Egyptian Agriculture in Transition: Farmer Perceptions of Risks and Adaptation Opportunities in a Changing Climate

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A thesis submitted in fulfilment of the degree of Doctor of Philosophy

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July 2021

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ABSTRACT

The world is witnessing major changes in climate, progressively causing environmental, socio-economic, and political challenges. Climate variability and change are affecting agricultural sectors across the globe and are impacting the economic and social conditions of many agricultural households in rural areas, particularly in developing countries. The agricultural sector in Egypt is already under stress due to population growth and critically low water availability. Egypt is likely to suffer further negative impacts of climate change with key concerns in food security, inundation of coastal areas, environmental degradation, land and freshwater resource depletion, and declining local production and economic conditions. Adaptation to climate change is critical to reduce or avoid the more extreme adverse effects of environmental change, meet the future needs of a growing population, and maintain secure livelihoods for those who depend on agriculture for their existence.

This study aims to understand the links between the phases of agrarian transition concerning perceptions of and adaptation to climate change to generate knowledge and enhance current and future local adaptation to climate change within rural Egypt. This research focuses on three components: (1) Farming households' perceptions of risks from climate change and other changes in the agricultural sector in Egypt; (2) the *in situ* and *ex situ* strategies that farmers and their households consider suitable while adapting to climate change within their socio-economic and cultural contexts and; (3) the cultures of migration that could influence current and potential migration decisions of rural households.

The study was conducted in four villages in Damietta, one of the governorates of the Nile Delta Region. This region was chosen because it is one of the most vulnerable to the impacts of climate change in Egypt, particularly concerning the potential threat of sea-level rise and water resource depletion. A mixed-method research approach is adopted, with both qualitative and quantitative data accessed. Primary quantitative data were collected from 350 small landholder farmers and waged agricultural labourers using a questionnaire implemented via face-to-face interviews from April 2018 to September 2018. A further 11 in-depth interviews were conducted with key respondents to gather qualitative data about the pressing challenges facing farming households in the study area.

Small landholder farmers in Damietta are experiencing climate change. They have high levels of perception of its adverse impacts on crop productivity and quality, and household incomes, yet their adaptation levels remain low. Stemming from the different paths or phases of the agrarian transition, three groups of households emerged from the initial analysis to form the basis for grouping three types of climate change adapters based on the relative contributions of agriculture to household income. The social and economic impacts of climate change appear largely unimportant for households who depend primarily on non-agricultural activities for a living. While some households are adapting *in situ* in Damietta, but those are the relatively wealthy households who are not wholly dependent on agriculture for their livelihoods. In contrast, those households who depend primarily on agriculture for a living have a strong perception of the negative impacts of climate change, yet, they are implementing the fewest adaptation responses - either *in situ* or *ex situ*, and are more reluctant to leave the agricultural sector or their communities. Consequently, relatively poor farming households appear to be less capable of adapting to climate change even though they form a more vulnerable cohort and potentially constitute a trapped population with little capacity to respond effectively to risk.

Considering the growing demographic, economic, social, and environmental challenges in Egypt and other parts of the Middle East and North Africa (MENA) region, many small landholder farming communities might find it difficult to sustain a living from agriculture or exploit livelihood opportunities elsewhere. This situation will be particularly critical for trapped populations who are unable or unwilling to relocate, as the repeated climate change stressors can continue to undermine their already fragile economic livelihoods and erode their asset base, making them less able to adapt either *in situ* or *ex situ*. As has already been experienced in several MENA countries, struggling rural households may form a potential latent group that could continue to drive radical social changes in Egypt if conditions for agriculture continue to deteriorate. Developing marginal communities' capacities to adapt *in situ* through investing in rural education and micro-economy is of key importance both to maintain local livelihoods and the broader social fabric.

DECLARATION

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint-award of this degree.

I give permission for the digital version of my thesis to be made available on the web, via the University's digital research repository, the Library Search and also through web search engines, unless permission has been granted by the University to restrict access for a period of time.

I acknowledge the support I have received for my research through the provision of an Australian Government Research Training Program Scholarship.

Sign: _ Date: 1 July 2021

ACKNOWLEDGMENTS

"All the praise is for God, the One Who has guided us to this"

First and foremost, I would like to express my sincere gratitude to my principal supervisor A/Prof Douglas Bardsley for his extraordinary supervision, support, and guidance. His immense knowledge and enthusiasm have significantly improved this thesis and pushed me farther than I thought I could. Without his valuable support, it would not have been possible for me to come this far in my journey. I would also like to extend my deepest appreciation to my co-supervisor, A/Prof Yan Tan, for supporting my scholarship application and for her insightful suggestions and invaluable contribution to this thesis.

I gratefully acknowledge the financial contribution of the Department of Geography, Environment and Population and the Charles and Frank Fenner Award, which funded my fieldwork and data collection in Egypt. I thank all staff and colleagues in the Department of Geography, Environment and Population. My most profound indebtedness goes to Dr. Jennifer Bonham, the department's former postgraduate coordinator, for her great support during my candidature. I am also grateful to the Adelaide Campus Child Care Centre for taking good care of my daughter during my PhD journey. I wish to thank my editor, Emma Short, for her efforts and generous advice on formatting.

I must also thank all those who facilitated my fieldwork in Damietta – Eng. Mohamed Abou Attia, Eng. Hassan El-Sharkawy, Mr. Hazim, Eng. Saber and Eng. Sherif Negm. Special thanks to the enumerator team, especially Ehab Hassan, and my colleagues and professors at Cairo University. My sincerest gratitude goes to the hundreds of farmers who participated in this study. I am thankful for their cooperation, time commitment, and wonderful hospitability and generosity.

To my father, Roushdy Omar, and my mother, Samar Ali, whom I deeply miss. Thank you for your endless love, support, and prayers and for your sacrifices for educating my sisters and me. You have always encouraged me to work hard and not think that anything was beyond me. I would like to thank my sisters and best friends, Soha and Shaza, and their lovely sons, Anas and Badr, for their incredible love and words of encouragement. Many thanks to my family in law for their support.

To my little girl, Nour "Light", you are my soul, sunshine, and the best thing ever happened to me. Thank you for getting me through the hard days and filling my life with happiness despite all difficulties. To my husband, Mohamed, thank you for your patience, understanding and encouragement throughout this project. Thank you for putting up with my mood swings, stress and many times of depression.

Last but not least, I thank my colleagues and close friends Hannah, Julia, Bridie, Bay, Jeremiah and Govind, who provided much-needed laughter, advice and many great memories that I will cherish forever. To my Egyptian friends, whom I consider my second family here in Australia, I am very thankful for your friendship and love.

ABBREVIATIONS AND ACRONYMS

CAPMAS	Central Agency for Public Mobilisation and Statistics (Egypt)
CTA	Technical Centre for Agricultural and Rural Cooperation
EEAA	Egyptian Environmental Affairs Agency (Egypt)
FAO	Food and Agriculture Organisation
FIAN	Food-First Information and Action Network
GRD	Grand Renaissance Dam
HH	Household
IFAD	International Fund for Agricultural Development
IOM	International Organisation for Migration
IPCC	Intergovernmental Panel on Climate Change
IRIN	Integrated Regional Information Networks
MALR	Ministry of Agriculture and Land Reclamation (Egypt)
MENA	The Middle East and North Africa
NGO	Non-governmental Organisation
OECD	Organisation for Economic Co-operation and Development
SIDA	Swedish International Development Cooperation Agency
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children's Fund
UNOCHA	The United Nations Office for the Coordination of Humanitarian Affairs
WWAP	United Nations World Water Assessment Programme

Chapter One: Introduction

1.1 Introduction

There are a range of political, economic and institutional dynamics that shape the agricultural sector (Pradeep & Shane 2003). Yet, environmental factors, especially climate, are considered the primary drivers that directly influence agricultural production in most places (Houghton 2009). Today, the world is witnessing significant changes in climate that are expected to affect most of the world adversely, but especially the poor who depend on agriculture as a primary source of living (IFAD 2010). The Middle East and North Africa (MENA) region appears as the global region most vulnerable to climate change, due to the expansion of aridity in many areas (Al Taweel, Ugursal & Boodlal 2015; Alboghdady & El-Hendawy 2016; Waha et al. 2017; Ozturk et al. 2018) and the lack of water resources (Droogers et al. 2012; Terink, Immerzeel & Droogers 2013; Alboghdady & El-Hendawy 2016). Consequently, the region is considered "one of the hot spots for worsening extreme heat, drought and aridity conditions under climate change" (Waha et al. 2017, p.1). The agricultural sector, in particular, is highly vulnerable to climatic variability (Wasimi 2010), and such vulnerability will have critical consequences as the sector employs most of the labour force and plays a significant role in meeting national food demand (Verner 2012).

The agricultural sector in the MENA region generally, and Egypt specifically, is already under stress due to population growth and critically low water availability (MALR 2009; Koocheki 2010; Sowers, Vengosh & Weinthal 2011; Verner 2012; Waha et al. 2017). This situation would be further challenged with the projected future population increases and resultant increasing demand for food and water (Nigatu & Motamed 2015; Waha et al. 2017). Climate change will exacerbate pressures on the increasingly scarce resources, and its effects upon the agricultural sector will be significant (Cline 2007; Sowers, Vengosh & Weinthal 2011). Such environmental pressures will affect many rural households who depend on agriculture for their livelihood and thus reinforce conditions of unemployment and poverty that are already prevalent in the region, leading potentially to social and political unrest and conflict over resources (Sowers & Weinthal 2010; IFAD 2010; Sowers, Vengosh & Weinthal 2011; Nigatu & Motamed 2015; Waha et al. 2017).

Therefore, adaptation to climate change is critical to attempt to reduce or avoid the adverse effects of climate change; to meet the future needs of a growing population; and to maintain secure livelihoods for those who depend on agriculture for their existence. For adaptation to be achieved, farmers first need to perceive or be made aware of the current and future risks associated with climate change (Smithers & Smit 1997; Weber 1997; Vedwan & Rhoades 2001; Maddison 2007; Patt & Schröter 2008; Weber & Johnson 2009; Gbetibouo 2009; Bardsley & Hugo 2010; Spence et al. 2011; Koerth et al. 2013; Bagagnan, Ouedraogo & Fonta 2019). This thesis aims to analyse Egyptian farmers' perceptions of climate change impacts, including risks for the agricultural sector and from climate change directly, and the measures to adapt *in situ* or *ex situ* with the household. The thesis also considers the socio-economic factors that influence households' adaptive capacities and perceptions of risk. The research takes into consideration how the climate risk perceptions and actions are influenced by households at different phases of the agrarian transition, by grouping households based upon their dependency on agriculture for the generation of their livelihoods. This categorisation of households aims to support an in-depth analysis and understanding of the vulnerability and the adaptive capacities of households within different socio-economic groups in an evolving Egyptian rural society.

The study adopts a mixed-methods approach in which quantitative and qualitative data were collected from four villages in Damietta, one of the governorates of the Nile Delta Region in Egypt. This region was chosen as being one of the most vulnerable areas to the effects of climate change in Egypt, particularly concerning the potential threat of rising sea-levels as it is bordered by the Mediterranean Sea (El-Raey 2010; EEAA 2010, 2016; Frihy & El-Sayed 2013; Wöppelmann et al. 2013; Elshinnawy & Almaliki 2021). Egypt is expected to be badly affected by climate change, as such change could have serious environmental, economic and social effects on the different sectors, but particularly the agricultural sector (EEAA 2010; 2016). Due to growing land fragmentation in Egypt, agricultural lands are dominated by small landholder farmers (Aboulnaga et al. 2017) – many of whom are considered to be extremely vulnerable to climate change (IFAD 2010). The general scope of this research, therefore, includes a discussion on the climate change implications for the Egyptian agricultural sector with a particular emphasis on smallholding farmers and landless agricultural labourers. It continues on to examine how different groups across the rural society of Egypt may experience and respond to climate change.

This introductory chapter begins by outlining the aims and objectives of the research. It outlines the persistent social, economic, demographic and environmental challenges in the MENA region in general, and in Egypt specifically, highlighting the key issues surrounding climate change with a particular focus on its impact upon the agricultural sector. The chapter then introduces some key theoretical concepts of risk perception, adaptation to climate change with its two approaches, *in situ* and *ex situ*, and agrarian transition theory. The author then emphasises some of the research gaps and outlines the current research questions. Finally, she frames how the remainder of the thesis will be organised to answer the research questions.

1.2 Purpose and objectives

This study aims to analyse the links between the phases of the agrarian transition and farmer perceptions and adaptation to climate change, to generate knowledge and to enhance current and future local adaptation to climate change within rural Egypt, MENA countries and other parts of the world experiencing climate change as they pass through the agrarian transition process.

Specific objectives of this study are as follows:

1. Identify the degree to which Egyptian rural households, particularly within small landholder communities, perceive current and future risks associated with climate change and employment in the agricultural sector;
2. Explore the current strategies that farmers and their households consider suitable while adapting to climate change within their socio-economic and cultural contexts; and
3. Identify the extent to which households' dependency on agricultural activities for their livelihood and other socio-economic factors influence their perception of, and level of, adaptation to climate change.

1.3 Research Background

1.3.1 Climate change and the MENA region: An area of concern

The MENA region encompasses twenty countries, as defined by UNICEF, located in the Middle East and northern part of Africa (Figure 1.1). In 2018, the region's population reached 484 million, with an average growth of 2.0 percent per year, exceeding the world's average by 0.7 percent (UNICEF 2019). Egypt and Iran are the two most populated countries in the region, containing nearly 40 percent of the region's population. By 2050, the MENA region's population is expected to reach 724 million, and Egypt will experience a large population increase, with an additional 26 million people expected between 2015 and 2030, and a further 60 million by 2050 (UNICEF 2019). Mostly poor and fragile countries or countries in conflict tend to have faster population growth (Walker 2016). In Egypt, for instance, roughly one-third of the population lived below the national poverty line (around $1.45 per day) in 2018, with 6.2 percent of Egyptians living in extreme poverty (less than a dollar per day) (CAPMAS 2019a). Together, the rapid population growth and widespread poverty already ensure that many people are extremely vulnerable across the country, even before the implications of climate change are examined.

Figure 1.1 Map of the Middle East and North Africa (MENA) region

Source: UNICEF (2019)

The MENA region is one of the most economically diverse areas of the world, ranging from the high-income, oil-rich countries in the Persian Gulf, to poorer countries with scarce resources and high populations, such as Egypt, Yemen, and Morocco (Terink, Immerzeel & Droogers 2013; OECD-FAO 2018). This economic diversity entails variability in the vulnerability to climate change risks and the adaptive capacities across the region, especially between the Arab Gulf States, including Saudi Arabia, United Arab Emirates, Kuwait, Qatar, Bahrain and Oman, and the other MENA countries (Waha et al. 2017). Many developing countries already face severe environmental threats, governance challenges, and problems in their social and economic structures (Adger et al. 2003; Lemos & Agrawal 2006); consequently, developing countries within the region are likely to bear the worst effects of climate change (Stern 2006).

Arid and low-lying coastal areas, prevailing through most of the MENA countries, are considered to be particularly exposed to the effects of climate change (Al Taweel, Ugursal & Boodlal 2015), as their flood-prone coastal zones hold the majority of economic activities and population, and the region is highly dependent on climate-sensitive agriculture (Alboghdady & El-Hendawy 2016). Therefore, the MENA is one of the most vulnerable regions to the risks of climate change in the world with potential adverse effects on water resources, the agricultural sector, and the socio-economic and political conditions of the region as is explained below (Alboghdady & El-Hendawy 2016; Waha et al. 2017; Ozturk et al. 2018).

1.3.1.1 Effects on water resources

The MENA region is one of the most arid, inhabited areas on the globe (Droogers et al. 2012; Terink, Immerzeel & Droogers 2013; Alboghdady & El-Hendawy 2016). This situation alone, coupled with the projected exponential population growth in the region, is increasing water stress (Koocheki 2010; Sowers, Vengosh & Weinthal 2011). However, the most significant effect could become evident in those countries that depend upon surface water supplies from rivers, such as Egypt relies upon the Nile, and the flow regimes are altered over time (Sowers, Vengosh & Weinthal 2011). Egypt's control over Nile water has been threatened by the Grand Renaissance Dam's construction in Ethiopia – a situation that could further put water availability in Egypt at enormous risk if sufficient water supply remains unavailable for downstream countries (Nunzio 2013; Power 2014). Together, climate change coupled with demographic challenges, water pollution, inefficient irrigation systems, and the proliferation of upstream developments along the Nile River is likely to mean that the water sector in Egypt will require significant reform in the future (Power 2014). In particular, farmers and communities directly reliant upon the Nile waters are likely to need to adjust their production and livelihood systems to adapt to these changing circumstances.

1.3.1.2 Impacts on agriculture and food security

The MENA region has many environmental systems within which there are limits of productive agriculture due to the scarcity of resources (land and water) and are experiencing ongoing degradation of agricultural lands caused by unsustainable farming practices and soil erosion (Koohfkan 2001; Koocheki 2010; OECD-FAO 2018). Population growth, together with water stress, has increased the dependence on imported food within this area (Waha et al. 2017); for instance, Egypt imports about 40 percent of its grain supply (Koocheki 2010; Nigatu & Motamed 2015).

Climate-related effects on agriculture are expected to be particularly significant in the MENA region given the current environmental, governance, and demographic challenges, which will be exacerbated by a changing climate (Cline 2007). Natural constraints limit the ability of MENA countries to increase their agricultural production meaning that their reliance upon food imports is likely to increase with population growth (Woertz 2017). The high dependence on food imports already raises critical questions about the reliability of global food markets to supply countries' needs, and that risk will increase with a changing climate (Nigatu & Motamed 2015; Woertz 2017; Waha et al. 2017; OECD-FAO 2018). Subsequent changes in agricultural production will have huge consequences on rural livelihoods, poverty, national economies and food security (Breisinger et al. 2012) and exemplify a significant challenge for sustainable development in the region, which will have increasingly global consequences if not managed effectively (Sowers, Vengosh & Weinthal 2011).

1.3.1.3 Impacts on socio-economic and political stability within the region

Political insecurity, economic inequalities, poverty, unemployment, and conflicts are key features in many parts of the MENA region (Mohtar, Assi & Daher 2017; Waha et al. 2017; SIDA 2019). Such conditions are likely to increase the vulnerability of many countries in the region to the negative effects of climate change (Elasha 2010) – and arguably those processes of destabilisation are already underway. Climate change is already driving violence and conflicts in many parts of the world (Selby & Hoffmann 2014; Schleussner et al. 2016; Von Uexkull et al. 2016; Detges 2016; Feitelson & Tubi 2017; Ide et al. 2021). With a growing population and limited economic diversification in countries such as Egypt, national labour markets face challenges of absorbing the expanding workforce, intensifying the problem of unemployment in the region, and particularly in the growing urban centres (Akhtar, Bolle & Nelson 2013; Nigatu & Motamed 2015; Bilgili & Marchand 2016). Verner (2012) argues that the adaptation challenge in MENA's rural areas is problematic in large part due to the prevailing poverty, with more than 34 percent of its rural population being classified as poor, which raises a critical question for this thesis – what role will migration play in supporting communities to adapt to climate change?

Climate change will not necessarily result in more migration within the MENA region (Bilgili & Marchand 2016), especially for those individuals who have extremely limited resources (Gemenne 2015). The opportunity or choice for people to migrate or not to adapt to climate change would unarguably interact with many other economic, social and political factors and could exacerbate current social and political instability within the region (Sowers, Vengosh & Weinthal 2011; Nigatu & Motamed 2015; Schilling et al. 2020). This situation could potentially create social conflict, disturbing human security within the region (Sowers & Weinthal 2010; Gleick 2014; Waha et al. 2017). Egypt has already recently experienced a period of protests and revolution, and with the growing threats of climate change and accelerated water scarcity due to the Renaissance Dam, the future of political stability in the country remains uncertain.

1.4 Conceptual Basis for the thesis

This section briefly outlines the main theoretical and conceptual basis for the thesis that will be further comprehensively discussed in the literature review in Chapter 2.

1.4.1 Agrarian Transition

The agrarian transition is usually paired with "structural transformation" that is widely considered key to the economic development process through which low-income societies become high-income societies (Barrett, Christian & Shiferaw 2017). Three central themes are involved in such transition of economies, including:

1. Agricultural intensification;
2. The existence of two-way linkages between farm and nonfarm sectors; and
3. The emergence of a strong relationship between agricultural production systems, demographic change and dietary shifts (Johnston & Mellor 1961; Timmer 1988, 2009; Dercon & Gollin 2014; Barrett, Christian & Shiferaw 2017).

The classical views of Byres (1977), articulate the transition from an agrarian society to be the result of several factors, including the penetration of capitalism as the primary mode of production, the subsequent development of a diversified class structure, the improvement of new agricultural techniques, and the emergence of urbanised societies. The process of agrarian transition has transformed many wealthy farmers into capitalist farmers, and many poor farmers into waged labourers or an urban proletariat, leading to a distinctive class structure within modern societies (Byres 1977) – a process that is still underway across the MENA region.

The World Bank Group (2015) suggests five stages of agricultural transformation based upon the contribution of the agricultural sector to the society's GDP and the percentage of labour force working in the sector:

- Agricultural-based societies
- Pre-transition societies
- Transition societies
- Urbanised societies
- Developed countries.

According to these phases, Egypt is considered a borderline transition and urbanising country, as Egyptian agriculture contributes 11.22 percent of the GDP and employs 21.7 percent of the labour force (CAPMAS 2020a).

Hopkins (1987) identifies two pathways of agricultural or rural transformation resulting in the dominant class structure in the Egyptian lands of the Delta. The first path is called the “capitalist path”, which depends upon the ability of large landholder farmers to accumulate capital and to acquire machinery and other means of production. The second path, on the other hand, is called the “petty commodity producers path” and involves small landholders and small-scale producers. In addition, there is an “agrarian bourgeoisie” another key class of landowners, who largely make their living from non-agricultural sectors present within the social structure of rural villages (Weinbaum 1982; Springborg 1990).

This thesis focuses on adopting the phases of agrarian transition suggested by the World Bank Group (2015) and the associated class structure presented by Hopkins (1987) and Springborg (1990) to assist in reporting and interpreting the results of the study. Taking the different paths inherent to the agrarian transition process into account allows for an in-depth understanding of the perceptions of risk associated with climate change, vulnerabilities, and decisions of rural households about risk and adaption within the different sectors of the Egyptian agrarian community.

1.4.2 Risk Perceptions

People have already developed complex perceptions about climate change (Mertz et al. 2009b; Nyanga, Johnsen & Aune 2011; Spence et al. 2011; Deressa, Hassan & Ringler 2011; Chaudhary & Bawa 2011; Akter & Bennett 2011; Omar et al. 2015).

Understanding perception is fundamental to the social sciences because the perception of issues influences people's willingness to act in specific ways or support decisions being made by others. Hence, adaptation responses in large depend on the ability of individuals to perceive climate change and to take action (Maddison 2007; Antle 2009; Weber & Johnson 2009; Bardsley & Hugo 2010; Bagagnan, Ouedraogo & Fonta 2019). This thesis takes into account farmers' perceptions of several current and future risks associated with climate change and risks related to working in the agricultural sector under present and upcoming environmental challenges.

1.4.3 Adaptation to climate change

Adaptation to climate change refers to the process of adjusting to the actual or expected effects of climate change (IPCC 2007a), which might eventually reduce people's vulnerability through an enhanced resilience to these changes (UNFCCC 2007). Reuveny (2007) classifies adaptation into three broad categories: "*in situ*", "migration or *ex situ*", and "no response". *In situ* adaptation includes localised measures that occur within an affected place, while *ex situ* adaptation implicates the movement of people, assets and/or whole systems from a vulnerable location (Bardsley & Hugo 2010). Not responding to actual or perceived climate change is generally related to a lack of adaptive capacity of individuals or systems to overcome the effects of climate change (Smit & Pilifosova 2003; Adger, Arnell & Tompkins 2005; Gallopín 2006).

Within the agricultural sector, *in situ* adaptations include practices that aim at adjusting or improving agricultural production, natural resources including water and land, and farm management (Smit & Skinner 2002; Grothmann & Patt 2005; Deressa et al. 2009; Marshall 2010; Osberghaus, Finkel & Pohl 2010). Some studies consider climate-induced migration as a last choice in which individuals fail to adapt to new conditions locally (Warner et al. 2010, Laczko & Piguet 2014), while some other researchers claim that migration might be considered an effective and successful response to climate change (Tacoli 2009; Bardsley & Hugo 2010; Black et al. 2011b; Lücke 2011; Gemenne 2013; Adger & Adams 2013; Baldwin & Gemenne 2013). It is also important to mention that options regarding migration might be limited under climate change conditions, especially for poor people with limited resources (Gemenne 2015), forcing many people to become "trapped" within their place or community (Black et al. 2011b; Black & Collyer 2014).

This thesis explores both *in situ* adaptation measures, with a particular focus on on-farm agricultural adaptation practices, and *ex situ* adaptation responses involving both occupational and geographical mobility-related decisions of the rural households in Damietta. It is important to mention that the culture of migration is believed to be an essential factor that influences individuals' migration-related decisions (Cohen & Sirkeci 2011). Hence, this thesis takes account of households' cultures of migration as a critical component that could influence their current and potential migration decisions (discussed in Chapter 2, Section 2.5.2.2).

1.5 Research Gap

Globally, researchers have been able to identify the impacts of climate change upon the agricultural sector and predict future consequences across the different economic sectors and regions around the world. As part of that process, there has been a lot of work suggesting approaches for minimising or avoiding the various direct negative effects and associated broader consequences of climate change on agriculture. However, the degree to which these suggested approaches are consistent with what farmers understand and have to potential to implement has not been studied thoroughly for Egyptian society.

Studies regarding climate change in Egypt have focused more on modelling the ecological physical, and economic effects of climate change on the agricultural sector (e.g. see Eid, El-Marsafawy & Ouda 2007; El-Raey 2010; El-Ramady, El-Marsafawy & Lewis 2013; Hassanein, Elsayed &Khalil 2012; Morsy, El-Sayed & Ouda 2016; Zohry & Ouda 2016; Ahmed et al. 2021). However, few studies have integrated the human aspects of the effects of climate change and addressed the current vulnerabilities to rural society and adaptive practices on the micro-level (Kassem et al. 2019).

Some studies have addressed local awareness and perceptions of climate change with less focus on adaptive practices and their implications for future environmental and socio-economic pressures (see, for example, Omar et al. 2015; Froehlich & Al-Saidi 2018; Hafez 2020). Some studies have addressed adaptive practices followed by rural farmers, although some were more concerned with *in situ* agricultural adaptive practices followed by farmers, with little to no emphasis on *ex situ* measures (Omar 2015; Kassem et al. 2019), while yet others focused on *ex situ* adaptation and decisions by rural households regarding migration and attempted to find links between environmental change and migration in Egypt (Warner et al. 2008; Afifi 2010; Adoho & Wodon 2014a). Although studies concerned with *ex situ* adaptive measures have found little evidence that environmental change causes migration in Egypt, only minor attention has been paid to possible reasons for immobility, particularly in relation to the local cultures of migration. Although the culture of migration is an important aspect that influences people's decisions about moving and the proportion of the population who might be trapped due to environmental change, it is under-researched in relation to Egyptian rural communities in relation to the effects of climate change, and development of that knowledge is one of the significant contributions of this thesis.

1.6 Research questions

The following questions will be addressed to achieve the objectives of the research:

1. What patterns of climate change have been experienced by rural households?
2. How do rural households perceive climate change risks and other risks associated with working in the agricultural sector?
3. Do rural households perceive additional future risks associated with climate change?
4. What kinds of adaptation strategies have been followed by farmers and their households to reduce the risks of climate change impacts?
5. What are the socio-economic, demographic and cultural characteristics that influence the capacity of farmers to adapt to the risk associated with climate change? and
6. Does the degree of dependency of a household on agriculture for a living influence its level of perception of and adaptation to climate change?

1.7 Organisation of the thesis

This thesis is organised into eight chapters, as shown in Table 1.1. The first chapter introduces the key arguments and the context for the research. Chapter 2 presents the literature review on agrarian transition, climate change, risk perceptions, and adaptation to climate variability. Chapter 3 outlines the research methods undertaken to generate empirical results, including the selection of data collection and analysis techniques. The justification for selecting the study area of the Egyptian delta is also discussed in this chapter. Chapters 4 to 6 discuss the results from the case study. Chapter 4 provides a general background to the livelihood conditions of the studied rural households, including their demographic characteristics and the ecological environment where they live.

Chapter 5 describes local perceptions of climate change patterns, impacts, and potential risks for agriculture. Chapter 6 discusses the adaptation strategies followed by rural households to reduce the risks of climate variability, including sudden shocks related to extreme weather events. Chapter 7 discusses the significant findings of the study and their implications, and then the conclusion is presented in Chapter 8.

In conclusion, this thesis focuses on perceptions of current and potential risks associated with climate change and other challenges associated with working in the agricultural sector in Egypt. It also explores the current adaptive practices of rural households, whether *in situ* or *ex situ*, and takes into account the local cultures of migration, particularly concerning the dominant socio-economic situations of farmer groups. Importantly, this thesis integrates the agrarian transition and acknowledges the differences in the vulnerabilities and adaptive capacities of rural households within the same agrarian system according to their reliance on agriculture as the source of their livelihood. The research discusses the implications of current adaptation practices within the broader context of current and future environmental, demographic, political and socio-economic pressures within Egypt and the MENA region.

Chapter Two: Review of Literature

2.1 Introduction

This chapter elaborates upon the current pressing risks and dimensions of vulnerability in the Middle East and North Africa (MENA) region under climate change conditions, looking at the current socio-economic, environmental, demographic and political issues prevailing in the region, with a particular focus on Egypt. It also presents conceptual descriptions of the key terms used in this study, as previously introduced in Chapter 1 (Section 1.4). It discusses the theoretical framework of the agrarian transition and addresses the nature and drivers of agrarian change in Egypt. It highlights some key policies that shaped the agricultural sector in Egypt, and the different pathways of agricultural transformation and the resultant class structure in the Egyptian rural areas. A discussion about the influence of risk perceptions on shaping the different responses to climate change follows. The chapter then presents a broad review of the key concepts related to vulnerability, adaptive capacities, and adaptation strategies to climate change, including *in situ* and *ex situ* measures within rural societies. The relevant literature on populations trapped within the context of climate change is also reviewed in relation to the factors that contribute to human immobility. The role of migration cultures is introduced, emphasising knowledge about their potential importance in guiding decisions about environmentally induced mobility.

2.2 Climate change in the MENA region: current challenges and future risks

As introduced in Chapter 1, the MENA region, including Egypt, is one of the areas especially vulnerable to climate change, particularly concerning the deteriorating circumstances within which the agricultural system currently functions. This following section will discuss in more detail the dimensions of the vulnerability of the MENA region, with a particular focus on Egypt, to the effects of climate change. It will also address the implications of climate change on national and regional food security, political instability and social unrest.

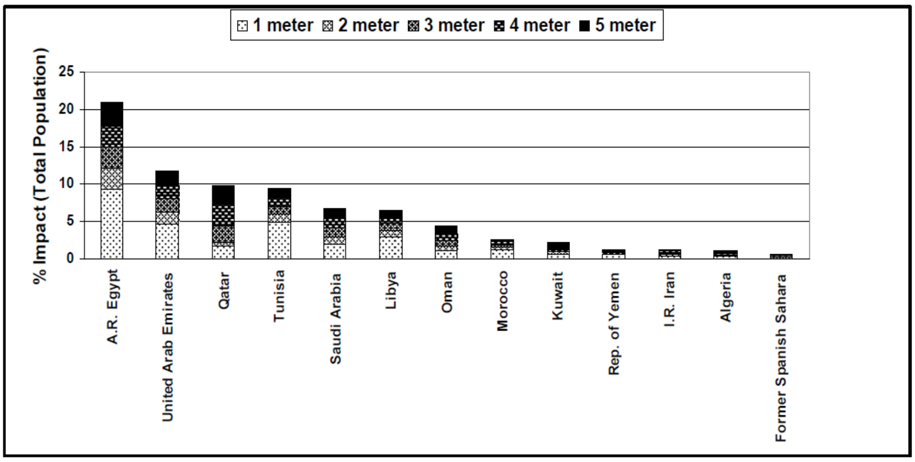
A 0.2°C warming has been observed in the MENA region over the period from 1961 to 1990, with a faster rate of warming since then (Waha et al. 2017). The Mediterranean coast, Algeria, Libya and large parts of Egypt are projected to face substantial warming with regional warming of 3°C by the end of the century (Waha et al. 2017). A severe increase in the number of high-temperature extremes has also been recorded since the 1960s (Seneviratne et al. 2012), with an increase in the heatwave intensity index particularly in North Africa and the Eastern Mediterranean (Kuglitsch et al. 2010). This trend is expected to continue in the MENA region over time (Lelieveld et al. 2016; Waha et al. 2017; Varela, Rodríguez-Díaz & deCastro 2020; Ozturk, Saygili-Araci & Kurnaz 2021). Similarly, several local studies in Egypt have recorded a general trend in warming since the 1990s (Saber 2009; Met Office et al. 2011; Seyam 2011; Hereher 2016), with more extreme weather events (Met Office et al. 2011; Nashwan, Shahid &Abd Rahim 2018).

Drought has been a "normal" characteristic of much of the Middle East semi-arid and arid climates (UNDP 2011), but studies have reported an enhanced drying trend over the region since the 1960s due to climate change (Hoerling et al. 2011; Sousa et al. 2011; Lelieveld et al. 2012; Donat et al. 2014; Lange 2019), which is projected to cause an average decline of 20 percent in precipitation throughout the 21st century in the MENA region (Conway & Hulme 1996; Arnell 1999; Sanchez et al. 2004; Milly, Dunne & Vecchia 2005; Suppan et al. 2008; Evans 2009; Ozturk et al. 2018). Such warmer and drier climatic conditions would increase the incidence of severe prolonged drought, even though there may be simultaneously more extreme and variable rainfall events, raising the likelihood of both flooding and desertification (Sowers, Vengosh & Weinthal 2011; Lelieveld et al. 2012; Ozturk et al. 2015; Ozturk et al. 2018). Egypt, in particular, has been suffering from more severe hydrologic droughts, which entail a decline in surface and subsurface water as a result of climate change (Hameed, Ahmadalipour & Moradkhani 2020).

Coastal areas are particularly vulnerable to the negative effects of climate change (IPCC 2007b; El-Raey 2010; Waha et al. 2017). In 2010, the population of MENA's coastal cities was roughly 60 million and is expected to reach 100 million by 2030 (World Bank 2011). Direct inundation resulting from slow-onset, rising sea-levels, increased erosion, saltwater intrusion into coastal aquifers, floods, and damage caused by storms and storm surges are considered the key effects of climate change projected for the coastal zones (El-Raey 2010; Hunt & Watkiss 2011; Brecht et al. 2012). Egypt, Libya, Tunisia, and the United Arab Emirates are among the countries at extreme risk of rising sea-levels worldwide based upon the affected percentage of population and land (Waha et al. 2017).

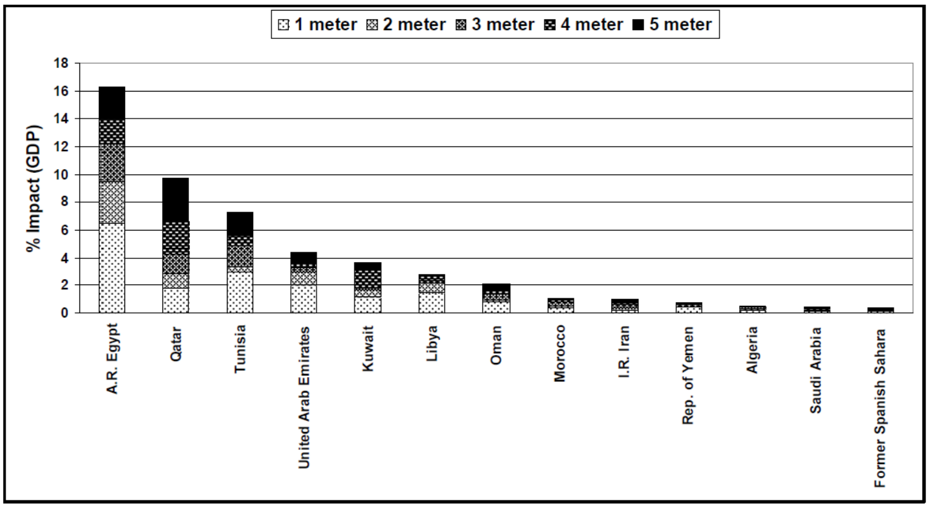
Egypt, in particular, is projected to be the most severely affected country in the MENA area (Kreimer, Arnold & Carlin 2003; Dasgupta et al. 2007; El-Raey 2010; EEAA 2016; Elshinnawy & Almaliki 2021). It is estimated that 13 percent of the Egyptian agricultural area will be lost (compared to 1.15 percent of the region's agricultural lands) with a rise in sea-level of 1m, affecting 10 percent of Egypt's population and causing a potential loss of about 6 percent of the national GDP (Figures 2.1 and 2.2) (Dasgupta et al. 2007; Dasgupta et al. 2009).

Figure 2.1: Projected percentage of Middle East and North Africa national populations affected by sea-level rise impact



Source: Dasgupta et al. (2007)

Figure 2.2: Projected impact of sea-level rise impact on the Middle East and North Africa national GDP



Source: Dasgupta et al. (2007)

Land subsidence will further aggravate the effects of rising sea levels in Egypt's Nile Delta, especially in the eastern part of the delta where Damietta, the area under current investigation, is located (Frihy & El-Sayed 2013; Wöppelmann et al. 2013). The rising sea-level is expected to have other serious effects besides direct inundation in terms of the salinisation of groundwater through saltwater intrusion, rising water tables, and reduction in soil drainage and soil quality (Werner & Simmons 2009; Hunt & Watkiss 2011; Elshinnwy & Almaliki 2021; Omar, Moussa & Hinkelmann 2021). Saltwater intrusion into coastal aquifers has already been a problem in some MENA countries, including Egypt (Weinthal et al. 2005; Kouzana, Mammou & Felfoul 2009; WWAP 2012; Agoubi 2021), as it is also associated with the over-extraction of water for irrigation, a lack of replenishment by freshwater, and increased anthropogenic contamination (Bouchaou et al. 2008; Waha et al. 2017). Sea-level rise, hence, is only aggravating the existing critical condition of groundwater resources (Vengosh 2003; Weinthal et al. 2005; Kouzana, Mammou & Felfoul 2009).

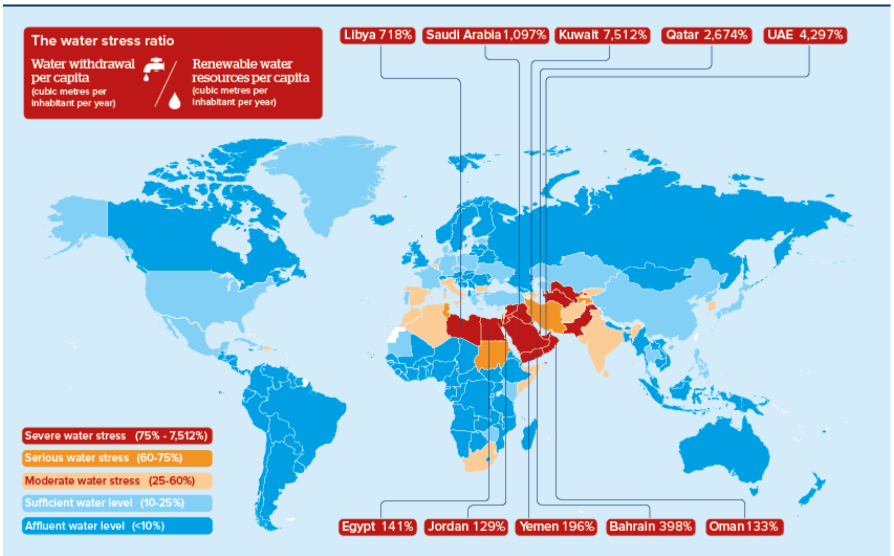
Another predictable effect of climate change is a higher intensity of storms (Knutson et al. 2010). More intense storms combined with rising sea levels will likely result in more intense storm surges, which would have a devastating effect on coastal areas in the eastern Mediterranean (Dasgupta et al. 2009). For example, Dasgupta et al. (2011) suggested that about 2.7 million people in the Egyptian city of Alexandria alone could be affected by storm surges in the future. The following subsections will discuss the critical environmental, socio-economic, demographic and political pressures already prevalent in the region, with a particular focus on Egypt.

2.2.1 Water

The MENA region has the greatest water scarcity on the globe (Droogers et al. 2012; Terink, Immerzeel & Doogers 2013; Alboghdady & El-Hendawy 2016), with the ten countries suffering most water stress on Earth concentrated in the region (as shown in Figure 2.3). Water stress in the MENA region is already evident, with severe challenges in terms of over-extraction of surface and groundwaters, demographic growth, rising sea levels, water pollution, and soil salinisation (Koocheki 2010; Sowers, Vengosh & Weinthal 2011). Climate change will very probably further profoundly affect the quality and quantity of water resources in the region with regards to all of these issues (Conway

& Hulme 1996; Sanchez et al. 2004; Milly, Dunne & Vecchia 2005; Suppan et al. 2008; Evans 2009; Sowers, Vengosh & Weinthal 2011).

Figure 2.3: Water stress ration in the Middle East and North Africa region



Source: Oxford Analytica (2015)

As mentioned earlier, North Africa is already suffering from the salinisation of coastal aquifers due to seawater intrusion and over-extraction of water from aquifers (Lofgren & Richards 2003; Koocheki 2010). If less water flows down the Nile, its ability to prevent the intrusion of saline seawater will be compromised due to less fresh water being available to recharge these aquifers, exacerbating the problem caused by rising sea levels, and placing the water resources in the region under even more pressure (Vengosh 2003; Weinthal et al. 2005). Water pollution from agricultural, urban and industrial wastes is another escalating challenge in the MENA region affecting the quality of water resources (Lofgren & Richards 2003).

Countries in the MENA region are generally classified into three groups based upon water resources and availability, as suggested by Terink, Immerzeel & Doogers (2013). The first group includes those countries that have sufficient quantities of renewable water; however, the range of annual and within-country variability still generates considerable challenges. Such countries with these characteristics include Iran, Morocco, Lebanon and Tunisia. The second group includes countries that depend primarily on non-renewable groundwater and desalinisation of seawater, such as Yemen, Libya, Jordan, and other Gulf countries that have limited natural sources of renewable water. The third group of

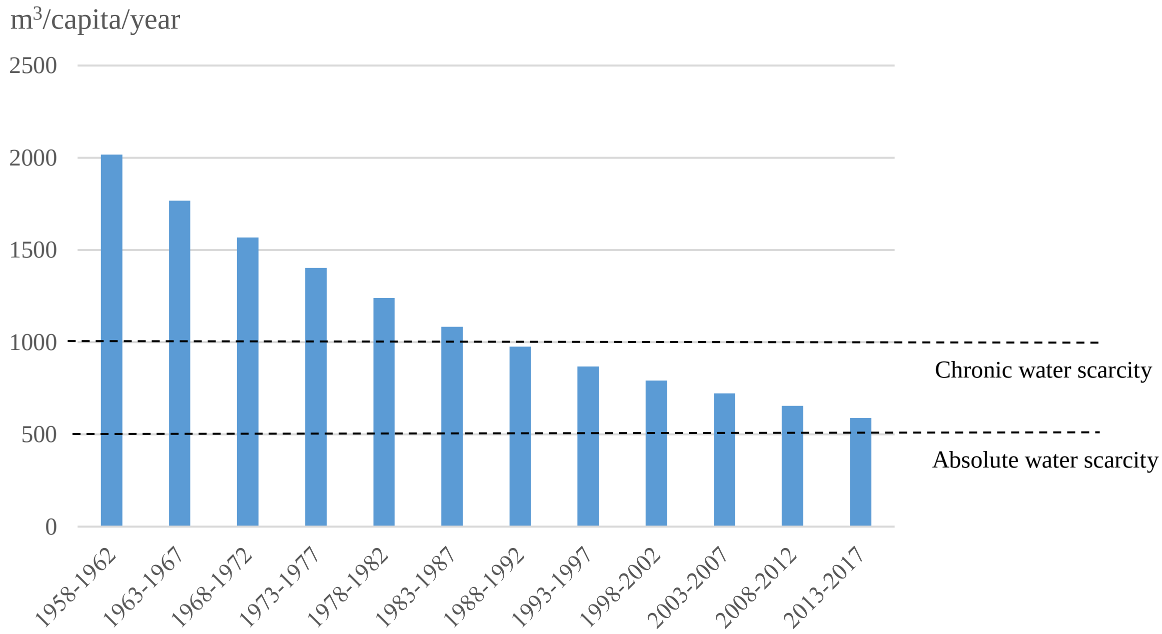
MENA countries are dependent on the inflow of transboundary exotic rivers, like the Nile in Egypt and the Tigris and the Euphrates in Syria and Iraq. This latter group of countries is of crucial concern as the inflow of rivers could be altered or controlled by other countries, in a manner similar to that which led to the recent conflict between Egypt, Sudan and Ethiopia that is discussed below.

2.2.1.1 Dimensions of water crisis in Egypt

Egypt has one of the highest population growth rates in the Middle East, with a population exceeding 100 million inhabitants (CAPMAS 2020a), which has nearly doubled over the past 30 years. Statistics show that the country's per capita freshwater resources per year have fallen from 2,000 m^3 in 1958 to less than 700 m^3 in 2013, which is well under the 1,000 m^3 threshold believed essential by the United Nations to provide an adequate amount of water for drinking and agriculture (Figure 2.4) (FAO 2017). In other words, Egypt is already below the water "poverty line", with an average of 570 m^3 per person in 2019 due to massive population growth, and is heading towards absolute water scarcity with less than 500 m^3 per capita in 2025 (Ebrahim 2019).

Population growth increases water stress by increasing the water requirements for both domestic and agricultural consumption to meet higher food demands (Dakkak 2020). Water demand is also expected to rise owing to the government's plans to expand land reclamation projects, industrial activities and urban centres into the desert (Swain 2011; El Bedawy 2014). Several other factors are likely to further reduce the availability of water in Egypt, including inefficient irrigation systems, pollution and the lack of a well-maintained water-delivery infrastructure (Soussa 2010; Karajeh et al. 2011; El Bedawy 2014; Power 2014; Dakkak 2020). It is estimated that Egypt's irrigation system operates at only 50 percent efficiency (Karajeh et al. 2011), placing the country in the bottom 10 percent of MENA region (Soussa 2010; Power 2014).

Figure 2.4: Renewable water resources per capita in Egypt, 1958–1962 to 2013–2017



Source: Adapted from FAO AQUASTAT (2017)

Agricultural pesticides, poor sewerage, and municipal and industrial discharge all contribute to water pollution in Egypt (Abdel-Shafy & Aly 2002; Barakat 2004; Gaballah et al. 2005; Negm, Saaverda & El-Adwy 2017). Persistent water pollution further aggravates the Egyptian water crisis and damages agricultural production by decreasing the quantity of suitable clean water available (Abdelaal & Thilmany 2019). As an illustration, it was estimated that the annual amount of waste water discharged into the Nile, both directly or indirectly through the agricultural drainage systems reached about 18.9 billion m^3 in 2016 (EEAA 2016). About 25 percent of the total volume of sanitary waste in Egypt is discharged into irrigation and drainage canals without any previous treatment, and the remaining 75 percent is released into freshwater canals with only primary treatment (Mohamed 2017). In addition, the huge investments in land reclamation projects not only cause the depletion and pollution of groundwater but also raise the question of whether Egypt has enough water to sustain new lands and any further reclamation (Kassim et al. 2018).

The history of agricultural policies has contributed to the critical water situation in Egypt. In 1984, the government declared water as a public good delivered to farms at no cost, so consequently farmers were discouraged from investing in water-conserving irrigation systems and still use traditional flood irrigation techniques (Kassim et al. 2018). With the implementation of economic reforms and especially a range of liberalisation policies, farmers were able to cultivate freely whatever they perceived as being the more economically profitable commodities. As a result, liberalisation increased the cultivation of rice, a water-demanding crop, and thereby affected the capability of the Ministry of Water Resources and Irrigation to uphold and fulfil the water delivery system (Kassim et al. 2018). Consequently, in the 2000s, the government reduced the area permitted for rice cultivation in the Delta by about half to save irrigation water (Ibrahim & Ibrahim 2003). Then in 2016, the government limited rice cultivation to an area of 2 million *feddans* (1 ha = 2.381 *feddans*), and after a further year the area was decreased to 1.7 million *feddans*, distributed over eight governorates in the Delta (Kassem et al. 2019). Farmers who grew rice outside the pre-defined boundaries would be fined and potentially imprisoned (Kassem et al. 2019). Subsequently in 2018, the Egyptian government announced its intention to import more rice to support such an arrangement (Reuters 2018).

Rice cultivation is essential to wash away the saline soils found in the north of the Delta through extensive leaching (Ahmed 1998; Mohamed 2017; El Nour 2018). As a result, reducing rice cultivation in the Nile Delta could lead to the loss of one-third of agricultural lands in the Delta due to salinity (El Nour 2018). Rice is considered a subsistence crop for rural dwellers, and is a main cash crop with high economic returns (Ahmed 1998; El Nour 2018), so limiting rice cultivation in the Delta will have a dramatic impact on the livelihood of millions of farmers and other labourers who work in the hundreds of rice factories across the region (El Nour 2018).

In addition to the broad range of internal pressures introduced above, Egypt is fundamentally dependent on external Nile water flowing from other African countries (Terink, Immerzeel & Doogers 2013) – a situation that increases Egypt's risk of losing access to its full-allocation of Nile waters. Throughout most of its history, Egypt has reserved its power over the control of the Nile, as the dominant user of Nile water (Whittington, Waterbury & Jeuland 014; Pemunta et al. 2021). The 1929 Anglo-Egyptian Treaty between Egypt and Great Britain, as the colonial power in eastern African countries, including Uganda, Sudan, Kenya, Tanzania and Ethiopia (Abdulrahman 2018). The treaty gave Egypt the right to monitor the use of the Nile's waters by upstream countries and veto any projects that would threaten Egyptian interests (Lumumba 2007; Ferede & Abebe 2014). Nile basin countries have increasingly seen this arrangement as unfair, ignoring their water rights in favour of Egypt's interests (Tesfaye 2013). The 1959 bilateral agreement between Egypt and Sudan consolidated their control of the river waters and allocated the entire flow of the river between the two countries, but again did not include any of the other riparian states, even Ethiopia, from which 80 percent of water originated (Lumumba 2007; Tesfaye 2013; Whittington, Waterbury & Jeuland 2014; Abdulrahman 2018). Until 2011 there had been no serious threat to Egypt's historical rights and apart from negotiating with Sudan, the *status quo* prevailed in the Nile basin (Whittington, Waterbury & Jeuland 2014). However, Ethiopia benefited from the turmoil of 2011 uprisings in Egypt and announced the construction of the Grand Renaissance Dam (GRD) (Whittington, Waterbury & Jeuland 2014). In July 2020, Ethiopia announced the completion of the initial filling of the GRD with 4.9 billion cubic meters of water in the dam's reservoir so far (Salam 2020).

The GRD could affect Egypt adversely in three ways. First, Egypt might not be able to withdraw enough water to supply all its agricultural needs if the filling of the GDR reservoir was to occur during a sequence of years in which the Blue Nile flowed and the Aswan High Dam reservoir itself was low. Secondly, after the completion of the GRD, Egypt might run deficits of water during a sequence of drought years if the operation of the GRD was not coordinated with the Aswan High Dam. Finally, Egypt could be negatively affected by withdrawal of water for irrigation taking place in upstream countries (Whittington, Waterbury & Jeuland 2014; El-Nashar & Elyamany 2018). Power (2014) claims that the construction of the GRD would lead to a loss of 3 billion cubic meters of water each year due to evaporation disturbing the flow of water downstream to Egypt. Such a situation would also affect the quality of downstream Nile waters through increasing salinity (Ramadan et al. 2013).

