CLIMATE CHANGE VULNERABILITY IN AGRICULTURE AND ADAPTATION STRATEGIES OF FARMERS TO CLIMATIC STRESSES IN KONYA, TURKEY

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submitted by **MELİKE KUŞ** in partial fulfillment of the requirements for the degree of **Doctor of Philosophy in Earth System Science Department, Middle East Technical University** by,

Prof. Dr. Halil Kalıpçılar
Dean, Graduate School of **Natural and Applied Sciences** ____________

Prof. Dr. Cemal Can Bilgin
Head of Department, **Earth System Science** ____________

Prof. Dr. Helga Rittersberger-Tılıç
Supervisor, **Earth System Science, METU** ____________

Assoc. Prof. Dr. Uğur Murat Leloğlu
Co-Supervisor, **Geodetic and Geographic Information Technologies, METU** ____________

Examining Committee Members:

Prof. Dr. Zuhal Akyürek
Department of Civil Engineering, METU ____________

Prof. Dr. Helga Rittersberger-Tılıç
Earth System Science, METU ____________

Prof. Dr. İlkay Dellal
Department of Agricultural Economics, Ankara University ____________

Prof. Dr. Mehmet Ali Çullu
Department of Agriculture, Harran University ____________

Prof. Dr. Bülent Gülçubuk
Agricultural Economics, Ankara University ____________

Date: 30.05.2019

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Surname: Melike Kuş

Signature:

ABSTRACT

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Kuş, Melike
Doctor of Philosophy, Earth System Science
Supervisor: Prof. Dr. Helga Rittersberger-Tılıç
Co-Supervisor: Assoc. Prof Dr. Uğur Murat Leloğlu

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Agriculture is highly vulnerable to climatic changes and extremes as it is generally an outdoor activity. Its vulnerability to climate change is estimated at different scales and then policies are developed to reduce sensitivity and improve adaptive capacity of the farmers accordingly. Assessments at different scales use different methodologies and indicators, which result in incomparable outcomes. Macro scale assessments lack further validation of the results at the local level, and the local level assessments do not clarify to what extent the household level vulnerability is generalizable to upper scales. Existing literature lacks a methodology combining the vulnerability assessments at different scales and determining the drivers of vulnerability acting at these scales. This thesis develops a multi scale approach to evaluate climate change vulnerability in agriculture sector using comparable indicators at district and household levels. Selection and weighing of indicators used in the calculation of vulnerability are generally criticized in terms of subjectivity. In this study, an index is developed using district level data and a socio-economic survey is conducted to evaluate the success of the selected indicators in explaining the variation in vulnerability levels of the farmers. In order to determine the vulnerability levels of the farmers, a new vulnerability calculation method is introduced. Household level vulnerability is defined as a function of crop losses due to climatic changes and extremes and the difficulty level of compensation of the losses.

Household level data is analyzed using both linear (Multiple Linear Regression) and non-linear regression (Random Forest) methods to understand the structure of the data better and find out the significant indicators with a model with higher explanatory power. The results show that the indicator approach can be used for determining highly vulnerable areas for prioritizing the actions at the macro scale. The factors significantly affecting the household level vulnerability are dependency ratio of the household, number of memberships to agricultural organizations, percentage of land with good soil quality and percentage of rain-fed land. The results also show that increasing number of livestock and agricultural equipment owned significantly contribute to adaptive behavior of the farmers. The results of this study can help policy makers to prioritize the policy subjects and implementation areas to get more influential results.

Keywords: Climate change adaptation; Climate change vulnerability index; Multiple linear regression; Random forest regression

ÖZ

KONYA'DA TARIMIN İKLİM DEĞİŞİKLİĞİ KIRILGANLIĞI VE ÇİFTÇİLERİN İKLİMSEL STRESLERE UYUM STRATEJİLERİ

Kuş, Melike
Doktora, Yer Sistem Bilimleri
Tez Danışmanı: Prof. Dr. Helga Rittersberger-Tılıç
Ortak Tez Danışmanı: Doç. Dr. Uğur Murat Leloğlu

Mayıs 2019, 150 sayfa

Tarımsal üretim çoğunlukla bir dış mekan faaliyeti olduğundan iklimsel değişkenliklerden oldukça etkilenmektedir. Tarımın iklimsel değişkenliklere ve aşırı iklim olaylarına karşı olan kırılganlığı farklı ölçeklerde tahmin edilmekte ve buna bağlı olarak çiftçilerin hassasiyetlerini azaltmak ve uyum kapasitelerini arttırmak için politikalar geliştirilmektedir. Farklı ölçeklerdeki değerlendirmeler farklı yöntemler ve göstergeler kullanmaktadır, ki bu birbiriyle karşılaştırılamayan çıktıların oluşmasına sebep olmaktadır. Makro ölçek analizler sonuçların yerel seviyede doğrulandığı ileri doğrulamaya sahip değilken, yerel seviye analizler hanehalkı düzeyinde kırılganlığın üst ölçeklere ne ölçüde genellenebileceğine açıklık getirmemektedir. Mevcut literatürde, farklı ölçeklerdeki kırılganlık analizlerini bir araya getiren ve bu ölçeklerdeki kırılganlığın dinamiklerini belirleyen bir yöntem bulunmamaktadır. Bu tez çalışması, tarım sektöründe iklim değişikliğine karşı kırılganlığın değerlendirilmesi için ilçe ve hanehalkı seviyesinde birbiriyle karşılaştırılabilir göstergeler kullanarak çok-ölçekli bir yaklaşım geliştirmiştir. Kırılganlığın hesaplanmasında kullanılan göstergeler ve bunların ağırlıklandırılması genellikle öznellik açısından eleştirilmektedir. Bu çalışmada, ilçe seviyesi veriler kullanılarak bir endeks oluşturulmuş ve seçilen göstergelerin çiftçilerin kırılganlık seviyelerindeki değişimi açıklamadaki başarılarının değerlendirilmesi için bir sosyo-ekonomik araştırma yürütülmüştür. Çiftçilerin kırılganlık seviyelerinin belirlenmesi için yeni bir kırılganlık hesaplama yöntemi sunulmuştur. Hanehalkı kırılganlık seviyesi iklimsel değişikliklerden kaynaklı ürün kayıpları ve bu kayıpların telafi edilmesindeki zorluğun bir fonksiyonu olarak tanımlanmıştır. Hanehalkı düzeyindeki veri yapısının daha iyi anlaşılması ve önemli göstergelerin açıklayıcı gücü yüksek bir modelle bulunması için hem doğrusal (Çoklu Doğrusal Regresyon), hem de doğrusal olmayan (Rastgele Orman) yöntemlerle analiz edilmiştir. Sonuçlar, gösterge yaklaşımının makro ölçekte faaliyetlerin önceliklendirilmesi için en kırılgan alanların seçilmesinde kullanılabileceğini göstermiştir. Hanehalkı seviyesinde kırılganlığı en çok etkileyen faktörler hanehalkının bağımlı nüfus oranı, tarım ile ilgili örgütlere üyelik sayısı, kaliteli toprağa sahip arazi yüzdesi ve kuru tarım arazisinin yüzdesidir. Sonuçlar ayrıca sahip olunan çiftlik hayvanı ve tarımsal ekipmanların sayısının artmasının çiftçilerin uyum davranışlarına önemli katkıları olduğunu göstermiştir. Bu çalışmanın sonuçları, politika yapıcılara daha etkili sonuçlar elde edilmesi için politika konuları ve uygulama alanlarının önceliklendirilmesinde yardımcı olacaktır.

Anahtar Kelimeler: İklim değişikliğine uyum; İklim değişikliği kırılganlığı endeksi; Çoklu doğrusal regresyon; Rastgele orman regresyonu

To vulnerable livings of a planet with changed climates.

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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
FA	Factor Analysis
GDP	Gross Domestic Product
GHGs	Green House Gases
IPCC	The Intergovernmental Panel on Climate Change
KMO	Kaiser-Mayer-Olkin
MLR	Multiple Linear Regression
NGO	Non-Governmental Organization
OECD	Organization for Economic Co-operation and Development
PCA	Principal Component Analysis
RF	Random Forest
TARSİM	Tarım Sigortaları Havuzu (Agricultural Insurance Pool)
UNFCCC	The United Nations Framework Convention on Climate Change

CHAPTER 1

INTRODUCTION

Frequency and severity of extreme climate events such as storms, floods, heat waves and drought increased in the last couple of decades all around the world (Johnson and Hutton, 2014; Hisali et al., 2011; Krishnamurthy et al., 2014; Trærup and Mertz, 2011). These climatic anomalies are considered as results of global warming and are expected to exacerbate the risks on the livelihoods and assets (Heltberg et al., 2009; Krishnamurthy et al., 2014; Luers et al., 2003). Climatic variability manifests itself not only as extreme events, but also slower and gradual changes in precipitation and temperature, which can be a major threat for agricultural production (Mertz et al., 2010). Agriculture, especially rain-fed agriculture, is quite sensitive to changes in climatic conditions due to specific requirements of the crops in terms of temperature and precipitation from planting to harvest. Furthermore, climatic variability increases the risks of pest and disease spread and soil degradation (Hisali et al., 2011). Recent crop growth models show that production of wheat, rice and maize will decline globally (Krishnamurthy et al., 2014). Despite the international attempts to slow down the generation of anthropogenic greenhouse gasses (GHGs), annual emissions of these gases do not show a declining trend in many parts of the world. Thus, climate adaptation emerged as an important strategy in the climate change agenda.

The future risks created by climate change requires actions in vulnerable areas, especially in the ones where there is a significant gap between the impact and the adaptive capacities. Agricultural sector is one of the areas in which vulnerabilities are not defined clearly in terms of temporal and spatial dimensions of climate change. It is a complicated sector with different actors such as producers, retailers and consumers, and have interacting social, economic and environmental dimensions affecting its vulnerability. The climate projections show that Turkey is in a region which will be affected from the climate change adversely (IPCC, 2014a). It is estimated that national yields will be negatively affected in the range of minus 3.8% to minus 10.1% by 2050 (Dellal et al., 2011). Thus, narrowing down “the gap between scientific knowledge on the impacts of the climate change on agriculture and the agricultural practices (Heltberg et al., 2009)” is becoming significantly important for Turkey, where agriculture constitutes 8.1% of the Gross Domestic Product (GDP) (Turkish Statistical Institute, 2019).

Agricultural vulnerability analysis requires clear definition of vulnerability and underlying causes based on a transparent methodology. However, the literature on climate change vulnerability in agriculture sector uses different indicators and different methodologies for different scales, which creates a knowledge gap for general policy development. In this dissertation, it is aimed to contribute the climate change literature by developing a multi-scale methodology connecting the findings of macro and micro scale analysis and validating the indicators driving the vulnerability dynamics at both scales. In the first part of the study, a vulnerability index is constructed to examine vulnerability levels of districts in terms of agricultural production in Konya, Turkey. In the second part, the results of the socio-economic survey, which further explores the drivers of vulnerability and climate change adaptation pathways at household level in three districts with different vulnerability levels, is reported. This study differs from others in that it determines the inter-scale climate change vulnerability indicators in agriculture sectors and reports the adaptation methods and the indicators affecting adaptation choices of Konya farmers for the first time in an interdisciplinary manner.

The dissertation is organized in five chapters. Chapter 2 reports the concept of climate change vulnerability in terms of agricultural production, the literature on vulnerability measurement and the climate change adaptation methods of the farmers. In Chapter 3, the details of the multi-scale methodology, the data used in the dissertation and the techniques used for the analysis of the data are explained. Linear and non-linear regression techniques are used in order to improve the explanatory power of the models developed for understanding the drivers of vulnerability and adaptation. Chapter 4 presents the results of the district and household level analysis. In the first part of this chapter, the results obtained from the index approach are presented, while in the second part, general findings on the demographic characteristics of the farmers, their farming practices, their observations on climatic changes, their statements on the factors of vulnerability and the indicators affecting vulnerability and adaptation are presented. Chapter 5 discusses the results from the perspective of similar studies in literature and provides recommendations for policy development and the future research. Finally, the questionnaire used in the survey and some additional tables on the results of the socio-economic survey are provided in Appendices.

CHAPTER 2

LITERATURE REVIEW

In the literature review, first of all, the literature on conceptualization of climate change vulnerability is provided. Then, we proceed with reviewing how vulnerability to climate change can be measured.

2.1. Climate Change Vulnerability

The term "vulnerability" emerged as a concept in the development debates of 1990s (Gbetibouo and Ringler, 2009). It was derived from the social sciences (Berry et al., 2006; Luers et al., 2003) and has been conceptualized differently in various disciplines. As there is no single conceptualization of vulnerability, there is no universal definition and methodology of assessing it (Zarafshani et al., 2012).

"Mapping of vulnerability began in the late 1970s (Currey, 1978). However, a large increase in the number of studies on assessment of spatial vulnerability occurred in the last decade. Two main reasons, perhaps, lead to this increase. The first is the recognition of the importance of vulnerability in hazard assessment and disaster management. The second is the availability of GIS technology, which made it possible to integrate data of different types (e.g., biophysical and socioeconomic) and from different sources, analyse data, and present results in a timely and appropriate manner for environmental and agricultural decision making" (Wilhelmi & Wilhite, 2002)

The United Nations Framework Convention on Climate Change (UNFCCC) calls the developed country Parties to assist the developing country Parties in affording the costs of adaptation (Hinkel, 2011). With the high adaptation costs and limited funds allocated, determination of the most vulnerable societies and prioritizing adaptation measures become a critical issue. The purpose of vulnerability assessments is to optimize the allocation of limited resources in order to identify mitigation and adaptation measures globally or locally (Luers et al., 2003).

The Intergovernmental Panel on Climate Change (IPCC) describes the term "vulnerability" as "the propensity or predisposition to be adversely affected" (IPCC, 2014a). IPCC defines vulnerability to climate change as the interaction between three components:

i) the magnitude and duration of climate-related **exposure**;

ii) the **sensitivity** of a target system to climate risk ; and

iii) the ability of a system to withstand or recover from the exposure (**adaptive capacity**)

In this definition, vulnerability is a function of exposure, sensitivity and adaptive capacity. These components are further explained by IPCC as given below:

"*Exposure*: the presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social or cultural assets in places and settings that could be adversely affected.

Sensitivity: the degree to which a system or species is affected, either adversely or beneficially, by climate variability or change. The affect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to the sea level rise).

Adaptive capacity: the ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences."

Although not providing a clearly defined methodology, this definition of the IPCC became the basis of many studies in vulnerability literature. The approaches used to measure vulnerability in these studies are summarized in the following section.

2.2. How Do We Measure Vulnerability to Climate Change?

Measuring vulnerability is found to be a challenging issue (Luers et al., 2003), if not found impossible (Hinkel, 2011). According to (Hinkel, 2011), vulnerability cannot be measured as it is a theoretical concept. As it is not a directly observable phenomenon, it should be operationalized. An operation is a method used for mapping vulnerability to observable concepts (Hinkel, 2011), which are functions called indicators. There are no “universal” indicators as the harm given may vary case to case or hazard to hazard (Hinkel, 2011). According to (Berry et al., 2006), vulnerability can be determined based on the relation between the change and its effects. Direct and indirect impacts of the hazard or slow climatic changes should be understood in order to adapt properly. For example, direct impacts of climate change on agriculture may have indirect effects on rural incomes, food prices, health, migration etc. (Heltberg et al., 2009).

Various techniques are used to assess vulnerability such as statistical analysis, GIS and mapping techniques, cluster analysis and using indices (Zarafshani et al., 2012). Most common method is using composite proxy indicators (indexes) (Bär et al., 2015; Luers et al., 2003) . The purpose of an index is to make a complex issue more understandable and useful for policy or general public. Some of the examples of composite indicators are Human Development Index developed by UNDP, Climate Change Vulnerability Index developed by Maplecroft, Global Adaptation Index by the Global Adaptation Initiative (Gbetibouo and Ringler, 2009), Index of Human Security (Luers et al., 2003).

Vulnerability indices can help to monitor the changes regarding vulnerability, determine the indicators causing the vulnerability and prioritizing solutions to reduce vulnerability (Shah et al., 2013). (Kelly and Adger, 2000) classifies approaches to determine indicators as “starting point approach” and “end-point approach”. The first approach evaluates adaptation to current climate variability, while the second one is a post-disaster approach. (Hinkel, 2011) elaborates the arguments for selecting and aggregating the indicators to develop vulnerability indexes in four categories based on their methodology:

- Deductive arguments using available scientific knowledge in the form of frameworks, theories or models in the selection and aggregation of indicating variables.
- Inductive arguments using data to build statistical models that explain observed harm through some indicating variables.
- Normative arguments which use value judgements in the selection and aggregation of indicating variables.
- Non-substantial arguments which are developed based on the structure of the data on the indicating variables, but do not explain how they combine in the process of causing vulnerability.

Vulnerability indexes can be used in various scales from global to local (Gerlitz et al., 2017). However, due to the large impact area of climate change and considerable differences between different areas, index approach is suggested to be used at local level (Hinkel, 2011; Hisali et al., 2011; Trærup and Mertz, 2011). Macro-level (global, national, regional, provincial etc.) climate change vulnerability studies using index methods are criticized in terms of subjectivity in selection of indicators and their weights. According to (Gbetibouo and Ringler, 2009), due to high heterogeneity within provinces and districts in terms of sensitivity and adaptive capacity, mapping vulnerability at the macro level may lead to a misleading sense of accuracy. Although, macro-level analysis can be used as a guidance for examining vulnerability, further work should be done at local levels such as in districts and villages (Fekete et al., 2010). On the other hand, many studies identifying household level vulnerability and adaptation methods do not give results that can be generalized to regional or national level. There is a gap in the literature on the linkages between methodologies for measuring vulnerability at different levels. The research on climate change vulnerability in agriculture at national and regional scales, which are based on primarily index calculations and statistical methods, do not shed light on household level vulnerability in the areas where vulnerability is examined (Wood et al., 2014).

Absence of a common methodology results in usage of different methods and scales in vulnerability analysis (Luers et al., 2003; Polsky et al., 2007), thus the knowledge on vulnerability and adaptation is fragmented (Hofmann et al., 2011) and incomparable most of the time (Polsky et al., 2007). According to (Polsky et al., 2007), adopting a 'vulnerability' perspective requires a thorough investigation of biophysical, cognitive, and social dimensions of human-environment interactions.

2.3. Strategies of Climate Change Adaptation

The impacts of climate change are various in nature; some of which are predictable and reducible, while others are unpredictable and have long-term consequences. The immediate impacts increase the stress on availability of water and favourable climatic conditions, which are the most important agricultural inputs. Thus, adaptation to climatic changes in crop production is crucial for sustainable agriculture, which have significant impacts on other sectors. Despite the global efforts to reduce global warming, it is important to be ready for the consequences of climate change.

The climate change adaptation attempts can be broadly categorized as responses to current occurrences (climatic variability) and planned adaptation (preparations to long term changes) (Hisali et al., 2011). The adaptation strategies also can be divided into two based on their spatial characteristics; on-farm strategies and off-farm strategies (Heltberg et al., 2009). On-farm strategies are basically based on agricultural practices such as water, crop, land and farm assets management. Water management practices include more irrigation (using additional resources such as ground and underground water, public irrigation system etc.) (Alauddin and Sarker, 2014; Below et al., 2012;

Schilling et al., 2012; Zorom et al., 2013), shifting the timing and amount of irrigation (Luers et al., 2003) , usage of water saving technologies (Alauddin and Sarker, 2014), water storage technologies such as runoff harvesting, watering ponds etc. (Below et al., 2012; Zorom et al., 2013) and making investments of water equipment (Schilling et al., 2012). Some agricultural practices such as cover crops and mulching also help conserving soil moisture, which in turn reduces the amount of irrigation water (Baudoin et al., 2014; Below et al., 2012)**.**

Crop management practices include introducing drought resistant and short-cycle crops (Alauddin and Sarker, 2014; Baudoin et al., 2014; Below et al., 2012; Deressa et al., 2009) or crop-mixes (Alauddin and Sarker, 2014; Below et al., 2012; Schilling et al., 2012; Zorom et al., 2013), changing crop varieties (Alauddin and Sarker, 2014; Hisali et al., 2011; Zorom et al., 2013), crop rotation (Below et al., 2012) and shifting to higher value crops (Luers et al., 2003). Despite the fact that climatic changes and extremes do not have a predictable pattern currently, changing planting/ harvest dates (Alauddin and Sarker, 2014; Baudoin et al., 2014; Schilling et al., 2012) is used as a response strategy.

Land management practices are based on soil conservation and restoration techniques (Alauddin and Sarker, 2014; Zorom et al., 2013) , especially against drought and land degradation. These techniques include tree planting (Alauddin and Sarker, 2014; Zorom et al., 2013), improving the soil quality via conservation agriculture practices such as direct seeding (Alauddin and Sarker, 2014) or by applying more organic or chemical fertilizer (Baudoin et al., 2014; Below et al., 2012; Mertz et al., 2010; Schilling et al., 2012; Zorom et al., 2013). Extending the farmland (Below et al., 2012) and ploughing the marginal lands are also used as an adaptation strategies in order to increase the production (Schilling et al., 2012).

Asset management practices include mortgaging/selling household assets and land (Deressa et al., 2009; Hisali et al., 2011; Trærup and Mertz, 2011), using past savings

(Hisali et al., 2011) and borrowing from formal or informal sources (Deressa et al., 2009; Hisali et al., 2011). Animal breeding and sales to cope with climatic shocks is also used as an adaptation strategy (Alauddin and Sarker, 2014; Below et al., 2012; Trærup and Mertz, 2011; Zorom et al., 2013).

Off-farm adaptation and coping strategies are practices allowing diversification of income and livelihood beyond the farm. Farmers either diversify their income by migrating to other places for wage employment (Baudoin et al., 2014; Below et al., 2012; Deressa et al., 2009; Hisali et al., 2011; Mertz et al., 2010; Schilling et al., 2012; Zorom et al., 2013), diversify their livelihood via trade or casual employment (Baudoin et al., 2014; Trærup and Mertz, 2011) , or rely on remittances from relatives or government support (Deressa et al., 2009; Mertz et al., 2010; Trærup and Mertz, 2011).

2.4. Drivers of Climate Change Adaptation

The on-farm and off-farm adjustments identified as adaptation responses to climate change in the previous section are affected from various socio-economic and physical factors. The direction of the relation between the impact factor and the adaptation method changes according to the method itself and the agroecological setting it is applied. The agroecological setting is defined based on climatic and physical factors that affect agricultural production, thus different households in different agroecological settings are expected to use different adaptation methods (Deressa et al., 2009; Hisali et al., 2011; Tessema et al., 2018).

The studies showed that farming experience of the household head has significant impact on adaptation behaviour, as experienced farmers perceive climate change better than the unexperienced ones (Below et al., 2012; Tessema et al., 2018; Trinh et al., 2018). Age of the household head, which is highly correlated with farming experience, is also an important factor (Deressa et al., 2009; Hisali et al., 2011;

Mulinde et al., 2019; Trinh et al., 2018). Gender of the respondent plays a key role in adoption of certain adaptation methods (Below et al., 2012; Deressa et al., 2009; Hisali et al., 2011; Mulinde et al., 2019; Thoai et al., 2018). In addition to these factors, education level of the household head is also determined as a driver of climate change response (Below et al., 2012; Deressa et al., 2009; Hisali et al., 2011; Mulinde et al., 2019; Nkondze et al., 2013; Tessema et al., 2018; Trinh et al., 2018), as some of the adjustments are complex and require awareness and understanding (Mulinde et al., 2019). In this sense, the other knowledge related factors highlighted in the studies are access to extension services (Below et al., 2012; Deressa et al., 2009; Hisali et al., 2011; Mulinde et al., 2019; Tessema et al., 2018), access to the markets (Below et al., 2012; Mulinde et al., 2019; Tessema et al., 2018), social networks (Below et al., 2012; Mulinde et al., 2019) and membership to local organisations (Mulinde et al., 2019; Thoai et al., 2018), which provide access to information and enable farmers to adjust to the climatic changes.

The studies also identified household size (Below et al., 2012; Mulinde et al., 2019; Tessema et al., 2018), dependency ratio (Below et al., 2012; Mulinde et al., 2019) and farm income (Below et al., 2012; Thoai et al., 2018) as other household characteristics which play role in adaptation strategies. In terms of the characteristics of the farming, total land area (Mulinde et al., 2019; Trinh et al., 2018), number of cultivated plots (Trinh et al., 2018) and land tenure (Below et al., 2012; Deressa et al., 2009; Hisali et al., 2011) are the ones that have impact on adaptation. Furthermore, access to credit and other financial resources (Deressa et al., 2009; Hisali et al., 2011; Tessema et al., 2018; Thoai et al., 2018) is prerequisite for some adaptation methods requiring investment, such as technological adjustments. In this regard, access to off-farm employment (Deressa et al., 2009; Hisali et al., 2011) enable farmers to diverse their income for implementing adaptation strategies or cope with the shocks.

CHAPTER 3

DATA AND METHODOLOGY

In this section, the two-step methodology developed and the data used to measure vulnerability to climate change are explained. Initially, an index is developed to assess the vulnerability of agricultural production to climate change at district level in Konya. Later, the accuracy of the parameters chosen to construct the vulnerability index is checked via a socio-economic survey conducted with the farmers in three districts from different vulnerability levels. Figure 3.1 shows the steps followed while creating the vulnerability index for agricultural sector in Konya.

Literature Findings	• Agricultural climate vulnerability studies reviewed • Indicators for agricultural vulnerability selected
Data Collection	• Availability of data for indicators checked • Available indicators determined
Index Construction	• Approaches used to determine weights of indicators are evaluated • A vulnerability map prepared for 10 districts
Site Survey	• A questionnaire referring to the vulnerability indicators prepared • A site survey is conducted with 376 farmers in 3 districts

Figure 3.1 Flow diagram of the two-step vulnerability assessment method

3.1. Study Site

The global projections show that Turkey is in a region which will be affected from the climate change adversely (IPCC, 2014b). Thus, narrowing down the gap between scientific knowledge on the impacts of the climate change on agriculture and the agricultural adaptation practices (Heltberg et al., 2009) is becoming significantly important for Turkey, where 19.4% of the population works in agricultural sector (Turkish Statistical Institute, 2018). The study is conducted in Konya Province located in the Central Anatolia (Figure 3.2). Total population of the province is recorded as 2.180.149 in 2017 and it has 31 districts, three of which are the central districts. The province covers 8.1% of the total agricultural land of the country and is a major actor in agricultural production (Turkish Statistical Institute, 2018). Thus understanding the factors contributing to vulnerability of Konya farmers is highly important in terms of developing climate change adaptation policies both for Konya and the other similar provinces in the region. There are five agro-ecological sub-regions in the province (Çelik et al., 2015), in which annual precipitation changes from 225 mm to 920 mm and elevation changes from 850 m to 1510 m above the sea level. As the study area represents a fairly large area, the crop pattern is highly diversified. The main agricultural products of the province are wheat, rye, barley, pulses, sugar beet, sunflower and maize. Irrigated farming is significantly dependent on underground water.

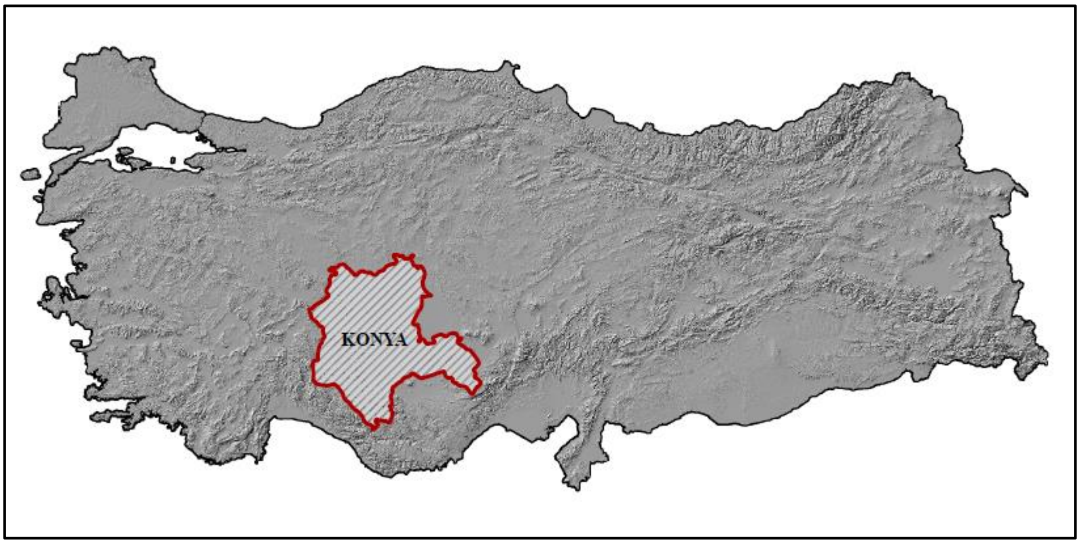

Figure 3.2 Location of Konya in Turkey

Konya Province is classified as a high risk zone for desertification and the farmers have frequently been exposed to climatic extremes such as drought in the recent years (Lelandais, 2016). Data on the population, area, precipitation, number of farmers, agricultural land and the percentage of rain-fed farming is given in Table *3-1*.

