchy that exists, but promote unregulated and illegal construction, as they do not solve the problems that have arisen because of the lack of urban planning in many settlements. Adding, that the framework's proposals make no reference to the forthcoming impacts of climate change, while it is known that the northern zone (coastal front) in the case of the region unit of Heraklion, where much of the economic activity takes place but also is inhabited by a large part of the population, will be affected sufficiently. Furthermore, they state that there is no provision and planning for the mainland on the inhibition and reduction of the phenomenon of desertification, in the same way that there is no reference for the imminent coastal erosion (Alexandrakis, et al., 2010) & (Monioudi, et al., 2014)

Indeed, although the proposal makes frequent use of terminology and ideas, that at a first glance one might assume that the aim is true sustainable development. A more thorough investigation instead has shown that these proposals are in conflict with each other, giving precedence to an industrialization of the landscape, which will result to its adverse degradation and affect all sectors, leading to further environmental pollution and disruption of the existing ecosystems.

6. The survey

6.1 Method

In order to ascertain the opinions of a random sample of citizens living in the region and to ensure that every member of the population had an equal probability of selection; it was considered plausible for this survey to use the systematic random sampling method based on the data available and the means to conduct this study. Thereby, as a sampling frame was used the telephone directory from which the potential respondents were chosen.

Seeing that, the telephone directory divides the persons listed in alphabetical order, creating thus clusters, the selection method was the following; in every page of the directory the first selected element was the 10th and the rest were selected at intervals of 20; this procedure was done for each cluster of the alphabetical directory, whereas the minimum number of positive responses gathered from each cluster was set at 5; in order to collect enough responses for statistical analysis.

I managed to complete 125 questionnaires, in the short time frame I had to perform my survey. Within five days, from March 30th till April 3th of 2015, I made 642 phone calls, of which 258 were left unanswered, in 117 cases the phone number was no longer existed, 119 residents were not interested to participate in my research, 23 respondents told me to call later, and finally from all those phone calls 125 inhabitants helped me to carry out this survey.

The questionnaire's design and structure was such, so that the answers gathered could be used, through coding and analysis, to answer specific research questions. Three different types of question were used; multiple choice, interval scale, and open-ended. In the following sections of this thesis a further analysis of the data gathered will take place. The key questions posed had the aim to reveal the level at which the inhabitants believe they would be affected in the future by climate change due to anthropogenic activities, if they have already experienced the effects of this change and at what degree, as well as, if they believe that local authorities are adequately prepared to cope with the impacts of climate change.

6.2 Hypothesis testing

As a next step, the data were tested in order to find if there are statistical significant differences between groups, as those were formed by categorical variables; respectively to their response in questions 1 & 2 of the questionnaire. The Chi-square test was used to examine how likely it is that the observed distribution of the data collected is due to chance. More specifically, the Chi-square test was implemented to measure how well the observed distribution of data fits with the distribution that is expected if the variables are independent based on the research hypothesis.

The categorical data tested were those concerning personal belief in climate change (question 1), and belief of having experienced climate change phenomena (question 2) in correlation to the discrete variables age, gender and educational level of the participants in the survey. The null hypothesis was used in order to estimate if there is no statistically significant difference between the groups of the survey sample. For computing the descriptive statistics the proportion of the participants in each response category of interest had to be calculated. The data were cross- classified into rows that included the categories of the first variable and columns that included the categories of the second variable.

The cross-classification was necessary in order to run the statistical test, since the data had to have a specific structure. The distribution of the data collected did not comply with the 2x2 (column x row) table used in basic Chi-square testing, hence an alternative test to calculate the independence of the data was required. Additionally there were a few cell entries with infrequent or less than 5 responses, a fact that could contribute to inaccurate results. It was therefore necessary to combine categories, but also to ensure that these categories were sufficiently related without "masking" any relationship. The software used was "R", and the Pearson's Chi-square test (Adery, 1968), was selected as the one appropriate for the survey sample collected and the structure of the data. Before "running" this test, and in order to interpret the results, the null hypothesis was set. The null hypothesis assumes that the variables tested do not predict one another. The significance level is measured by the p -value which is set at 0.05, whereas any number equal or less implies that the null hypothesis is incorrect and therefore has to be rejected.

6.3 Survey Analysis

According to the results of the survey I carried out in the municipality of Heraklion, a vast number (69%) of those participated are highly confident of climate change happening due to human interventions and the possible impacts these imply for their way of life in the near future, followed by those who have strong suspicions that climate change will affect their lives (Figure 3). While, a small proportion of the interviewees are completely sure (3%) or more skeptical (6%) as to whether people are to blame for climate change or if climate change is a true fact that will affect their way of living. Those who stated unaware to the issue, account for 3%.

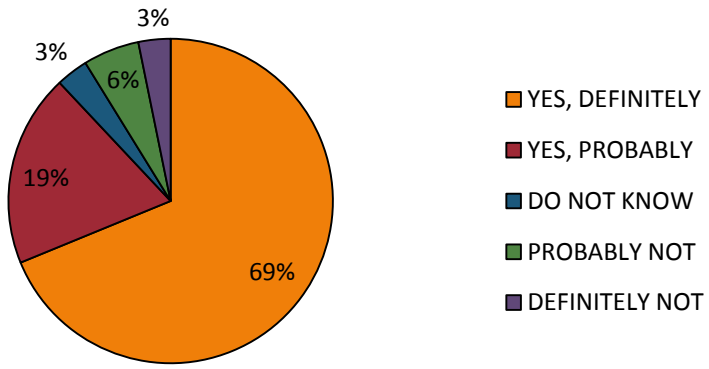

Figure 3: Results in percentages of question 1. "Do you think that climate is changing because of human activities to such extend that it will substantially affect your way of life?"

In the same manner, the majority of respondents answered with high confidence or with some reservations that they have experienced extreme weather events which they attribute to climate change.

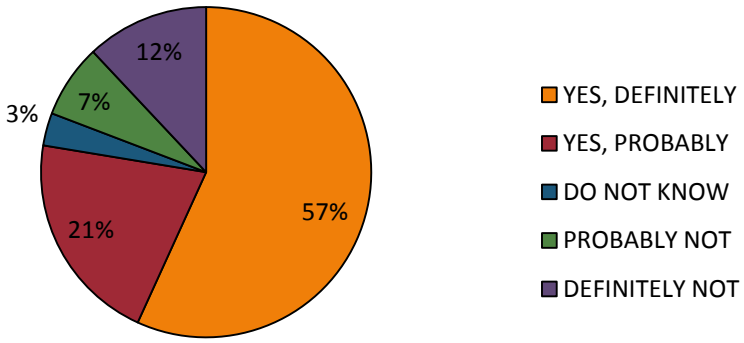

Figure 4: Results in percentages of question 2. "Have you experienced any extreme weather conditions that you interpret as caused by long-term global climate change?"

Actually, more than half of them (57%) are highly confident to have already experienced climate extremes out of the ordinary (Figure 4). While a smaller percentage amounts for those who are strongly negative (12%) or highly skeptical (7%) as to whether they have experienced extreme weather conditions due to global warming. Those who stated unaware to the issue, account for 3%.

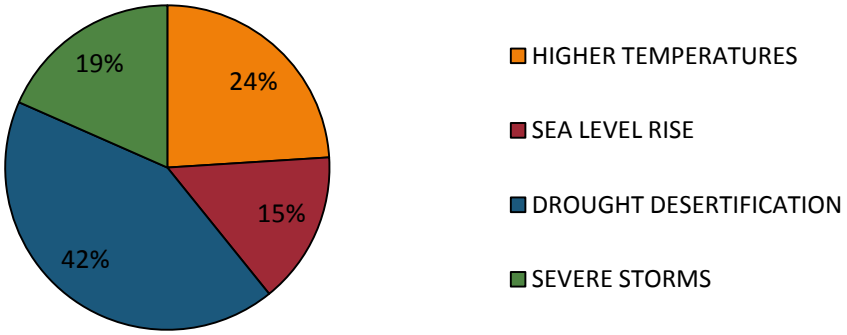

Figure 5: Results in percentages of question 3. "Which do you believe is the worst threat from climate change in the region?"