Future changes in precipitation in the Ethiopian Highlands due to climate change could also affect Nile river water flow for Egypt and Sudan (Conway 2005). Higher temperatures coupled with climate change already entail higher rates of evaporation of Lake Nasser, the large reservoir behind the Egyptian Aswan High Dam, and of the White Nile river in southern Sudan reducing the annual river discharge (Sowers, Vengosh & Weinthal 2011). Climate change can potentially change water supply and demand patterns in the basin, and hence, the allocation of the already scarce Nile water resources may become a serious security challenge in the future (Swain 2011; Pemunta et al. 2021).

As a result, it is argued that the current governance of countries' access to Nile water could trigger an interstate conflict, which could destabilise the whole North African region if the situation is not managed well (Nunzio 2013; Pemunta et al. 2021).

Climate change is also projected to affect water availability further in Egypt through the increasing demand for irrigation water for many crops (El-Marsafawy 2008; Elshamy, Sayed & Badawy 2009; Kim & Kaluarachchi 2009; Ahmed at al. 2021). As already mentioned, there is the potential for rising sea-levels to threaten low-lying Nile Delta lands in particular with increased saltwater intrusion causing detrimental effects to freshwater supplies and agricultural productivity (McCarl et al. 2015; Elshinnawy & Almaliki 2021).

In brief, water security in Egypt is threatened by water scarcity regionally; however, with Egypt specifically, upstream Nile projects, population growth, and risks associated with resource extraction, governance and climate change are all expected to intensify challenges with water scarcity (Tellioglu & Konandreas 2017). Given these escalating water-related issues, Egypt could face mounting food insecurity and unemployment, which, in turn, could spark grievances against the state or even lead to political instability and conflict in the Nile basin region (Climate Diplomacy n.d-a; Pemunta et al. 2021).

2.2.2 Agriculture and food security

The agriculture and food security situation in the MENA region is very challenging. Current environmental systems within the region limit agricultural productivity due to the scarcity of resources (land and water) and the ongoing degradation of agricultural lands caused by unsustainable farming practices and erosion (OECD-FAO 2018). Although the agricultural sector does not contribute significantly to the national economies of many countries in the MENA region, it still employs a significant percentage of the labour force in most places (Sowers, Vengosh & Weinthal 2011; Woertz 2017). As discussed, the lack of water availability is considered the critical constraint in the agricultural sector in the MENA region (Koocheki 2010), as the agricultural sector is already the largest consumer of water in the area, consuming an average of 80 percent of the water budget, leaving little for urban or other commercial uses (Sowers, Vengosh & Weinthal 2011; Woertz 2017). With the water scarcity in the region, it is expected that less water would be allocated to the agricultural sector in the future, as has already happened in Yemen, Jordan and Libya, because the economic returns from the use of water and the political power within the region's states are increasingly concentrated in urban areas (Sowers, Vengosh & Weinthal 2011).

Population growth, together with water stresses on agricultural production, have increased dependence on imported food within the MENA region (Waha et al. 2017). For instance, Egypt now imports about 40 percent of its grain supply (Koocheki 2010; Nigatu & Motamed 2015). Economic and population growth have changed dietary preferences and raised food consumption and demand across the region, making the MENA region a key influence over world trade in agricultural commodities (Nigatu & Motamed 2015). The reliance on food imports is likely to continue and is predicted to increase over time as current trends continue (Woertz 2017). This high reliance on food imports makes the region vulnerable to fluctuations in global markets and food production in and from other world regions (Woertz 2017; Waha et al. 2017; OECD-FAO 2018). For instance, in the years 2007–2008 and 2010–2011, Egypt experienced a massive spike in global food prices as a result of trading conditions and adverse weather events that affected several major food-exporting countries (Sternberg 2013; Climate Diplomacy n.d-a). Furthermore, ongoing geopolitical conflicts and the potential for many new forms of economic or environmental instability generate considerable uncertainties regarding both food demand in and supply to the region (OECD-FAO 2018).

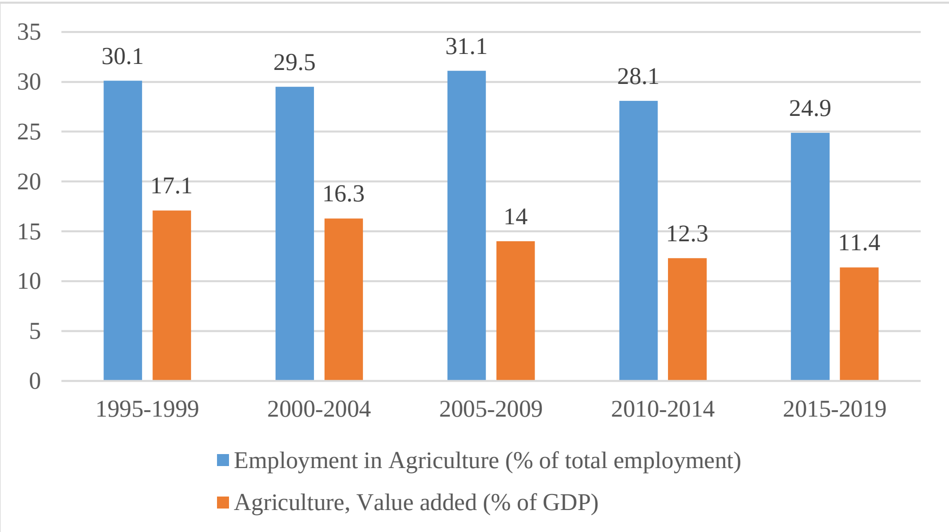
The expected degradation in the quality of irrigation water due to climate or non-climate stressors would decrease the quality of agricultural lands within the region (GLOWA 2009). Another challenging problem that faces the sustainable use of agricultural lands is the unbalanced use of fertilizers and chemical biocides in the region (Koohfkan 2001; Koocheki 2010). The excessive use of inorganic fertilizers and chemicals, which might further increase with climate change as farmers respond to more challenging growing conditions, has already caused environmental pollution, pest resistance to chemicals and weakening responses to fertilizers (Koohfkan 2001; Koocheki 2010). Chemical pesticides, for example, have been extensively used in the Egyptian agriculture sector since the 1950s with a total of about 1 million metric tons of pesticides being used over the intervening 50 years (Mansour 2008). This rate is expected to increase, given the growing population that requires the production of sufficient food.

The lack of government control measures for monitoring the use of chemical pesticides together with a lack of awareness about the acceptable agricultural practices needed for handling and using pesticides contribute primarily to the health and environmental hazards caused by them in Egypt, as well as in many developing countries around the world (Mansour 2004; Mansour 2008). Sheahan, Barrett & Goldvale (2017) found that the application of pesticides was associated with increased health costs and time lost from work due to illness, although it correlated with high agricultural output value. Their findings highlight that pesticides were becoming more extensively used in several African countries.

2.2.2.1 Agriculture and food security in Egypt

Agriculture represents one of the most important sectors driving the Egyptian economy. It contributes to the overall food needs of the country, provides raw material for the domestic market, and generates income for agricultural labour, as well as labour for related businesses such as wholesalers, exporters, and transporters of agricultural produce (Tellioglu & Konandreas 2017). In 2019, the sector contributed roughly 11 percent of the national GDP, a decline of about 7 percent since the mid-1990s (World Bank 2020). Employment in agriculture has declined less dramatically with the sector still considered as being labour-intensive, employing 23.8 percent of the total national labour force as in 2019 (Figure 2.5) (World Bank 2020). Moreover, agriculture provides the livelihood for more than 57 percent of the population living in rural areas of Egypt in 2018 (IFAD 2019).

Figure 2.5: The role of the agricultural sector in the Egyptian economy, 1995–2019

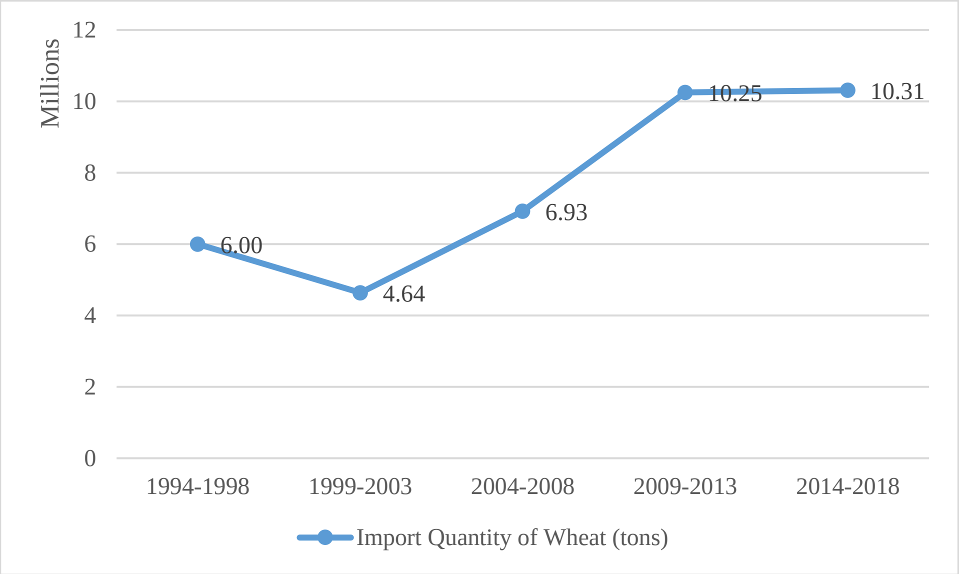


Source: Adapted from World Bank (2020)

Recently, Egypt has become a growing importer of basic foodstuffs, and the world's largest importer of wheat reaching more than 10 million tons in 2018 (Figure 2.6)

(Koocheki 2010; Nigatu & Motamed 2015; Tellioglu & Konandreas 2017; FAO 2020). This can be attributed to not only the Camp David agreement (further discussed in Section 2.3.1.2) but also, the weakening agricultural reforms, population growth, and severe water stress; hence, the low capacity to produce domestically (Bush 2007).

Figure 2.6: Egypt imports from wheat, 1994–2018



Source: Adapted from FAOSTAT (2018)

Climate change scenarios in Egypt show that warmer and drier weather is expected to increase the water requirements of many crops and lower their productivity particularly with wheat, rice and other grain crops by an average of 18 percent by 2050 (Abou-Hadid 2006; Eid, El-Marsafawy & Ouda 2007; El-Marsafawy 2008; El-Ramady, El-Marsafawy & Lewis 2013; Ahmed et al. 2021). Production of livestock will also be affected by climate change, through reducing the quality and quantity of feed and water available, changes in livestock diseases and the escalating heat stress (Thornton et al. 2009; Ahmed et al. 2021). Moreover, Ahmed et al. (2021) predict that many Egyptian agricultural labourers could lose their jobs in the near future due to climate change. For illustration, it is estimated that 3.5 million landholders will be affected by temperature increase in the Nile Delta by 2030 (Gouda 2020). In additional, roughly 2090 landholders and their households in four governorates in the Nile Delta region will be adversely affected by rising sea levels, with 259 landholders in Damietta by 2030 (Gouda 2020). A total of 153 agricultural labourers are predicted to lose their jobs by 2030 due to sea-level rise in the Northeast Delta, in addition to the loss of 3162 direct and indirect jobs (Gouda 2020).

2.2.2.1.1 Land scarcity and fragmentation

Arable land is scarce in Egypt, and is highly fragmented into small plots, limiting the capacity to develop efficiency in production and sustainable agricultural development in general (Tellioglu & Konandreas 2017). In the old lands of the deltaic and riverine regions of the Nile, the overall average land area per holding decreased from 6.3 *feddans* (1 *feddan* = 0.42ha) in 1950 to 3.2 *feddans* in 1960, and further to 2.1 *feddans* according to the 1999–2000 agricultural census (MALR 2009). In 2013, the average land area per holding per rural household was 1.6 *feddans*, or only 0.67ha (Nawar & Abdel-Hakim 2013). Land reform laws have exacerbated the fragmentation of agricultural landholding in the country (discussed in Section 2.2.1.1), made worse by rapid population growth and the practising of Islamic inheritance laws (Kassim et al. 2018).

Inheritance laws applied in Muslim countries facilitate or demand the subdivision of holdings among all heirs (Golmohammadi 2020). Consequently, when inheriting land, this land becomes a joint property belonging to several heirs or it is divided into pre-defined parts, which leads to fragmentation of the land (Golmohammadi 2020). What exacerbates the problem of land fragmentation in Egypt is the current tax law of agricultural lands. As illustration, farmers who own less than 2 *feddans* are exempt from paying tax on their lands, which discourages the sale and consolidation of farmland (Tellioglu & Konandreas 2017).

Land fragmentation obstructs the conservation of natural resources due to preventing collective crop rotations and the organisation of agricultural production services (Aboulnaga et al. 2017). Furthermore, it is often economically unfeasible to introduce extension and technology to each small farming unit (Tellioglu & Konandreas 2017). Consequently, land fragmentation has adverse effects on agricultural production, food security and efficiency in the use of natural resources, as well as on the living conditions of small landholders and their households (Abouelnaga et al. 2017). For example, a recent study in Iran found that land fragmentation and small holdings were considered main barriers for utilising modern technologies, increasing agricultural productivity and achieving food security and self-sufficiency (Golmohammadi 2020).

The small and fragmented holdings are usually held onto tightly by individual farmers who have limited resources and hence, are incapable of managing their farms in an efficient manner, which in turn puts them at high risk from environmental change and economic fluctuations (EEAA 2010). To illustrate this point, evidence from Egypt shows that small landholder farmers are often characterised by low literacy levels, low economic status and modest standard of living, high dependence on the farm as the main source of income and weak decision making and political influence (Aboulnaga et al. 2017).

2.2.2.1.2 Land degradation

Many factors cause land degradation in Egypt, particularly in the Nile Delta, including salinity, alkalinity, nutrient depletion, waterlogging, pollution, seawater intrusion and urban encroachment (Mohamed 2017). Desertification is also one of the challenges that affects large swathes of land in the Eastern and Western delta, where approximately 800,000ha have been affected by the active encroachment of desert sands and dunes (Warner 2010). Soil salinity is also considered a key challenge in the Nile Delta, especially in the northern part of the Nile Delta where Damietta is located, due to poor quality irrigation water, shallow water tables and seawater intrusions (Mohamed 2017). Due to the lack of sufficient freshwater for irrigation, farmers have no choice but to reuse agricultural wastewater, especially those whose farms are located at the tail of the water canal (Mohamed 2017), a situation that causes further deterioration of soil properties. Urban encroachment is another critical problem that causes land degradation and threatens agricultural land available in the Nile Delta of Egypt (Negm, Saaverda & El-Adwy 2017). It is estimated that 2,536.3km^2 of agricultural lands were lost to urbanisation over the period from 1984 to 2006, which represents roughly 7.5 percent of the total agricultural area in the Nile Delta as in 2002 (Shalaby 2012).

2.2.3 Demographic pressure, unemployment and security

The MENA region hosts one of the fastest growing populations in the globe. Population numbers have more than quadrupled in four decades, raising from 138 million in 1970 and reaching 456 million (World Bank 2019b). According to the medium-fertility scenario of the United Nations, the population of the region is expected to reach 600 million by 2050, and 845 million in 2100. Around 50 percent of the population is considered to be less than 25 years of age (Forouheshfar, El Mekkaoui & d’Albis 2020), making the region one of the most youthful areas in the globe (Tür 2018). The large proportion of youth in the population, known as the “youth bulge”, is a central fact conditioning the region’s social, economic, political and cultural development (UNDP 2016).

Demographic pressures are a leading cause of high youth unemployment rates in the region (UNDP 2016; Tür 2018; Al-Shammari & Willoughby 2019; Forouheshfar, El Mekkaoui & d'Albis 2020). The labour market of the region is characterised by a continuing job crisis particularly among youth and it has been unable to provide sufficient job opportunities to absorb the new entrants (Dimova, Elder & Stephan 2016). Youth unemployment rates in most MENA countries are double the global average (World Bank 2019), with higher rates of unemployment found amongst educated youth (Barsoum, Ramadan & Mostafa 2014; Assaad & Krafft 2015). For example, unemployment in Egypt reached 11.2 percent in 2018, with 75 percent of the unemployed aged 15–29 years (IFAD 2019). However, youth unemployment rates in Egypt are rather misleading because they often underestimate the number of poor youths who are forced to work at whatever job they find as they cannot afford to be unemployed (Bremer 2018). They may, thus, be working at lower pay (or in some cases at no pay at all in a family business for example), fewer hours, and with less security (Bremer 2018). Underemployment is, hence, another problem that young people are increasingly facing today in the region (Sika 2019; Assaad Krafft & Yassin 2020). In order to stabilise youth unemployment, the region needs to generate more than 60 million jobs in the upcoming decade to absorb the large number of job entrants (UNDP 2016), a challenging situation when one considers the massive number of young workers expected to enter the labour market (Forouheshfar, El Mekkaoui & d'Albis 2020).

The critical situation of unemployment in the region goes beyond the mismatch between labour supply and demand. The educational attainment is argued to be inconsistent with the labour market's demand for skills, owing to a deficient education system prevalent in the region (Barsoum, Ramadan & Mostafa 2014; Dimova & Stephan 2020). Inequality of opportunity is also a contributing cause for the malfunctioning of labour markets in the MENA region (Dimova & Stephan 2020). Educational attainment depends substantially on parents' background and community characteristics (Salehi-Isfahani, Hassine & Assaad 2014). Consequently, young people from advantaged backgrounds are found to have better access to higher-skilled job opportunities when they become available (Dimova & Stephan 2020). The presence of social "connections" in securing job opportunities is also another dimension of inequality (World Bank 2014; Sika 2019; Assaad & Krafft 2020; Bremer 2020). According to Sika (2019), unemployment in Egypt is mainly associated with highly educated young men from low-income families who lack the social connections to boost their chances of employment.

Moreover, recent evidence from Egypt shows that social class plays a role in determining the success or the failure of the transition from school to work (Assaad & Krafft 2020). Assaad & Krafft (2020, p.1) suggest "whether youth successfully make transitions to formal jobs, embark on such transitions and fail, or pursue more traditional careers in informal employment or family businesses or farms depends on a complex and changing interaction between their own educational attainment and the resources of their families".

The high level of youth unemployment in the region is consistent with the global trend of premature deindustrialisation that hinders the capacity of developing countries to create jobs for their labour market entrants (Rodrik 2016, 2017). Almost all the labour markets in MENA countries are characterised by dominant service sectors, which have historically been less successful in developing job opportunities than a typical growing manufacturing sector (Sika 2016; Dimova & Stephan 2020). Moreover, Egypt saw limited gains in productivity from sectoral labour reallocation over the past three decades (Morsy & Levy 2020). Not only did labour fail to shift from agriculture towards high-productivity manufacturing and private sectors, but it stayed limited to low-value-added activities such as the public sector and construction, locking Egypt into a "low value trap" (Morsy & Levy 2020). On the contrary, many emerging economies have improved their per capita income and created decent job opportunities by rapidly reallocating labour from less to more productive sectors as has happened in China for example (Roncolato & Kucera 2014).

The high percentage of young people reaching over 40 percent of the total population marks the problem of school-to-work transition and its patterns of vital priority for both the economic policy discussion in Egypt and the political stability of the country (Selwaness & Roushdy 2019). The country has not completed its demographic transition with no definitive reduction in birth rates (Bremer 2018). Accordingly, the number of population under 14 will continue to rise quickly, resulting in a second youth bulge double the size of the youth cohort at the time of 2011 mass demonstrations (Bremer 2018).

Over the last decade, several countries in the MENA region have already experienced the political instability that is still being witnessed in recent times, as in Syria, Yemen, and

Libya, and high youth unemployment rates are argued to be one of the chief causes of political instability and important trigger for the Arab Spring in the region (World Bank 2014; Heyne & Gebel 2016; Al-Shammari & Willoughby 2019; Selwaness & Roushdy 2019; Forouheshfar, El Mekkaoui & d'Albis 2020).

Unfortunately, the Arab Spring has not led to any real, significant improvements in employment opportunities that the youth might have hoped for in Egypt (Assaad & Krafft 2014; Heyne & Gebel 2016; Selwaness & Roushdy 2019). The political instability that came after the revolutions was associated with economic stagnation and a deterioration in the quality of jobs with mounting informality and irregularity of employment (Amer 2015; Heyne & Gebel 2016; Paciello & Pioppi 2020). The Egyptian government in particular, has showed a lack of commitment to the large-scale growth and real structural change that would facilitate a transformation in employment opportunities in the country (Bremer 2018; Morsy & Levy 2020).

Climate change has also been a driver of political unrest in the region, as evidence shows that it has contributed to political instability in 16 countries and conflicts in 15 countries of the MENA region from data analysed over the period 1985 to 2016 (Sofuoğlu & Ay 2020). Arguably, the experiences in Syria over the last decade are an actual example of the effects of climate change on human mobility. In this case, the severe drought that took place in 2006–2007 caused agricultural failures that affected millions of farmers and herders, and their communities, leading to a massive increase in the rates of migration to urban areas in search of better income prospects (Gleick 2014; Kelley et al. 2015; Suter 2017). Evidence suggest that the uncontrolled rural-urban migration already aggravates underemployment and unemployment conditions in urban areas (Chaudhuri 2000; Herrmann & Svarin 2009; Zenou 2011). Consequently, the internal mismanaged displacement and the few employment opportunities in the major cities added more pressure on the socio-economic tensions already existing in the area, and helped to trigger the mass protests of 2011 and subsequent conflict (De Châtel 2014; Gleick 2014; Kelley et al. 2015; Suter 2017; Selby et al. 2017).

This story is no different from what is currently happening in Yemen where water is scarce and its unsustainable use together with climate change has augmented its depletion at a faster pace (Glass 2010; Sowers & Weinthal 2010; Suter 2017). With population growth and higher rates of urbanisation, water became even more scarce and unaffordable for most of the poor population, aggravating tribal conflicts, the rural–urban gap, and violence over the control of water in several areas (Suter 2017). Recently, the control over limited water is steadily becoming a war tactic employed by both sides of the conflict, the Houthi and Saudi-led coalition (Suter 2017). Both factions have been blocking humanitarian aid deliveries of food and water to the other side (Human Rights Watch 2020) – a situation that is preventing millions of Yemenis from accessing adequate and safe drinking water (UNOCHA 2019).

Evidence shows that income inequality, unemployment, and poverty were the main triggers of the Egyptian uprising in 2011 (Verme et al. 2014; Ianchovichina, Mottaghi & Devarajan 2015). However, there is also a growing argument that the implications of climate change and environmental stress on food security were a hidden, indirect factors for the revolution in Egypt (Null & Prebble 2013; Sternberg 2013; Ayeb & Bush 2019). In 2010 for instance, drought and heatwaves affected the world's largest producers of wheat, such as Russia, Ukraine, Australia and China, playing an essential role in the rapid increases in global food prices (Sternberg 2013). Despite high subsidies, especially on bread, food prices in Egypt rose sharply in 2011, significantly affecting food security and living standards of many people across the country (Ghoneim 2012). Several commentators have argued, the increasing food process played a role in sparking the Egyptian uprisings in 2011 (Grossman-Cohen 2011; Null & Prebble 2013; Sternberg 2013; Maystadt, Trinh Tan & Breisinger 2014).

The Egyptian government is still at risk of a severe crisis of legitimacy due to declining agriculture caused by water scarcity (Climate Diplomacy n.d-b; Power 2014). Dwindling water resources due to both climatic and non-climatic factors may further intensify present grievances related to deficient water management infrastructure, poor management of the Egyptian water sector, as well as unequal distribution of water (Cunningham 2012). Recent years have already witnessed several protests in response to water shortages, pollution and water-intensive land reclamation projects in Egypt (IRIN 2010; Swain 2011; Pacific Institute 2020). For illustration, in 2007 and 2008 thousands of people staged demonstrations in the governorates of Fayyoum, Daqahliya and Ismailia to protest against severe shortages in irrigation and drinking water (OOSKAnews Correspondent 2008). Several protests were recorded in the summer of 2012 in which rural protestors blocked highways in Menoufiya and Fayyoum over a shortage in irrigation water (OOSKAnews Corrspeondent 2012a). Another incident in Beni Sueif governorate, resulted in one farmer being killed while others were injured during a conflict over irrigation water (OOSKAnews Correspondent 2012a). Water contamination was the basis for a protest by Egyptian villagers in Menoufiya in 2012 (OOSKAnews Correspondent 2012b), while in 2015, residents in an urban area in Giza protested against ongoing water cuts and police using tear gas had to be deployed (Hamama & Charbel 2015; Local Press Report 2015). Such grievances could intensify with further depletion of the available water resources. Ultimately, water shortage and political instability in Egypt may affect the entire Nile basin, either unintentionally due to Egyptian unrest or as a deliberate course of action to blame upstream countries (Climate Diplomacy n.d-b).

Egypt has witnessed a series of riots and protests in rural areas over the past century. In 1919, there was one of the biggest small farmers' revolts, not only against the British occupation, but also against the big landowners who were seen to have been supported by, and in turn supported, the British regime (Goldberg 2009; Shaarawy 2012; El Nour 2015). Similarly, the 1952 revolution was preceded by unrest between 1944 and 1951 due to the increase in rental prices for agricultural land by big landowners, low wages and heavy taxes (Berque 1967 cited by El Nour 2015). As a result, one of the main actions that took place after the 1952 revolution was the restructuring of the Egyptian agrarian system in an attempt to put an end to the power of big landowners (Abdel-Fadil 1975; Bush 2007).

However, in the early 1970s, a counter-revolution to these reforms has been ongoing in rural Egyptian villages (de Lilles 2020). Policies promoted the gradual elimination of subsidies on agricultural inputs, the liberalisation of markets for seeds and pesticides, privatisation of irrigation, a demolished role of agricultural cooperatives, and a massive shift towards state-led reclamation actions aimed at developing large-scale agricultural projects simultaneously accompanied with neglect in investment in smallholder agriculture, as further discussed in Section 2.2.1.2 (Bush 2007; El Nour 2015). In 1977, Egypt witnessed widespread protests driven by the threat of reducing food subsidies and increasing bread prices (Bush 2007). The 1992 and subsequent land tenancy reform laws were considered the turning point in agricultural policies, sparking violent movements and protests in the Egyptian countryside that increased after the implementation of the law in 1997 (Bush 2007; Bush 2011; El Naggar 2012; Keshk 2012; El Nour 2015). The tenancy law caused the formation of "networks of resistance" among agrarian communities, solidarity, activist and political organisations (Bush 2011). Farmers continued to protest against the change in tenancy law after 2000, and by 2010 there were estimated 2,000 arrests, more than 1,500 injuries and 200 deaths resulting from land disputes and clashes with farmers (Bush & Martiniello 2017). These farmers' protests drove successive waves of protests by workers and employees in the cities, eventually leading to the 2011 revolution (Sharaawy 2012; El Nour 2015).

Protests by members of the working-class and farmers in January 2011, were therefore provoked by general frustration at the high prices of food (Bush & Martiniello 2017). Therefore, it is claimed that the 2011 revolution in Egypt was an outcome of a decade of widespread protests at all levels of society (de Lellis 2019); however, the participation of rural areas in the revolution was, significantly, often outside the focus of the media (Abu-Lughod 2012). The trouble in rural communities continued after the revolution with a total of 158 farmers protesting against shortages in resources, in particular, irrigation water and fertilizers in 2012 (Land Centre for Human Rights 2012 cited by El Nour 2015). The regime was resilient against the forces of change and was largely able to restore itself after the 2011 revolution (Gervasio & Manduchi 2020). The agrarian system also remained the same, including its dependency on international markets to provide its food needs rather than striving for self-sufficiency (Breisinger et al. 2012).

In conclusion, evidence supports the view that climate change generates, accelerates and deepens current instabilities in the countries of the MENA region (Sofuoğlu & Ay 2020). Climate change could have huge negative effects on the Egyptian economy, putting the country at risk from decreased food production and associated high food costs potentially giving rise to increased malnutrition and unemployment (Smith et al. 2014). Simultaneously, Egypt has a long history of food protests and riots in its modern history, with small landholder farmers often being at the heart of economic and political struggles (Bush & Martiniello 2017). Riots in Egypt, especially in rural areas, have been driven primarily by food crises and shortages in resources, particularly water and land. With the growing water crisis, land depletion and losses in rural livelihoods due to climate change, as well as the ever-increasing unemployment, rural poverty and marginalisation of rural areas (further discussed in Section 2.3.1), Egypt could potentially face a chronic food crisis and a growing threat of political instability.

2.3 Agrarian transition

The concept of the agrarian transition refers to the process through which agrarian societies are exposed to rapid and profound societal and environmental transformations as a result of the growing capitalist drivers of change facilitating their shift into industrial societies (Castella 2012). The change is experienced across most of society, including economic policies, market integration, environmental regulations and demographic change. The classical views of Byres (1977, 1986) describes the agrarian transition as the penetration of capitalist relations of production, the modernisation of agricultural production, the emergence of a consequential class structure, and the expansion of urban-industrial societies. He argues,

> "capitalism became the dominant mode of production in agriculture: growing out of simple commodity production, here via a landlord class and there via a peasantry which gradually became differentiated (so providing, at the extremes, a stratum of rich peasants who ultimately became capitalist farmers and a stratum of poor peasants who were transformed into agricultural labourers or who joined urban proletariat)" (Byres 1977, p.258).

The crucial component in the development of capitalism in agriculture is the production of surpluses – in labour, food, raw material and financial (Byres 2016). Land use, changing technologies, tenure, class relations and differentiation, and the role of the government are the major themes that are in flux during the agrarian transition of societies, which have been addressed in a range of studies (Scott 1976; Scott 1985; Kerkvliet 1990; De Koninck 1992; Pincus 2000; Rigg 2001). However, Kelly (2011) suggests that there is a more complex and broader set of processes driving the transition of agrarian societies during the global era, rather than merely one process of capitalist commodification, such as the form the agrarian transition takes within any particular developing country will vary significantly. These processes include agricultural expansion into new production zones; agricultural production intensification through mechanisation and genetic modification; urbanisation and industrialisation of land use and livelihoods; changing regulatory frameworks; environmental change; and, the impact of migration on agrarian production and the social and cultural processes in which it is embedded (Rigg 2006; Kelly 2011). Hence, a significant component of any agrarian transition is the increasing urbanisation of populations, and the associated de-agrarianisation and diversification of livelihoods within rural locales (Kelly 2011;

Castella 2012; Barrett, Christian & Shiferaw 2017; Barrett et al. 2017). Labour movement out of agriculture into non-farming activities within rural communities and secondary towns is argued to be more effective in reducing poverty than migrating to big cities, especially if rates of industrial development are unable to provide individuals with employment opportunities (Barrett et al. 2017). Hence, the effectiveness of any transition out of agriculture for reducing poverty is highly dependent on where off-farm jobs are available and whether immigrants have the capacity to move into new occupations (Christiaensen, De Weerdt & Todo 2013; Dorosh & Thurlow 2014; Christiaensen & Kanbur 2016).

The agrarian transition extends beyond an agricultural transformation to affect broader structural transformations (Barrett, Christian & Shiferaw 2017). That process can be described as the mechanisms through which low-income agrarian societies become high-income developed societies having relatively small, yet productive, agricultural sectors (Barrett et al. 2017). Economic development in most developing societies is typified by a decline in agriculture's share of both GDP and employment over time as a result of income growth, urbanisation, demographic change and poverty reduction (Barrett et al. 2017). The macro-level descriptors of the transition of economies involves three central dimensions (Barrett et al. 2017). First, the early stages of transition involve agricultural intensification through the extended use of purchased modern inputs and technology and increased market-oriented production, which consequently improves the productivity of farms and labour (Johnston & Mellor 1961; Timmer 1988). Second, the transition leads to the existence of new forms of two-way linkages between farm and non-farm sectors in which agricultural productivity growth encourages progress in the non-agricultural sector, and households start to diversify their income sources through the non-farm sector, often then reinvesting further capital into agricultural intensification (Johnston & Mellor 1961; Barrett, Reardon & Webb 2001). And third, the process involves the emergence of a strengthened relationship between agricultural production systems, broad societal demographic changes and dietary shifts that are commonly paired with increases in income growth and urbanisation (Barrett, Christian & Shiferaw 2017; Barrett et al. 2017).

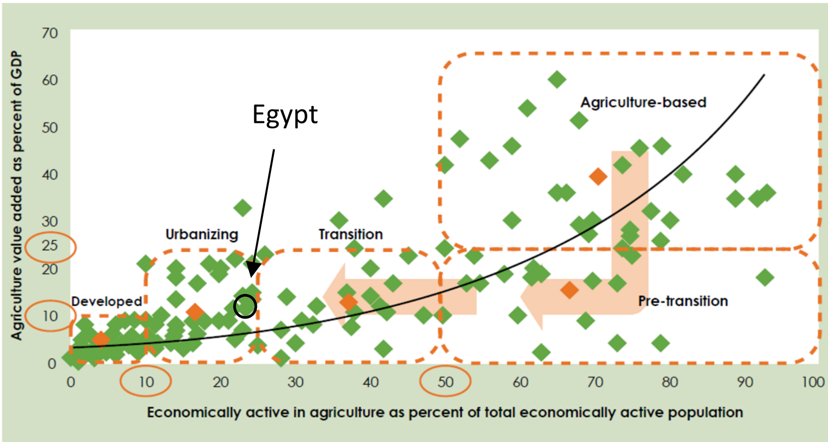
There are different ways to interpret the stages of transition. Timmer (1988) identifies four stages of agricultural transformation, starting with "Getting Agriculture Moving", which involves huge investments in the agricultural sector particularly in research, technology and rural infrastructure. The second phase "Agriculture as a Contributor to

Growth" consists of the transformation of the agricultural sector into a key contributor to economic growth, and consequently, a state of de-equilibrium occurs between agriculture and industry, which widens the gap between both sectors (Kuznets 1966; Chenery & Taylor 1968; Chenery & Syrquin 1975). Thirdly, comes "Integrating Agriculture into the Macro Economy", which involves a narrowing of the gaps between secondary industry (urban) and primary agricultural (rural) sectors, through the improvement of more efficient labour and credit markets that link the two sectors together. In other words, within Timmer's framework, the transformation also involves a transfer of labour and capital from the agricultural sector to other industries or services over time. Although the evolution of a more complex economy provides flexibility for individuals who might otherwise be trapped in low-income occupations, rural labour productivity may stagnate during the transformation if industrial development is unable to absorb the proletariat effectively, resulting in both rural–urban and urban–urban income distribution problems across societies (Timmer 1988). The integration of the agricultural sector into a capitalist macro-economy can make agricultural communities more susceptible to fluctuations in prices and trade systems (Schuh 1976). The fourth and final phase of the agricultural transformation is "Agriculture in Industrial Economies" (Timmer 1988). By this stage, the share of the agricultural labour force has generally declined below 20 percent and the amount of money spent on food by urban household's drops to around 30 percent. Some political issues might also arise as agriculture becomes less important to the overall economy (Anderson 1983).

This last situation has often led to a rural–urban tension where low farm incomes due to declining returns for their products, encourage farmers to redirect resources from agriculture, and the emergent industrial sectors in urban areas are often incapable of sustainably absorbing rural migrants (Timmer 1988). The outcome as seen throughout many countries towards the final stages of their agrarian transition, and across Africa in particular due to industrial production not keeping pace with the liberation of labour from farming areas, is a rise in unemployment, forcing agricultural labour to remain in the sector, often in association with rising rural landlessness and poverty (Timmer 1988; van Neuss 2019; Wood 2019).

Similar to Timmer's analysis, the World Bank (2015) suggests five stages of agricultural transformation based upon the contribution of the agricultural sector to the society's GDP and the percentage of labour force working in the sector (Figure 2.1), as shown below.

Figure 2.7: Stages of agricultural transformation based upon workforce and contribution of the agricultural sector in GDP



Source: World Bank (2015)

The World Bank Group (2015) classification reflects five different stages of agricultural transformation within countries as follows:

1. **Agriculture-based countries**: agriculture contributes to over 25 percent of GDP and employs more than 50 percent of the economically active population;
2. **Pre-transition countries**: agriculture still employs more than 50 percent of the workforce, however, its contribution to GDP decreases to less than 25 percent;
3. **Transition countries**: agriculture supports a smaller labour force, employing 25 percent to 50 percent of the economically active population, and less than 25 percent of GDP;
4. **Urbanised countries**: agriculture still contributes to less than 25 percent of GDP, whereas it employs between 10 to 25 percent of the workforce; and
5. **Developed countries**: workforce engagement in agriculture drops to less than 10 percent and its contribution to the GDP also drops to below 10 percent.

According to the stages in Figure 2.7, Egypt as a whole is considered to be reaching the border between a transition and urbanising country, as Egyptian agriculture contributes 11.05 percent of the GDP and employs 23.3 percent of the labour force (World Bank 2020). In such a context, within every single region, there will be significant social complexity as different groups take on new roles or are stuck in entrenched positions, with limited opportunities either in rural or urban settings.

The agricultural transformation process is an integral part of the dominant development approach or the process of modernisation through which societies pass. The dynamics of modernisation create new global risks and threats, like environmental risks, which are the unintended consequences of scientific, technological and economic developments (Beck 1989; 2008). Risks constitute the driving force of modern industrial society, and consequently, late modernity can be described as "risk society" (Beck 1992; 2002). Accordingly, the main feature of risk society theory is that modernisation is increasing the likelihood of new future threats, instead of overcoming societal risks (Bardsley 2015).

Modernisation causes risks not only associated with the irreversible endangering of human, animal and plant life, as occurs with the use of chemical substances in agricultural production (Beck 1989), but also with the limitations of modern systems to foresee, control and overcome these risks (Beck 1995, 2002, 2008; Cohen 1997). Risk society is affected by an uncontrollable set of threats in the areas of ecology, economy and politics that typically generate conflicts (Beck 2002, 2008). Even if modern systems proved a success in managing environmental risks, climate change is now threatening these accomplishments (Bardsley 2015). Environmental risks, as well as other risks caused by the modernisation of society, become social problems (Beck 1992) and create new inequalities either between different social classes and groups of the same society or among other international countries (Beck 1989, 2010). The emergent disparities and the socially recognised risks have the power to become political and to develop new social movements (Beck 1989). Beck, Giddens & Lash (1994) believe that reflexive modernity is a critical pathway that might allow societies to move beyond the redevelopment of risks as they develop.

Consequently, for agricultural communities to successfully respond to increasing risks associated with the modern world, they will need to build "complex, resilient and sustainable modern system[s] in light of future climate change and resources constraints" (Bardsley & Knierim 2020 p.4). In order to establish resilient agrarian systems, farmers will need to work closely with researchers, policy-makers, national government and non-government organisations in order to adapt in a sustainable way (Pretty et al. 2018; Bardsley & Knierim 2020). The following section will discuss the historical evolution of land use, tenure and agricultural policies in Egypt that shaped the dominant paths of agrarian change. It also highlights some of the risks generated by the national agricultural development interventions.

2.3.1 Historical development of some land and agricultural policies that drove agrarian change in Egypt

There are several social factors that have driven agricultural change in rural Egypt over the last two centuries. These factors include commoditisation, migration, capital investment, irrigation, electricity, road networks, transportation, mechanisation, education, urbanisation, and government policy toward agricultural and rural development (Hopkins 1987). There are several essential policy milestones in the history of Egyptian agriculture that had enormous influence over the transformation of the sector and rural areas in Egypt as described below.

2.3.1.1 The 1952 Revolution and land reform policies

In the first half of the twentieth century, Egypt had one of the most unequal distributions of land ownership in the world (Woertz 2017). Land in Egypt was not valued for its income-generating capacity alone, but possession of land always stood as a symbol of political power and social prestige (Oweis 1971 as in Abdel-Fadil 1975). In the 1940s, 0.5 percent of landholders owned only 37.1 percent of the cultivated land, while 70 percent owned 12.4 percent (Cliff 1946). The number of landless families was also increasing, and big landlords monopolised land and water resources raising the prices of land rents leaving little profit for the tenant farmers or sharecroppers (Abdel-Fadil 1975). This substantial disproportionality in land distribution intensified poverty and social inequality across rural areas, which led, in part, to the 1952 revolution that promised a radical social reform program for Egypt (Abdel-Fadil 1975; Bush 2007).

The successful revolutionary process of transformation in Egypt involved significant changes to the agrarian structure through land reforms that started in the 1950s. The land reforms of 1952 and later had three main objectives: the redistribution of rural resources to give landless and small-farmers' rights to land; attempts to shift the balance of political power in the countryside away from an extreme minority and; the desire to allocate capital surpluses from agriculture to subsidise urban growth and industrialisation (Abdel-Fadil 1975; Bush 1994, 2007, 2011). To achieve these goals, the government redistributed agricultural lands, mandated crop rotation schedules and crop area allocations, forced obligatory delivery quotas for crops at fixed prices that were considerably below international prices, and subsidised consumer prices for basic food commodities (Cassing et al. 2009).

The first land reform in 1952 limited land ownership to 200 *feddans* (84 hectares), the maximum that could be reserved by the owner for himself, with an additional 100 *feddans* allowed for any dependent children (Marii 1954; Bush 1994; Bush 2011). Following that initiative, a second Land Reform Law was enacted in 1961 limiting ownership to 100 *feddans* per person (Abdel-Fadil 1975). The law was then modified again in 1969 to reduce levels of single household ownership further to 50 *feddans* (Abdel-Fadil 1975). Another significant aspect of these state policies since 1952, relates to the expansion of agricultural land through land reclamation programs (Bromley & Bush 1994). Land reclamation started with about 78,000 *feddans* based on small-farmer ownership (Lewis 2008). Since 1952, the land chosen for reclamation has been in two areas; on the fringes of already cultivated areas in the Nile Delta and valley where reclamation was largely only a matter of installing pumping systems so that Nile water could irrigate raised areas of land, and in the desert and coastal areas which otherwise depended on groundwater and rainfall (Voll 1980).

During this period, agricultural cooperatives were also established to provide farming inputs and machinery, grant agricultural loans to rural members, provide advice for farmers on the selection of crops, efficient land cultivation, and destruction of pests, support sales of the principal crops, and provide for other agricultural services, including the provision of canals and drainage (Margold 1957). Agricultural cooperatives were mandated mainly to determine cropping patterns, provide inputs to farmers and organise the purchase of outputs from them at fixed prices (Bush 2007; Cassing et al. 2009).

Cooperatives coordinated the provision of credit and output allocations with agricultural credit banks, which together became an essential instrument of agricultural trade and allocation of finance (Cassing et al. 2009; Kassim et al. 2018). The system also attempted to provide a legal and institutional rural framework for the first time, setting fixed minimum wages and land rents, and improving tenancy agreements in an attempt to break the power of big landlords, in order to benefit the peasantry (Bush 1994). The new legislation even gave tenants rights of inheritance, which had not been identified previously (Bush 2007).

The most notable feature of the agrarian reforms in Egypt was the fact that after two major attempts in redistributing land, the landholding size distribution remained very similar over time, leaving the relative numbers of big landowners, medium-scale and small landowners almost unchanged (Abdel-Fadil 1975). The poor peasants and landless saw minimal real gains during the reform periods (Woertz 2017). It was mostly the middle and upper-middle segment of peasants who benefited from such reforms by increasing their holdings, controlling the benefits to be derived from the agricultural cooperative system, and boosting their market access and influence (Bush 1994; Woertz 2017). Arguably, the major outcome of the post-colonial agrarian reform policies was the shift of near-subsistence family farms into petty-commodity producers, who became highly dependent on state subsidies for production and subsistence (Araghi 2009).

As part of the socialist regime adopted in the 1950s, the food subsidy system was introduced to provide basic commodities at a subsidised price to all Egyptians (Kassim et al. 2018). Bread was the cornerstone of the subsidy system in which the government was involved extensively in all stages of production from procurement of wheat to milling into flour, to production in bakeries, to produce bread for eligible customers at subsidised prices (Tellioglu & Konandreas 2017). The number of subsidised commodities increased gradually, reaching 18 food items by the early 1970s (Ahmed et al. 2001; Cassing et al. 2009).

In response to the ongoing low profitability of agriculture in the late 1960s and early 1970s, yields decreased, self-sufficiency gaps grew wider, exports fell, the rural–urban gap became wider, and labour began to move out of the agricultural sector to seek better opportunities in the non-agricultural sectors (Cassing et al. 2009). Farmers became frustrated as taxes consumed a large part of their earnings and yet simultaneously, the food subsidy system represented a considerable burden on a budget of the government (Cassing et al. 2009). With the expansion of non-farm employment as well as more government public positions becoming available, and mechanisation, young men became more engaged with education in the search for employment opportunities away from agriculture, resulting in a further labour shortage in the sector (Commander & Hadhoud 1986).

2.3.1.2 The open-door economic policy

In response to slower growth in the agricultural sector, the government started an open-door international policy to attract foreign investments (Lewis 2008; Cassing et al. 2009). With the beginning of the open-door policy after the 6th of October War in 1973, a short-term boom in the Egyptian economy was driven by high oil prices, labour remittances and high rents from the Suez Canal leading to further neglect of agriculture because it was seen as a less profitable enterprise (Bush 2007; Cassing et al. 2009; Abdou 2013). The agricultural sector experienced further labour shortages due to the migration of rural inhabitants to the oil-producing Gulf Countries (Commander & Hadhoud 1986). Simultaneously, cities indicated that they had limited capacity to absorb rural migration flows sustainably (Woertz 2017).

The open-door policy encouraged foreign investment in reclaimed lands and made it legal for joint-venture (Egyptian and foreign) companies to own thousands of *feddans* on reclaimed lands (Dixon 2020). The private sector was, hence, allowed to reclaim desert land, often in a disorganised manner, for agricultural use and at the same time, urban encroachment on agricultural land expanded prominently with the growth of remittances (Lewis 2008).

Consequently, agriculture's share of the GDP and employment declined significantly over this period (Cassing et al. 2009), and the sector lost its dominant economic position (Lewis 2008). The neglect of agricultural development during the early phase of the open-door policy also caused a severe decline in exports as the sector converted into a free-market with severe levels of intra-state competition (Abdou 2013). One of the favourable outcomes of the open-door policies was the transfer of technology and scientific cooperation from western and international organisations leading to remarkable improvements in yields (Abdou 2013). However, trade liberalisation also shifted Egypt and many other developing countries from food self-sufficiency to import dependency, especially as the US and EU were seen to subsidise agriculture to maintain global prices of strategic grains at less than the costs of production in the developing world (Bush & Martiniello 2017). By 1976, Egypt was the world's third-largest importer of grain, increasing its external debt (Bush 2007). Accordingly, in 1977, the government attempted to reduce the total expenditure on subsidies for some food items, which caused substantial, violent rioting because people had grown dependent on state-subsidised food (Alderman 1986; Ahmed et al. 2001). The country then experienced a food crisis in the

1980s resulting from low local grain production and a growing population necessitating further increases in imports (Bush 1994).

Another significant feature of this era was the Camp David agreement signed between Egypt and Israel in 1978 and mediated by the United States. The agreement came after years of ongoing tension following the first Arab–Israeli war in 1948 after Israel declaration of independence. According to the agreement, Egypt took back its land in Sinai, and benefited from the foreign aid that was allocated to the Egyptian government by the United States as a condition of the agreement (Bani Salameh, Bani Salameh & Al-Shra'h 2012).

Accordingly, Egypt became significantly more dependent upon the United States' economic and military assistance after 1979 (Sharp 2020). The situation was seen as essential to keeping peace and funding a political regime that supported American interests in a critical region of the world (Bani Salameh, Bani Salameh & Al-Shra'h 2012). The agreement also involved cooperation between Egypt and Israel in the development of agricultural research and technology, tourism, transport, and trade (Pohoryles 2009). Accordingly, the agreement ended the economic boycott, and it ensured the free movement of people and goods between Egypt and Israel and *vice versa*, and cheap, high-quality Israeli goods began to out-compete the Egyptian products on the free market (Hamdan 1989). Simultaneously, also as a result of this agreement, which had been seen to accede considerable sovereign power to the US, the Arab countries imposed economic and political sanctions on Egypt and cut off trade and democratic relations (Bani Salameh, Bani Salameh & Al-Shra'h 2012). With the decline in domestic food supply of main strategic crops, including wheat, maize, rice and sugar in relation to total consumption (Bruton 1983), Egypt has become increasingly dependent on imports from the US to supply the needs of a growing population.

2.3.1.3 Economic reform, privatisation and liberalisation

The state-interventionist policies began to be gradually dismantled in 1986, as the government's role was curtailed in favour of the private sector (Cassing et al. 2009; Woertz 2017; Kassim et al. 2018). The prices for the main strategic crops were partially or entirely liberalised, input subsidies were cut, and forced delivery of the strategic crops to the state were eliminated or contracted out, thereby decreasing the government monopoly on agricultural inputs and outputs (Cassing et al. 2009). The strategy removed pricing constraints to encourage farmers, purchasers and processors of agricultural commodities to invest in agricultural productivity (Bush 2007).

Liberalisation policies advanced further in the 1990s, and by 1994, only sugar and cotton stayed under government regulation (Woertz 2017). In 1991, the government agreed to adopt economic reform and a structural adjustment program, with the help of the International Monetary Fund (IMF) and the World Bank. The program sought to promote an export-led agricultural development and market-oriented economy through the production of less nutritious foodstuffs with high-value for export (Bush 2007). Simultaneously, Gulf investments in land reclamation increased in Egypt, with the aim of producing agri-food commodities needed to ensure food security for people living in Gulf countries (Henderson 2017). Cotton marketing was then liberalised in 1994, all remaining state input subsidies were removed, and the private sector was encouraged to play a more significant role in agricultural trading (Cassing et al. 2009). However, the attempts to shift Egypt to an export-led agricultural economy were mostly unsuccessful, and the cultivation of crops of high value for exports have not contributed much to the economy or the local incomes of farmers (Bush 2007).

Another significant aspect of the liberalisation of Egypt’s rural areas has been the implementation of Law 96 of 1992 entitled, “Reform of the tenancy relationship between owner and tenant” (Cassing et al. 2009; El Nour 2015). The law aimed to promote land consolidation, increase agricultural productivity and promote rural stability (Bush 2000). However, the law made the extension and continuity of rental contracts of farming lands invalid for the first time since 1952, and it regulated for the total suspension and replacement of existing land-holding agreements after a five year transitional period (FIAN 2000). It also gave landlords the right to levy rents at market rates and allowed contracts to be reduced to 12 months and revoked without notice (Bush 2000). In 1997, after the full implementation of the law, landlords had the right to evict current tenants and lease the land to new tenants at higher rates (Ibrahim & Ibrahim 2003; Adriansen 2009). Consequently, the law led to increasing insecurity for tenants and raised rents for agricultural lands more than threefold, meaning that many farmers were unable to pay their rents (Kassim et al. 2018).

As a result of the reconsolidation, landlords were able to regain their lands that they had lost during previous reforms and access new lands, triggering a process of domestic land grabbing (Fautras & Iocco 2019). Yet land appropriation was generally not for agricultural purposes, with many agricultural lands taken for public infrastructure projects and private wealth gains, such as the establishment of tourists resorts (Dixon 2020). About one million tenants lost their land across Egypt and became sharecroppers, renting small plots of land from a landlord in return for a part of their crop to be given to the landlord (Kassim et al. 2018).

The law resulted in more rural poverty, landlessness, and increased the desire for migration by younger family members of ex-tenants, often at a time of fewer opportunities in urban areas (Bush 2000; El Nour 2015). The law also sparked violent protests by farmers in more than 100 villages across Egypt's countryside (El Nour 2015) that were repressed by the government (Saad 2002). Market liberalisation, hence, created greater poverty and unemployment in many Egyptian rural areas (Bush 2004). However, farmers managed this deteriorating economic situation through greater dependence on family resources and assets (Bush 2004).