Table 3-1 *Data on 31 districts of Konya Province*

District	Population	Area (km^2)	Precipit. (mm)	Number of Registered Farmers	Agri. Area (ha)	Rain-fed Farming (%)
Ahırlı	4.722	325	550	449	6.383	82%
Akören	6.390	640	300	901	21.313	83%
Akşehir	94.133	895	499	5.709	31.859	65%
Altınekin	14.357	1.312	375	3.297	71.688	24%
Beyşehir	**71.336**	**2.054**	**580**	**3.621**	**37.107**	**48%**
Bozkır	27.457	1.105	580	1.247	21.473	96%
Cihanbeyli	**54.892**	**3.702**	**290**	**7.473**	**220.136**	**87%**
Çeltik	10.209	640	397	2.093	34.269	35%
Çumra	**65.054**	**2.089**	**306**	**6.523**	**127.628**	**30%**
Derbent	4.612	359	530	1.027	10.758	79%
Derebucak	7.272	451	500	179	2.203	41%
Doğanhisar	17.683	482	600	2.785	15.836	80%

District	Population	Area (km^2)	Precipit. (mm)	Number of Registered Farmers	Agri. Area (ha)	Rain-fed Farming (%)
Emirgazi	9.135	798	250	2.297	45.756	94%
Ereğli	**139.131**	**2.214**	**277**	**6.958**	**94.693**	**42%**
Güneysınır	9.769	482	360	1.407	15.519	93%
Hadim	**13.260**	**1.165**	**690**	**1.426**	**8.088**	**33%**
Halkapınar	4.519	605	375	512	5.366	65%
Hüyük	16.296	443	580	1.928	16.916	78%
Ilgın	**55.790**	**1.636**	**340**	**6.040**	**82.625**	**78%**
Kadınhanı	33.065	1.568	380	5.738	208.360	79%
Karapınar	**48.968**	**2.623**	**279**	**6.351**	**144.341**	**56%**
Karatay	295.322	2.832	320	6.890	165.008	23%
Kulu	**50.675**	**2.234**	**275**	**5.605**	**114.081**	**90%**
Meram	340.817	1.822	400	2.848	59.259	52%
Sarayönü	26.335	1.620	300	4.641	120.590	92%
Selçuklu	584.644	1.931	523	2.569	61.950	78%
Seydişehir	**63.773**	**1.458**	**679**	**2.876**	**35.296**	**41%**
Taşkent	6.620	457	550	322	3.372	71%
Tuzlukçu	6.890	704	375	2.356	37.600	87%
Yalıhüyük	1.666	94	920	166	3.705	82%
Yunak	**23.956**	**2.101**	**225**	**5.778**	**129.240**	**84%**

Source: Konya Provincial Directorate of Food Agriculture and Livestock (2014)

Vulnerability mapping study is conducted for 10 of the 31 districts for which the meteorological data regarding temperature and precipitation is available and complete (Figure 3.3).

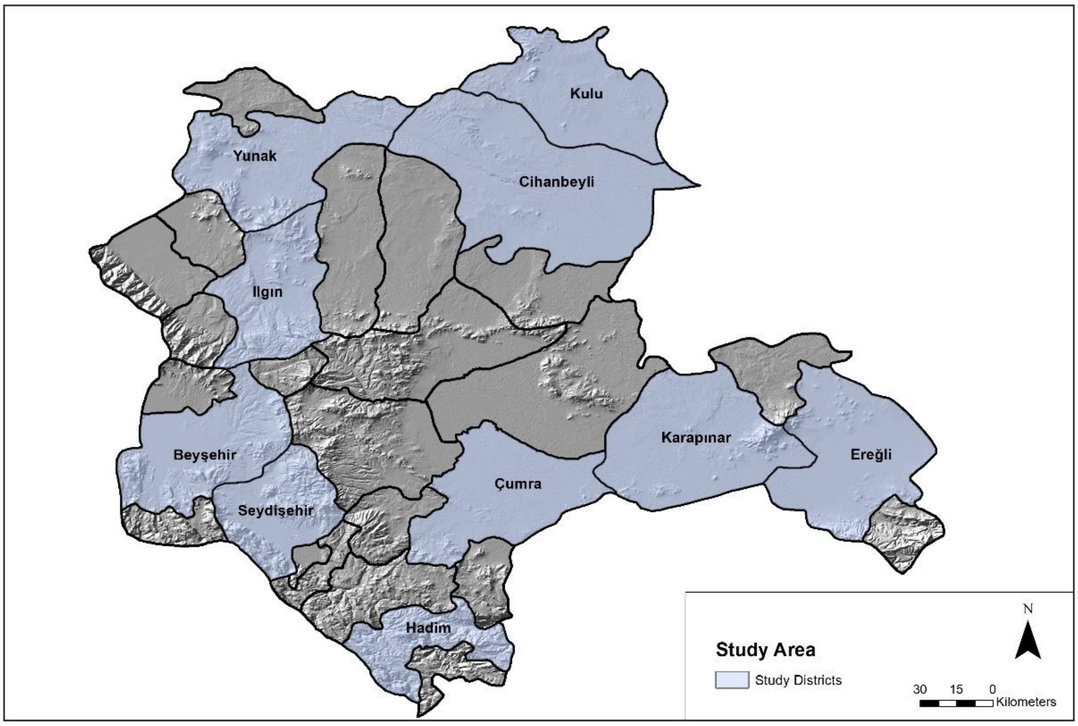

Figure 3.3 The districts selected for vulnerability mapping

3.2. Two-Step Approach to Evaluate Climate Change Vulnerability Factors in Agriculture

Composite index method used in the upper scale (national, regional etc.) climate change vulnerability studies is criticized in terms of subjectivity in selection of indicators and their weights. In order to increase the accuracy of the vulnerability index, the indicators and the weights used in the index should be justified with household level data. Some of the parameters selected or the weights assigned to these parameters might not be as significant as expected in the lives of the farmers. In this study, a two-step approach is developed to assess the vulnerability to climate change in agriculture.

3.2.1. Step 1: Aggregated Index

In the first step, the index method aggregates 18 indicators, selected based on the literature, at district level into a composite index based on the vulnerability definition of IPCC (a factor of exposure, sensitivity and adaptive capacity) (IPCC, 2014b); while in the second step, linear and non-linear regression models are used to determine the importance levels of household level indicators, which are comparable to the district level ones, using quantitative household survey data (Table *3-2*).

Table 3-2. *The multi scale approach used in the study to evaluate climate change vulnerability and its drivers in agriculture in Konya*

	Method	**Aim**	**Scope**
Step 1	Aggregated Index (Deductive)	Assessment of district level climate change vulnerability in agriculture with district level data	18 indicators are aggregated using the IPCC definition of vulnerability
Step 2	Multiple Linear Regression (linear) and Random Forest (non-linear) Models (Inductive)	Assessment of climate change vulnerability in agriculture and its drivers using household level data	A quantitative survey is conducted with 376 farmers. Regression models are used to determine importance levels of vulnerability indicators

A composite vulnerability index is built using three sub-indexes measuring exposure, sensitivity and adaptive capacity. The indicators for each sub-index are selected among the ones determined in the literature review based on their relevancy and data availability. Vulnerability was calculated according to Equation 1, in which the sub-indexes were calculated by taking the unweighted arithmetic averages of the indicators (Gbetibouo and Ringler, 2009).

$$\text{Vulnerability} = \text{Exposure} + \text{Sensitivity} - \text{Adaptive Capacity} \qquad (1)$$

Data for some indicators (number of small scale farms, land degradation index, non-agricultural employment opportunities, agricultural income and groundwater amount) was not available at the district level, thus these indicators were not included in the index.

3.2.1.1. Exposure Indicators

The main body of literature on climate change related vulnerability analysis defined exposure as “long term regional climatic changes or climatic variability, including climatic disasters, which impact the assets and the livelihoods”. In this study, following climate related exposure indicators are used to determine the level of exposure to climatic variability:

Table 3-3. *Selected indicators for exposure*

Indicators	Explanation
Average of daily maximum temperature above 35 ^{o} C, between 2000 and 2015	Temperatures above certain limits, which are called stress limits, result in yield reduction or even in crop loss. In this study, exposure to extreme heat is calculated as the average degrees of daily maximum temperature above 35 ^{o}C whole year (Porter & Semenov, 2005).
Average of daily minimum temperature below 0 ^{o} C, between 2000 and 2015	Exposure to extreme cold is measured as the average degrees of daily minimum temperatures below 0 ^{o}C in March, April and May (expert judgement from Konya Provincial Directorate of Food, Agriculture and Livestock)
Mean deviation from average past (1960-1999)	The absolute deviation (on both directions) amount of monthly precipitation from average past in mm (1960-1999), between 2000 and 2015.

Indicators	Explanation
monthly precipitation, between 2000 and 2015	

The number of extreme climate events such as droughts, flood etc. data was available from Turkish State Methodological Service, however this data was not confirmed by the Provincial Directorate of Food, Agriculture and Livestock, thus was not used in the analysis. The duration of extreme events data is not available either.

3.2.1.2. Sensitivity Indicators

Sensitivity is described as the degree to which the system is susceptible to direct or indirect climatic impacts. It is shaped by human-environmental conditions that can either worsen the conditions or trigger and impact (Gbetibouo and Ringler, 2009). In this study, following indicators are used to determine the level of sensitivity to climatic variability:

Table 3-4. *Selected indicators for sensitivity*

Indicators	Explanation
Mean annual precipitation (mm)	Precipitation is a significant factor, especially for rain-fed agriculture. Plants require certain amount of water during different stages of their growth. Higher amount of precipitation reduces the risk of losing crops due to drought and increases mean yield.
The ratio of rain-fed agricultural land in the total agricultural area (%)	Rain-fed agriculture is more sensitive to climatic changes and extremes, especially to drought, than irrigated agriculture. Lack of precipitation may cause complete crop loss (Wani et al., 2009). High reliance on rain-fed agriculture increases the vulnerability of

Indicators	Explanation
	agricultural production in the areas exposed to erratic weather patterns (Abid et al., 2016; Gbetibouo and Ringler, 2009; Krishnamurthy et al., 2014; Mertz et al., 2010; Schilling et al., 2012) .
The ratio of farmer population to the general population (%)	The larger the proportion of the population obtaining income from agricultural production, the higher the vulnerability of that population to climatic changes. (Gbetibouo and Ringler, 2009) and (Krishnamurthy et al., 2014) used rural population density as a sensitivity indicator in their studies. As rural population data is not available at district level for Konya, the percentage of farmer population is used as a proxy.
Dependency ratio (proportion of the population below 15 and above 65) (%)	Ratio of dependent population (population below 15 and above 65), which is considered as unproductive, increases the vulnerability level. In some studies it is used as an adaptive capacity indicator (Ahsan and Warner, 2014; Hahn et al., 2009; Piya et al., 2012; Shah et al., 2013; Wiréhn et al., 2015), while in some others it is used as a social vulnerability indicator (Lee, 2014).
Illiteracy rate (%)	Education increases the adaptation capacity significantly (Deressa et al., 2009) as it increases the capacity to utilize existing assets and opportunities (Piya et al., 2012). Literacy rate is used as an adaptive capacity indicator by (Ahsan and Warner, 2014; Ahumada-Cervantes et al., 2017; Gbetibouo and Ringler, 2009; Mohmmed et al., 2018; Monterroso et al., 2014; Tubi et al., 2012; Zarafshani et al., 2012). In

Indicators	Explanation
	this study, illiteracy rate is used as a sensitivity indicator which worsens readiness for exposure.
The ratio of forest land in the total area of the district (%)	Forest land reduces the vulnerability of agricultural production by providing ecosystem services such as natural disturbance regulation, biological pest control, water regulation, erosion control etc. (Decocq et al., 2016). Percentage of forest land is used as an environmental indicator for sensitivity (Corobov et al., 2013; Krishnamurthy et al., 2014; Monterroso et al., 2014). [1 – Index Value] is used in the calculations as this indicator reduces sensitivity.
The ratio of first degree (very fertile) land to the total area of the district (%)	Soil quality has been defined as the capacity of a given type of soil to maintain functions such as regulation of chemicals, nutrient recycling for productivity etc. (Berrouet et al., 2018). High quality soils are more resistant to drought due to their higher retention capacity. Soil quality is used as a sensitivity indicator in many studies (Ahumada-Cervantes et al., 2017; Murthy et al., 2015; Below et al., 2012; Corobov et al., 2013; Luers et al., 2003; Wiréhn et al., 2015) . In this study, soil quality is used as the percentage of first degree soils in Land Use Capability Classification maps. [1 – Index Value] is used in the calculations as this indicator reduces sensitivity.
Crop Diversification Index	Growing multiple crops on the same field, either at the same time or after each other in sequence, lowers the risk of complete crop loss. Furthermore, the second

Indicators	Explanation
	crop in the sequence might have benefits such as nitrogen fixation and reduced disease or pests (Waha et al., 2013). Crop diversification index is used as a vulnerability indicator in various studies (Alauddin and Sarker, 2014; Gbetibouo and Ringler, 2009; Wiréhn et al., 2015). In this study, Simpson Diversification Index is calculated using district level data. [1 – Index Value] is used in the calculations as this indicator reduces sensitivity.

Some indicators are difficult to categorize such as “dependency ratio”, “illiteracy rate” and “crop diversification index”. They can be used as indicators of sensitivity or adaptive capacity. In this study, they are selected as sensitivity indicators as sensitivity is considered to be social and environmental conditions of the district, while adaptive capacity is considered to be related with the agricultural implementations and human/physical capacity related to the agricultural production.

In literature, percentage of rural population is used as a sensitivity indicator; however, this data is not available for Konya as the management units in the country are changed with the Law numbered 6360, which turned the rural areas such as villages into urban neighbourhoods, in 2012. Percentage of farmer population is used as a proxy indicator for percentage of rural population.

For the soil quality indicator, total percentages of first and second degree soil in Land Use Capability Classification maps prepared by former General Directorate of Land Wand Water (TOPRAKSU) between 1966-1971 and updated 1982-1984 (Kalkınma Bakanlığı, 2014). The classifications in the map, which show the suitability of soils for most kinds of field crops, are determined by the United States Department of

Agriculture (Klingebiel and Montgomery, 1961). There are eight classes of soils in this classification method:

Class I- have few limitations that restrict their use

Class II- have some limitations that reduce the choice of plants or require moderate conservation practices

Class III- have severe limitations that reduce the choice of plants or require special conservation practices or both

Class IV- have very severe limitations that restrict the choice of plants, require careful management or both.

Class V- have little or no erosion hazard but have other limitations impractical to remove that limit their use largely to pasture, range, woodland, or wildlife food and cover

Class VI- have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife food and cover

Class VII- have very severe limitations that make them unsuited to cultivation and that restrict their use largely to grazing, woodland or wildlife

Class VIII- have limitations that preclude their use for commercial plant production and restrict their use to recreation, wildlife, or water supply or to aesthetic purposes.

Crop Diversification Index:

Growing two or more crops on the same field, either at the same time or after each other in sequence, lowers the risk of complete crop loss. Furthermore, the second crop in the sequence might have benefits such as nitrogen fixation and reduced disease or pests (Waha et al., 2013). Several Crop Diversification Index methods are used to explain diversity of crops in an area with a single indicator such as *Bhatia's Method* (Wiréhn et al., 2015), *Jasbir Singh's Method* (Pal and Kar, 2012), *Gibbs-Martin Index* (Roy and Barman, 2014; Das and Mili, 2013; Gbetibouo and Ringler, 2009; Patel, 2015; Sajjad and Prasad, 2014), *Herfindhal Index* (Bradshaw et al., 2004; De and Chattopadhyay, 2010; Heltberg and Bonch-Osmolovskiy, 2011; Ibrahim et al., 2009; Mukherjee, 2010; Ojo et al., 2014; Velavan and Balaji, 2012), *Simpson Index* (Bhattacharyya, 2008; De and Chattopadhyay, 2010; Idowu et al., 2014; Sichoongwe et al., 2014; Singha et al., 2014), *Composite Entropy Index* (CEI) (Acharya et al., 2011) and *Modified Entropy Index* (Mesfin et al., 2011).

Bhatia's Method and Jasbir Singh's Model uses $\frac{Percent\ of\ cropped\ area\ under\ x\ crops}{Number\ of\ x\ crops}$ formulate to determine the crop diversity. It considers the crops occupying 10 per cent or more of the sown area, while Jasbir Singh's Model uses the same formula and considers the crops whose proportion is 5 per cent or more. In this study, a model that considers all the crops regardless of their share in the total sown area is preferred.

Gibbs-Martin Index, Herfindhal Index and Simpson Diversity Index are most commonly used indices in literature. Simpson Index ($\sum P_i^2$), where P_i is the proportion of a certain species individuals in the total number of different species individuals, is used in ecology to measure the probability that two randomly selected individuals belong to the same species. The same method is used by Herfindhal to determine the level of concentration in the industry. Both indices range between 0 and 1 and gets closer to 1 when diversification reduces. Simpson Diversification Index ($DI = 1 - \sum P_i^2$) is used in crop diversification analysis. Here, P*i* is "Proportionate area of the i^th^ crop in the Gross Cropped Area" and the index gets closer to 1 as the diversification increases. Gibbs-Martin Index ($GM = 1 - \frac{\sum X_i^2}{\sum(Xi)^2}$) is used in urbanization pattern analysis, crop diversification and demographic studies (Patel & Rawat, 2015) . In the crop diversification analysis, "X" refers to the percentage of certain crop in the total cropped area. In this study, Simpson Index is used to determine crop diversity parameter for each district. The results of the Simpson Diversity Index for each district is given in Table *3-5* below.

Table 3-5. *Results of the Simpson Diversification Index*

District	SDV
Beyşehir	0,54
Cihanbeyli	0,56
Çumra	0,82
Ereğli	0,81
Hadim	0,60
Ilgın	0,68
Karapınar	0,79
Kulu	0,54
Meram	0,66
Selçuklu	0,62
Seydişehir	0,66
Yunak	0,51

3.2.1.3. Adaptive Capacity Indicators

The adaptive capacity is defined as the ability of a system or society to adapt to or cope with the changes in the external conditions. Social and economic characteristics of the households and their environment affect their adaptive capacity (Hahn et al., 2009). In this study, following indicators are used to determine the adaptive capacity:

Table 3-6. *Selected Indicators for adaptive capacity*

Indicators	Explanation
Density of farm animals	Livestock ownership diversifies the income sources of farmers and reduces their vulnerability level (Below et al., 2012). Livestock ownership (density of farm animals at macro scale) is used in various studies (Alauddin and Sarker, 2014; Deressa et al., 2009; Hahn et al., 2009; Mohmmed et al., 2018; Monterroso et al., 2014; Nkondze et al., 2013; Tesso et al., 2012). In this study, density of farm animals is calculated as “number

Indicators	Explanation
	of bovine animals + (number of ovine animals/3)" per hectare of district land.
Number of agricultural equipment per farmer	Farm assets, especially irrigation equipment, reduces the vulnerability of farmers both by facilitating agricultural production and as a coping strategy by selling them when required. Total value of the farm assets (Gbetibouo and Ringler, 2009) and ownership of vehicles (Huynh and Stringer, 2018) are used as indicators to measure vulnerability. In this study, number of agricultural equipment per farmer is used as an adaptive capacity indicator.
Density of road network	Road infrastructure, especially paved roads, gives farmers opportunity to reach markets, inputs, information and off-farm employment (Piya et al., 2012). Lack of road network escalates overall socio-economic vulnerability (Ahsan and Warner, 2014), thus road density is used as a vulnerability indicator in various studies (Ahumada-Cervantes et al., 2017; Corobov et al., 2013; Gbetibouo and Ringler, 2009; Krishnamurthy et al., 2014). In this study, density of road network is calculated by dividing the length of the main roads in the district to the total area of the district.
Extension trainings given per farmer	Extension trainings on crop and livestock increases the adaptation capacity to climate change (Deressa et al., 2009b). Thus, design of training programs, especially targeting small farm holders, is suggested to develop capacity of the farmers to utilize their assets and opportunities (Piya et al., 2012; Zarafshani et al., 2012).

Indicators	Explanation
	In this study, average number of extension trainings given per farmer is used as an adaptive capacity indicator at the district level.
Number of agricultural organizations per farmer	Memberships to the local institutions, especially the agricultural ones, is considered to be a factor improving farmer's resilience to the impacts of climate change (Tesso et al., 2012; Zarafshani et al., 2012) . In this sense, the number of farmers who are members of agricultural organizations (Gbetibouo and Ringler, 2009) or the number of community-based farmer organizations (Huynh and Stringer, 2018) are used as indicators of adaptive capacity. In this study, the number of agricultural organizations per farmer is used as an indicator of adaptive capacity at district level.
Amount of agricultural subsidies provided per hectare (Turkish Lira)	Government provides subsidy schemes to shape crop patterns and increase resilience of the farmers. Institutional support is an important factor that determines the asset portfolio of a household (Monterroso et al., 2014). Governmental support is a significant indicator for adaptive capacity (Ahumada-Cervantes et al., 2017; Alauddin and Sarker, 2014; Huynh and Stringer, 2018). In this study, amount of agricultural subsidies provided per hectare in Turkish Lira in the district is used an adaptive capacity indicator.
Percentage of agricultural land insured	Agricultural insurance is found as a significant adaptive strategy and low level of agricultural insurance increases vulnerability of the farmers (Mohmmed et al.,

Indicators	Explanation
	2018). Existence of crop insurance is used as an adaptive capacity indicator in various studies (Hinkel, 2011; Mallari and Ezra, 2016; Robinson et al., 2015; Schilling et al., 2012; Zarafshani et al., 2012). In this study, percentage of insured agricultural land is used as an adaptive capacity indicator at the district level.

Indicators such as number of small scale farms, non-agricultural employment opportunities, agricultural income and groundwater amount were also chosen to be used in the index; however, such data is not available for the districts of the province. Percentage of rain-fed farming is considered as a proxy data for the underground water amount as the main irrigation source in the province is underground water. Amount of chemical fertilizers used per hectare was initially considered as an indicator to calculate vulnerability. The available fertilizer use data for districts is obtained from registered fertilizer dealers and in some districts there is no dealer, thus the farmers obtained the chemical fertilizers from other districts. Furthermore, there are unregistered dealers, which makes the fertilizer usage data unreliable.

3.2.2. Vulnerability Index Construction

Composite index construction is composed of data normalization, weighting the indicators and aggregation. Further details are given in the below sections.

3.2.2.1. Normalization

Indicators used in the index have different measuring units and should be normalized in order to be comparable. In this study, the data is normalized based on the method used in the United Nations Development Programme (UNDP)'s Human Development Index (UNDP, 2002):

$$\text{Index Value} = \frac{(\text{Actual value - minimum value})}{(\text{Maximum value - minimum value})} \qquad (2)$$

The indicator values which are hypothesized to have a negative relationship with the related sub-index are used as [1 – Index Value]. For example, the ratio of forest land in the total area of the district, the ratio of first degree (very fertile) land in the total area of the district and Crop Diversification Index reduce sensitivity, thus their index value is subtracted from one to reduce their contribution to sensitivity during normalization.

3.2.2.2. Weighting and Aggregations

There are three main ways to give weights to the indicators (Gbetibouo and Ringler, 2009; Monterroso et al., 2014; Piya et al., 2012; Wiréhn et al., 2015):

a) expert judgement
b) equal weights
c) statistical models such as principal component analysis (PCA) or factor analysis (FA)

Expert judgement method is found too subjective and for most of the indicators there might be no consensus among experts (Gbetibouo and Ringler, 2009; Piya et al., 2012).

Principal Component Analysis (PCA) is a dimension reduction technique that captures the common information by linearly transforming an original set of variables into a smaller set of uncorrelated variables (Dunteman, 1989; Gbetibouo and Ringler, 2009; Sanguansat, 2012). PCA is frequently used in the vulnerability index construction. The requirements for the factors in PCA are: a) having associated eigenvalues larger than one, b) individually contributing to the explanation of overall variance by more than 10%, c) cumulatively contributing to the explanation of overall variance by more than 60% (Nardo et al., 2005). Furthermore, The Kaiser-Mayer-Olkin (KMO) measure of sampling adequacy test and Bartlett's sphericity test are used to determine the suitability of PCA in terms of correlation between the variables. KMO value should be larger than 0.5 and Bartlett's test of sphericity value should be larger than 0.05 (Abson et al., 2012). The district level data used in the study did not fulfil the requirements of PCA analysis. On the other hand, in PCA method, the principal axis may correspond to some other parameter than vulnerability and it is not possible to know which axis does, if one does correspond.

In this study, equal weights method is used to aggregate the index figures at district level analysis. In equal weights approach, the parameters are treated as they are perfect substitutes of each other and averages of the parameters were calculated to build each sub-index.

3.2.3. Step 2: Socio-Economic Survey

The objective of the socio-economic survey was to obtain detailed farmer level data to validate the district level analysis and get further details regarding the vulnerability drivers at household level. Prior to the survey, non-structured interviews were made with agricultural experts from the local authorities and the farmers in order to have an overall understanding of the characteristics of agricultural production in the province and problems faced by the farmers. It is not always easy to differentiate the climatic and non-climatic factors of vulnerability (O. Mertz et al., 2010), thus the interviews aimed at deep understanding of the factors of agricultural vulnerability and isolating the climatic factors from economic, social and cultural ones. The questionnaire included questions on demographic characteristics of the household, farming practices and assets, observations regarding climatic changes over the past 10 years, the impacts of extreme events exposed and the coping mechanisms, and physical and social setting of the places lived. The questionnaire was tested on 20 randomly selected farmers in the survey districts. The final questionnaire included 198 multiple choice and open-ended questions.

3.2.3.1. Selection of Pilot Sites

The results of the district level vulnerability analysis are used to select the districts for the household level farmer vulnerability survey. Due to financial constraints, limited number of districts had to be selected among 10 districts, thus the districts are grouped into three classes (low, medium and high) using two different methods and one from each is picked to ensure that the chosen districts are representative of the vulnerability distribution. Initially, the districts are grouped using Natural Breaks (Jenks) Classification Method in ArcGIS 10.1 software. Jenks method divides the features into classes by minimizing the variance within the class while maximizing the variance between the classes (Chen et al., 2013) . The vulnerability classes based on Jenks Method is determined with the following formula (Baz et al., 2009a) using district level aggregated vulnerability scores:

$$GVF = 1 - \frac{\sum_{j=1}^{k}\sum_{i=1}^{Nj}(z_{ij}-\bar{z}_j)^2}{\sum_{i=1}^{N}(z_i-\bar{z})^2} \qquad (3)$$

“where GVF is the goodness of variance fit; z_{ij} is the sum of squared deviations from the array mean; $\bar{z}_j$ is the sum of squared deviations between classes” (Baz et al., 2009b).

In the second step, the districts are grouped using k-means clustering technique. Clustering analysis is a group of multivariate techniques which aim at clustering objects based on their characteristics (Hair et al., 2009). There are two commonly used partitioning procedures for cluster analysis: hierarchical cluster procedures and non-hierarchical cluster procedures. In hierarchical cluster analysis, the objects are clustered in a tree-like structure by grouping the most similar objects iteratively until all the objects are grouped into one cluster. This clustering technique has two major procedures called agglomerative method and divisive method, in which clusters are successively joined or divided (Hair et al., 2009). In the non-hierarchical cluster analysis, which is referred to as k-means clustering, the objects are grouped into a pre-determined number of classes. k-means clustering method is used to group the objects in a way that intragroup homogeneity and intergroup difference is as high as possible (Kijewska and Bluszcz, 2016). It is commonly used in data mining, pattern recognition and clustering based estimation (Al-Wakeel and Wu, 2016). Partitioning of the data into user-specified number of groups is done by assigning -k- initial centroids and refining them iteratively until each centroid is the mean of its constituent data (Wagstaff et al., 2001). In this study, k-means analysis is carried out using SPSS 23 software and k is chosen as three to comply with the vulnerability classes determined using Jenks Method. The analysis is carried out using all 18 vulnerability indicators. The most representative district for its cluster is chosen based on the Euclidian distance (straight-line distance) to the cluster mean with the following formula:

$$D_{x,M} = \sqrt{\sum_{i=1}^{n}(x_{ik} - M_j)^2} \qquad (4)$$

where $D_{x,M}$ is the Euclidean distance between the observation and the center of the cluster, x_i is the measurement of the i^{th} case for the k^{th} variable, Mj is the mean of the k^{th} cluster and n is the number of variables. The districts with the closest figures to their cluster means were Cihanbeyli, Karapınar and Seydişehir.