The results revealed that most interviewees view as a worst threat (Figure 5) drought and desertification (42%), followed by higher temperatures (24%); severe storms (19%) and sea level rise (15%).

The survey results show that the majority of respondents (63%) consider that the agricultural sector is the one most exposed to the impacts of climate change, followed by the sectors of health (14%); environment (12%); tourism (6%); energy (3%) and infrastructure (2%), (Figure 6).

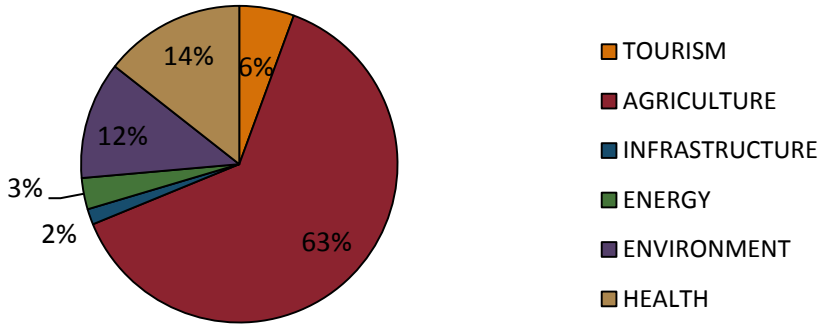

Figure 6: Results in percentages of question 5. "Which sector do you believe to be more vulnerable, in economic terms?"

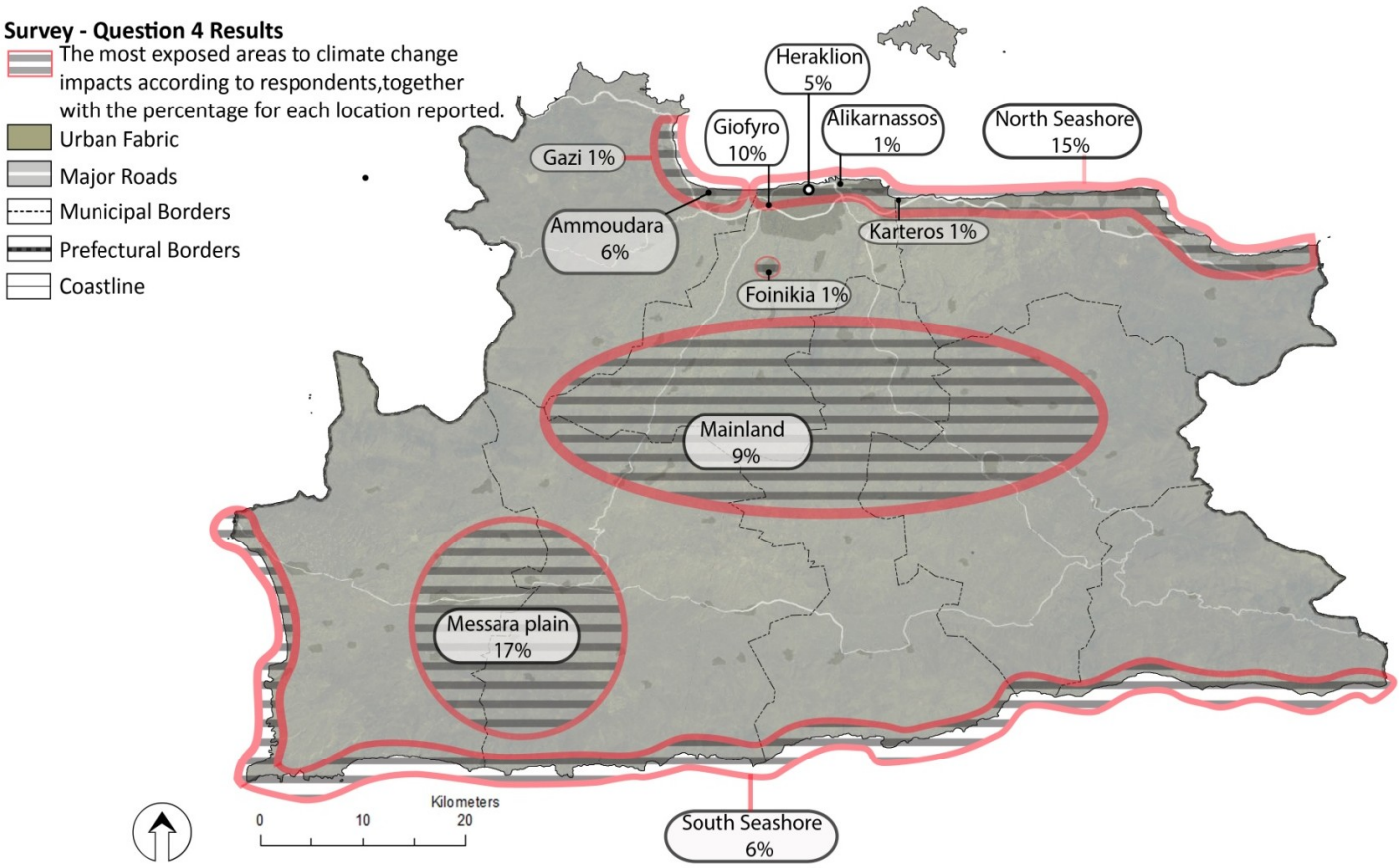

Figure 7: Map illustrating the results of question survey 4: Which area do you identify as the most vulnerable?

The respondents identified a number of areas as the most vulnerable at a potential exposure to climate extremes as it can be seen from the map (Figure 7) and the graph that follows (Figure 8). Most areas are located at the north coast while the highest percentage that was attributed specifically at one location was the Messara plain (17%). Also a great percentage of the respondents (28%) did not have an opinion on the matter.

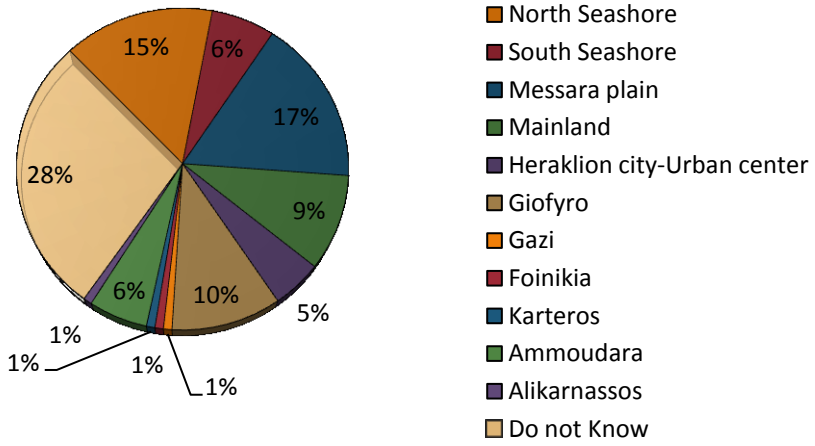

Figure 8: Most Vulnerable Areas to Climate Change in the Heraklion Regional Unit as identified by the correspondents.

The next graph (Figure 9) provides information of the level of trust the inhabitants have for the local authorities coping ability, whereas a large percentage of them believe that are not adequately prepared to great extend (67%), followed by those who gave a negative response but remained skeptical. Only 1% of them were highly confident that the local authorities are prepared enough, while a 7% of them gave a positive answer with some reservations. Those who stated unaware to the issue, account for 2%.

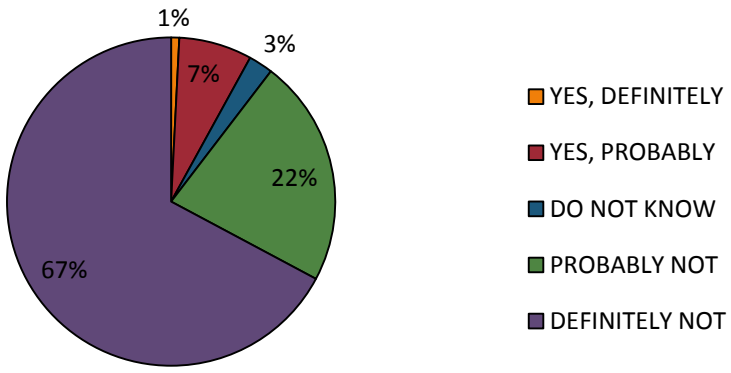

Figure 9: Results in percentages of question 6. "Do you think that the local authorities are adequately prepared to cope with the possible impacts of climate change?"