Importantly, the implementation of the neo-liberal reforms since the 1980s and 1990s radically altered labour conditions resulting in a labour class that was insecure, fragmented, increasingly precarious, and dispossessed of substantial socio-economic rights (Paciello & Pioppi 2020). The economic reform and structural adjustment program reduced the role for the public sector in the economy and labour market, which became unable to absorb the growing numbers of job entrants (Bremer 2018). Although the goal of these reforms was to create a strong private sector, Egypt was unable to create decent, formal jobs in the private sector (World Bank 2014). With the expansion of urban economic opportunities and the rise in rural populations, peasants migrated to urban areas in the last decade of the twentieth century to become absorbed into the informal economy (Bremer 2018).

Adding to these economic challenges, Egyptian farmers face two main contemporary issues that threat their livelihoods. The first, the Grand Renaissance Dam in Ethiopia under development since 2014 when Egypt, under the current president, signalled its acceptance that there is little it could do to prevent the dam from being completed (The Economist 2015; Barnes 2020). The second, farmers being dispossessed from natural resources through the process of domestic land grabbing driven by members of the local elite and capitalist investors who have political and economic power at the national level

(El Nour 2019). Cochrane (2016 p.1) defines land grabbing as "the application of force to coerce individuals to illegally give up their land or the other wise illegal dispossession of land".

It can be concluded that rural areas in Egypt have been suffering from decades of marginalisation and growing poverty (Bush 2000; Bush 2004; El Nour 2015; Bush 2016). For instance, recent statistics show that 32.5 percent of the population in Egypt (32 million citizens) live below the national poverty line (around US$ 1.45 per day) in 2018 (CAPMAS 2019a), an increase of 15.8 percent since 1999 (World Bank 2017). Poverty rates are generally high in rural areas reaching 51.9 percent in some regions in Egypt in 2018 (Armanious 2018).

De Lellis (2019) claims that government policies have been working against the agriculture labour force for at least 30 years, dispossessing them of economic and natural resources. He argues,

> "Since the late 1980s, dispossession of natural resources and marginalisation of the poor peasants have been a constant feature of agrarian transformations in North Africa. This has affected the whole landscape of societies, engendering phenomena of migration, urbanisation, environmental degradation, impoverishment and unemployment. Dispossession in Egypt has been gradual and the result of different forms of commoditisation of land and of other crucial agricultural inputs and services" (de Lellis 2019, p.583).

Dispossession is not only about physical elements but also about the intertwined social order, the customs and representations connected with means of accessing and controlling resources (Fautras & Iocco 2019). Indeed, small food producers in many developing countries have faced increased dispossession from land throughout the process of transitioning to commercial agriculture and commoditisation (Desmarais 2007). Many small-scale farmers in the developing world have been unable to combat the effects of trade liberalisation and compete with subsidised large-scale agricultural production of the developed countries (Bush & Martiniello 2017), a process that is referred to as "depeasantisation" (Dixon 2020). Likewise, the process of "de-agrarianisation" refers to the pushing of small farm households into non-farm sectors to supplement low agricultural income that is often reduced under capitalism (Bryceson 2004; Bush & Martiniello 2017).

These two processes contribute to a structural crisis and accumulated resistance, often sparking protests, among dispossessed farmers and other rural people who find limited employment opportunities in towns and countryside (as explained earlier in Section 2.2.3) (Bush 2016; Bush & Martiniello 2017). Recent decades have witnessed growing social movements in many agrarian societies that engaged in struggles against liberalisation and the mass dispossession caused by capitalism (Borras, Edelman & Kay 2009; Murari 2015; Vergara-Camus 2014; Tilzey 2020; Engles 2021).

Moore (2010) also advocates that the production of cheap food became an integral aspect of modernity over the expense of ecological sustainability. He links patterns of capital accumulation and the crisis of capitalism in agriculture with climate change and other ecological crises, as industrialised agriculture has generated "negative value" and caused depletion of natural resources (Moore 2015). For instance, the introduction of chemicals as a feature of modern agriculture has undermined the sustainable management of soil nutrition in many places (Bush & Martiniello 2017) and eradicated natural enemies of pests (Foster & Magdoff 1998). This mismatch between capitalism and resource depletion, which is, again, a characteristic of a risk society (Beck 1992), has made food riots and protests a persistent feature of modern times (Moore 2010).

The modern global food system has commoditised food to the extent that the landless poor only have access to nutrients just adequate for survival if they can purchase it (Bush & Martiniello 2017). Consequently, poor and ecologically marginal countries that fail to ensure adequate local food production, or are unable to buy food and distribute it at affordable prices for poor people, will likely face persistent food crises and associated political opposition (Bush & Martiniello 2017).

2.3.2 The paths of agrarian transition in Egypt and the resultant class structure

To better understand the agricultural sector in Egypt, we need to recognise the history and trajectories of agrarian change that have produced the current situation of agriculture at local and regional scales. Hart, Turton & White (1989) advocate the importance of conducting local-specific studies and even further recognizing the significance of nonfarm incomes and production processes within the household as a whole when addressing agrarian change. On a local scale, the nature of rural villages in Egypt are different from one another based upon their location (near or far from river or water canal, city, desert), history, economic diversity, cultural sophistication, or the internal economic structures (Hopkins & Mehanna 1981 cited in Hopkins 1987). More importantly, rural villages are also distinguished from one another based upon the "paths of rural transformation" (Keyder 1983). Hopkins (1987) identifies three primary paths of agrarian transformation in rural Egypt as follows:

1. The "capitalist" path, which results from the ability of a stratum of large landholder farmers to acquire machinery and other means of production and to accumulate funds. These capitalist farmers rely on machinery and hired labour, thus reproducing capitalist relations of production in the villages they dominate.
2. The "petty commodity producers" path. These include small-scale producers having control over several *feddans*; however, they have less access to other means of production than the large landholders. They typically rely on family labour, but also sometimes hire labour to supplement the household labour supply, and hire tractors and pumps to complete their farm work. Such small farmers are losing some of their decision-making over the agricultural process, and they are "deskilled'. In sum, the petty commodity path exists, but the producers are, to some extent, falling under the influence of capitalist farmers.
3. The third path of agrarian transformation revolves around the role of the state in newly reclaimed lands or agrarian reform areas. In these areas, the state controls both land and water, whether through cooperatives or state companies. Villages within the newly reclaimed areas have large landholdings and their dependence on government policy support is high. People resettle there from elsewhere, and most are smallholders, recent graduates or officials. Finally, they are villages that depend predominantly on labour from outside the villages.

Individual villages are often typified by one or another of these dominant paths of agrarian transformation; however, within each village, particularly in the old lands of the Delta, both capitalist farmers and petty commodity producers can be found within single locations (Hopkins 1987). More importantly, the class structure of virtually every village also contains a substantial number of people who might possess a small farm area or none at all, and who earn their living mainly through working outside the village or the agricultural sector (Commander & Hadhoud 1986; Hopkins 1987). Springborg (1990) refers to this group of people who earn from non-farm sectors as a new class of landowners called “agrarian bourgeoisie” who emerged following the implementation of agrarian reforms.

The fundamental sources of status and income for the agrarian bourgeois are commonly generated from outside agriculture and beyond the local area (Weinbaum 1982). This category of rural dwellers relies on superior technical and managerial skills to exploit capitalist opportunities and often have more educational qualifications than the traditional capitalist farmers (Springborg 1990). Therefore, this category of individuals is found in the agrarian class structure of the village, and they continue to reside in the village and have political and social influence (Hopkins 1987).

It can be concluded then, that villages in Egypt are composed of distinct groups of farmers and their households each of which could represent or reflect the different stages of the agrarian transition process (Table 2.1). This heterogeneity requires more attention when studying farmers’ vulnerabilities and capacity to adapt in response to climate change, because different social groups will have different levels of vulnerability to socio-ecological change and have variable opportunities to adapt. It is therefore important to integrate these social categories into the data analysis and the explanation of the study results.

Table 2.1 Dominant class structure within the Egyptian rural areas and the representing stage of the agrarian transition process

Stage of agrarian transition	Dominant class	Characteristics
Agricultural-based societies	Petty Commodity producers	- Small landholders or landless, agricultural waged labourers - High dependency on family labour - Low political and social power
Pre-transition societies	Capitalist farmers	- Relatively larger landholders - High dependency on machinery and hired labour - High political and social power
Transition societies	Agrarian bourgeois	- Earn largely from non-agricultural sources - Living in rural areas and reserving some social and political powers - High educational qualifications

Source: Adapted from Hopkins 1987; Springborg 1990; World Bank Group 2015

This integration allows for an explanation of the links between the broader context of perceptions of risk caused by climate change, and the social and economic characteristics of these groups, and it will help to frame the particular vulnerabilities and decisions to adapt within the Egyptian agrarian community under investigation. The following section will, therefore, present a broad review of key concepts linked to risk perceptions and adaptation to climate change.

2.4 Risk perceptions

The study of risk perception refers to the analysis of the instinctive judgment of individuals and groups about the features and severity of risk (Slovic 1987). Risk generally involves "the degree of uncertainty in a given situation" (Roumasset, Boussard & Singh 1979 p.4). Environmental perception is the way by which individuals seek to comprehend their surrounding environment, and it can either occur directly through personal experience with environmental events (storms, droughts and floods), or indirectly through other individuals and community members, government agencies, media, and scientists (Koubi, Stoll & Spilker 2016).

O'Connor, Bard & Fisher (1999) argue that risk perception is a significant factor for predicting behavioural intentions. One of the key factors that significantly influences individuals' decisions regarding adaptation is their perception of the risks linked to the adverse effects of climate change (Weber 1997; Vedwan & Rhoades 2001; Patt & Schröter 2008; Gbetibouo 2009; Smithers & Smit 2009; Weber & Johnson 2009; Bardsley & Hugo 2010; Spence et al. 2011; Koerth et al. 2013; Bagagnan, Ouedraogo & Fonta 2019). Likewise, Maddison (2006) suggests that adaptation requires two steps: the first is perceiving that climate change has occurred and the second is deciding whether or not to adopt a certain adaptation measure. Similarly, Antle (2009) suggests that farmers' perceptions of current and future climate change-related risks together with farming conditions and their socio-economic characteristics, were key factors affecting their decisions to adopt particular adaptation measures.

Consequently, to develop an appropriate and effective response to climate change, it is essential first to understand whether farmers have observed changes in climatic conditions and how they perceive the risks associated with these changes (Wheeler, Zuo & Bjornlund 2013; Li et al. 2017). Assessing perceptions of risk is also crucial in understanding individuals' preparedness to adopt adaptation strategies and hence, assist appropriate policy design in a given setting (Li et al. 2017).

Perceptions of environmental change not only depend on individual's exposure to climatic events but they are also mediated by his or her ability to mediate or cope with environmental stressors, given their individual and household circumstances (Koubi, Stoll & Spilker 2016). Actions that follow perceptions of climate change risks are informed by different factors such the resource base, cultural values, political and institutional environment and there is no assurance that perceptions of climate change would result in effective adaptation responses (Weber 2010). Therefore, most research studying individual or household decisions about migration-related adaptation emphasises the importance of understanding perceptions of environmental change, as it allows a better explanation of why some people decide to migrate, for example, when exposed to a given environmental stress, while others do not (Mortreux & Barnett 2009; Bardsley & Hugo 2010; Black, Kniveton & Schmidt 2011; Black et al. 2013; Hunter, Luna & Norton 2015).

Numerous studies have suggested that people, whether in developed or developing countries, have already developed their own perceptions about climate change (Mertz et al. 2009b; Akter & Bennett 2011; Chaudhary & Bawa 2011; Deressa, Hassan & Ringler 2011; Nyanga, Johnsen & Aune 2011; Spence et al. 2011; Nnko et al. 2021). There are several socio-economic, demographic and biophysical factors that shape individuals' perceptions of climate change including geographic location and soil types (Maddison 2007; Gbetibouo 2009; Omar et al. 2015), income (Semenza et al. 2008), ethnic background (Leiserowitz 2006), gender (Leiserowitz 2006; Rothermich et al. 2021), age (Diggs 1991; Maddison 2007; Ishaya & Abaje 2008; Rothermich et al. 2021), education and access to extension services (Maddison 2007; Gbetibouo 2009; Omar et al. 2015; Nnko et al. 2021), irrigation infrastructure (Niles & Mueller 2016) and the source of the information about climate change (Sampei & Aoyagi-Usui 2009; Weber 2010). Adger et al. (2013) also suggest that culture is one of the factors that mediate people's risk perceptions and adaptive behaviour as will be further addressed in the following discussions about adaptation to climate change (Section 2.5).

2.5 Adaptation to climate change

The rewards of a whole year's effort in farming are largely dependent on two fundamental variables that are outside the farmers' direct control: the weather and prices (Timmer 1988). The sensitivity of the agricultural sector to climate makes the sector one of the most vulnerable sectors to the impacts of climate change (Parry & Carter 1989; Smit & Skinner 2002; Mendelsohn 2008). Therefore, adaptation to climate change is crucial for sustaining the agricultural sector and the livelihood of people working within the sector. Human adaptation to climate change is defined as "the process of adjustment to actual or expected climate and its effects by seeking to moderate or avoid harm or exploit beneficial opportunities" (IPCC 2014 p.5).

Adaptation is influenced by socio-economic, cultural, political, geographical, ecological and institutional factors that shape the human–environment interrelationships (Eriksen et al. 2011). Smithers & Smit (1997) argue that individuals and systems (social, economic, institutional and ecological systems) can and do adapt to changing environment. However, sustainable and effective adaptation depends on the adaptive capacity of those involved (IPCC 2007a). Many factors influence the adaptive capacity of farming communities such as knowledge about, and perceptions of, climate change (Adger et al. 2003; Adger et al. 2007; IPCC 2007a), education (Abid et al. 2019; Ekemhonye et al. 2020), social capital and networks (IPCC 2007a; Smit & Wandel 2006; Tinch et al. 2015; Jones, Ludi & Levine 2010; Abid et al. 2017), household size (Ekemhonye et al. 2020), off-farm income (Ekemhonye et al. 2020; Khan et al. 2021), access to information and appropriate technology (Abid et al. 2019; Awazi et al. 2020; Khan et al. 2021), access to markets (Ado et al. 2020; Marie et al. 2020), household income (Awazi et al. 2020), land size and tenure (Defiesta & Rapera 2014; Abid et al. 2019; Khan et al. 2021), and access to credit (Abid et al. 2016; Awazi et al. 2020; Khan et al. 2021). Lack of availability and access to assets, including both tangible capitals (natural, physical and financial) and intangible ones (human and social), may significantly limit the capacity of a system to adapt to climate change (Jones, Ludi & Levine 2010). Adger et al. (2003 & 2007) stress the influence of values and traditions in shaping the adaptive capacity of communities.

The resilience of livelihoods and their alternatives in terms of diversification and financial remittances and mobility is another critical factor that influenced the adaptive capacity of communities (Barnett 2001; Sutherland et al. 2005; IFAD 2008; Sobczak-Szelc & Fekih 2020; Benveniste, Oppenheimer & Fleurbaey 2020; Maharjan et al. 2020). Income diversification both within the same sector and across the different economic sectors has often been considered a risk mitigation strategy (Barrett, Reardon & Webb 2001; Barrett, Bezuneh & Aboud 2001) and is essential to avoid poverty traps (Barrett, Reardon & Webb 2001; Barrett, Bezuneh & Aboud 2001; Haggblade, Hazell & Reardon 2007; Marenya & Barrett 2007; Bezu, Barrett & Holden 2012; Stephens et al. 2012). However, many smallholder households are incapable of seizing high-return, non-farm opportunities due to their limited human capital and other forms of capital including non-land capital assets, and poor access to markets and financial services (Barrett, Reardon & Webb 2001; Barrett, Bezuneh & Aboud 2001; Amare & Shiferaw 2017).

Adaptive capacity is a critical component for reducing the climate change vulnerability of any system (Smit & Wandel 2006). Vulnerability often refers to the "degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change" (IPCC 2007a p.52). The IPCC's definition of vulnerability highlights exposure, sensitivity and adaptive capacity as the three essential features. The term vulnerability generally covers physical or natural, social, and economic vulnerabilities (UNDP 2014). Physical vulnerability includes aspects of location, place and geography (Wilbanks 2003; Anjum & Fraser 2021), whereas social vulnerability often relates to the characteristics of people affected by climate change (Piguet, Pecoud & de Guchteneire 2011). Several scholars have identified common aspects of social vulnerability including race (Fothergill, Maestas & Darlington 1999; Elliott & Pais 2006; Bolin 2007; Cutter & Finch 2008; Elliott & Pais 2010; Drzewiecki et al. 2020; Woo et al. 2020), education (Drzewiecki et al. 2020; Poudel et al. 2020), age (Wisner 2006; Bartlett 2008; Peek 2008; Peek & Stough 2010), socio-economic status (Bolin 2007; Ray-Bennett 2009; Ribot 2013; Poudel et al. 2020), gender (Sen 1983; Ray-Bennett 2009; Poudel et al. 2020), migration and housing tenure (Cutter & Finch 2008), and health conditions (McGuire, Ford & Okoro 2007; Peek & Stough 2010). Vulnerability is the outcome of exposure to climate change as well as inequalities in socio-economic status and income (IPCC 2014). Waly Ayad & Saadallah (2020) suggest that high levels of poverty, inequality, and problems related to housing, unemployment, access to basic public facilities such as sanitation and drinking water define the social vulnerability of communities.

The vulnerability of a society is subjective to its level of development, distribution of resources, physical exposures, previous pressures and social and government institutions (Kelly & Adger 2000; O'Brien et al. 2004; Smit & Wandel 2006). Political stability and good governance both influence the adaptive capacity of societies as adaptation is viewed as a transformative socio-political process (Ribot 2011; Eriksen, Nightingale & Eakin 2015; Nightingale 2017). People living in areas where conflicts are prevalent are particularly vulnerable to climate change (Adger et al. 2014). All societies can adapt to some variation in climate, yet adaptive capacities are unequally distributed, both across countries and within communities (Adger et al. 2007).

For instance, developing countries, like Egypt, are more likely to suffer from the effects of climate change (Ayers & Huq 2009; Mertz et al. 2009a; Loayza et al. 2012; IPCC 2014), in part, due to the exposure to climate change highlighted previously. This greater vulnerability is also due to several social factors prevailing in developing countries including:

1. Economic structures and livelihoods of a large population depend on climate-sensitive agriculture (Noy 2009; Loayza et al. 2012);
2. High rates of poverty in which poor people have low adaptive capacity, and
3. Inadequate economic and technical capacity needed for successful adaptation to climate change (Mertz et al. 2009a).

The effects of climate change would significantly influence most impoverished and marginalised people as they are least able to adapt, resulting in them becoming poorer (Bohl, Downing & Watts 1994; Adger et al. 2003; Thomalla et al. 2006; Parry et al. 2007; Mirza 2011; IPCC 2014; Warner, Hoffmaister & Milan 2015; Islam & Winkel 2017; Otto et al. 2017). Small landholders and the landless are among the most vulnerable to climate change (Morton 2007; Oppenheimer et al. 2014; Warner, Hoffmaister & Milan 2015). Clay & King (2019) also suggest that small landholders have uneven vulnerabilities and capacities to adapt to the impacts of climate change.

Even within both developing and developed countries, there are some regions, communities, social groups or individuals that are lacking the capacity to adapt to climate change (O'Brien et al. 2007). For instance, communities located in geographically remote areas are more vulnerable to climate change (Kohler et al. 2010). Rural households and communities, especially in developing countries, are the most vulnerable because their livelihoods are very dependent on primary resources (Paavola & Adger 2002; Agrawal & Perrin 2009; Dasgupta et al. 2014). Rural households are also exposed to other non-climate stressors, including land degradation, problems with policy regarding land and natural resources, and under-investment in agriculture (Field et al. 2014). Füssel & Klein (2006) argue that non-climatic stressors are considered an essential determinant in shaping people's vulnerability. Below, Schmid & Sieber (2015) categorise non-climatic factors into three groups: socio-economic factors at the household level (e.g. gender, size, age structure, health status, income, ownership of livestock, and access to land), biophysical (e.g. soil quality, water availability) and institutional factors (e.g. the presence of extension services, access to markets, prices of farm inputs and produce). It is hence important to note that the adaptive capacity of societies is mostly dependent on the relative distribution of health, education and wealth (Feenstra et al. 1998). As a result, if a society or community includes a larger number of poor, unhealthy and poorly-educated people, the more vulnerable it is likely to be to climate change and the less likely it will be to adapt (Feenstra et al. 1998). Not responding to perceived or actual climate change risk is not always related to lack of adaptive capacity; it can be considered as proactive means when people have strong resilience and do not consider climate change as a significant risk (Mortreux & Barnett 2009).

Within this context, Warner, Hoffmaister & Milan (2015) classified rural households into:

1. Resilient households**,** which are those who are poor but possess a variety of assets (social, financial, political, educational) and who have better access to adaptation or risk-management measures (including mobility measures) and options to diversify their livelihoods.
2. Vulnerable households, which are those who are land scarce or landless, and poor with very few opportunities for livelihood diversification and *in situ* adaptation. They usually manage climate-related risk through selling assets, consuming less food of a poorer quality, and seeking help from other community members.

Climate change can have a detrimental effect on the agricultural sector in the absence of adaptation; however, with the implementation of successful adaptation measures, vulnerability can be significantly reduced (Easterling et al. 1993; Smit & Skinner 2002). Consequently, adaptation can be seen to have the overarching aim of reducing vulnerability or improving resilience to climate change and variability (Smit & Pilifosova 2003). Decisions about adaptation do not only depend on perceptions of risk held by the society, as discussed earlier (see Section 2.4), but also on the places and cultures of a given society that may limit the array of adaptation measures (Adger et al. 2009).

Adaptation takes several forms at various social and spatial scales (Bryant et al. 2000), and research on it has employed different typologies to describe its multi-dimensional and multi-scale nature. Burton, Kates & White (1993) classified adaptation by its specific objectives as:

1. share the loss
2. bear the loss
3. modify the events
4. prevent the effects
5. change the use, or
6. change location.

Adaptations can also be classified according to their timing (reactive *vs* proactive); motivation of adaptation (economic improvement or safety); duration of adaptation (long-term *vs* short-term); impact of adaptation (worsened or enhanced resilience); ways of implementation (autonomous *vs* planned), etc. (Klein 1998; Smit et al. 2000; Klein 2003; Adger, Arnell & Tompkins 2005; Bryan et al. 2009; Smithers & Smit 2009). Other researchers typify adaptation as adjustments that occur in place (i.e. *in situ*) *vs* those that have mobility elements (i.e. *ex situ*) (Bardsley & Hugo 2010). Another approach developed by Park et al. (2012), suggested two central categories of adaptation: incremental and transformational. Incremental adaptation aims to retain the "integrity of a system or process at a given scale". In contrast, transformational adaptation suggests necessary changes "in the biophysical, social or economic attributes of a system from one form, function or location to another" Park et al. (2012 p.5). Wheeler, Zuo & Bjornlund (2014) proposed three main means for incremental adaptation; either by expanding land or water use, or decreasing irrigated land or water use; or accommodating the new conditions through improving irrigation efficiency and changing the mix of crops. Transformational adaptation comprises activities that are:

1. New to a system or region;
2. At a larger scale of intensity; and
3. In new places and locations (Kates, Travis & Wilbanks 2012).

The agricultural sector globally has been mostly adopting incremental adaptation strategies such as agricultural intensification, improvements to crop varieties and livestock breeds, or improving water and soil management practices, and transformational adaptation means are less applied in practice so far (Dowd et al. 2014). Incremental adaptation might be inefficient or ineffective in promoting sustainable development of the agricultural sector on the long term (Howden, Crimp & Nelson 2010; Rickards & Howden 2012), and it could even lead to "maladaptation" (Barnett & O'Neill 2010). Maladaptation refers to adaptation measures that do not reduce vulnerability, but increase it instead (UNFCCC 2007). It can be concluded then, that farmers' responses to weather variations have aggregate consequences (Roumasset, Boussard & Singh 1979). Therefore, adaptation to climate change plays a key role in enabling or restraining development in the agricultural sector.

This study explains adaptation measures within the broader categorisation of *in situ* and *ex situ* as will be discussed in further detail in the following sections (2.5.1 and 2.5.2).

2.5.1 *In situ* adaptation

In situ adaptation strategies refer to localised adjustments to climate change and other environmental pressures (Yang et al. 2019). *In situ* adaptation practices in the agricultural sector include strategies aiming to alter or improve agricultural production, farm management, living habits and personal lifestyles, and the use of natural resources particularly land and water (Smit & Skinner 2002; Grothmann & Patt 2005; Deressa et al. 2009; Marshall 2010; Osberghaus et al. 2010).

This thesis explains *in situ* adaptation as localised adjustments in farming activities that improve agricultural production and farm management. The definition could include cases of income diversification within the agricultural sector while remaining in the original farming occupation. Income diversification activities within agriculture could consist of livestock production, trade, or paid labour (Below et al. 2010). Hassan & Nhemachena (2008) found that better access to markets, extension and credit services, farm assets (labour, land and capital), technology and information about adaptations, including technological and institutional methods, affect adaptation to climate change. Consequently, to ensure effective *in situ* adaptation practices that reduce vulnerability in the long run, it is argued that governments need to provide infrastructure, improve access to financial services, cash returns and social safety nets, and provide information and incentives to improve economic transformation (Castells-Quintana, Lopez-Uribe & McDermott 2018).

Several studies address specific agricultural adaptation measures that could reduce the vulnerability of the sector in Egypt. These measures include changing sowing dates, altering the crop mix to minimise the area cultivated with high-water use crops like sugarcane and rice, improving the efficiency of irrigation systems, increasing irrigation requirements and enhancing technical progress for fast-growing crop varieties (Eid et al. 2007; Attaher, Medany & Abou-Hadid 2009; Attaher, Medany & El-Gindy 2010; McCarl et al. 2015).

2.5.2 *Ex situ* adaptation

As populations and economies grow, people and their systems can move from one place to another to seize opportunities, improve the quality of their lives and to avoid risks. Migration is an essential social and economic phenomenon in all societies (Adger et al. 2015). There is diverse evidence that economic growth and demographic changes, particularly in developing countries drive migration (de Haas 2010b; Hugo 2011); and theories of migration have formed a basis for understanding the reasons behind human migration.

For instance, the neoclassical economic theory claims that wage disparities between sectors or countries, particularly labour-rich countries and capital-rich countries drive migration (Massey et al. 1993). Likewise, the dual labour market theory argues that migration is primarily caused by "pull" factors (i.e. the demand for cheap, unskilled labour) in developed, receiving countries rather than "push" factors in the sending countries (Piore 1979; Massey et al. 1993). The social networks theory of migration, however, focuses on the crucial role of social networks and ties (i.e. social capital) between former migrants and non-migrants at their origin, in identifying people's decisions and their ability to migrate (Massey 1990; de Haas 2010a). Another theory, the new economics of labour migration, explains migration as a risk-sharing decision made collectively by families or households rather than individually (Massey et al. 1993; de Haas 2010b). According to this theory, households make decisions to migrate to reduce their risk of loss of income due to crop failure, market-related failures (labour, credit, insurance), price fluctuations, and unemployment and to improve the household's overall economic well-being (Massey et al. 1993). Stark & Levhari (1982) consider migration of family members is a "clear strategy" rural households follow whenever there are either no alternatives for diversification of income, or if there are alternatives, then they are insufficient for their needs.

Migration theories have focused fundamentally on the economic, social, institutional, demographic and cultural factors of migration (Massey, Axinn & Ghimire 2010); nevertheless, it is widely agreed that environment is one of the key factors that influence human mobility (Hugo 1996; Warner et al. 2008; Jäger et al. 2009; Warner et al. 2009; Warner et al. 2010; Massey, Axinn & Ghimire 2010; Black et al. 2011a & 2011b; Foresight 2011; Afifi et al. 2016; Raha & Gayen 2021). In recent years, the effects of environmental change have already manifested themselves in several regions of the world, such as droughts in Yemen, flooding and landslides in Nepal and India, cyclones and storm surges in Pakistan, and several other incidences (Martin, Weerasinghe & Taylor 2014). As a result of the economic losses caused by these extreme weather events and natural disasters (Neumayer, Plümper & Barthel 2014), and the systematic environmental changes, migration and environment has become an evolving research discipline (Adger et al. 2015).

Climate change is expected to generate human movements not only due to increased frequency and intensity of natural disasters, but also due to potential new conflicts over scarce resources (Martin, Weerasinghe & Taylor 2014). The usual environmentally-related risks such as natural disasters, drought, crop failures, and the social and economic changes that take place within countries during development generate an economic environment where uncertainty and unpredictability prevail in both urban and rural areas (Massey 1990). Migration is, therefore, considered a well-known strategy to spread risks under challenging environmental conditions (Massey 1990; Adger & Adams 2013).

The influence of environmental factors on migration patterns is closely related to other factors – demographic, environmental, economic and socio-political – and hence, such a relationship entails complexity and multiple causalities (Foresight 2011). Climate change impacts has a multiplier effect on other drivers that influence human migration (Afifi & Warner 2008). In other words, the effects of any environmental events are multiplied by other structural elements like poor governance, high levels of poverty and inequality, insufficient access to basic services, conflict, poor health, unemployment, economic constraints, and weaknesses in both the local and national capacity to act against risks (Kniveton et al. 2008; Foresight 2011; Martin, Weerasinghe & Taylor 2014).

Consequently, migration as an adaptation to climate change is considered a complex phenomenon that is shaped by various drivers and is hardly triggered by a sole cause (Kniveton et al. 2008; Foresight 2011).

Although migration has also been viewed as a failure to adapt in several studies (Conisbee & Simms 2003; Renaud et al. 2007; Stern 2007; Warner et al. 2009), evidence has shown that migration as a consequence of climate change is not necessarily a negative outcome (Bardsley & Hugo 2010; Black et al. 2011a & 2011b; Piguet, Pecoud & de Guchteneire 2011; Adger & Adams 2013; Baldwin & Gemenne 2013; Gemenne & Blocher 2017). Migration is often an important strategy for households to diversify their incomes that is much needed in the context of environmental change (Foresight 2011; Sobczak & Fekih 2020). Within the agricultural sector, migration might help support agricultural production (Rigg 2007). Studies show that remittances sent to rural areas represent a significant source of capital to purchase land and machinery, adopt new crops, and even to expand non-farm employment in rural areas (Banzon-Bautista 1989; Gibson, Law & McKay 2001; McKay 2003; Asfaw et al. 2019; Sobczak & Fekih 2020).

When studying migration environment nexus, it is important to consider the extent to which migration is considered as a rational option of an array of adaptation alternatives or a failure of *in situ* adaptation measures i.e. whether people are forced to move or migrate as a precautionary adaptation to environmental changes (Bardsley & Hugo 2010). Climate change induced migration can take many forms, involve various degrees of voluntariness, and generate different outcomes (Hugo et al. 2009; Piguet, Pecoud & de Guchteneire 2011). Generally, there are three forms of movements as a response to any humanitarian crisis (Martin, Weerasinghe & Taylor 2014):

1. **Displacement**: includes people who are obliged to move as a result of being directly threatened by certain events.
2. **Anticipatory movement**: encompasses people who choose to move as a result of some potential future risks to their living conditions. Such future risks would include slow-onset events such as rising sea-levels or increasing desertification, or drought.
3. **Relocation for trapped populations**: includes those individuals who are directly affected by certain crisis but who do not, or cannot, move and hence are in need of relocation.

Environmental change influences patterns of migration by altering the mix of economic activities at the location and altering the location itself (Adger & Adams 2013). Consequently, this study refers to *ex situ* adaptation through the broader context of mobility, both occupational and geographical mobility. Mobility entails the movement of people across jobs and physical space (Long & Ferrie 2006). Internal and international movements are thus understood as geographical mobility, while movement from the agricultural sector to other non-farm economic sectors is referred to as occupational mobility. Geographical mobility can also be further classified based upon the distance (short-distance or long-distance), and type of movement (forced or voluntary) (Long & Ferrie 2006). In this sense, migration is considered one of the forms of mobility and hence the terms "mobility" and "migration" are used interchangeably in the thesis.

The study of Rigg (2006) states that five main forces push rural households away from agriculture are:

1. The reduction in the profitability of small-lands;
2. The rise of non-farm employment;
3. Changes in the cultural and social context of rural areas such as migration and education;
4. Environmental losses; and
5. Shortages in resources.

Another critical dimension that should be considered when studying environmental induced migration, is the nature of the climate change events, whether slow-onset or sudden events (Bardsley & Hugo 2010). Slow onset events paired with environmental degradation and climate change may cause a gradual loss of people's resilience and governments' capacity to protect them (Bronen 2015). The study of Koubi, Stoll & Spilker (2016) suggests that slow-onset environmental events such as drought decreased the likelihood of migration. Consequently, understanding individuals and their household's adaptation strategies to slow-onset events, particularly migration decisions, if any, is crucial in understanding the "tipping point" or threshold of any environmental crisis. The likelihood that some people could be unable to migrate or move away from a specific environmental risk emphasises the importance of explaining the nature and causes of trapped populations that are discussed in the next section.

2.5.2.1 Immobility and trapped populations

One of the earliest attempts to explicitly theorise immobility was Standing's (1981) research. In his study, he noted that the global changes in the economic and political systems had reduced mobility and hence he challenged the assumptions of migration theories entailing the inevitable movement of poor and unemployed due to wage disparities. In one example, Standing (1981) believed that very poor households were unable to finance migration of their members or unable to spare the labour and suggesting that it is the most marginalised households that are more likely to become trapped.

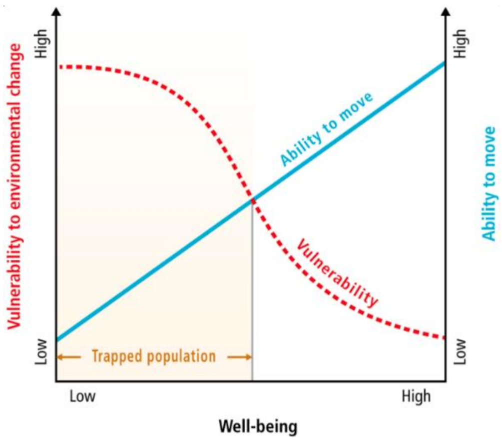
Researchers have agreed that environmental factors play a key role in human mobility (Jäger et al. 2009; Warner et al. 2009; Van der Geest, Vrieling & Dietz 2010; Black & Collyer 2014; Afifi et al. 2016; Thornton et al. 2019; Raha & Gayen 2021). However, attention to immobility has gained momentum in recent years, particularly within the broader concerns about the impacts of climate change (Black et al. 2011a, 2011b; Black et al. 2013; Adger et al. 2015; Afifi et al. 2016; Ayeb-Karlsson, Smith & Kniveton 2018; Farbotko et al. 2020). Although many people move as a result of acute events or to avoid potential future risks, some others lack the resources or capacities to migrate (Martin, Weerasinghe & Taylor 2014; Warner & Afifi 2014; Black et al. 2013; Adams 2016).

Access to resources or capital generally influences the ability of individuals or households to migrate (Black & Collyer 2014), and lack of one or more forms of capital (social, cultural, human, economic, geographical and political) can be a burden to human mobility (Kothari 2003). Therefore, migration may not be a consequence of environmental change if people do not have sufficient economic resources, networks and capital (Adger & Adams 2013; Black & Collyer 2014*)*. Environmental change can be barrier to movement rather than an encouraging factor (Black et al. 2011a; Foresight 2011; Gary & Mueller 2012). Climate change is expected to undermine already fragile economic livelihood, especially in those populations which are actually or potentially trapped in place due to poverty (Black et al. 2011a; Foresight 2011; Gray & Mueller 2012; Hallegatte 2012; Nawrotzki & DeWaard 2018). Climate change might bring about less migration not only through removing the resources needed for migration but also through increasing the need for labour at the place of origin (Foresight 2011; Gray & Mueller 2012). Such loss of individuals' assets and capital are among the main reasons that cause people's immobility and trapped populations (Black et al. 2013).

Black & Collyer (2014) identify “trapped” populations as those people who lack control over their decisions to move away or escape potential risk or threat. In their study, they highlighted the theoretical problem arising from distinguishing between individuals who aspire to move but are unable to, and those who do not wish to move. However, it is of great importance to advance our understanding of immobile populations as they are the most vulnerable to being “trapped” in more severe environmental crises. Being immobile magnifies the vulnerability of those individuals who are unable to move or incapable of coping; therefore, vulnerable populations will be more likely to be trapped and to bear the ultimate burdens and risks (Black & Collyer 2014).

Immobility leaves vulnerable populations who do not have the resources to migrate at increased risks (Adger & Adams 2013). Figure 2.8 shows the dynamics of vulnerability to environmental change, well-being, and mobility patterns. People who are most exposed and vulnerable to the impacts of climate change have the least capacity for migrating (Foresight 2011; Adger & Adams 2013). Similarly, low levels of capital increase the vulnerability of individuals to crisis and decrease their ability to move (Black & Collyer 2014). Therefore, it has been claimed that people are trapped by their lack of mobility (Black et al. 2013), and those trapped populations are the most to suffer a significant injustice (Adger & Adams 2013). Research emphasises that some people who depend on natural resources for living such as farmers, herders, fishermen and pastoralists are more exposed to climate stressors and maybe the least able to move (Betts 2010; Black et al. 2011a). These potentially “limited mobility” populations could face declining livelihood conditions within their local communities, with fewer possibilities for moving to more desirable places in a safe and effective manner (Adger & Adams 2013).

Figure 2.8: Relationship between vulnerability to environmental change and mobility representing trapped population



Source: Adger & Adams (2013)

Information on the presence and features of trapped populations is crucial to advise policy interventions (Martin, Weerasinghe & Taylor 2014; Zickgraf et al. 2016). Although trapped populations or those who choose to stay in areas vulnerable to climate change represent a significant policy concern, empirical work addressing such populations is very limited (Zickgraf 2019). Current information about the mechanism of trapped populations is inadequate to suggest any clear measures to be specified in policy aiming at reducing their vulnerability or enabling them to move when they feel they need to (Black & Collyer 2014). Consequently, advancing understandings of the reasons contributing to individuals' immobility could help guide policy responses to consider their real situation and needs (Black & Collyer 2014).

Researchers have criticised existing migration theories as they are more concerned with drivers of migration and they fail to address why populations stay (Hammer & Tamas 1997), and to distinguish between not being able to migrate and not wanting to and (Carling 2002). The study of Lubkemann (2008), for instance, found that females who were left behind in rural Mozambique were forced to be immobile during drought-prone seasons as a result of civil war that prevented them from their normal mobility during these times. Hence, recognising the fact that some people do not, and prefer not to, migrate could guide efforts in developing policy to assist trapped populations to adapt *in situ* (Findlay 2011).

Zickgraf (2018) argues that immobility is an outcome of the interaction between several factors including political, economic, social, environmental, demographic and cultural factors Consequently, advancing research about the characteristics of immobile populations requires examining not only what constrains mobility (in terms of low assets and capital that reduce the capacity of individuals to migrate), but also what convinces people to migrate or stay. The following section will further discuss some determinants of immobility culturally embedded within some communities.

2.5.2.2 Culture of migration

Black at al. (2011a p.447) argue, “the greatest risks will be borne by those who are unable or unwilling to relocate”. This unwillingness to migrate can be derived by culture. Adger et al. (2013) studied the cultural dimension of the effects of climate change and adaptation and argued that society’s response to every dimension of climate change was influenced by culture. Migration is embedded in the identity and culture of societies (Hugo 2006; Adger & Adams 2013). Some communities and households choose to migrate while others experiencing similar conditions do not (McLeman & Smit 2006). The structure and history of migration and its continuity are factors that characterise past and present movements for most “sending” communities and create a “culture of migration” that supports movers and non-movers and enables network creation between origin and destination populations (Cohen 2004; Cohen & Sirkici 2011). Massey & España (1987) believe that people in a community from which a large number of its members have migrated should be more likely to migrate, whereas, people are unlikely to migrate from communities where migration is relatively unusual. Accordingly, some societies are more mobile than others, and in some countries, migration constitutes a fundamental basis to many aspects of cultural, economic and political influence in rural areas such as in the Philippines and across South East Asia (Lee 1985; Quisumbing & McNiven 2005; Kelly 2011; Knerr 2017). In Nepal for instance, the emigration rate for 2011 was estimated at 10.77 migrants per 1,000 population (IOM 2019). On the contrary, the rate in Egypt was only 1.9 per 1,000 population in 2017 (Forouheshfar, El Mekkaoui & d’Albis 2020). In 2020, it was estimated that 3.6 million Egyptian were residing abroad representing only 3.5 percent of the population (IOM 2020a). This percentage is considered to be lower than other countries in the MENA region such as Jordan and Lebanon where 8.1 percent and 10.7 percent of their populations were residing abroad in 2020, respectively (IOM 2020b, 2020c).

In Egypt, permanent emigration is mostly restricted to highly educated individuals working in highly skilled occupations such as health and engineering (EACH-FOR 2009). A recent study in the MENA region found that workers with higher levels of education are more likely to migrate than less qualified workers as their potential gains are usually higher (Ramos 2019). Temporary and circular migration, however, in Egypt has been traditionally important and continues to occur, but with much less significance (Zohry 2005). The number of temporary migrants to Gulf countries increased in 1974 after the oil boom, until the mid-1980s, with the Iran–Iraq war reducing oil prices and pushing down the number of Egyptian migrants (Zohry 2002, 2007 & 2014). The number of Egyptians emigrating continued to decline, and simultaneously, the flow of returning migrants from Gulf countries increased after the 1990 Gulf War between Iraq and Kuwait (Zohry 2007, 2014). Since the 2000s, the increased competition of immigrant workers from Asia as well as the desire of Gulf countries to replace their non-national labour force with citizen workers has further stagnated the share of Egyptian migrants in exploiting work opportunities in the Gulf (Zohry 2007). The rate of internal migration is also considered low due to the stagnant rate of urbanisation in Egypt since the 1970's which limits rural-urban migration flows (World Bank 2014).

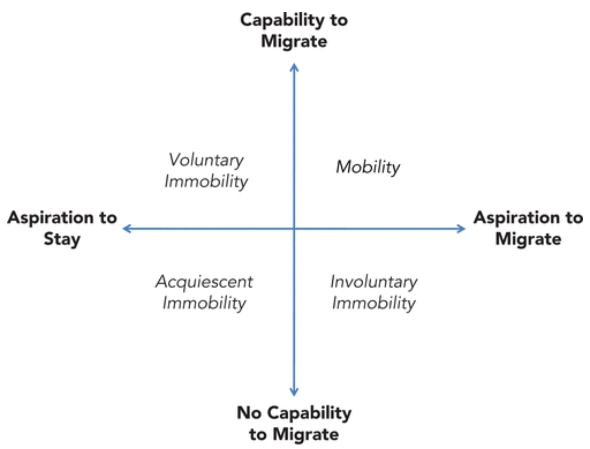
Another key aspect that contributes to immobility, besides the capacity of individuals to migrate is their aspirations (Carling 2002). Carling (2002) suggests that immobility results from the lack of either the ability or the aspirations to migrate. Hence, people might have the capacity to migrate but lack the aspiration to migrate and *vice versa.* As a result of the two critical aspects of mobility/immobility (capacity and aspirations), there are four general categories of mobility (Figure 2.9):

1) Mobility (i.e. having both the ability and aspiration to migrate);
2) Voluntary immobility (i.e. having the ability but not the aspiration to migrate);
3) Involuntary immobility (i.e. having the ambition but not the ability to migrate); and
4) Acquiescent immobility (i.e. neither having the aspirations nor the ability to migrate) (Carling 2002; Schewel 2019).

Low levels of aspiration to move may limit the prospects of what people visualize for their futures. Development processes and modernisation within societies tend to increase individuals' aspirations which thereby coincide with his or her increased desire to migrate (De Haas 2007, 2014). Migration itself is both a result and a cause of high aspirations;

even when taking into consideration socio-economic and demographic factors such as younger age, wealth, and better education, migrants tend to have higher aspirations than non-migrants (Czaika & Vothknecht 2014). Within the MENA region, Ramos (2019) found that the aspirations of qualified youth to migrate abroad differed from one country to another. Interestingly, more qualified youth in Palestine and Jordan, for instance, have more aspirations to migrate than those in Egypt (Ramos 2019).

Figure 2.9: Schematic representation of (im)mobility categories



Source: Schewel (2019)

The degree of attachment to a specific place is another cultural dimension that could influence decisions of individuals and communities to migrate or stay, and could lead to a situation of immobility. High levels of attachment to place may drive individuals to stay in a risky location (Adger & Adams 2013; Adams 2016; Singh et al. 2020). For example, Farbotko (2018) and Farbotko et al. (2020) found that many indigenous people in the Pacific are "voluntary immobile", expressing a high preference to stay in their lands for cultural reasons, even with the continuing deterioration in health and livelihoods as a result of climate change. Besides, the study of De Sherbinin et al. (2011) found that individuals resisted planned resettlement schemes even when they perceived that the risks of staying were high.

Fie (1939) was one of the lead researchers who tried to theorise immobility through founding the "Earthbound compulsion" theory to describe the attachment of Chinese peasants to their lands that contributed to low rates of migration in China at that time. The "rootedness of people" as the standard and favourable state of affairs is assumed to be a reason for immobility (Malkki 1992; Bakewell 2008). People develop knowledge and skills relevant to a particular place or occupation and accordingly, staying in place can make economic sense, even if higher incomes may be found in another area (Schewel 2019). The individual sees a "location-specific capital" in the place of origin (DaVanzo 1980), and develops "bounded rationality" in which people lean towards choosing alternatives that are "good enough" instead of the best option among all those available (Simon 1982).

In conclusion, there can be social and cultural limits to adaptation that may well be related to the differences found among individuals in their experiences, interpretations and responses to climate change (Adger et al. 2007). Individuals may have different vulnerabilities and preferences about adaptation measures to risk, depending on their set of values, beliefs and their understanding about the world (Adger et al. 2007). Pre-existing migration patterns will have significant influence on future migration decisions of the different societies (Laczko & Piguet 2014). Recognising these cultural dimensions is critical for planning and governing successful adaptation responses to current and future risks associated with climate change.

2.6 Climate change perception and adaptation studies in Egypt

There is quite a large number of studies addressing perceptions of global, environmental change conducted in many regions of the world (Pyhälä et al. 2016). However, risk perception of climate change is a relatively new area of research in the MENA region and in Egypt specifically, and in the past few years, studies on public perceptions of climate change have been gaining momentum. The following section reviews the findings from previous studies addressing public perceptions of climate change, particularly in rural areas in the MENA region, including Egypt.

The study by Adoho & Wodon (2014b) addressed the perceptions of climate change held by householders in five MENA countries, including Egypt, Yemen, Morocco, Algeria, and Syria. The study showed that most households across all of the countries had perceived increases in temperature and changes in rainfall patterns, in particular, more frequent droughts and more erratic rainfall with significant adverse effects on crop and livestock production. Households also believe that diseases were increasing for livestock and that there were more insects and pests in crops. The study suggests that poor or less-wealthy households were more likely to suffer from crop and income losses due to climate change. On the local level, households from Egypt were less likely to perceive climate change and its adverse effects in comparison to other countries, specifically Syria, with higher levels of perceptions.

Omar et al. (2015) studied farmers' perceptions of climate change in Egypt through a survey conducted on 197 interviewees. Results of the study revealed that farmers had noticed an increase in temperatures, humidity and incidence of heatwaves, and a decrease in rainfall. Most farmers also perceived significant adverse effects on agricultural and livestock production in addition to increased severity of pest infestation and disease infection such as foot-and-mouth disease in cattle. Education, age and experience in agriculture were the key factors influencing farmers' perception of climate change. Similar results were revealed in the study by Froehlich and Al-Saidi (2018). They found that changes in temperature and patterns of rainfall, as well as increased incidence of extreme weather events, were the three most perceived changes in climate in the studied areas. Their study also suggested that farmers in rural areas experienced more animal diseases and crop pests, water shortages, and health problems/exhaustion due to climate change.

Hafez (2020) addressed perceptions of the effects of climate change on agriculture, livelihoods and women on 200 households in Egypt. Results showed that nearly half of the interviewees observed an increase in temperature, as well as in incidence of sudden wind and rainfall. On the contrary, the majority were not fully aware of climate change as a phenomenon and of means for reducing its associated risks. Similarly, the results of the study of Kassem et al. (2019) on farmers' awareness of climate change revealed that most of the farmers studied were not aware of climate change and consequently, its adverse effects.

Regarding adaptation, some attempts have been made to analyse how farmers adapt to climate change in Egypt and the MENA region. Most of these studies have addressed and confirmed that rural households were adopting several agricultural practices *in situ* to reduce the associated risks. In one example, Adaho & Wodon (2014c) found that rural inhabitants in the five MENA countries had mostly adopted four agricultural adaptation strategies including increasing the use of fertilisers and pesticides, changing farm production technology, storing grains and water, and seeking off-farm income. The study also found large differences between countries in the adoption of adaptation practices, with households in Egypt and Syria making fewer changes to their modes of livelihood in comparison with Algeria, Yemen and Morocco.

Similarly, the study by Omar (2015) focused only on agricultural, adaptation measures *in situ* to reduce the risks of climate change. The study found that only a small percentage of farmers in rural Egypt have adapted to climate change, and the most-adopted measures included changing sowing dates, changing irrigation timing and increasing the frequency of irrigation. Her study found that adaptations to climate change positively correlated with education and perceptions of climate change risks.

Kassem et al. (2019) also found that most of the studied farmers in Egypt fell in the low adopter category, regarding *in situ* adaptation measures. The most popular on-farm practices included maximising the use of manure, changing cropping patterns, crop rotation, and cultivating drought-resistant varieties. The study also found that education, farm size, farm income diversification within the agricultural sector, and membership in water user associations were vital factors that influenced the likelihood of adoption of adaptation measures.

On *ex situ* adaptations, unlike other regions of the world, there is very little empirical evidence that environmental change and shocks influence migration in the MENA region, including Egypt (Laczko & Piguet 2014). Most of the existing research confirms the importance of the socio-economic and political factors in driving decisions about migration rather than environmental problems. For example, the study by Adaho & Wodon (2014b) on five MENA countries suggested that climate change and extreme weather events resulted in a higher possibility of migration; however, the role of climate as a driver of migration remained smaller as compared to socio-economic drivers and job prospects in the cities.

Likewise, the study of Afifi (2010) found that the effects of climate change alone are less likely to drive decisions to migration in rural Egypt. Despite the small sample size, his study suggested that people in Egypt would be migrating from one place to another within the country in the case of water shortage and/or land degradation only under certain conditions. These conditions included not owning land, being socially and financially capable of leaving their place of origin and/or being forcibly displaced by government or landowners. He concluded that rural people would not be willing to leave their homes as long as they were not facing a sudden natural disaster, such as earthquakes or floods.

Hence, the study suggests that slow-onset climate events do not drive migration and also gave a notion about the importance of integrating the culture of migration of rural dwellers in the analysis of their adaptation preferences or decisions. Similarly, Warner et al. (2008) study of rural-urban migrants in Egypt found that problems with unemployment and poverty were the main factors influencing their decisions to migrate. Most importantly, they highlighted that land degradation, and water shortages in the place of their origin had caused these problems, although the migrants did not mention it explicitly.

In conclusion, perceptions of, and adaptation to, climate change are relatively new disciplines in the MENA region, and specifically in Egypt. Most of the local studies on these perceptions have focused on the level of perception and/or awareness of people (either in rural or urban areas) to climate change and its current related risks. This thesis, however, considers farmers' perceptions of several current and future risks associated with climate change in addition to those risks related to working in the agricultural sector under present and upcoming environmental challenges. Moreover, studies on adaptation in Egypt and MENA region have mostly focused on agricultural adaptation practices *in situ* that farmers follow, while only a few have addressed *ex situ* adaptation, providing evidence that climate change has less influence on their decision to migrate than other socio-economic factors. Consequently, this thesis aspires to address these gaps in current knowledge, focusing expressly on both *in situ* and *ex situ* adaptation practices followed by rural households in the study area.