Table 3-7. *K-means clustering of the districts*

Districts	Cluster Number	Distance from Cluster Centre
Beyşehir	1	0,849
Hadim	1	1,133
Seydişehir	**1**	**0,755**
Cihanbeyli	**2**	**0,543**
Ilgın	2	1,063

Districts	Cluster Number	Distance from Cluster Centre
Yunak	2	0,819
Kulu	2	0,878
Karapınar	**3**	**0,835**
Çumra	3	1,023
Ereğli	3	0,928

As these districts belong to three different vulnerability groups determined using the Jenks Method, they are considered to be the representative of each vulnerability group and selected as the survey[1] districts.

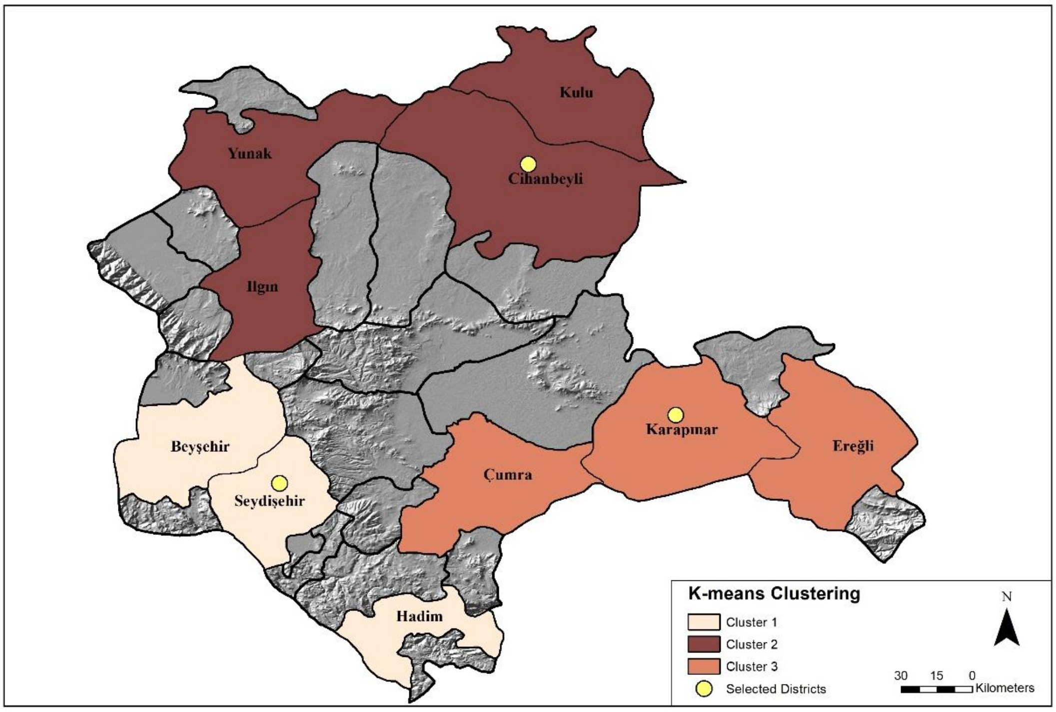

Figure 3.4 K-means clustering and selected districts for the survey

[1] The survey was approved by the Human Ethics Research Committee of the Middle East Technical University, No: 2016-SOS-044 on March 22, 2016.

3.2.3.2. Sampling Procedure and the Sample Size

The sample size is calculated using the following formula (Krejcie and Morgan, 1970):

$$s = (X^2NP(1-P)) \div (d^2(N-1) + X^2P(1-P)) \quad (5)$$

where,

s = required sample size,

X^2 = the table value chi-square for one degree of freedom at the desired confidence level (3.841),

N = the population size,

P = the population proportion (assumed to be 0.50 since this would provide the maximum sample size) and

d = the degree of accuracy expressed as a proportion (0.05).

The population size including the number of farmers in Cihanbeyli, Karapınar and Seydişehir is 16.700 and the sample size is calculated as 376. The number of interviews per each district is determined according to the ratio of their farmer population to the total farmers in three districts (Table *3-8*).

Table 3-8. *The sample distribution of survey data*

	Cihanbeyli	Karapınar	Seydişehir
Number of sample	168	143	65
Proportion	45%	38%	17%
Number of samples for irrigated farming	49	114	48
Number of samples for rain-fed farming	119	29	17

As the aim of the survey was to determine the drivers of the farmer level vulnerability, it was important to reach the farmers who were affected from the climatic changes and extremes. Thus, while selecting the neighborhoods to be visited for the survey, further stratifications were carried out for each district. As the dominant factor affecting crop pattern and crop yield is availability of water in the region, the neighborhoods were categorized as irrigated and rain-fed based on the dominance of the net area of irrigated and rain-fed farming. It is done by using the following method:

- village point data and irrigated areas raster data are combined,
- the village is classified as "irrigated" or "rain-fed" based on the percentage of intersection of the 2-km buffer zone around the village centre with the irrigated areas layer,
- initial classification is crosschecked with the multi-temporal satellite images for final classification.

Secondly, depending on the percentage of population in the irrigated and rain-fed villages, the sample size is stratified in order to determine the number of farmers to be interviewed in irrigated agriculture villages and rain-fed agriculture villages (Table *3-9*).

Table 3-9. *Stratification of sample size according to irrigation*

District	Population living in the irrigated agr. villages	Population living in the rain-fed agr. villages	% share of population living in irrigated agr. villages	% share of population living in rain-fed agr. villages	Sample size for each district	# of farmers to be interviewed in irrigated agr. villages	# of farmers to be interviewed in rain-fed agr. villages
Cihanbeyli	7.398	17.995	29%	71%	168	49	119
Karapınar	7.652	1.942	80%	20%	143	114	29
Seydişehir	11.370	3.956	74%	26%	65	48	17
Total	**26.420**	**23.893**			**376**	**211**	**165**

In order to increase the probability of reaching to the farmers who had loss from the climatic changes and extremes, the villages are ranked according to their risk level.

The Ministry of Agriculture and Forestry established Agricultural Insurance Pool (TARSİM) by the Law on Agricultural Insurances dated 14.06.2005 and Numbered 5363 to promote farmers insuring their production materials and crops. In this system, certain percentage of the premium is paid by the Government. Risk levels for hail, frost, storm, flood and rain of each village in a district is determined by Tarsim (Table *3-10*).

Table 3-10. *An example of risk zones table*

DISTRICT	NEIGHBOURHOOD	2017 HAIL RISK ZONE	2017 FROST RISK ZONE	2017 STORM RISK ZONE	2018 FLOOD RISK ZONE	2019 RAIN RISK ZONE
SEYDİŞEHİR	AKÇALAR	C	H	D	I	K
SEYDİŞEHİR	AŞAĞIKARAÖREN	B	H	D	C	K
SEYDİŞEHİR	BAŞKARAÖREN	B	H	D	I	K
SEYDİŞEHİR	BOSTANDERE	B	H	D	I	K
SEYDİŞEHİR	BOYALI	C	H	D	C	K
SEYDİŞEHİR	DİKİLİTAŞ	B	H	D	C	K
SEYDİŞEHİR	GEVREKLİ	B	H	D	I	K
…	…	…	…	…	…	…

Risk levels for hail, frost, storm and flood and insurance premium (%) for different crops are also determined by TARSİM and a general classification for crop is done (Table *3-11*). Risk evaluation for frost do not cover the major crops cultivated in Konya, thus is not used in the calculations. Furthermore, drought risk levels are determined at district level, thus drought risk is considered equal in all the neighbourhoods.

In order to use this data and determine the numeric equivalent of risk zone classifications for the neighbourhoods, area percentages of crops cultivated in a district is used to weigh the premium prices (%).

Table 3-11. *Hail coverage premium price table*

Crop Sens. Class	Hail Risk Zones and Premium Prices (%)									
	A	**B**	**C**	**D**	**E**	**…**	**T**	**U**	**V**	**Y**	**Z**
1	0,28	0,32	0,36	0,40	0,44	…	1,84	2,00	2,20	2,40	2,64
2	0,35	0,40	0,45	0,50	0,55	…	2,30	2,50	2,75	3,00	3,30
…	…	…	…	…	…	…	…	…	…	…	…
75	1,76	2,02	2,27	2,52	2,77	…	11,59	12,60	13,86	15,12	16,63

Table 3-12. *Risk zone classifications for the neighbourhoods*

Neighbourhood	2017 Hail Risk	2017 Storm Risk	2017 Flood Risk	Total Risk	Average Risk	Population over 18
SIĞIRCIK	2,82616441	1,294751135	1,09	5,210916	1,736972	98
TURANLAR	2,82616441	1,294751135	1,09	5,210916	1,736972	214
YAPALI	2,82616441	1,294751135	1,09	5,210916	1,736972	866
DAMLAKUYU	2,56089546	1,395609835	1,09	5,046505	1,682168	306
KELHASAN	2,56089546	1,294751135	1,09	4,945647	1,648549	942
KIRKIŞLA	2,56089546	1,294751135	1,09	4,945647	1,648549	579
KUŞCA	2,56089546	1,294751135	1,09	4,945647	1,648549	1187
KARABAĞ	1,7456065	1,294751135	1,68	4,720358	1,573453	1853
GÜNYÜZÜ	2,17202683	1,294751135	1,09	4,556778	1,518926	1264
…	…	…	…	…	…	…

Sampling can be classified as random and non-random. Random sampling, also known as probability sampling, includes a random mechanism to obtain a representative sample and includes methods such as simple random sampling, systematic sampling, stratified sampling, cluster sampling and multistage sampling. In non-random sampling on the other hand, the sample is drawn based on non-random mechanisms, such as snowball sampling and quota sampling, due to unavailability of sample frame listing of potential respondents or locations (Crano et al, 2015). The research used the methodology used by (Shah et al., 2013), which is based on a systematic sampling method, in which interviews started at the end of the main road or main branch road based on a random number table. Furthermore, quota sampling is used in order to assure that the farmers who had crop, equipment or animal loss in their agricultural production in the last five years were reached. In this technique, the respondents are sampled randomly until a predefined number of participants is achieved (Crano et al, 2015). It was assured that at least 50% of the interviewees were affected from some kind of climatic extreme such as drought, frost, flood etc. before the interviews were completed in each village.

The questionnaire was applied using tablet PCs and the data of each interview could be uploaded in the system instantly. The fieldwork was conducted by experienced surveyors between 29th and 31st May 2017. The interviews took an average of 45 minutes per farmer and they were conducted with self-identified heads of the households (all of whom are men). The data was analysed using either IBM SPSS Statistics 23 or Microsoft Excel.

3.2.4. Measuring Household Level Vulnerability

Household level vulnerability is measured using two different methods based on farmer statements (Table *3-13*), which can be used for measurement of exposure, sensitivity and adaptive capacity.

Table 3-13. *Indicators used for measuring household level vulnerability*

Sub-index	Indicator	Explanation
Exposure	Average annual number of climatic extremes farmers were exposed	Average number of climatic extremes farmers were exposed per year for the last five years
Sensitivity	The impact of crop loss due to climatic extremes on the household income	The impact of the crop losses due to any disasters in the last 5 years on the household income (1-5 scale; 1: no impact, 5: significant impact)
Adaptive Capacity	Easiness level in compensation of the losses	If the farmer could compensate the losses, how difficult it was (1-5 scale; 1: Not easy at all, 5: extremely easy)

In the first method, farmer vulnerability is calculated similar to the formula used in district level analysis (Formula 1):

$$\text{Household Level Farmer Vulnerability} = \text{Exposure} + \text{Sensitivity} - \text{Adaptive Capacity} \quad (6)$$

In the second method, household level farmer vulnerability is calculated as the ratio of sensitivity to adaptive capacity using the following formula:

$$\text{Household Level Farmer Vulnerability} = \text{Sensitivity} / (\text{Adaptive Capacity} + 1) \quad (7)$$

In order to make a multi scale comparison of the driving factors of vulnerability, data on the following indicators are obtained in the household survey (Table *3-14*). The indicators are either equivalents of the ones used at the district level, or their proxy at the household level.

Table 3-14. *Indicators affecting household level vulnerability*

Indicators	Explanation
Education level of the household head	Certain characteristics of the household heads, who generally position themselves as the decision makers in the household, have significant impact on sensitivity and adaptive capacity of the household. Educational level of household head is found to be a significant determinant of resilience to climate change in household (Alauddin and Sarker, 2014; Below et al., 2012; Deressa et al., 2009; Ghimire et al., 2010; Hisali et al., 2011; Morzaria-Luna et al., 2014; Notenbaert et al., 2013; Tesso et al., 2012; Thoai et al., 2018; Zarafshani et al., 2012).

Indicators	Explanation
Dependency ratio	Dependent population in the household (members below 15 and above 65) is considered unproductive and increases vulnerability (Ahsan and Warner, 2014).
Percentage share of agricultural production in income	Income diversification improves the resilience of the farmers, as their income is not solely dependent on agriculture. Percentage share of agricultural income, non-agricultural income and access to non- agricultural income are the widely used indicators of household level vulnerability (Deressa et al., 2009; Ghimire et al., 2010; Robinson et al., 2015). In this study, percentage share of agricultural production in income is used as an indicator of vulnerability.
Percentage of rain-fed land	Rain-fed areas are more vulnerable to climatic changes and extremes, especially to drought. Access to water resources and irrigation infrastructure reduces vulnerability of farmers (Gbetibouo and Ringler, 2009; Hisali et al., 2011; Melkonyan, 2014; Mohmmed et al., 2018; Monterroso et al., 2014; Murthy et al., 2015; Zarafshani et al., 2012). Thus, percentage of rain-fed land in the farm is used as an indicator of vulnerability.
Percentage of land with good soil quality	Soil content and moisture are highly important factors that increase resilience of agricultural production. Higher nutrient and moisture content increases the resistance of the crop against climatic changes and extremes, such as drought. Thus, soil type and fertility are used as indicators of vulnerability (Below et al., 2012; Luers et al., 2003; Murthy et al., 2015). In this

Indicators	Explanation
	study, self- assessed soil quality is used as an indicator of the household level vulnerability.
Existence of forest near by agricultural land	Forests provide various ecosystem services to agricultural production such as soil protection from extreme events, hosting pollinators and natural enemies etc. (Decocq et al., 2016), thus existence of forests is considered as a resilience indicator and used in vulnerability studies (Mendoza et al., 2014; Notenbaert et al., 2013). At district level, percentage of forest land was used as an indicator and it is transformed into household level as existence of a forest nearby the agricultural land.
Crop diversity at different plots	Crop diversity reduces vulnerability of farmers by securing certain share of agricultural income. Crops can be diversified throughout the year or on the same land at the same time. Highly vulnerable regions are characterized by low crop diversity (Ahumada-Cervantes et al., 2017; Hahn et al., 2009; Mohmmed et al., 2018a; Tesso et al., 2012). Crop diversity at different plots is used as an indicator in this study.
Total number of livestock owned	Livestock ownership diversifies household livelihood and results in a shift in vulnerability category of the households from higher to lower (Ghimire et al., 2010; Nkondze et al., 2013).
Number of agricultural equipment	More access to physical and material resources increases the flexibility of farmers to cope with a changing environment (Ghimire et al., 2010).

Indicators	Explanation
Number of memberships to agricultural organizations	Participation to the activities of agricultural organizations and number of memberships to these organizations are strong determinants of household's resilience to climate change impacts (Ghimire et al., 2010a; Huynh and Stringer, 2018; Notenbaert et al., 2013; Piya et al., 2012; Tesso et al., 2012). In this study, the number of agricultural organizations that the farmer is registered as a member is used as an indicator.
Number of agricultural training obtained in previous year	Extension on crop and livestock provides access to information required to assess the impacts of climatic changes, thus have an influence on farmers' vulnerability (Deressa et al., 2009; Ghimire et al., 2010; Zarafshani et al., 2012).
Number of subsidies obtained from the Ministry	Institutional support and subsidies have significant impact on crop choice and asset portfolio of the household (Alauddin and Sarker, 2014). The success of adaptation strategies rely on financial support from various organizations (Huynh and Stringer, 2018).
Number of facilities available	Economic potential and infrastructure of the area have positive impacts on adaptation (Below et al., 2012). One of the factors that affects the resilience is institutional arrangements (Mohmmed et al., 2018). In this study, infrastructure and economic capacity of the settlement where farmer lives are measured with the number of available facilities such as schools, health centers etc.
Agricultural insurance in the last 5 years	One of the characteristics of highly vulnerable regions is low level of agricultural insurance (Mohmmed et al.,

Indicators	Explanation
	2018; Robinson et al., 2015). Insurance schemes can be used as a way to compensate crop losses associated climate variability (Antwi-Agyei et al., 2013; Schilling et al., 2012).

3.2.5. Modelling Household Level Vulnerability and Adaptation Behavior

In order to model the overall household vulnerability and adaptation behavior, and to determine the highly contributing factors, regression analysis, which aims at predicting a dependent variable from a number of independent variables, was run. Both linear (multiple linear regression- MLR) and non-linear (random forest- RF) regression models were constructed to compare the results in terms of the form of the relationship between the dependent variable and the predictors, and the model fit. The dependent variables were the household level vulnerability, which is determined based on farmer statements, and the number of adaptation techniques used. The independent variables were household level socio-economic indicators comparable to the ones used in the district level analysis.

The significance of the MLR model, which fits a linear equation on the data, was estimated by using F-test, which indicates if the model provides a better fit compared to an intercept-only model. The overall fit of the model was estimated using the correlation coefficient (R^2), which represents the percentage of the variation in the outcome that can be explained by the model (Field, 2009).

The random forest is a machine learning technique that randomly selects subsets of predictors to grow multiple decision trees. The subsets are independent, the predictors are selected with equal probability and sampling is done with replacement, which allows predictors to occur in several subsets (Kamińska, 2018). In order to stabilize variable importance scores, the forests were constructed with 2000 trees (Şen et al.,

2017) and the predicted output is obtained by averaging all the trees. The performance of the model was ensured by the out-of-bag (OBB) procedure (Li et al., 2017) and importance of each predictor is illustrated via partial dependence plots (Şen et al., 2017). Mean Squared Error (MSE), which is the averaged squared errors, is used to measure the model fit in the RF model. Low MSE indicates that model has high explanatory power.

CHAPTER 4

RESULTS

In this chapter, the results of vulnerability index analysis and the socioeconomic survey conducted based on the index results are reported.

4.1. Vulnerability Index Results

4.1.1. Exposure Sub-Index Results

The exposure sub-index is calculated as an average of the number of days that the maximum temperature exceeds 35 ^{o}C, the number of days that the minimum temperature drops below 0 ^{o}C and difference between the monthly averages of precipitation between 1960 and 2000 and between 2000 and 2015. The normalized figures for the districts are given in Table 4-1 below.

Table 4-1. Exposure sub-index components

Districts	Deviation from Max. Temp.	Deviation from Min. Temp.	Deviation from Mean Precipitation	Exposure Average
Beyşehir	0,496	0,077	0,000	0,191
Cihanbeyli	1,000	0,385	0,422	0,602
Çumra	0,681	0,332	0,448	0,487
Ereğli	0,783	0,139	0,195	0,372
Hadim	0,000	0,786	0,768	0,518
Ilgın	0,682	0,571	0,175	0,476
Karapınar	0,925	1,000	0,225	0,717
Kulu	0,837	0,929	1,000	0,922
Seydişehir	0,617	0,000	0,920	0,512
Yunak	0,652	0,776	0,360	0,596

Figure 4.21 shows the results of the exposure sub-index calculations. The results showed that Kulu and Karapınar are exposed to climatic extremes and variabilities more than the other districts, while the least exposed districts are Ereğli and Beyşehir. The rest of the districts have a medium level exposure to climatic changes and extremes.

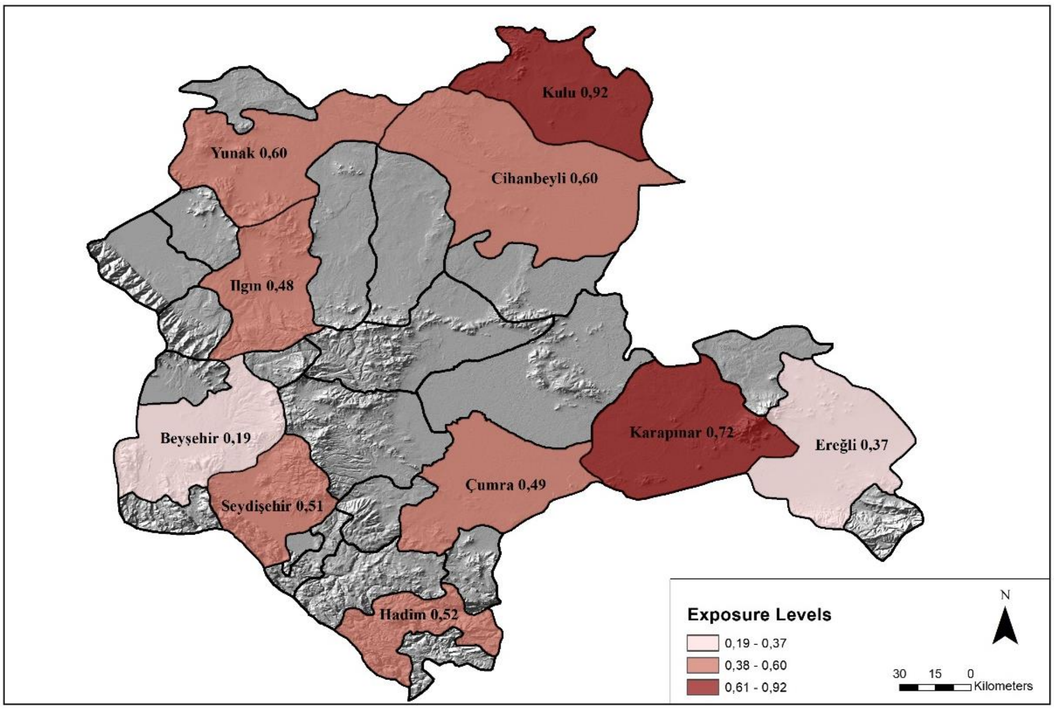

Figure 4.1 Exposure sub-index results for the selected districts

As seen in Figure 4.2 below, Kulu district is equally affected from maximum and minimum temperature variations and precipitation change. Maximum temperature and minimum temperature variations affects Karapınar more than changes in monthly precipitation. Variations in maximum temperature, which is the number of days exceeding 35 ^{o}C, is the dominant component of exposure index in Cihanbeyli, while temperature variations in Yunak are more effective than the amount of precipitation change. Ilgın is highly affected from maximum and minimum temperature variations.

Hadim and Seydişehir, which are located in southern part of the Province, have medium level exposure. Hadim is affected from minimum temperature variation and precipitation variation almost equally, while Seydişehir is affected from maximum temperature variation and precipitation change. Beyşehir has the least exposure level and the dominant factor in this exposure level is the maximum temperature variation, while precipitation change has comparatively no impact.

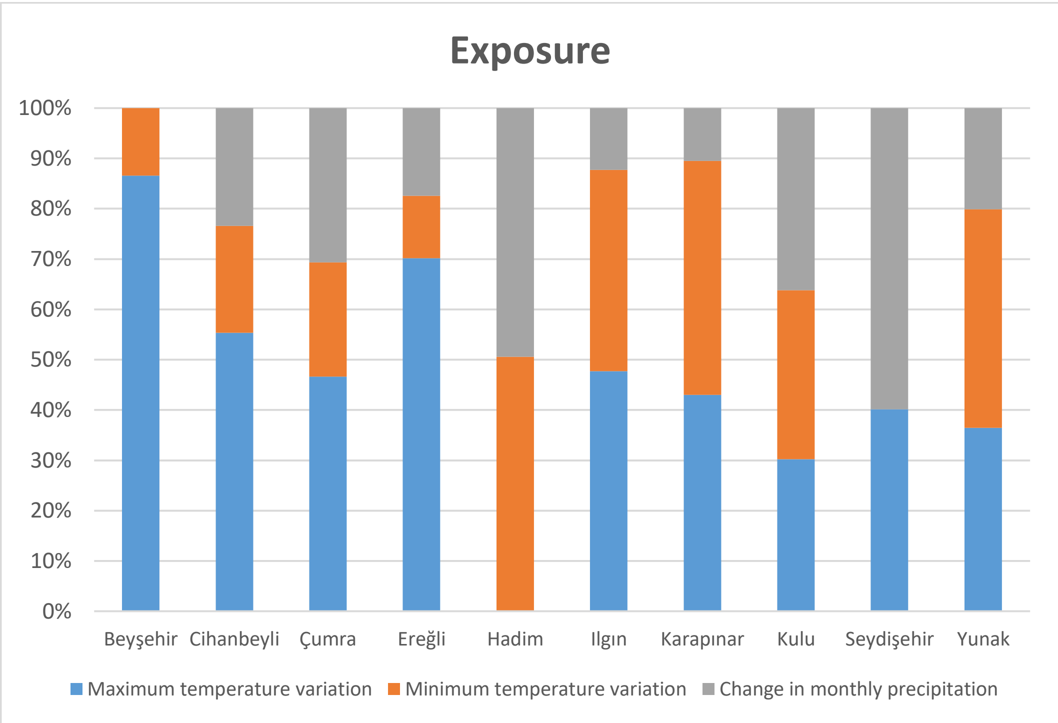

Figure 4.2 Contributions of the components of exposure for each district

Maximum temperature variation is the dominant factor and almost equal to sum of minimum temperature variation and change in monthly precipitation in Çumra, while in Ereğli it exceeds sum of minimum temperature variation and change in monthly precipitation.

4.1.1. Sensitivity Sub-Index Results

The sensitivity sub-index is composed of annual precipitation, ratio of rain-fed agriculture, crop diversity, ratio of farmer population, ratio of forest land, soil quality, dependency ratio and illiteracy ratio indicators. The normalized figures for the districts are given in Table 4-2 below.

Table 4-2. *Sensitivity sub-index components*

Districts	**Annual precipitation**	**Ratio of rain-fed agriculture**	**Crop diversity**	**Ratio of farmer population**	**Ratio of forest land**	**Soil quality**	**Dependency ratio**	**Illiteracy ratio**	**Sensitivity average**
Beyşehir	0,237	0,310	0,913	0,029	0,273	0,622	0,377	0,219	0,372
Cihanbeyli	0,860	0,937	0,845	0,464	1,000	0,383	0,336	0,516	0,668
Çumra	0,826	0,000	0,000	0,281	0,925	0,117	0,693	0,000	0,355
Ereğli	0,888	0,212	0,061	0,025	0,929	0,513	0,187	0,308	0,390
Hadim	0,000	0,060	0,717	0,318	0,000	1,000	1,000	0,325	0,428
Ilgın	0,753	0,793	0,466	0,322	0,719	0,439	0,621	0,567	0,585
Karapınar	0,884	0,439	0,118	0,431	0,986	0,462	0,781	0,233	0,542
Kulu	0,892	1,000	0,915	0,334	1,000	0,000	0,000	0,596	0,592
Seydişehir	0,024	0,181	0,519	0,000	0,088	0,494	0,205	0,076	0,198
Yunak	1,000	0,903	1,000	1,000	0,998	0,141	0,719	1,000	0,845

The results showed that among the northern districts, Yunak has the highest sensitivity level (0.85), while Kulu (0.59), Cihanbeyli (0.67) and Ilgın (0.59) have medium level of sensitivity. Medium level sensitivity group also includes Karapınar (0.54). Beyşehir, Hadim, Seydişehir, Çumra and Ereğli have the lowest sensitivity levels (Figure 4.3).

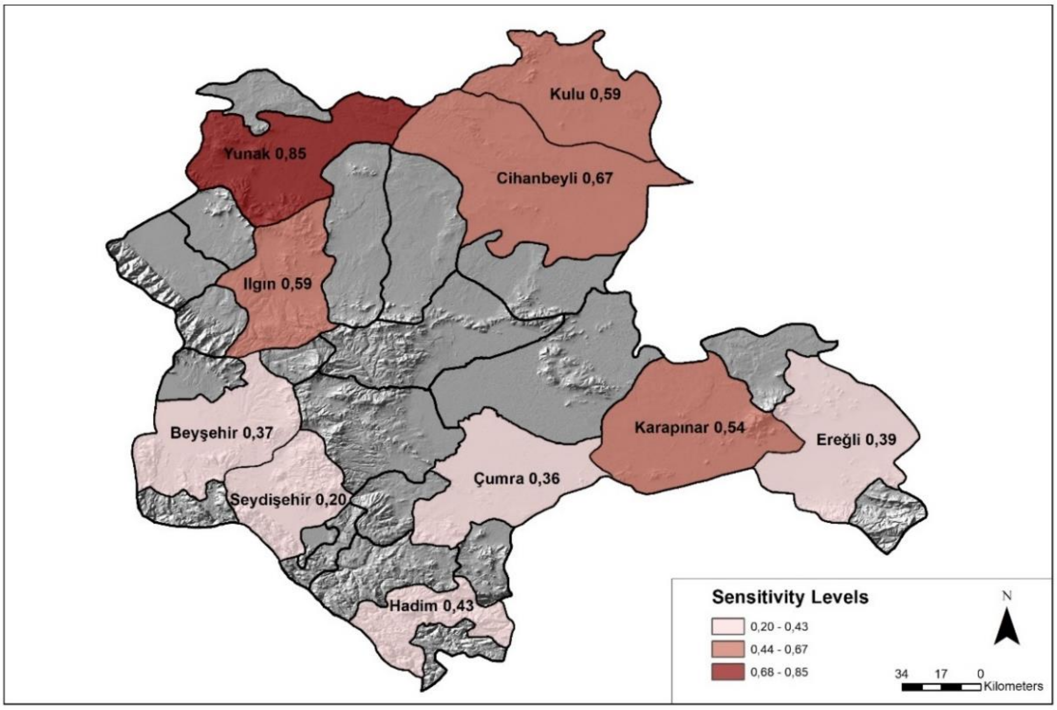

Figure 4.3 Sensitivity sub-index results for the selected districts

Figure 4.4 shows the percentage contribution of each component of sensitivity for the study districts. In Yunak, almost all the components of sensitivity contributes equally, other than soil quality, which shows Yunak has relatively high percentage of first and second degree quality soil lands. Ilgın and Kulu have the same level of sensitivity (0.59) but the contribution of the sensitivity components vary. In Kulu, soil quality and dependency ratio have no contribution, while percentage of farmers to district population (which is used as a proxy to rural population) has minimal contribution in overall sensitivity. High percentage of rain-fed agriculture, low precipitation rate, low amount of forest cover, comparatively high illiteracy rate and less diverse crop pattern in the district makes the agricultural productivity highly sensitive.