Nearly half of the respondents (45%) do not see any reason that could suggest any possible positive effects in the region due to climate change (Figure 10), while a 9% has the same opinion but remains skeptical. On the other hand nearly a quarter of the participants are positive that climate change has some advantageous aspects, with 13% of them to be highly confident and 14% to have some reservations. A relatively high percentage of then had no opinion on the matter (19%).

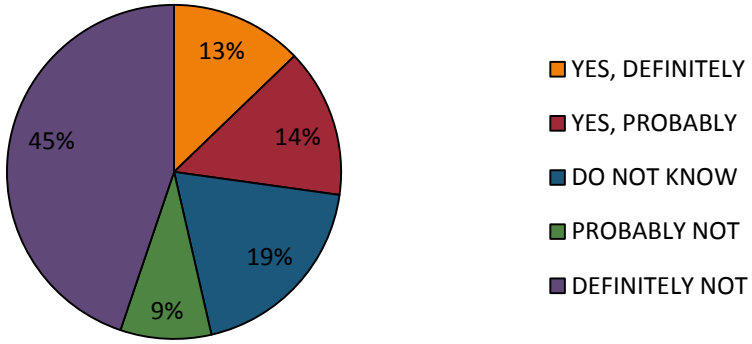

Figure 10: Results in percentages of question 7. "Do you see any positive effects from climate change?

The participants of the survey who answered positively in question 7 were prompted to answer two more sub questions. First to identify which sector could benefit by the effects of climate change (Figure 11), and secondly to choose at which level the positive effects of climate change could compensate for the losses resulting from the negative ones (Figure 12).

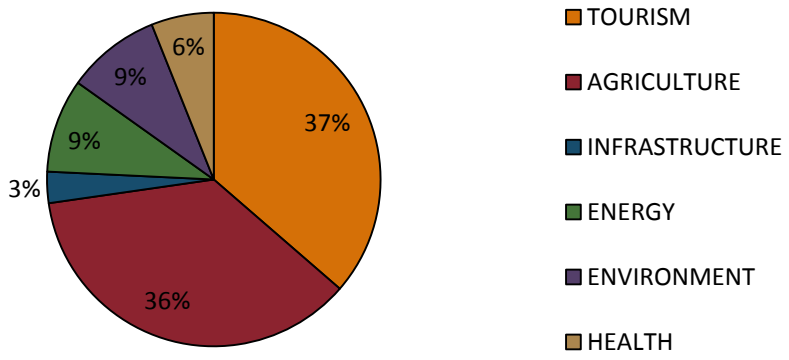

Figure 11: Results in percentages of question 7i. "Which sectors do you believe could benefit from the positive effects?"

According to the interviewees opinion the sectors of tourism (37%) and agriculture (36%) are the ones that can rip some benefits due to climate change. Whereas nearly half of them (49%) believe that these profits can balance for the losses of negative impacts.

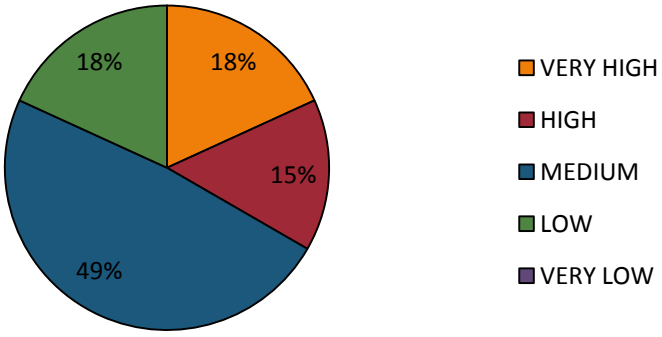

Figure 12: Results in percentages of question 7ii. "To what degree do you believe that positive effects could compensate for the losses resulting from the negative effects?"

6.4 Cross classification and data testing

Generally, as can be seen from figure 13, a combination of age groups strongly believes in climate change due to anthropogenic reasons. A large percentage of the respondents (82%) belonging to the age group of 26-60, who largely took part in the survey are definitely positive.

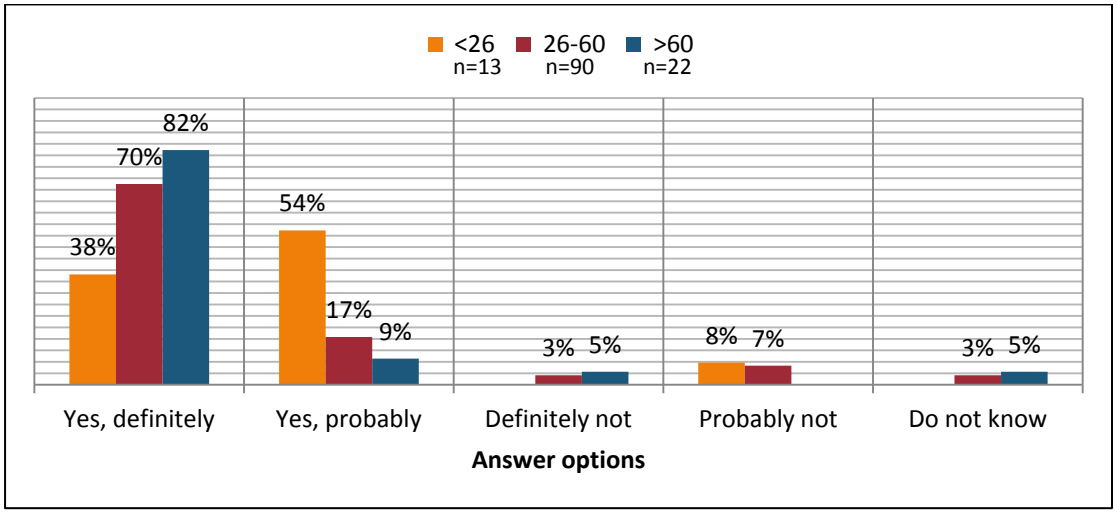

Figure 13: Correlation between age and belief in Climate Change due to anthropogenic activities, ($x^2 = 14.507$, df=8, P-value=0.07285, the result is not significant at $P < 0.05$)

The correlation between gender and belief on climate change caused due to anthropogenic activities showed that almost equally both males and females are highly certain of it (Figure 14). The higher number (n) of women is primarily due to the fact that, during the realization of the survey, they were more willing to participate in the survey compare to men.

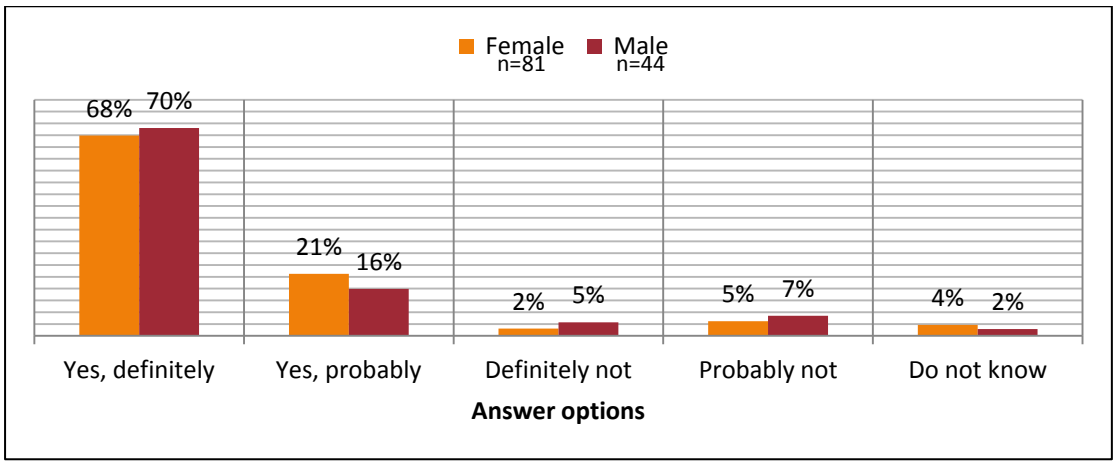

Figure 14: Correlation between gender and belief in Climate Change due to anthropogenic activities, (x^2=1.1565, df=4, P-value=0.8804, the result is not significant at $P < 0.05$)