This thesis also aims to integrate the culture of migration as an essential factor that could influence rural households' current and future decisions to migrate. More importantly, the study aims at integrating the paths of agrarian transition and the resultant class structures with risk perceptions and adaptations to climate change. It also pinpoints the likelihood of the presence of potentially trapped rural populations in Egypt and other countries with similar conditions in the developing world.

2.7 Summary

The chapter discussed the main theoretical approaches and conceptual basis for this thesis, looking at the current socio-economic, environmental, demographic and political issues in the MENA region. It then deliberated on the theoretical framework of the agrarian transition and then discussed the policy evolution of land and tenure in Egypt, the different pathways of agricultural transformation and the resultant class structure in Egypt.

Previous local agrarian studies show that the agricultural and economic policies had already imposed several economic, social, political and often environmental risks on the agricultural sector. With the internal demographic, economic, social, political and environmental pressures prevalent in the MENA region and in Egypt specifically, climate change is further jeopardising the agricultural sector and the livelihoods of many rural dwellers in the region.

The chapter addressed the concept of perceptions of risk and their importance in guiding adaptation actions to climate change. It also explored, based on previous research, the contextual factors that influence individuals' and communities' perception of risk. Afterwards, the chapter outlined the concept of climate change adaptation and the related concepts of vulnerability and adaptive capacity. It broke down adaptation into *in situ* and *ex situ* measures and then emphasising the reasons behind immobility and trapped populations.

Chapter Three: Research Methodology

3.1 Introduction

This chapter describes the methodology adopted to investigate the research questions and meet the research objectives. This study adopts a mixed-method approach of data collection and has a deductive nature as it begins with formulating research questions that guided the data collection process (Neuman 2014). The chapter starts with a brief discussion of the epistemological and philosophical foundations of the study, including the reasoning behind the selection of the mixed-methods approach. Following that, there is a detailed discussion of the specific quantitative and qualitative methods and techniques used in the data collection process. Justification for choosing the study area is also included. The techniques and tools employed for data entry, processing, and analysis are introduced and will link across to the significant findings presented in the results chapters (Chapters 4, 5 and 6). Finally, the chapter concludes with the researcher's perspective and experiences in conducting the research data, including a brief outline of the research limitations.

3.2 Adopting an epistemological position

Epistemology concerns the theory of knowledge and is essential for framing the research approach because each researcher will hold a particular opinion about what constitutes acceptable knowledge (Bryman 2016). Epistemological and philosophical assumptions are defined as researchers' "assumptions about how they will learn and what they will learn during the inquiry" (Creswell 2003 p.3). Teddlie and Tashakori (2009) identify three major epistemological schools of thought in behavioural and social science research, including positivism, constructivism, and pragmatism. Among the three schools, pragmatism is the one that focuses primarily on the problem being researched and the consequences of the research itself (Feilzer 2010). Pragmatists hence, do not insist on a particular method or mix of methods and do not exclude any based on a fixed epistemological position (Feilzer 2010). Instead, they support the view that the choice of methodology should be the best to meet the needs of the research (Creswell 2003; Johanson & Onwuegbuzie 2004; Teddlie & Tashakori 2009).

Feilzer (2010) asserts that pragmatism is the best path through the dichotomy of positivism and constructivism. Positivism relies on empirical evidence, whereas constructivism depends on learning from social interactions and psychological processes (Armstrong 2013). Consequently, pragmatism could be considered as the most suitable epistemological position for a mixed-methods approach, which in this case combines both a numerical, positivist approach and a narrative-based, constructivist approach to generating and analysing the data needed to answer the research questions (Bryman 2006; Teddlie & Tashakkori 2009; Feilzer 2010).

3.3 Research Approach: Mixed Methods

Following the developments of quantitative and then qualitative research, a mixed-methods approach is referred to as the "third methodological movement" (Tashakkori & Teddlie 2003, p.5), the "third research movement" or "third wave" (Johnson & Onwegbuzie 2004, p.17). Mixed methods research has become an accepted approach that has been increasingly adopted in social research (Bryman 2016). Johnson and Onwegbuzie (2004, p.17) define mixed-methods research as "the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study". Likewise, Tashakkori and Teddlie, (2003, p.711) define mixed methods as "a type of research design in which qualitative and quantitative approaches are used in types of questions, research methods, data collection and analysis procedures, and/or inferences".

Mixed-methods research entails mixing of at least one qualitative method and one quantitative method in the same research project (Hesse-Biber 2015). Quantitative research is more concerned with the collection and analysis of numerical data, whereas qualitative research emphasises words in the collection and analysis of research data (Bryman 2016). Quantitative research methods focus on the collection of numerical data that can be analysed by statistical techniques. In contrast, qualitative research methods are more concerned with exploring how individuals understand and put meanings to their social world (Walter 2013).

Mixed-methods research gives more evidence for investigating a research problem than either qualitative or quantitative research can provide solely (Creswell & Clar 2017). Mixed methodologies are useful in obtaining data that are more consistent and comprehensive and help broaden the scope and dimension of the study (Morse 2003; McKendrick 2009). The mixed-methods approach allows the researcher to utilise the strengths of both quantitative and qualitative data jointly, to obtain a better understanding of the research problems than using either approach alone (Creswell 2015). The use of both qualitative and quantitative methods either sequentially or independently improves the findings of a study (Teddlie & Tashakkori 2009). Moreover, Neuman (2014) suggests the use of more than one method of data collection whenever the research has a descriptive and explanatory nature to ensure that a holistic analysis is developed. Similarly, Bryman (2016) suggests that using mixed methods enables the researcher to address the research questions from multiple dimensions and to cross-check data gathered from the field through a process of triangulation, hence strengthening the validity and credibility of the study results.

The primary aim of this research is to understand how agricultural communities perceive and respond to the risks associated with climate change. Applying a mixed-methods approach to the collection and analysis of the data helps to provide a more complete or in-depth analysis of the agrarian communities in rural Egypt. Given that a mixed-methods approach is adopted, there is a considerable effort made to try and consolidate the knowledge generated by comparing and contrasting the quantitative and qualitative data. Although this study prioritises quantitative collection and analysis of data, qualitative data and findings will illustrate, check and correct the quantitative conclusions. Primary quantitative data were collected from the survey, whereas primary qualitative data were gathered using in-depth interviews with farmers within the areas under investigation. The core findings of the study were obtained from the analysis of survey data, while data collected from in-depth interviews supported the development of an understanding of farmers' perception of risk and adaptation choices within the Egyptian context. The following section (3.4) will discuss in further detail the approaches taken for primary data collection during the study.

3.4 Data collection approaches

3.4.1 Unit of Analysis and levels and dimensions of data

This study employed a multilevel model (individual, household, community levels) in designing the tools to collect data for different levels of information through household surveys and in-depth interviews with farmers. The study is mainly concerned with the perceptions of small landholder and landless farmers, who work as waged agricultural labourers, and their households in northern Egypt. Small landholders in this study are defined as those farmers who own, rent or share agricultural lands with less than 5 *feddans* (11.9 ha). Individual and household information was gathered through household surveys using a structured questionnaire in face-to-face interviews. Further qualitative in-depth data were collected from interviews with farmers regarding their local experiences with climate change, and their opinions of the biggest local environmental problems and of the government interventions aiming at developing their community and reducing risks of climate change. Table (3.1) summarises the levels and dimensions of data sought.

Table 3.1: Dimensions and level of data collection

Data collection tool	Information sought	Level of data		
		Individual	Household	Community
Questionnaire survey	Perceptions of climate change (observed patterns, frequency, and impacts)	X	X	
	Adaptation responses (*in situ* and *ex situ*)		X	
	History of migration	X	X	
	Migration culture	X	X	
	Demographic characteristics	X	X	
In-depth interviews	Experiences with climate change	X	X	X
	Local environmental challenges	X	X	X
	Government interventions to reduce risks associated with climate change	X	X	X

3.4.2 Survey

Surveys are the main method for collecting quantitative data (Bryman 1984). “Surveys are arguably the most-used tool for social scientists, market research and a variety for others looking for information regarding people’s attitudes, behaviours and experiences”

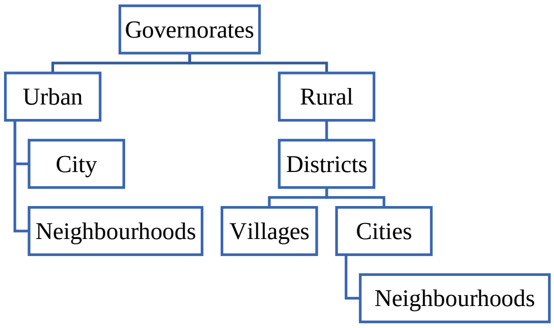
(Abbott & McKinney 2013 p.36). Walter (2006) refers to survey research as, "the collection and analysis of respondents' answers to the same set of structured questions". One of the significant advantages of the survey is that it allowed the researcher to generate data from a large number of respondents within a short time (Neuman 2014). Surveys typically provide information on facts observed by respondents, their behaviours, perceptions and attitudes (Dane 1990 p.121). Hence, the survey would be the most suitable quantitative data collection method for this study as it aims to gain insights on small landholder farmers' perceptions of risk, adaptation behaviours and experiences with climate change, in addition to their opinions about working in the agricultural sector under current and future environmental changes.

The survey was started on 22 April 2018 and ended on 30 September 2018. Before the survey was conducted, several preparatory steps took place, including applying for ethics approval, selecting the study area and designing the questionnaire, sampling methods and population. Pre-testing the questionnaire and choosing and providing training to enumerators also took place, as well as planning and handling fieldwork. These steps are introduced in order below.

3.4.2.1 Justification of the case study areas

There are three levels of administration in Egypt: governorates, districts and villages. Egypt is divided into 26 governorates with four that are administratively considered as Urban Governorates (Cairo, Alexandria, Suez and Port Said) with no rural population. Whereas, each of the other 22 governorates is subdivided into urban and rural areas (UNICEF 2018). The Nile Delta region of Lower Egypt holds nine of these governorates, while eight governorates are located in the Nile Valley of Upper Egypt, and five are located on the eastern and western boundaries of Egypt. The Egyptian administrative levels are illustrated in Figure 3.1.

Figure 3.1: Local Administration Levels of Egypt



Source: El Megharbel (2011)

The geographical area of study was chosen from rural areas of the Nile Delta region. The Nile delta is located in the northern part of Egypt overlooking the Mediterranean Sea having a total area of about 20,000 km^2 (Figure 3.2). The total length of the delta coast is 250 km^2 extending from Alexandria (west) to Port Said (east) governorates.

Figure 3.2: The Egyptian Nile Delta region

Source: Google maps

This study chose the Nile Delta region to conduct fieldwork for three reasons. Firstly, this region is strategically and economically important as it contains the core fertile agricultural lands of Egypt and produces almost half of all national crop production (MALR 2009). Besides, the region hosts major economic hubs, including the ports of Alexandria, Rosetta, Damietta and Port Said.

Secondly, as introduced in chapter 2, Egypt's coastal zones are reported as being particularly vulnerable to the various effects of climate change including rising sea levels and the other potential effects that would affect their water and coastal resources, agricultural productivity, tourism, and human settlements (EEAA 2010). As sea level rises, the area between Damietta and Rosetta is expected to disintegrate into distinct islands surrounded by water due to the uneven topographical nature of the coastal area (EEAA 2016).

Thirdly, besides the high rate of population growth (hosting 50% of the total Egyptian population of 93 million), the Nile Delta region is suffering from many problems including high rates of urbanisation, excessive erosion rates, and land subsidence, relatively low elevation, excessive pollution and degradation of the natural ecosystem and weak institutional management systems (MALR 2009).

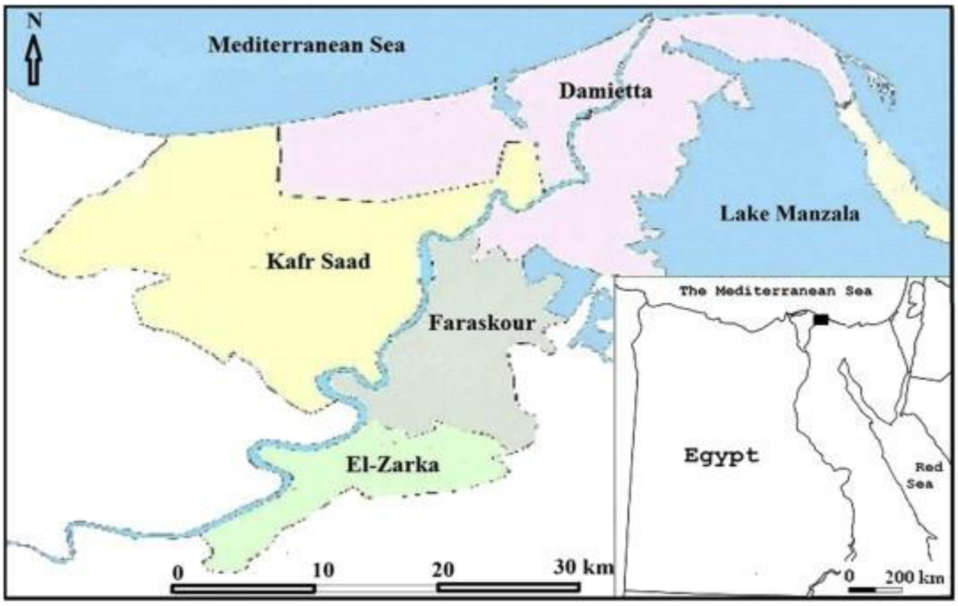
Out of the ten governorates located in the Nile Delta Region, Damietta governorate was the focus for the fieldwork. Damietta governorate is situated along the branch of the Damietta Nile. Damietta governorate's coastal location makes it one of the most vulnerable to sea-level rise (SLR), with projections that parts of Damietta will be inundated between 2040 and 2050 (EEAA 2016; Elshinnawy & Almaliki 2021). It is a peninsula embraced from the north and west by the Mediterranean Sea, and to the east by El Manzala Lake, as shown in Figures 3.3 and 3.4.

Figure 3.3: Damietta location within the Nile Delta region

Source: Google maps

The governorate's economy relies on a diverse number of economic activities besides agricultural production. Damietta is well-known for its furniture industry, fishing, production of cheese and other dairy products, and patisserie (SIS 2009).

Figure 3.4: Map of Damietta

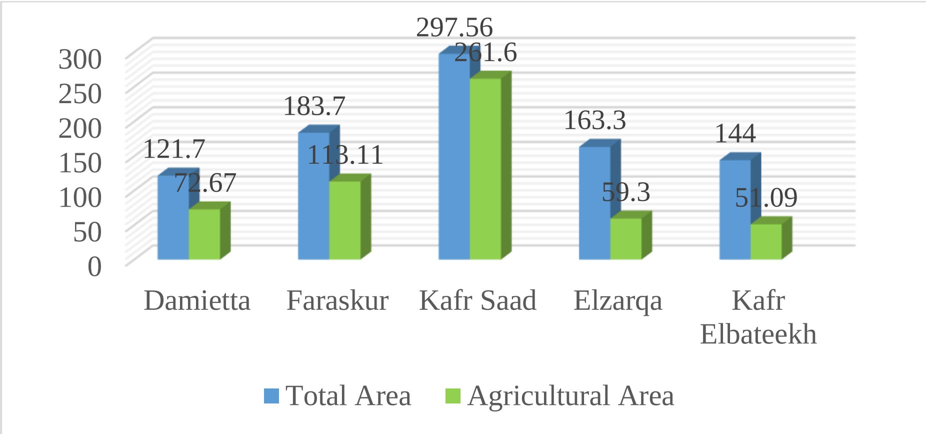


Source: El-Gammal, Ali & Eissa (2014)

In 2018, the total population of Damietta was estimated as being 1,496,765, out of which 39.4 percent of the population are living in urban areas, whereas the majority (60.6 percent) live in rural areas (Damietta's Census Data for 2018). The governorate consists of five central administrations, ten cities, 47 local units, 85 villages and 486 hamlets.

The five central administrations (*marakez*) are Damietta, Faraskur, Elzarqa, Kafr Saad, and Kafr Elbateekh. Figure 3.5 shows the total land area and agricultural land area within each central administration in square kilometres and including fallow/uncultivated land areas.

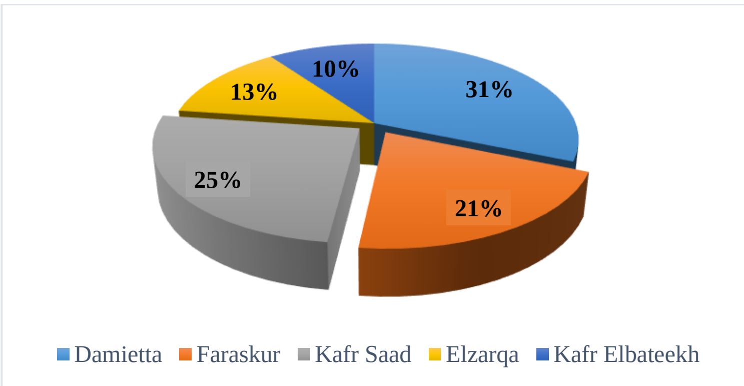
Figure 3.5: Agricultural land area relative to the total inhabited land area of the five central administrations of Damietta (km²)



Source: Adapted from Information and Decision-making Support Unit of Damietta (2017)

Faraskur and Kafr Saad were chosen as the two central administrations for the survey for three reasons. Firstly, the two central administrations together hold the largest agricultural land areas: representing 55.8 percent of the total agricultural area of the governorate (18.4 percent in Faraskur and 37.4 percent in Kafr Saad) as shown in Table 3.2. Secondly, roughly 46 percent of the total rural population of the governorate lives in Faraskur and Kafr Saad (25.3 percent for Kafr Saad and 20.6 percent for Faraskur) as shown in Figure 3.6. Thirdly, the two local administrations together hold 53.2 percent of the governorates' small-landholder farmers. Kafr Saad has the highest number of small-land holders with 33,340 holders (representing 37.0 percent), and Faraskur comes in third place with 14,611 small-land holder farmers (representing 16.2 percent).

Figure 3.6: Distribution of the total rural population over the five central administrations



Source: Adapted from Damietta's census data (2018)

Table 3.2: Area of cultivated agricultural lands and number of holdings by central administrations as in 2017

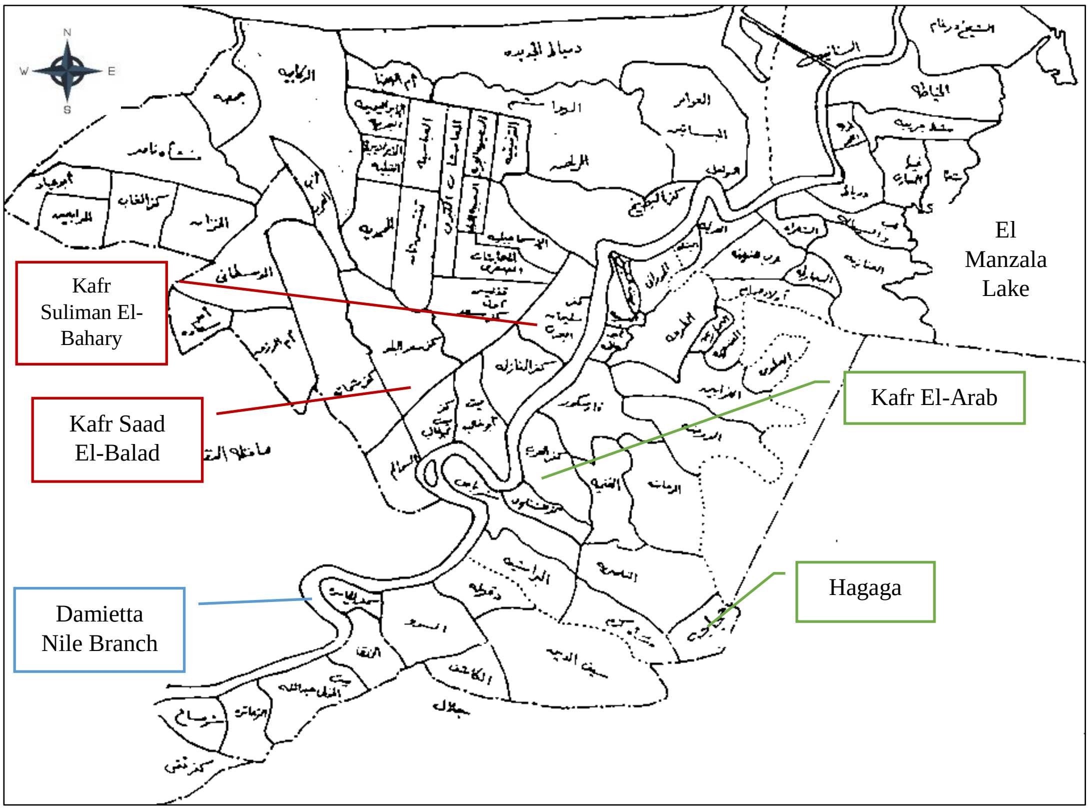
Central Administration	Farm size (*feddan**)	Agricultural Area		Holdings	
		Feddan	Percentage	Holders	Percentage
Damietta	**< 5**	9,502	67.9	14,821	97.2
	≥5	4,490	32.1	431	2.8
Total		**13,992**	**100**	**15,252**	**100**
Faraskur	**< 5**	11,451	61.3	14,611	95.6
	≥5	7,223	38.7	667	4.4
Total		**18,674**	**100**	**15,278**	**100**
Kafr Elbateekh	**< 5**	12,438	72.3	13,161	95.9
	≥5	4,754	27.7	559	4.1
Total		**17,192**	**100**	**13,720**	**100**
Kafr Saad	**< 5**	26,537	69.8	33,340	96.6
	≥5	11,498	30.2	1,183	3.4
Total		**38,035**	**100**	**34,523**	**100**
Elzarqa	**< 5**	8,730	63.0	14,320	97.2
	≥5	5,125	37.0	411	2.8
Total		**13,855**	**100**	**14,731**	**100**
Total Governorate		**101,748**		**93,504**	

Source: Adapted from Damietta's Department of Agriculture data (2017)

During the preliminary and pre-testing stages of the fieldwork, it was revealed that several villages of Faraskur were suffering from severe water pollution, as the water used for both irrigation and drinking is mixed with sewage water and agricultural wastewater. Therefore, the area was found to be interesting to target an investigating of how current environmental problems could further interact with the impacts of climate change and affect the livelihood of farmers living there. A detailed description of the conditions of the study areas and the studied households will be further discussed in Chapter 5.

Four villages have been included in this study; two villages affiliated to each central administration (pinpointed in Figure 3.7). The villages were chosen based upon the variation in crops cultivated within each village, the availability of a local facilitator from each village who was willing to help, and the ease of accessibility of the village to decrease costs and efforts related to data collection. The study villages are Hagaga, Kafr El-Arab, Kafr Suliman El-Bahary, and Kafr Saad El-Balad. Hagaga was specifically chosen due to the persistence of severe water pollution in the village, which was observed during the preliminary visits.

Figure 3.7: The location of the studied villages in Damietta governorate map



Source: Damietta's Department of Agriculture (2018)

3.4.2.2 Sampling

Based upon the statistics sample size calculator tool[1], a random sample size of 384 respondents was calculated with a 5% margin error and a level of significance equivalent to 95% in the two selected central administrations with a population of more than 500,000. However, after data cleaning, 350 valid responses were used in the analysis.

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[1] The tool used to calculate the sample size can be found in http://www.raosoft.com/samplesize.html

The sample units involved:

1. Smallholder farmers (farmers who are either renting or owning less than 5 *feddans* (=2.1 ha.); and

2. Landless agricultural labourers both women and men aged between 18 years of age and over.

A de-identifiable list of farmers was obtained from the local agricultural organisations, and respondents were chosen by simple random sampling. However, the main methodological issue is involved with the lack of a sample frame of agricultural labourers especially temporary workers. Therefore, snowball sampling was adopted to provide a sample of workers. Snowball sampling consists of gathering respondents by the referral methods by which each respondent who volunteers to join the survey is asked to identify one or more people with certain characteristics who would be willing to participate in the study (Babbie 2011; Hibberts, Johnson & Hudson 2012). The distribution of sampled households by the four villages is shown in Table 3.3.

Table 3.3: The distribution of sampled households by survey locations

Local Administration	Village	Sample size
Faraskur (n=180)	Hagaga	110
	Kafr El-Arab	70
Kafr Saad (n=170)	Kafr Saad Elbalad	85
	Kafr Suliman Elbahary	85
Total		350

Source: Field survey 2018

3.4.2.3 Questionnaire Development

Questionnaires are the most suitable data collection tools for providing more descriptive and comprehensive information about human actions and behaviour patterns (Preston 2009; Sahu 2013). In this study, a structured questionnaire was designed for rural households, with a focus on hired agricultural labourers and small landholder farmer respondents. The questionnaire was formulated to gather individual and household data adopting the insights of the New Economics of Migration theory (NELM), which states that migration is largely a household decision, rather than just an individual one. The questions were organised into several sections (as shown Table 3.4) in line with the main objectives of this study to seek information on:

a) the social, economic and demographic conditions and other related aspects of rural agricultural households;
b) previous migration experience and current/future migration intentions;
c) employment conditions and job satisfaction; and
d) environmental factors particularly climate variability and extremes and current decisions regarding adaptation.

Table 3.4: Summary of content of the questionnaire

Section	Sub-section	Information sought
A	Household information	Individual information: gender, educational level, marital status, age
	Employment situation	Primary and secondary occupations, distance to work, the reason for unemployment, type of employment
	Perception of working in agriculture	The degree of exposure to issues related to working in the sector
B	Previous movements (2012–2017)	Individual movements, time, duration, destination, reasons for migration / non-migration
	Migration culture	Opinions on migration and encouraging family members to migrate, the likelihood of migrating / leaving the agricultural sector
	Remittances	The situation, regularity and uses.
C	Perception of climate variability and extremes and their impacts	Experience with climate variability; patterns and frequency. Climate change impacts on crop quality and productivity, health, income, housing, employment, livestock productivity, labour productivity, and communication.
	Adaptation to climate variability and extremes	The measures adopted by the household to adapt to climate variability and extremes, including on-farm / *in situ* adaptation practices and other household practices, including *ex situ* actions.
D	Social capital	Social relationships, the institution, and/or people who provide help to the households in times of need, participation in community events, membership in any formal or informal groups, communication means, etc.
	Economic conditions	Household’s monthly expenditure, the contribution of income sources to the total annual income, assets ownership.
	Health conditions	Health ranking of household members, health problems, satisfaction with local health services.
	Housing and transportation	Property: type, size, facilities present, and satisfaction Transportation: Distance to some places as primary school, market, town, main road, public transport, etc.
E	Land Use and patterns of production	Land tenure, size, current use, marketing channels, members responsible for the different agricultural operations, satisfaction with inputs, short-term agricultural problems encountered and adaptation response, etc.
	Perception of future risks and related governmental actions	The most significant risk in agriculture in the next 10 years, current government support and its impact on farm business and future actions needed. Opinion on the required government actions in the future.
F	Movement intentions and plans	Individual and household occupational and geographical movement plans (temporary and permanent) for the next 12 months.

The questionnaire was first designed in English and then translated into Arabic, which is the official language of Egypt. The final Arabic version of the questionnaire incorporated feedback from the pilot study, which was later translated into the English version that can be found in Appendix 1. Closed-ended questions were the main types of questions included in the questionnaire; however, there are several open-ended questions requesting open-ended responses dispersed amongst them. Open-ended questions allow the respondent who is being interviewed to elaborate on any issues and answer on their terms without being forced to choose from pre-determined choices (Bryman 2016). Open-ended questions were used to enable the generation of qualitative data from respondents shedding light on responses to specific closed-ended questions. For example, respondents were asked if they would like to comment further on their perceptions of climate change and the adaptation strategies followed by the households to reduce risks of climate change. The partially open-ended responses were in the form of “others” so that respondents could provide answers that might not be mentioned. For illustration, in the section measuring social capital, respondents were asked to mention “other” individuals or institutions that could have provided help in times of difficulties other than the mentioned categories. Several filter questions were also included in the questionnaire so that the respondents could only answer relevant questions.

3.4.2.4 Fieldwork

Organising and training interviewers: The researcher had to work with a team of enumerators given the size of work and the limited time frame for data collection. The team of enumerators consisted of six graduates from the Department of Rural Sociology, Faculty of Agriculture, Cairo University, and the researcher. The members of the team were chosen based on their previous experience in data collection and their sound knowledge of the nature of rural agricultural areas in Egypt. As suggested by Bryman (2016), the enumerators need training in contacting potential respondents and providing an introduction to the study, using suitable probing styles and reading out questions as written and recording the exact answer. Since the questionnaire was somehow complex and comprehensive, it took three days to train the enumerators. The training introduced the research aims and questions to the team. It gave an item-by-item review of the questionnaire to explain how questions should be delivered and what kind of explanations should be provided to respondents. It also provided clarification for ambiguous questions and procedures related to ethics and safety considerations in the field.

This review was followed by a mock interview in which pairs practised the questionnaire together. In the beginning, the interviewer took from 45 to 60 minutes to complete the interview, but after several attempts, each enumerator was expected to finish the questionnaire within 30 minutes only. This training was crucial for decreasing variations among interviewers during the administration of the survey.

Contact and cooperation with local agricultural organisations: Being a staff member of Cairo University, the researcher requested three formal letters from its Dean to the general directors of Damietta's Department of Agriculture, the Information and Decision-making Unit, and Agricultural Extension Unit. These letters were essential for conducting fieldwork in Egypt; otherwise, no one would have cooperated. The letters formally introduced the researcher and her work, and requested the specified institutions to cooperate in facilitating the fieldwork and in providing the required secondary data. The researcher personally travelled for this initial contact and to introduce the aims and contents of the survey. A copy of the questionnaire was also handed in so that officials could review it and have a better picture of the goals of the research. It was also essential to obtain consent from the higher levels of government before the survey, otherwise, the local authorities could have terminated the survey at any time. The director of Damietta's Department of Agriculture, with whom the researcher has a good relationship as the result of previous work in Damietta, referred her to the responsible persons in the agricultural association in the selected local administrations so that they provided her with the required support.

Face-to-face interviews: The questionnaires were administered by face-to-face interviews. Interviews are the most common modes of data collection and allow direct interaction between the researcher and the participants. A face-to-face interview also has several advantages over other modes of data collection, including the higher response rate and the lower possibility of questions being misinterpreted (Neuman 2012; Walter 2013; Davies & Hughes 2014). Face-to-face interviews are beneficial whenever the respondents are illiterate or have low educational levels, which is common in Egyptian rural areas. All interviews were conducted in public places to ensure the safety of the interviewers. Having a facilitator from local agricultural associations accompanying the interviewers helped in gaining the trust of rural dwellers and ensured their safety as well. Most of the respondents were very friendly and cooperative and showed respect to the enumerators' team. Before each interview, the interviewer provided a verbal briefing on the scope of the study, and respondents were assured that they would remain anonymous with the right to withdraw from the interview at any point. People who were 18 years of age or older were invited to join the survey. Only two respondents terminated the interview halfway through, which reflects the high response rate of face-to-face interviews.

3.4.3 In-depth Interviews

In-depth interviewing is considered a fundamental method of exploring social meanings in social science research (Walter 2013). In-depth interviewing is more like an open-ended conversation between an interviewer and a participant, and it is usually guided by a set of general themes (Travers 2006). Such interviews tend to be flexible and allow the interviewer to ask additional questions, explore issues as the interviewee raises them, and express his or her opinion where appropriate (Travers 2006). Qualitative interviews allow the interviewer to even adjust the emphasis in the research as a result of any emerging significant issues to generate qualitative data that is focused on particular concerns or opportunities (Bryman 2016).

The interviews were conducted to collect and justify information about individual and household opinions and experiences with the effects of climate change on their livelihoods and their current and potential migratory behaviour. The interviews also gathered community-level information on topics related to current problems facing the communities, significant future environmental threats, government adaptation measures, and expected community and governmental adaptation actions. It was essential in this study to adopt in-depth interviews to allow the interviewees, the local farmers, to express their opinions about the challenges within the agricultural sector and issues related to adaptation to climate change, particularly those *in situ* measures.

In total, eleven in-depth interviews were undertaken in Damietta governorate. During the survey, respondents were asked if they were willing to participate in a follow-up, in-depth interview. The selection of interviewees was random. The interviewees were un-identifiable and anonymous, and are referred to in the text by their “interview number”. All interviews were completed in a one-on-one format by the researcher alone and were conducted in public areas. The average length of an interview was about 20 minutes. Most of the interviewees consented to having the interview audio-recorded, with only two interviewees preferring not to be audio-recorded, so the interviewer had to take manual notes. All interviews were conducted in Arabic, and later they were transcribed and translated into English.

The interviews were used to capture detailed experiences on pre-determined themed topics like farming, climate change, and adaptation, including *ex situ* experiences. An interview guide involving the general themes of the research was set before the fieldwork started. The first theme involved the main challenges within the Egyptian agricultural sector. The next theme was more concerned with local environmental problems and climate change experiences, while the third theme discussed adaptation measures followed with an emphasis on local migration experiences. The fourth theme was related to projections about the future of agriculture in Egypt and whether people would leave agriculture or migrate if the situation became more intolerable for farmers and labourers. And the final theme was concerned with knowledge and opinions about government actions that were present, if any, that were aimed at improving local livelihoods of rural households in the light of climate change.

3.5 Secondary data

Pawar (2004) argues that the collection of secondary data is as crucial as collecting primary data to achieve meaningful research. The primary qualitative and quantitative data gathered through the survey and interviews were complemented by secondary data collected from mainly four sources as follows:

1. Reviewing academic literature around climate change in the region, agricultural practices, adaptation and coping mechanisms, and migration within the Egyptian context. The main aim of the secondary data review was to help the researcher establish a basis for the research, based upon methods and tools in the field, and theories that have been applied for similar studies (Bryman 2016);
2. Government documents such as annual reports, policies, and planning reports. These data were useful in describing the broad institutional context within which the Egyptian agricultural sector is operating;
3. Public data, such as census data and demographic data. These data were instrumental in understanding the general characteristics of the population; and
4. Local records and reports from government officials in Damietta. During the fieldwork, the researcher visited local government offices, including Damietta's Department of Agriculture and the local Information and Decision-making

Support Unit to access a range of data, reports, and maps of the study area. These included land tenure data, agricultural profiles, and types of crops cultivated in each central administration in Damietta over the five years that preceded the survey.

Secondary data sources were fundamental to helping the understanding of the current situation in the study region, and in building the complex arguments in the research.

3.6 Data Analysis techniques

3.6.1 Quantitative data analysis

For social data to be analysed statistically, they need first to be converted into a numerical form (Babbie 2013). The questionnaire was pre-coded, meaning that each question was assigned a variable code, and every possible response was assigned a particular value. This process of assigning codes or values to data is referred to as coding (Bryman 2016; Babbie 2016). SPSS 21 software was used to create a database for the questionnaire survey data by first defining the variables within the questionnaire and assigning their specific codes to facilitate the following stage of the data entry. Open-ended questions were translated into English and were also post-coded before data entry. Data entry was conducted by the researcher solely, and the complete database was checked and cleaned carefully to ensure the accuracy of the data.

Quantitative data analysis is usually either descriptive or explanatory (Babbie 2013). The study used two approaches in analysing the quantitative data, which were descriptive analysis and non-parametric statistical analysis. Descriptive analysis was used to summarise perceptions of climate change effects, demographic characteristics, the culture of migration, opinions on the agricultural sector, future risks, and so forth. Univariate analysis was used to analyse and represent data in the form of tables, bar charts, and pie charts. Continuous variables (ratio or interval) such as age, land area, and other variables measured on a 10-point scale were re-coded into ordinal variables for easier representation and interpretation.

Non-parametric inferential statistics were employed to identify relationships and establish an association between variables. Non-parametric statistical methods are robust and easier to use (McHugh 2013). The Kruskal–Wallis test or one-way analysis of variance (ANOVA) on-ranks test was the primary technique used in the study to compare between two or more independent groups of samples of equal or different sample sizes. The identification of three categories or groups of rural households was introduced and justified in Chapter 5. The test assumes that the population was not normally distributed and tests against the null hypothesis that the median values of the three groups were equal. The test was employed to compare the three groups of households and capture any significant differences found among them in some demographic characteristics, land area acquisition, perceptions of the effects of climate change and levels of adaptation, and opinions about migration. The results of the Kruskal–Wallis test are explained in Chapters 5 and 6. The dependent variables used for this test were measured at a continuous level which was conditional on validating the use of the Kruskal–Wallis test.

A Chi-squared test was also conveyed to test the significance of ordinal or nominal data. This was done, for example, to identify significant differences between households living in each local administration in their level of perception of the effects of climate change. The techniques mentioned above for quantitative analysis were used extensively throughout this study, and their results were supplemented with qualitative evidence to explain further and validate the key findings.

3.6.2 Qualitative data analysis

Qualitative data for this study were primarily gathered through in-depth interviews. The interviews were transcribed and translated into English, and the key concepts and similar experiences related by the interviewees were identified and coded as themes. Direct quotes from the interviews have been used in the results chapters to illustrate, supplement, and validate quantitative results when needed. Quotations from the interviews were used mainly to reflect farmers' perceptions of the effects of climate change and other risks associated with working in agriculture, and are given in Chapter 5. They were also used to supplement quantitative data to explain local adaptation measures, particularly those decisions related to *ex situ* adaptations in Chapter 6.

3.7 Ethical considerations

This study was conducted under the *Australian Code for the Responsible conduct of Research*. The research was approved by the Human Research Ethics committee (HREC) of the University of Adelaide on 17th April 2018, approval no. H-2018-012. The researcher sought the consent of all participants in the survey and interviews before the commencement. The principle of consent is concerned with ensuring that the respondents are fully informed about the nature of the research and their participation, and that they would not be forced to participate (Bryman 2016). Each participant was given the details of the survey, the participant information sheet, and the signed consent form to retain in the Arabic language. Before each interview, the enumerator team and the researcher explained to the respondents that they were under no obligation to participate in the study, and they could withdraw at any point during the interview. The researcher also sought permission from participants to audio-record their interviews.

To ensure anonymity, the researcher did not collect any identifying data such as names, addresses, or phone numbers from the respondents. Consequently, individual respondents were protected from identification as participants in the study. The researcher also ensured the confidentiality of respondents so the information they provide could not be linked to them. This was very important as some questions might have touched on specific political issues, such as expressing opinions about government actions. The researcher clearly explained that the research was being conducted through an independent university and that her work was not related to any governmental bodies. All interviews were conducted in public areas, such as the local agricultural association or a local coffee shop, instead of private spaces, to ensure the safety of respondents and the enumerators' team and to avoid any feeling of discomfort among the participants.

3.8 Post-study reflections and limitations of the research

Being an Egyptian and having prior experience in fieldwork in Damietta helped the researcher to communicate easily with local authorities and gain access to the study sites. Moreover, informing the local authorities formally through Cairo University was extremely helpful in facilitating their participation. It is also important to mention that although the researcher was able to communicate and mingle with the locals actively, the researcher was still considered a "female outsider" with an urban cultural background, as she was born and raised in Cairo. Typically, most of the time, the researcher had to share her name and home location, and in many incidences, she was asked about her marital status and family situation. Stemming from the different rural cultural background, the respondents adopted certain attitudes and perceptions of roles that females should typically perform. Hearing comments like, "Does your husband agree to you travelling on your own for doing research?"; "You should be beside your daughter"; "Why are you exerting so much effort travelling from Cairo to do research?" and "Why are you doing that to yourself?" all the time was the most challenging component of the fieldwork. Although this situation was very discomforting for the researcher, conversely, it helped encourage farmers to participate in the study due perhaps to a feeling that they needed to help the researcher, a mother, to return to her toddler.

The fieldwork was conducted during spring and summer, during which several intense heatwaves occurred. These extreme events could have influenced/supported some responses regarding perceptions of climate change that are explained in detail in Chapter 5. Travelling from Cairo to Damietta and commuting between the study sites at a temperature reaching 45°C was very difficult for the researcher and the accompanying team.

Fieldwork started at the beginning of summer crop cultivation, particularly after the declaration of limiting rice cultivation by the government to conserve Nile water resources (Reuters 2018; Kassem et al. 2019). This policy was of significant concern to local farmers, and it was their primary focus of complaint during the survey and interviews. The researcher had to continuously refocus the attention of the respondents on the main objectives of the study and interview, while assuring them that some questions would cover this issue, and that more notes would be taken in the open-ended questions. Moreover, the researcher and the accompanying team were mistakenly understood to be government officials by non-participating farmers, who approached us on many occasions during interviews to complain about the rice policy, thinking that we could voice their opinions to higher authorities.

Secondary data about migration in Damietta was minimal, and the only data that could have been obtained was the number of overseas work permits provided by Damietta's Police Department. Overseas work permits were very difficult to obtain for two reasons; firstly, the safety of the researcher given that she is affiliated to a foreign independent university was not assured, and secondly, the need for national security approval that could take up to one year to be completed. Moreover, any data would only capture international migration data, and data on internal migration would still be limited.

The questionnaire was conduct in a face-to-face interview mode due to the low literacy rate of the study participants, who found it challenging to understand the questions thoroughly. The interviewers provided explanation and clarification of questions as needed during the interviews. Lastly, the in-depth interviews were all conducted in an Arabic dialect and then translated into English. Some information may be misinterpreted in the process of translation, given the difficulty of the process from the local dialect. However, the researcher read and compared the transcribed and translated information several times and discussed some issues with local people to avoid this problem.

3.9 Summary

This chapter has discussed the design, approach, and methods used to conduct this research and meet its aims, as well as justifying the choice of a mixed-methods approach to answer the research questions best. The chapter also provided an overview of the study area, its administrative divisions, and reasons for selecting the study sites. Primary quantitative and qualitative data were collected using a questionnaire survey and in-depth interviews. In total, 350 respondents were surveyed in a face-to-face interview, and further 11 in-depth interviews were conducted over the period from April to October 2018. The SPSS 21 software was used for quantitative data entry and analysis.

The main statistical techniques used to analyse quantitative data involved descriptive statistical analysis and the use of other non-parametric statistical tests, particularly the Kruskal–Wallis and Chi-squared test to measure significant relationships between dependent and independent variables, while the qualitative data were transcribed, translated and analysed using a thematic approach. Triangulation was achieved through the use of various methods in data collection and analysis, which increased the validity of the research findings. The results of the analysis will be discussed in detail in Chapters 4, 5 and 6.

Chapter Four: An overview of the livelihood conditions of rural households in Damietta Governorate

4.1 Introduction

This chapter provides an overview of the livelihood conditions of households in the study area. It starts with a comprehensive analysis of the key demographic data for the sampled households. The analysis also outlines the social, economic and environmental conditions of the studied villages in Damietta governorate to provide a general understanding of the local environment and the agricultural situation in the villages. Hence, this chapter is essential for providing the context for discussing farmers' perceptions of risks caused by climate change mentioned in Chapter 5 and the options for adaptation to climate variability and extremes discussed in Chapter 6. In addition, it provides a justification for the importance of distinguishing between different groups of rural households based upon their income from agricultural activities, which is the basis of the detailed statistical analysis adopted in this study.

4.2 General characteristics of the studied households

4.2.1 Household size, gender and age

A total of 322 respondents (representing 92.0 percent) out of the 350 respondents are the heads of their households (Table 4.1). Other respondents include spouses (5.4 percent), sons or daughters (1.1 percent) and parents and parents-in-law (0.9 and 0.6 percent, respectively). This result suggests that the respondents are mostly the household heads, and are therefore the main decision-makers within their immediate context.

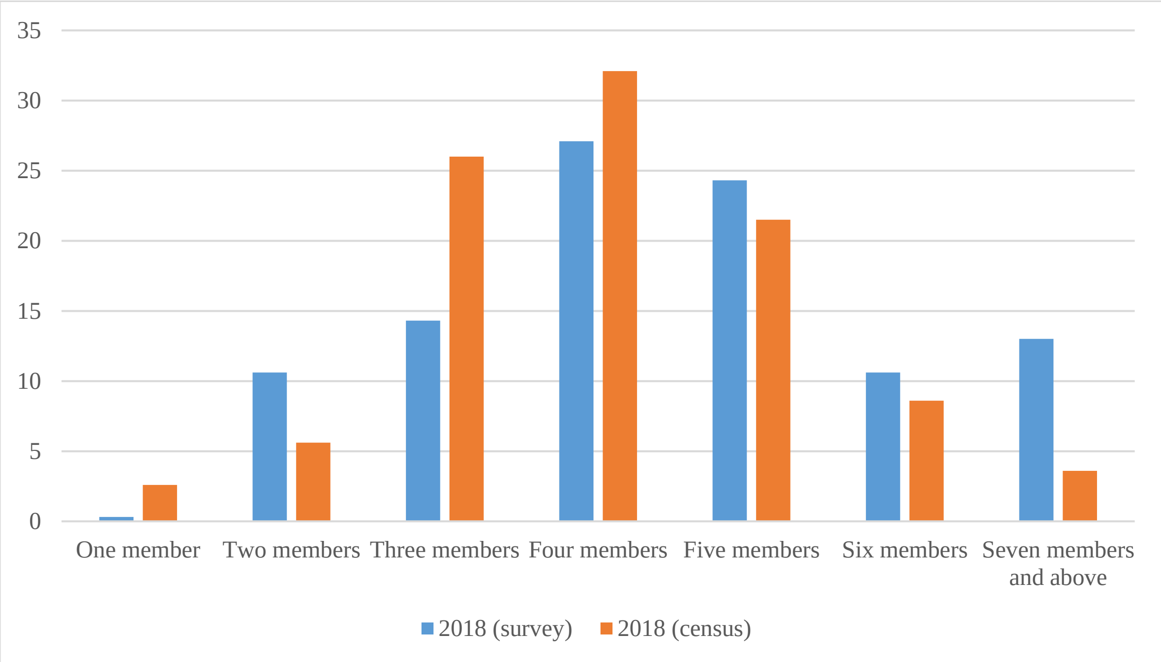
Table 4.1: The relationship of the respondents to the household's head

		Frequency	Percentage
Respondents	Head of the household	322	92.0
	Spouse	19	5.4
	Son/daughter	4	1.1
	Parent	3	0.9
	Parent-in-law	2	0.6
	Total	350	100.0

Source: Field survey 2018

The studied households have an average of approximately 5 members each, with a maximum of 13 household members and a minimum of 1 member. Most households (62.0 percent) are medium-sized (4–6 members) for rural Egypt, as displayed in Figure 4.1. Large households (7 members and more accounted for 13 percent of the sample, and 25.0 percent are small households (3 members or fewer). Similarly, the census of Damietta (2018) also shows that most rural households (62.2 percent) are medium-sized.

Figure 4.1: Distribution of households by household size in Damietta, 2018



Source: Field Survey 2018; Damietta's Census data 2018

Within the 350 interviewed households, 54.1 percent of the 1630 members are males, and 45.9 percent are females (Table 4.2). These percentages relate to the general statistics presented in the governorate's census data of 2018, in which the percentage of males is higher than females corresponding to 51.2 and 48.8 percent of the whole population living in governorate's rural areas, respectively (Table 4.3).

Table 4.2: Distribution of all household members by gender

		n	Percentage
Total Gender of household members	Male	882	54.1
	Female	748	45.9
Total		1630	100.0

Source: Field survey 2018

Table 4.3: Distribution of governorate's rural population by gender

		Counts	Percentage
Rural population by gender	Males	464,964	51.2
	Females	442,578	48.8
Total rural population		907,542	100.0

Source: Damietta's census data 2018

Results from the descriptive analysis show that the maximum age found for respondents is 85 years old, and the minimum is 20 years of age, with a mean of approximately 51 years across the cohort. The majority of respondents, or 45.4 percent, fall in the category of 45 to 60 years of age, whereas 29.1 and 25.4 percent of the cohort fall in the first and third categories with ages 18 to less than 45, and 60 or above, respectively (Table 4.4).

Table 4.4: Age groups of the respondents

		Frequency	Percentage
Age groups	18-45	102	29.1
	45-60	159	45.4
	≥ 60	89	25.4
	Total	350	100.0

Source: Field survey 2018

For the age categories of all members within the households, including children, (n=1,630) (Table 4.5), a majority of 63.3 percent could be considered to be economically active, falling in the age categories between 16 and 60 years of age, followed by 27.7 percent being younger than 16 years of age, then 9.0 percent who are 60 years old or more. Therefore, more than one-third of household members could be considered economically dependent.

Table 4.5: Distribution of all household members on the different age groups

		Frequency	Percentage
Age groups	< 16	452	27.7
	16–60	1,032	63.3
	≥ 60	146	9.0
	Total	1630	100.0

Source: Field survey 2018

4.2.2 Education and employment conditions

Results reveal that the average length of formal education experienced by the respondents is approximately 7 years, with a minimum of zero and a maximum of 23 years. The percentage of respondents who are illiterate or who haven't received any formal education is equivalent to 30.0 percent, while 10.0 percent had some formal schooling but left without completion (Table 4.6). This result suggests that 40.0 percent of all respondents from Damietta have no or very low educational attainment. About 11.4 percent and 3.4 percent of respondents, respectively, have completed primary or preparatory schooling, suggesting that they have completed a basic level of education. Almost one-third of respondents (representing 32.3 percent) have completed secondary education, whereas 12.9 percent have university degrees or higher.

At the household level, over half of the other adult members within the household (aged 16 or above) had completed secondary education or higher. In contrast, approximately 25.0 percent of the cohort of all household members have received no or fewer than 6 years of formal education (Table 4.7). This result could suggest that although most household heads have low educational attainment, they tend to encourage younger household members to complete at least secondary education, especially as opportunities for formal education have improved in the region. Hence, education may be taken as means of improving individuals' employability, income and social mobility (Barnett & Adger 2007), and consequently, improve the living conditions and, by association, the adaptive capacities of rural households in the studied area.

Table 4.6: Distribution of respondents by educational level in Damietta, 2018

	Frequency	Percentage
Illiterate / no formal education	105	30.0
Some formal education without a degree	35	10.0
Primary degree	40	11.4
Preparatory degree	12	3.4
Secondary and post-secondary degree	113	32.3
University degree or higher	45	12.9
Total	350	100.0

Source: Field survey 2018

Table 4.7: Distribution of other adults within the households by educational level in Damietta, 2018

	Frequency	Percentage
Illiterate / no formal education	175	21.1
Some formal education without a degree	43	5.2
Primary degree	73	8.8
Preparatory degree	80	9.7
Secondary and post-secondary degree	367	44.3
University degree or higher	90	10.9
Total	828	100.0

Source: Field survey 2018

Household members who were over the age of 16 were asked whether they are working in any paid occupation. The employment data is presented in-depth because it provides a key component of the later analysis of perception and adaptation data and gives a clear reflection of the modes of income diversification within the rural community studied.

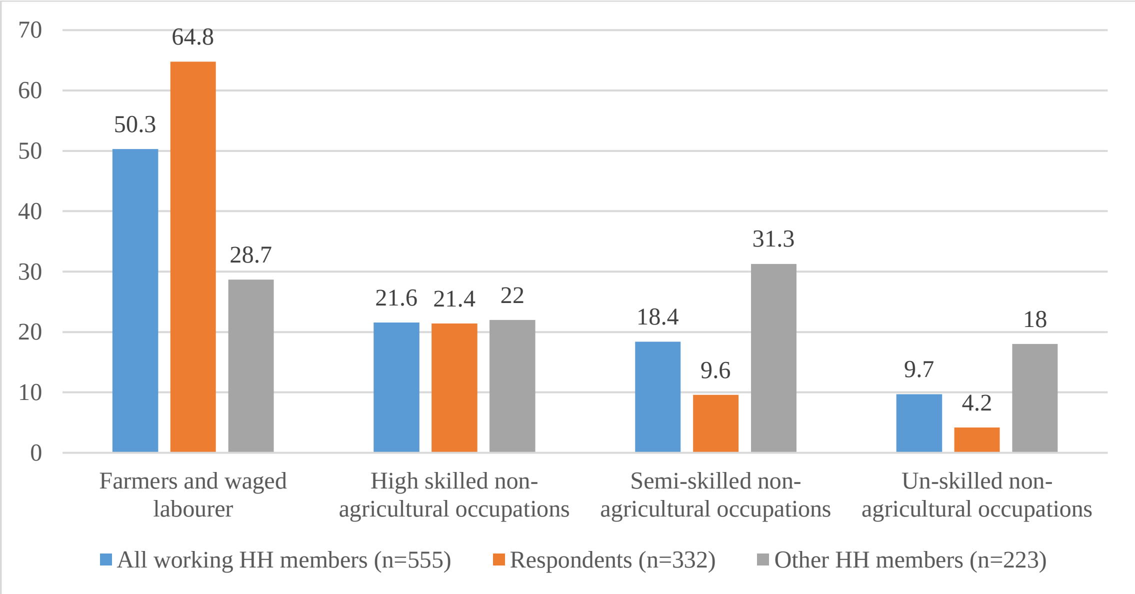
Primary occupations (that provide the biggest portion of income) were categorised into four broad groups, including:

1. Agricultural-related occupations, mainly involving farmers and waged agricultural labourers; and
2. Unskilled non-agricultural occupations for those who possess no particular skills nor related educational background;
3. Semi-skilled non-agricultural occupations that require less academic or technically skilled backgrounds; and finally:
4. Highly skilled non-agricultural occupations which include jobs that require higher educational level and/or higher technical background (such as doctors, teachers, lawyers, government officials, etc.).