In Ilgın, percentage of farmer population in the district population and crop diversity index contributes less than other components to the overall sensitivity.

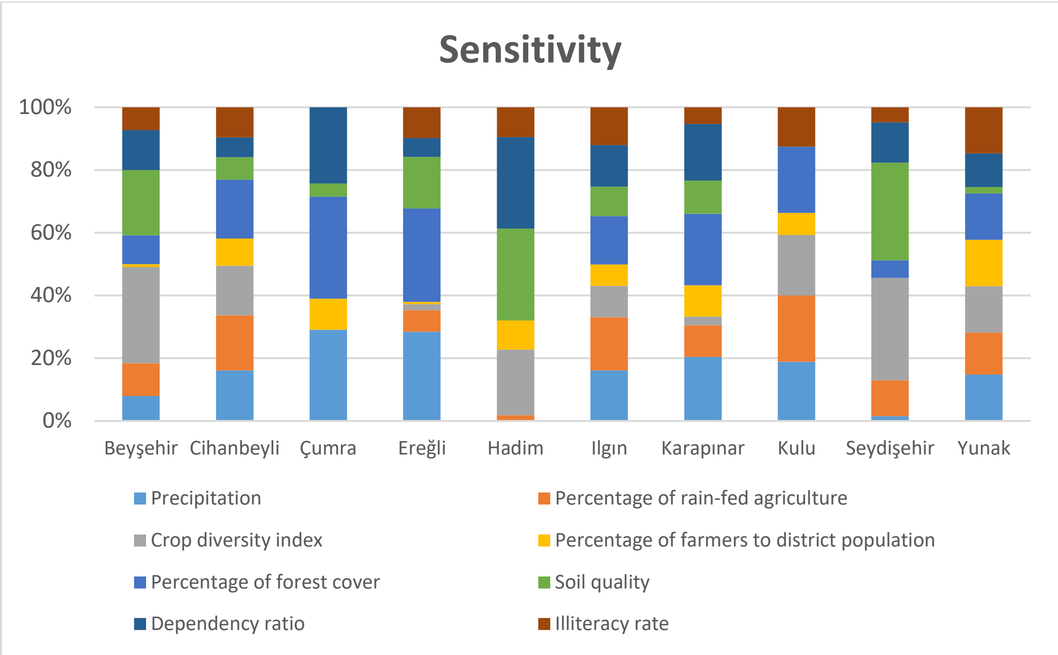

Figure 4.4 Contributions of the components of sensitivity for each district

In Cihanbeyli, dependency ratio and soil quality contributes less to the overall sensitivity than the other components. In Karapınar, crop diversity index and illiteracy rate have less share in overall sensitivity. On the other hand, amount of annual precipitation (279 mm), comparatively less amount of forest cover, high dependency and low soil quality make the district sensitive to climatic changes.

In Beyşehir, low crop diversity and low soil quality are the major factors contributing sensitivity, followed by high dependency ratio and farmer population. Similar to Beyşehir, low crop diversity and soil quality are the two of the major factors in addition to percentage of rain-fed agriculture and dependency ratio in Seydişehir's sensitivity. In Hadim, dependency is also a significant factor in addition to these two factors. For Çumra, major factors are low annual precipitation, low forest cover and high dependency ratio, while for Ereğli they are precipitation, low forest cover and low soil quality.

4.1.1. Adaptive Capacity Sub-Index Results

The adaptive capacity sub-index is composed of density of farm animals, number of agricultural equipment per farmer, density of road network, extension trainings given per farmer, number of agricultural organizations per farmer, amount of agricultural subsidies provided per hectare and percentage of agricultural land insured. The normalized figures for the districts are given in Table *4-3* below.

Table 4-3. *Adaptive capacity sub-index components*

Districts	**Density of farm animals**	**# of agricultural equipment per farmer**	**Density of road networks**	**Extension trainings given per farmer**	**# of agricultural organizations per farmer**	**Amount of agri. subsidies provided per hectare**	**% of agricultural land insured**	**Adaptive Capacity Average**
Beyşehir	0,188	0,429	0,735	0,311	0,754	0,149	0,020	0,369
Cihanbeyli	0,183	0,192	0,286	0,000	0,000	0,000	0,897	0,223
Çumra	0,556	1,000	1,000	0,025	0,873	0,526	0,525	0,644
Ereğli	1,000	0,181	0,477	1,000	0,865	1,000	0,274	0,685
Hadim	0,000	0,976	0,000	0,782	1,000	0,438	0,016	0,459
Ilgın	0,429	0,449	0,458	0,423	0,649	0,079	0,198	0,384
Karapınar	0,941	0,233	0,188	0,518	0,967	0,465	0,595	0,558
Kulu	0,234	0,000	0,204	0,357	0,164	0,022	1,000	0,283
Seydişehir	0,258	0,687	0,538	0,274	0,759	0,135	0,000	0,379
Yunak	0,045	0,124	0,310	0,023	0,004	0,047	0,919	0,210

The analysis results showed that the northern districts which have found to be highly exposed to climatic changes have less adaptive capacity to these changes (Figure 4.5).

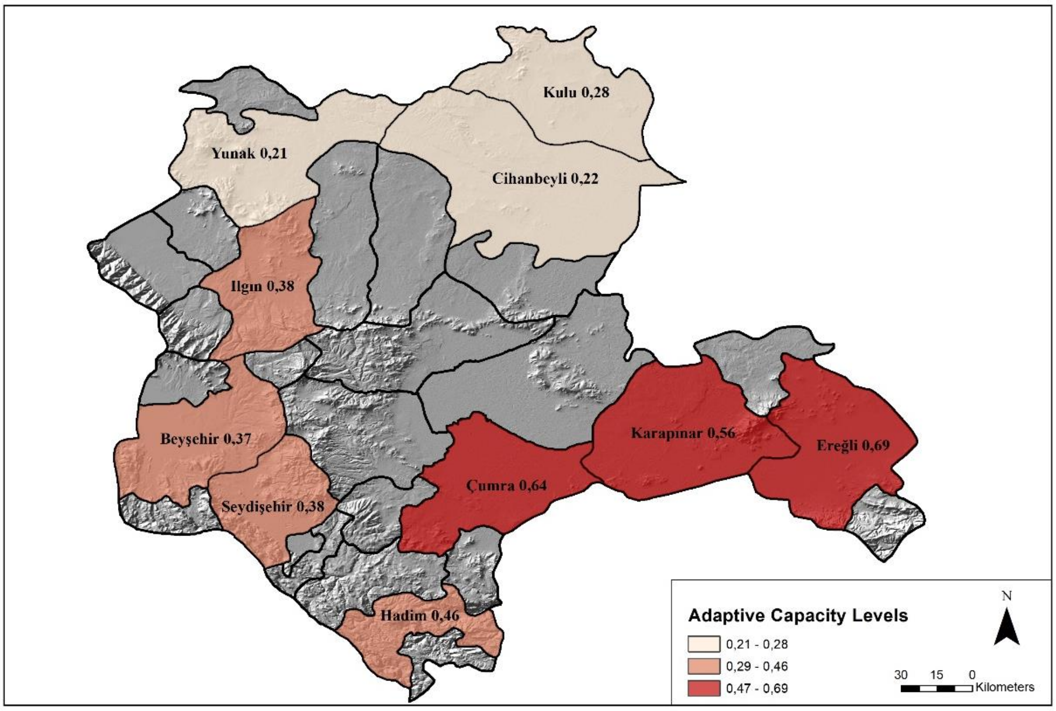

Figure 4.5 Adaptive capacity sub-index results for the selected districts

Cihanbeyli (0,22), Yunak (0,21) and Kulu (0,28) have the lowest adaptive capacity among the study districts. Cihanbeyli gets the lowest figures for the number of extension trainings per farmer, the number of agricultural support staff, the number of agricultural organizations and amount of agricultural subsidies per hectare. The major factor contributing to its adaptive capacity is the percentage of insured land. Kulu has the highest percentage of insured land, and the number of agricultural equipment per farmer is the least contributing factor to its adaptive capacity. In Yunak, the percentage of insured land is the dominant factor contributing to its adaptive capacity, while the number of support staff per farmer and the number of extension trainings given per farmer are the least contributing factors.

For Ilgın, the components contributing to adaptive capacity are number of agricultural organisations per farmer, road density, number of agricultural equipment per farmer, density of farm animals and extension trainings per farmer. Amount of agricultural subsidies per hectare is the least contributing factor to the adaptive capacity of Ilgın.

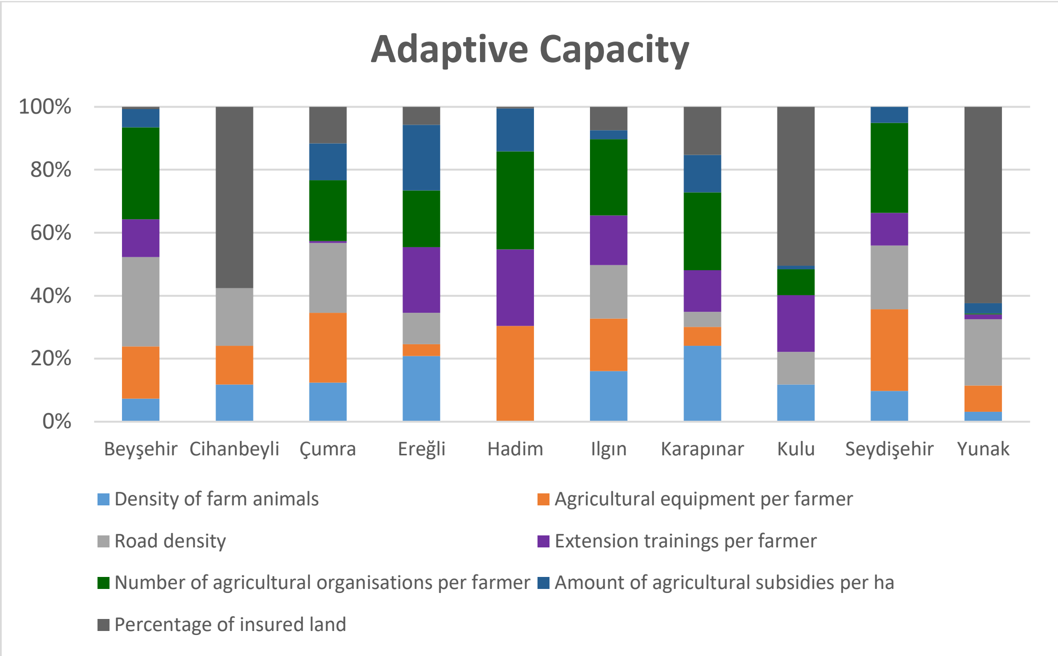

Figure 4.6 Contributions of the components of adaptive capacity for each district

Ilgın, Beyşehir, Seydişehir and Hadim have medium level adaptive capacity. Ilgın has fairly equally distributed indicators of adaptive capacity except for road density and amount of agricultural subsidies provided to the farmers. These two factors contribute the least. Beyşehir's adaptive capacity is mainly derived from the road density and the number of agricultural organizations per farmer, while the least contributing factors are density of farm animals and the amount of subsides provided per farmer. Seydişehir's adaptive capacity is based on the equipment per farmer, road density and the number of agricultural organizations per farmer. In Hadim, number of agricultural organizations per farmer and by the number of agricultural equipment per farmer are the major indicators contributing to the adaptive capacity. The number of extension trainings per farmer are also an indicators increasing its adaptive capacity. The farm animal density and the percentage of insured land are the indicators contributing the least to its adaptive capacity.

Çumra, Karapınar and Ereğli forms the highest adaptive capacity groups. Among the ten districts, Ereğli has the highest adaptive capacity, which has the highest figures for the density of farm animals, the number of extension trainings per farmer and the amount of agricultural subsidies given per hectare. The least contributing factors to its adaptive capacity are the number of agricultural equipment per farmer and the percentage of insured land.

The number of agricultural organizations and the density of farm animals are the two factors highly contributing to adaptive capacity of Karapınar, followed by the percentage of insured land the number of extension trainings per farmer. Density of the road network and the number of agricultural equipment per farmer Extension trainings given per farmer is the least contributing factor to its adaptive capacity.

In Çumra, dominant indicators contributing to the adaptive capacity are agricultural equipment per farmer, the number of agricultural organizations per farmer and road density. The amount of agricultural subsidies given per hectare, the percentage of insured land and the density of farm animals fairly equally contributes to its adaptive capacity. The number of extension trainings per farmer is the least contributing factor to the adaptive capacity of this district.

4.1.1. Overall Vulnerability Index Results

Vulnerability level of each district is determined by calculating arithmetic mean of the indicators. Exposure, sensitivity and adaptive capacity levels, in addition to the overall vulnerability of the districts are given in Table *4-4* below. The results show that Kulu, Yunak and Cihanbeyli districts, which are located in the northern part of Konya, are exposed to temperature and precipitation variation more than the other districts, while their sensitivity are higher and adaptive capacities are lower.

Table 4-4. *Exposure, sensitivity, adaptive capacity and vulnerability levels of the districts*

District	Exposure	Sensitivity	Adaptive Capacity	Overall Vulnerability
Kulu	0,922	0,592	0,283	1,231
Yunak	0,596	0,845	0,210	1,231
Cihanbeyli	0,602	0,668	0,223	1,047
Karapınar	0,717	0,542	0,558	0,700
Ilgın	0,476	0,585	0,384	0,678
Hadim	0,518	0,428	0,459	0,487
Seydişehir	0,512	0,198	0,379	0,332
Çumra	0,487	0,355	0,644	0,199
Beyşehir	0,191	0,372	0,369	0,194
Ereğli	0,372	0,390	0,685	0,077

Karapınar, Ilgın and Hadim have medium level vulnerabilities, while Seydişehir, Çumra, Beyşehir and Ereğli have comparatively low overall vulnerability levels. Figure 4.7 shows the vulnerability groups map of the districts.

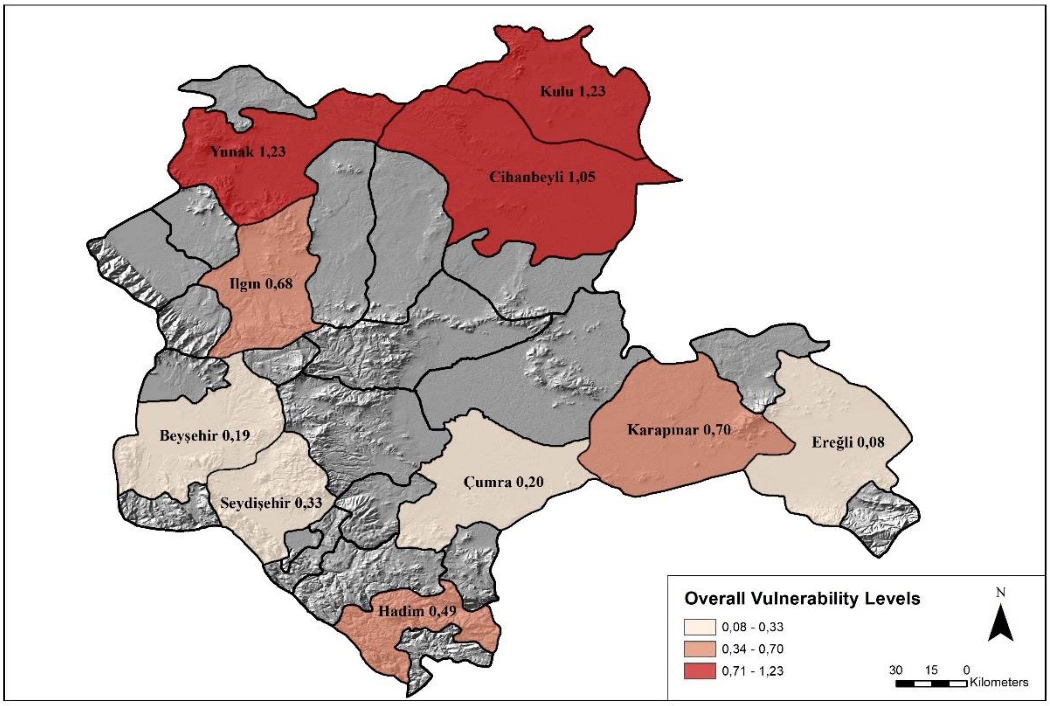

Figure 4.7 Overall vulnerability index results for the selected districts

Figure 4.8 shows the sub-index and composite vulnerability index results for the ten districts in an increasing order.

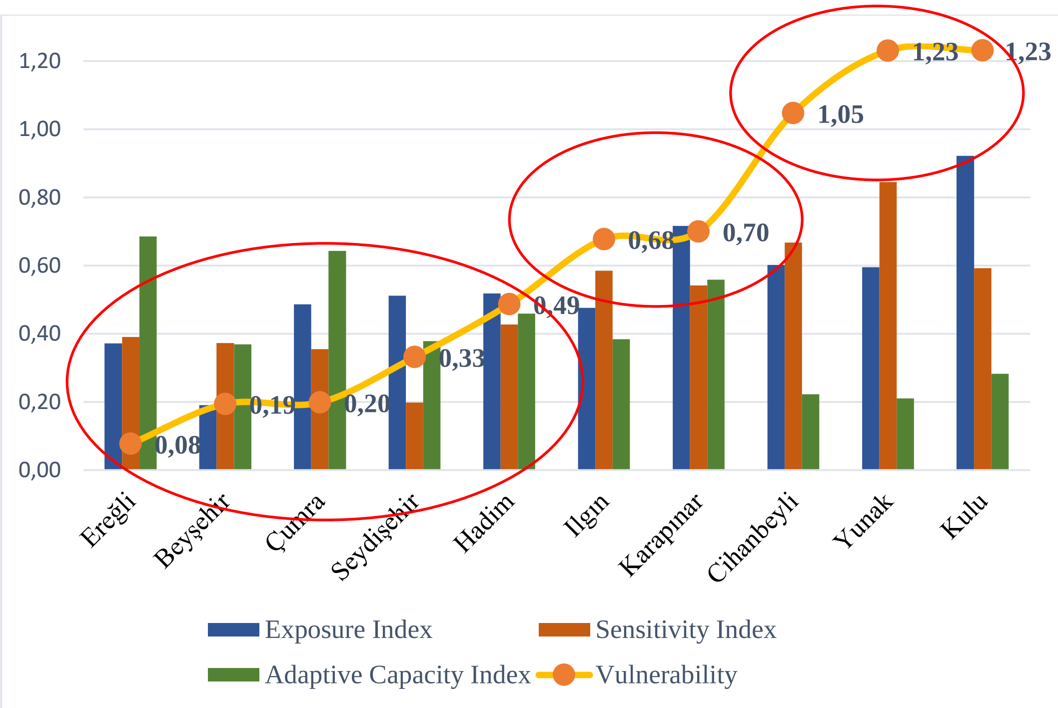

Figure 4.8 Levels of the components of overall vulnerability for ten districts

4.2. Household Characteristics, Climatic Observations and Risk Coping

In this chapter, indicators affecting household level vulnerability, climatic observations of the farmers and adaptation strategies of farmers to climatic changes in Cihanbeyli, Karapınar and Seydişehir, which are selected as pilot sites for the survey, are reported.

4.2.1. Demographic Characteristics of the Households

In this section, findings of the survey regarding the certain characteristics of the household and the respondent farmer are presented. All the respondent farmers were male and declared themselves as the household head. The average age of the household head is more than 50 in all the districts (Table *4-5*).

Table 4-5. *Demographic characteristics of the households*

Vulnerability Variables	**Cihanbeyli**	**Karapınar**	**Seydişehir**
Household Head (Farmer)			
Average age of the household head	52	53	55
Education level of the household head (dominant group)	Primary school (51.8%)	Primary school (69.9%)	Primary school (66.2%)
Duration of residency in the village (months)	11.1	11.7	11.0
Farming experience (years)	28.0	29.9	31.4
Household			
Average household size (people)	4.9	5.5	3.8
Dependency Ratio	34.6%	30.6%	35.0%
Percentage of family members working in agriculture	35.3%	40.7%	56.4%
Percentage share of agricultural income	25%- 50% (26.2%)	25%- 50% (24.5%)	Less than 25% (26.2%) 25%- 50% (26.2%)
Average number of external workers in the farm (people)	1.2	0.7	3.0
Annual Income (TL)[2]	15.001-40.000 (47.6%)	15.001-40.000 (46.9%)	15.001-40.000 (60.0%)

The results highlight that majority of the farmers (more than 60% in all districts) belong to 30-60 age group, while there were no farmers interviewed younger than 18 years old. Farmers in "older than 60 years old" group have more than 30% share in all the districts (Figure 4.9).

[2] Income level is based on the farmer statement.

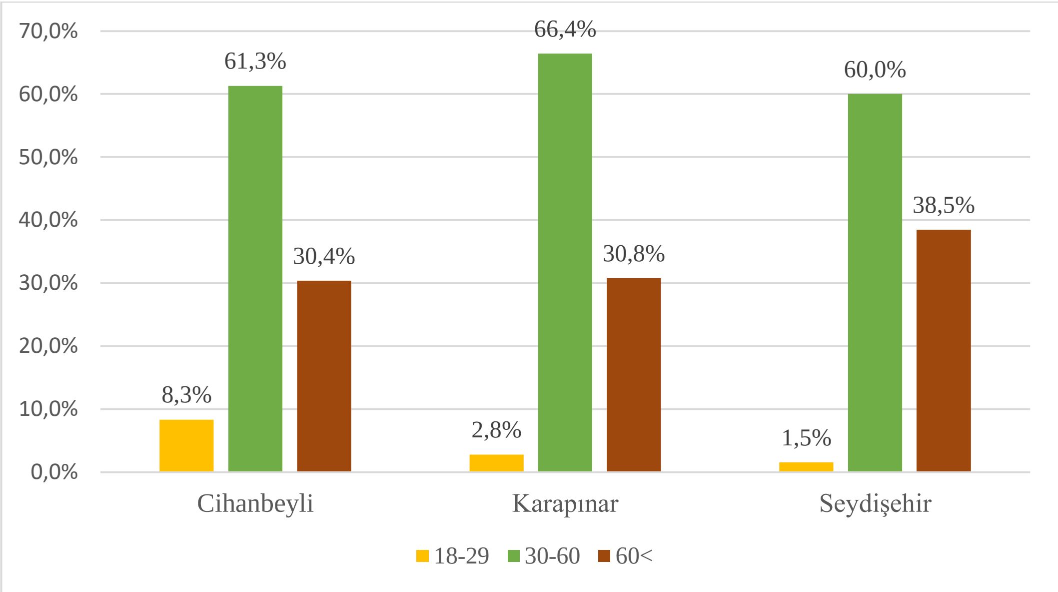

Figure 4.9 Age groups of the farmers in three districts

The dominant education level of the farmers is primary school in all three districts. The farmers spend at least 11 months in the village where they are engaged in farming and their average farming experience is more than 28 years.

The average size of the farmer' families vary between 3.8 (Seydişehir) and 5.5 (Karapınar) and the households in the three districts have a similar dependency ratio varying between 30.6% and 35.0%. Percentage of the household members working in agricultural sector is the lowest in Cihanbeyli (35.3%), while it is the highest in Seydişehir (56.4%). Farms of Seydişehir also have the highest number of external workers (3.0 people), while Karapınar has the lowest help from outside in agricultural production with 0.7 people.

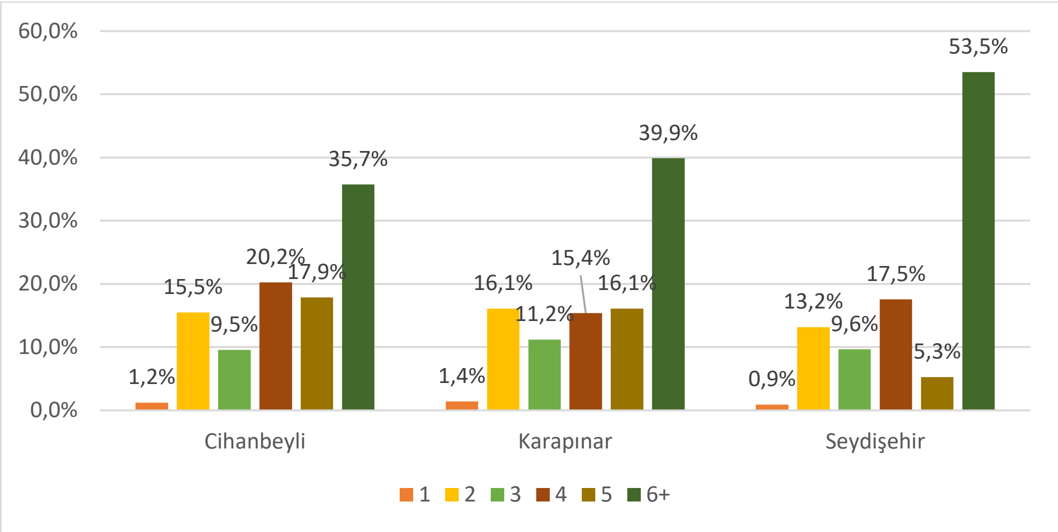

Figure 4.10 Household size

Majority of the farmers belong to low income groups and earns 15.0001-40.000 TL per annum in all the districts. The total percentage of the lowest income groups is 23.81% in Cihanbeyli, 25.17% in Karapınar and 26.15% in Seydişehir. In Seydişehir, there are no farmers belonging to the highest two income groups (Figure 4.11).

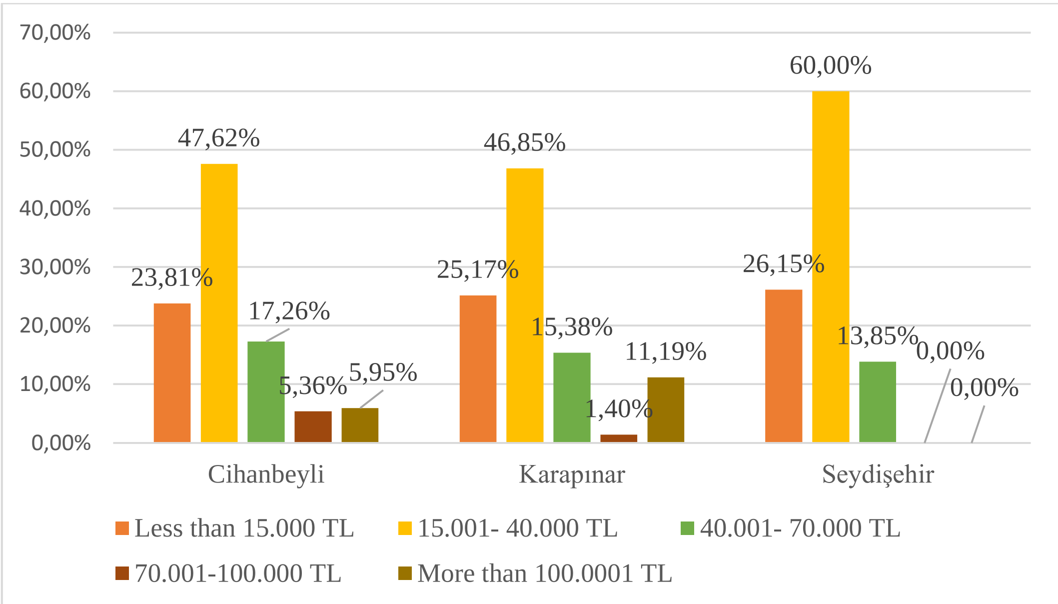

Figure 4.11 Income groups

Share of agricultural production in farmers’ incomes is less than 25% in Karapınar and between 25% and 50% in Cihanbeyli. In Seydişehir, percentage of farmers with less than 25% agricultural income and with 25% to 50% agricultural income is equal and 26.15% (Figure 4.12).