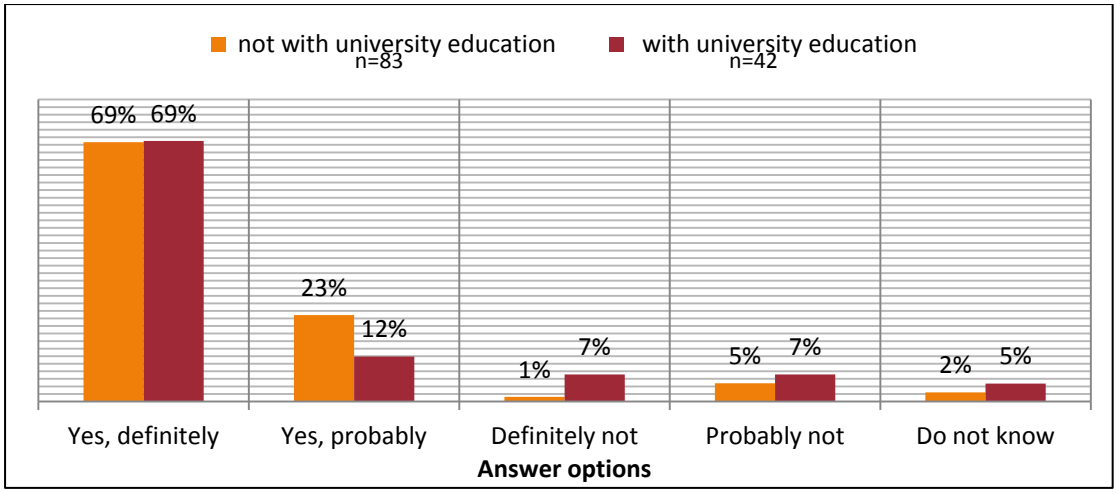

Figure 15: Correlation between education level and belief in CC due to anthropogenic activities, (x^2=5.5779, df=4, P-value=0.2257, the result is not significant at P < 0.05)

According to the survey statistics (see appendix, p.62) the majority of the respondents are well educated whereas 52% of them acquire a lyceum diploma, and 34% a university degree, while those who have reached only till elementary education are mostly senior citizens that grew up in a harsher socio-economic era. Moreover, the correlation between the educational level of the respondents and the belief in climate change due to anthropogenic activities showed that the majority of the respondents who have a high-school diploma and those who acquire a university degree strongly believe in climate change (Figure 15). Whereas a small percentage corresponds to those in denial that climate is changing due to anthropogenic activities.

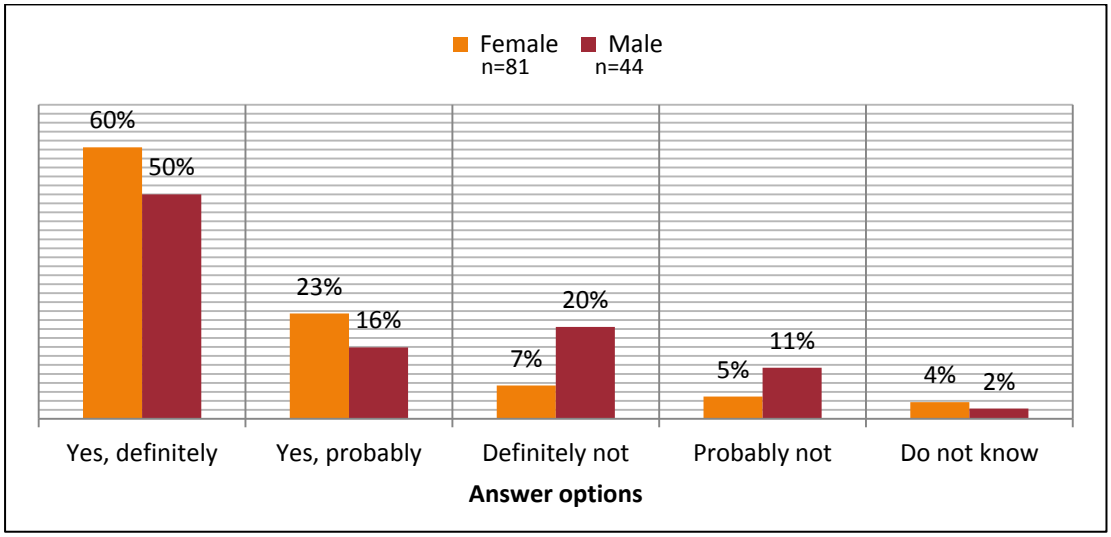

Figure 16: Correlation between gender and the belief of having experienced extreme weather conditions caused by long-term global climate change, (x^2=7.1956, df=4, P-value=0.1204, the result is not significant at P < 0.05)

The gender related results show that both sexes strongly believe they have experienced extreme weather conditions as an after effect of the global climate change (Figure 16). Whereas a fare proportion of them are not so sure of whether to attribute these conditions to climate change. On the other hand the male proportion that views these extreme conditions more sceptically, or does not attribute them at all to global climate change is slightly higher compare to the female respondents. Though, it has to be mentioned again that the overall highest percentage of women is primarily due to the fact that, during the realization of the survey, they were more willing to participate in the survey compare to men, who most of the times gave the excuse of being preoccupied with their work at the given moment the survey took place.

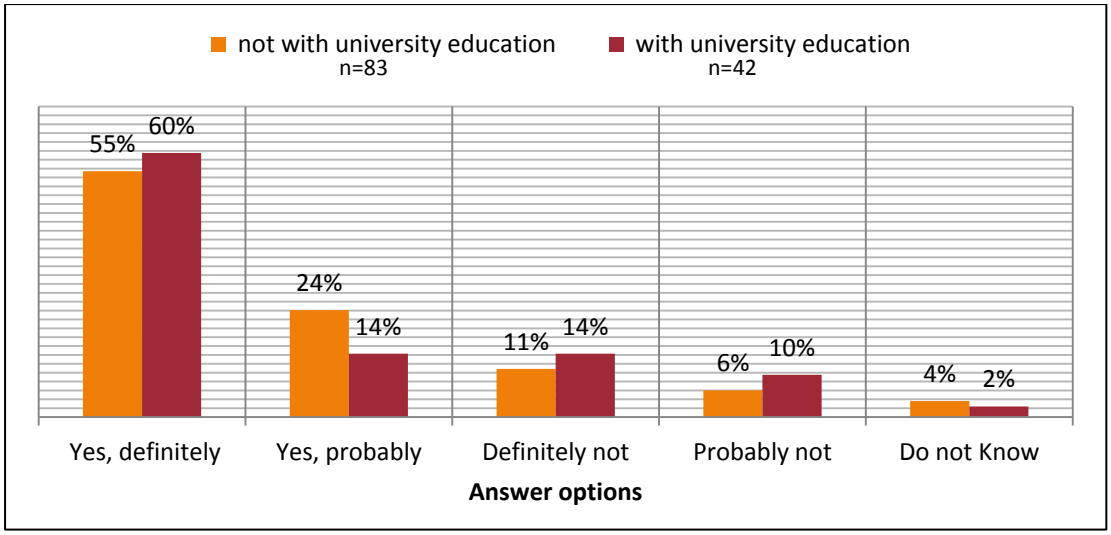

Figure 17: Correlation between educational level and the belief of having experienced extreme weather conditions caused by long-term global climate change, (x^2=2.2555, df=4, P-value=0.7158, the result is not significant at $P < 0.05$)

The correlation between the educational level of the respondents and the belief of having experienced extreme weather conditions due to global climate change showed that both groups of the respondents, those who have acquired a university degree and those who have not, are certain or almost that the extreme weather conditions they experienced are an after effect of global climate change (Figure 17). A fare percentage, of both categories, corresponds to those who do not perceive that weather conditions are out of the ordinary or related to global climate change, whereas at the same time those with no university degree seem to be more prone towards this opinion.