As shown in Figure 4.2, most of the working respondents (n=332), representing 64.8 percent, work primarily as farmers and/or waged agricultural labourers in the study area. The subsequent most prevalent occupation were high-skilled non-agricultural occupations (21.4 percent), whereas 9.6 percent and 4.2 percent of respondents work in semi-skilled and unskilled non-agricultural occupations, respectively.

These results can be conceptualised slightly differently at the household level. There are 555 household members in total (47.1 percent) who have paid work, out of 1,178 members who are 16 years of age or above. Most members, representing 50.3 percent, work as farmers or waged agricultural labourers. Only 21.6 percent of members work in highly-skilled, non-agricultural occupations and 18.4 percent work in semi-skilled non-agricultural occupations. Finally, only 9.7 percent of members work in unskilled non-agricultural occupations. Consequently, the ratio of individuals who work in the agricultural *versus* non-agricultural sectors is roughly one to one. Notably, the majority of households' members other than the respondents work primarily in non-agricultural sectors.

Figure 4.2: Distribution of households' members by occupation in Damietta, 2018



Source: Field survey 2018

Therefore, it can be implied that rural households have been diversifying their income sources through other household members, mostly younger individuals working in non-agricultural sectors. This result might also suggest that in later years, if younger family members inherit farmland, they would then probably be operating agricultural activities as a secondary job or occupation. For illustration, a farmer (Interview 10, Kafr Saad), speaking about his sons' occupations, stated:

> *"My children are not working in agriculture, one is a driver, and the other has a private dairy-products shop in Damietta town and commutes there every day. They told me, "we don't want to work in agriculture; you stay working in it until you die, and we shall see what we would do after" … they are not even helping me with our land".*

Another farmer (Interview 1, Faraskur) was asked whether he would encourage his young sons to work in agriculture in the future responded in the following way:

> *"No, no, no, no, I already told them* [i.e. his children] *no one works in agriculture. I didn't make anything from working in agriculture; what comes from this business is barely equal to what has been paid. I want them to complete their education and work in any other sector".*

Due to such variation in the primary occupations of household members, more attention should be given to the contribution of each of the agricultural and non-agricultural sectors to the total income of households, as will be presented in section 4.2.3.2. Identifying the degree to which each household depends on agricultural activities to generate their livelihood could have a key influence on their decisions regarding various aspects of their production patterns and climate change adaptation responses which will be discussed later in the following chapters.

Most primary occupations of household members are undertaken in the same village as their residence, representing 75.9 percent of responses (Table 4.8). Following that, 12.0 percent and 8.2 percent of employed members work in towns or other villages within the governorate, respectively. Finally, 2.7 percent are employed overseas and 1.3 percent outside Damietta.

Table 4.8: Location of primary occupations of employed members

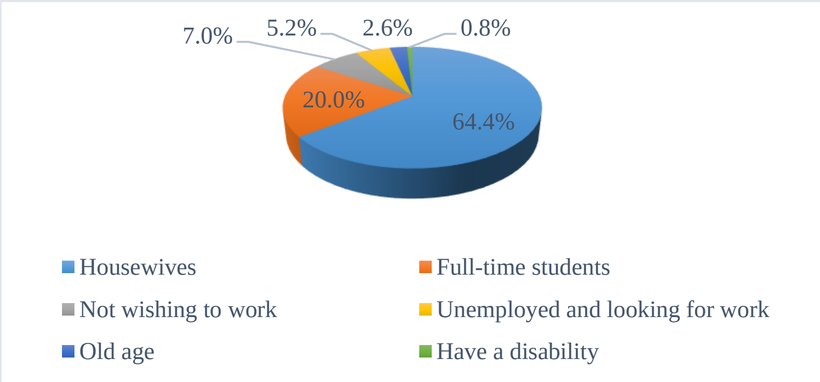
		Frequency	Percentage
Location of primary occupation	In the same village	418	75.9
	Another village within the governorate	45	8.2
	Town	66	12.0
	Another governorate	7	1.3
	Overseas	15	2.7
Total		551	100.0
Missing		4	

Source: Field survey 2018

Several reasons were reported for those household members above the age of 16 who are not working in any paid job (n=623) (Figure 4.3). The majority are housewives representing 64.7 percent of the unpaid cohort, followed by 20.1 percent who are full-time students. Approximately 7 percent of household members reported that they do not wish to work (mostly females) and 5.2 percent were unemployed and looking for a job.

Only a few (3.4 percent) reported that household members are too old or have a disability, which would not allow him/her to work. So even if those household members are economically dependent, they are still performing essential household functions.

Figure 4.3: Distribution of non-income earning adult household members by reasons for unemployment



Source: Field survey 2018

Another remarkable result is that most household members aged 16 and above do not regularly participate in unpaid agricultural activities or help on the farm, with only 22.3 percent regularly participating in farming. More specifically, 66.8 percent of household members between the age of 16 and 40 (n=644) do not regularly participate in unpaid agricultural activities. Taking gender into consideration, most of the household members aged 16 and above who participate in unpaid farm activities are males (85.2 percent), while females only represent 14.8 percent of the agricultural labour cohort. This result is of particular interest as agriculture in Egypt is traditionally considered to be a family business, with all family members contributing (Abou-Hadid 2008), but the differentiation of household labour may be indicative of a broader transformation in agriculture which will be discussed later. Importantly, the results suggest that younger members of rural households in Damietta, especially males, are becoming less engaged with work in the agricultural sector or even assist in farming activities. Younger males are increasingly engaged with off-farm occupations and/or education, meaning that they have limited free time to participate in household agricultural activities actively, or perhaps they are merely unwilling to participate.

Moreover, only 14.7 percent of household members under the age of 16 (n=452) are engaged in some form of child labour. The majority (87.7 percent) of the cohort voluntarily help on the farm without getting paid. Very few children within respondent households work as paid labourers in agricultural or non-agricultural sectors – 3.1 and 9.2 percent, respectively. It needs to be acknowledged that there could be a limitation to the analysis, as this age group might not provide a true representation of child labour either because it includes very young children (for example babies and toddlers) who will not be able to participate in any form of labour anyway, or people may be less willing to reveal how much their children are working on their farm.

4.2.3 Livelihood and economic conditions of households

This section describes the living conditions of households, with a particular focus on their social relationships and participation and other economic and physical aspects of their lives. Questions on social capital, economic conditions, particularly income, health conditions, and housing and transportation conditions are outlined. It is essential to understand the social context of households as it could have a considerable influence on their adaptive capacity and perceptions of risks related to climate change (Isham 2002; Adger 2003; Armitage 2005; Deresssa et al. 2009; Thomas, William & Tobias 2018; Mekonnen & Kassa 2019; Shinbrot et al. 2019).

4.2.3.1 Social Capital

Respondents were asked to rate their relationships with other family members, relatives and friends, neighbours and village fellows, colleagues, and government cadres to generate an indicator of social capital. Almost all respondents representing 96.9 percent, 94.3 percent, and 82.0 percent have good relationships with other family members, relatives and friends, and neighbours and village fellows, respectively (Table 4.9). Also, almost three-quarters of respondents (74.0 percent) stated that they have good relationships with their colleagues. In contrast, their relationship with government employees was valued as good by only 51.4 percent of respondents. The perceived social distance to government officials could have important implications for the acceptance or the implementation of policy in the studied area; specifically, a good relationship with government officials is likely to facilitate and promote adaptation to climate variability (Pelling et al. 2008; Fatti & Patel 2013).

Table 4.9: Distribution of households by forms of social relationships

	Percentage			
	Very poor and Poor	Neutral	Good and Very good	Mean
Family members	0.9	2.3	96.9	9.26
Relatives and friends	0.3	5.4	94.3	8.93
Neighbours and village fellows	0.6	17.4	82.0	8.59
Colleagues	1.1	24.9	74.0	8.16
Government cadres	25.1	23.4	51.4	6.15

Source: Field survey 2018

Another aspect of understanding the social capital of households is the degree of participation in local community events (Table 4.10). Respondents were asked how often their households discuss public events, organise public activities, give advice to others, solve conflicts with others, and attend community events. Results revealed that 43.4 percent of households regularly participate in the discussion of public events; 61.1 percent of them always provide advice to others, and 64.6 percent frequently help to solve conflicts among others.

Table 4.10: Distribution of households by frequency of participation in community events

	Percentage			
	Never and rarely	Neutral	Often and Always	Mean
Discussion of public affairs	34.0	22.6	43.4	5.05
Organising public activities	46.9	26.0	27.1	3.90
Giving advice to others	11.1	27.7	61.1	6.97
Solving conflicts	12.9	22.6	64.6	7.10
Attendance of community events	58.3	17.1	24.6	3.61

Source: Field survey 2018

However, respondents' social participation is less common in organising and attending public activities and community events, with the majority being 46.9 percent and 58.3 percent, respectively. Hence, results suggest that the social participation of most households in community activities is not particularly high, except for aspects of involvement related to giving advice and solving conflicts among others.

A social participation index was developed to identify the overall level of social participation of respondents through a compilation of their reported scores for each of the 5 aspects of the previously mentioned social participation criteria. Then an average of social participation was calculated on 10 point scale (0=no participation to 10= high participation). Results from cross-tabulation reveal that social participation is particularly low amongst respondents whose primary occupation is farming and waged agricultural labouring, or who are working in unskilled, non-agricultural occupations, a result that is significantly less than the other two occupation categories (Pearson Chi-squared p= >0.001) (Table 4.11). Therefore, the degree of social participation of respondents is likely to be interconnected with their primary occupations. Once again, this result might have implications for the application of adaptation policy because people who depend on agricultural livelihoods may also have the least social capital on which to rely.

Table 4.11: Cross-tabulation between respondents' level of social participation and their primary occupations

		Social participation			
		Low	Medium	High	Total
Farmers and waged labourer	Count	**24**	148	43	215
	% within primary occupation	**11.2**	68.8	20.0	100.0
Unskilled non-agricultural occupations	Count	**5**	6	3	14
	% within primary occupation	**35.7**	42.9	21.4	100.0
Semi-skilled non-agricultural occupations	Count	5	19	8	32
	% within primary occupation	15.6	59.4	25.0	100.0
High skilled non-agricultural occupations	Count	8	31	32	71
	% within primary occupation	11.3	43.7	45.1	100.0
Total	Count	42	204	86	332
	% within primary occupation	12.7	61.4	25.9	100.0

Source: Field survey 2018

Results also suggest that there was no significant difference in the distribution of households in the two studied local administrations in terms of their degree of social participation (Pearson Chi-squared p=0.25) (Table 4.12).

Table 4.12: Cross-tabulation between the level of social participation and the studied local administrations

			Social participation			
			Low	Medium	High	Total
Local administration	Faraskur	Count	21	102	57	180
		% within Local Unit	11.7	56.7	31.7	100.0
	Kafr Saad	Count	28	109	33	170
		% within Local Unit	16.5	64.1	19.4	100.0
Total		Count	49	211	90	350
		% within Local Unit	14.0	60.3	25.7	100.0

Source: Field survey 2018

Another important element that reflects a household's social capital is the amount of support (financial, psychological, help in daily activities) that household members receive from individuals other than their family members whenever they are in need. Results show that almost 70 percent of households receive help from others, and most respondents (46.3 percent) suggested that support is mainly in the form of financial assistance, i.e. lending money or goods, help in finding a job, help in agricultural operations, etc. (Table 4.13). About 37 percent and 16.6 percent of responses indicated that help is provided in the form of psychological support, i.e. emotional support or giving advice, and assistance in daily activities, i.e. taking care of children or patients, respectively.

Table 4.13: Forms of support accessed from the local community (multiple responses)

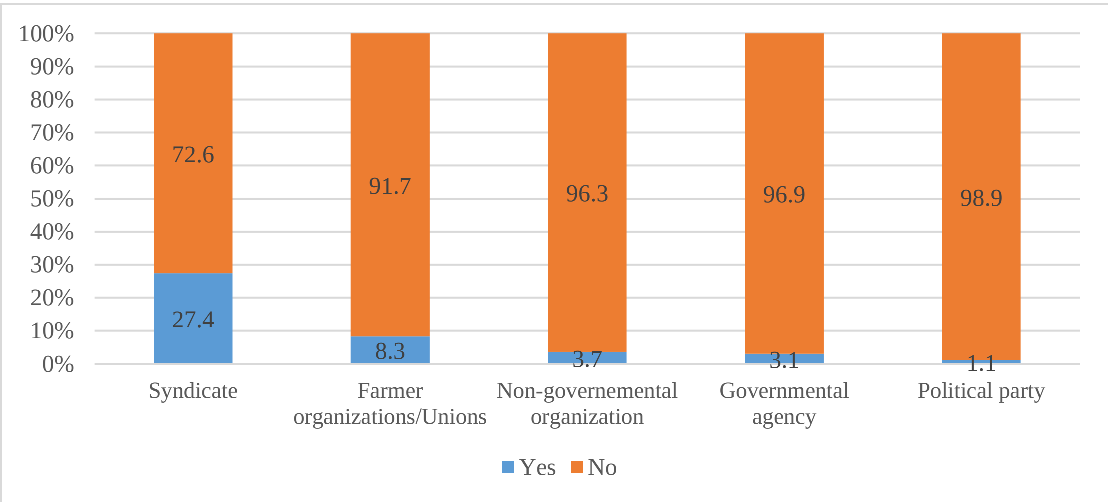
		Responses	
		Frequency	Percentage
Kinds of support offered	Financial support	206	46.3
	Psychological support	165	37.1
	Help in daily activities	74	16.6
Total		445	100.0

Source: Field survey 2018

Respondents were also asked whether or not they were members of any of the following organisations: syndicates, farmers or labour organisations or unions, non-governmental organisations, government agencies, and political parties. Syndicates are considered as formal groups or organisations for individuals having a similar profession. The key mandate of syndicates in Egypt is to protect the professional interest of their members, such as conditions of work, salaries and pensions. There are also some political functions for syndicates, such as recruiting political leaders and advocacy. However, historically, syndicates in Egypt were considered primarily as a means by which the government could control the behaviours of their members and, in many instances, mobilise professionals to support the régime (Springborg 1978). Moreover, several recent professional organisations and unions for farmers were established or came into force after the Egyptian revolution in 2011 (Nawar & Abdel-Hakim 2013). The main objectives of these unions were set around particular goals such as providing their members with agricultural inputs and services; resolving economic, marketing and land tenure problems; providing farmers with a pension, health insurance, and social services, especially to marginalised categories; and improving agricultural extension activities in rural Egypt (Nawar & Abdel-Hakim 2013).

As illustrated in Figure 4.4, results show a very low participation rate amongst respondents, even though they are primarily household heads, with only a few being members of one or more associations. Only one-third of respondents are members of syndicates, and 8.3 percent of respondents reported being members of farmers' unions or organisations. This low level of participation in formal bodies could have a considerable influence on the vulnerability of many rural households and the recognition of their political, economic and social circumstances by decision-makers in Egypt.

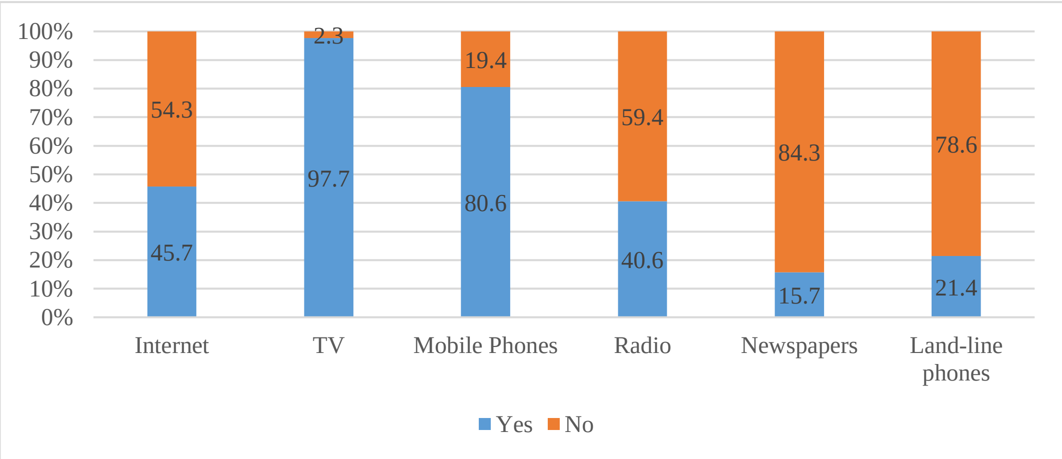
Figure 4.4: Distribution of respondents by membership in organisations



Source: Field survey 2018

Information about access by household members to the various information sources, including internet, TV, mobile phones, radio broadcast, newspapers, and land-line phones, was also gathered. As illustrated in Figure 4.5, televisions and mobile phones are the most common and accessible sources of information for most households. More specifically, the majority (97.7 percent) reported that televisions were the primary source from which they obtain their information.

Figure 4.5: Distribution of households according to the access to information sources



Source: Field survey 2018

Followed by mobile phones (80.6 percent), internet (45.7 percent), radio (40.6 percent) and land-line phones (21.4 percent). Newspapers, as a source of information, are considered the least accessible to households. Low literacy rates could be a reason for depending more upon audio-visual information sources other than those that could require higher reading abilities or even learning a new technological skill, such as using a smartphone or a computer to obtain information.

4.2.3.2 Income of households

From personal experience working in Egyptian rural communities, it is more suitable to ask about the income of rural dwellers by identifying their expenditure, because rural people often feel uncomfortable responding to direct questions related to income or economic earnings. In fact, consumption expenditure can provide a good reflection of the permanent income of households (Freidman 1975; DeJuan & Seater 1999; Sweeney et al. 2018). Therefore, the incomes of households were estimated by adding together the monthly expenditure on various household items including food, clothes, health, education, house maintenance, cigarettes and mobile phone recharging, electricity, gas, transportation, rent, gifts and donations, water, entertaining activities, non-food groceries, and any other uncategorised item. Due to the way respondents' financial capital was established, expenditure and income concepts will be used interchangeably throughout the thesis. Results suggest that the minimum monthly income of households is equivalent to EGP 1,150 (AUD 1 = EGP 11.87, i.e. AUD 97 per month), while the maximum income is EGP 21,005 (i.e. AUD 1,770 approximately) with an average of about EGP 5,530 (i.e. AUD 466) of monthly income. For more straightforward interpretation of the results, income was then categorised into four groups (1= below EGP 2,404; 2= from EGP 2,404 to less than 5,530; 3= from EGP 5,530 to below EGP 8,656 and finally; 4= equivalent to EGP 8,656 and higher), calculated through the mean and standard deviation. Most households (60 percent) have income below the average monthly income of EGP 5,530 per month, including about 7 percent of respondent households with very low income, corresponding to approximately less than AUD 210 per month (Table 4.14). At the same time, 28.6 percent and 11.4 percent of households fall in the third and fourth income categories, respectively. This result shows that most households have low-income levels.

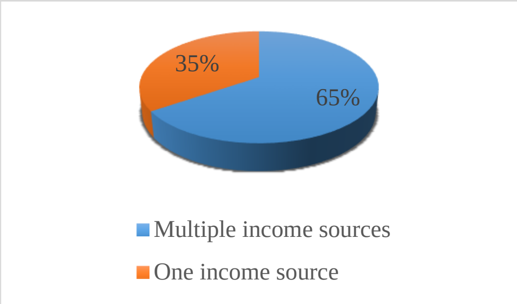
Table 4.14: Categories of households' monthly income

	Frequency	Percentage	Cumulative Percentage
EGP 0-2404	24	6.9	6.9
EGP 2404.0 – 5530	186	53.1	60.0
EGP 5530.0 – 8656	100	28.6	88.6
EGP > 8656.0	40	11.4	100.0
Total	350	100.0	

Source: Field survey 2018

Most households, or 65 percent, have more than one income source (Figure 4.6). Within those households, the contribution of agricultural activities varied significantly from 10 percent to 99 percent of the total household income. Approximately 35.0 percent depend solely on agriculture, having no other secondary occupations or sources of income. This result also supports a broader argument regarding the importance of categorising households based upon their dependency on agricultural activities for their livelihoods. This categorisation could be a key influencer on their perceptions about the agricultural situation in general and, consequently, may affect their decisions. That point will be taken up and discussed in detail in Chapter 5.

Figure 4.6: Distribution of households based upon dependency on multiple income sources



Source: Field survey 2018

4.2.3.3 Health and housing conditions

Respondents were asked to rate their health condition on a 10-point scale (1=very poor to 10=very good). Descriptive analysis shows that the minimum rate they reported is 1, and the maximum is 10, with an average of about 7, which means that the health of most respondents is relatively good. Around three respondents in ten have chronic diseases, mostly liver, kidney and heart-related diseases. About 30 percent of respondents reported having health insurance, with only 30.8 percent of those who have chronic diseases having health insurance. At the household level, 10.2 percent of the respondents' other household members suffer from chronic diseases. Health services in the studied areas are inadequate, as suggested by the fact that 60 percent of households were dissatisfied with the health services provided in the village (Table 4.15).

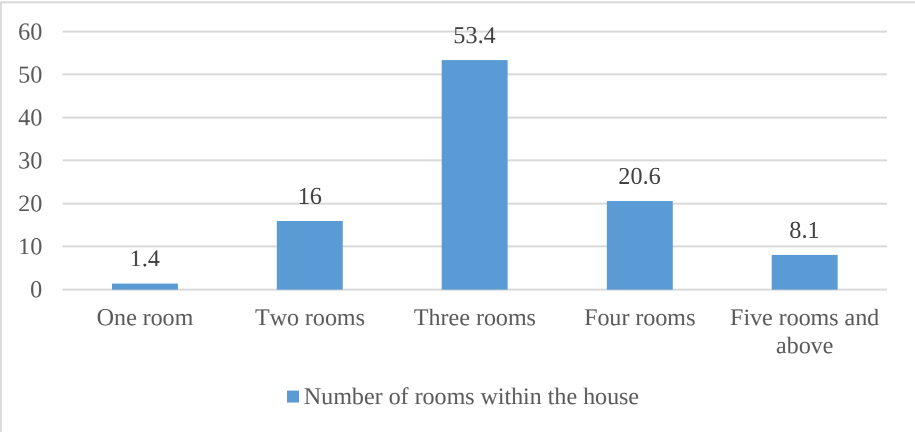
Table 4.15: Households satisfaction with local health services

	Frequency	Percentage
Very dissatisfied and dissatisfied	212	60.6
Neutral	64	18.3
Satisfied and very satisfied	74	21.1
Total	350	100.0

Source: Field survey 2018

Several questions were framed to assess the physical structure and location of respondents' houses in Damietta. Firstly, the housing arrangement, as almost all households own their residences, with only 12 households representing 3.4 percent are leasing their homes. Secondly, the number of rooms within the house reflects the size of the house. Results show that the average number of rooms per house is 3, with a minimum of 1 room and a maximum of 18 rooms. The majority of households have three rooms within their houses (53.4 percent), followed by 20.6 percent of houses with four rooms (Figure 4.7). Only 17.4 percent of houses are comprised of two rooms or less, whereas 8.1 percent of houses have five rooms and above.

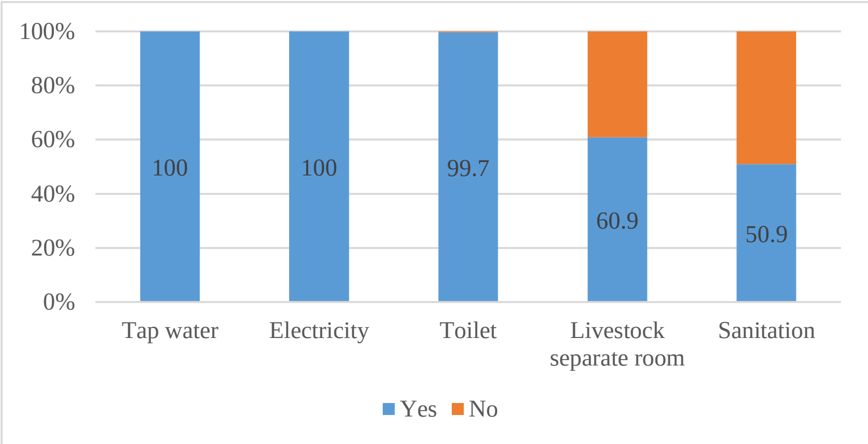
Figure 4.7: Distribution of households by the number of rooms within the houses



Source: Field survey 2018

Thirdly, the different types of facilities found on properties included tap water, electricity, toilet, separated room for poultry and livestock and, finally, sanitation. Except for just one house, all houses of the studied households have tap water, electricity and toilets (Figure 4.8). About 70 percent of houses have separate rooms for rearing poultry and livestock, and almost 60 percent have a sewerage sanitation system. More specifically, 172 houses out of 350 are not connected to either a public or a private sewerage system, which could be one of the reasons for the prevailing local problems with water pollution in the study area, and which will be discussed in more detail later in this chapter (Section 4.4). This result was also consistent with the governorate's census data obtained during fieldwork, indicating that 55.1 percent of households in the two studied local administrations are connected to a public sewerage system. On the contrary, 44.9 percent of the households living in the two local areas are connected to either a private network, a cesspit or an open field.

Figure 4.8: Distribution of houses by basic facilities in Damietta, 2018



Source: Field survey 2018

Fourthly, respondents were asked to indicate the average distance between their residential houses and the nearest essential amenities such as primary schools, public transportation, medical units, markets, main roads or towns. For most households, the mean distance for almost all services is approximately 2 kilometres, except for the distance to town, which is approximately 6.0 kilometres (Table 4.16).

Table 4.16: Basic analysis for the distances (in kilometres) between houses and several local destinations

	n	Minimum	Maximum	Mean
Primary school	346	0.02	6.00	1.1163
Public transportation	344	0.00	8.00	1.0854
Medical unit	345	0.02	15.00	1.7238
Market	337	0.02	17.00	2.2630
Main road	344	0.00	20.00	1.0247
Town	336	0.00	35.00	5.7076

Source: Field survey 2018

Finally, respondents were requested to indicate the level of satisfaction with their houses and to rate the quality of the services provided in their area, including water, electricity, sewerage system, and removal of refuse. The majority or 81.1 percent of households demonstrated a general satisfaction with their houses (Table 4.17).

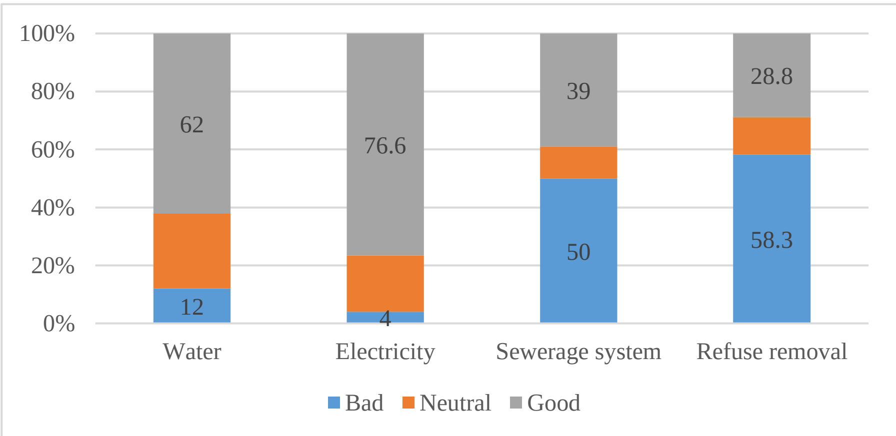
Table 4.17: Households satisfaction with their houses

	Frequency	Percentage
Very dissatisfied and dissatisfied	14	4.0
Neutral	52	14.9
Satisfied and very satisfied	284	81.1
Total	350	100.0

Source: Field survey 2018

Regarding the quality of services, most households are generally satisfied with the quality of the water and electricity services provided in the local area (62.0 and 76.6 percent, respectively). However, almost 50.0 percent of households rate the quality of sewerage systems and refuse removal as bad (Figure 4.9). This result again could be indicative of the severe pollution that is predominant in the study area.

Figure 4.9: Quality of public services provided in the local area as rated by the households



Source: Field survey 2018

4.3 Agriculture in Damietta

Two dominant types of rural communities can be found in Egypt, and it is essential to differentiate between them:

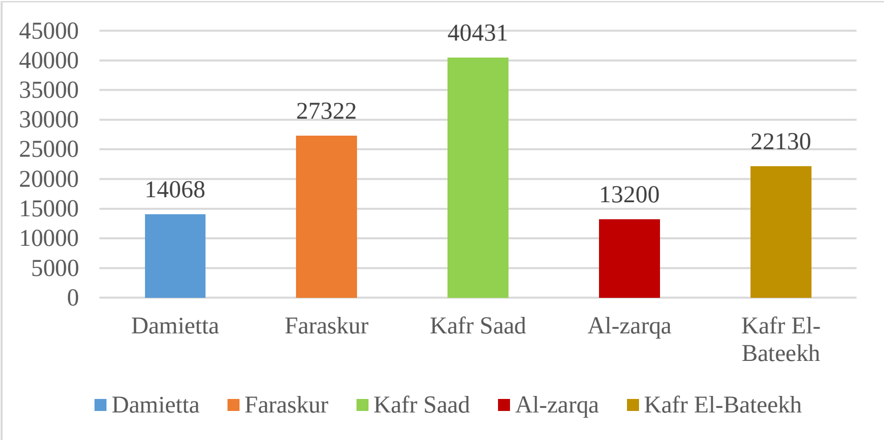
1. The "old" rural communities located around the Nile valley and Delta that were established several centuries or millennia ago; and
2. The "new" rural communities which are built settlements established across reclaimed areas (desert or dried lakes areas) within the last few decades (Nawar & Abdel-Hakim 2013).

The total cultivated land area in Egypt is 8.9 million *feddans* (approximately 3.7 million ha) (CAPMAS 2018). The newly reclaimed lands represent only one-third of these agricultural land areas and are mostly unregistered, while most are old, registered agricultural areas. The average size of farms in the old rural communities is generally much smaller than in the newly reclaimed areas (Nawar & Abdel-Hakim 2013). Egyptian agriculture is characterised by the prevalence of individual smallholdings and the high rate of land fragmentation (MALR 2009; Aboulnaga et al. 2017). According to the latest agricultural census (2010), 92.1 percent of the total cultivated land in Egypt are considered individual landholdings farms, with the majority of less than 5 *feddans* (2.1 ha) (Aboulnaga et al. 2017).

In Damietta, the total cultivated land area is 117,151 *feddans* (approximately 49,203 ha) including 7,440 *feddans* (3,125 ha) of gardens and excluding 5,756 *feddans* (2,417 ha) of urban encroachment on to agricultural lands. Old farmland accounts for 94.0 percent of the total land area in Damietta, and only 6.0 percent is newly reclaimed land. The two local administrations selected for the study, namely Faraskur and Kafr Saad, together hold 57.0 percent of the governorate's total cultivated land area (Figure 4.10). There are 6,672 *feddans* of agricultural lands in Faraskur that are newly reclaimed land, and mainly includes the dried areas of El-Manzala Lake, which is a brackish water lake (Department of Agriculture in Damietta 2017). This situation is a specific problem for Faraskur, where higher levels of soil salinity prevail in some areas.

Regarding land tenure, 93,504 individuals hold a total agricultural land area of nearly 100,754 *feddans* (42,317 ha) in Damietta, with a mean area of 1.08 *feddan* per holder (0.76 ha) (Table 4.18). Most occupiers of farmland, representing 70.8 percent of all landholders in Damietta, have very small farms of less than 1 *feddan* and what they hold only represents 20.2 percent of Damietta's total cultivated agricultural area. There is also 21.1 percent of landholders who hold farms of between 1 and less than 3 *feddans*, and what they hold represent 31.6 percent of total cultivated land areas in Damietta. Almost 5 percent of landholders occupy about 16.3 percent of the total cultivated land area in Damietta of size between 3 and less than 5 *feddans*. These results indicate that the vast majority of holders (nearly 97 percent) are considered small landholders occupying less than 5 *feddans* of agricultural land.

Figure 4.10: The area of cultivated agricultural lands within each administration area in Damietta (in *feddans*)



Source: Department of Agriculture in Damietta, December 2017

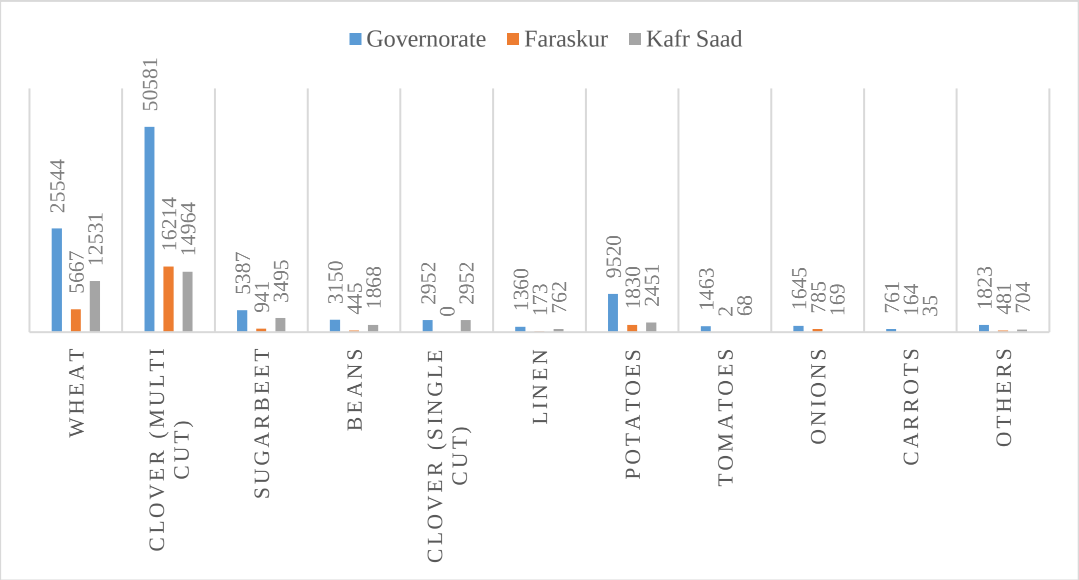
Table 4.18: Distribution of cultivated lands by farm size and holders in Damietta in 2017

Farm size (*feddan**)	Area		Holdings		Average (*feddan*)
	Feddan	%	Holders	%	
Less than 1	20,396	20.2	66,192	70.8	0.31
1-3	31,875	31.6	19,699	21.1	1.61
3-5	16,392	16.3	4,362	4.7	3.75
5-10	15,389	15.3	2,305	2.5	6.67
10-20	9,446	9.4	696	0.7	13.57
20+	7,256	7.2	250	0.2	29.02
Total	100,754	100	93,504	100	1.08

Source: Department of Agriculture in Damietta, December 2017
Note: *1 *feddan*=0.42 ha

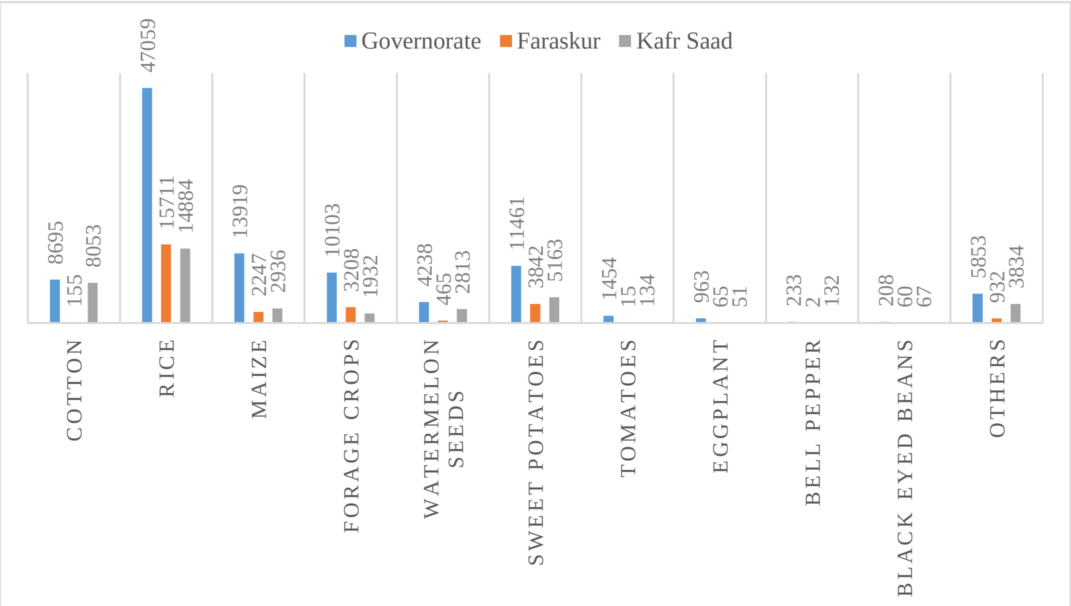
During the winter season of 2017–2018, the most important cultivated field crops were wheat, linen, beans and clover, whereas vegetables, including potatoes, tomatoes and onions were widely cultivated (Figure 4.11). For summer field crops (2018 season), the largest land areas were cultivated with cotton, rice, maize, green forage (maize, elephant grass and torpedo grass) and watermelon, whereas sweet potatoes, tomatoes, eggplants and bell peppers were the most widely cultivated vegetable crops (Figure 4.12). Some areas were cultivated with fruit trees, including guava, palm trees, oranges, mangoes, and grapes within Damietta as in 2017 (Department of Agriculture in Damietta). In 2011, the total number of large ruminants (i.e. cattle and buffaloes) was 121,120 head, and the total number of poultry was equivalent to 17,306,097 in Damietta (FAO 2018).

Figure 4.11: Distribution of total cultivated land area by winter crops and vegetables 2017–2018



Source: Department of Agriculture, December 2017

Figure 4.12: Distribution of total cultivated land area by summer crops and vegetables 2018



Source: Department of Agriculture, December 2017

4.3.1 Land size and patterns of production in the studied area

The sample data analysis shows that the mean area of owned agricultural land in the studied areas is approximately 1.8 *feddans* (0.756 ha). In comparison, the mean area of rented or shared agricultural lands is roughly equivalent to 0.7 (0.294 ha) and 0.2 *feddans* (0.084 ha), respectively. There are 23 households who are landless and are only engaged in agriculture as waged agricultural labourers. The total land area (owned, rented and shared) was categorised into three categories as follows 1=less than 2.6 *feddans* (i.e. 1.092 ha), 2=equal to 2.6 and less than 5.5 *feddans* (i.e. 1.092 ha to less than 2.31 ha), and 3=equal to or greater than 5.5 *feddans* (i.e. 2.31 ha). Most households (58.0 percent) fall in the first category, which also includes landless households, whereas 37.1 percent of households fall into the second category (Table 4.19). Only 4.9 percent of households own, share or rent an area greater than 5.5 *feddans* of agricultural land. Hence, most households have access to small areas of land and are considered small landholders. According to Aboulnaga et al. (2017), farms with less than 3 *feddans* generate income that does not provide livelihoods that exceed the international poverty line (USD 1.25 per day per capita). Therefore, many experts suggest that agriculture-dependent households holding less than 3 *feddans* in Egypt are the highly vulnerable category of farmers. In addition, results revealed no significant spatial differences between the two studied local administrations in the distribution of land areas (Pearson Chi-Square p=0.007).

Table 4.19: Total agricultural land area owned, shared and/or rented by households

	Frequency	Percentage
<2.6	203	58.0
2.6-5.5	130	37.1
≥ 5.5	17	4.9
Total	350	100.0

Source: Field survey 2018

About 71.0 percent of households report that their farmland is considered to be near their residential houses. In comparison, 17.4 percent live some distance away, and 11.6 percent have mentioned that their agricultural lands are ‘far away’ (Table 4.20).

Table 4.20: The distance between agricultural farmland and the households

	Frequency	Percentage
Near	232	70.9
Not very far	57	17.4
Far away	38	11.6
Total	327	100.0

Source: Field survey 2018

Results from multiple response analyses show that most farmers, representing about 62.0 percent of the total cohort were cultivating field crops at the time of the fieldwork, with around half of them using the land for rearing livestock as well (i.e. mixed-use) (Table 4.21). Around 5 percent of farmers were cultivating vegetables either solely or in combination with other field crops and/or fruits. Only 1.5 percent and 1 percent of responses included cultivation of fruits and/or medicinal and aromatic plants, respectively.

Table 4.21: Damietta respondents' agricultural land use from early May–late September 2018

	Responses	
	Frequency	Percentage
Crops	321	62.1
Livestock	159	30.8
Fruits	8	1.5
Vegetables	27	5.2
Fallow	1	0.2
Medicinal and aromatic plants	1	0.2
Total	517	100.0

Source: Field survey 2018

Most households, or 71.7 percent, sell their agricultural products mainly through tradesmen or middlemen (Table 4.22). About a quarter of households (25.5 percent) sell their products directly, while very few households mentioned collective marketing or government-arranged purchases as their primary marketing channels, with percentages of 1.2 and 0.9, respectively. Finally, 0.6 percent of households use their production solely for domestic consumption.

Table 4.22: Main marketing channel adopted by households for selling agricultural produce

	Frequency	Percentage
Self-selling	82	25.5
Tradesman	231	71.7
Collective marketing	4	1.2
Government-arranged purchase	3	0.9
No selling/ household use	2	0.6
Total	322	100.0

Source: Field survey 2018

Table 4.23: Cross-tabulation between marketing channels and rate of product selling

			Rate your products selling			
			Very bad and bad	Neutral	Good and very good	Total
Marketing channel adopted by the households	Direct selling	Count	4	22	56	82
		% within self-selling	4.9	26.8	68.3	100.0
	Tradesman	Count	51	47	130	228
		% within tradesman	22.4	20.6	57.0	100.0
	Collective marketing	Count	0	4	0	4
		% within collective marketing	0.0	100.0	0.0	100.0
	Government-arranged purchase	Count	2	0	1	3
		% within government purchase	66.7	0.0	33.3	100.0
Total		Count	57	73	187	317
		% within total	18.0	23.0	59.0	100.0

Source: Field survey 2018

Almost six out of ten households rated their agricultural produce selling over the past five years as good, whereas 18.0 percent of households were not satisfied and rated it as poor, while 23.0 percent were neutral. To shed more light on this point results from cross-tabulation reveal that households who self-sell their products are more likely to be satisfied with their methods of sales than those who sell through a third party such as a tradesman or through government (Pearson chi-square p=>000.1) (Table 4.23). Hence, although most (71.7 percent) choose tradesmen to sell their produce, 43.0 percent of that cohort tend to be generally dissatisfied with the arrangement, rating the quality of the process as six or lower on a 10-point scale.

Households were requested to indicate the percentage of their dependency on family members' paid or unpaid labour in different agricultural operations. Some households indicated their full dependence on family members, while some others always hire paid labourers to take care of their land. Several households have an equal reliance on family members and paid labour. Table 4.23 shows the mean percentage of dependency on paid agricultural labour *versus* family members in households' different farming operations. The degree of dependence on paid agricultural labour was higher in operations related to land preparation (61.5 percent), planting (60.4 percent) and harvesting (66.6 percent). In contrast, the percentage of dependency on family members was higher in irrigation (69.5 percent) and crop operations (52.8 percent).

Table 4.24: Household dependency on family members and paid labourers in agricultural operations (mean percentages)

Agricultural operations	Family members	Paid agricultural labour	Unpaid labour
a. Land Preparation	35.3	61.5	3.2
b. Planting	36.6	60.4	3.0
c. Irrigation	69.5	27.8	2.7
d. Crop operations	52.8	44.1	3.1
e. Harvesting	29.3	66.6	4.1

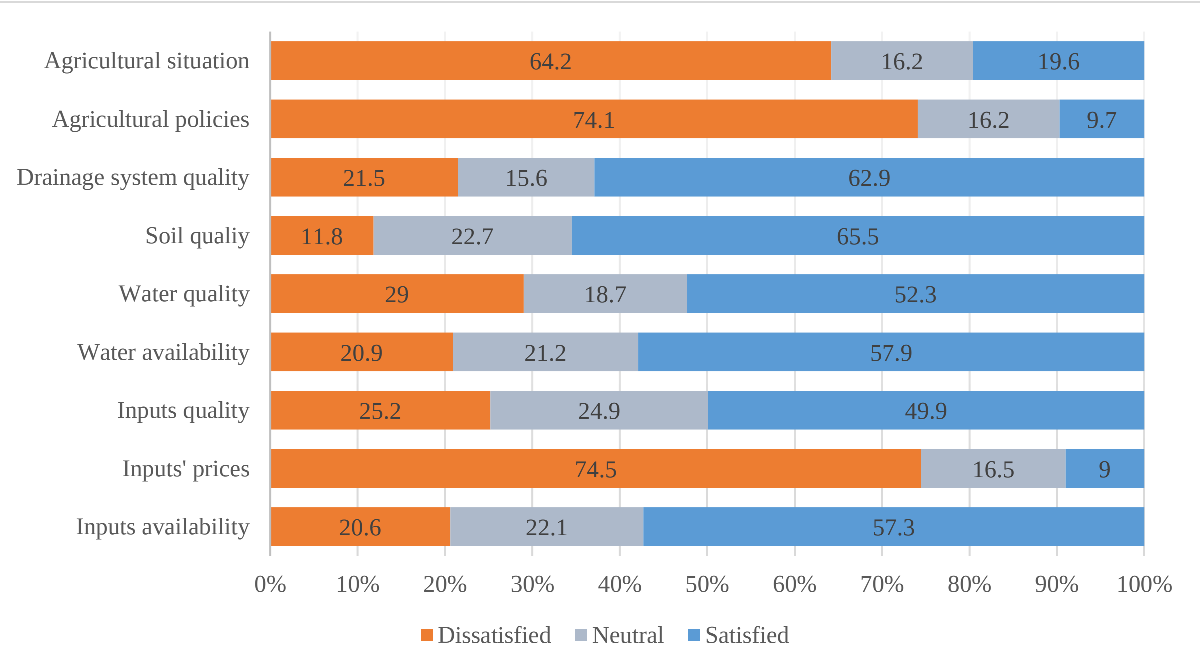
Source: Field survey 2018

4.3.2 Households' satisfaction with the agricultural situation in the study area

Households were requested to rate their degree of satisfaction with several key factors related to agricultural production, including the availability and quality of the different resources and inputs such as soil, water, fertilisers or pesticides. In addition, the satisfaction with agricultural policies imposed by the government and the agricultural situation, in general, were explained.

About 66.0 percent of households are satisfied with the soil quality, and 63.0 percent of the cohort are satisfied with the quality of their agricultural drainage systems. Approximately 58.0 percent of households are happy with the availability of water and agricultural inputs, whereas only about half are satisfied with their quality. On the contrary, and essential for generating context during later discussion, three in four households are dissatisfied with the prices of the inputs and the agricultural policies imposed by the Egyptian government. Furthermore, as a final point, just about 65.0 percent of households are generally dissatisfied with the overall agricultural situation in Egypt (Figure 4.13).

Figure 4.13: Household respondents' satisfaction with the different factors of agricultural production in Egypt



Source: Field survey 2018

To highlight the issue related to input availability and prices, a farmer (Interview 1, Faraskur) speaking about the major problems in the agricultural system in his area stated that:

> *"Fertilizers are not available, and if found, they would be very expensive … very high in prices – 270 or 280 pounds per bag (50kg) is definitely expensive for farmers. For farmers' crop production, the country is not subsidising their crop, so when the farmer spends money on their land, plant, and fuel … and you know that fuel prices have risen … so the crop prices don't bring even what has been paid. The farmers are losing, and this is the problem; nothing is easy for them; everything is difficult".*

Another farmer (Interview 2, Kafr Saad) elaborated on the problems in relation to the agricultural inputs stated that:

> *"Yes, we have several problems. First of all, they cheat on pesticides; the pesticides are not effective at all. Another thing is the high prices of fuel, the prices of fuel increased, and this increased the cost of irrigation. Generally, the prices of all inputs have risen; we don't know what we shall do. And, the water, we face water shortages in the cultivation season between 1st May and 15th June, the water is not enough. I know some farmers who left their lands fallow; they couldn't cultivate it".*

A critical issue for agricultural policy raised by several farmers is the government's plan to reduce rice cultivation in the Nile Delta region to conserve irrigation water (Kassem et al. 2019). Limiting rice cultivation is a particular concern for Damietta as high rates of soil salinisation already prevail. Farmers reported that they need to wash out the soil through the use of irrigation water during rice cultivation. Another important aspect is the economic returns households obtain from rice production. Rice is a short-growing season crop with good financial returns, which can also be used for household consumption (Tarek 1998). As an illustration, a farmer from Faraskur mentioned (Interview 8) the following:

> *"The soil here is saline, the lands are considered to be newly reclaimed and have a percentage of salinity. So, cultivating rice is good for the soil. This year the government said we should cultivate vegetables. I am a farmer, and I best know what is suitable for my land. I have two* feddans*; at least they allow me to cultivate only a* feddan *of rice. As farmers, we cannot buy rice from outside, and our food depends on the rice we cultivate. The government said farmers will pay a fine of 8,000 to 10,000 pounds for each violated* feddan *and will be imprisoned for a year. I cultivated maize this year; it cost me 4,700 pounds for one* feddan *from seeds to ploughing to cultivation, and I wanted to sell it, and no one wanted to buy it as fodder for livestock. The cobs started to dehydrate and dry out, so I made silage for my livestock. I cultivated the other* feddan *a bit later, and a trader came, and he will pay 300 pounds per ton. The* feddan *produced 11 tonnes; hence I will sell it with 3,300, so I lost, and I*

will keep losing as long as the minister of agriculture wants us to cultivate dry crops".

In one further example, a farmer (Interview 3, Kafr Saad) said:

> *"The same thing happened with rice, before the limitation of its cultivation, Egypt produced 6.5 million tons, we use only 4 million, and the rest is being exported. Now, the government wants to import rice, and we are self-sufficient; this is just crazy. The government needs to understand that it is irrational to stop cultivating rice, especially in the areas where the soil has a percentage of salinity".*

Another farmer (Interview 11, Faraskur) explained the socio-economic and ecological threats of not cultivating rice and stated:

> *"We are a population of 100 million, and the government needs to feed us. We eat bread and rice- the basic food we eat. I hope that government officials can provide them to citizens. The person who says don't cultivate rice, and he is sitting on his desk and office away from the real world. Does he understand the nature of my soil? Does he know the quality of our water? Does he know the quality of my drainage system?*
>
> *I am currently cultivating a dry crop* (i.e. vegetables)*, I swear to god, I swear to god, it is not even giving the costs I paid for cultivating it. I will not even tell you the price of the land rent; I am only saying the costs of its cultivation only. I am forced to pay the rent to the landlord in all cases; the land got revenue or not, it's none of his business. We sell assets, borrow money or do anything to give the landlord the rent".*

For more illustration on the perceptions of policy, a farmer (Interview 2, Kafr Saad) when he was asked about current governmental programs aiming at improving the agricultural situation in the area, responded:

> *"The government!? The government doesn't do anything, oh … it only does one thing that is to put more burdens on farmers. The policies are sick. We cultivate four crops per year, and the government provides fertilisers only twice a year. And more, we normally cultivate two rotations of potatoes, and the government says, "No, you must cultivate*

only one rotation". And now the government is annoying us with the rice policy. It is disgusting".