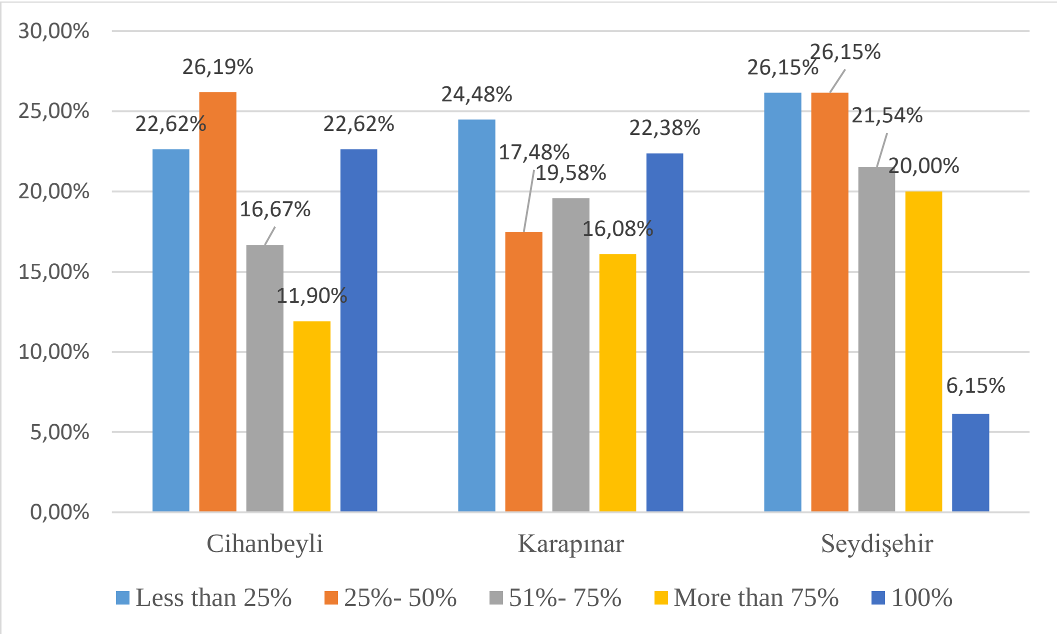

Figure 4.12 Percentage share of agricultural income

The percentage of farmers who declared that their income is 100% dependent on agriculture is 22.62% in Cihanbeyli, 22.38% in Karapınar and 6.15% in Seydişehir.

4.2.2. Features of Farming Systems

Irrigation increases the crop variety and yield, which increases the income of the farmers in return. Furthermore, irrigated farming is less vulnerable to drought. Thus, the farmers were asked if they are managing rain-fed land or irrigated land. In Cihanbeyli, 47.6% of the farmers do only rain-fed farming, while in Karapınar irrigated farming is the dominant method (60.8%). In Seydişehir, more than half of the farmers (52.3%) do both irrigated and rain-fed farming (Figure 4.13).

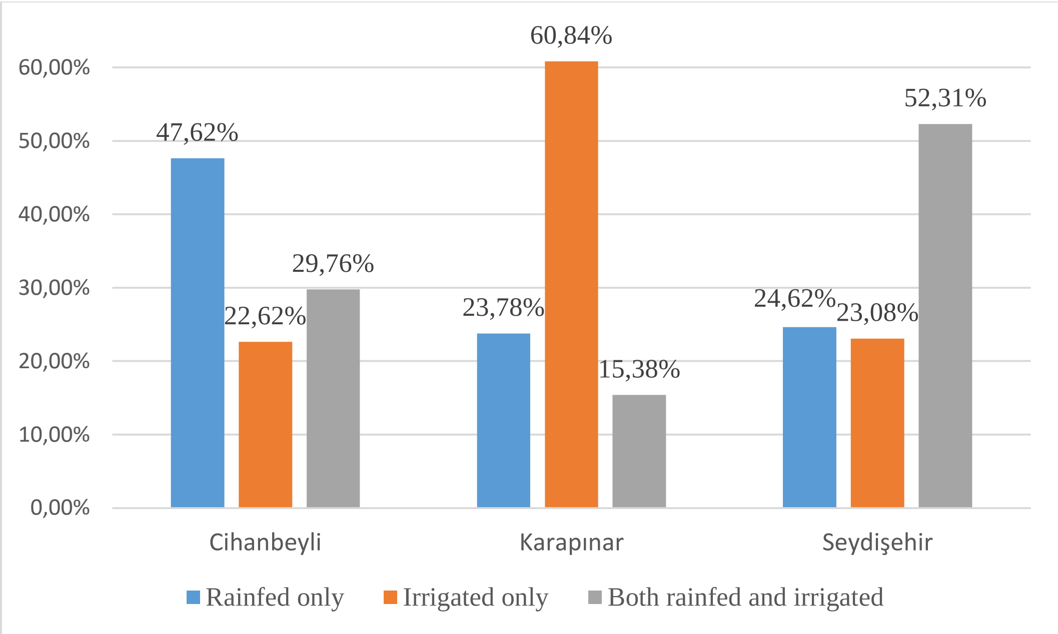

Figure 4.13 Percentage of rain-fed and irrigated land ownership

In order to understand the structure of the farming systems, the farmers were asked questions regarding the size of the land and the number of plots they manage, soil quality (self-assessment by the farmer) and slope of the land and the number of equipment they use on the farm. Cihanbeyli has the highest percentage of average land size (45.5 ha), followed by Karapınar (39.2 ha) and Seydişehir (7.2 ha). Despite the smallest average land size, Seydişehir has the highest number of plots (12.6), which makes farming lands more fragmented than the ones in the other districts and reduces the average parcel size managed by the farmer (7.2). On the other hand, Seydişehir farming lands have higher soil quality and lower slope than other districts (Table *4-6*).

Table 4-6. *Features of farming systems*

Features of farming systems	Cihanbeyli	Karapınar	Seydişehir
Average size of land managed by the farmer (decares)	400.9	196.8	91.2
Average number of parcels managed by the farmer	8.3	5.0	12.6
Average size of parcels managed by the farmer (decares)	48.5	39.2	7.2
Percentage of land with good and medium soil quality (%)	86.2	82.7	93.0
Percentage of land with low and medium slope	91.1	89.9	96.8
Percentage of irrigated land	37.4	66.7	46.6
Number of devices used with tractor	5.7	5.5	6.2

When percentage of the irrigated land in the total land managed considered, Karapınar farmers have the highest figure (66.7%), while Cihanbeyli farmers only irrigate 37.4% of their agricultural production land. The average number of agricultural equipment that farmers own in Cihanbeyli is 5.7, in Karapınar it is 5.5, while Seydişehir farmers have 6.2 equipment on average.

4.2.3. Crop Diversity

Crop diversity is an adaptation strategy to climatic changes and it can be done either increasing the number of crops cultivated in a year or planting different crops on different plots. The farmers of Cihanbeyli cultivate 2 crops in a year on average, while Karapınar farmers cultivate 1.8 and Seydişehir farmers cultivate 2.3 crops. The reason of cultivating single crop was declared as having no alternative product in rain-fed farming. The percentage of the farmers diversifying their crop production on different plots is the highest in Seydişehir (84.6%) fallowed by Karapınar (73.4%) and Cihanbeyli (66.1%) (Table *4-7*).

Table 4-7. *Crop diversity*

Crop Diversity	Cihanbeyli	Karapınar	Seydişehir
Average number of crops cultivated in a year	2.0	1.8	2.3
Percentage of farmers diversifying their production on different plots (%)	66.1	73.4	84.6

The main reason for crop diversification on different plots is given as diversifying/ increasing income in all the districts (Figure 4.14).

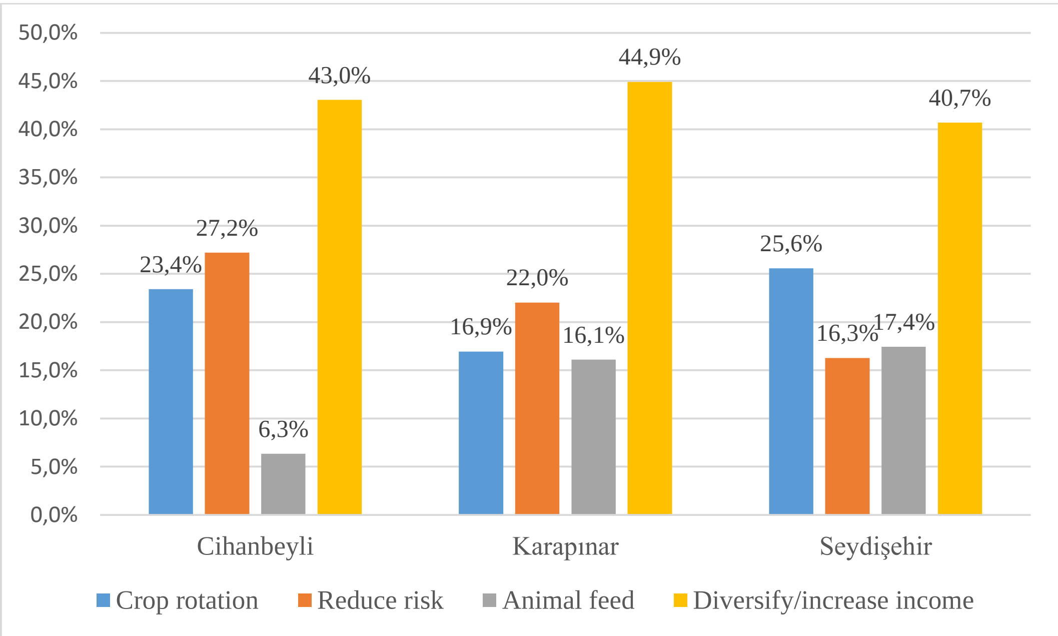

Figure 4.14 Reasons of crop diversity on different plots

4.2.4. Observed Climatic Changes

The farmers were asked about the climatic changes they observe in the last ten years. In all the districts, changing precipitation patterns such as decreasing, irregular or delayed precipitation and shorter precipitation periods and increasing temperatures are highly observed (more than 90% in all the districts). On the other hand, only 14.9% of the farmers in Cihanbeyli, 7.7% in Karapınar and 7.7% in Seydişehir stated that they observe increasing precipitation. Regarding the temperatures changes, increasing temperatures are observed by more than 90% of the farmers in all the districts. Increase in day and night time temperature difference is observed by 53.0% of the farmers in Cihanbeyli, 60.1% in Karapınar and 66.2% in Seydişehir (Table *4-8*).

Table 4-8 *Observed climatic changes*

Observed Climatic Changes	**% of Respondents Observing the Related Climatic Change**		
	Cihanbeyli (n= 168)	**Karapınar** (n= 143)	**Seydişehir** (n= 65)
Rainfall			
Increasing precipitation	14.9	7.7	7.7
Decreasing precipitation	93.5	90.9	90.8
Irregular precipitation	96.4	92.3	89.2
Delayed precipitation	96.4	95.1	95.4
Shorter precipitation period	94.0	93.7	89.2
Temperature			
Increasing temperature	92.9	93.7	90.8
Increase in day-night temperature difference	53.0	60.1	66.2
Extremes			
Increasing # of floods	92.9	93.7	90.8
Increasing # of hails	4.2	2.1	1.5
Increasing # of frost	30.4	30.8	15.4
Increasing # of simoons	57.1	65.0	78.5
Increasing # of storms	62.5	58.0	55.4

The increasing number of simoons is observed by 57.1% of the farmers in Cihanbeyli, while 30.4% of the farmers stated that they observe increasing number of frost. Increasing number of storms is observed by 62.5% of the farmers and increasing number of hails is observed by 4.2%. In Karapınar, increasing number of flood events are observed by 93.7% of the farmers, followed by 65.0% observing increasing number of simoons, 58.0% observing increasing number of storms and 30.8%

observing increasing number of frost. Increasing number of hail events is observed by only 2.1% of the farmers in Cihanbeyli.

In Seydişehir, increasing number of floods has the highest percent of observation, like the other two districts, by 90.8%, followed by increasing number of simoons by 78.5%. Increasing number of storms is observed by 55.4% of the farmers, while only 15.4% states that they observed increasing number of frosts. Hails are least observed extreme events in all the districts.

The farmers were further asked about their opinions on the cause of climatic changes. Majority of the farmers in all districts stated that they have no idea about the cause of the climatic changes. 28.6% of the respondents stated it as human activities including industrialization and deforestation in Cihanbeyli, 22.4% in Karapınar and 27.7% in Seydişehir respectively. 22.0% in Cihanbeyli, 20.3% in Karapınar and 20.0% of the respondents in Seydişehir defined it as global warming, greenhouse gases, melting glaciers or ozone layer depletion (Table *4-9*).

Table 4-9 *Causes of climatic changes*

Cause of Climatic Changes	**% of Respondents**		
	Cihanbeyli (n= 168)	**Karapınar** (n= 143)	**Seydişehir** (n= 65)
Don't know	35.7	45.5	40.0
Human activities destroying natural balance/ unconsciousness/ industrialization(chemicals, fertilizers, fuel use)/ deforestation	28.6	22.4	27.7
Global warming/ greenhouse gases/ glaciers melting/ ozone layer depletion	22.0	20.3	20.0
God's will	5.4	2.1	0.0
There is no change	1.2	2.1	3.1
Other	7.1	7.7	9.2

In Cihanbeyli 5.4% and in Karapınar 2.1% of the farmers stated that the changes in climatic conditions are the God's will. The percentage of the farmers who stated that there is not climatic change is 1.2% in Cihanbeyli, 2.1% in Karapınar and 3.1% in Seydişehir. The "other" responses included El Nino, wars, disappearance of lakes, air pollution, irresponsibility of governments and natural cycle.

4.2.5. Exposure to Climatic Extremes and Crop Loss

The farmers are asked if they were exposed to drought, frost, hail, storm, flood and any other extreme event in the last five years, how many years they were exposed, if they had crop loss due to this event, the crop type they lost and the percentage of the loss in the production. The results of the study revealed that drought is the major extreme event with the highest percentage of crop loss in all the districts. In Cihanbeyli, 92.3% of the farmers stated that their production was exposed to drought and they had an average of 89.9% crop loss. In Karapınar, 88.1% of the respondents had 83.2% crop loss due to drought. In Seydişehir, 75.4% of the respondents stated that they experienced drought and lost 73.8% of their crop (Table *4-10*).

Table 4-10 *Exposure to extreme events and crop loss*

Exposure to Extreme Events and Crop Loss	**% of Respondents Exposed to Extreme Events and Crop Loss**		
	Cihanbeyli (n= 168)	**Karapınar** (n= 143)	**Seydişehir** (n= 65)
Exposure to drought	92.3	88.1	75.4
Crop loss due to drought	89.9	83.2	73.8
Exposure to frost	53.6	61.5	83.1
Crop loss due to frost	48.2	53.8	78.5
Exposure to hail	51.2	53.1	26.2
Crop loss due to hail	45.2	46.2	21.5
Exposure to storm	25.0	10.5	30.8
Crop loss due to storm	22.0	7.0	18.5
Exposure to flood	3.6	2.1	9.2
Crop loss due to flood	1.8	2.1	7.7
Exposure to other disaster	7.7	10.5	7.7
Crop loss due to other disaster	7.7	7.7	7.7

The second most experienced weather extreme is frost and Seydişehir has the highest number of farmers (83.1%) exposed to this event and has the highest crop loss (78.5%) among the three districts, followed by Karapınar with 61.5% exposure rate and 53.8% crop loss and Cihanbeyli with 53.6% exposure rate and 48.2% crop loss, accordingly. Cihanbeyli and Karapınar have close exposure rates to hail (51.2% and 53.1%, respectively) and crop loss due to the extreme event (45.2% and 46.2%, respectively), while Seydişehir has the lowest rate of exposure with 26.2% and 21.5% crop loss.

Almost one third of the respondents in Seydişehir stated that their production was exposed to storm event and they had a crop loss of 18.5% on average, followed by Cihanbeyli with 25.0% exposure rate and 22.0% crop loss. Karapınar has the lowest exposure (10.5%) and crop loss (7.0%) rates due to storm event. Flood is the least experienced extreme event, with the least crop loss in all three districts. Other disasters experienced by the farmers were simoon, sinkholes and pest attacks.

In order to evaluate the significance of the correlation between the number of exposure years to climatic extreme in the last five years and percentage of crop loss, Pearson Correlation (for parametric indicators) method is used. The results show that the correlation between the exposure to extreme events and crop loss is not statistically significant in any of the districts (Table *4-11*).

Table 4-11 *Correlation between exposure to extreme events and percentage of crop loss*

District	**Pearson Correlation Coefficient**	**Sig. (2-tailed)**
Cihanbeyli	0.063	0.437
Karapınar	0.070	0.421
Seydişehir	0.091	0.484

4.2.6. Risk Coping Strategies and Adaptation Methods

The farmers were further asked how they compensated their losses (spontaneous adaptation) due to the extreme events. In Cihanbeyli, barrowing (19.2%), using savings/ income from other source (16.7%), taking loan (16.0%), barrowing agricultural input from retailers (11.5%) and applying for government support (10.9%) are the mostly used compensation methods. Other than applying for government support, these methods are also the most preferred ones in the other districts; while taking a loan has the highest percentage (34.4%) in Karapınar and usage of savings/ salary has the highest figure (22.2%) in Seydişehir (Table *4-12*).

Table 4-12 *Coping strategies of the farmers after a climate related crop loss*

Compensation Method	**% of Respondents Applying the Compensation Method**		
	Cihanbeyli (n= 156)	**Karapınar** (n= 131)	**Seydişehir** (n= 63)
Taking a loan	16.0	34.4	20.6
Borrowing	19.2	17.6	9.5
Mortgaging of properties	7.1	2.3	1.6
Selling properties/animals	5.8	9.2	15.9
Using of savings/ income from other source	16.7	14.5	22.2
Borrowing materials from retailers	11.5	11.5	15.9
Reducing consumption	8.3	2.3	3.2
Buying food	4.5	2.3	0.0
Help from other family members	7.7	3.8	1.6
Applying for government support	10.9	3.8	3.2
Working outside agricultural sector	5.1	3.1	1.6
Working abroad	1.3	0.0	0.0

Although mentioned by only 1.3% of the respondents, Cihanbeyli is the only district in which working abroad is a compensation method for the climate related losses. It is known that Cihanbeyli residents have social and economic relations in especially central and northern European countries, due to the migrations in 1960s (Kalaycıoğlu et al., 2010).

In order to understand how the respondents adapt to the extreme events (planned adaptation), they were asked which of the listed methods they started using in the last five years. All the possible methods were selected from the literature study and the final list in the questionnaire was determined during the pilot.

Table 4-13 *Adaptation techniques of the farmers to climate related risks*

Adaptation Method	**% of Respondents Applying Risk Coping Strategy**		
	Cihanbeyli (n= 168)	**Karapınar** (n= 143)	**Seydişehir** (n= 65)
Change of planting time	32.1	46.9	49.2
Change of tillage time	31.0	46.2	49.2
Change of cultivation time	24.4	39.2	47.7
Started crop rotation	33.9	37.8	38.5
Conservation agriculture	25.0	21.0	16.9
Started diversifying crops	39.3	35.0	46.2
Change of crop	57.7	58.0	56.9
Use of efficient irrigation techniques	40.5	62.9	53.8
Drilling well	23.8	32.9	10.8
Use of natural fertilizer	18.5	30.1	20.0
Started fallowing	57.7	35.7	20.0
Started animal husbandry	17.3	25.2	23.1
Selling animals	17.3	28.0	38.5
Started orchard	11.3	16.8	27.7
Started working in non-agricultural sector	23.8	23.8	18.5

Change of crop cultivated and starting fallowing is the most preferred adaptation methods in Cihanbeyli with 57.7% for both methods. Karapınar farmers' most preferred strategies are using more efficient irrigation techniques (62.9%) and changing the crop (58.0%) in order to cope with the extreme events, as well as the farmers of Seydişehir with 53.8% and 56.9% for the same strategies, respectively. A significant percentage of the farmers in Karapınar and Seydişehir also use changing planting, tillage and cultivation times as coping strategies with the climatic changes (Table *4-13*). When the total number of adaptive strategies used by the farmers is examined, it is observed that Karapınar farmers use 5.39 strategies on average, followed by Seydişehir farmers with 5.17 and Cihanbeyli farmers with 4.54 (Figure 4.15.

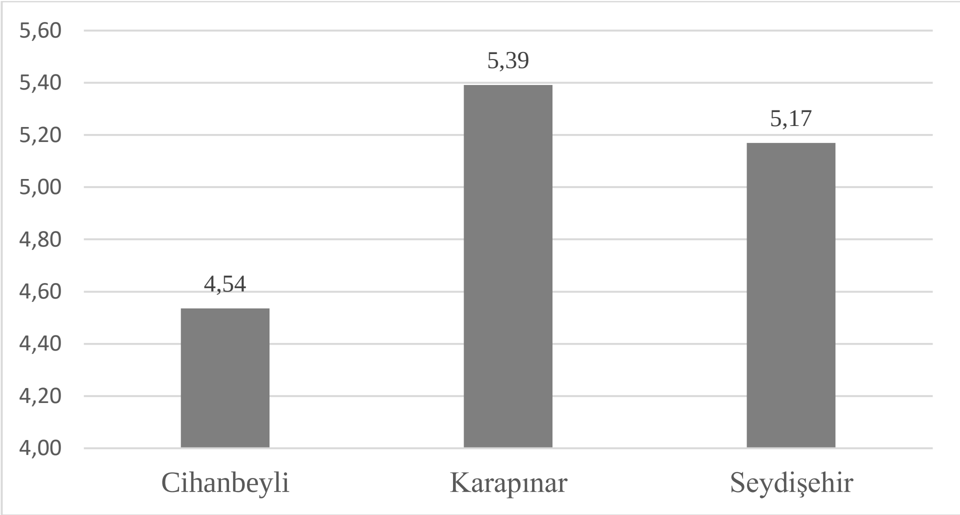

Figure 4.15 Number of adaptive strategies implemented by the farmers to climatic extremes

4.3. Household Level Vulnerability Results

4.3.1. Mean Exposure, Sensitivity, Adaptive Capacity and Overall Vulnerability

Exposure figures for the households are calculated by normalizing the average number of disasters in a year experienced by each farmer. In terms of exposure to climatic changes and extremes, Karapınar (0.439) has the highest exposure figure, followed by Cihanbeyli (0.360) and Seydişehir (0.288). This in line with the findings at district level in terms of ranking.

Sensitivity figures are obtained by normalizing the stated impact of crop loss on income in 1 to 5 Likert Scale (1- no impact, 5- high impact) for each farmer. Average sensitivity figures of the districts indicate that crop loss due to a disaster had the highest impact on the incomes of Cihanbeyli farmers (0.682), followed by Karapınar

(0.669) and Seydişehir (0.637). This ranking is also in line with the findings at district level.

Table 4-14 *Descriptive statistics for farmer statement based district level vulnerability components*

District	Summary Statistics	Exposure	Sensitivity	Adaptive Capacity
Cihanbeyli	*Mean*	0.360	0.682	0.239
	Minimum	0.000	0.000	0.000
	Maximum	1.000	1.000	1.000
	Std. Dev.	0.212	0.279	0.333
Karapınar	*Mean*	0.439	0.669	0.222
	Minimum	0.000	0.000	0.000
	Maximum	1.000	1.000	1.000
	Std. Dev.	0.262	0.286	0.306
Seydişehir	*Mean*	0.288	0.637	0.277
	Minimum	0.000	0.000	0.000
	Maximum	1.000	1.000	1.000
	Std. Dev.	0.213	0.226	0.355

Adaptive capacity of the farmers are calculated by normalizing the level of difficulty in compensating the crop loss on income stated in 1 to 5 Likert Scale (1- not easy, 5- quite easy). Average household figures for each district show that Seydişehir has the highest adaptive capacity level (0.277), followed by Cihanbeyli (0.239) and Karapınar (0.222). At district level analysis, Karapınar had the highest adaptive capacity, while Cihanbeyli has the lowest.

In order to compare with the district level results, overall vulnerability figure for each farmer is calculated using two different methods. The first method uses the same formula used at the district level analysis, in which overall vulnerability is calculated by summing exposure and sensitivity figures and subtracting adaptive capacity figure from this sum. According to the results of this method, Karapınar has the highest figure of overall vulnerability (0.885), calculated by averaging the household figures, followed by Cihanbeyli (0.803) and Seydişehir (0.648) (Table *4-15*).

Table 4-15 *Descriptive statistics for farmer statement based district level vulnerability components*

District	Summary Statistics	Overall Vulnerability (Method 1)	Overall Vulnerability (Method 2)
Cihanbeyli	*Mean*	0.803	0.586
	Minimum	-0.670	0.000
	Maximum	1.870	1.000
	Std. Dev.	0.505	0.293
Karapınar	*Mean*	0.885	0.570
	Minimum	-0.430	0.000
	Maximum	2.000	1.000
	Std. Dev.	0.546	0.279
Seydişehir	*Mean*	0.648	0.534
	Minimum	-0.750	0.000
	Maximum	2.000	1.000
	Std. Dev.	0.543	0.234

The second method uses the ratio of "the impact of climatic extremes on their income-sensitivity" to "how difficult it was to compensate the losses- adaptive capacity". The results of the second method showed that Cihanbeyli (0.586) has the highest overall vulnerability figure, followed by Karapınar (0.570) and Seydişehir (0.534). This ranking is in line with the results of the district level analysis.

In order to evaluate if the exposure, sensitivity, adaptive capacity sub-indexes and vulnerability levels for the farmers in the three districts are different from each other, one-way analysis of variance test is conducted on the results of the both methods. The results of Anova test showed that the sub-indexes and the overall vulnerability levels for the farmers in the districts are not statistically different from each other ($p > 0.05$) in both methods (Table *4-16*).

Table 4-16 *Districts level one-way Analysis of Variance (Anova) results for vulnerability components*

Index	**Sum of Squares**	**Mean Square**	**F**	**Sig.**
Exposure	0.007	0.003	0.112	0.894
Sensitivity	0.096	0.048	0.642	0.527
Adaptive Capacity	0.133	0.066	0.622	0.537
Vulnerability (Method 1)	0.324	0.162	0.666	0.514
Vulnerability (Method 2)	0.125	0.062	0.806	0.448

4.3.2. Modelling Household Level Vulnerability

The farmer level vulnerability figures are calculated using two methods. The average household vulnerability figures of three districts calculated using two different methods are given in Table *4-17*.

Table 4-17 *Vulnerability averages of the farmers in each district*

District	**Vulnerability Score (Method 1)**	**Vulnerability Score (Method 2)**
Cihanbeyli	0.803	0.586
Karapınar	0.885	0.570
Seydişehir	0.648	0.534

The results of Method 2 gives a ranking consistent with the district level results, in which vulnerability is the highest in Cihanbeyli, followed by Karapınar and Seydişehir. The drivers of farmer vulnerability are examined for both the vulnerability levels obtained using two different methods in the following section.

4.3.3. The Drivers of the Household Level Farmer Vulnerability

Household level farmer vulnerability is modelled using linear and non-linear methods. The results of the F-statistics of multiple linear regression model shows that the model has significant explanatory power, especially for Method 2 figures ($p < 0.001$) (Table

4-18) and district level indicators explain approximately 14% in household level vulnerability calculated using this method (Table *4-19*). However, the amount of the variation explained by this model (based on the R^2) is quite low despite the significance of the model.

Table 4-18 *Significance of regression model for household level vulnerability*

Component	**Sum of Squares**	**Mean Square**	**F**	**Sig.**
Regression model for Method 1	8.46	0.60	2.89	0.0004
Regression model for Method 2	2.89	0.23	4.06	<0.0001

Table 4-19 *Regression model summary for household level vulnerability with district level indicators*

	R^2	**Adjusted R^2**	**Std. Error of the Estimate**
Regression model for Method 1	0.11	0.07	0.46
Regression model for Method 2	0.14	0.11	0.23

The results of the regression model for Method 1 (Table *4-20*) showed that "number of memberships to agricultural organizations", "total number of animals owned" and "dependency ratio of the household" are the significant factors contributing the farmer vulnerability.

Table 4-20 *Significant indicators of household level vulnerability (Method 1) determined by multiple linear regression*

Indicator	**Estimate**	**Sig.**
Intercept	1.026	<0.0001*
Number of memberships to agricultural organizations	- 0.410	0.0008*
Total number of animals owned	- 0.460	0.0263*
Dependency ratio of the household	- 0.190	0.0285*
Percentage of land with good soil quality	-0.130	0.0549
Percentage of rain-fed land	0.086	0.2282

Indicator	Estimate	Sig.
Agricultural insurance in the last 5 years	-0.030	0.2378
Number of facilities available	-0.120	0.2700
Number of obtained agricultural training in past year	0.225	0.2740
Crop diversity at different plots	-0.020	0.4896
Number of subsidies obtained	-0.070	0.5649
Education level of the HH Head	-0.070	0.6320
Share of agricultural production in income	0.007	0.9258
Number of agricultural equipment	-0,0005	0.9970
Existence of forest near by agricultural land	0,0001	0.9974

* Significant indicators

The results for Method 2 show that "number of memberships to agricultural organizations", "dependency ratio of the household", "percentage of land with good soil quality" and "percentage of rain-fed land" contribute significantly to MLR model (Table *4-21*).