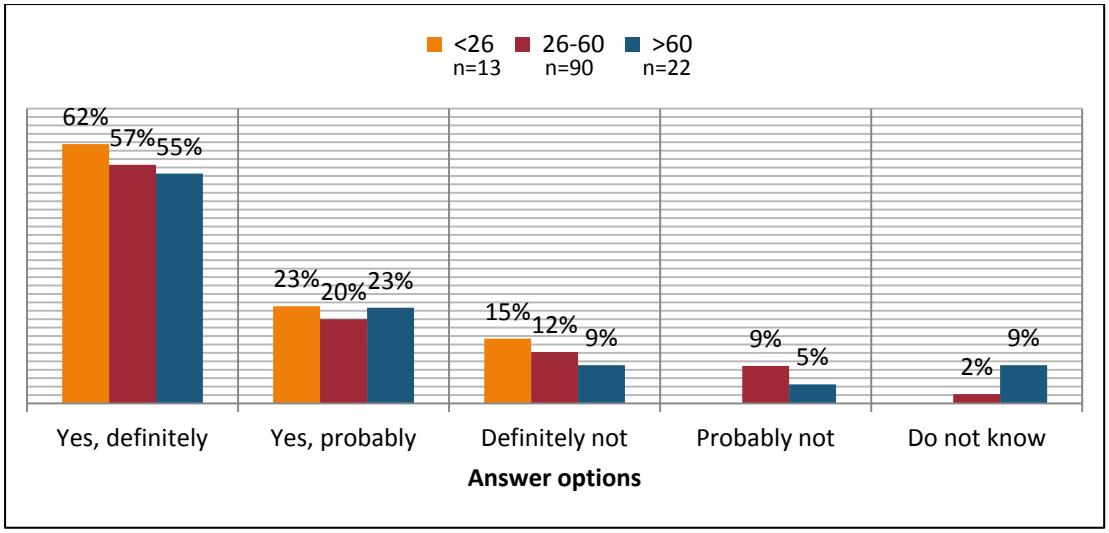

Figure 18: Correlation between age and the belief of having experienced extreme weather conditions caused by long-term global climate change, (x^2=14.507, df=8, P-value=0.0713, the result is not significant at $P < 0.05$)

On average the correlation between age and the belief of having experienced extreme weather conditions caused by long-term global climate change showed that the respondents belonging in all three different age groups in their most part strongly believe or give into the possibility of having experienced extreme weather conditions due to global climate change (Figure 18).

7. Discussion

7.1 Policies and measures taken so far

At national level the government of Greece has not yet prepared any plan for addressing the effects of climate change nor has decided any mitigation or adaptation strategies. The only policies decided are those regarding the Kyoto protocol. Actually, in the review of the Sixth National Communication of Greece, (2015), from the United Nations Framework Convention on Climate Change (UNFCCC), it is stated that Greece has managed to decrease GHG emissions close to the levels agreed. It is also mentioned though that the reduction levels result from the economic devastation of the country. (United Nations FCCC, 2015)

The identification and analysis of the factors responsible for the increased levels of vulnerability should be studied in depth in order to enhance adaptive capacity and to reduce vulnerability. Though, through the review of official documents, it can be said that the identified factors can sometimes characterized as superficial. This is probably either due to early stages of research or due to the generalization of the issues regarding climate change, as an attempt to classify the problems between the countries involved into categories. The classification aims to create a common framework upon which decisions will be taken. The multiple generalizations along with the inability of the authorities at national and regional level to recognize the connections between socio-economic forces and the climate change issues increase the probability of not assessing and addressing the issues in question efficiently. Since, rather than highlighting the source of problem, authorities focus only at the results of the problem. For example, a report by Casali & Sciortino, (2006) from the Surveillance System for Assessing and Monitoring Desertification (DeSurvey), illustrates that the Greek National Action Plan (NAP) for combating desertification did not included a number of important socioeconomic driving forces, it rather focused greatly on the problems arising from desertification.

Yet, often decisions to address issues arising from climate change and human activities do not correspond with the development decisions decided at other levels. For example, in order to assess desertification in the north east of the

Heraklion regional unit (Greek National Committee for Combating Desertification, 2001), the proper management practices proposed to prevent and mitigate desertification include the control of urban expansion especially of highly populated areas over the rural areas, that exhibit a number of values such as aesthetic beauty, high biodiversity and other significant social and economical values. On the other hand, according to the proposed plan of future development for the wider region of Crete (Hellenic Republic Ministry of the Environment, Energy and Climate Change, 2014.), does not include an analysis of the future impacts of climate changes neither proposes strategies the issues related to climate. What's even more upsetting is that it promotes the overexploitation of land with various ways as well as the further urbanization of much of the rural land, especially at the north coast.

Additionally, the few organizations and institutions, namely, the National observatory of Athens, the Hellenic National Meteorological Service and the institute of Environmental research and Sustainable Development, which collect data regarding climatic conditions and climate change, have not carried out extensive collaborative research studies on the impacts resulting from climate change. As a result to this, there is a lack of knowledge about how these impacts will or are affecting various domains of environment, social life et cetera.

At regional level, regarding the Heraklion regional unit, the measures taken are mostly focused on more sustainable ways of using water resources, such biological treatment and reuse for other purposes. In some cases though sustainability is questionable especially if the value of precious ecosystems is downgraded and biodiversity is threatened. Such is the construction of the Aposelemi dam at the municipality of Hersonissos that it was put in use in 2015 and it will supply the water demand of the city of Heraklion.

In 2008 the region of Crete participated in the project Regioclima that aimed at exchanging knowledge and ways to enhance adaptive capacity at regional and local level with other European regions that also participated in the project. By creating a drafting framework regarding adaptation strategies a number of guidelines were set for the regions in order to provide clear directions and leadership. It also aimed at raising awareness at local stakeholders so as to be prepared to adapt in the future climate changes and to minimize the damaging effects. (European Commission, 2013)

It is often, that climate change impacts are analysed as different components by the way they influence each sector of our society. Hence, in the interest of a deeper insight of the impacts at these isolated sectors, climate change is being viewed from narrow perspectives. Therefore, understanding the impact of these issues from rigid positions such as from a purely environmental or economic angle, can lead to false adaptive strategies that may not be possible to be realised or may not be as effective as they could be.

7.2 Population vulnerability and climate change

In the study made by Blennow, et al. (2012), was found that the belief in climate change together with the experience of climate extremes were a good indicator of the readiness of the people to respond to climate change. Accordingly, in the survey included in this thesis these results were used to investigate the readiness of the citizens to respond to climate change and support interventions from the authorities. Furthermore, the identification of the vulnerable areas within the region of Heraklion is indicative of the probable level of exposure of each area at climate extremes, and it is also connected to the extreme events perceived by the local population so far.

It has to be mentioned though that the region of Heraklion experienced out of the ordinary climatic conditions during the first months of 2015, a fact that possibly influenced the outcome of the survey which was conducted shortly after the occurrence of these extreme events. More specifically, in February it snowed twice at the plains and coastal areas while the bad weather lasted for quite a few days both times, affecting thus transportation, agriculture production et cetera. This particular phenomenon is rather unusual since snow at so low altitudes in the island and at that intensity is something rare, that might happen once in a hundred years though in less intensity and not so prolonged and repeatable. Another factor that hints towards this conclusion is the fact that a large proportion of the respondents after I had asked them the question number 2: “Have you experienced any extreme weather conditions that you interpret as caused by long-term, global climate change?” they were answering with a disarming way by asking me back “Are you being serious? Don't you see that the weather has gone crazy?" This also entails the probability that inhabitants might have exaggerated climate change risks.