Another farmer (Interview 11, Faraskur) added to this point when he mentioned:

"As far as I know, and I am a man with intermediate education and I don't understand politics, but I do understand in everyday life I am living in. Does Egypt have money? Yes, it does, and the government knows very well that the country is rich, but who has the money and how it is spent? For example, the new Suez Canal has been completed more than a year now, what are its benefits to the citizens? Only God knows. The huge expenditure on roads and bridges and other things, what do we get as citizens from them? I am a farmer, how it is useful for me? Do they facilitate the marketing of my produce? The tradesman who come and buy from me is the one who profits not me.

The government should first monitor the prices of everything and the money spent on mega projects that are being done. The citizens need the money the most, and citizens' quality of life is the most important aspect the government should consider. Even education, we don't want education, because eventually what shall the graduate do with his degree, many educated people can't find jobs anyway".

It is also important to mention that no significant difference was found between Faraskur and Kafr Saad concerning farmers' satisfaction with the agricultural situation in general (Pearson Chi-squared p=0.201). Rather, there was a general agreement that the prices of inputs are high and that the governmental context within which farmers are functioning is not very encouraging. Moreover, in every other factor of agriculture production, there is a large group of households, reaching 50 percent in relation to several aspects, who rated their satisfaction 6 or less on a 10-point scale, and hence there is a wide variation in the opinions of households about the agricultural situation

4.3.3 Households' exposure to agricultural-related shocks and risks

This section highlights the significant economic, social and environmental shocks that surveyed households were exposed to during the two years that preceded the survey (2016 and 2017). After identifying the particular shocks, households who experienced a shock were asked to mention how they dealt with it.

Most of the households have been exposed to crop or income losses as a result of extreme weather events (52.8 percent), increase in the prices of agricultural inputs (57.9 percent) and increases in the cost of renting farmland (61.0 percent) (Table 4.25). Approximately 40.0 percent of households have been exposed to a lack of cash liquidity when purchasing inputs and 37.0 percent experienced reductions in yields as a result of pest infestation and disease infections. More than 35.0 percent of households have experienced a drop in crop prices upon selling their products, and roughly one-third of households have experienced low crop returns due to water and labour shortages. Finally, 23.0 percent of households reported having a reduction in crop yields as a result of irregular agricultural operations. Only 15.5 percent have experienced food shortages within their household, but that does suggest that low food availability and access do have local impacts. To conclude, most of the sudden shocks experienced by the households were economic (particularly increased cost of inputs) and shocks linked with the negative effects of climate change on income and crop production.

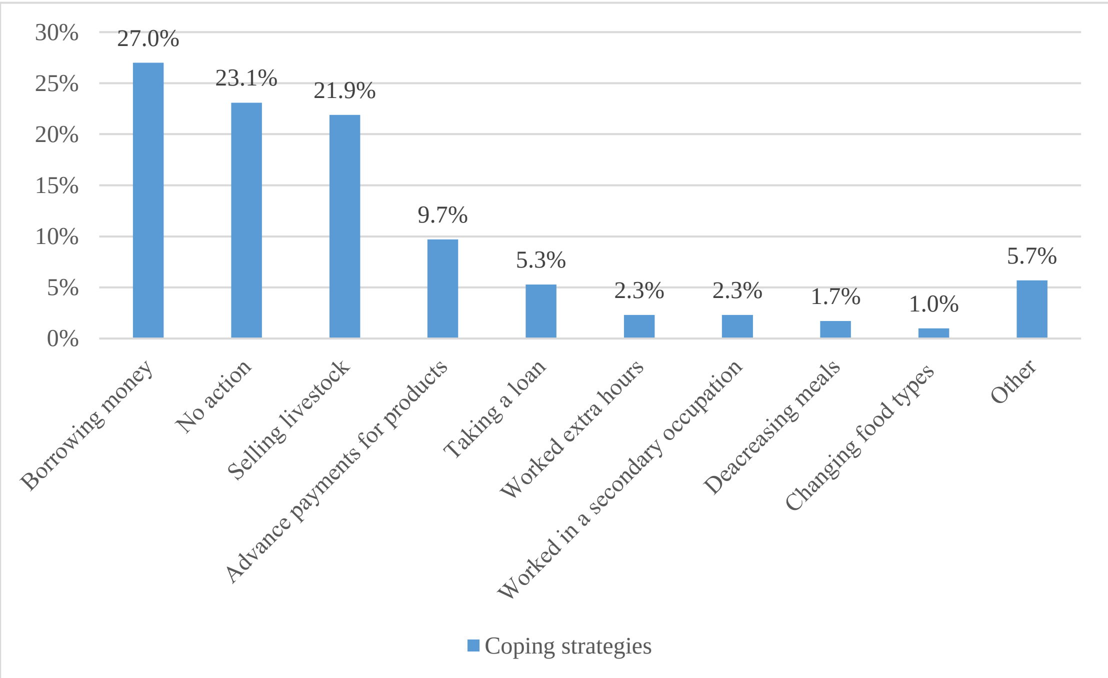
Table 4.25: Respondent households' exposure to sudden shocks during 2016 and 2017 (in percentages)

	Percentage	
	Yes	No
Poor crop returns due to water shortage (n= 304)	30.3	69.7
Crop/income losses due to extreme weather events (n= 324)	**52.8**	47.2
Reductions in yields as a result of pests and diseases (n= 305)	37.4	62.6
Reductions in crop yields due to irregularities in agricultural operations (n= 304)	23.0	77.0
Crop prices dropped upon selling agricultural products (n= 304)	35.5	64.5
Food shortages in the household (n= 329)	15.5	84.5
Labour shortages (n= 304)	30.3	69.7
Increase in the land rent prices (n= 100)	**61.0**	39.0
Increase in the prices of the agricultural inputs (n= 304)	**57.9**	42.1
Lack of cash liquidity when purchasing production inputs (n= 304)	40.5	59.5

Source: Field survey 2018

Borrowing money from relatives or friends and selling livestock are the two most frequent strategies for reducing the risks associated with these shocks, as reported by 27 percent of households (Figure 4.14). About 23.0 percent of households did not act in response to these events, and hence they just bore the losses. Approximately 10.0 percent of households' responses were taking advance payments from a tradesman, whereas taking a loan was a coping strategy for 5.3 percent of households. Around 2.0 percent of responses regarding coping strategies involved working extra hours on the farm to overcome the labour shortage and working in a secondary occupation. A few households decreased the number of meals consumed and changed the types of food consumed, representing 1.7 percent and 1.0 percent of the responses, respectively. Several other strategies were mentioned by a small number of those sampled, involving postponing activities until labourers were founding (1.0 percent), intensifying agricultural production (0.8 percent), a child or woman starting to work outside the home (0.8 percent), selling assets from the house (0.7 percent), changing occupation (0.7 percent), increasing hiring rate for labourers (0.6 percent), taking donations from people or religious institutions (0.4 percent), decreasing the amounts of inputs used until the required money had been saved (0.4 percent). The final strategy mentioned was the migration of a family member (0.3 percent). This result suggests that mobility (whether geographical or occupational) as a coping strategy to short term sudden shocks is very rarely adopted by rural households in the study area.

Figure 4.14: Coping strategies adopted by households to reduce losses from sudden shocks



Source: Field survey 2018

4.4 Ecological environment in Damietta

The ecological and natural resource management within Damietta governorate, primarily involves aspects of the soil and water in the area. There are generally six categories for soil in Egypt, based upon its type, properties, and productivity. The soils in Damietta governorate are commonly sandy and calcareous, and almost 70 percent of them are classified as average to low productivity, especially where salinity and alkalinity problems are common (EEAA 2003). Nile water is considered the sole source for irrigation in Damietta (Department of Agriculture in Damietta 2017). Consequently, the area is particularly vulnerable to the effects of climate change as there are no alternative irrigation sources. The Nile Delta is enclosed within two Nile River branches; one, namely Damietta Branch, is in the governorate and ends downstream near Damietta city.

Water pollution is the most predominant environmental problem that was reported by households in the study area. As illustrated in the photos in Figures 4.15 and 4.16, the main open canal that holds water for agricultural irrigation and household use is polluted with farm wastewater and sewage waste from the surrounding households. The problem was more apparent in the local unit of Faraskur in comparison to Kafr Saad. A remarkable comment from a farmer during the fieldwork that was mentioned in one of the questionnaire's open-ended questions stated: "*We are consuming our own wastes".*

Figure 4.15: Water canal pollution in Hagaga village- Faraskur central administration, Field survey 2018

Figure 4.16: The pollution of irrigation water in Kafr El-Arab village - Faraskur central administration, Field survey 2018

During in-depth interviews, another farmer (Interview 1, Faraskur) speaking about water problems in Faraskur stated the following:

> *"People living here drink sewage water, which is the same as what they irrigate from. Two days ago, we had no water for a whole day … whole day … By the end of the day, I opened the faucet I found black water coming out of it. Here* [i.e. in the village], *we have the highest percentage of people who have kidney failure".*

The water quality problem has been persistent since 2003, as the environmental report of Damietta governorate (EEAA 2003), emphasises five crucial environmental issues related to water pollution (Table 4.34).

Table 4.26: Predominant environmental problems in Damietta

Problem	Dimensions of the problem
1. Solid-waste management	Getting rid of the waste by throwing it in open plains and water canals or through burning – blockage of drainages and canals – water pollution – widespread related health problems.
2. Sewerage system	Absence of sewerage system that covers all areas within the governorate – exposed banks – pollution of drinking water – lack of system maintenance – pollution of water canals – widespread related health problems.
3. Drinking water-related services and water quality	Drinking water shortage – low water pressure – inefficient water pumps – power outages – lack in the number of water treatment units – poor maintenance of water pipes.
4. Water pollution	Deficiency in sewerage systems – exposed (uncovered) water canals – irrigation and drainage water pollution – widespread diseases such as schistosomiasis.
5. Lack of public environmental awareness	Weak coordination between the different governmental administrations responsible for providing the services – lack of public awareness about acceptable environmental practices.

Source: EEAA (2003)

4.5 Summary

Initial key results relating to demographic, economic, social, production and policy perceptions provide key information that will be elaborated on in future chapters. The data showed that most heads of households have either no or limited schooling, with more than half either illiterate or having completed only primary education. Regarding the primary occupations of respondents, most work predominantly as farmers or waged agricultural labourers; however, on the household level, there is a notable percentage of households' members who work in non-agricultural occupations, which will help to frame the discussion in the following chapters. Since most households depend on more than one source of income, it is necessary to understand the importance of farming activities in contributing to the income of households, especially given that agriculture is one of the most vulnerable sectors to climate change. Therefore, households of this study are grouped into three groups based upon the contribution of agricultural activities to their overall income and will be discussed in detail in the next Chapter 5 (Section 5.5). Most of the respondents have good relationships with their family members, relatives and other rural dwellers. In contrast, their social participation in community events is low, particularly amongst full-time farmers and waged labourers and unskilled labourers in other non-agricultural sectors. There is also general agreement that local public services providing health services, sewerage systems and refuse removal in the studied villages are poor. These issues add to the problem of water pollution predominant across the study area. Many householders also complained about the prices of farming inputs and the agricultural system in Egypt, suggesting a broad dissatisfaction with governance arrangements relevant to their places and production activities.

Chapter Five: Perceptions of climate change and other risks associated with working in the agricultural sector

5.1 Introduction

As mentioned earlier (Section 2.4), individuals' experiences and perceptions of environmental change are considered as intermediary factors that influence their decisions to adapt (Maddison 2007; Weber & Johnson 2009; Bardsley & Hugo 2010; Bagagnan, Ouedraogo & Fonta 2019). Perception, on the other hand, is shaped by several factors, including characteristics of individuals and households such as age, education, income, food security and other elements (Diggs 1991; Maddison 2007; Ishaya & Abaje 2008). Hence, understanding how rural households experience and perceive climate variability and extremes could allow us to understand their adaptation behaviour, whether *in situ* or *ex situ*, in relation to environmental change.

Since many rural households depend on the agricultural sector for their livelihoods, their perception of working in the sector is crucial for understanding the general circumstances within which they generate resources to enable the household to function. Knowledge of perceptions of agricultural risk is also vital in determining whether a farming family might move to a different area, especially because farming activities are directly dependent on environmental conditions and sensitive to minor changes in climatic stresses (Parry & Carter 1989; Smit & Skinner 2002).

This chapter describes how rural households perceive of their work in the agricultural sector, in addition to their perceptions of climate variability and extreme weather events. Moreover, it addresses the significant future risks and uncertainties of working in, and a reliance on, agriculture from the rural households' perspectives. Finally, it discusses the different attitudes towards climate change, and other future uncertainties found among the studied households' groups.

5.2 Households' perceptions of climate variability and extremes

This section focuses on households' experiences and perceptions of climate variability and its adverse impacts on agriculture. Results revealed that the majority of the interviewed households (90 percent) had experienced remarkable climate variability and extreme weather events by 2018. Results from the descriptive analysis suggest that the minimum number of times the households have experienced unusual climate variability and extreme weather events in a year is one, and the maximum is 30 times, with an average of about four events per year. Most of the climatic events have been experienced during summer and winter according to 48.2 percent and 42.2 percent of household responses, respectively (Table 5.1).

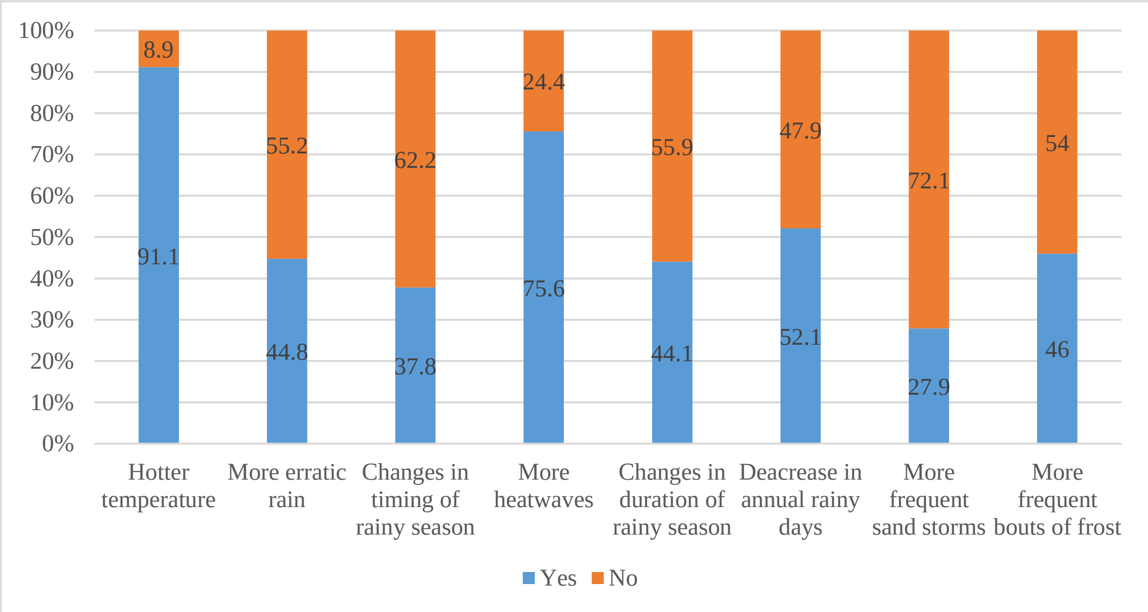
Table 5.1: The perceived timing of the most observed climate variability and extreme weather events in Damietta by 2018 (multiple-response question)

		Responses	
		Frequency	Percentage
	Summer	216	48.2
	Winter	189	42.2
	Spring	30	6.7
	Autumn	6	1.3
	Between seasons	7	1.6
Total		448	100.0

Source: Field survey 2018

The households who stated that they had experienced climate variability and extremes (n=315), were further requested to indicate the perceived patterns of change (Figure 5.2). The majority of households, or 91.1 percent, recognised that they were experiencing higher temperatures, with roughly three-quarters of households perceiving more frequent heatwaves. More than half of the cohort observed a decrease in the number of rainy days each year. About 46.0 percent and 44.8 percent of households stated they were experiencing more frequent bouts of frost or cold spells and more erratic rain, respectively. Finally, 37.8 percent of households mentioned changes in the timing of the rainy season and 27.9 percent perceived more frequent sand storms.

Figure 5.1: Distribution of households by the observed forms of climate variability and extremes in Damietta by 2018 (n=315)



Source: Field survey 2018

To further illustrate households' experiences with climate variability and extreme in the studied area, a farmer (interview 4, Faraskur) stated:

> *"Yes, the weather had changed a lot from the past. It has become much hotter, and such hot weather burns crops and decreases their productivity".*

Another farmer (interview 10, Kafr Saad) mentioned:

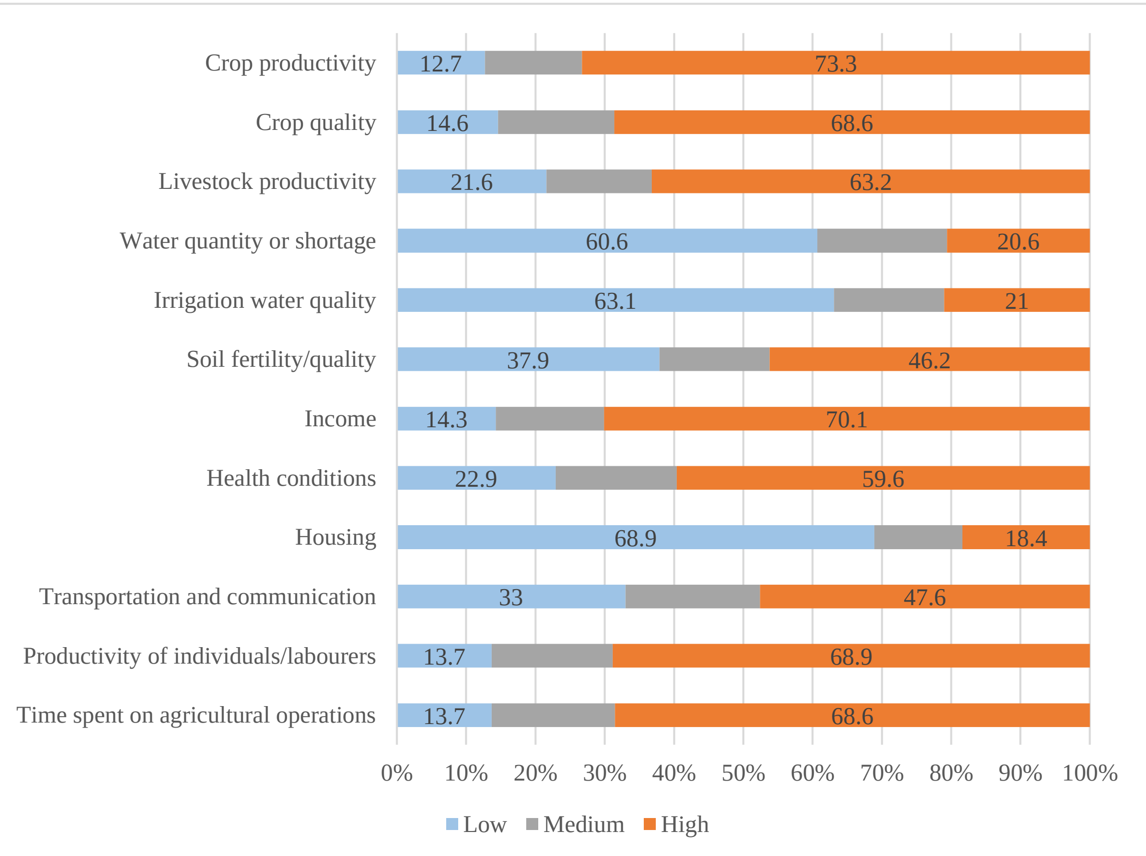
> *"There are certainly more frequent heatwaves and cold spells, but we can withstand the hot weather, the cold weather, the sun, and everything. This is what God wants, what we shall do, we get used to that".*

Moreover, a farmer (interview 11, Faraskur) stated the following when he was asked about the environmental problems that prevail in his local community:

> *"There are problems in everything, especially farming; it is full of problems. For instance, sometimes you find the weather is really hot, so the next day you find worms all over the crops due to the heatwave. Such weather conditions are something uncontrollable, and not my fault or anyone's fault. Consequently, you run to buy pesticides and apply them to the affected crop. Some other times you find it raining in an unexpected time of the year, this also negatively impacts crops".*

Regarding household perceptions of the adverse effects of climate variability and extremes (Figure 5.2), the majority of respondents, or 73.3 percent, believed that there were important adverse effects on crop productivity. Roughly 70.1 percent of households perceived that their income had been badly affected, and 68.9 percent of the cohort also perceived much reduced productivity of individuals or labourers. Similarly, crop productivity was perceived to be greatly reduced while the amount of time spent on agricultural operations increased as indicated by approximately 69.0 percent of households. Furthermore, livestock productivity, health conditions, and soil fertility or quality were all greatly affected, as stated by 63.2 percent, 59.6 percent and 46.2 percent of households, respectively. About 60.0 percent of households perceived severe impacts upon health conditions, and nearly half of the households (47.9 percent) mentioned that transportation and communication within their local communities were also badly affected by this variation in climate and its extremes.

Figure 5.2: Distribution of households by respondents' perceptions of the degree of severity of the adverse impacts of climate variability and extremes



Source: Field survey 2018

On the contrary, roughly 60 and 63 percent of households perceived less severe impacts on housing conditions and the quality and quantity of irrigation water, respectively.

An index of climate change perception was developed by compiling the indicated score for each of the 12 impact items then calculate an average for the overall perception level (0=less severe adverse impacts to 10=more severe adverse impacts). Results revealed that most households, or 48.9 percent, perceived that climate change was having important impacts on the agricultural and living conditions in the studied rural villages (Table 5.2), whereas 34.6 percent of households were neutral, and only 16.5 percent of the cohort perceived few or low levels of impact. Importantly, this means that almost half of the studied households have perceived that climate change is strongly negatively affecting their livelihood conditions.

Table 5.2: Household overall perceptions of the adverse impacts of climate variability and extremes

		Frequency	Percentage
Perception of adverse impacts	Less severe adverse impacts	52	16.5
	Neutral	109	34.6
	High severe adverse impacts	154	48.9
Total		315	100.0

Source: Field survey 2018

Results also revealed no significant spatial difference (Pearson Chi-squared p=0.407) between the two studied central administrations of Faraskur and Kafr Saad, in relation to perceptions or the adverse impacts of climate variability and extremes (Table 5.3). Hence, households within the studied areas seem to have a similar level of experience with climate variability and extremes.

Table 5.3: Distribution of households by their overall perceptions of the adverse impacts of climate variability and central administration

			Categories of the total perception of adverse impacts			
			Less severe	Neutral	High severe	Total
Central Administration	Faraskur	Count	30	57	73	160
		% within Local Unit	18.8	35.6	45.6	100.0
	Kafr Saad	Count	22	52	81	155
		% within Local Unit	14.2	33.5	52.3	100.0
Total		Count	52	109	154	315
		% within Local Unit	16.5	34.6	48.9	100.0

Source: Field survey 2018

In addition, households had the opportunity to discuss the adverse climate change impacts in answers to open-ended questions. After re-coding and categorising responses, results revealed that most of these unstructured responses related to the negative effects of particular heatwaves and frost events on the productivity of several crops, including wheat, beans, potatoes, onions, tomatoes, and clover (Table 5.4). For instance, some respondents have mentioned that due to heatwaves, the productivity of wheat decreased. More specifically, the wheat grains were “burnt” (or, in other words, were smaller and darker), and the stem becomes more fragile and easily broken in hot conditions. Some additional comments noted a decline in the milk production of livestock and an increase in infections with foot and mouth disease among cattle due to the warmer climate. Three cases have also reported losing huge numbers of chickens due to heatwaves.

Table 5.4: Respondents comments on the adverse impacts of climate variability

Item affected	Form of climate variability	Comments
Wheat production	Warmer climate / hotter temperature / heatwaves	A sharp decline in production
		"Burnt" and the grains are darker and smaller than normal
		Fragile stems / easily broken and burnt
	Irregular rainfall	Adversely affected wheat at harvesting stage
Rice production	Warmer climate / hotter temperature / heatwaves	Grains are darker and severely affected by heatwaves
Vegetable production (particularly tomatoes, onions, and potatoes)	Warmer climate / hotter temperature / heatwaves	A sharp decline in production
	Frost bouts / Cold spells	A sharp decline in production
	Not specified	Vegetables are specifically vulnerable to any minor changes in climate
Corn production	Warmer climate / hotter temperature / heatwaves	An increase in worm infestation
Clover production	Warmer climate / hotter temperature / heatwaves	Badly affected by heatwaves
Livestock and poultry production	Warmer climate / hotter temperature / heatwaves	A decline in milk production
		Increase in foot and mouth disease among cattle
		Huge losses / deaths among chickens due to heatwaves
Cotton Production	Warmer climate / higher temperature / heatwaves	A decline in production
Road quality	Irregular rainfall	Severely affected with rainfall
Soil quality	Less rainfall	Reduced quality of agricultural lands particularly where salinity prevails
Productivity of individuals	Warmer climate / hotter temperature / heatwaves	It was hard to work in hot weather Didn't complete the farming activities I was assigned to do and had to leave due to very hot weather

Source: Field survey 2018

To shed more light on the adverse impacts of climate variability, a farmer (interview 2, Kafr Saad) mentioned the following when being asked about any observed climate variability:

> *"Yes, definitely, the climate has changed, specifically the temperatures in the summer season. Cold spells also harm potatoes; for instance, the productivity of potatoes decreased by 50 percent in the last season. I am afraid that we would lose more in the upcoming years, even cattle are affected by the warmer weather.*

For me, I own and rent around 25 feddans. *My losses are severe, to clarify, during the previous cold spell, I lost 15,000 Egyptian pounds per* feddan *on potatoes".*

Another farmer adding more to the cold bouts (interview 1, Faraskur)

> *"Of course, we have experienced many climate variability incidences in our area. For instance, last winter season, we witnessed a severe cold spell that negatively affected clover and destroyed all of the potatoes crops I was cultivating".*

Another farmer (interview 3, Kafr Saad) stated:

> *"Yes, humidity and high heat. This variability in weather affects agricultural production, especially vegetables. Nowadays, it is not worth cultivating vegetables, and we don't get any profit from it; it barely gives back what we pay for. I think I would probably stop cultivating vegetables. To add more to that, last season, the weather destroyed the wheat crop; hot weather and lack of rainfall decreased the productivity by almost half. The productivity was 10-12* Ardab *per* feddan (1,500-1,800 Kg) *instead of 22-24* Ardab (3,300-3,600 Kg), *which is what we would normally get. What made the problem even worse, the selling price was very low, so I didn't sell it; I decided to feed the cattle with it".*

Another farmer (interview 5, Faraskur) speaking about his experience with climate variability and extremes mentioned:

> *"…….for instance, a severe heatwave happened in April of this year, negatively affecting the productivity of tomatoes, potatoes, and onions".*

Another farmer (interview 6, Faraskur) stated:

> *"I wish it would rain, instead of this bad water quality. It happens that we experience severe heat waves that destroy wheat, the grain dries and consequently affects productivity".*

Another farmer (interview 11, Faraskur) speaking about heatwaves and irregular rainfall stated:

> *"Very recently, it happened and affected wheat. Last year the productivity was 16* Ardab *per* feddan (2,400 Kg). *This year, the very high temperature decreased the productivity to 7* Ardab *only* (1,050 Kg). *Also, irregular rainfall adversely impacted on wheat spikes during the filling stage of the grains".*

In conclusion, the studied households have high levels of perception of climate change and associated risks linked to its adverse impact on agriculture and their livelihoods.

5.3 Households' perceptions of working in the agricultural sector

The agriculture sector in Egypt is already facing challenges that hinder its progression (MALR 2009); however, the extent to which rural households perceive such challenges is vital in explaining the real experienced situation of Egyptian agriculture from the local perspective. This section, therefore, outlines the opinions of the studied households about the agricultural sector and how they perceive of their work and reliance on the sector. As in Table 5.5, results revealed that most respondents or 58.3 percent are very likely or likely to experience income losses due to climate variability and extremes. This result was also reflected with the high level of perceptions of climate change and its risks, as mentioned earlier (Section 5.2). Approximately 46.0 percent of the cohort mentioned that it is very likely or likely to get poisoned due to the application of pesticides. On the contrary, 54.6 percent of all respondents mentioned that it is unlikely to experience accidents during commuting to and from their farms.

Table 5.5: Distribution of households by the likelihood of getting exposed to problems in the agricultural sector (n=350)

		Percentage		
		Very unlikely and unlikely	Neutral	Likely and very likely
Likelihood of	Income losses as a result of climate variability	25.1	16.6	58.3
	Poisoning as a result of applying pesticides	39.1	14.6	46.3
	Accidents during moving to or from farm	54.6	18.3	27.1

Source: Field survey 2018

For households who have one member or more working as a waged agricultural labourer (n=88), more than half of households (56.8 percent) mentioned that they are unlikely not to be paid for the work they had done (Table 5.6). In additional, 47.7 percent of households reported that it is unlikely to be paid less than what was agreed upon with the landlord. Finally, equal percentages of households mentioned that they were 'likely' and 'unlikely' not to find paid agricultural jobs easily, with 43.2 percent of respondents in each category.

Table 5.6: Distribution of households having members working as waged labourers by the likelihood of getting exposed to employment problems in the agricultural sector (n=88)

		Percentage		
		Very unlikely and unlikely	Neutral	Likely and very likely
Likelihood of	Not being paid for work	56.8	12.5	30.7
	Being paid less than was agreed upon	47.7	13.6	38.6
	Not finding paid agricultural roles easily	43.2	13.6	43.2

Source: Field survey 2018

As shown in Table 5.7, the majority of respondents disagreed with two statements outlining that wages of the agricultural sector are good relative to other sectors (44.9 percent), and that current agricultural policies are reinforcing and improving agriculture in Egypt (78.9 percent). There were nearly equal percentages of respondents who agreed (41.1 percent) and who disagreed (40.9 percent) that working in the agricultural sector is more secure and stable in comparison with other sectors. Finally, nearly half of the cohort (46.9 percent) agreed that the future of the Egyptian agricultural is uncertain. This result would indicate that many households are generally not content with working in the agricultural sector and are worried about their future livelihoods.

Table 5.7: Distribution of households by agreement with aspects of working in agriculture (n=350)

	Percentage		
	Strongly disagree and disagree	Neutral	Agree and strongly agree
Wages of agricultural labourers are relatively good in comparison with other sectors	44.9	21.1	34.0
Working in the agricultural sector is more stable and secure than other sectors	40.9	18.0	41.1
Current agricultural policies are reinforcing and improving the Egyptian agricultural situation	78.9	12.6	8.6
The future of agriculture in Egypt is uncertain	36.0	17.1	46.9

Source: Field survey 2018

To further illustrate the problem of wages in the agricultural sector, a farmer (interview 5, Faraskur) stated that:

> *"When we talk about the problem of labourers, as an example, the farmer sells one kilogram of strawberries for an average of 5 to 7 pounds, the labourer who is harvesting makes 2 pounds for every kilogram collected. From the farmers' viewpoint, the wages of labourers are high. If you calculate production costs, the farmer has to pay for labourers, pesticides application, water usage, and fertiliser. However, from the viewpoint of labourers, the wages are very low; paid labour from women makes 50 pounds per day and men 100 pounds per day. What will she do with 50 pounds and she works from 6 am to 11 am? So, it is a waste of money for both sides, for the farmer as he loses money because he has to pay for many other things, and for the labourer himself, as it wouldn't be sufficient for living".*

Another farmer (interview 8, Faraskur), also speaking about the wages, said:

> *"Waged labourers are available but expensive; for instance, if I want to bring a labourer to hoe the corn, he asks for a hundred pounds. The labourer works from 6 am to 8 am, i.e. two or two and a half hours at most and he wants 100 pounds. Yet, what would he do with 100 pounds? Living conditions are expensive for him as well".*

One farmer (interview 10, Kafr Saad) also added to the same issue:

> *"No one wants to work in agriculture; people think it is not worth working in the sector. The waged labourer works for 80 pounds per day; at the end of the day, he will get 2kg of rice with 20 pounds and think about the other expenses, like children, schools, and clothes. If someone works as a worker in the construction field, he makes about 150 pounds per day, do you think he will come work for me with 70?"*

As an initial conclusion, therefore, the results suggest that many households are likely to be exposed to loss of income due to climate variability and are generally not content either with working in the agricultural sector or with the policy structure in Egypt.

5.4 Perception of future risks related to the agricultural sector

This section introduces results focusing on household perceptions of future risks paired with their employment in the agricultural sector. Respondents were asked about what they considered the most significant threats to their businesses or work in agriculture in the next five years by identifying a level for each risk on a 10 point scale (0=no risk to 10=high risk). As Table 5.8 shows, about 56.4 percent have high levels of concern about future environmental degradation (soil erosion, desertification, salinisation) and about 60.0 percent of the cohort perceived higher future risks related to climate variability and extreme weather events.

The greatest threat that was perceived by 79.8 percent of respondents is the risk of financial stress and related consequences. About 60.0 percent of households had high levels of concerns about the future lack of governmental support, wage reduction and lower purchasing power, and risks of unemployment. Risks related to a decrease in demand for a household's crop production were also perceived to a high level by 45.9 percent of households. Finally, only 37.4 percent of households perceived that they could be at greater risk from the effects of large agricultural businesses or corporations. This low concern about the effects of large corporations on their small business could be related to the fact that companies, cooperatives, government, and other entities hold only 7.87 percent of total agricultural land areas in Egypt, which is equivalent to 766 thousand *feddans*. In comparison, individual household landholdings still represent 92.73 percent of the total cultivated land area, constituting an area of 8965 million *feddans* in the country (Aboulnaga et al. 2017). Therefore, rural household farms continue to represent the most important production structure in the Egyptian agricultural system, and hence respondents are not reflecting a high level of concern about the influence of large corporations on their farming businesses.

Regarding future threats linked to the deterioration of resources, 71.8 percent of households perceived high future risks from pressures of urban development, and 65.7 percent of the cohort had high levels of concern about the risk of water shortages from the River Nile in the future. Approximately 60.0 percent of households perceived future threats related to a decline in their capacity to access resources (electricity, fuel and land), while the risk of losing agricultural lands was perceived as important by 56.6 percent of the cohort.

Table 5.8: Distribution of households by perceptions of future risks in the agricultural sector

		Percentage			
		Low	Medium	High	Mean
Environmental related risks	Environmental degradation (soil erosion, desertification, salinisation) (n=321)	29.6	14.0	56.4	5.94
	Climate variability and extremes (n=320)	29.4	14.7	55.9	6.13
Economic and business-related risks	Reduction in demand for your production (n=320)	36.6	17.5	45.9	5.08
	Impacts of large agricultural businesses or corporations (n=302)	37.4	25.2	37.4	4.85
	Wage reduction or lower purchasing power (n=329)	26.7	14.9	58.4	6.35
	Lack of governmental support (n=326)	21.8	13.8	64.4	6.82
	Financial stress and related impacts (n=326)	8.0	12.3	79.8	7.88
	Unemployment (n=325)	27.4	15.1	57.5	5.94
Resources deterioration related risks	Shortage in Nile river water (n=329)	20.7	13.7	65.7	6.85
	Decrease of resources (electricity, fuel and land) (n=302)	24.7	16.3	59.1	6.38
	Loss of agricultural land (n=318)	29.6	13.8	56.6	5.93
	Urban development pressure (n=319)	16.0	12.2	71.8	7.22

Source: Field survey 2018

Results also suggest that again, there were no significant differences in perceptions of future agricultural risks between households living in Faraskur and those who live in Kafr Saad (Pearson Chi-square p=0.572) (Table 5.9). Therefore, households within the studied areas seem to be experiencing very similar levels of future risk related to the agricultural sector, including threats from climate variability and extremes.

Table 5.9: Distribution of overall household perceptions of future risks by central administration

			Low	Neutral	High	Total
	Faraskur	Count	18	78	74	170
		% within Local Unit	10.6	45.9	43.5	100.0
	Kafr Saad	Count	13	74	80	167
		% within Local Unit	7.8	44.3	47.9	100.0
Total		Count	31	152	154	337
		% within Local Unit	9.2	45.1	45.7	100.0

Source: Field survey 2018

Risks related to the deterioration of local natural resources have been of significant concern to several respondents, who commented on the above-mentioned future threats of agriculture in Egypt (Table 5.10). In this regard, some respondents emphasised the risks of water deficits. For instance, a farmer (interview 4, Faraskur) raised concerns about water shortages in the local area and mentioned:

> *"Currently, there is one general issue on Damietta's level, which is the water in relation to rice cultivation. We want to cultivate rice, and the water is deficient, that's why the government has decreased rice cultivation to reach 36 percent of the total cultivated land area this year … this is because of the "Renaissance Dam", and wait till it works with its full capacity, the area will be only 12 percent, and as a proof to what I say is that the government is planning to import all types of Indian rice".*

The deterioration of soil quality due to the excessive dependency on polluted water for irrigation was a major future concern to some respondents as well. Moreover, the imposed national rice policy has forced farmers to limit their rice cultivation and, therefore, raised further concerns about the deterioration of the soil quality where high levels of salinity prevail. Some other risks were related to lack of government support, high input prices, and the quality and availability of inputs.

Table 5.10: Respondents' most important open-ended comments on their perceived future risks within the agricultural sector

Future risks	
Economic and business-related risks	• High input prices • Low quality of pesticides • Lack of agriculture extension specialists • Lack of governmental support • Government doesn't provide enough agricultural inputs • Rice policy entailing cutting down areas cultivated with rice
Resources deterioration related risks	• Water deficiency • Weak policies will enforce farmers to produce less and build on lands • Residents should stop polluting the water canal as it affects crops
Environmental related risks	• Foot and mouth disease in cattle due to warmer climate • Desertification for lands as a result of irrigation from sewage water • The policy requiring no rice cultivation on coastal regions will increase soil salinity degrading lands • The land can't be cultivated with crops other than rice due to using sewage water and high salinity

Source: Field survey 2018

Again, an initial conclusion is that most of the studied rural households perceive of high levels of risk from future climate variability and extreme weather events. They also have high levels of concern about future economic losses and the deterioration of the natural resources base in the studied areas.

5.5 Introducing household groups based upon their income from agricultural activities

As discussed in Chapter 4, the majority of respondents work primarily as farmers or waged agricultural labourers. However, at the household level, there is a notable percentage of household members who work in other non-agricultural occupations. Although most households depend on more than one income source, dependency on agricultural activities to generate livelihoods varies from as low as 10 percent to 100 percent. This wide variation suggests variable levels of potential climate change vulnerability based on the recognition of the differences between households in terms of their reliance on farming activities and the percentage of income coming from this sector. By grouping households into three groups based upon the contribution of agricultural activities to the total income of the household, the levels of perceived risk and opportunities for adaptation were analysed further. The three groups are as follows:

1. **Group 1** includes those households that have one or more sources of income, and income from agricultural activities represent less than 50 percent of their total income. Meaning that for Group 1 households, agricultural activities are not the primary source of income.
2. **Group 2** involves households whose income is largely dependent on agricultural activities, contributing from 50 to less than 95 percent of their total income. Although farming activities for those households are considered to be important income-generating activities, they still have at least one other source of income that could balance or compensate any losses or failures they are or will potentially encounter within the agricultural sector.
3. **Group 3** encompasses households who are almost wholly dependent on agricultural activities for their livelihood, including subsistence food production, and where income from agricultural activities represents 95 percent or more of their total income. Hence, working in agriculture is a vital component of their livelihood.

This categorisation into three groups helps to generate an understanding of the key (social, economic and cultural) differences between rural households. It also allows the author to elaborate on how different groups of farmers perceive climate change. The three groups could be considered a reflection of the model of agrarian transition or agricultural transformation explained broadly in Chapter 2 (Section 2.2). During this process, societies pass through a process from being an agricultural-based country to a developed or industrialised country (World Bank 2015; Barrett, Christian & Shiferaw 2017). A vital characteristic of the agricultural transformation of societies is that the financial and labour resources increasingly flow out of the agricultural sector and into other non-farm sectors (Timmer 1988).

At the micro-level analysis presented in this study, the three groups of households could be seen to reflect the first three stages of a labour transition in relation to the agricultural transformation presented by the World Bank (2015): from chiefly agricultural-based economies which represent Group 3 in this case; to a pre-transition or transition group (i.e. Group 2); to a group more typical of an urbanising or late-transition economy (Group 1). Group 1 (n=75) represents 21.4 percent of the interviewed households; Group 2 (n=151) represents the majority of households at 43.1 percent; Group 3 (n=124) includes 35.4 percent of households, and these people depend almost solely on agriculture as the primary source of their income (Table 5.11).

Table 5.11: Distribution of households by income from agricultural activities

		Frequency	Percentage
Group	**1** <50 %	75	21.4
	2 50–95 %	151	43.1
	3 ≥95 %	124	35.4
	Total	350	100.0

Source: Field survey 2018

Most respondents (generally the heads of the households), or 71.7 percent, within Group 1 work in highly skilled and semi-skilled non-agricultural sectors, whereas almost all respondents in Group 3 are working as farmers and waged labourers. About 66.0 percent of respondents within households in Group 2 are farmers and waged-labourers, while around a quarter work in highly skilled non-agricultural occupations (Table 5.12). Results from Pearson Chi-square test revealed no significant difference (p=0.693) in the distribution of household heads or respondents across the different occupation groups living in the two studied administrations (Table 5.13). This lack of distinction between the two places further supports a focus on the differences in household types based on the contribution of the agricultural sector to their livelihoods.

Table 5.12: The distribution of agricultural dependence groups by the respondents' primary occupations in Damietta

			The primary occupation of respondent				
			Farmers and waged labourers	Unskilled non-agricultural occupations	Semi-skilled non-agricultural occupations	Highly-skilled non-agricultural occupations	Total
Income from agriculture by Group	1 <50 %	Count	5	8	23	35	71
		% within	7.0	11.3	32.4	49.3	100.0
	2 50–95 %	Count	96	5	9	36	146
		% within	65.8	3.4	6.2	24.7	100.0
	3 ≥95 %	Count	114	1	0	0	115
		% within	99.1	0.9	0.0	0.0	100.0
Total		Count	215	14	32	71	332
		% within	64.8	4.2	9.6	21.4	100.0

Source: Field survey 2018

Table 5.13: The distribution of households living in the two studied areas by the respondents' primary occupations in Damietta

			The primary occupation of respondent				
			Farmers and waged labourers	Unskilled non-agricultural occupations	Semi-skilled non-agricultural occupations	Highly-skilled non-agricultural occupations	Total
Local Adminis tration	Faraskur	Count	115	7	19	43	184
		% within	62.5	3.8	10.3	23.4	100.0
	Kafr Saad	Count	100	7	13	28	148
		% within	67.6	4.7	8.8	18.9	100.0
Total		Count	215	14	32	71	332
		% within	64.8	4.2	9.6	21.4	100.0

Source: Field survey 2018

5.5.1 Agricultural dependency and perceptions of climate variability and extremes

Agriculture is an activity that is particularly sensitive to climate change (Parry & Carter 1989; Smit & Skinner 2002). Hence, it is of great importance to understand the differences present across the three household groups in perceiving climate change, and the social and economic differences that would contribute to shaping their perceptions. To do so, the Kruskal–Wallis test was used to analyse the strength of differences among the three groups in perceiving climate variability and extremes (Table 5.14). Households in Group 3, comprising those who are wholly dependent on the agricultural sector for their livelihood, have a higher perception of the adverse impacts of climate variability and extremes than the other two groups (K–W p=<0.001). Group 3 also perceived increased incidences of climate variability and extreme weather than Group 1 (K–W p=0.023). This heightened perception of climate change could be a result of their high dependence on and work within the climate-dependent agricultural sector, where any minor climate stress could be considered a significant potential threat to their livelihood conditions.

Table 5.14: Agricultural dependence groups' mean rankings of household perceptions of climate change

	< 50%		50-95 %		≥95 %		**Kruskal–Wallis (K–W) significance level (p)**
	Group 1 (mean)	Group 1 (mean rank)	Group 2 (mean)	Group 2 (mean rank)	Group 3 (mean)	Group 3 (mean rank)	
Overall perception of adverse impacts of climate variability	5.33	144.42^{a}	5.32	141.46^{a}	6.14	**184.59**^{b}	<0.001
Frequency of experiencing climate variability and extremes in a year	4.00	125.76^{a}	4.51	133.20^{a,b}	4.57	**156.92**^{b}	0.023

Pairwise statistical difference between groups at 0.05 significance level is indicated with the use of ^{a,b,c}. Different letters indicate a significant difference between groups. Groups with the same letter are not significantly different.

To help to discuss these results in more detail, Table (5.15) shows the differences between groups in their experiences with and perceptions of the adverse effects of climate variability and extremes on agriculture and other livelihood conditions. Group 3 has higher mean ranks of perceived climatic impacts on crop productivity (K–W p=<0.001), crop quality (K–W p=< 0.001), livestock productivity (K–W p=<0.001), health conditions (K–W p=0.001) and individuals' or labourers' productivity (K–W p=0.003), in comparison with the other two groups. Furthermore, households in Group 3 also have a higher perception of climate variability and extremes on soil fertility and quality (K–W p=0.001), income (K–W p=0.004) and the amount of time spent on agricultural operations (K–W p=0.001) than households in Group 2. Again, the perceived exposure of agricultural systems to climate change could be a result of their lack of options in diversifying their income and their high engagement in agricultural activities. Accordingly, it appears that respondents from households in Group 3 generally have higher perception levels of climate change adverse impacts and perceive that their livelihoods are more vulnerable to its impacts.

Table 5.15: Agricultural dependence groups' mean rankings of household perceptions of climate variability and extremes adverse impacts

Perception of the adverse impacts of climate variability and extremes on:	< 50%		50-95 %		≥95 %		**Kruskal–Wallis (K–W) significance level (p)**
	Group 1 (mean)	Group 1 (mean rank)	Group 2 (mean)	Group 2 (mean rank)	Group 3 (mean)	Group 3 (mean rank)	
Crop productivity	6.87	145.37[a]	6.70	133.95[a]	8.18	**192.37**[b]	<0.001
Crop quality	6.54	149.81[a]	6.44	135.70[a]	7.81	**187.74**[b]	<0.001
Livestock productivity	5.83	137.80[a]	6.20	137.17[a]	7.71	**193.36**[b]	<0.001
Soil fertility or land quality	5.04	155.49[a,b]	4.33	136.90[a]	5.98	**182.98**[b]	<0.001
Income	6.70	148.12[a,b]	6.77	143.66[a]	7.44	**179.91**[b]	0.004
Health conditions	5.67	140.34[a]	5.97	145.70[a]	6.89	**182.33**[b]	0.001
Productivity of individuals or labourers	6.46	139.97[a]	6.89	147.43[a]	7.50	**180.64**[b]	0.003
Amount of time spent on agricultural activities	6.66	151.16[a,b]	6.59	140.11[a]	7.44	**182.02**[b]	0.001

Pairwise statistical difference between groups at 0.05 significance level is indicated with the use of [a,b,c]. Different letters indicate a significant difference between groups. Groups with the same letter are not significantly different.

5.5.2 Household group perceptions of employment in the agricultural sector

This section addresses the differences between the three household groups in relation to their perceptions of working in the agricultural sector. Results from the Kruskal–Wallis test (Table 5.16) show that households in agriculturally-dependent Group 3 have a higher mean rank for the likelihood of experiencing income or crop losses as a result of climate variability and extremes (K–W p=>0.001), and the possibility of being poisoned by the application of pesticides (K–W p=>0.001) when compared with the other two groups. Respondents in Group 1, in general, work primarily in non-agricultural occupations and therefore, many did not respond to these questions.

Table 5.16: Agricultural dependence groups' mean rankings of household perceptions of working in agriculture

		< 50%		50-95 %		≥95 %		Kruskal–Wallis (K–W) significance level (p)
		Group 1 (mean)	Group 1 (mean rank)	Group 2 (mean)	Group 2 (mean rank)	Group 3 (mean)	Group 3 (mean rank)	
The likelihood of	Exposure to losses in income or work opportunity due to climate variability	6.13	169.33[a]	5.49	148.87[a]	7.42	**211.66[b]**	>0.001
	Getting poisoned because of pesticides application	4.19	137.69[a]	4.74	153.29[a]	7.15	**225.42[b]**	>0.001
Agreement with the future of agriculture in Egypt is uncertain		5.89	184.93[a]	4.56	**146.82[b]**	6.59	204.72[a]	>0.001

Pairwise statistical difference between groups at 0.05 significance level is indicated with the use of [a,b,c]. Different letters indicate a significant difference between groups. Groups with the same letter are not significantly different.

Results also revealed that there is a significant difference among the three groups in their agreement with the statement about the uncertainty of the future of agriculture in Egypt, with Group 2 having a lower mean than the other two groups (K–W p=>0.001). This result suggests that households in Group 2 which are still strongly involved in the sector, but not wholly dependent upon it, are more optimistic about the future of Egyptian agriculture.

5.5.3 Agricultural dependency and perceptions of future risks in the agricultural sector

It is perhaps unsurprising that the overall perception of future agriculture-related risks is higher amongst households highly dependent on farming activities for their livelihood. Households in Group 3 have a higher mean rank of their perception of future risks (K–W p=<0.001) than the other two groups (Table 5.17). They also have significant doubts about their future economic conditions and the sustainability of the natural resources they have access to. In particular, households in Group 3 perceived higher future risks linked to climate variability and extremes (K–W p=<0.001) than Group 2. In addition, the mean ranks of the perceived future potential decline in resources (K–W p=0.004) and environmental degradation (K–W p=0.004) were higher among households in Group 3 than those in Groups 1 or 2.

The perceived risks of the reduction of the future demand for their produce (K–W p=<0.001), wage reduction or lower purchasing power (K–W p=<0.001), unemployment (K–W p=<0.001), and lack of government support (K–W p=0.005) were found to be higher among households in Group 3, than Groups 1 or 2. Agricultural dependent households also seem to have more concerned about future financial stress than households in Group 2 (K–W p=0.002). This result could be due to their less-diversified income and high dependency on working in a sector that is characterised by low wages, unstable income, poor health and safety regulations and declining natural resource conditions (Powell et al. 2006; Hurst et al. 2007). Finally, households in Group 3 are more likely to perceive future risks of losing their farmlands (K–W p=0.002) and threats linked to shortages in the Nile river water (K–W p=0.003) than Group 2. In conclusion, households in Group 3 have higher levels of concern regarding their future economic and livelihood conditions.

Table 5.17: Agricultural dependence groups' mean rankings of household perceptions of future risks within the agricultural sector

Perception of future risks	< 50%		50-95%		≥95%		**Kruskal–Wallis (K–W) significance level (p)**
	Group 1 (mean)	Group 1 (mean rank)	Group 2 (mean)	Group 2 (mean rank)	Group 3 (mean)	Group 3 (mean rank)	
Climate variability and extremes	5.87	152.63[a,b]	5.64	146.10[a]	7.00	**185.95[b]**	<0.001
Environmental degradation (soil erosion, desertification, salinisation)	5.21	141.86[a]	5.72	152.78[a]	6.73	**184.99[b]**	0.004
Wage reduction or lower purchasing power	5.44	137.33[a]	5.88	149.56[a]	7.54	**202.67[b]**	<0.001
Reduction in demand for your produce	3.74	130.49[a]	4.90	153.81[a]	6.20	**190.31[b]**	<0.001
Lack of government support	6.36	149.48[a]	6.58	152.44[a]	7.43	**186.78[b]**	0.005
Nile river water shortages	6.64	158.11[a,b]	6.37	150.09[a]	7.60	**188.88[b]**	0.003
Decrease of resources (electricity, fuel, land)	5.91	146.40[a]	6.06	149.50[a]	7.09	**184.36[b]**	0.004
Financial stress and related impacts	7.59	158.04[a,b]	7.60	147.36[a]	8.43	**188.30[b]**	0.002
Loss of the agricultural lands	5.69	154.43[a,b]	5.48	143.73[a]	6.70	**184.28[b]**	0.002
Unemployment	5.17	144.89[a]	5.57	147.89[a]	6.93	**194.47[b]**	<0.001
Overall perception of future risks	5.80	147.48[a]	5.96	152.77[a]	7.08	**202.93[b]**	<0.001

Pairwise statistical difference between groups at 0.05 significance level is indicated with the use of [a,b,c]. Different letters indicate a significant difference between groups. Groups with the same letter are not significantly different.