Table 4-21 *Significant indicators of household level vulnerability (Method 2) determined by multiple linear regression*

Indicator	Estimate	Sig.
Intercept	0,752	<0.0001
Number of memberships to agricultural organizations	-0,209	0.0005*
Dependency ratio of the household	-0,137	0.0012*
Percentage of land with good soil quality	-0,069	0.0322*
Percentage of rain-fed land	0,074	0.0379*
Total Number of Animals Owned	-0,164	0,1115
Crop diversity at different plots	-0,023	0,1293
Agricultural insurance in the last 5 years	-0,020	0,1332
Number of facilities available	-0,050	0,3621
Number of agricultural equipment	-0,050	0,4282
Number of subsidies obtained	-0,045	0,4537
Number of obtained agricultural training in past year	0,050	0,6228
Education Level of the HH Head	-0,025	0,7161
Existence of forest near by agricultural land	-0,004	0,8403
Percentage share of agricultural production in income	0,004	0,9161

* Significant indicators

Mean Square Error of the RF model for Method 1 is calculated as 0.2192, while this figure is 0.0532 for Method 2, which indicates a better model fit than Method 1. Thus, only the results of RF model is given for the vulnerability figure calculated using Method 2 to explain the significant indicators of vulnerability.

Random forest model gave similar results to the MLR model for Method 2-based vulnerability figures. The results show that "dependency ratio of the household", "number of memberships to agricultural organizations", "percentage of rain-fed land" and "percentage of land with good soil quality" contribute significantly to the model (Figure 4.16). With its high explanatory power, RF model validated that these four indicators are significant in determining the vulnerability levels of the farmers.

Significance levels of the indicators are visualized using OOB predictor importance estimate plot. Negative figures in the graph shows that the variable is not predictive enough and does not contribute to the model (Merz et al., 2013).

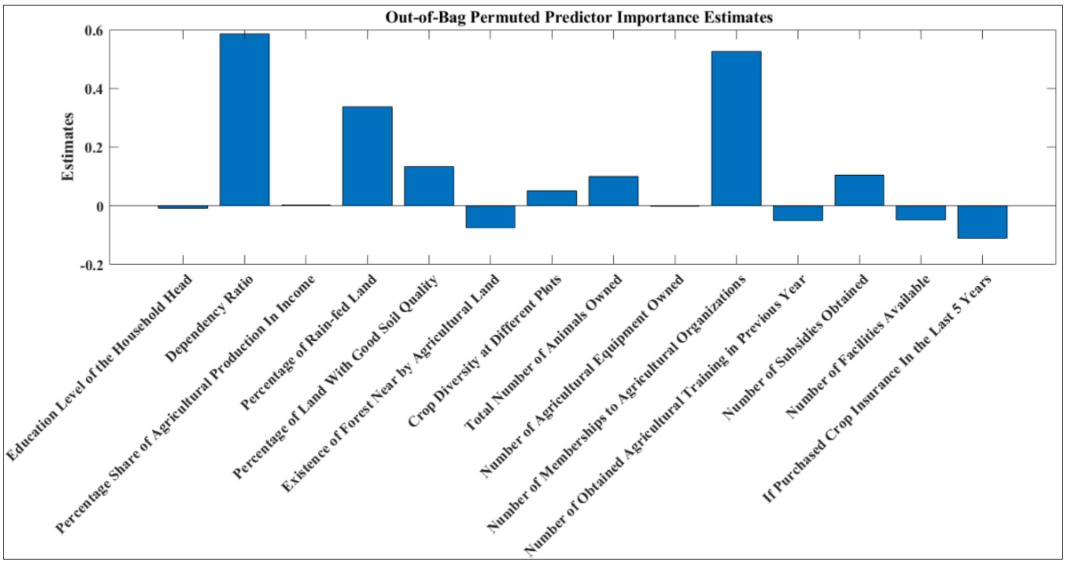

Figure 4.16 Out-of-bag predictor importance estimate results

In random forest model, the direction of the relationship of household level vulnerability with the contributing indicators is illustrated using the partial dependence plot. A positive relation is represented by an ascending line towards right hand side of the graphic, while a negative relationship is represented by a descending one towards right hand side.

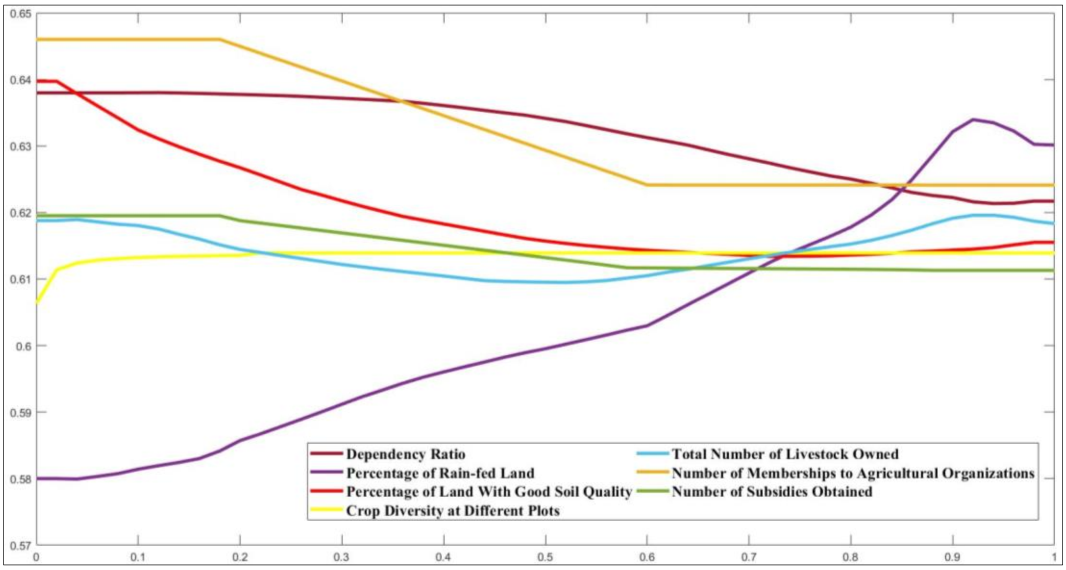

Figure 4.17 Smoothed partial dependence plot for contributing indicators

The results showed that dependency ratio has a negative impact on vulnerability, which indicates that increasing number of dependent members in the household reduces vulnerability level. The results also showed that the number of memberships to agricultural organizations is the second most significant factor, which reduces household level vulnerability. Increasing percentage of rain-fed land increases vulnerability level, while percentage of land with good soil quality has a negative impact on household level vulnerability.

The number of subsidies has a very limited impact on vulnerability level and it slightly reduces it. Another factor which has a very limited impact on the farmer vulnerability is the total number of livestock owned. In the current research, 75% of the farmers who raise livestock stated that the pasture land they use is medium or low quality. Crop diversity at different plots have the least impact on the farmer vulnerability with no tendency towards reducing or increasing it.

Education level of the household head, percentage share of agricultural income, existence of a forest in agricultural production area, the number of agricultural equipment owned, the agricultural trainings obtained, the facilities available and crop diversity at different plots have no significant impact on farmer vulnerability at household level.

4.3.4. Household Level Indicators Correlated with the Adaptive Strategy and Precautionary Behavior

4.3.4.1. Indicators correlated with adaptive strategy

The adaptive strategies implemented by the farmers against climatic changes and extremes are summarized in Table *4-13*. In order to determine the correlations between household level indicators and the number of adaptive strategies implemented by the farmer, correlation analysis is conducted. Results of the analysis show that age of the farmer has a negative correlation at the 0.05 level with the number of adaptive strategies implemented (Table *4-22*). This indicated that as the age of the farmer increases, the farmer tends to implement less number of adaptive strategies. Indicators related to land and land management such as the total amount of land, percentage of irrigated land, number of agricultural equipment used, the number of water sources used and sufficiency of irrigation water have significant positive correlation at the 0.01 level with the number of adaptive strategies implemented. Furthermore, the number of parcels managed by the farmer have a positive correlation at the 0.05 level.

Table 4-22 *Indicators correlated with adaptive strategy*

Parametric Indicators	Pearson Correlation Coefficient	Sig. (2-tailed)
Age of farmer	- 0.114*	0.032
Total amount of land managed by the farmer	0.168**	0.002
Percentage of irrigated land	0.204**	0.000
Number of parcels managed by the farmer	0.114*	0.033
Number of agricultural equipment	0.210**	0.000
Number of water resources used	0.226**	0.000
Total number of livestock raised	0.142**	0.008
Number of memberships to agricultural organizations	0.105*	0.049
Number of agricultural training obtained in the previous year	0.200**	0.000
Non-parametric Indicators	**Spearman's Rank Correlation Coefficient**	**Sig. (2-tailed)**
Water sufficiency	0.199**	0.000
Participation to activities of agricultural organization	0.196**	0.000
Obtained agricultural trainings	- 0.273**	0.000
Following agricultural programmes/ publishing	- 0.155**	0.004

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Animal husbandry has a positive correlation at 0.01 level, as the number of animals raised increases, the number of adaptive strategies implemented increases. The number of memberships to agricultural organizations have a positive correlation significant at 0.05 level with the number of strategies implemented. The results how that obtaining agricultural training, the number of trainings obtained in the previous year and following up agricultural broadcast and publishing increases the number of adaptive strategies implemented.

4.3.4.2. Indicators correlated with the number of precautions taken

The number of precautions taken by the farmer against climatic changes and extremes is affected from various physical and socio-economic indicators. Results of the analysis show that percentage share of agricultural income has the highest correlation figure among all the indicators with 0.221 at 0.01 level, followed by the indicators related to land and land management such as the total amount of land managed and the percentage of irrigated land. Age of the farmer (0.01 level), percentage of household members working in agriculture (0.05) and share of non-agricultural income sources (0.05 level) have negative correlations with the number of precautions taken. Household size, education and income level of the farmer have positive correlation with the precautionary behavior at 0.05 level (Table *4-23*).

Water sufficiency, the number of agricultural trainings obtained in the previous year, the number of subsidies obtained from the Ministry and average size of the parcels have significant positive correlation at 0.01 level with the number of adaptive strategies implemented. The number of irrigation water sources used by the farmer have a positive correlation at the 0.05 level.

Table 4-23 *Indicators correlated with the number of precautions taken*

Parametric Indicators	Pearson Correlation Coefficient	Sig. (2-tailed)
Age of the farmer	- 0.171**	0.001
Household size	0.131*	0.014
Percentage of household members working in agriculture	- 0.111*	0.037
Percentage share of agricultural production in income	0.221**	0.000
Total amount of land managed by the farmer	0.219**	0.000
Percentage of irrigated land	0.212**	0.000
Average size of parcels managed by the farmer	0.143**	0.007
Number of water resources used	0.142*	0.008

Parametric Indicators	Pearson Correlation Coefficient	Sig. (2-tailed)
Total number of livestock raised	0.135*	0.011
Number of memberships to agricultural organizations	0.139**	0.009
Number of agricultural training obtained in the previous year	0.160**	0.003
Number of subsidies obtained from the Ministry	0.152**	0.004
Share of non-agricultural income sources	- 0.113*	0.033
Non-parametric Indicators	**Spearman's Rank Correlation Coefficient**	**Sig. (2-tailed)**
Education level of farmer	0.106*	0.047
Income group	0.135*	0.011
Water sufficiency	0.188**	0.000
Participation to activities of agricultural organization	0.150**	0.005
Farmer Registration System Membership	- 0.111*	0.038
Contract-based agricultural production	- 0.208**	0.000
Existence of non-agricultural income sources	0.136*	0.011

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Number of memberships to agricultural organizations has a positive correlation at 0.05 level, however, participation to activities of agricultural organization significantly reduces the number of precautions taken. Registering to the Farmer Registration System and contract-based production has a positive impact on the number of precautions taken, while an increasing number of livestock raised and existence of non-agricultural income sources reduces the number of precautions taken.

4.3.5. The Drivers of Adaptation

The factors affecting the number of adaptation methods used are modelled using linear and non-linear regression. The results of the F-statistics of multiple linear regression model show that the model has significant explanatory power ($p < 0.001$) (Table *4-24*) and the indicators explain approximately 15% in household level vulnerability (Table

4-25). The amount of the variation explained by this model (based on the R^2) is quite low (14%) despite the significance of the model.

Table 4-24 *Significance of regression model for household level vulnerability*

Component	Sum of Squares	Mean Square	F	Sig.
Regression model (overall vulnerability)	2.18	0.145	3.839	<0.0001

Table 4-25 *Regression model summary for household level vulnerability*

	R^2	Adjusted R^2	Std. Error of the Estimate
Regression model (overall vulnerability)	0.138	0.10	0.194

The results also show that "percentage of rain-fed land", "age of household head" and "number of obtained agricultural trainings in previous year" contribute significantly to MLR model on the number of adaptive measures (Table *4-26*).

Table 4-26 *Significant indicators of household level vulnerability determined by multiple linear regression*

Indicator	Estimate	Sig.
Intercept	0.458	<0.0001
Percentage of rain-fed land	-0.107	0.0003
Age of household head	-0.147	0.0149
Number of obtained agricultural trainings in previous year	0.314	0.0372

The results of the random forest model for the same data set showed that "percentage of rain-fed land", "number of subsidies obtained", "number of memberships to agricultural organizations", "the total number of livestock owned", "number of agricultural equipment owned", "age of household head" and "annual income" contribute significantly to the model (Figure 4.18). Mean Square Error of the RF model is calculated as 0.0374, which indicates a good model fit. With its high explanatory power, RF model validated that these four indicators are significant in determining the vulnerability levels of the farmers. Significance levels of the indicators are visualized using OOB predictor importance estimate plot.

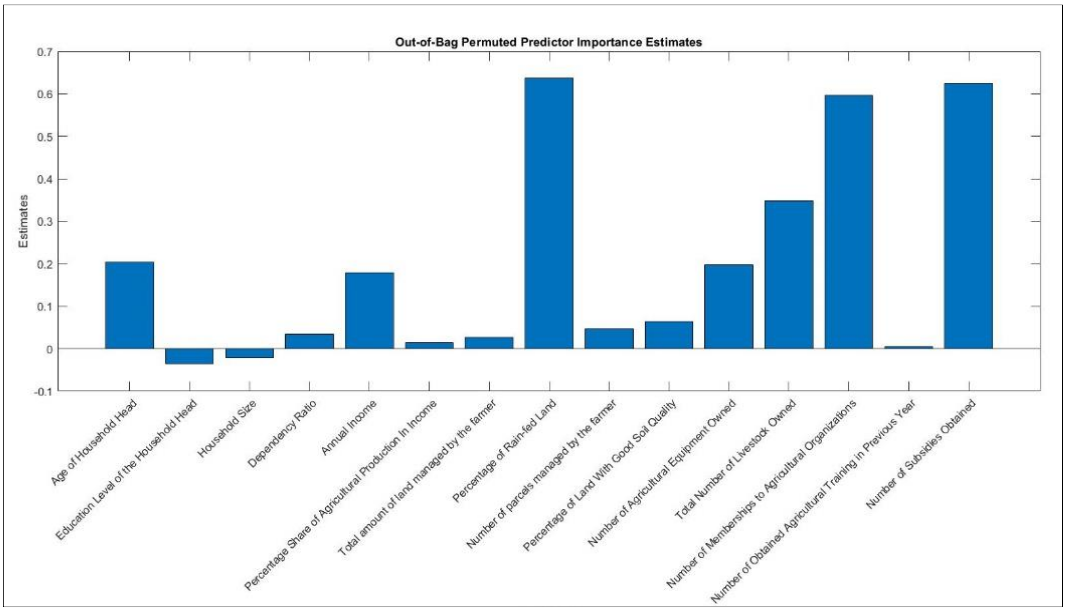

Figure 4.18 Out-of-Bag Predictor Importance Estimate Results

The direction of the relationship of the number of adaptive strategies applied with the contributing indicators is illustrated using the partial dependence plot (Figure 4.19). A positive relation is represented by an ascending line towards right hand side of the graphic, while a negative relationship is represented by a descending one towards right hand side.

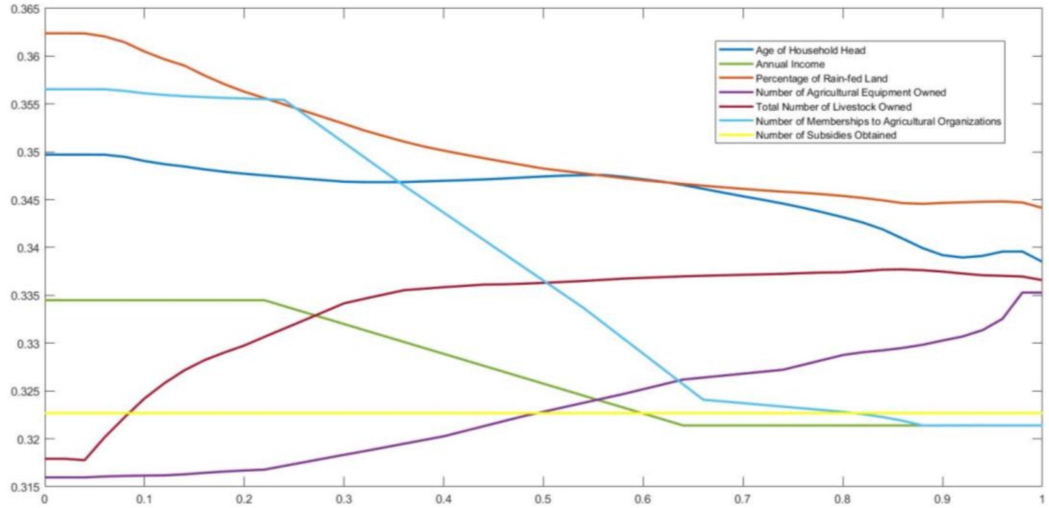

Figure 4.19 Smoothed Partial Dependence Plot for Contributing Indicators

The results indicate that “percentage of rain-fed land”, “age of household head”, “number of memberships to agricultural organizations” and “annual income” have a negative impact on the number of adaptation methods applied, indicating that increase in these indicators reduces the number of adaptive strategies applied. The indicators which increase the number of adaptive strategies applied are “total number of livestock owned” and “number of agricultural equipment owned”. Despite its significance, the relationship of “number of subsidies obtained” and the number of adaptive strategies applied does not have a positive or negative trend.

CHAPTER 5

DISCUSSION AND RECOMMENDATIONS

In the current study, it is aimed at developing a multi scale (district and household) methodology to evaluate vulnerability to climate change in agricultural sector. There are various studies measuring vulnerability at macro scales; however, the findings are not validated using a higher-resolution data. For example, regional scale vulnerability analyses are done using aggregated data based on assumptions on vulnerability indicators; however, the results are not further examined using local data to clarify if the assumptions were correct. Furthermore, household level vulnerability assessments do not further discuss if the findings at this scale can be aggregated to estimate upper scale vulnerability and develop macro scale policies. The current study develops a methodology using comparable indicators generally used in the studies with bottom-up and top-down approaches in order to examine scalability of the results.

In the first part of the dissertation, an agricultural vulnerability index is developed for 10 districts of Konya using 18 indicators. The results of the district level vulnerability analysis showed that there is a geographical division of vulnerability in Konya, the northern part being the most vulnerable while the southern part being the least vulnerable. Common features of the highly vulnerable districts are their high exposure and sensitivity figures and low adaptive capacities. Main cause of high sensitivity is low precipitation and limited water resources, which increases the percentage of rain-fed agriculture land and reduces crop diversity. Low adaptive capacity is mainly a result of low insurance rate and partly due to lack of road infrastructure.

In the second part of the dissertation, a socio-economic research is carried out at household level in 3 of the districts representing high, moderate and low vulnerability classes. The vulnerability analysis at district level and household level gave similar results in terms of vulnerability ranking of the districts. Cihanbeyli has the highest vulnerability level among the tree districts, followed by Karapınar and Seydişehir. The results of the survey also showed that the factors significantly affecting the household level farmer vulnerability are “dependency ratio of the household”, “number of memberships to agricultural organizations”, “percentage of land with good soil quality” and “percentage of rain-fed land”.

(Ahsan and Warner, 2014) found in their study that dependency ratio significantly contributes to vulnerability. In the current study, the results showed that dependency ratio has a negative impact on vulnerability, which indicates that increasing number of dependent members in the household reduces vulnerability level. This can be explained by unregistered participation of children and elderly in agricultural labour. (Gumus and Wingenbach, 2015) states that 44.7% of total employed children work in agricultural sector. The workforce contribution of the elderly in the household does not cover only the agricultural production but also the house works such as taking care of children, cooking etc.

Farming organizations, when have enough capacities to give agricultural extension services, increase the capacity of the farmers in terms of knowledge on new technologies and farming techniques and even how to tackle with climatic changes. Thus, number of memberships to the farming organizations reduces vulnerability of the farmers (Piya et al., 2012; Tesso et al., 2012). The results of the current study showed that the number of memberships to agricultural organizations is a significant factor, which reduces household level vulnerability. In order to improve resilience of the farmers against climatic changes and extremes, membership and active participation to the activities of agricultural institutions should be promoted. In addition to this, capacities of the agricultural organizations should be increased on the impacts of climate change on agriculture. The farmers can then make an informed decision on adaptation choices.

Rainfall is a significant limiting factor in rain-fed agriculture and climate change increases the frequency of drought events (Ghimire et al., 2010; Wani et al., 2009; Zarafshani et al., 2012). The current study showed a positive relationship, meaning that increasing percentage of rain-fed land increases vulnerability level. Rain-fed farming is not only a high-risk production method in terms of climate variability, but also limits crop diversity and the number of adaptive strategies applied. Both at district and household levels, rain-fed production increases vulnerability, thus existing water resources should be made available for agricultural irrigation with efficient irrigation techniques. In case of lacking water resources, conserving soil moisture becomes critical during drought events. Soil moisture can be conserved by increasing soil organic matter through conservation agriculture techniques (Li et al., 2011).

Soil fertility is found to be an indicator reducing climate change vulnerability, while soil degradation increases the vulnerability level (Gbetibouo and Ringler, 2009; Murthy et al., 2015). In the current study, percentage of land with good soil quality has a negative impact on household level vulnerability. Konya Province is highly vulnerable to desertification due to heavy wind erosion and intensive agriculture. Thus, soil conservation and improvement approaches such as conservation agriculture should be promoted, especially on rain-fed lands.

The number of subsidies has a very limited impact on vulnerability level and it slightly reduces it. This is basically due to the fact that farmers can only get the subsidy based on their production and lose their eligibility for the subsidy in case of a complete crop loss due to a climatic change or extreme. Another factor which has a very limited impact on the farmer vulnerability is the total number of livestock owned. Its impact on vulnerability is negative up to a certain threshold and positive afterwards. In the current research, 75% of the farmers who raise livestock stated that the pasture land they use is medium or low quality. Reduction in pasture quality increases the need for livestock feed purchase, which might be a significant financial burden for a farm with high numbers of livestock.

Crop diversity at different plots have the least impact on the farmer vulnerability with no tendency towards reducing or increasing it. Education level of the household head, percentage share of agricultural income, existence of a forest in agricultural production area, the number of agricultural equipment owned, the agricultural trainings obtained, the facilities available and crop diversity at different plots have no impact on farmer vulnerability at household level. Despite its insignificant impact on farmer vulnerability, equipment ownership has a positive impact on the number of adaptive strategies implemented by the farmers.

Despite the significance of the Multi Linear Regression models for vulnerability level of the farmers and the number of adaptive strategies implemented by them, the explanatory power of the models were low. Thus, a non-linear technique (Random Forest) was also applied to the data. The explanatory power of the Random Forest models for vulnerability level of the farmers and the number of adaptive strategies implemented were quite high. Both MLR and RF analysis indicated the same indicators as the drivers of vulnerability, which showed that the structure of the data is linear and also validated the significance of the indicators. On the other hand, the results of these two techniques for modelling the number of adaptive strategies implemented by the farmer pointed out different indicators. In this case, the indicators given by RF model was considered as the significant ones, due to the high explanatory power of the model. Using two different techniques gave us the opportunity to understand the structure of the data better and find out the significant indicators with a model with higher explanatory power. Existing literature has limited number of models explaining the vulnerability components and adaptation strategies for households. This study has gone some way towards enhancing our understanding of climate change vulnerability in agriculture sector.

The current research showed that the indicator approach can be used as a guidance to comparatively determine the highly vulnerable areas. However, household level analysis also showed that many of the commonly used macro scale indicators explain a very limited percentage of variation in vulnerability of the farmers. The results given by two different regression models revealed that there are four indicators significantly affecting the vulnerability level of farmers. However, these factors explain a very limited percentage of farmer vulnerability. Other factors controlling household level vulnerability which have not taken into account in the existing literature should be studied via further research, including deep interviews and long term observations, at the household level and models should be developed to upscale the results.

CHAPTER 6

CONCLUSIONS

Changes in climatic conditions and extremes due to climate change will have negative impacts on agricultural production and livelihoods of the farmers. This will have implications on the society in terms of food security, economy, social structure and welfare. In order to reduce the negative impacts, planned adaptation strategies should be implemented by the producers and this should be guided and supported by the country policies. As stated in the Turkey's National Climate Change Adaptation Strategy and Action Plan, climate change adaptation in agriculture sector requires a comprehensive approach considering production, consumption, insurance systems, subsidy and market policies, productivity and competition, drought and desertification, conservation of biodiversity, crop and animal health and production, research and development (Ministry of Environment and Urbanization, 2011). This is a complex and difficult task which requires significant amount of effort, accurate data and financial resources. Thus, priority areas should be determined via more research on vulnerability at both farmer level and administrative levels.

This research presents an index-based vulnerability calculation methodology that can be used to determine the highly vulnerable areas at district level. The results of the vulnerability index analysis showed that the northern part of Konya is highly vulnerable to climate change. The results also showed that there are a number of policy options to support climate change adaptation in Konya. First of all, rain-fed farming practices, which cover 67% of the agricultural land of the province, are highly vulnerable to climate change. Currently, there is no climate-resilience targeted subsidy system for rain-fed farming, which might lead to reduction or cessation of agricultural production on these lands due to increasing drought events in the future. Subsidy policies should be reformulated to support rain-fed production, especially in the highly vulnerable areas.

Increasing the irrigation infrastructure at water-abundant locations can also be a policy option to increase drought resilience in these areas. However, irrigation projects should be complemented with trainings on efficient training techniques and climate change adaptation. Lack of knowledge on these issues might lead to excessive use of water resources, which could result in soil erosion, salinization, fungal diseases etc. in return. Furthermore, reducing water losses in agriculture is an important strategy and requires more implementations at farming conditions. There are available subsidies aimed at reducing the initial investment cost of modern pressurized irrigation systems such as drip and sprinkler irrigation in the region (Albayrak et al., 2010). Availability of these subsidies should be increased, especially for the highly vulnerable farmers.

Drought resistance can also be increased by improving the soil carbon via some conservation agriculture techniques. In Konya, good soil quality has a negative impact on household level vulnerability. Due to its vulnerable condition in terms of erosion and desertification, there are various projects carried out in Konya on sustainable landuse management and climate change adaptation. Despite the positive impacts of these attempts, there is room for improvement in research and development in conservation agriculture. First of all, there is no one-size-fits-all implementation in agriculture that can solve a specific problem in all the regions in the same way. There are various socioeconomic, cultural, geographic and climatic factors affecting the success of an agricultural implementation and these factors vary at different locations. Thus, success of each conservation practice (e.g. direct seeding, wind breakers, mulching etc.) should be monitored and practical solutions should be found for the problems faced during implementation of these practices. Secondly, success of the implementations require a governance structure with well-defined responsibilities of the institutions. Training of the farmers, provision of subsidies and grants for conservation practices, monitoring and reporting of the activities, technology research and development and coordination of all these activities should be shared responsibilities of different institutions including government authorities, farmer organizations, NGOs, research centers, academia and the private sector. In this structure, farmer organizations such as cooperatives, unions and chambers of agriculture have significant roles. They are more in communication with farmers than other institutions. This research revealed that memberships to farmer organizations reduce the vulnerability of the farmers. Thus, in addition to formulating policies to increase the number of memberships to these organizations, improving their knowledge on climate change adaptation and their financial and human resources capacities to transfer this knowledge to the farmers will have significant impacts on reducing vulnerability of farmers.