The sectors identified as most exposed to the impacts of climate change were those of agriculture, environment, health, and tourism. These results aside from being directly connected to the level of vulnerability of each sector are also the ones that the inhabitants rely on to make their living. Not to mention the importance of environment and how the loss of biodiversity and the disturbance of precious ecosystems could affect many aspects of the inhabitants life.

There is also a correlation between the sectors identified as vulnerable and the areas the interviewees named as mostly exposed to the impacts of climate change. For instance, the Messara plain that was pinpointed by (17%) of them, produces much of the agricultural products of the region, that supply the local markets but are also exported abroad. The main produced goods are olive oil, grapes, and a wide range of other fresh vegetables. Whereas the production capacity of the plain is highly vulnerable to the extreme weather conditions and particularly to drought and severe storms (e.g. hailstorms) and the possible diseases that can arise because of the weather extremes and can affect as a result crop productivity. The reasons, of course, that make the region of the plain vulnerable to climate change are also associated with human activities. More specifically, the large extent of land occupied by monocultures (e.g. olive plantations) and the repercussions these pose to biodiversity, the improper soil and water management associated with intensive tillage and the use of incorrect irrigation and fertilization methods, as well as the increased use of pesticides, do constitute the reasons why the local community is more sensitive and exposed to climate change.

In the same manner, the identification by a (9%) of the respondents that the mainland is exposed to climate change, is related to the severe storms and erosion that threats these areas. The population in these areas lives in a number of small villages and settlements, either at the mountainous zone or at the small valleys formed. Because of the high altitudes prevailing in the mainland, the climate is classified as continental, with very cold winters, high percentage of rainfall and moderate temperatures in summer. The vulnerability to climate change in these locations arises from various reasons, and not only due to the possible exposure to extreme weather events, but also is related to the individual coping ability of the inhabitants and the state's basic infrastructure. For example, the present road network has problems in several of its sections either due to bad design or due to poor maintenance, so

that problems are exacerbated in cases of severe weather conditions and make it difficult to transit to and from these regions.

A large proportion of the inhabitants' income at these villages comes from agriculture or livestock farming, and since farming activities directly depend on climatic conditions, a possible exposure to extreme climate events can affect seriously their way of living. It also common that at these villages the percentage of the elderly inhabitants to be far greater than that of the young people who choose to live there. Additionally a large number of the houses in these villages are very old, and often exhibit no signs of renovation, lacking of proper insulation, heating et cetera, thus influencing heavily the elders' health, especially when exposed at extremely harsh climatic conditions. As for those living at the valleys due to the extreme precipitation events during the rainy season are often faced with the risk of flooding. This is caused due to the fact that the valley streams tend to overflow since they have been filled up with hard material or have been turned to roads.

Moreover, the problem of land erosion is bold in these areas, and has been intensified to large extend by the abandonment of agriculture in many mountainous and hilly areas. Where, in the past the creation of embankments (beds per-steps) prevented the loss of soil. Today however, this growing method has been abandoned, mainly because of the introduction of the tractor, resulting in erosion and denudation of the humic soil cover. Consequently, according to the climate scenarios, as rainfall is expected to become more intense and sporadic, while the temperature rise will favor the weathering and mineralization of soil's organic components, will reduce fertility in most types of soil. It is expected that a further increase of erosion in many areas that today present this problem.

Regarding the southern coast the respondents have not identified any specific areas, rather than the entire southern coastline. According to the data collected in this work, the south coastline was not classified particularly vulnerable to climate change. Actually, only the coast of the Gulf of Messara, located in the southwest is threatened by the possible rise in sea level, but was not mentioned specifically by any of the respondents. Possibly, this is due to the fact that the inhabitants of the municipality of Heraklion are not so familiar with the landscape of the south coast and consequently this influenced their response outcome.

On the other hand since the sample of respondents was obtained from the municipality of Heraklion, many of them identified a number of areas within the municipal borders as the most vulnerable at a possible exposure to extreme climate events. The reasons why they selected each location will be discussed further. Since vulnerability is defined by the priori conditions, these are directly connected to the human activities. For example, the wider area of Gazi (1%) and specifically Ammoudara (6%) both of which are closely located to the city of Heraklion are areas highly urbanized. Within the Gazi area and close to Ammoudara is located the public electricity corporation (ΔΕΗ) right next to the seashore. This electricity hub station has been responsible for the contamination with two heavy metals, nickel and vanadium, of the surrounding land and the river Almyros that runs through these areas. Endangering by extend also the precious wetland that exists nearby, not to mention the impacts concerning the health of the local population. Furthermore, Ammoudara is a low lying area located next to the sea front, and so is at risk due to the sea level rise trends and the intense storms.

Likewise, a large percentage of the respondents (15%) have identified the whole north coast as vulnerable. One factor could be the sea level rise trends that are going to influence the vast number of the population residing there and affect their activities. Even if the modest IPPC projections come true and the sea level rises by 50 centimeters it would result in the loss of half the width of the coastal zone, whereas much of the tourism infrastructure is located. Since the tourism sector that flourishes there is one of the main sectors of employment for the locals, they will be directly affected. The same applies for other identified areas in the north coast, namely the city of Heraklion (5%), Alikarnassos (1%), Karteros (1%). Of course the problems arise not only due to the sea level trends and intense storms but also because of individuals that want to benefit from tourism, who repeatedly violate the laws protecting the shoreline. While in other cases it is the State that has authorized much of the tourism development across the coastline by creating legal ways in order to secure the exploitation of coasts. As a result to these activities coastal erosion has increased putting at risk many of these areas (Doukakis, 2004).

7.3 Unsustainable practices and issues that arise

Unsustainable practices can lead to adverse effects due to the over exploitation of resources, which are more evident in overpopulated areas, such as the north coast especially when tourism season is at its peak. In fact, during the summer period, it is a common policy of the city of Heraklion to discontinue completely the provision of water to the residents for 2-3 hours at midday due to increased demand, which is worsened by the needs of the tourism sector. Whereas, one of the main underground water reservoirs that supplies the city of Heraklion and the whole north east coast, that located under the villages of Malia and Sissi (aquifer code: GR1300112), has undergone salinization due to over extraction, not to mention the number of illegal pumps used, and thus its quality has been degraded greatly (Water Management Decentralized Administration of Crete, 2013). It can be then understood that the inhabitants are already aware of the effects of resources depletion in their daily life. Additionally, a research community program by the European Commission estimates that in Crete the increase in water demand in urban areas, will increase the probability of water shortage from 20% in 1980 to 85% in 2020 (MEDALUS II, 1996).

It can be also said that some of the main reasons that make the city of Heraklion vulnerable to extreme climate events are related to urban planning issues that have not been addressed effectively by the authorities responsible. Regarding the basic infrastructure such as the road network it is often inadequately maintained, posing risks for the commuters, whereas its design often creates more problems than the ones it is meant to solve. Many of the problems stem from the form of the urban fabric and by the way urbanization spreads towards the outskirts of the city.

It is of importance though to understand the reasons why the respondents did not equally chose the infrastructure or energy sector. Especially since the infrastructure sector so far when exposed to extreme climate events showed a relatively small range of coping ability. As for the energy sector it creates a heavy burden for the environment, since the electricity produced is mostly dependent on oil rather than renewable or more clean sources. Thereby as an energy medium it is not only vulnerable to the global trends of the economy, but also it contributes to the greenhouse effect since it is not a source of clean energy.

Likewise, the results of the survey revealed, the responsibility of local authorities, as the range of regional coping ability was characterized as very small by the respondents (67%). This belief most possibly arises from how the local authorities and consequently the critical infrastructure have responded at the occurrence of extreme weather conditions so far. This situation though has its origin at higher levels, when no plans or decision have been taken regarding climate change and its impacts at regional and local levels. The mitigation strategies regarding the reduction of GHG emissions are not enough to protect the population from the exposure to extreme climatic conditions or their impacts. The economic crisis and political instability since 2010, on the other hand, it is obvious that have affected all sectors significantly, hence setting critical infrastructure that defines regional adaptive capacity more vulnerable.