5.5.4 The socio-economic conditions of household groups

This section focuses on the differences between the three groups with differing dependence on agriculture in relation to a range of social and economic variables. As shown in Table 5.18, results from Kruskal–Wallis test revealed that there is a significant difference between the three groups in the total land area (owned, rented, shared), with Group 2 (agricultural sector contributes from 50 percent to less than 95 percent household income) having a higher mean rank in comparison with Groups 1 and 3 (K–W p=>0.001). This result also gives an indication of the importance of agricultural and non-agricultural activities to this group. In the case of Group 2, the non-agricultural income may be assisting in providing the financial capital needed to manage their agricultural businesses, which still contribute to a large part of their income, and could be working as a safeguard from any potential losses in agriculture, and vice versa.

Table 5.18: Agricultural dependence groups' mean rankings of demographic and economic conditions

	< 50%		50-95%		≥95%		Kruskal–Wallis (K–W) significance level (p)
	Group 1 (mean)	Group 1 (mean rank)	Group 2 (mean)	Group 2 (mean rank)	Group 3 (mean)	Group 3 (mean rank)	
Total land area	1.63	121.31^{a}	3.35	**207.95**^{b}	2.36	168.76^{c}	>0.001
Age of the respondent	46.46	140.56^{a}	53.76	**201.87**^{b}	49.09	164.52^{a}	>0.001
Years of education of the respondent	11.08	**233.51**^{a}	7.46	178.94^{b}	5.06	**136.22**^{c}	>0.001
Number cows or buffalos owned by the HH	2.11	129.63^{a}	4.18	**201.69**^{b}	3.04	169.90^{c}	>0.001
Total number of employed members	1.6	180.79^{b}	1.8	167.16^{b}	1.34	**145.93**^{a}	>0.001
Total number of employed HH members in agriculture	0.13	78.82^{a}	0.74	171.62^{b}	1.27	**238.70**^{c}	>0.001
Total monthly expenditure	6123.66	201.69^{a}	5006.16	**153.73**^{b}	5803.1290	186.17^{a}	0.001

Pairwise statistical difference between groups at 0.05 significance level is indicated with the use of ^{a,b,c}. Different letters indicate a significant difference between groups. Groups with the same letter are not significantly different.

The mean rank of the years of education of the respondents is higher in Group 1 than in Groups 2 and 3 (K–W p=>0.001). Higher educational attainment could directly help explain the reason for their access to non-agricultural activities for a living, with more positions in business or professional, highly–skilled jobs. Most of the households in this group have higher degrees, and they are more likely to work in professional occupations that fit with their degrees in other sectors, even if they maintain a small interest in agriculture. Even if they have a degree in agricultural sciences, they are likely to prefer to work as a governmental official or establish a private business. Respondents in Group 3 have the lowest mean rank of years of formal education and hence are the least educated. Moreover, Group 3 was found to have a smaller number of employed members, either in the agricultural or non-agricultural sectors, in comparison to the other two Groups (K–W p=>0.001). The number of household members employed in the agricultural sector was found to be higher among households in Group 3 in comparison with Group 1 or 2 (K–W p=>0.001).

The mean rank of the respondent age was also highest in Group 2 in comparison with the other two groups (K–W p=>0.001). This relative old age of respondents, who were generally the head of the household, could indicate that household heads in Group 2 have more accumulated experience in farming activities. Also, there is a significant difference between the three groups in asset acquisition, represented in the number of cows or buffaloes owned by each household category, where Group 2 has a higher mean rank than the other two groups (K–W p=>0.001). Households in Group 2 possess an average of 4 cows or buffaloes, which means that they have also acted to diversify their income sources within the agricultural sector to generate income from both crop and animal production, suggesting again that households in Group 2 are a group of relatively wealthy landowners.

This argument seems to be supported by another significant difference that was found in the expenditure/income of households among the three groups. Households in Group 2 have lower monthly expenditure in comparison to the other two groups (K–W p=0.001). This result might suggest that households in this group could be effectively managing their agricultural business, and saving money, especially that they have other sources for non-farm income, bigger farmland areas, and more assets (i.e. cows and buffaloes). This result is further clarified by analysing each expenditure item for each group of households (Table 5.19). Households in Group 1 were found to be spending more money on food (K–W p=0.002) and clothes (K–W p=0.001) in comparison with the other two groups. Less reliance on farming activities could be a reason for their relative high expenditure on food as the farmland they possess might not be providing sufficient. Households in Group 1 also have a higher mean rank of expenditure on education (K–W p=0.018) and gas (K–W p=>0.001) than households in Group 2. Households in Group1 are mainly engaged in highly-skilled non-agricultural professions, which might be a reason for their high spending on education. They are encouraging the younger members of their households to continue their education which could guarantee them a better future in non-agricultural occupations. On the contrary, households in Group 3 were found to be spending more money on health (K–W p=>0.001) and house rent (K–W p=0.009) than households in Group 2. All households in Group 2 (except for one household) own their houses, whereas about 8 percent of households in Group 3 are renting their homes, which clarifies the relatively high figure for expenditure on house rents. Moreover, households in Group 3 are more exposed to health trade-offs linked to farming activities, such as pesticide application and frequent exposure to polluted water, which could justify the more spending on health. Households in Group 3 also have the highest mean rank of expenditure on the water than those households in both other groups, perhaps due to the remotely-located houses in Group 3 households raising the costs of water delivery.

Table 5.19: Agricultural dependence groups' mean rankings of household expenditure items

	< 50%		50-95%		≥95%		Kruskal–Wallis (K–W) Significance level (p)
	Group 1 (mean)	Group 1 (mean rank)	Group 2 (mean)	Group 2 (mean rank)	Group 3 (mean)	Group 3 (mean rank)	
Expenditure on food	2742.6	**210.61**[a]	2260.9	168.48[b]	2171.0	162.82[b]	0.002
Expenditure on clothes	610.9	**212.99**[a]	374.9	162.25[b]	396.0	168.96[b]	0.001
Expenditure on health	484.7	177.92[a,b]	364.7	146.61[a]	660.0	**209.22**[b]	>0.001
Expenditure on education	681.1	**198.51**[a]	502.1	160.22[b]	715.4	180.19[a,b]	0.018
Expenditure on gas	114.5	**180.07**[a]	107.0	143.68[b]	137.7	211.48[a,b]	>0.001
Expenditure on house rent	43.3	177.45[a,b]	0.26	169.11[a]	56.9	**182.10**[b]	0.009
Expenditure on water	84.1	172.74[a]	76.9	149.99[a]	135.2	**208.23**[b]	>0.001

Pairwise statistical difference between groups at 0.05 significance level is indicated with the use of [a,b,c]. Different letters indicate a significant difference between groups. Groups with the same letter are not significantly different.

Regarding social participation of the households (as shown in Table 5.20), those in Group 2 are likely to be more actively participating in social activities that require more formal networks represented in the discussions on public affairs in the village (K–W p=0.002), organising public activities in the area (K–W p=>0.001) and attending local community events (K–W p=0.001). However, they are less likely to give advice to other villagers in comparison with Group 3 households (K–W p=0.043). Group 3 households are more likely to participate in solving conflicts, if any, between other villagers than the other two groups (K–W p=>0.001). Moreover, households in Group 2 were significantly less likely to have asked for help in the year before the survey (K–W p=>0.001), and have relatively poorer relationships with their relatives (K–W p=>0.001), neighbours and other villagers (K–W p=>0.001). These results could indicate that households in Group 2 are more dependent on formal social networks than the informal ones, given their high participation and involvement in social activities. In general, households of Group 3 have the least mean rank in their overall social participation (K–W p=0.045) in comparison to the other two groups. Although their relationship with informal social networks seems to be more developed, households in Group 3 are less involved in informal social activities.

Table 5.20: Agricultural dependence groups' mean rankings of social participation and relationships

	< 50%		50-95%		≥95%		Kruskal–Wallis (K–W) Significance level (p)
	Group 1 (mean)	Group 1 (mean rank)	Group 2 (mean)	Group 2 (mean rank)	Group 3 (mean)	Group 3 (mean rank)	
The number of times you asked for help in the past year	43.26	124.60^{a}	9.28	**78.88**^{b}	16.95	133.54^{a}	.000
Rate the relationship with your relatives	9.09	191.33^{b}	8.62	**152.15**^{a}	9.23	194.36^{b}	>0.001
Rate the relationship with neighbours and village fellows	8.72	188.84^{b}	8.11	**148.76**^{a}	9.10	199.99^{b}	>0.001
Participation in discussing local public affairs	4.64	166.74^{a,b}	5.81	**196.68**^{a}	4.36	155.01^{b}	0.002
Participation in organizing public activities	3.72	170.23^{b}	4.87	**204.9**^{a}	2.83	142.87^{b}	>0.001
Participation in giving advice to other villagers	6.71	169.50^{a,b}	6.80	163.80^{a}	7.32	**193.37**^{b}	0.043
Participation in solving conflicts between others	6.79	167.06^{a}	6.64	154.60^{a}	7.84	**206.06**^{b}	>0.001
Participation in attending local community events	3.68	173.00^{a,b}	4.17	**197.13**^{a}	2.89	150.67^{b}	0.001
Overall social participation	5.11	166.49^{a}	5.7	190.83^{a}	5.04	**162.28**^{b}	0.045

Pairwise statistical difference between groups at 0.05 significance level is indicated with the use of ^{a,b,c}. Different letters indicate a significant difference between groups. Groups with same letter are not significantly different.

There are significant differences between respondents within household groups who were members of syndicates (Pearson Chi-squared p=>0.001), or farming organisations and unions (Pearson Chi-squared p=>0.001). There are large minorities of 45.3 percent of respondents in Group 1 and 37.7 percent in Group 2 who are members of syndicates, while almost no respondents in Group 3 are members of syndicates (Table 5.21).

Table 5.21: Distribution of agricultural dependence groups by respondent's membership in syndicates

			Are you a member of any syndicate		
			Yes	No	Total
Income from agriculture by Group	**1** <50 %	Count	34	41	75
		% within	45.3	54.7	100.0
	2 50–95 %	Count	57	94	151
		% within	37.7	62.3	100.0
	3 ≥95 %	Count	5	119	124
		% within	4.0	96.0	100.0
Total		Count	96	254	350
		% within	27.4	72.6	100.0

Source: Field survey 2018

Close to 17.0 percent of respondents in Group 2 are members of one or more farming organisations or unions, while most respondents within the other two groups are not (Table 5.22).

Table 5.22: Distribution of agricultural dependence groups by respondent's membership in farmers' organisations or unions

			Membership in any farmers organisations or unions		
			Yes	No	Total
Income from agriculture by Group	**1** <50 %	Count	1	74	75
		% within	1.3	98.7	100.0
	2 50–95 %	Count	26	125	151
		% within	17.2	82.8	100.0
	3 ≥95 %	Count	2	122	124
		% within	1.6	98.4	100.0
Total		Count	29	321	350
		% within	8.3	91.7	100.0

Source: Field survey 2018

These results suggest that there is a significant percentage of households within Group 2 who have connections to several formal bodies and organisations and hence, could have a disproportionate influence on local decision-making on agricultural issues, including such decisions that influence their adaptive capacity. This result could also be directly related to having relatively large farmlands, as individuals who have relatively large land areas would hold or acquire more power through their relative wealth, or *vice versa*, and hence are more likely to be actively participating in local community politics and have strong connections with formal organisations.

Regarding housing and living conditions for the households in the study area, Group 3 has higher mean ranks than the other two groups regarding the distance between their houses and the nearest primary school (K–W p=>0.001), medical unit (K–W p=>0.001), market (K–W p=>0.001) or main road (K–W p=>0.001) (Table 5.23). Individuals in Group 3 are more likely to take longer to reach their farms or workplaces (K–W p=0.016). This result suggests that these households are more likely to be sited in more remote areas, which may infer that they are more likely to be marginalised from core social and natural resources.

Table 5.23: Agricultural dependence groups' mean rankings of housing and other living conditions in the study area

	< 50%		50–<95 %		≥95 %		Kruskal–Wallis (K–W) significance level (p)
	Group 1 (mean)	Group 1 (mean rank)	Group 2 (mean)	Group 2 (mean rank)	Group 3 (mean)	Group 3 (mean rank)	
Satisfaction with local health services	2.75	153.71^{a}	4.10	**201.87**^{b}	2.81	156.56^{a}	>0.001
Number of rooms in the house	3.43	197.18^{a,b}	3.57	**191.29**^{a}	3.12	154.05^{b}	0.004
Distance to nearest primary school (kilometres)	1.03	172.71^{a,b}	0.94	148.12^{a}	1.38	**204.98**^{b}	>0.001
Distance to nearest medical unit (kilometres)	1.42	153.39^{a}	1.33	150.79^{a}	2.38	**212.00**^{b}	>0.001
Distance to nearest market (kilometres)	1.79	150.37^{a}	1.76	145.75^{a}	3.13	**207.21**^{b}	>0.001
Distance to main road (kilometres)	0.66	164.99^{a}	0.80	151.42^{a}	1.51	**202.62**^{b}	>0.001
Satisfaction with the house	7.96	186.00^{a,b}	7.98	**186.88**^{a}	7.35	155.29^{b}	0.019
Satisfaction with local refuse removal	3.20	162.68^{a}	4.31	**196.89**^{b}	2.94	157.21^{a}	0.002
Rate product selling in past 5 years	5.39	133.17^{a}	6.71	**173.81**^{b}	6.05	154.67^{a,b}	0.008
Degree of job satisfaction	7.51	181.44^{a}	7.23	172.78^{a,b}	6.55	**146.39**^{b}	0.022
Time taken to reach work (in minutes)	22.98	170.98^{a,b}	18.81	146.23^{a}	26.44	**178.14**^{b}	0.016

Pairwise statistical difference between groups at 0.05 significance level is indicated with the use of ^{a,b,c}. Different letters indicate a significant difference between groups. Groups with the same letter are not significantly different.

In addition, there is a significant difference between groups in the degree of satisfaction with their houses (K–W p=0.019) and the number of rooms in them (K–W p=0.004), where members of Group 3 are less satisfied with their houses, which have fewer rooms in comparison with Group 2. Households in Group 2 are also more likely to be satisfied with health services provided in their village (K–W p=>0.001), and with local refuse removal (K–W p=0.002) than households in the other two groups. Finally, the respondents of households in Group 3 are less satisfied with their occupations compared to those in Group 1, who work primarily in non-agricultural occupations (K–W p=0.022).

As shown in Table 5.24, households in Group 3 were found to be highly dependent on family members for most of the agricultural operations, including land preparation (K–W p=0.003), planting (K–W p=0.003), irrigation (K–W p=>0.001), crop operations (K–W p=>0.001) and harvesting (K–W p=0.001) in comparison to those in Group 1.

Table 5.24: Agricultural dependence groups' mean rankings of household reliance on unpaid/paid labourers for agricultural operations

	< 50%		50- 95 %		≥95 %		Kruskal–Wallis (K–W) significance level (p)
Percentage of dependency on	Group 1 (mean)	Group 1 (mean rank)	Group 2 (mean)	Group 2 (mean rank)	Group 3 (mean)	Group 3 (mean rank)	
Family members in land preparation	26.59	131.33[a]	34.39	162.19[a,b]	42.17	**180.18**[b]	0.003
Family members in planting	27.46	132.08[a]	35.41	161.44[a,b]	44.20	**180.74**[b]	0.003
Family members in irrigation	49.57	124.72[a]	67.82	153.66[a]	84.76	**196.32**[b]	>0.001
Family members in crop operation	41.67	135.29[a]	44.2	144.19[a]	71.93	**202.57**[b]	>0.001
Family members in harvesting	23.77	137.08[a]	26.40	155.29[a]	36.93	**186.01**[b]	0.001
Paid agricultural labour in irrigation	45.29	194.01[a]	29.42	168.89[a]	14.29	**130.08**[b]	>0.001
Paid agricultural labour in crop operation	51.45	178.31[a]	53.23	181.60[a]	26.70	**122.68**[b]	>0.001
Paid agricultural labour in harvesting	69.06	**176.27**[a]	70.27	168.80[a,b]	59.95	**141.76**[b]	0.023

Pairwise statistical difference between groups at 0.05 significance level is indicated with the use of [a,b,c]. Different letters indicate a significant difference between groups. Groups with the same letter are not significantly different.

Although households in Group 1 have a smaller mean area of farmland, their dependency on paid agriculture labourers is higher than those in Group 3, particularly in crop operations (i.e. pesticides or application of fertilisers, etc.) (K–W p=>0.001), irrigation (K–W p=>0.001) and harvesting (K–W p=0.023). This high reliance on paid labourers might suggest that households in Group 1 are more reluctant to participate even in basic agricultural activities like irrigation and crop operations. Their reluctance to participate in farming activities could be a result of working primarily in non-agricultural sectors and hence, have much less time available to spend farming that already contributes to less than 50 percent of their living.

There are also some significant differences between the three household groups concerning their satisfaction with several aspects of the agricultural situation in the study areas (Table 5.25). Group 3 has the highest mean ranks in the satisfaction with the availability of agricultural input (fertilizers, pesticides etc.) (K–W p=>0.001) and quality (K–W p=0.002); in comparison to Group 2, Group 3 householders also have the highest mean rank regarding their satisfaction with the quality of the agricultural drainage system (K–W p=0.003) and with the general agricultural situation in Egypt (K–W p=>0.001), compared to the other two groups. However, Group 3 is less satisfied with the prices of the different agricultural inputs (K–W p=0.036) in comparison to Group 2.

Table 5.25: Agricultural dependence groups' mean rankings of aspects related to the satisfaction with the agricultural situation in the study area

	< 50%		50- 95 %		≥95 %		Kruskal–Wallis (K–W) significance level (p)
Satisfaction with	Group 1 (mean)	Group 1 (mean rank)	Group 2 (mean)	Group 2 (mean rank)	Group 3 (mean)	Group 3 (mean rank)	
Agricultural inputs availability	7.00	167.49^{a,b}	5.84	135.49^{a}	7.39	**192.45**^{b}	>0.001
Agricultural inputs prices	2.72	159.88^{a,b}	2.75	**173.84**^{a}	2.00	143.75^{b}	0.036
Agricultural inputs quality	5.87	159.14^{a,b}	5.39	144.47^{a}	6.53	**185.37**^{b}	0.002
Agricultural drainage system quality	6.16	149.98^{a}	6.03	148.12^{a}	6.98	**186.27**^{b}	0.003
The agricultural situation in general	2.33	126.80^{a}	3.07	157.20^{a}	4.24	**188.80**^{b}	>0.001

Pairwise statistical difference between groups at 0.05 significance level is indicated with the use of ^{a,b,c}. Different letters indicate a significant difference between groups. Groups with same letter are not significantly different.

These findings suggest that although respondents in Group 3 are not satisfied with their occupation as farmers and waged labourers, and have relatively poor housing conditions and lower social participation and connections, their satisfaction with the agricultural situation is still relatively high, possibly because it is all that they know. In other words, this could result from their relatively low educational attainment and their high dependency on agriculture for a living. Hence, their opportunities for exposure to different external occupations are limited, having little chance of comparing their lifestyles with those of others.

5.7 Summary

Rural households in the study area were found to experience great climate variability. The most observed patterns of climate variability are related to a higher temperature and more frequent heatwaves, in addition to experiences with changes in rainfall patterns and cold spells. Such increasing variability in climatic conditions was also found to be having negative impacts upon the agricultural productivity of crops and livestock in Damietta, which in turn had adverse influences on the income and other living conditions of the sampled households. Most households perceive of increasing risks linked to climate variability and extremes, and environmental degradation. Perceptions of future risks were also high when looking at financial stress, unemployment, lack of government support, urban development pressure, water deficiency and the deterioration of the local resources.

It was found that there were no significant differences in the perceptions of climate variability and other future risks across the two studied local administrations. Stemming from this result and guided by the insights of the phases of agrarian transition, three groups of households were proposed based upon the contribution of farming or agricultural activities to their overall income. A focus on the classification of households according to their dependency on agriculture to generate their livelihoods could help to reflect the differences in the needs and levels of vulnerability within agrarian communities. Significant differences were identified between the three groups of households in relation to their perceptions of climate change and other future risks related to Egyptian agriculture. It was found that households in Group 3, whose livelihoods are vitally dependant on agriculture, were more likely to experience and perceive climate variability and have more concerns about the future of agriculture in Egypt than those in Groups 1 and 2, who were less dependent on agriculture. Household heads in Group 3 were found to have lower social participation and educational attainment, and their households live in smaller and remotely-located houses – again, issues that are likely to limit their adaptive capacities to climate change.

Chapter Six: Households' adaptation to climate variability and extremes in Damietta

6.1 Introduction

Egypt has been experiencing increased climate variability and extreme weather events over the recent past, and those climate changes are expected to get worse in the future (Saber 2009; Met Office et al. 2011; Seyam 2011; Hereher 2016; Nashwan, Shahid & Abd Rahim 2018). Such conditions are adversely affecting agriculture and are threatening the livelihood of households who are dependent on the agricultural sector for subsistence or sales. Adaptation is hence crucial to overcome the adverse effects of climate change and to protect the livelihood of rural dwellers, and reduce the vulnerabilities of rural communities.

This chapter describes how the rural households studied adapt to climate variability and extreme weather events. It addresses both their agro-based livelihood strategies, together with other strategies involving alterations in the livelihood options of rural households. It also discusses in more detail the specific coping strategies used by households in overcoming the risks paired with sudden shocks generated by the extreme weather events that occurred in the two years that preceded the survey. Following the general discussion about adaptation, the influence of households' socio-economic characteristics upon their level of adaptation and choices for adaptation is then addressed. Since mobility can be considered one means of adaptation to environmental change (Bardsley & Hugo 2010), the chapter also focuses on the current migration patterns of the households studied, and whether migration as an adaptation choice for the different groups of households could be considered as being effective. Moreover, analytical emphasis is placed on household cultures of migration, which is vital in understanding their potential decisions to move, particularly in cases of current and future variability in climate. Households' conceptions of, and engagement in, migration is of particular importance to the study area, as Damietta is highly vulnerable to potential rising sea levels. Hence, an understanding of how people use migration could help to guide policy-makers when developing policies suitable for both the current situation and the emerging risk cultures of the affected inhabitants.

6.2 Household adaptation to long-term climate variability and short-term, environmental shocks in Damietta

As explained earlier in Chapter 5, most households perceive of and experience increasing climate variability and extreme weather events within their area. Such climate change has also adversely affected agricultural production, natural resources, incomes and other livelihood conditions. Those households that were perceiving the adverse effects of climate change were asked whether they had adopted strategies to reduce losses or adapt to the changing climatic patterns within the five years that preceded the survey. Adaptation strategies were grouped into two general categories: the first of which included on-farm measures that involved any direct changes in the farming operations, while the second group involved strategies related to any changes in the livelihood conditions of the households, such as those involving decisions about migrating.

On-farm adaptation measures relate mainly to those households who both perceived changes in climate variability and who had access to farmland, and hence, could make farm-related decisions. Subsequently, landless households who perceived increases to climate variability (n=21), and those households who hadn't perceived any change in climate conditions (n=35), including landless (n=2) and land-holders (n=33)) have been excluded from the current analysis. Overall, results revealed that only a few households (n=10, 3.4 percent) within the total households who perceived increased climate variability and who were able to make farm-related decisions (n=294), did not introduce any on-farm adaptation methods. Whereas the majority, or 96.6 percent, had adopted at least one on-farm adaptation strategy to overcome risks associated with the perceived climate change.

For forms of on-farm adaptation measures (Table 6.1), most households, (76.2 percent) have increased irrigation and more than half of them (56.1 percent) mentioned increasing the use of pesticides and fertilisers. The problem of irrigating with mixed water (sewerage, agricultural wastewater and Nile water) and the excessive use of chemicals may exacerbate the problem of soil salinity in the study area in the near future. Rural households have already been complaining about the poor quality of water in the study area especially in Faraskur.

To illustrate that point, a farmer (Interview 2, Kafr Saad) said:

> *"Desertification of agricultural lands in the area will happen sooner or later as long as we continue irrigating from sewage water"*.

Approximately 39.0 percent of households have made some changes in planting dates and nearly 37.0 percent of the cohort had stopped cultivating certain crops. Some farmers (n=7) commented further on this specific adaptation strategy, mentioning that beans, potatoes, tomatoes and cucumbers were particularly sensitive to slight changes in climatic conditions and extreme weather events, so they had stopped cultivating those crops. Some of the respondents (n=15) also mentioned stopping the cultivation of cotton as the warmer weather has encouraged pest infestations.

Table 6.1: On-farm adaptation strategies adopted by the households to reduce losses or adapt to climate variability and extremes from 2012 to 2017

	Percentage	
On-farm adaptation (n= 294)	Yes	No
Increasing irrigation	76.2	23.8
Improving irrigation systems	34.4	65.6
Diversifying or increasing water sources for irrigation	13.6	86.4
Planting different crop varieties	23.8	76.2
Stop planting certain crops	37.4	62.6
Increase use of chemicals fertilizers/ insecticides, pesticides or fungicides	56.1	43.9
Changing planting dates	39.1	60.9
Change livestock types or sizes	24.8	75.2
Mulching for soil conservation or moisture protection	17.7	82.3

Source: Field survey 2018

In addition, improving irrigation systems and changing the type and/or size of livestock are another two strategies adopted by 34.4 percent and 24.8 percent of households, respectively. Of the studied households, 23.8 percent had used different crop varieties that were more drought or heat resistant, or varieties with shorter growing seasons. Some farmers (17.7 percent) had adopted soil conservation or moisture protection measures such as mulching, while other farmers, representing 13.6 percent, had diversified or increased the sources of irrigation water.

Regarding other adaptation strategies, all households who perceived climate change have been included in this analysis. Such strategies involve mobility decisions that took place to overcome economic losses associated with increasing climate variability and extremes. Consequently, members of landless households, who were merely engaged as paid agricultural labourers, were also included in this analysis as they might have made some decisions to move, to avoid or reduce environmental risks and the associated income losses within the sector.

In general, few households have adopted other adaptation strategies such as migration or other occupational shifts as a result of climate change (Table 6.2). More specifically, only 9.9 percent of households mentioned that a formally educated family member had to join the agriculture sector, whereas 4.8 percent of the cohort indicated a shift from agricultural to non-agricultural occupations. Regarding migration as an adaptation strategy, only 2.2 percent of households stated that one or more family members migrated to nearby towns or market centres for work outside the agricultural sector, and 1.3 percent of the cohort had sent a family member to the city for a different occupation. Migration of a family member to another country or rural area to work in an agricultural-based occupation were two potential adaptation strategies adopted by only 2.9 percent and 1.0 percent of households, respectively.

Table 6.2: Livelihood adaptation strategies adopted by the households to reduce losses or adapt to increasing climate variability and extremes from 2012 to 2017

	Percentage	
Other livelihood adaptations (n=315)	Yes	No
Formally educated family member joined agriculture	9.9	**90.1**
Shifted from agriculture to non-agriculture occupation	4.8	**95.2**
Migration of family members to nearby town/market centre for different occupation	2.2	**97.8**
Migration of family members to the city for different occupation	1.3	**98.7**
Migration of family members to another rural area for agro-based occupation	1.0	**99.0**
Migration of family member to another country	2.9	**97.1**

Source: Field survey 2018

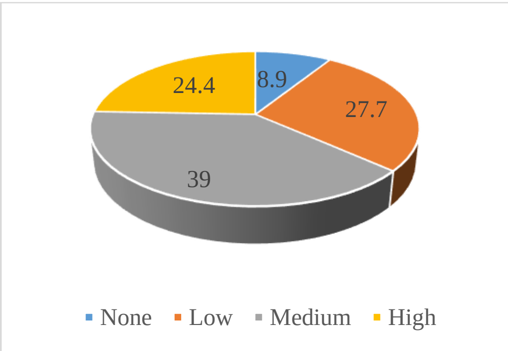
Within the household group sampled, migration was not a widely implemented adaptation strategy. This result could be due to the wide diversification of sources of income for most households, and/or the high dependence on family members for helping in the farmlands. Another aspect that could influence the low migration rate is the households' migration culture that is discussed later in this chapter (Section 6.4).

In order to understand the level of adaptation in households, the number of strategies adopted was counted in each, and households were then grouped into four categories based upon their level of adaptation as follows:

1. No adaptation although perceiving climate variability;
2. Low adaptation, i.e. 1 to 2 adaptation measures have been adopted;
3. Medium adaptation, i.e. 3 to 4 adaptation measures; and
4. High adaptation, i.e. equal to, or greater than, five strategies adopted by each household.

As shown in Figure 6.1, almost one-third of the households, or 27.7 percent, are considered to have low climate change adaptation, whereas 24.4 percent had high adaptation, and 39.0 percent had medium adaptation to changing climatic variability and extremes. Results also revealed that some households (n=20, or 8.9 percent) had not exploited any strategies for reducing the climatic risks. It was found that all of those, 20 households had no accessibility to land and were only engaged in the agricultural sector as waged agricultural labourers. Consequently, they are incapable of implementing major decisions regarding the adoption of any on-farm and agricultural-related adaptation strategies. Besides, they had not implemented any occupational or geographical mobility decisions to overcome the risks of climate change during the period 2012 to 2017.

Figure 6.1: Distribution of households by their adaptation level to climate change (in percentages)



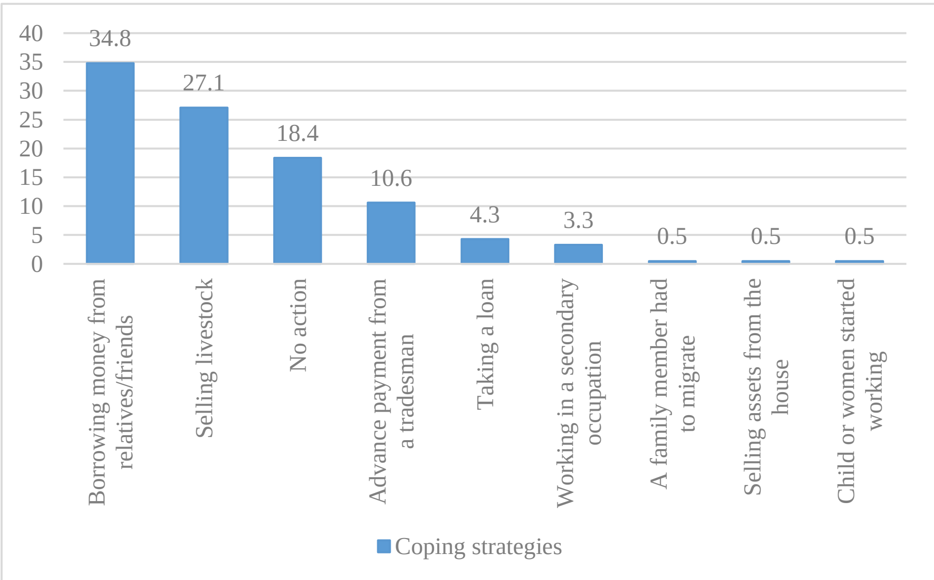
Source: Field survey 2018

As previously mentioned in Chapter 4, most households had been exposed to one or more economic and environmental shocks in the two years 2016–2017 preceding the fieldwork

(Section 4.3.3). Households have also been exposed to loss of crops or income due to climatic variability or extremes. Roughly half the households (52.8 percent) had been exposed to crop or income losses as a result of extreme weather events during 2016 and 2017 in the study area.

In relation to households who were exposed to crop or income losses due to climate variability and extremes, and how they coped, 34.8 percent declared that they had to borrow money from relatives and friends and 27.1 percent sold their livestock (Figure 6.2). About 18.4 percent of the households took no action, and 10.6 percent of the cohort took an advance payment from the tradesman as a means of spreading their risks. Taking out a loan or working in a secondary occupation besides agriculture were two coping strategies that were followed by 4.3 percent and 3.3 percent of households, respectively. A few households (0.5 percent) mentioned other coping strategies such as the migration of a family member, selling assets from the house, and a child or woman working.

Figure 6.2: Household strategies for coping with income losses as a result of climate variability and extremes that took place in 2016 – 2017 (multiple-response question)



Source: Field survey 2018

Again it can be concluded that almost all of the households investigated did not adopt migration as an adaptation strategy to short-term sudden extreme weather events. This result was also evident in the in-depth interviews when respondents were asked whether the observed increases in climate variability and extremes would be likely to drive rural dwellers to migrate or move to different non-agricultural sectors. For example, a farmer (Interview 5, Faraskur) responded with the following:

> *"Nobody leaves agriculture. Where the farmer would go; there are no other secondary occupations available today. When the farmer feels very hopeless, he will lease his farmland".*

Another farmer (Interview 1, Faraskur) mentioned the following:

> *"No, no, no, migration has no relation with that* [i.e. climate change]. *There are some cases of migration where people seek opportunities to "eat bread"* [i.e. generate income]. *Someone would see that farming is not worthy anymore and he has kids, schools, education, marriage, daughters, so he sees his livelihood in other places".*

While another (Interview 2, Kafr Saad) also mentioned the following when he was asked about whether or not climate variability is causing migration in his local area:

> *"At this stage, no, but if the situation remains the same, I will leave the agricultural sector myself, and I think all farmers would do the same. The costs of farming are high, and the production doesn't cover the costs".*

Similarly, Interviewee 11, from Faraskur mentioned:

> *"Of course no, and it will never happen because the farmer has only a sole source of income which is coming from farming; what other work would be done than that? The farmer can't find anything other than farming to do, he can't find any other occupations, and he is unable to work in any other sector".*

Likewise, a farmer from Kafr Saad (Interview 10) reported:

> *"We can withstand any environmental problems, even if the water dried. The government controls the water flow in the canals anyway, and we could spend a week without water for irrigation, so we can adapt to any environmental issue. I have no occupation other than agriculture. I don't know how to work in any other sector. I would never think about quitting the sector or leaving my farmland".*

6.2.1 Climate change adaptation according to the dependence of households on agriculture

The Kruskal–Wallis test was used to identify whether there were statistically significant differences between the three independent groups of households according to their level of dependence on agriculture in relation to their level of adaptation. As introduced in chapter 5, the three household groups were categorised according to the contribution of agricultural activities to the total income of the households:

Group 1 – households who depend upon agriculture for less than 50 percent of their income;

Group 2 – households' for which agricultural activities make up 50 to 95 percent of their income; and

Group 3 – households for which agricultural activities make up more than 95 percent of their income (i.e. who depend primarily on agricultural activities for a living).

Results showed that households in Group 3, who depend solely on agriculture for their livelihood, were adapting less to increased climate variability and extremes (K–W $p=0.001$). However, they were more likely to perceive and recognise the adverse effects of climate change than the other two groups (K–W $p=<0.001$) (see Section 5.5.1 in Chapter 5). Households in Group 2 were found to be more adapting to increasing climate variability and extremes, as shown in Table 6.3. This relatively high adaptation could be as a result of the presence of other non-agricultural sources of income that could be allocated for investments and improvements in the agricultural sector, which still contributes to a significant portion of their income. The respondents within Group 2 (generally the household heads) have a higher mean age; hence they could be more experienced in managing their agricultural businesses (see Section 5.5.4 in Chapter 5). Moreover, those household heads were also found to have higher social participation and were likely to be members of syndicates and/or one or more farming organisations (see Section 5.5.4 in Chapter 5). Households within Group 2 also seem to be living in more centrally-located houses in towns and, therefore, have better access to services and sources of information. Such accessibility to markets and those forms of social and natural resources could be improving their adaptive capacity to climate variability.

Table 6.3: Agricultural dependence groups' mean rankings of climate change adaptation levels

	< 50%		50-95%		>95%		*Kruskal–Wallis (K–W) significance level (p)*
	Group 1 (mean)	Group 1 (mean rank)	Group 2 (mean)	Group 2 (mean rank)	Group 3 (mean)	Group 3 (mean rank)	
Number of adaptation measures adopted by the HH	3.18	155.09[a,b]	3.68	**179.41**[a]	2.74	**135.95**[b]	0.001

Pairwise statistical difference between groups at 0.05 significance level is indicated with the use of [a,b,c]. Different letters indicate a significant difference between groups. Groups with the same letter are not significantly different.

The Chi-square statistical test was used to examine further the specific distributions of the three groups of households by their choices of climate change adaptation strategy. Households in Group 2 were found to have adopted more advanced adaptation strategies such as planting different crop varieties (Pearson Chi-squared p=0.004), changing planting dates (Pearson Chi-squared p=0.004), and using strategies to conserve soil and protect moisture (Pearson Chi-squared p=>0.001), particularly when compared with Group 3 that was the least to adopt those three strategies (Table 6.4, 6.5 and 6.6).

Table 6.4: The distribution of agricultural dependence groups by their choice of planting different crop varieties from 2012 to 2017

			Yes	No	Total
Income from agriculture	<50 %	Count	13	55	68
		% within	19.1%	80.9%	100.0%
	50-95 %	Count	**42**	85	127
		% within	**33.1%**	66.9%	100.0%
	≥95 %	Count	15	**84**	99
		% within	15.2%	**84.8%**	100.0%
Total		Count	70	224	294
		% within	23.8%	76.2%	100.0%

Source: Field survey 2018

Table 6.5: The distribution of agricultural dependence groups by their choice of changing planting dates to reduce losses from 2012 to 2017

			Yes	No	Total
Income from agriculture	<50 %	Count	28	40	68
		% within	41.2%	58.8%	100.0%
	50-95 %	Count	61	66	127
		% within	48.0%	52.0%	100.0%
	≥95 %	Count	**26**	73	99
		% within	**26.3%**	73.7%	100.0%
Total		Count	115	179	294
		% within	39.1%	60.9%	100.0%

Source: Field survey 2018

Table 6.6: The distribution of agricultural dependence groups by their choice of mulching to reduce losses from 2012 to 2017

			Yes	No	Total
Income from agriculture	<50 %	Count	6	62	68
		% within	8.8%	91.2%	100.0%
	50-95 %	Count	**38**	89	127
		% within	**29.9%**	70.1%	100.0%
	≥95 %	Count	8	91	99
		% within	8.1%	91.9%	100.0%
Total		Count	52	242	294
		% within	17.7%	82.3%	100.0%

Source: Field survey 2018

Households in Group 3 were found to be more likely to have adopted strategies relying upon increasing the amounts of inputs from pesticides and fertilisers than other groups (Pearson Chi-squared p=>0.001) (Table 6.7). Again this result shows that households in Group 2 seemed to have better access to modern technology and to people who could provide them with the required advice to overcome business-related losses caused by climate change – consequently implying the better adaptive capacity of this group in comparison with households in Group 3.

Table 6.7: The distribution of agricultural dependence groups by their choice of increasing the use of chemicals/fertilizers/insecticides to reduce losses from 2012 to 2017

			Yes	No	Total
Income from agriculture	<50 %	Count	31	37	68
		% within	45.6%	54.4%	100.0%
	50-95 %	Count	56	71	127
		% within	44.1%	55.9%	100.0%
	≥95 %	Count	**78**	21	99
		% within	**78.8%**	21.2%	100.0%
Total		Count	165	129	294
		% within	56.1%	43.9%	100.0%

Source: Field survey 2018

Roughly 41.0 percent of households within Group 2 stated that they had improved their observation of meteorological information as a result of climate variability and extremes, a significantly greater percentage than households in Group 3 (Pearson Chi-squared p=>0.001) (Table 6.8). The low educational attainment of the respondents in Group 3 could also limit their capacity to access or make use of meteorological information, or perhaps they are less likely to understand that timely meteorological information will become more critical with a changing climate.

Table 6.8: The distribution of agricultural dependence groups by their choice of improving their observation of meteorological information from 2012 to 2017

			Yes	No	Total
Income from agriculture	<50 %	Count	14	56	70
		% within	20.0%	80.0%	100.0%
	50-95 %	Count	**53**	76	129
		% within	**41.1%**	58.9%	100.0%
	≥95 %	Count	**18**	98	116
		% within	**15.5%**	84.5%	100.0%
Total		Count	85	230	315
		% within	27.0%	73.0%	100.0%

Source: Field survey 2018

6.3 Current migration pattern in the study area

Migration is considered as a means for adapting to climate change (Massey 1990; Adger & Adams 2013) and people migrate as an effective response (Bardsley & Hugo 2010;

Black et al. 2011a, 2011b; Foresight 2011; Adger & Adams 2013; Baldwin & Gemenne 2013; Gemenne & Blocher 2017). However, as discussed earlier in this chapter, mobility with its two forms (geographical and occupational) is not considered an adaptation strategy to climate variability and extreme weather events for most of the studied rural households in Damietta. This section addresses the current migration pattern of the households interviewed and highlights some of the limiting or enabling factors that influence their decisions. Results show that there were only 45 household members who lived outside their residential area for at least six months during the period from 2012 to 2017 (Table 6.9). About 42.0 percent were returned migrants at the time the survey was conducted, and 40.0 percent were considered permanent migrants (i.e. those who had been living outside the area for more than five years). About 9.0 percent of those who migrated were considered seasonal migrants, 6.7 percent of the cohort were new migrants, and 2.2 percent were temporary migrants.

Table 6.9: Nature of migration in Damietta in 2018

		Frequency	Percentage
Nature of migration	New migrant	3	6.7
	Return migrant	19	42.2
	Seasonal migrant	4	8.9
	Temporary migrant	1	2.2
	Permanent migrant	18	40.0
Total		45	100.0

Source: Field survey 2018

As Table 6.10 shows, the place of destination for 68.9 percent of those who migrated was outside Egypt, particularly neighbouring Saudi Arabia and Libya. About 20.0 percent of the cohort migrated to a town or city outside Damietta, followed by 6.7 percent and 4.4 percent migrating to a town within Damietta and a rural village outside the governorate, respectively.

Table 6.10: Place of destination for household members migrating from Damietta in 2018

		Frequency	Percentage
Within Damietta	A town within the governorate	3	6.7
Outside Damietta	Town/city	9	20.0
	Rural village	2	4.4
Overseas	Unidentified	5	11.1
	Saudi Arabia	13	28.9
	Nigeria	1	2.2
	UAE	1	2.2
	Jordan	1	2.2
	Libya	6	13.3
	Kuwait	3	6.7
	Iran	1	2.2
Total		45	100.0

Source: Field Survey 2018

Regarding drivers of migration, about 46.4 percent of responses stated that employment was the main reason for migration, followed by accumulating savings, which is also income-related, and represent 38.1 percent of responses (Table 6.11). Other reasons for migration involved education (7.1 percent), the rise in the price of agricultural lands (4.8 percent), and better infrastructure in the place of destination (3.6 percent).

Table 6.11: Reasons for migration from Damietta 2018 (multiple-response question)

		Frequency	Percentage
	Work	39	46.4
	Education	6	7.1
	Accumulate savings	32	38.1
	Better infrastructure	3	3.6
	The rise in the prices of agricultural lands	4	4.8
Total		84	100.0

Source: Field Survey 2018

Only 15 households (or 4.2 percent) were receiving remittances from migrants at the time of the survey. The average amount of remittances received by these households was about EGP51,800 (roughly equivalent to AUD4,500) per year. The majority (34.8 percent) indicated that they received the remittances monthly; some other households received it bi-monthly (23.1 percent), quarterly (23.1 percent), and half-yearly (15.4 percent). Remittances were widely used for accumulating savings, as mentioned by 18.8 percent of respondents, and about 17.2 percent of the cohort mentioned using it for living costs (Table 6.12). Households also mentioned spending the remittance money on marriage expenditures, health and education with 14.1 percent, 12.5 percent, and 7.8 percent of responses, respectively. Equal percentages of responses (6.3 percent) gave other uses for remittances, including buying lands or houses, investing in non-agricultural businesses, and repaying debts. Finally, only 3.1 percent of responses mentioned using the money for agricultural intensification or improvement. This result suggests that households who receive remittances prefer to save the money or spend it on day-to-day expenditure rather than investing it in their agricultural businesses or buying farmland. Rural households might fear spending money on the agricultural sector due to the increased uncertainties, and market fluctuations that are linked with the sector.

Table 6.12: Uses of remittance money as stated by the studied households in Damietta 2018 (multiple-response question)

		Frequency	Percentage
	Living costs	11	17.2
	Savings	12	18.8
	Agricultural intensification/ improvement	2	3.1
	Education	5	7.8
	Health related expenditure	8	12.5
	Business in non-agricultural activity	4	6.3
	Buying land/house	4	6.3
	Buying assets	5	7.8
	Marriage expenditure	9	14.1
	Repayment of debts	4	6.3
Total		64	100.0

Source: Field Survey 2018

The reasons why most households do not migrate was also asked (Table 6.13). Of the household respondents questioned, 34.6 percent talked about stable family and living conditions within the area, followed by 21.6 percent, stating that they had no opportunity to leave their local area. Some other responses involved not wanting to leave their homes or area (7.9 percent), the inability to travel as a result of being old (7.5 percent), and being financially incapable as migration was seen as a costly action (7.61 percent). Some other respondents (6.7%) mentioned holding on to agriculture and being unable to leave their land. About 5.1 percent of responses stated that they already had a variety of income sources within their local areas, and 3.1 percent of the cohort indicated that there were only poor income opportunities abroad and hence it was not worth migrating. A few respondents mentioned not wanting to leave their parents (2.4 percent), having a chronic disease (1.2 percent), and lack the capability of working in non-agricultural sectors (1.2 percent). Finally, very few responses mentioned limited capacities of family members to migrate and no social networks living abroad, with 0.8 percent of responses each.

Table 6.13: Reasons for not migrating from Damietta 2018

		Frequency	Percentage
	A variety of income sources within the area	13	5.1
	Stable family and living conditions	88	34.6
	I am the only son and can't leave my parents	6	2.4
	Bad financial conditions and migration is costly	18	7.1
	Old age unable to travel/can't travel at this age	19	7.5
	Have chronic disease	3	1.2
	Don't want to leave home/place	20	7.9
	No good income abroad/ not worth migrating	8	3.1
	No opportunity for migration appeared for me	55	21.6
	Holding on agriculture/land	17	6.7
	Incapable of working in sectors other than agriculture	3	1.2
	No networks to help in finding an opportunity outside	2	0.8
	Limited capacities of family members	2	0.8
Total		254	100

Source: Field Survey 2018

There was a general attitude that migration is not a practical action. One interviewee (Interview 7, Faraskur) speaking about migration patterns in his residential community stated the following:

> *"No, people don't migrate, and now countries have complicated work permits and travel regulations. To migrate in recent days, you need a lot of money and a sponsor or patron. Moreover, money abroad is not good anymore".*

While another farmer (Interview 9, Kafr Saad) had the following opinion:

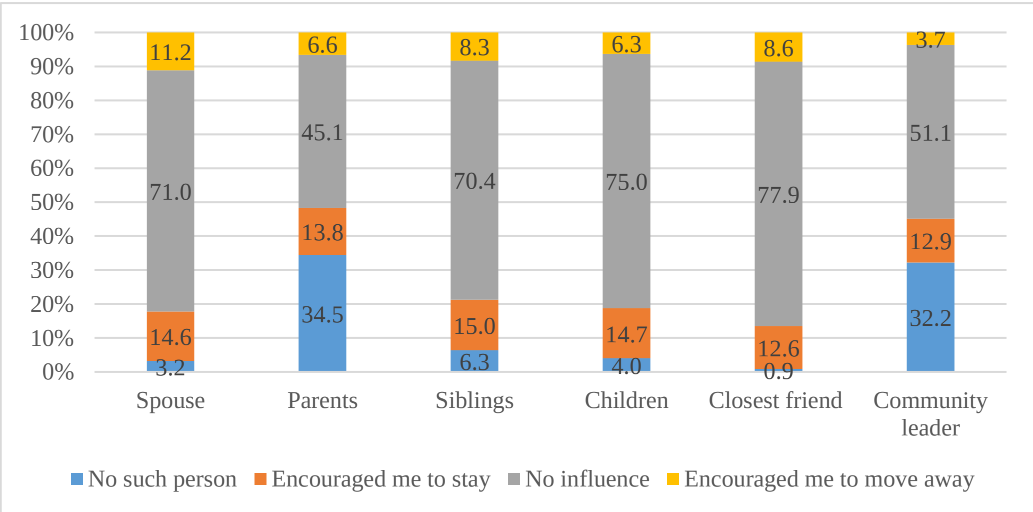
> *"Migration rates these days are lower than the past, most people have now returned, nothing is rewarding abroad".*

6.4 Culture of migration in rural Damietta

Cultural values and traditions are among other essential factors that influence the adaptation decisions within households (Adger et al. 2013), particularly migration-related decisions (Cohen & Serkici 2011). The culture of migration itself is shaped by the structure of migration within the sending communities, or in other words, the history and continuity of migration within a particular place (Cohen 2004). Understanding the culture of migration of the rural households in the study area could explain their potential migration behaviour in times of climate-related stressors.

Since migration is generally a household decision rather than an individual decision according to the New Economics of Labour Migration theory (Stark & Bloom 1985; Massey et al. 1993; de Haas 2010b), it was important in this study to identify the degree to which household members influenced the migration decisions of each other. Figure 6.3 shows that most respondents stated that their spouses, parents, siblings, children, closest friends or neighbours had no influence on their decision about migration at all. In other words, they neither encouraged the respondents to stay in the local area nor to move away during the five years (2012–2017) that preceded the survey.

Figure 6.3: The influence of important household community members on encouraging the respondents to stay or move away from the local area between 2012-2017 in Damietta (n= 248)



Source: Field Survey 2018

In more detail, an almost equal percentage of respondents, approximately 14.7, mentioned that their spouses and children had encouraged them to stay. Whereas, only 11.2 and 6.3 percent of the cohort said that their spouses and children encouraged them to move away from their local community, respectively. Parents and siblings were also found to encourage respondents to stay in the local area as stated by 13.7 percent and 14.9 percent of the respondents, respectively. About 12.6 percent of the respondents stated that their closest friends were most likely to encourage them to stay in their local community, and 12.9 percent of the cohort stated that they were also encouraged not to leave the area by a community leader.

Similarly, results suggest that household members were unlikely to encourage the respondent to leave the agricultural sector, as 70.3 percent of the respondents stated (Figure 6.14). Only roughly one in four respondents reported that their household members are likely to encourage them to leave the sector, and 6.6 percent of the cohort were neutral. Importantly for the future of local agriculture and investment in the sector, about 47.4 percent of respondents stated that they were unlikely to encourage their children or younger generations to cease working in the agricultural sector. Rather almost half or about 45.0 percent of the cohort were more likely to encourage younger generations to leave the sector.