Due to the increasing frequency and severity of climatic extremes and gradual changes in climatic conditions, adaptation activities are highly needed in agricultural practices. Despite increasing awareness regarding the impacts of climate change on production, most of the current adaptation practices done by farmers are autonomous emerging as a response to changes. There are certain precautions that can be taken by the farmers to reduce climate related losses. Some the precautions require only changes in implementation of the practices, while some others require investment and long-term efforts. Thus, farmers should be guided by informative trainings and supported by financial incentives. Due to the limited resources, successful adaptation can only be achieved by effective planning and efficient use of scarce resources. The results of this study can help policy makers to prioritize the policy subjects and implementation areas, which will result in more influential results.

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APPENDICES

A. The Questionnaire Applied in the Survey

İlçe ……………………………….

Mahalle ……………………………

HANEHALKININ DEMOGRAFİK ÖZELLİKLERİ

1. Hanehalkı reisinin doğum yılı nedir?

   ____

2. Hanehalkı reisinin en son öğrenim durumu nedir?
   a. Okur-yazar değil
   b. İlkokul terk
   c. İlkokul mezunu
   d. Ortaokul terk
   e. Ortaokul mezunu
   f. Lise terk
   g. Lise mezunu (Normal, Düz, Anadolu)
   h. Lise mezunu (Meslek)
   i. Üniversite terk
   j. Üniversite mezunu (Açıköğretim)
   k. Üniversite mezunu (2 yıllık)
   l. Üniversite mezunu (Normal öğretim)
   m. Lisanüstü veya doktora terk
   n. Lisansüstü veya doktora

3. Hanehalkı reisinin cinsiyeti nedir?
   a. Erkek
   b. Kadın

4. Hanede DÜZENLİ olarak kaç kişi yaşıyor?

   ____

5. Hanede bulunan 15 yaş altı kişi sayısı nedir?

   ____

6. Hanede bulunan 65 yaş üstü kişi sayısı nedir?

   ____

7. Tarımsal üretimde düzenli olarak kaç kişi çalışıyor?

____

8. Tarımsal üretimde hane dışından DÜZENLİ olarak ücretli kaç kişi çalışıyor?

____

9. Tarımsal üretimde hane dışından DÜZENLİ OLARAK ücret almadan kaç kişi çalışıyor?

____

10. Köyde imece yapılır mı?
    a. Evet
    b. Hayır

11. Yılın kaç ayı burada yaşıyorsunuz?
    a. 1 aydan az
    b. 1 ay
    c. 2 ay
    d. 3 ay
    e. 4 ay
    f. 5 ay
    g. 6 ay
    h. 7 ay
    i. 8 ay
    j. 9 ay
    k. 10 ay
    l. 11 ay
    m. 12 ay [Soru 13]

12. (12 aydan az süre bulunduğu yerde yaşıyorsa) Diğer aylarda nerede yaşıyorsunuz? [İL ve İLÇE ismi)

____

13. Yıllık geliriniz ne kadardır?
    a. 15.000 TL altı
    b. 15.001- 40.000 TL
    c. 40.001- 70.000 TL
    d. 70.001-100.000 TL
    e. 100.0001 TL ve üzeri

TARIMSAL ÜRETİMİN ÖZELLİKLERİ

14. Tarımsal üretiminiz kendiniz için mi? Satmak için mi? Yoksa her ikisi için mi?

    a. Hiçbir şekilde tarımsal faaliyette bulunmuyorum **[GÖRÜŞME SONA ERER]**
    b. Sadece kendi tüketimim için
    c. Hem kendi tüketimim hem de satış amaçlı
    d. Sadece satış amaçlı

15. Kaç yıldır çiftçilik yapıyorsunuz?

    ____

16. Gelirinizin ne kadarını tarımdan sağlıyorsunuz?
    a. %25'ten az
    b. %25-%50
    c. %51-%75
    d. %76'dan fazla
    e. Tamamı

17. Sulu tarım mı, kuru tarım mı yapıyorsunuz?
    a. Sadece Kuru Tarım yapıyorum
    b. Sadece Sulu Tarım yapıyorum
    c. Hem Kuru hem Sulu Tarım yapıyorum.

18. Kuru Tarım için TAMAMINA sahip olduğunuz arazi kaç dekar?

    ____

19. Kuru Tarım için TAMAMINA sahip olduğunuz arazi kaç parsel?

    ____

20. Kuru Tarım için SAHİBİ OLMADIĞINIZ ama işlettiğiniz HİSSELİ arazi kaç dekar?

    ____

21. Kuru Tarım için SAHİBİ OLMADIĞINIZ ama işlettiğiniz HİSSELİ arazi kaç parsel?

    ____

22. Kuru Tarım için kiraladığınız arazi kaç dekar?

    ____

23. Kuru Tarım için kiraladığınız arazi kaç parsel?

    ____

24. Kuru Tarım için ortak işlettiğiniz arazi kaç dekar?

    ____

25. Kuru Tarım için ortak işlettiğiniz arazi kaç parsel?
____

26. Sizce kuru tarım yaptığınız arazilerin ne kadarı İYİ TOPRAK KALİTESİNE sahip?
____________ dekar

27. Sizce kuru tarım yaptığınız arazilerin ne kadarı ORTA TOPRAK KALİTESİNE sahip?
____________ dekar

28. Sizce kuru tarım yaptığınız arazilerin ne kadarı DÜŞÜK TOPRAK KALİTESİNE sahip?
____________ dekar

29. Sizce kuru tarım yaptığınız arazilerin ne kadarı AZ EĞİMLİ?
____________ dekar

30. Sizce kuru tarım yaptığınız arazilerin ne kadarı ORTA EĞİMLİ?
____________ dekar

31. Sizce kuru tarım yaptığınız arazilerin ne kadarı ÇOK EĞİMLİ (bayır/ sırt)?
____________ dekar

32. KURU TARIM yaptığınız arazilerde yılda dekara ortalama kaç kg alt gübre ve üst gübre kullanıyorsunuz?
___________ kg/ dekar

33. KURU TARIM yaptığınız arazilerde yılda dekara ortalama kaç kg doğal gübre kullanıyorsunuz?
___________ kg/ dekar

34. Kuru tarımda dekarda en fazla gelir elde ettiğiniz 1. ürün nedir?
____

35. Bu ürünün dekarda ortalama verimi nedir?
___________ kg/ dekar

36. Dekarda en fazla gelir elde ettiğiniz 2. ürün nedir?
____

37. Bu ürünün dekarda ortalama verimi nedir?
___________ kg/ dekar

38. Dekarda en fazla gelir elde ettiğiniz 3. ürün nedir?
____

39. Bu ürünün dekarda ortalama verimi nedir?
___________ kg/ dekar

40. Kişi SADECE kuru tarım yapıyorsa “Evet”i işaretleyin. Hem kuru hem sulu tarım yapıyorsa “Hayır”ı işaretleyin.
    a. Evet
    b. Hayır [Soru41]

41. Sulu Tarım için TAMAMINA sahip olduğunuz arazi kaç dekar?
____

42. Sulu Tarım için TAMAMINA sahip olduğunuz arazi kaç parsel?
____

43. Sulu Tarım için SAHİBİ OLMADIĞINIZ ama işlettiğiniz HİSSELİ arazi kaç dekar?
____

44. Sulu Tarım için SAHİBİ OLMADIĞINIZ ama işlettiğiniz HİSSELİ arazi kaç parsel?
____

45. Sulu Tarım için kiraladığınız arazi kaç dekar?
____

46. Sulu Tarım için kiraladığınız arazi kaç parsel?
____

47. Sulu Tarım için ortak işlettiğiniz arazi kaç dekar?
____

48. Sulu Tarım için ortak işlettiğiniz arazi kaç parsel?
____

49. Sizce sulu tarım yaptığınız arazilerin ne kadarı İYİ TOPRAK KALİTESİNE sahip?
____________ dekar

50. Sizce sulu tarım yaptığınız arazilerin ne kadarı ORTA TOPRAK KALİTESİNE sahip?
____________ dekar

51. Sizce sulu tarım yaptığınız arazilerin ne kadarı DÜŞÜK TOPRAK KALİTESİNE sahip?
____________ dekar

52. Sizce sulu tarım yaptığınız arazilerin ne kadarı AZ EĞİMLİ?
____________ dekar

53. Sizce sulu tarım yaptığınız arazilerin ne kadarı ORTA EĞİMLİ?
____________ dekar

54. Sizce sulu tarım yaptığınız arazilerin ne kadarı ÇOK EĞİMLİ (bayır/ sırt)?
____________ dekar

55. SULU TARIM yaptığınız arazilerde yılda dekarda ORTALAMA kaç kg alt gübre ve üst gübre kullanıyorsunuz?
___________ kg/ dekar

56. SULU TARIM yaptığınız arazilerde yılda dekarda ORTALAMA kaç kg doğal gübre kullanıyorsunuz?
___________ kg/ dekar

57. Sulu tarımda dekarda en fazla gelir elde ettiğiniz 1. ürün nedir?
____

58. Bu ürünün dekarda ortalama verimi nedir?
___________ kg/ dekar

59. Dekarda en fazla gelir elde ettiğiniz 2. ürün nedir?
____

60. Bu ürünün dekarda ortalama verimi nedir?
___________ kg/ dekar

61. Dekarda en fazla gelir elde ettiğiniz 3. ürün nedir?
____

62. Bu ürünün dekarda ortalama verimi nedir?
___________ kg/ dekar

63. Tarımda ne kadar geleneksel, ne kadar modern yöntemleri kullanıyorsunuz?
   a. Tamamen geleneksel yöntemleri kullanıyorum
   b. Tamamen modern yöntemleri kullanıyorum
   c. Her ikisini de kullanıyorum

64. Traktörünüz var mı?
   a. Evet
   b. Hayır [Soru66]

65. Traktörünüzle kullandığınız toplam kaç adet tarım aletiniz var?
____________ adet

66. Biçerdöveriniz/ hasat makineniz var mı?
    a. Evet
    b. Hayır

67. Sahip olmadığınız ama ihtiyacınız olan tarımsal makineleri kiralıyor musunuz?
    a. Evet
    b. Hayır [Soru69]

68. Sahip olmadığınız ama ihtiyacınız olan tarımsal makineleri kiralamakta sıkıntı yaşıyor musunuz?
    a. Evet
    b. Hayır
    c. Bazen

69. Toprak analizi yaptırıyor musunuz?
    a. Evet
    b. Hayır [Soru72]

70. Toprak analizinin sonucuna göre mi gübre veriyorsunuz?
    a. Evet
    b. Hayır [Soru72]

71. Toprak analizi sonucuna göre gübre vermemenizin sebebi nedir?
    ____

72. Tarım yapılan arazinin yakınında ağaçlandırma alanı/ orman var mı?
    a. Evet
    b. Hayır [Soru74]

73. Bu alanın araziyi kuraklık, sel, fırtına gibi aşırı iklim olaylarına karşı koruduğunu düşünüyor musunuz?
    a. Evet
    b. Hayır

74. Bir yıl içerisinde 1'den fazla ürün ekiyor musunuz?
    a. Evet
    b. Hayır

75. Bir yıl içerisinde kaç çeşit ürün ekiyorsunuz?
    ______________ adet [1'den fazla ise Soru75] [1 ise Soru76]

76. Yıl içerisinde birden fazla ürün ekmenizin sebebi nedir?
a. Münavebe için
b. Riski azaltmak için
c. Hayvan yemi için
d. Geliri çeşitlendirmek için
e. Diğer

____

77. Yıl içerisinde tek çeşit ürün ekmenizin sebebi nedir?
a. Kuru tarımda alternatif yok, tek ürün ekilebiliyor
b. Diğer

____

78. Aynı anda farklı parsellerde farklı ürünler ekiyor musunuz?
a. Evet
b. Hayır [Soru79]

79. Aynı anda farklı ürünler ekmenizin sebepleri nelerdir?
a. Münavebe için
b. Riski azaltmak için
c. Hayvan yemi için
d. Geliri çeşitlendirmek için
e. Diğer

____

80. (Sulu tarım yapıyorsa) Kullandığınız suyun kaynağı nedir?
a. Yeraltı suyu
b. Akarsu
c. Göl
d. Baraj/ gölet
e. Kanal
f. Diğer

____

81. Tarımsal üretimde kullandığınız su yeterli mi?
a. Evet
b. Hayır
c. Yıla göre/ iklim koşullarına göre değişiyor

82. Su kullanımı için enerji harcıyor musunuz?
a. Evet
b. Hayır

83. Yıllar içerisinde kullanabildiğiniz su miktarında azalma oldu mu?
   a. Evet
   b. Hayır [Soru85]

84. Suyun azalmasıyla sulama konusunda önlem almaya başladınız mı?
   a. Evet
   b. Hayır [Soru85]

85. Ne tür önlemler almaya başladınız?

   ____

86. Hayvancılık ile uğraşıyor musunuz?
   a. Evet
   b. Hayır [Soru92]

87. Hayvancılıkla uğraşıyorsanız:

   a. Büyükbaş hayvan sayısı…………………………..
   b. Küçükbaş hayvan sayısı……………………………
   c. Arılı kovan sayısı………………………………………
   d. Kanatlı hayvan sayısı………………………………..
   e. Diğer

   ____

88. Hanede kaç kişi DÜZENLİ olarak hayvan bakımıyla ilgilenir?

   ____

89. Hane dışından olup DÜZENLİ olarak hayvanların bakımıyla ilgilen var mı?
   a. Evet
   b. Hayır

90. Hane dışından olup DÜZENLİ olarak hayvanların bakımıyla ilgilen kaç kişi var?

   ____

91. Merada otlatma yapıyor musunuz?
   a. Evet
   b. Hayır [Soru92]

92. Mera kalitesi nasıl?
   a. İyi
   b. Orta

c. Kötü

İKLİM DEĞİŞİKLİĞİ KONUSUNDA FARKINDALIK

93. Son 10 yılda iklimde (hava koşullarında) eskiye göre bir değişiklik görüyor musunuz?

	Evet	**Hayır**
Artan yağış		
Azalan yağış (kuraklık)		
Düzensiz yağış		
Geciken yağış		
Yağış döneminin kısalması		
Artan sıcaklık		
Sel olaylarında artış		
Dolu olaylarında artış		
Don olaylarında artış		
Sıcak rüzgarlarda artış		
Fırtınada artış		
Gece-gündüz sıcaklık farkının artması		
Diğer…		

94. İklimdeki bu değişimlerin sebebi nedir sizce?

____

95. Son beş yılda kuraklık yaşadınız mı?
   a. Evet
   b. Hayır [Soru99]

96. Son 5 yılın kaç yılı kurak geçti?

____

97. Kuraklıktan dolayı ürün kaybı yaşadınız mı?
   a. Evet
   b. Hayır [Soru98]

98. En çok hangi üründe kayıp yaşadınız?

____

99. Bu üründe ne kadar kayıp yaşadınız %?

____

100. Köyde yağmur duasına çıkıldı mı?
    a. Evet
    b. Hayır

101. Son 5 yılda Sel yaşadınız mı?
    a. Evet
    b. Hayır [Soru105]

102. Son 5 yılın kaç yılında sel oldu?

    ____

103. Selden dolayı ürün kaybı yaşadınız mı?
    c. Evet
    d. Hayır [Soru105]

104. En çok hangi üründe kayıp yaşadınız?

    ____

105. Bu üründe ne kadar kayıp yaşadınız %?

    ____

106. Son 5 yılda DOLU yaşadınız mı?
    a. Evet
    b. Hayır [Soru110]

107. Son 5 yılın kaç yılında dolu oldu?

    ____

108. Doludan dolayı ürün kaybı yaşadınız mı?
    e. Evet
    f. Hayır [Soru110]

109. En çok hangi üründe kayıp yaşadınız?

    ____

110. Bu üründe ne kadar kayıp yaşadınız %?

    ____

111. Son 5 yılda DON yaşadınız mı?
    a. Evet
    b. Hayır [Soru115]

112. Son 5 yılın kaç yılında don oldu?

____

113. Dondan dolayı ürün kaybı yaşadınız mı?

    g. Evet
    h. Hayır [Soru115]

114. En çok hangi üründe kayıp yaşadınız?

____

115. Bu üründe ne kadar kayıp yaşadınız %?

____

116. Son 5 yılda fırtına yaşadınız mı?

    a. Evet
    b. Hayır [Soru120]

117. Son 5 yılın kaç yılında fırtına oldu?

____

118. Fırtınadan dolayı ürün kaybı yaşadınız mı?

    a. Evet
    b. Hayır [Soru120]

119. En çok hangi üründe kayıp yaşadınız?

____

120. Bu üründe ne kadar kayıp yaşadınız %?

____

121. Saydıklarım dışında son 5 yılda yaşamış olduğunuz afet oldu mu?

    a. Evet
    b. Hayır [Soru126]

122. Bu afet nedir? (kar, sam yeli vb.)

____

123. Bu afeti son 5 yılda kaç kez yaşadınız?

____

124. Bu afetten dolayı ürün kaybı yaşadınız mı?

    a. Evet
    b. Hayır [Soru131]

125. En çok hangi üründe kayıp yaşadınız?

____

126. Bu üründe ne kadar kayıp yaşadınız %?

____

127. Başka bir afet yaşadınız mı?

a. Evet
b. Hayır [Soru131]

128. Bu afeti son 5 yılda kaç kez yaşadınız?

____

129. Bu afetten dolayı ürün kaybı yaşadınız mı?

a. Evet
b. Hayır

130. En çok hangi üründe kayıp yaşadınız?

____

131. Bu üründe ne kadar kayıp yaşadınız %?

____

132. Son beş yılda herhangi bir afet sebebiyle HAYVAN veya EKİPMAN KAYBINIZ oldu mu?

a. Evet
b. Hayır [Soru134]

133. Toplam EKİPMAN kaybınız ne kadar olmuştur [TL] ?

____

134. Toplam HAYVAN kaybınız ne kadar olmuştur [TL] ?

____

135. [SORMADAN YANITLAYINIZ] Görüştüğümüz kişi afetlerden herhangi birini yaşamışsa EVET'i işaretleyip devam ediyoruz. Afetlerden herhangi birini yaşamadıysa HAYIR'ı işaretliyoruz.

a. Evet
b. Hayır [Soru139]

136. Yaşadığınız kayıpların GELİRİNİZ üzerindeki etkilerini 1’den 5’e kadar değerlendirir misiniz?
   a. 1 Hiç etkilemedi
   b. 2
   c. 3
   d. 4
   e. 5 Son derece etkiledi

137. Kayıpları telafi edebildiniz mi?
   a. Evet
   b. Hayır [Soru139]

138. Kayıpları telafi etmeniz ne kadar kolay oldu 1’den 5’e kadar değerlendirir misiniz?
   a. 1 Hiç kolay olmadı
   b. 2
   c. 3
   d. 4
   e. 5 Son derece kolay oldu

139. Kayıpları telafi etmek için aşağıdaki yöntemlerden herhangi birini kullandınız mı? (birden fazla işaretlenebilir)
   a. Kredi çekme
   b. Borç alma
   c. Malların ipotek edilmesi
   d. Malların/ hayvanların satılması
   e. Geçmiş birikimlerin/ maaşın kullanılması
   f. Esnaftan borç ile malzeme alma
   g. Tüketimin azaltılması
   h. Gıdayı dışardan temin etme
   i. Ailenin dışarıda bulunan üyelerinden yardım alma
   j. Devlet desteğine başvurma
   k. Tarım sektörü dışında işler yapma
   l. Yurtdışında çalışma

140. İklim değişikliğinin olumlu etkilerini hissediyor musunuz?
   a. Evet
   b. Hayır [Soru141]

141. Hissettiğiniz olumlu etkiler nelerdir?

   ____

142. Kuraklığa karşı önlem alıyor musunuz?
   a. Evet
   b. Hayır [Soru143]

143. Kuraklığa karşı aldığınız önlem nedir?
   ____

144. Kuraklığa karşı önlem almamanızın sebebi nedir? (Birden fazla seçilebilir)

	Evet	Hayır
a. Gerek duymamak		
b. Yeterli bilgiye sahip olmamak		
c. Teknik desteğin yetersiz olması		
d. Maliyeti karşılayacak gücünün olmaması		
e. Arazisinin küçük olması		
f. Sulama imkânlarının yetersiz olması		
g. Tarımsal gelirinin az olması		
h. Kuraklığı geçici bir durum olarak görmek		
i. Sonuçların uzun vadede görülecek olması j. İşgücü yetersizliği		
k. Değişimden/ yeni yöntemlerden çekinmek		
l. Bir önlem alınabileceğini düşünmemek		
m. Diğer ______________		

145. Sel/ su baskınına karşı önlem alıyor musunuz?
   a. Evet
   b. Hayır [Soru146]

146. Sel/ su baskınına karşı aldığınız önlem nedir?

____

147. Sel/ su baskınına karşı önlem almamanızın sebebi nedir? (Birden fazla seçilebilir)
   a. Gerek duymamak
   b. Yeterli bilgiye sahip olmamak
   c. Teknik desteğin yetersiz olması
   d. Maliyeti karşılayacak gücünün olmaması
   e. Arazisinin küçük olması
   f. Tarımsal gelirinin az olması
   g. Sel/su baskınını geçici bir durum olarak görmek
   h. Sonuçların uzun vadede görülecek olması
   i. İşgücü yetersizliği
   j. Değişimden/ yeni yöntemlerden çekinmek
   k. Bir önlem alınabileceğini düşünmemek
   l. Diğer

____

148. Dona karşı önlem alıyor musunuz?
   a. Evet
   b. Hayır [Soru149]

149. Dona karşı aldığınız önlem nedir?

____

150. Dona karşı önlem almamanızın sebebi nedir? (Birden fazla seçilebilir)
   a. Gerek duymamak
   b. Yeterli bilgiye sahip olmamak
   c. Teknik desteğin yetersiz olması
   d. Maliyeti karşılayacak gücünün olmaması
   e. Arazisinin küçük olması
   f. Tarımsal gelirinin az olması
   g. Donu geçici bir durum olarak görmek
   h. Sonuçların uzun vadede görülecek olması
   i. İşgücü yetersizliği
   j. Değişimden/ yeni yöntemlerden çekinmek
   k. Bir önlem alınabileceğini düşünmemek
   l. Diğer

____

151. Fırtınaya/ sam yeline karşı önlem alıyor musunuz?
   a. Evet
   b. Hayır [Soru152]

152. Fırtınaya/ sam yeline karşı aldığınız önlem nedir?
   ____

153. Fırtınaya/ sam yeline karşı önlem almamanızın sebebi nedir? (Birden fazla seçilebilir)
   a. Gerek duymamak
   b. Yeterli bilgiye sahip olmamak
   c. Teknik desteğin yetersiz olması
   d. Maliyeti karşılayacak gücünün olmaması
   e. Arazisinin küçük olması
   f. Tarımsal gelirinin az olması
   g. Fırtına/ sam yelini geçici bir durum olarak görmek
   h. Sonuçların uzun vadede görülecek olması
   i. İşgücü yetersizliği
   j. Değişimden/ yeni yöntemlerden çekinmek
   k. Bir önlem alınabileceğini düşünmemek
   l. Diğer

   ____

154. Bunlar dışında önlem aldığınız bir afet var mı?
   a. Evet
   b. Hayır [Soru159]

155. Bu afet nedir?
   ____

156. Nasıl bir önlem alıyorsunuz?
   ____

157. Önlem aldığınız başka bir afet var mı?
   a. Evet
   b. Hayır [Soru159]

158. Bu afet nedir?
   ____

159. Nasıl bir önlem alıyorsunuz?
   ____

160. Son 5 yıl içerisinde aşağıdakilerden herhangi birini yaptınız mı?
  a. Ekim zamanında değişiklik
  b. Tarlayı ekime hazırlama zamanında değişiklik
  c. Hasat zamanında değişiklik
  d. Münavebeli tarıma geçilmesi
  e. Korumalı toprak işleme
  f. Birden fazla ürün ekmeye başlama
  g. Ekilen ürünü/ ürünleri değiştirme
  h. Damla/ yağmurlama sulamaya geçiş
  i. Su kuyusu açtırma
  j. Hayvan gübresi uygulamaya başlama
  k. Nadas yapmaya başlama
  l. Hayvancılık yapmaya başlama
  m. Hayvanların satılması
  n. Bahçecilik yapmaya başlama
  o. Tarım dışı işlerde çalışmaya başlama

161. İklim değişikliği yüzünden tarımdan kazandıklarınız yetmezse ne yaparsınız? [Birden Fazla İşaretlenebilir]
  a. Tarım dışı bir işte çalışmaya başlarım [Soru161]
  b. Hayvancılığa başlarım
  c. Tarlaları kiralarım
  d. Göç ederim
  e. Tarımdan başka iş yapamam
  f. Diğer [Lütfen Belirtiniz]

  ____

162. İş olanaklarının nerelerde mümkün olacağını düşünüyorsunuz?
  a. Yaşadığım şehirde
  b. Yakınımdaki şehirlerde
  c. Yurt dışında

163. Son 10 yılda, çevrenizde iklim değişikliği sebebiyle KESİN göç eden oldu mu?
  a. Evet
  b. Hayır [Soru164]

164. İklim değişikliğinin bu göçte yüzde kaç etkili olduğunu düşünüyorsunuz?
  a. %25'ten az
  b. %25-%50
  c. %51-%75
  d. %76'dan fazla
  e. Tamamen iklim koşulları etkili oldu

165. Çevrenizde iklim değişikliği sebebiyle GEÇİCİ olarak göç eden oldu mu?/ oluyor mu?
   a. Evet
   b. Hayır [Soru166]

166. İklim değişikliğinin bu geçici göçte yüzde kaç etkili olduğunu düşünüyorsunuz?
   a. %25'ten az
   b. %25-%50
   c. %51-%75
   d. %76'dan fazla
   e. Tamamen iklim koşulları etkili oldu/oluyor

167. Son 10 yılda, çevrenizde iklim değişikliği sebebiyle göç etmese de tarımı bırakanlar oldu mu?
   a. Evet
   b. Hayır [Soru168]

168. Göç etmeyip tarımı bırakanlar yeni geçim kaynağı olarak neyle uğraşmaya başladılar?

   ____

169. Yaşanan iklimsel değişimler, konusunda herhangi bir kişi ya da kurum tarafından bilgilendirme yapıldı mı?
   a. Evet
   b. Hayır [Soru170]

170. Hangi kişi ya da kurum tarafından bilgilendirme yapıldı?
   a. İl/ilçe Gıda Tarım ve Hayvancılık Müdürlüğü
   b. Araştırma Enstitüsü (Bahri Dağdaş vb.)
   c. Vakıf/ dernek (Önder Çiftçi Derneği vb.)
   d. Tarımsal danışmanlık büroları
   e. Tar-gel personeli
   f. Özel sektör (Tohum şirketleri, ziraai ilaç bayi vb.)
   g. Muhtarlık
   h. Diğer [Lütfen Belirtiniz]

171. Meteoroloji bilgilerine DÜZENLİ olarak EN SIK hangi kaynaktan ulaşıyorsunuz?
   a. Radyo
   b. Gazete
   c. TV
   d. Internet

e. TARBİL istasyon verisi
f. Diğer çiftçiler
g. Bilgi alamıyorum
h. Diğer [Lütfen Belirtiniz]

172. Son 5 yılda tarımsal faaliyetleriniz için finansal desteğe ihtiyaç duydunuz mu?
    a. Evet
    b. Hayır [Soru175]

173. Finansal destek aldınız mı?
    a. Evet
    b. Hayır [Soru175]

174. Finansal desteği nerelerden aldınız?
    a. Devlet/ özel banka hibe kredisi
    b. Kalkınma Ajansı (hibe ve teşvik kredisi)
    c. Tarım ve Kırsal Kalkınmayı Destekleme Kurumu (TKDK) hibe desteği
    d. Tarım kooperatifi
    e. Arkadaş/ akraba borç
    f. Esnaftan borca malzeme almak
    g. Arkadaş/akraba destek
    h. Arkadaş/akraba destek
    i. DİĞER [Lütfen Belirtiniz]

175. Aldığınız desteği hangi amaçla kullandınız?
    a. Mazot borçları için
    b. Gübre borçları için
    c. Yem borçları için
    d. Tohum almak için
    e. Arazi alımı için
    f. Hayvan alımı için
    g. Tarımsal ekipman alımı için
    h. Tarımsal sulama için
    i. Tarım dışı ihtiyaçlar için
    j. Diğer [Lütfen Belirtiniz]

176. Sizce tarımsal kredi olanakları yeterli mi?
    a. Evet
    b. Hayır

FİZİKSEL VE SOSYAL ALTYAPI

177. Yaşadığınız yerde aşağıdakilerden hangileri bulunuyor?
    a. İlköğretim okulu
    b. Lise
    c. Cami
    d. Çalışan sağlık ocağı
    e. Çalışmayan sağlık ocağı
    f. Spor tesisi
    g. Veteriner
    h. Gübre, ilaç bayisi
    i. Diğer [Lütfen Belirtiniz]

178. Aşağıdaki kuruluşlardan hangilerine üyesiniz?
    a. Ziraat odası
    b. Üretim kooperatifi
    c. Sulama kooperatifi
    d. Tarım Kredi kooperatifi
    e. Birlik
    f. Önder Çiftçi Derneği
    g. Diğer [Lütfen Belirtiniz]