So far the authorities have unsuccessfully assessed and addressed the issue of unregulated building construction, which increases the level of vulnerability of the inhabitants. The illegal construction percentage in some areas is by no means negligible, particularly in those that are not integrated within the master urban plan of the city.

More specifically, many of these buildings have been built without the basic standard specifications set by the law, while are often built on lands and areas not suitable for the purpose of use intended. In some cases are blocking or are very close to stream passageways, or are next to areas where the occurrence of landslides is common. As a result, those who live in there are facing the risk of flooding in case of heavy rainfall, and their arbitrary actions can possibly cause a domino effect that might be disastrous for the surrounding areas. It is a fact that both issues mentioned above have led to a number of floods events in the area Giofyro, whereas the river that runs through the area quite often overflows when exposed to intense precipitation. (Cretalive, 2015)

In the same manner an unfortunate event with disastrous effects took place in the same area which had an impact in a wider extend. In January, 2015, severe weather conditions caused many problems in the municipality of Heraklion. More specifically, the heavy rainfall caused the river in Giofyro and of its tributaries to overflow. What followed was the breakage of the river embankment which caused severe damages at the nearby biological sewage treatment plant. As a result the nearby areas and the sea were contaminated by the untreated urban sewage, forcing the regional authorities to ban bathing

and fishing in the wider maritime area of Heraklion Bay, within 2 nautical miles from shore. (Region of Crete, 2015. *Press release*)

Additionally, another important factor that influences the inhabitants' vulnerability and their adaptive capacity is the economic situation of the country. The economical crisis has caused not only high unemployment but also the reduction of many of the social provisions provided by the state. The restructuring measures applied, which aim to downsize of the public sector have caused significant decrease of the basic social benefits affecting thus directly, particularly vulnerable groups of the population. As a consequence to the shrinkage of all sectors and the lack of funds has notably affected the healthcare sector and the maintenance of basic infrastructure. Moreover, as the high unemployment rates continue to escalate, the percentage of people belonging to vulnerable groups is increasing. According to data, (Hellenic Statistical Authority, 2015), the percentage of the Greek population living below the poverty line, with annual income of 4.608 Euro in 2014, amounts to 35.7%.

7.4 Thoughts on risk management and planning strategies

If each society's adaptive capacity and vulnerability is not measured, how can anyone suggest what is the best response to climate change? If we agree that human activities and overexploitation of Earth's resources are driving global warming and climate change a step further towards climatic conditions we have never experience before, which will threaten our very own future existence. It is then understood that mankind's actions have consequences that not only affect the environment but humans as well, since humans are part of this environment.

Moreover, applying mitigation or adaptation measures just for the sake of it should not be regarded as a sustainable solution. If the aim is a society to be truly prepared and to respond with the most effective and possible way to the upcoming climate change, an analysis of the social dynamics is prerequisite. Understanding how each nation, its population, and the several marginalised groups are affected and how they could respond to climate change is essential.

When it comes to climate mitigation and adaptation those responsible should look and seek at the "flaws" of the society, and recognize that just issuing policies does not solve this major issue. In this state of conditions, people's voices matter a lot. It's not a decision that has to be taken solely by politicians, planners or authorities in general. What people experience is crucial for understanding where society stands and what has to be done, so as not to jump in wrong conclusions and thus to wrong solutions that can do more harm than good.

The level of the future exposure of each community to climate change should be studied, and also the possible response of each sector to climate change impacts. Public awareness should be raised regarding the possible adaptation measures that can be followed in individual/ local/ regional level, and most importantly the local population must be given the chance to explain its situation and also to indicate the factors that may inhibit the results of certain suggested strategies, policies, and mitigation or adaptation measures.

For instance, the results from question 7 and its sub-questions can be interpreted in two ways that probably both coexist. More specifically, although the inhabitants are aware of climate change it is highly likely that they lack the knowledge of how they can adapt to climate change at individual level as well as at community level. It is also evident that they believe that the regional adaptive capacity level is low, since only a small percentage (13%) of them answered with medium confidence that there could be ways to compensate for the losses resulting from negative impacts.

This perception is also confirmed by the recognition of tourism (10%) and agriculture (10%) sectors, which are extensively connected to private interests, as the ones that they can benefit to some extent from climate change if adaptive measures are taken. Hence, since the rest sectors are part of the public administrative authorities, they were considered having less chances to benefit probably because they show signs of low coping ability. Consequently it can be said that only a small percentage of them were aware that actions at individual level can decrease vulnerability.

It is understood that assessing vulnerability requires the contribution of the local population's knowledge and understanding of climate change. Whereas their knowledge should be used for better understanding of the adaptive capacity of the local population and the level of vulnerability of the various

disciplines responsible, institutions and local decision makers. The ability to cope in other words should be based on the cooperation between all actors and with respect to the participatory approaches. Thus, enabling the design and implementation of strategic solutions based on scientific knowledge that can be applied successfully at local level.

In the fifth assessment report from the IPCC, according to Kirtman, et al. (2013), the necessity of understanding the factors that influencing population's vulnerability to climate change was recognised. Population dynamics were acknowledged to play a key role in reducing climate change vulnerability. Therefore, the interaction between society's basic domains should be regarded as indicative of the vulnerability but also of the adaptive capacity of a population.

Analogously, a number of UN agencies have identified the key domains that influence people's vulnerability which are the social, environmental and economic (United Nations Task Team on Social Dimensions of Climate Change, 2011). These domains not only define people's vulnerability but are also highly interconnected. For example, as a result of climate change people experience an increase of extreme weather phenomena or a reduce natural resources or both, which result in losses at several sectors affecting the economy. Hence, if there is a lack of national capital to compensate for these losses and to drive growth, social vulnerability will increase.

This above paradigm though focuses more on the vulnerability of the economy to climate change, and it is often seen especially in politics to communicate issues or risks by estimating the costs of measures, losses et cetera. The economy clearly affects all sectors as it is the link that connects them, but it should not overshadow other values and needs of society, which are equal or greater in many cases.

According to O'Brien, et al. (2011), the social dimensions of vulnerability are often disregarded as less important. Since the whole discourse of climate change and its' impacts can be considered to be in a relatively early stage, it is logical that the climate change had to be initially studied in depth from a biophysical point and models to be created that would analyze the future consequences of this change, so that subsequently to enable researchers analyze the social dimensions of future impacts, and the methods that can make societies more resilient.

Of course climate change is not something static, is currently already happening and this is confirmed by many facts and events across the globe. Thereby particularly vulnerable populated areas are already experiencing these effects without having been properly prepared to cope with the occurrence of out of the ordinary climatic conditions. For this reason, the practical approach (bottom-up), of these effects from a social point of view is considered necessary. Wherein the local population will indicate the problems that affect its vulnerability and help ensure that the measures taken will be possible to be implemented and that will have the desired effect so as to increase the resilience and adaptability of the local community. (Smit & Wandel, 2006)

What has become evident from bottom up approaches in developing countries is that vulnerability is site and time specific but also stimuli specific, as well as no adaptive measure should be implemented based only on climate change (UNFCCC, 2007). For example, a community might be sensitive to drought but not to sea level rise, and even if it is at both it will be at different level at each case because of the different factors that influence its exposure and coping ability to such extreme events. Additionally in accordance to Oppenheimer, et al. (2014), if a community or region is considered vulnerable due to socioeconomic and environmental decline, and is high likely to be affected by extreme climate events, then it is regarded as in high risk. Vulnerability can be portrayed through the relationship between exposure-sensitivity and the degree of adaptive capacity. Thus, since vulnerability is always linked to a specific extreme climate event or sets of events, it remains inseparable with exposure (Blaikie, et al., 1994).

Consequently, vulnerability is not evenly distributed across society, the elderly, women and kids together with marginalized groups of people, such as refugees, poverty stricken, homeless or those living in slums et cetera, which most possibly do not have access to proper health care and to a number of basic social services are more sensitive since they are highly exposed in case of extreme events.