179. SORMADAN YANITLAYINIZ HİÇBİR ÜYELİĞİ YOKSA "YOK" varsa "VAR"ı işaretleyin.
    a. Yok [Soru181]
    b. Var

180. Bu kuruluşların düzenlediği faaliyetlerden DÜZENLİ olarak hangilerine katılıyorsunuz?
    a. Kuruluş faaliyet düzenlemiyor
    b. Toplantı
    c. Eğitim
    d. Seçim
    e. Gezi (sosyal faaliyet)
    f. Tanıtım gezisi (Fuar)
    g. Diğer [Lütfen Belirtiniz]

181. Üye olmama sebebiniz nedir?
    a. Yaşadığı yerde bu kuruluşlar yok
    b. Kuruluşlar yaşadığı yere uzak
    c. Kuruluşlar aktif çalışmıyor
    d. Diğer [Lütfen Belirtiniz]

182. Şimdiye kadar bir tarımsal eğitime katıldınız mı? (Targel personelinden vb.)?
   a. Evet
   b. Hayır [Soru1832]

183. Geçen yıl kaç tarımsal eğitime katıldınız?
   ____

184. Tarımsal programları/ yayınları takip ediyor musunuz?
   a. Evet
   b. Hayır [Soru185]

185. Tarımsal programları en çok nereden takip ediyorsunuz?
   a. Televizyon
   b. İnternet
   c. Radyo
   d. Diğer [Lütfen Belirtiniz]

186. ÇKS kaydınız var mı?
   a. Evet
   b. Hayır [Soru189]

187. Gıda Tarım ve Hayvancılık Bakanlığı tarafından verilen tarımsal desteklerden faydalanıyor musunuz?
   a. Evet
   b. Hayır [Soru189]

188. Tarımsal destek alınan toplam arazi büyüklüğü ne kadar?
   ________________ dekar

189. Hangi desteklerden faydalanıyorsunuz? (birden fazla işaretlenebilir)
   a. Havza bazlı fark ödemesi (yağlık ayçiçeği, dane mısır, soya fasülyesi, aspir, kanola, dane mısır, hububat, nohut, mercimek vb.)
   b. Alan bazlı destekler (mazot, gübre, toprak analizi, organik tarım, iyi tarım vb.)
   c. ÇATAK
   d. Yem bitkileri desteklemesi
   e. Sertifikalı tohum kullanımı desteklemesi
   f. Sertifikalı fidan/fide ve standart fidan kullanımı desteklemesi
   g. Sertifikalı tohumluk üretimi desteklemesi
   h. Biyolojik ve biyoteknik mücadele desteklemesi
   i. Makine/ekipman desteği
   j. Hayvancılık desteği

k. Diğer [Lütfen Belirtiniz]

190. Belediye, kaymakamlık gibi kurumlardan yardım alıyor musunuz?
   a. Evet
   b. Hayır [Soru192]

191. Ne tür yardımlar almaktasınız?
   a. Yiyecek yardımı
   b. Geçim temin edici yardımlar (iş kurmak için ekipman vb.)
   c. Barınma yardımı
   d. Eğitim yardımı (kitap, kırtasiye vb.)
   e. Nakdi yardım
   f. Yakacak yardımı
   g. Diğer (ayni sağlık, düğün vb.)
   h. Diğer [Lütfen Belirtiniz]

192. Aldığınız bu destek toplam gelirinizin ne kadarını oluşturuyor?
   a. %25'ten az
   b. %26-%50
   c. %51-%75
   d. %76'dan fazla

193. Sözleşmeli üretim yapıyor musunuz?
   a. Evet
   b. Hayır

194. Hanenin tarım dışı geliri var mı?
   a. Evet
   b. Hayır [Soru195]

195. Tarım dışı gelir(ler) toplam gelirin yüzde kaçını oluşturuyor?
   a. %25'ten az
   b. %26-%50
   c. %51-%75
   d. %76'dan fazla

196. Son 5 yıl içerisinde tarım sigortası yaptırdınız mı?
   a. Evet
   b. Hayır [Soru197]

197. Yaşadığınız bir afetten dolayı tarım sigortasından tazminat aldınız mı?
   a. Evet
   b. Hayır

198. Tarım sigortası yaptırmamanızın sebebi nedir?
   a. Pahalı
   b. Erişim zor
   c. Ürünlerimin risk altında olduğunu düşünmüyorum
   d. Diğer [Lütfen Belirtiniz]

B. The Results of the Socio-Economic Survey

Table B-1 *Demographic features of the households*

Vulnerability Variables	**Cihanbeyli**	**Karapınar**	**Seydişehir**
Age	52	53	55
Education	Primary school (52.9%)	Primary school (69.9%)	Primary school (65.7%)
Sex	All male	All male	All male
Average Household Size	4.9	5.5	3.8
Dependency Ratio	34.8%	30.7%	34.4%
Family members working in agriculture	35.2%	41%	56.6%
External help for agricultural production	Average 1.2 person	Average 0.7 person	Average 2.9 people
Duration of residency	11.1 months	11.7 months	10.8 months
Annual Income	15.001- 40.000 TL	15.001- 40.000 TL	15.001- 40.000 TL
Aim of agricultural production	Selling and consumption	Selling and consumption	Selling and consumption
Years of farming experience	28.6	29.7	31.7
Percentage share of agricultural production in income	25%- 50%	Less than 25%	Less than 25%

Table B-2. *Age Groups of the Respondents*

Age Groups	**Cihanbeyli**		**Karapınar**		**Seydişehir**	
	#	%	#	%	#	%
<18	0	0,0	0	0,0	0	0,0
18-30	14	8,0	4	2,7	1	1,5
30-60	106	60,9	96	65,8	41	61,2
60<	54	31,0	46	31,5	25	37,3

Table B-3. Education Levels of the Respondents

Education Level	**Cihanbeyli**		**Karapınar**		**Seydişehir**	
	#	%	#	%	#	%
Illiterate	2	1,1	0	0,0	0	0,0
Abandoned primary school	7	4,0	4	2,7	0	0,0

Education Level	Cihanbeyli		Karapınar		Seydişehir	
	#	%	#	%	#	%
Primary school graduate	92	52,9	102	69,9	44	65,7
Abandoned secondary school	8	4,6	5	3,4	3	4,5
Secondary school graduate	22	12,6	15	10,3	5	7,5
Abandoned high school	8	4,6	4	2,7	0	0,0
High school graduate (regular, Anatolian)	23	13,2	9	6,2	6	9,0
High school graduate (vocational)	4	2,3	0	0,0	3	4,5
Abandoned university	2	1,1	0	0,0	2	3,0
University graduate (open university)	1	0,6	0	0,0	1	1,5
University graduate (2-year license)	1	0,6	1	0,7	1	1,5
University graduate (regular)	4	2,3	5	3,4	2	3,0
Abandoned post graduate/ doctorate	2	1,1	0	0,0	0	0,0
Post-graduate	7	4,0	1	0,7	0	0,0

Table B-4. *Household Size of the Respondents*

Household Size	Cihanbeyli		Karapınar		Seydişehir	
	#	%	#	%	#	%
1	2	1,1	2	1,4	1	0,8
2	27	15,5	24	16,4	15	12,7
3	17	9,8	16	11,0	12	10,2
4	35	20,1	22	15,1	21	17,8
5	32	18,4	24	16,4	6	5,1
6+	61	35,1	58	39,7	63	53,4

Table B-5. *Income Levels of the Respondents*

Income Levels	**Cihanbeyli**		**Karapınar**		**Seydişehir**	
	#	%	#	%	#	%
Less than 15.000 TL	40	23,0	36	24,7	17	25,4
15.001- 40.000 TL	85	48,9	68	46,6	40	59,7
40.001- 70.000 TL	30	17,2	22	15,1	9	13,4
70.001- 100.000 TL	9	5,2	3	2,1	1	1,5
More than 100.0001 TL	10	5,7	17	11,6	0	0,0

Table B-6. *Percentage Share of Agricultural Income*

Percentage share of agricultural income	**Cihanbeyli**		**Karapınar**		**Seydişehir**	
	#	%	#	%	#	%
Less than 25%	39	22,4	35	24,0	18	26,9
25%- 50%	45	25,9	25	17,1	17	25,4
51%- 75%	28	16,1	29	19,9	14	20,9
More than 75%	22	12,6	25	17,1	13	19,4
100%	40	23,0	32	21,9	5	7,5

Table B-7. *Features of the Farming Systems*

	Cihanbeyli	**Karapınar**	**Seydişehir**
Total amount of land managed by the farmer	396,1 decares	209,9 decares	90,7 decares
Irrigated/Total	38,2%	67,4%	46,7%
# of parcels managed by the farmer	8,5	5,1	12,8
Average size of parcels managed by the farmer	46,5 decares	41,2 decares	9,4 decares
Percentage of land with good and medium soil quality	86,7%	83,1%	92,5%
Percentage of land with low and medium slope	91,0%	89,9%	96,8%
Traditional/ modern/ both	Traditional (8,1%) Modern (86,2%) Both (5,7%)	Traditional (6,9%) Modern (75,3%) Both (17,8%)	Traditional (7,5%) Modern (76,1%) Both (16,4%)
Number of devices used with tractor	5,7	5,6	6,2

Table B-8. *Irrigated vs Rain-fed Farming Land*

Irrigation	**Cihanbeyli**		**Karapınar**		**Seydişehir**	
	#	%	#	%	#	%
Rain-fed only	81	46,6	34	23,3	17	25,4
Irrigated only	41	23,6	90	61,6	16	23,9
Both rain-fed and irrigated	52	29,9	22	15,1	34	50,7

Table B-9. *Soil Analysis and Fertilization*

	Cihanbeyli	**Karapınar**	**Seydişehir**
Having soils analyzed?	Yes: 89.7% No: 10.3%	Yes: 74.0% No: 26.0%	Yes: 20.9% No: 79.1%
Fertilization according to soil analysis results	Yes: 71.8% No: 28.2%	Yes: 74.1% No: 25.9%	Yes: 100.0% No: 0.0%
Reasons of not fertilizing according to analysis results	Analysis results are no trustable Analysis results do not prescribe enough amount of fertilizer Trust to traditional knowledge Economic incapability To benefit from subsidies		

Table B-10. *Crop Diversification*

	Cihanbeyli		**Karapınar**		**Seydişehir**	
# of crops in a year	2,0		1,8		2,2	
Reason of crop diversity at different plots	#	%	#	%	#	%
Crop rotation	37	22,8%	21	17,1%	22	25,6%
Reduce risk	44	27,2%	29	23,6%	14	16,3%
Animal feed	10	6,2%	19	15,4%	15	17,4%
Diversify/increase income	71	43,8%	54	43,9%	35	40,7%
Crop diversity on different plots						
Yes	66,1%		74,0%		82,1%	
No	33,9%		26,0%		17,9%	
Reason of single crop	No alternative in rain-fed farming					

Table B-11. *Water Resources*

	Cihanbeyli		Karapınar		Seydişehir	
Water source	#	%	#	%	#	%
Groundwater	90	92,8	111	100	14	18,9
Surface water (river, lake, pond, canal)	5	5,2	0	0	60	81,1
Is water enough	#	%	#	%	#	%
Yes	58	63,0	85	76,6	31	59,6
No	21	22,8	12	10,8	5	9,6
Changes depending on the climatic conditions	13	14,1	14	12,6	16	30,8
Energy consumed for irrigation	#	%	#	%	#	%
Yes	90	97,8	108	97,3	46	88,5
No	2	2,2	3	2,7	6	11,5
Reduction in irrigation water	#	%	#	%	#	%
Yes	63	68,5	92	82,9	37	71,2
No	29	31,5	19	17,1	15	28,8
Precaution against irrigation water reduction	#	%	#	%	#	%
Yes	28	44,4	59	64,1	9	24,3
No	35	55,6	33	35,9	28	75,7

Table B-12. *Animal Husbandry*

	Cihanbeyli		Karapınar		Seydişehir	
Average number of animals per farmer	9,8		16,1		6,0	
Pasture quality	#	%	#	%	#	%
Good	8	26,7	6	18,2	5	31,3
Medium	13	43,3	15	45,5	8	50,0
Bad	9	30,0	12	36,3	3	18,8

Table B-13. *Social Setting*

	Cihanbeyli	Karapınar	Seydişehir
# of facilities available	4,3	4,6	3,5
# of memberships to agricultural organizations	2,0	2,4	2,8
# of activities participated	1,2	1,5	1,7

	Cihanbeyli		Karapınar		Seydişehir	
# of obtained agricultural training in past year	1,1		1,6		0,9	
Source of agricultural programmes?	#	%	#	%	#	%
Television	121	90,3	125	98,4	63	100
Internet	13	9,7	2	1,6	0	0
Radio	0	0	0	0	0	0
Other	0	0	0	0	0	0

Table B-14. *Agricultural Subsidies*

	Cihanbeyli		Karapınar		Seydişehir	
Registry to Farmer Registration System	#	%	#	%	#	%
Yes	153	87,9	129	88,4	52	77,6
No	21	12,1	17	11,6	15	22,4
Obtaining agricultural support of the Ministry? (among the registered farmers)	#	%	#	%	#	%
Yes	86	56,2	73	56,6	37	50,7
No	67	43,8	56	43,4	36	49,3
# of agricultural subsidies obtained	#	%	#	%	#	%
1	16	18,6	18	24,7	5	13,5
2	33	38,4	22	30,1	10	27,0
3	20	23,3	21	28,8	16	43,3
4	9	10,5	10	13,7	6	16,2
5	5	5,8	2	2,7	0	0
6	2	2,3	0	0	0	0
7	1	1,1	0	0	0	0
Type of Subsidies Obtained	#	%	#	%	#	%
Basin-based difference payment	40	46,5	38	52,1	18	48,6
Area-based subsidies	79	91,9	69	94,5	36	97,3
ÇATAK	1	1,2	0	0,0	0	0,0
Animal feed subsidy	7	8,1	5	6,8	0	0,0
Certified seed subsidy	48	55,8	32	43,8	28	75,7
Certified sapling/seedling and standard sapling subsidy	3	3,5	4	5,5	0	0,0
Certified seed production subsidy	18	20,9	10	13,7	5	13,5

	Cihanbeyli		Karapınar		Seydişehir	
Biological and biotechnical pest control subsidy	0	0,0	0	0,0	0	0,0
Machinery/ equipment subsidy	8	9,3	4	5,5	3	8,1
Animal husbandry subsidy	16	18,6	12	16,4	6	16,2

Table B-15. *Other Livelihood Options*

	Cihanbeyli		Karapınar		Seydişehir	
Support from municipality/ district governorship	#	%	#	%	#	%
Yes	1	0,6	3	2,1	1	1,5
No	173	99,4	143	97,9	66	98,5
Contract-based agricultural production	#	%	#	%	#	%
Yes	45	25,9	16	11,0	27	40,3
No	129	74,1	130	89,0	40	59,7
Non-agricultural income sources	#	%	#	%	#	%
Yes	122	70,1	103	70,5	55	82,1
No	52	29,9	43	29,5	12	17,9
Share of non-agricultural income sources in total income	#	%	#	%	#	%
Less than 25%	23	18,9	17	16,5	3	5,5
26%- 50%	55	45,0	27	26,2	18	32,7
51%- 75%	29	23,8	46	44,7	29	52,7
More than 76%	15	12,3	13	12,6	5	9,1

Table B-16. *Agricultural Insurance*

	Cihanbeyli		Karapınar		Seydişehir	
Agricultural insurance in the last 5 years	#	%	#	%	#	%
Yes	125	71,8	61	41,8	10	14,9
No	49	28,2	85	58,2	57	85,1
Insurance indemnity due to a disaster	#	%	#	%	#	%
Yes	50	40,0	4	6,6	1	10,0
No	75	60,0	57	93,4	9	90,0

	Cihanbeyli		Karapınar		Seydişehir	
Causes of not having insurance	#	%	#	%	#	%
Fatalistic behaviour	4	25	3	10	0	0
Do not possess the deed title	2	13	4	13	4	22
The insurance do not compensate losses	5	31	3	10	3	17
Did not consider necessary	1	6	5	16	10	56
Missed the deadline	2	13	14	45	1	6
Do not know	2	13	2	6	0	0

Table B-17. *Observed Climatic Changes*

	Cihanbeyli		Karapınar		Seydişehir	
	#	%	#	%	#	%
Increasing precipitation	28	16,1	12	8,2	5	7,5
Decreasing precipitation (drought)	160	92,0	133	91,1	61	91,0
Irregular precipitation	168	96,6	135	92,5	60	89,6
Delayed precipitation	166	95,4	139	95,2	64	95,5
Shorter precipitation period	164	94,3	136	93,2	60	89,6
Increasing temperature	161	92,5	137	93,8	61	91,0
Increasing # of floods	8	4,6	3	2,1	1	1,5
Increasing # of hails	52	29,9	44	30,1	10	14,9
Increasing # of frost	100	57,5	95	65,1	53	79,1
Increasing # of simoons	108	62,1	84	57,5	37	55,2
Increasing # of storms	59	33,9	37	25,3	33	49,3
Increase in day-night temperature difference	91	52,3	89	61,0	44	65,7
Other	0	0,0	0	0,0	0	0,0

Table B-18. *Reason of Climatic Changes*

	Cihanbeyli		Karapınar		Seydişehir	
	#	%	#	%	#	%
Don't know	61	35,1	66	45,2	27	40,3
Global Warming	29	16,7	25	17,1	4	6,0
Human Activities Destroying Natural Balance	25	14,4	9	6,2	4	6,0
Industrialization (chemicals, fertilizers, fuel use)	13	7,5	6	4,1	10	14,9
No afforestation/ deforestation	8	4,6	3	2,1	2	3,0
No change	2	1,1	3	2,1	2	3,0
Ozone layer depletion	4	2,3	4	2,7	5	7,5
God's will	9	5,2	3	2,1	0	0,0
Greenhouse gases	3	1,7	1	0,7	0	0,0
Glaciers melting	2	1,1	0	0,0	4	6,0
Unconsciousness	5	2,9	2	1,4	2	3,0
Natural cycle	5	2,9	0	0,0	1	1,5
Agriculture (chemicals, fertilizers, excess usage of water-moisture)	0	0,0	13	8,9	0	0,0
Other	7	4,0	11	7,5	5	7,5

Table B-19. *Exposure to Climatic Changes and Livelihood Strategies*

Exposure	Cihanbeyli		Karapınar		Seydişehir	
	#	%	#	%	#	%
Exposure to drought	160	92,0	129	88,4	51	76,1
Crop loss due to drought	156	89,7	122	83,6	50	74,6
Exposure to flood	6	3,4	3	2,1	6	9,0
Crop loss due to flood	3	1,7	3	2,1	5	7,5
Exposure to hail	89	51,1	76	52,1	17	25,4
Crop loss due to hail	79	45,4	66	45,2	0	0,0
Exposure to frost	92	52,9	91	62,3	55	82,1
Crop loss due to frost	83	47,7	80	54,8	52	77,6
Exposure to storm	42	24,1	15	10,3	21	31,3
Crop loss due to storm	37	21,3	10	6,8	12	17,9
Exposure to other disaster	13	7,5	16	11,0	5	7,5
Crop loss due to other disaster	13	7,5	12	8,2	5	7,5
Equipment loss	0	0,0	0	0,0	1	1,5

Table B-20. *Adaptation Methods*

Adaptation Methods	**Cihanbeyli**		**Karapınar**		**Seydişehir**	
	#	**%**	**#**	**%**	**#**	**%**
Take a loan	25	14,4	46	31,5	13	19,4
Borrowing	30	17,2	23	15,8	6	9,0
Mortgage of properties	11	6,3	3	2,1	1	1,5
Selling properties/animals	9	5,2	12	8,2	10	14,9
Usage of savings/ salary	26	14,9	19	13,0	14	20,9
Borrowing materials from retailers	18	10,3	15	10,3	10	14,9
Reduction in consumption	13	7,5	3	2,1	2	3,0
Buying food	7	4,0	3	2,1	0	0,0
Help from other family members	12	6,9	5	3,4	1	1,5
Applying for government support	17	9,8	5	3,4	2	3,0
Working outside agricultural sector	8	4,6	4	2,7	1	1,5
Working abroad	2	1,1	0	0,0	0	0,0

Table B-21. *Precautions Taken Against Drought*

Precaution	**Cihanbeyli**		**Karapınar**		**Seydişehir**	
	#	**%**	**#**	**%**	**#**	**%**
Afforestation	1	0,6	6	4,1	1	1,5
More irrigation	8	4,6	2	1,4	0	0,0
Efficient irrigation	10	5,7	20	13,7	8	11,9
Opening up/ deepening well	5	2,9	6	4,1	0	0,0
Insurance	10	5,7	3	2,1	0	0,0
Early usage of fertilizers and chemicals	2	1,1	0	0,0	0	0,0
Fertilization	0	0,0	1	0,7	0	0,0
Drought resistant crops	0	0,0	1	0,7	0	0,0

Table B-22. *Reason of Not Taking Precaution Against Drought*

	Cihanbeyli		Karapınar		Seydişehir	
	#	%	#	%	#	%
Find unnecessary	33	19,0	32	21,9	10	14,9
Lack of information	17	9,8	15	10,3	5	7,5
Lack of technical support	14	8,0	6	4,1	4	6,0
Cannot afford	17	9,8	4	2,7	2	3,0
Small size of farm land	2	1,1	1	0,7	2	3,0
Lack of irrigation opportunity	44	25,3	31	21,2	6	9,0
Low agricultural income	4	2,3	3	2,1	0	0,0
Think drought temporary	3	1,7	0	0,0	0	0,0
Too long to see the results	2	1,1	2	1,4	0	0,0
Lack of labour	4	2,3	0	0,0	0	0,0
Abstain from change/ new methods	2	1,1	4	2,7	0	0,0
No precaution can be taken	82	47,1	65	44,5	35	52,2
Other	4	2,3	2	1,4	1	1,5

Table B-23. *Precautions Taken Against Flood*

Precaution	Cihanbeyli		Karapınar		Seydişehir	
	#	%	#	%	#	%
Channel/ embankment construction	2	1,1	1	0,7	1	1,5
Insurance	2	1,1	0	0,0	0	0,0

Table B-24. *Reason of Not Taking Precaution Against Flood*

	Cihanbeyli		Karapınar		Seydişehir	
	#	%	#	%	#	%
Find unnecessary	125	71,8	106	72,6	42	62,7
Lack of information	3	1,7	2	1,4	2	3,0
Lack of technical support	0	0,0	0	0,0	1	1,5
cannot afford	0	0,0	0	0,0	0	0,0
small size of farm land	0	0,0	0	0,0	1	1,5

low agricultural income	0	0,0	0	0,0	0	0,0
think drought temporary	0	0,0	1	0,7	0	0,0
too long to see the results	0	0,0	0	0,0	0	0,0
lack of labour	1	0,6	0	0,0	0	0,0
abstain from change/ new methods	0	0,0	0	0,0	0	0,0
no precaution can be taken	16	9,2	11	7,5	11	16,4
other	4	2,3	0	0,0	0	0,0

Table B-25. *Precautions Taken Against Frost*

Precaution	**Cihanbeyli**		**Karapınar**		**Seydişehir**	
	#	**%**	**#**	**%**	**#**	**%**
Late planting	2	1,1	1	0,7	0	0,0
Over fertilization	6	3,4	2	1,4	0	0,0
Insurance	2	1,1	0	0,0	0	0,0
Burning fire	0	0,0	1	0,7	0	0,0
Frost cover	0	0,0	0	0,0	1	1,5

Table B-26. *Reason of Not Taking Precaution Against Frost*

	Cihanbeyli		**Karapınar**		**Seydişehir**	
	#	**%**	**#**	**%**	**#**	**%**
Find unnecessary	60	34,5	42	28,8	12	17,9
Lack of information	11	6,3	7	4,8	2	3,0
Lack of technical support	9	5,2	2	1,4	1	1,5
Cannot afford	12	6,9	1	0,7	1	1,5
Small size of farm land	3	1,7	0	0,0	0	0,0
Low agricultural income	3	1,7	0	0,0	0	0,0
Think drought temporary	1	0,6	0	0,0	0	0,0
Too long to see the results	0	0,0	1	0,7	0	0,0
Lack of labour	0	0,0	0	0,0	0	0,0
Abstain from change/ new methods	1	0,6	0	0,0	0	0,0
No precaution can be taken	92	52,9	81	55,5	49	73,1
Other	6	3,4	3	2,1	1	1,5

Table B-27. *Precautions Taken Against Storm/ Simoon*

Precaution	**Cihanbeyli**		**Karapınar**		**Seydişehir**	
	#	**%**	**#**	**%**	**#**	**%**
Additional irrigation	2	1,1	0	0,0	0	0,0
Insurance	1	0,6	0	0,0	0	0,0
Wind breakers	0	0,0	1	0,7	0	0,0

Table B-28. *Reason of Not Taking Precaution Against Storm/ Simoon*

	Cihanbeyli		**Karapınar**		**Seydişehir**	
	#	**%**	**#**	**%**	**#**	**%**
Find unnecessary	66	37,9	51	34,9	16	23,9
Lack of information	12	6,9	8	5,5	2	3,0
Lack of technical support	3	1,7	3	2,1	1	1,5
Cannot afford	6	3,4	2	1,4	3	4,5
Small size of farm land	1	0,6	0	0,0	1	1,5
Low agricultural income	1	0,6	0	0,0	0	0,0
Think drought temporary	0	0,0	0	0,0	0	0,0
Too long to see the results	1	0,6	0	0,0	0	0,0
Lack of labour	1	0,6	0	0,0	0	0,0
Abstain from change/ new methods	2	1,1	0	0,0	0	0,0
No precaution can be taken	79	45,4	61	41,8	36	53,7
Other	6	3,4	1	0,7	0	0,0

Table B-29. *Adaptation to Climatic Changes*

Adaptation Method	**Cihanbeyli**		**Karapınar**		**Seydişehir**	
	#	**%**	**#**	**%**	**#**	**%**
Change of planting time	58	33,3	69	47,3	33	49,3
Change of tillage time	54	31,0	68	46,6	33	49,3
Change of cultivation time	43	24,7	58	39,7	32	47,8
Started crop rotation	60	34,5	55	37,7	25	37,3
Conservation agriculture	44	25,3	31	21,2	11	16,4
Started diversifying crops	68	39,1	53	36,3	30	44,8

Adaptation Method	Cihanbeyli		Karapınar		Seydişehir	
Change of crop	102	58,6	85	58,2	38	56,7
Use of efficient irrigation techniques	71	40,8	93	63,7	35	52,2
Drilling well	41	23,6	48	32,9	8	11,9
Use of natural fertilizer	33	19,0	44	30,1	14	20,9
Started fallowing	101	58,0	51	34,9	14	20,9
Started animal husbandry	29	16,7	37	25,3	15	22,4
Selling animals	30	17,2	41	28,1	25	37,3
Started orchard	20	11,5	24	16,4	18	26,9
Started working in non-agricultural sector	41	23,6	34	23,3	13	19,4

Table B-30. Share of Climate Change in Permanent Migration

	Cihanbeyli		Karapınar		Seydişehir	
	#	%	#	%	#	%
Less than 25%	20	24,7	41	53,2	12	48,0
25%- 50%	38	46,9	21	27,3	9	36,0
51%- 75%	14	17,3	13	16,9	3	12,0
More than 76%	8	9,9	2	2,6	1	4,0
Completely	1	1,2	0	0,0	0	0,0
TOTAL	81	100	77	100	25	100

Table B-31. Share of Climate Change in Temporary Migration

	Cihanbeyli		Karapınar		Seydişehir	
	#	%	#	%	#	%
Less than 25%	35	49,3	35	66,0	12	66,7
25%- 50%	28	39,4	13	24,5	3	16,7
51%- 75%	7	9,9	3	5,7	1	5,6
More than 76%	1	1,4	2	3,8	2	11,0
Completely	0	0,0	0	0,0	0	0,0
TOTAL	71	100	53	100	18	100

CURRICULUM VITAE

PERSONAL INFORMATION

Surname, Name	: Kuş, Melike
Nationality	: Turkish (TC)
Date and Place of Birth	: 15 September 1979, Antalya
Phone	: +90 507 380 96 60
E-mail	: melikekus@gmail.com

EDUCATION

Degree	Institution	Year of Graduation
MS	Hacettepe Environmental Engineering	2011
MS	Southampton Environmental Assessment	2009
BS	METU City and Regional Planning	2002
High School	Karatay High School, Antalya	1997

WORK EXPERIENCE

Year	Place	Enrollment
2013-Present	Nature Conservation Centre	Programme Coordinator
2011 Dec	FutureCamp Turkey	Carbon Reduction Consultant
2011 May	University of Southampton	Environmental Consultant
2008 Sept	TÇT Environmental Technologies	Environmental Consultant
2007 April	Alter International	Environmental Consultant

FOREIGN LANGUAGES

Advanced English

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