Adaptive capacity is inversely proportional to the size of the vulnerability of a community to the occurrence of a specific disaster, in other words is context and time specific just as vulnerability is. Thereby, what shapes adaptive capacity are the linkages between socioeconomic, environmental processes, which are illustrative of the level of exposure-sensitivity, along with cultural,

political and other social factors. The processes and resources affecting adaptive capacity vary from local to higher scales, but that does not imply that are independent, contrariwise each process especially the ones at larger scales are influencing and are indicative of the processes at local scale. (Smit & Wandel, 2006)

Moreover, under normal climatic conditions, the occurrence for example of a mild drought in an region where mini drought events during a specific period of the year are common is not regarded as disastrous since the population is aware of them and has found various ways of coping with this issue. However if, the drought is more severe and lasts longer this will stress the adaptive capacity of the population. Especially, if the occurrence of such events is repeatable within a small time frame or if it coincides with other extreme climate events or socioeconomic decline or both, can lead the community's adaptive capacity beyond its coping range.

Therefore, consecutive disasters along with socioeconomic and political instability can be catastrophic, whereas the coping ability can be altered to such an extent that it may take years to be restored. For this reason, the study and analysis of adaptive capacity at local level can be beneficial by taking measures and initiatives for adaptation that are feasible and can reduce vulnerability by enhancing resilience. It becomes obvious then that the priori conditions such as the institutional structure, political drivers, economical resources, et cetera will influence the kind of strategy that can be applied. For instance, not all communities have the funds to use highly specialized technology to support such strategies, thus every community or region has to decide on adaptation actions based on its needs and capabilities.

8. Conclusions

The data collected from various sources in this thesis for the Region of Heraklion, support the view that weather extremes resulting from climate change, due to the anthropogenic activities, will affect the local population to a fairly large extent. Whether the local population that will be exposed to those extreme climate conditions will be able to respond with resilience to such cases is subject to the range of its coping ability, the regional preparedness and the adaptation measures that will be applied at local and regional level. Therefore, inadequate policies and poor planning by both government and local actors in the occurrence of an extreme event or more might threaten human security in various ways.

The survey results imply that the majority of the population in the Heraklion prefecture strongly believes in climate change due to anthropogenic reasons, with a large proportion of them too also believe in having experienced already the effects of it. This notion might have as a base the unpredictable extreme weather conditions that have occurred regionally. The recent experience of weather extremes seems to make the local population more observant and aware of climate change. Also according to the findings it seems that the high percentage of personal belief in climate change due to anthropogenic actions is strongly related to the current experience of the local population of extreme weather phenomena.

Consequently, what the survey results revealed is the high level of vulnerability of the local population, as the prefecture seems to be one of the many regions which to a great extend might face more losses at several sectors in the future due to climate change, especially if no measures of adaptation are taken in municipal and governmental level, that could otherwise enable and support actions in individual level. Moreover, the survey findings highlight the personal belief in climate change, and that experiencing the subsequent phenomena that follow is a fact that urges for adaptation measures. In accordance to the findings by Blennow, et al. (2012), the survey results also indicate a readiness among the respondents to take measures to adapt to the impacts of climate change. None the less there can be arguments about the accuracy and interpretation of this survey results. On the other hand there are research studies that support the findings of this survey.

Overall, the issue that rises here is not only that personal belief and experience of climate change implies adaptation, but also how adaptation strategies should be formed and applied in different regions of the world, where the socio-economic and environmental context at stake is different. Hence, for example the solutions applied in wealthier developed nations are not feasible to implement in every part of the globe.

Even though the economical crisis makes things more complicated, this should not be seen as an obstacle for no action. A bottom up perspective can give more direct and easy to implement measures that can strengthen the adaptive capacity of a community, rather than counting solely on long term mitigation and adaptation measures whose actual effect remains to be seen, and may not compensate for today's losses.

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10. Appendix

10.1 Questionnaire

1. Do you think that climate is changing because of human activities to such extend that it will substantially affect your way of life?

YES, DEFINITELY	YES, PROBABLY	DO NOT KNOW	PROBABLY NOT	DEFINITELY NOT

2. Have you experienced any extreme weather conditions that you interpret as caused by long-term, global climate change?

YES, DEFINITELY	YES, PROBABLY	DO NOT KNOW	PROBABLY NOT	DEFINITELY NOT

3. Which do you believe is the worst threat from climate change in the region?

HIGHER TEMPERATURES	SEA LEVEL RISE	DROUGHT DESERTIFICATION	SEVERE STORMS

4. Which area do you identify as the most vulnerable?

……..

5. Which sector do you believe to be more vulnerable, in economic terms?

TOURISM	AGRICULTURE	INFRASTRUCTURE	ENERGY	ENVIRONMENT	HEALTH

6. Do you think that local authorities are adequately prepared to cope with the possible impacts of climate change?

YES, DEFINITELY	YES, PROBABLY	DO NOT KNOW	PROBABLY NOT	DEFINITELY NOT

7. Do you see any positive effects from climate change?

YES, DEFINITELY	YES, PROBABLY	DO NOT KNOW	PROBABLY NOT	DEFINITELY NOT

7(i): Which sectors do you believe could benefit from the positive effects?

TOURISM	AGRICULTURE	INFRASTRUCTURE	ENERGY	ENVIRONMENT	HEALTH

7(ii): To what degree do you believe that positive effects could compensate for the losses resulting from the negative effects?

VERY HIGH	HIGH	MEDIUM	LOW	VERY LOW

8. When were you born?

……..

9. Gender:

F	M

10. What's the highest level of education you reached?

ELEMENTARY/ OR EQUIVALENT	(GYMNASIUM) JUNIOR HIGH SCHOOL/ OR EQUIVALENT	(LYCEUM) HIGH SCHOOL/ OR EQUIVALENT	UNIVERSITY EDUCATION / OR EQUIVALENT

10.2 Survey results

Table 1: Questions assessing respondents' perceptions in relation to climate change, and socio-demographic variables, possible responses to the questions, and percentage responses of respondents. n=125

Question	Response option	Percentage of respondents responses
1. Do you think that climate is changing because of human activities to such extend that it will substantially affect your way of life?	Yes, definitely	69%
	Yes, probably	19%
	Do not know	3%
	Probably not	6%
	Definitely, not	3%
2. Have you experienced any extreme weather conditions that you interpret as caused by long-term, global climate change?	Yes, definitely	57%
	Yes, probably	21%
	Do not know	3%
	Probably not	7%
	Definitely, not	12%
3. Which do you believe is the worst threat from climate change in the region?	Higher temperatures	24%
	Sea level rise	15%
	Drought – Desertification	42%
	Severe storms	18%
4. Which area do you identify as the most vulnerable?	The results for this question are illustrated at figures 7 & 8.	
5. Which sector do you believe to be more vulnerable, in economic terms?	Tourism	6%
	Agriculture	63%
	Infrastructure	2%
	Energy	3%
	Environment	12%
	Health	14%
6. Do you think that local authorities are adequately prepared to cope with the possible impacts of climate change?	Yes, definitely	1%
	Yes, probably	7%
	Do not know	2%
	Probably not	22%
	Definitely, not	67%

7. Do you see any positive effects from climate change?	Yes, definitely	13%
	Yes, probably	14%
	Do not know	19%
	Probably not	9%
	Definitely, not	45%
7(i): Which sectors do you believe could benefit from the positive effects? (answered by 33 of the respondents from total of 125)	Tourism	10%
	Agriculture	10%
	Infrastructure	0%
	Energy	2%
	Environment	2%
	Health	2%
7(ii): To what degree do you believe that positive effects could compensate for the losses resulting from the negative effects?	Very high	5%
	High	4%
	Medium	13%
	Low	5%
	Very low	0%
8. When were you born?	Mean 1969, range 1928 - 1997	
9. Gender?	Female	65%
	Male	35%
10. What's the highest level of education you reached?	Elementary or equivalent	14%
	Gymnasium (Junior high school) or equivalent	1%
	Lyceum (High school) or equivalent	52%
	University education or equivalent	34%