Table 6.14: Respondents' opinion about occupational mobility and migration in Damietta (n=350)

		Percentage			Mean
		Very unlikely and unlikely	Neutral	Likely and very likely	
Likelihood of	Household members encouraging you to leave the agricultural sector	70.3	6.6	23.1	2.6
	Encouraging your household members and other community members from younger generations to quit working in the agricultural sector	47.4	7.7	44.9	4.6
		Strongly disagree and disagree	Neutral	Agree and strongly agree	Mean
Agreement with	If I found a better work opportunity in other sectors, I would definitely leave the agricultural sector	63.1	4.9	32.0	3.5
	Migration of you or any other family member is the best solution to improve your economic situation	58.0	8.3	33.7	3.7
	If I am financially capable, another family member or I would definitely migrate	75.4	4.9	19.7	2.3
	I would leave this area if I found a guaranteed and good opportunity to move	68.3	3.4	28.3	3.0

Source: Field Survey 2018

Most respondents (63.1 percent) stated that they were unlikely to leave the agricultural sector even if they found a better work opportunity outside the sector, whereas 32.0 percent of the cohort indicated the likelihood of leaving the sector upon finding a better work opportunity in other non-agricultural sectors. Most respondents (58.0 percent) did not think that migration of one of their family members was the best solution for improving the economic situation of the household. About 33.7 percent of the cohort agreed that migration was the best way to improve the economic conditions of the household. Nearly eight in ten respondents stated that they were unwilling to migrate, even if they were financially capable of migrating. On the contrary, 19.7 percent of respondents thought that they would emigrate if they were financially capable of it. Nearly 68.3 percent of respondents were unlikely to leave their local area even if they found a guaranteed employment opportunity. In comparison, 28.3 percent of the cohort mentioned their willingness to leave the area if they saw an opportunity for migration.

Respondents' scores in each of the previously mentioned statements were compiled to calculate their overall migration culture. Most of them, representing 66.0 percent of households, were reluctant to migrate, while 14.9 percent of the cohort were more willing to migrate and leave the agricultural sector (Table 6.15). A further 19.1 percent of respondents fell in the second category, and had a neutral opinion about migration.

Table 6.15: The distribution of the respondents by their migration culture Damietta (n=350)

	Frequency	Percentage
Very reluctant and reluctant to migrate	231	66.0
Neutral	67	19.1
Willing and very willing to migrate	52	14.9
Total	350	100.0

Source: Field Survey 2018

Some of the respondent's opinions about migration were reflected in the in-depth interviews. For example, one farmer (Interview 4, Faraskur) mentioned the following, speaking about the migration of farmers:

> *"The farmer is always in debt, and he has many problems accumulated on his shoulders, today the productivity of a* feddan *is much less than he spends on. So, where would he go? He just can't leave."*

While another farmer (Interview 6, Faraskur) illustrating the importance of the farmland as a concept to farmers mentioned:

> *"The farmer cannot give away his land; he must strive as much as he can. How can I leave farming? It is the source of food for my children and me. I can't do any other thing, and I do have nothing except the land and two cows. If I left it, from where shall I feed myself and my family? I am an old man, and I cannot work on the land with all my full capacity, so all my sons help me, all of them are farmers, they can't leave me or the land".*

Another interviewee (interview 7) from Faraskur stated:

> *"Look, I have worked in many non-agricultural occupations; carpenter, smith, wall painter, etc., but I eventually returned to agriculture. I just take a turn in other occupations and go back to agriculture. At least I will be able to eat from my farmland, even having a cow or a buffalo, I can guarantee to have some milk every day. My* per diem *pay from other occupations barely gets a box of cigarettes and a bottle of oil, and at the end of the day, I return home without a single pound".*

He added:

> "*I want to leave here, but I can't find any opportunity to migrate. We are a big family, and we only own 0.5 feddans. I wish to move elsewhere and start a new life for myself – a newly reclaimed area like the New Valley, for example, buy a house with land and live there instead of suffering here. I wish to go to any of the government's newly reclaimed lands in the desert, where the government resettle people and help them until they establish their lives".*

An interviewee from Faraskur (Interview 11) responded the following when he was asked about any plans of leaving the agricultural sector:

> *"What shall I work? If drought or flood happened in the area, where shall I go, and what would I work? Even if the agricultural situation gets worse, which is already bad, what shall I do? I have no option other than agriculture ... even if I want to migrate, today travelling requires a lot of money".*

On the contrary, some other interviewees reported their keenness to migrate; for instance, one farmer (Interview 1, Faraskur) stated the following when he was asked how he would act if the agricultural situation in Egypt worsens:

> *"I will quit the agriculture sector; this is for sure. Currently, I trade in livestock besides agriculture, and I cultivate my land to feed the livestock. I even wish to leave the area here, not specifically Damietta, I mean Egypt. I want to leave Egypt and go to Kuwait, for example. They say that living there is good and it has nice people".*

Similarly, another farmer (Interview 2, Kafr Saad) stated:

> *"If the situation gets worse and I found a good opportunity to leave, I would certainly leave for any other place".*

Results from the Pearson Chi-squared test showed that there were no spatial differences between the two studied local administrations in relation to their overall culture of migration (Pearson Chi-squared p=0.008). However, upon running the Pearson Chi-squared test on each statement, results showed that there was a significant difference between the two local administrations concerning which households in Faraskur would be more willing to migrate if they were financially capable of doing so (Pearson Chi-squared p=0.003) in comparison with those living in Kafr Saad (Table 6.16). It is not clear why there is such a difference, but it could be a result of the particularly poor environmental conditions and water pollution prevailing in the Faraskur area that limits local agricultural activities (see Section 4.4, Chapter 4).

Table 6.16: The distribution of respondents residing in the two local administrations by their agreement with: "If I am financially capable, another family member or I would definitely migrate".

		Strongly disagree and disagree	Neutral	Agree and strongly agree	Total
Faraskur	Count	122	11	47	180
	% within	67.8%	6.1%	26.1%	100.0%
Kafr Saad	Count	142	6	**22**	170
	% within	83.5%	3.5%	**12.9%**	100.0%
Total	Count	264	17	69	350
	% within	75.4%	4.9%	19.7%	100.0%

Source: Field Survey 2018

6.4.1 Household culture of migration in relation to their dependence on agriculture

As previously mentioned, the degree of perception of increasing climate variability by households was found to be different based upon their dependency upon agricultural activities for generating their livelihoods. Results also revealed that there were some significant social and economic differences present among the three groups depending on their level of agricultural dependency. Unsurprisingly, results also showed the presence of some significant differences between the three groups of households in their migration culture, which will be addressed in this section. Again the Kruskal–Wallis test was used to analyse any significant differences present between the three groups of households in their views and opinions about migration (Table 6.17).

Group 3, households who are fundamentally dependent upon farming activities for their livelihoods, was found to have the lowest mean rank in their total mobility/migration culture (K–W p=<0.001) in comparison with Groups 1 and 2. More specifically, households in Group 3 have a lower mean rank in the likelihood that their members would encourage the respondent (generally the head of the household) to leave the agricultural sector (K–W p=<0.001) in comparison with the other two groups. These households were also less likely to encourage their household members and other community members from younger generations to cease working in agriculture (K–W p=<0.001) than the other two groups.

On the contrary, households who depend on agricultural activities for less than 50 percent of their total income, namely Group 1, were more likely to choose to migrate if they had the financial capacity to do so (K–W p=0.001), and to leave the agricultural sector upon finding better work opportunities in other sectors (K–W p=<0.001) compared with the other two groups. The mean rank for any of the family members viewing migration as the best solution for improving the economic situation of the household was also higher in Group 1 (K–W p=0.001) than Group 3. Moreover, Group 1 has a higher mean rank relating to the likelihood of leaving the studied area upon finding a guaranteed way or good opportunity for migration (K–W p=0.001) compared with Groups 2 and 3.

Table 6.17: Agricultural dependence groups' mean rankings of household cultures of migration in the study area

Migration/mobility culture	< 50%		50-95%		≥95 %		**Kruskal–Wallis (K–W) significance level (p)**
	Group 1 (mean)	Group 1 (mean rank)	Group 2 (mean)	Group 2 (mean rank)	Group 3 (mean)	Group 3 (mean rank)	
Overall migration culture or willingness for mobility	4.96	234.84[b]	2.94	165.71[b]	2.65	**151.53**[a]	<0.001
The likelihood that any member of the HH encourages you to leave the agricultural sector	4.95	224.91[b]	2.00	164.10[b]	1.99	**159.50**[a]	<0.001
The likelihood of encouraging HH members and other community members to quit working in the agricultural sector	5.69	205.35[b]	4.87	183.33[b]	3.56	**147.92**[a]	<0.001
Migration of you or any other family member is the best solution to improve the economic situation	4.97	**206.37**[a]	3.72	178.29[a,b]	2.80	153.43[b]	0.001
If I am financially capable, another family member or I would definitely migrate	3.80	**210.18**[a]	1.91	160.25[b]	1.98	173.09b	0.001
I would leave this area if I found a guaranteed way or good opportunity for migration	4.65	**213.06**[a]	2.43	162.23[b]	2.54	168.95[b]	0.001
If I found a better work opportunity in other sectors, I would definitely quit working in the agricultural sector.	5.71	**224.11**[a]	2.70	157.77[b]	3.02	167.69[b]	<0.001

Pairwise statistical difference between groups at 0.05 level is indicated with the use of [a,b,c]. Different letters indicate a significant difference between groups. Groups with the same letter are not significantly different.

Consequently, households in Group 3 were more likely to have stronger ties to their local place, farmlands and agricultural occupations, whereas households in Group 1 were more willing to migrate and leave the agricultural sector. The educational attainment and the age of the head of the household or the respondent could also be critical factors in shaping their opinions, capacities and opportunities for migration.

6.5 Migration plans and intentions of the studied households in Damietta

Respondents were requested to state whether or not they and their household members had any plans or intentions to migrate during the two years following the survey 2019–2020 (Table 6.18). Most of the respondents, representing 78.9 percent, stated that they were unlikely to leave the agricultural sector permanently to join another sector in the next two years that followed the survey. About 16.0 percent of the cohort had intentions to leave the sector, and about 4.8 percent were neutral. Also, approximately eight in ten respondents stated that they were unlikely to leave the area either permanently or temporarily in the next two years that followed fieldwork. Only 13.1 percent of respondents mentioned that they were likely to leave the local area permanently, and 15.7 percent of the cohort stated that they would likely leave their residential areas temporarily in 2019–2020. Most of the respondents, or 75.4 percent, were also reluctant to move in the near future, whereas about 21.2 percent of the cohort expressed their willingness to move in the future.

Table 6.18: Household respondents' future migration intentions in Damietta

		Percentage			Mean
		Very unlikely and unlikely	Neutral	Likely and very likely	
Likelihood of	Leaving the agricultural sector and joining another sector in the next two years	78.9	4.8	16.3	3.2
	Permanently leaving the area in the next two years	83.1	3.7	13.2	2.8
	Temporarily leaving the area in the next two years	80.6	3.7	15.7	2.9
		Very reluctant and reluctant to	Neutral	Willing and very willing to	
	Are you and your family members willing to move in the future	75.4	3.4	21.2	3.5

Source: Field Survey 2018

Furthermore, almost all respondents, or 91.4 percent, stated that neither they nor any of their household members had plans to move away from the area in 2019.

6.5.1 Household migration plans in relation to their dependence on agriculture

Although most of the respondents and their household members are less likely to migrate or occupationally move to other non-agricultural sectors in the near future, results from the Kruskal–Wallis test showed that there were some significant differences between household groups in their future intentions. As shown in Table 6.19, households in Group 3 have lower mean rank than Groups 1 and 2 in their willingness to move in the future (K–W p=0.003). Households in Group 3 were also found to be less likely to permanently leave the area in 2018–2019 (K–W p=0.009) than Group 1, or to leave the area even temporarily (K–W p=0.003) in comparison with both groups.

Table 6.19: Agricultural dependence groups' mean rankings of household migration intentions in the study area

Migration intentions	< 50%		50- 95 %		≥95 %		**Kruskal–Wallis (K–W) significance level (p)**
	Group 1 (mean)	Group 1 (mean rank)	Group 2 (mean)	Group 2 (mean rank)	Group 3 (mean)	Group 3 (mean rank)	
You and your family members willing to move in the future	3.39	192.77[b]	2.52	185.59[b]	1.51	**152.77**[a]	0.003
Leaving the agricultural sector permanently and joining another sector in the next two years	3.37	**202.52**[a]	1.62	171.05[b]	1.37	164.58[b]	0.009
Permanently leaving the area in the next two years	2.39	194.56[a]	1.63	180.89[a,b]	1.05	**157.41**[b]	0.009
Temporarily leaving the area in the next two years	2.47	195.57[b]	1.92	183.09[b]	1.10	**154.11**[a]	0.003

Pairwise statistical difference between groups at 0.05 significance level is indicated with the use of [a,b,c]. Different letters indicate a significant difference between groups. Groups with the same letter are not significantly different.

Finally, Group 1 has a higher mean rank for their likelihood of permanently leaving the agricultural sector and joining another sector in the two years following the fieldwork (K–W p=0.009) than Groups 2 and 3. Expectedly, again this result shows that households in Group 3 are particularly less likely to have any potential migration decisions in the near future.

To conclude, results suggest that the household respondents in Damietta were very reluctant to move, and as will be discussed in chapter 7, may increasingly represent a stuck or trapped population as the climate changes (i.e. Black et al. 2011b) because they will be unlikely to exploit positive options to migrate if needed in the near future. This result is of key importance, as Damietta is considered to be one of the most vulnerable areas to future rising sea-levels and other impacts of climate change in Egypt, and their unwillingness to move either geographically or occupationally could result in failure of adaptation efforts within the area.

6.6 Summary

This chapter addressed the adaptation strategies implemented by the studied households to reduce losses in the agricultural sector as a result of increasing climate variability and extremes. Some on-farm adaptation methods have been widely implemented by the respondents, including increasing the use of chemicals, increasing irrigation water, changing planting dates and ceasing to plant those crops that are sensitive to climate variability and extremes.

To cope with sudden shocks of climate variability and extreme weather events, respondents were borrowing money from relatives, selling livestock, and taking advance payment from the traders in the short-term. Migration as a short or long-term adaptation strategy is not being adopted by most households, as became evident when the migration culture of households in the study area was investigated – most were highly reluctant to migrate. Most respondents were unwilling to leave the agricultural sector or to move away from their local areas. There were a few households from whom a household member had migrated and who were receiving remittances by the time the survey was conducted. Most of the money received as remittances was allocated for expenses other than investment in the agricultural sector. This result could also provide information about rural households' decisions regarding the allocation of remittances. Subsequently, even if households have chosen migration as a means of adaptation to environmental change, they might be disinclined to invest remittance money in improving their farm business.

Chapter Seven: Livelihood challenges and dimensions of the vulnerability of agrarian communities in Egypt

Multiple challenges face the agricultural sector in Egypt and hinder its growth and development. Rural areas in Egypt have witnessed decades of neglect, and there has been a lack of national drive for real, sustainable forms of rural development (Bush 2000, 2004; El Nour 2015; Bush 2016; de Lellis 2019). This chapter discusses some of the critical stressors, climatic and non-climatic, which small-scale farmers in northern Egypt face. It then deliberates on the factors influencing farmers' perceptions of, and adaptation to, climate change, highlighting some of the potential burdens for effective transformation in Egypt, the Middle East and the other rural communities across the globe with similar circumstances. Finally, the chapter discusses some of the differences found among households within the same agrarian community in their level of vulnerability, risk perceptions and adaptive capacities by integrating the agrarian transition model.

7.1 Livelihood challenges for rural households in Damietta

As explained in Chapters 1 and 2, climate change is a global problem, but its effects are mostly defined at the local level. Hence, it is vital to recognise the current challenges presented to local communities to better understand how climate change generates obstacles and shapes rural communities' vulnerabilities in Egypt, as well as recognising that the extreme situation in Egypt provides many lessons for other developing countries with similar situations. Understanding the local context also allows for a reflection on the factors that can influence the adaptive capacity of rural regions, and different social groups within such regions. This section will look at the critical socio-economic, environmental and agricultural problems already reported by the rural households targeted and discuss how these emerging issues are increasingly linked with a range of pressing challenges found at the national and regional scales.

7.1.1 Socio-economic challenges

Nearly half of the respondents in Damietta, who were mainly the heads of the households, have low educational levels, and one-third of the total group has received no formal education (Table 4.6). The sample findings are similar to broader rural illiteracy rates amongst adults in Egypt, reaching 32.2 percent in 2017 as indicated in the national census data (CAPMAS 2020b). Such low levels of educational attainment increase the social vulnerability of many small-scale farmers in Egypt (Drzewiecki et al. 2020; Poudel et al. 2020) and could potentially limit their capacity to adapt to climate change both *in situ* and *ex situ* (Ekemhonye et al. 2020). In particular, low educational levels of individuals limit their opportunities for income diversification and social mobility (Barnett & Adger 2007). This argument seems to be supported by the findings of this research, which indicate that a large proportion of respondents work primarily as farmers or waged labourers, of whom nearly half have no secondary occupations and are highly dependent upon agriculture for their livelihoods.

On the other hand, results show that another 40 percent of respondents have completed secondary schooling or higher. This result implies that there is a wide divergence in the educational attainment among respondents in Damietta, which may entail a variation in the vulnerabilities of small-scale farmers to climate change. Similarly, the results presented in Chapter 4 (Section 4.2.2) show higher levels of educational attainment among other adult household members (aged 16 or above), both males and females. This result could suggest that although most household heads have low educational attainment, they tend to encourage younger household members to complete at least secondary education. At the household level, education may be taken as means of improving individuals' employability and income (Barnett & Adger 2007) and thus improve the overall economic conditions of the household. This argument is supported by this research, which indicates that most of the other working household members, excluding the respondents themselves, are primarily employed in non-agricultural occupations (Figure 4.2) and most households have more than one source of income (Figure 4.6). This result also suggests that if younger family members inherit farmland in later years, they would probably be operating agricultural activities as a secondary job or occupation – a situation that could undermine local agricultural production and, over time, threaten the national food security considering the reduced effort invested in it.

It was also noted that younger members of rural households in Damietta, especially males, were becoming more reluctant to work in the agricultural sector or even to assist in farming activities (Section 4.2.2). Similarly, Aboulnaga et al. (2017) state that small-scale family agriculture in Egypt, like many countries in the developing world, is characterised by an increased dependency upon older people, rather than younger individuals who have been shown to be more disinclined to participate in farming activities. The reasons leading to low levels of youth participation in agricultural activities were not explored in the current study. However, it is likely to be associated with their engagement with education and a growth in alternative opportunities, limiting their free time available to participate in agricultural activities actively (Kabbani 2019). They may also merely be unwilling to participate in the difficult, routine activities of farming which provide relatively small financial reward (Ojebiyi et al. 2015). Earlier youth studies have identified one of the main reasons that turn young people away from agriculture relate to the problems of inheritance and customs in developing countries increasingly limiting the ability of young rural people to access land while still young (White 2012; IFAD 2014; FAO, CTA & IFAD 2014). The growing dependency on ageing farmers in agriculture in many countries around the world is seen as a problem due to the perceived loss of potential in creating profitable, innovative and sustainable farms (FAO, CTA & IFAD 2014; Zagata & Sutherland 2015), which are attributes that will be particularly needed in the context of global climate change.

Although it might appear that households are diversifying their incomes, the degree to which most households depend upon the agricultural sector for a living is still high, particularly amongst the relatively poor. Income from agriculture contributes to 50 percent or more of the total income for the majority of sampled households (Table 5.11). Such a high dependency on an increasingly climate-sensitive activity and a potentially declining primary resource base make most of the studied farmers vulnerable to climate change (Paavola & Adger 2002; Agrawal & Perrin 2009; Betts 2010; Dasgupta et al. 2014). Despite the high livelihood dependency on agriculture, more than half of the households own, share or rent less than 3 *feddans* of agricultural land. According to Abouelnaga et al. (2017), farms of less than 3 *feddans* do not allow households to develop livelihoods above the international poverty line in Egypt (USD 1.25 per day per capita). Poor economic conditions increase the vulnerability of many rural households in Egypt and many other developing countries, and hinder their ability to mitigate the risks of climate change (Mertz et al. 2009a; Waly et al. 2020) resulting in trends of increasing poverty (Bohle et al. 1994; Adger et al. 2003; Thomalla et al. 2006; Parry et al. 2007; Mirza 2011; IPCC 2014; Warner, Hoffmaister & Milan 2015; Islam & Winkel 2017; Otto et al. 2017).

Moreover, the social participation of most households in organizing and attending community activities and in discussing public affairs is generally low (Table 4.10). In addition, nearly half of the studied farmers find themselves distanced from government officials, with one-quarter of the total group rated their relationship with government officials as very poor and poor – a result that could have significant implications on the acceptance and implementation of policies regarding adaptation, if any, in the studied areas. Poor relationships with government officials are unlikely to facilitate and promote sustainable adaptation to climate change, as Pelling et al. (2008) and Fatti and Patel (2013) suggested. On the contrary, another half of the group rated their relationship with government cadres as good and very good. Again, this wide variation implies that the degree of vulnerability of rural households is not equal and requires further explanation as presented later in this Chapter (Section 7.4).

Interestingly, the degree of social participation of respondents is associated with their primary occupations (Section 4.2.3.1). Respondents working primarily as farmers or waged labourers and unskilled labourers in non-agricultural occupations have relatively low social participation levels in community events. The majority of respondents even lack the institutional arrangements that could provide them with some influence over the decision-making processes in Egypt. For instance, only a few of the studied respondents are members of one or more formal associations such as syndicates, farmers unions and organisations, government agencies, NGOs, and political parties. Such low social capital could have a huge impact on adaptive capacities, as well as a considerable effect on their vulnerability and the recognition of their social, economic, political values, needs and circumstances by decision-makers in Egypt. In terms of collaboration and social relationships and networks, social capital is a critical factor to boost accessibility to adaptation measures (Adger 2003; Warner, Hoffmaister & Milan 2015).

More than half of the households in Northern Egypt are dissatisfied with the local health services (Table 4.15) and nearly 60 percent of the group rated the refuse removal services in the studied areas as bad (Figure 4.9). Almost half of their houses are not connected to a public or a private sewerage system (Figure 4.8). Similar records were obtained from Damietta's census data which shows that only 55.1 percent of households in the two local administrations are connected to a public sewerage system. The lack of access to basic public facilities is another dimension that contributes to the social vulnerability of rural communities in Egypt to climate change, especially as those poor amenities diminish the quality of the local environment (Waly, Ayad & Saadallah 2020).

7.1.2 Environmental challenges

Nearly half of the studied farmers are not satisfied with water quality in the local areas and rated their satisfaction “6 and below” on a 10-point scale (Figure 4.13). Water pollution is a predominant environmental problem observed in Damietta and it has been a persistent issue since 2003 (EEAA 2003). Deficiency in sewerage systems and poor solid waste management has forced dwellers to get rid of wastes in exposed water canals, and a shortage in the number of water treatment units has contributed to the pollution of drinking, irrigation and drainage water in the area, as it does in Egypt more broadly (EEAA 2003; Aboulnaga 2017).

Salinisation of agricultural lands is another major environmental issue reported by the studied households during the interviews. These findings are consistent with several studies addressing Egypt’s ecological problems specifically and the broader MENA region in general (Koohfkan 2001; Lofgren & Richards 2003; GLOWA 2009; Koocheki 2010; Sowers et al. 2011). However, Damietta and the Nile Delta are of specific concern for Egypt due to their location near the Mediterranean Sea, where high soil salinity levels are prevalent (Mohamed 2017). Sea-level rise has the potential to further threaten the northern coast of Egypt through inundation and rising soil salinity of the fertile agricultural areas in the Nile Delta region, including Damietta (Kreimer, Arnold & Carlin 2003; Dasgupta et al. 2009; Werner & Simmons 2009; El-Raey 2010; Hunt & Watkiss 2011; Brecht et al. 2012; EEAA 2016). The persistent water pollution could also be progressively adding to local salinisation, land degradation and deteriorating soil quality (Nunzio 2013; Abdelaal & Thilmany 2019), and more than half of the studied households perceive further future land degradation in their local areas (Table 5.8).

Farmers from Northern Egypt are facing water shortages, particularly at the beginning of the summer season cultivations. Shortages in Nile river water is perceived as an important future risk by roughly two-thirds of the studied households (Table 5.8). Due to a lack of sufficient freshwater for irrigation, Mohamed (2017) argues that farmers are already forced to reuse agricultural waste water. The availability of Nile water is crucial for agricultural production as farmlands in Damietta, as like many parts of Egypt, the region depends solely upon it for irrigation (Information and Decision Support Unit of Damietta 2017). However, several factors are expected to exacerbate water shortages in Egypt further in the coming years. First, population growth is increasing the demand for water for domestic and industrial use; consequently, water is already less likely be allocated to the agricultural sector and that trend is likely to continue in the future, as has already happened in Yemen, Jordan, and Libya (Sowers et al. 2011). Second, water pollution trends in Egypt in general, as well as the studied area, are expected to continue to reduce the quantity of clean water available for agricultural use (Abdelaal & Thilmany 2019). Third, there are escalating geopolitical challenges over Nile water. Egypt is losing control over Nile water which has been a pillar of security for the country, particularly due to the Ethiopian Grand Renaissance Dam (GDR) development (Nunzio 2013; Power 2014; ECC n.d). Fourth, the poor management of the water sector in Egypt in terms of inefficient irrigation systems, urban expansion mismanagement, and poor water delivery infrastructure are all diminishing the available resources (Soussa 2010; Karajeh et al. 2011; Swain 2011; El Bedawy 2014; Power 2014; Dakkak 2020). Added to all of those issues, climate change is projected to have adverse effects on the volumes of Nile river water flowing into Egypt (Conway 2005; Sowers et al. 2011). Consequently, the agricultural sector could face progressively increasing water shortages and reductions in quality. Such changes would adversely affect agricultural production by reducing the cultivated areas and crop productivity (Abdelaal & Thilmany 2019).

The combination of factors exacerbates risks associated with water availability, a fundamental input for agricultural production, consequently threatening many rural dwellers' livelihoods, particularly of those depending mainly on agricultural activities for living. On the national level, land degradation, water shortages and risks of climate change will undermine goals of achieving food security in Egypt, particularly when associated with rising levels of poverty and malnutrition and the declining levels of food production (Abdelaal & Thilmany 2019).

7.1.3 Agricultural-related challenges

Most respondent farmers stated that they are less than satisfied with the situation of the agricultural sector in general than they were in the past (Figure 4.13). They reported their discontent with the rising costs of agricultural inputs, which have dramatically increased in Egypt in recent years. For example, the price of 50kg of urea (a type of nitrogen fertiliser) increased by 17.5 percent in a year, reaching EGP 285 due to the rise in fuel prices (Al-Fiqi 2018). The majority of households were highly exposed to rising agricultural input costs during 2016 and 2017 (Table 4.25). Similarly, almost two-thirds of the studied farmers who leased their agricultural lands were exposed to a sudden increase in the land rent prices in 2016-2017 (Table 4.25). The high increase in prices of renting agricultural land has been witnessed in Egypt since the 1990s, with the introduction of structural adjustment policies (Bush 2000; Kassim et al. 2018). However, the costs of leasing agricultural lands have almost doubled in several villages in the Nile Delta region since 2015 (Al-Fiqi 2018). The high leasing prices of agricultural lands might limit the capacity of ambitious, small landholder farmers to exploit a potential adaptation pathway involving accessing extra land to create more economically viable and profitable market-oriented farms, as suggested by Collier & Dercon (2014). The increased costs of agricultural inputs are becoming more difficult to tolerate for many Egyptian farmers, with no profit guaranteed under the context of climate change. This conclusion was further reinforced by the high percentage of households who were exposed to crop and income losses due to climate variability and extreme weather events in 2016-2017 (Table 4.25). The problem is not only restricted to the rising prices of agricultural inputs and resources, but also their availability in the future. For instance, more than half of the studied farmers perceive future threats related to losing their agricultural lands and a decline in their capacity to access resources such as fuel, land and electricity that are crucial for sustaining their farm businesses (Table 5.8).

Egyptian agricultural policies were also reported by farmers as being disappointing (Section 4.3.2). More than three-quarters of them perceive that the current agricultural policies are unlikely to reinforce or improve the agricultural situation in Egypt (Table 5.7). A policy of particular complaint relates to the decreasing area for cultivated rice, which the government imposed in 2018 to rationalise water usage, meaning that Egypt has stopped being the largest rice producer in the Middle East (Nigatu & Motamed 2015) and now searches the international market to import rice (Reuters 2018). As a result of this policy, many farmers in the Nile Delta region were forced to plant crops such as vegetables that required less irrigation but less profit, with non-compliance resulting in fines or, in extreme cases, imprisonment (Kassim et al. 2018).

Although reducing the area used for cultivating crops requiring high water usage is a recommended adaptation measure to reduce the vulnerability of the Egyptian agricultural sector to climate change (McCarl et al. 2015), banning rice cultivation might impose further environmental, cultural and socio-economic pressures on the farming communities. Rice is considered a subsistence crop for rural dwellers, a major cash crop with high economic returns, in addition to its ability to reduce soil salinity (Tarek 1998). In fact, experts advise that the increased level of soil salinity prevalent in the northern part of the Delta necessitates the cultivation of rice as a reclamation crop to leach salts from the soils, and which is necessary since the absence of Nile flooding due to Aswan High Dam and the Grand Renaissance Dam in Ethiopia (Mohamed 2017; El Nour 2018). Such a recommendation runs counter to government plans to reduce the area under rice in the Nile Delta, thus putting the agricultural land at massive risk of deterioration.

Egypt is already one of the highest global importers of wheat in association with the Camp David Accords of 1978, and its decision to import rice, another strategic crop, could threaten local food security. The high dependency on food imports raises critical questions about global food markets' reliability to supply the country's needs, especially under climate change conditions (Waha et al. 2017; Woertz 2017; OECD-FAO 2018). In addition, the reliance upon food imports is likely to continue and is predicted to increase over time due to population growth (Woertz 2017). Such high reliance on food imports makes the region vulnerable to fluctuations in global markets and food production in other parts of the world (Waha et al. 2017; Woertz 2017; OECD-FAO 2018). Simultaneously, ongoing geopolitical conflicts and any new forms of potential economic or environmental instability generate considerable uncertainties regarding both food demand in, and supply to Egypt and many countries in the region (OECD-FAO 2018).

The majority of farmers choose traders as the main marketing channel for their produce (Table 4.22), a traditional marketing system in rural Egypt linked mainly to small and medium landholdings (Aboulnaga et al. 2017). However, a large proportion of them (43.0 percent) were generally dissatisfied with this marketing arrangement (Table 4.23). The traders are highly influential over product prices, and they deal directly with the farmers, who have weak bargaining powers, at the peak of production and when prices are lowest (Aboulnaga et al 2017). Hence, farmers generally get low prices for their produce, while traders earn high profits. Economic liberalisation in the 1980s resulted in the withdrawal of government marketing of major crops, and many small-scale producers have been unable to compete in the national or international markets (Bush & Martiniello 2017), leaving small-scale farmers under the control of middlemen and traders. Consequently, improving the marketing system in Egypt and increasing farmers' access to better market arrangements is necessary to improve local adaptive capacities and to reduce risks of climate and market-related failures (Ado et al. 2020; Marie et al. 2020).

Although most of the farmers perceive that the future of agriculture is uncertain and are generally dissatisfied with the agricultural situation in Egypt (Section 4.3.2), a quite high percentage (reaching 41.1 percent) of them still do believe that working in the farming sector, until now, has been more stable and secure than other sectors (Table 5.7). Interestingly, the results of this study found that nearly two-thirds of the studied households are not inclined to leave the agricultural sector (Table 6.14), and that more than three-quarters of the group do not have any plans to leave the sector in the near future (Table 6.18). These findings were quite surprising and suggest that those farmers might not have reached the threshold of stress, yet, that would force them to move away from the sector or their local areas (Bardsley & Hugo 2010). The incremental environmental pressures that are expected to grow in the future, however, are likely to impose more burdens on local socio-economic conditions, particularly for small landholders with limited resources, financial capital or *in situ* adaptive capacities (Morton 2007; IFAD 2010; Oppenheimer et al. 2014; Warner, Hoffmaister & Milan 2015).

With a growing population and limited economic diversification in Egypt, national labour markets are already facing challenges of absorbing an expanding urban workforce, intensifying unemployment (Akhtar et al. 2013; Nigatu & Motamed 2015; Bilgili & Marchand 2016). This scenario raises an important question of how small scale farming communities could respond effectively if their local agricultural situation continues to worsen under climate change. With the high rates of urban and rural unemployment in the region, finding alternative non-farming sources of income could become increasingly problematic for many rural households (Dixon, Gulliver & Gibbon 2001). The threat of future unemployment was already evident to more than half of the studied households as presented in Table 5.8.

7.2 Perceptions of climate change risks

Respondent smallholder farmers have been made aware of climate change through their lived personal experiences (Section 5.2). This result is in line with findings from other studies on natural resource users' perceptions of climate change in Egypt, such as those by Adoho and Wodon (2014b), Omar et al. (2015), Froehlich and Al-Saidi (2018), and Hafez (2020). The most frequently observed forms of climate change experienced by the studied households are higher temperatures and more frequent heatwaves (Figure 5.1). These particular perceptions of patterns of variability coincide with the findings of other studies also looking at perceptions of climate change in Egypt (Adoho & Wodon 2014b; Omar et al. 2015; Froehlich & Al-Saidi 2018; Hafez 2020), and with the actual climate data recorded and published in a number of studies on Egypt and MENA region (Saber 2009; Kuglitsch et al. 2010; Met office et al. 2011; Seyam 2011; Seneviratne et al. 2012; Hereher 2016; Waha et al. 2017; Nashwan et al. 2018). Other patterns of extreme weather events perceived by the studied households are more frequent incidences of frost and more erratic rain (Figure 5.1). Again, these results are consistent with the findings of Nashwan (2016) and Met. Office et al. (2011) who document a trend towards more temperature extremes (heat and cold) and rainfall extremes in Egypt over the last decade. Those climate change trends are expected to continue in the MENA region, and Egypt in particular, over time (Lelieveld et al. 2016; Waha et al. 2017), and more than half of the studied households perceive the future threats of increasing climate variability and extremes as high (Table 5.8).

Egypt has been suffering from the negative effects of climate change on health, agriculture, and livestock (EEAA 2010, 2016), and these were apparent to roughly 70 percent of households studied, who reported that climate change had adversely affected crop productivity, crop quality, livestock productivity, and subsequently their incomes (Figure 5.2). Health conditions were also perceived to be adversely affected by climate change by nearly 60 percent of the studied group as presented in Figure 5.2. These results are in line with other studies in Egypt that found that climate change has resulted in a decline in crop productivity and livestock productivity (Adoho & Wodon 2014b; Omar et al. 2015), income losses (Adoho & Wodon 2014b) and increased health problems or exhaustion (Froehlich & Al-Saidi 2018). The majority of households also perceived the productivity of farmers or labourers as being impacted negatively by climate change, which can be associated with the increased feeling of exhaustion due to climatic extremes. For illustration, Dunne, Stouffer and John (2013) project that heat stress would reduce labour capacity to work and increase risks in many parts of the world where agriculture relies still on manual labour. Additionally, most of the studied households observed that climate change had impacted heavily on the amount of time spent on agricultural operations. Likewise, Ebow et al. (2019) suggest that climate change can particularly affect the amount of effort spent on agricultural activities, given the extra work needed to overcome the impacts of climate change.

Despite the low educational attainment of most respondents, they have a high level of perception of climate change's adverse effects, which contradicts some other findings for Egyptian farmers (Omar et al. 2015), and other farmers among the developing world (Maddison 2007; Gbetibouo 2009; Nnko et al. 2021). While there are several socio-economic, demographic and biophysical factors that shape individuals' perceptions of climate change, this study found that the degree of dependency on agricultural activities for a living is a significant contributor to increasing perceptions of current and future risks associated with climate change, as explained further in Section 7.4. Agriculture is an activity sensitive to minor variations in climate; consequently, those who depend more on the sector for livelihood are more exposed to climate change risks.

7.3 Adaptation to climate change

Despite the high level of awareness of climate change amongst households, their adaptation levels are low (Figure 6.1) – a result that concurs with the notion that there is no assurance that climate change perceptions result in effective adaptation responses (Weber 2010). Even their attempts to cope with sudden short term climate risks rely on seeking help from other members of the family and community, selling assets and/or taking no action (Figure 6.2)

7.3.1 *In situ* adaptation methods

Broadly speaking, the results of this study found that increasing irrigation use is the most adopted on-farm adaptation method (Table 6.1). Although this strategy might appear to be a feasible and rational solution to climate change for many farmers, it could exacerbate the Egyptian water crisis. Moreover, the escalating water shortages and hydrologic drought caused by climate change (Hameed et al. 2020) would limit many agrarian communities' future efforts to adapt by freely utilising and increasing irrigation under extreme weather conditions.

Another on-farm adaptation method widely adopted by the studied households is the increased use of pesticides and fertilisers (Table 6.1) – a result that is similar to what Adaho & Wodon (2014c) found in several MENA countries including Egypt. The application of inorganic fertilisers and pesticides serves as a marker of agricultural intensification in the early stages of agrarian transformation (Barrett, Christian & Shiferaw 2017), and has been widely used for several decades to improve product yield and quality (Delcour, Spanoghe & Uyttendaele 2014). However, the increasing usage of chemicals in agriculture, which is projected to further increase under climate change conditions (Koohfkan 2001; Delcour, Spanoghe & Uyttendaele 2014; Koocheki 2010), could intensify the removal of soil nutrients, especially in fragile soil (Valdivia, Antle & Stoorvogel 2017). As previously highlighted, the northern Nile Delta is already facing deteriorating land quality due to the rising water tables, intrusion of seawater, inadequate drainage systems, high water pollution levels, and shortages of freshwater that are driving farmers to use more saline drainage water on their farms (Mohamed 2017). Consequently, the excessive application of chemicals could further reduce the quality of irrigation water in the studied area, which will ultimately enhance land degradation.

Although increasing the application of fertilisers and pesticides correlates with an increased harvest value, it also increases health costs and time wasted due to farmers being unable to work from sickness (Sheahan, Barrett & Goldvale 2017). One of the challenges already reported by nearly half of the respondents is the likelihood of being poisoned during the application of pesticides (Table 5.5). Many low-income farmers do not know or understand the health and safety procedures that they should follow to protect themselves when applying chemicals, and in being unaware or less informed about the health effects of these chemicals, there are significant trade-offs between food production and farmers' health (Sheahan, Barrett & Goldvale 2017). There is no accurate data about the amounts and types of pesticide used by rural households in Egypt or even the numbers of poisoning or contamination cases (Mansour 2008).

With the expected increased application of pesticides due to climate change and the lack of government regulations governing their use, the health of farmers and even many consumers could be adversely affected. Consequently, regulating the use of pesticides in Egypt is a very important part of building a sustainable agricultural system.

7.3.2 *Ex situ* adaptation methods

Migration-related adaptation strategies were found to be unpopular with most of the rural households studied (Table 6.2). Likewise, earlier studies addressing environmentally induced migration in Egypt have found that climate change is unlikely to encourage decisions to migrate (Afifi 2011; Adoho & Wodon 2014a). Again, farmers from Northern Egypt might not have reached the threshold of stress that would push them away from their local communities, but there are signs that farming is going to become more difficult, which raises the question about whether they are more likely to need to move in the future? Afifi (2011) also found that people in Egypt are not willing to leave their homes if they are not facing the immediate impacts of a sudden natural disaster, such as earthquakes or floods. Within the stable rural communities, the incremental effects of climate change are likely to keep undermining many small scale farmers' livelihoods, and especially those highly dependent on the sector for livelihood, which eventually will lead to critical situations with an absence of possible sustainable adaptation pathways.

The state of relative immobility could also be directly related to the households' migration culture shaped by the experiences and history of migration within their households and the broader communities they live in, as presented in Section 6.3. Most households have not experienced migration, and only a few households had a member who was a migrant at the time of the survey (Table 6.9). Similarly, community-level data gathered from in-depth interviews also showed limited migration experience within the local community. Even the pattern of mobility found in the studied areas is mostly restricted to movements within Damietta's regional boundaries (Table 4.8). In an ongoing cycle, the lack of experience with migration could have influenced their migration culture (Cohen 2004), which in turn has made household members more reluctant to move away from their communities. For example, most households in Northern Egypt are unlikely to leave their local communities even if they have found a guaranteed and better opportunity elsewhere (Table 6.14). Consequently, *ex situ* adaptation strategies might not be the best possible pathway for effective agricultural transformation in Egypt under the climate change context.

Importantly, the statistics and field observations from this research reveal that small landholder farmers in Egypt are not single blocks of households with a homogenous base and interests. Small-scale farmers in Egypt are considered vulnerable to climate change; however, the degree of such vulnerability varies significantly. The next section will explain the dimensions of vulnerability found among the studied households by framing the study results within the agrarian transition model.

7.4 Climate change vulnerability across the agrarian transition process

The vulnerabilities of different groups of farmers vary across the different phases of agricultural transformation within rural societies. Three groups of households were categorised based upon their livelihood dependency on agricultural activities, and used in the analysis to typify farming households with a range of different attributes, challenges and opportunities. The three household groups reflect examples of the first three phases of societal agricultural transformation, namely agricultural-based, pre-transition and transition households, and classified according to the contribution of agriculture economic activity. Group 3 includes households who depend almost wholly or wholly on agriculture to generate their livelihoods, with more than 95 percent of their income sourced from agricultural activities. For households in Group 2, income from agriculture contributes 50 to less than 95 percent of their total income. Finally, Group 1 includes households whose incomes mainly depend on non-agricultural activities, where agricultural activities only contribute less than 50 percent of their income.

Small-scale agriculture is among the most vulnerable sectors to the impacts of climate change due to its inherent sensitivity to climate (Parry & Carter 1989; Smit & Skinner 2002). Hence, individuals and households who depend on natural resources to generate their livelihoods are believed to be more vulnerable to climate stressors (Betts 2010; Black et al. 2011b). Consequently, more attention here is given to the category of households in Group 3 and the dimensions of their vulnerability to climate change. The data reveals important attributes of this most vulnerable group of households in relation to climate change risk, which suggests important lessons for adaptation in rural areas, and Egypt more broadly.

7.4.1 Group Three: Agricultural dependence and climate change

The first stage in the agrarian transition is defined as societies that are wholly dependent on agriculture, and such a population are exemplified by households in Group 3, who heavily depend on agricultural activities for their livelihoods. The agricultural sector is not only contributing to more than 95 percent of the total income of households in this Group, but results also reveal that the agricultural sector absorbs the majority of the local labour force (Table 5.18). These are the main two characteristics of agricultural-based societies, as identified by the World Bank (2015). This Group also reflects the Egyptian class structure referred to as "petty commodity producers" (Hopkins 1987), who may even have control over or ownership of a small land area, but have limited access to other means of production. The household heads of the households in Group 3 are the least educated, with an average of 5 years of formal education.

The income of households in Group 3 is highly dependent on agricultural activities, yet, most respondents were either landless or held only small areas of farmland, with an average below three *feddans* (equivalent to 1.26 ha) (Table 5.18). As previously mentioned, previous work by Aboulnaga et al. (2017) has already indicated that agricultural dependent households with less than three *feddans* are the most vulnerable category of farmers in Egypt, as their income generally falls below the international poverty line (US$ 1.25 per day per capita). In Damietta, households in Group 3 were found to have fewer assets (particularly livestock) and live in small houses located away from community services, with inadequate local refuse removal (Table 5.23). They also have low social participation rates, particularly within formal social settings, and they mostly do not hold membership in any farmers' organisations (Section 5.5.4).

The household heads of Group 3 have high levels of awareness of the negative impacts of climate change, despite their low educational attainment (Tables 5.11 and 5.18). The results from northern Egypt suggest that risk perceptions are more linked to risk exposure, which in this case is partly reflected by the individual or household dependency on the climate-sensitive activity of agriculture for a living (Koubi, Stoll & Spilker 2016). In line with Adoho and Wodon (2014b) study, poor or less-wealthy households, prevalent in Group 3, are more likely to suffer from crop and income losses due to climate change (Tables 5.15 and 5.16). Thus, irrespective of their education level, respondents who rely immediately on the weather to generate their livelihoods also appear to have a greater recognition of climate change risks.

Despite their high levels of perception of current and future climate change-related risks, and in contrast to earlier findings (Omar 2015), households in Group 3 are adapting less to climate change than other groups (Table 6.3). Many factors could limit the adaptive capacity of individuals and households, including education (Abid et al. 2019; Ekemhonye et al. 2020), income diversification (Thulstrup 2015; Ekemhonye et al. 2020; Khan et al. 2021), mobility (Adger et al. 2009; Bohensky et al. 2010; Sobczak-Szelc & Fekih 2020; Benveniste, Oppenheimer & Fleurbaey 2020; Maharjan et al. 2020), social networks and capital (Smit & Wandel 2006; Tinch et al. 2015; Abid et al. 2017), assets and wealth (Warner, Hoffmaister and Milan 2015), and land size and tenure (Defiesta & Rapera 2014; Abid et al. 2019; Khan et al. 2021). Consequently, the agriculturally-dependent households in Group 3 appear to have less capacity than other groups to adapt either *in situ* or *ex situ* to climate change due to their low social capital and assets, limited income diversification opportunities, and low educational attainment of their household heads.

Poor socio-economic factors limit their capacities to adapt and may force them to make unfavourable decisions that could often lead to a situation of maladaptation that does not reduce vulnerability but increase it instead (UNFCCC 2007). This situation was already apparent in the adaptation strategies adopted by most households and specifically those in Group 3 (Section 6.2.1). They have, for example, increased the use of chemicals in the form of pesticides and fertilisers to overcome problems imposed by climate variability and extremes. Excessive use of pesticides was found to increase health costs and time wasted by the farmers due to being ill (Sheahan, Barrett & Goldvale 2017). For illustration, the results of this study indicate that household members in Group 3 are more likely to get poisoned while applying pesticides (Table 5.16), and their expenditure on health is relatively high (Table 5.19).

7.4.1.1 A potentially trapped population? Place attachment and migration culture as barriers to *ex situ* adaptation

The vast majority of households, particularly in Group 3, have strong ties to their communities, farmlands and agricultural occupations. Even though many are suffering from poor working conditions, are dissatisfied with their primary professions, and have high levels of perception of current and future economic and environmental risks, they still state that they are unwilling to leave the sector or migrate (Section 6.5.1). Interestingly, the satisfaction of households in Group 3 with the agricultural situation is still relatively high - possibly because it is all that they know. In other words, people develop knowledge and skills in relation to a particular place, system or occupation. Accordingly, staying in a place, with a system or in an occupation makes economic sense even though the quality of their livelihoods may be declining (Schewel 2019). Such households might have developed a "bounded rationality" and chosen alternatives that are "good enough" in the short-term instead of the best option among all those available over the long-term (Simon 1982). For example, farming households may only know how to farm, so shifting their work to other non-agricultural occupations would be difficult or even unimaginable when they need to compete in a difficult labour market in Egypt. The low educational attainment of household heads in Group 3 and lack of income diversification might have limited their opportunities for previous exposure to other off-farm occupations. So for many Egyptian farmers who have spent their whole lives working in agriculture, they perceive of little alternative to move in the labour market.

Group 3 respondents even appear to wish to discourage their children from working in non-agricultural sectors (Table 6.17), which was also reflected in their high dependency on household members in the different farm operations (Table 5.24). Encouraging younger generations to stay in the sector could result from the need for workers to help on the farm and, hence, act to reduce business costs, especially as they may experience extra work with a declining local environment. This notion is reinforced by previous findings in the literature suggesting that impoverished and marginalised households can neither finance migration of their members, nor spare labour, and consequently have the potential to become trapped in deteriorating livelihood and spatial situations (Standing 1981; Black et al. 2011b; Foresight 2011; Black & Collyer 2014; Nawrotzki & DeWaard 2018). They may also wish to keep family close to look after them in their old age. Culturally, the family in Egypt is considered the most important institution for the care of the elderly, and children are aware of their responsibility towards their elderly parents (Fadel-Girgis 1983). Similarly in many other countries, family play a central role in elder care. For example, in China, there is a strong intergenerational solidarity and family members have the primary responsibility for taking care of their elderly parents by law and constitution (Li & Tracy 1999; Zhang, Gu & Luo 2014).

Migration for households in Group 3 is not a "clear strategy" that they follow despite the absence of sufficient local income diversification alternatives, as also suggested by Stark & Levhari (1982). These findings from Damietta could imply that some agricultural communities in the developing world might choose to be "voluntary immobile" even with the continuing deterioration in their living conditions because of climate change. Similarly, evidence from several parts of the developing world has shown that many people choose to stay, citing place attachment and cultural motivations as reasons for their immobility (Mortreux & Barnett 2009; Adams 2016; Farbotko 2018; Zickgraf 2019; Singh et al. 2020; Farbotko et al. 2020; Nunn et al. 2020).

In contrast, some countries such as Nepal, Haiti and the Philippines have large populations who are traditionally more mobile than others, readily seeking livelihood opportunities in other places either internally or externally in their countries (Quisumbing

& McNiven 2005; Kelly 2011; Joseph & Neiburg 2020). These countries are likely to either develop or maintain a strong migration culture as human mobility forms an increasingly important foundation to many aspects of economic, cultural and political power in their rural areas (Kelly 2011). In Damietta, high levels of attachment to place or specific cultural attributes or institutions could make it more likely that many individuals will stay in an increasingly risky location, threatened by increasing climate change impacts, including sea-level rise. These findings may also imply that *ex situ* adaptation strategies might not be a useful pathway for many agrarian communities and may only be exploited once their livelihoods are undermined, or risks become too evident and lives are put at immediate risk (Bardsley & Hugo 2010). In such a context and given their socio-economic and cultural constraints, enhancing the capacities for more impoverished, less educated smallholder farmers to adapt *in situ* becomes even more critical for generating local resilience to climate change impacts.

Spatial immobility magnifies the vulnerability of those individuals who are unable or unwilling to move (Warner, Hoffmaister and Milan 2015). Therefore, even if they need to move under extreme conditions in the future, such vulnerable Group of households will likely be trapped or forced to move in a manner in which they will be distressed and fail to find new livelihood opportunities (Bardsley & Hugo 2010; Black & Collyer 2014). For trapped populations who are unable or unwilling to relocate, repeated climate change stressors can continue to undermine their already fragile economic livelihoods and erode their asset base, making them extremely vulnerable to climate change (Black et al. 2011b; Foresight 2011; Gray & Mueller 2012; Warner & Afifi, 2014; Bronon 2015). It can be concluded that people who are poor and highly dependent on natural resources for a living such as households in Group 3, are more exposed to climate stressors and yet may also be the least able to move effectively to facilitate adaptation through the development of alternative livelihoods in other locations (Betts 2010; Black et al. 2011b).

Another dimension that contributes to the potentially "trapped" rural populations in developing countries is that some farming households might not effectively transition out of agriculture, especially under climate change situations. As mentioned earlier in Chapter 2, the early stages of transition involve agricultural production intensification, increased market-oriented production (Johnston & Mellor 1961; Timmer 1988) and the de-agrarianisation and diversification of livelihoods within rural areas (Kelly 2011;

Castella 2012; Barrett et al. 2017a, 2017b). The availability of off-farm jobs and the capacities to exploit skills and labour to move into new occupations are crucial for any individual to effectively transition out of agriculture (Christiaensen, De Weerdt & Todo 2013; Dorosh & Thurlow 2014; Christiaensen & Kanbur 2016). Therefore, it is both physical and labour-market mobility that will facilitate effective adaptation for many within transitioning societies. In other words, if societies do not have the means to intensify their agricultural production and diversify income sources for their population, they are likely to be limited in their abilities to improve farm and labour productivity and overall living conditions (Johnston & Mellor 1961; Timmer 1988; Barrett, Reardon & Webb 2001). More specifically, the proven incapability of the labour markets in Egypt and other countries in the MENA region to provide sufficient job opportunities in more productive sectors, and thereby absorb a growing population seeking opportunities away from small-scale agriculture, could further undermine the capacity of many agrarian communities to find alternative employment pathways. Hence, feedback loops could develop where a lack of industrialisation results in a stumbling agrarian transition process, limiting further opportunities for development and wealth creation.

7.4.1.2 Structural issues that are intertwined with being “trapped” in place

The implementation of neoliberal policy reforms since the 1980s in Egypt has exacerbated the fragmentation of the labour class by limiting state-led industrial investment, and many poorer, uneducated migrants to towns and cities have relied upon informal, low-productivity activities (Morsy & Levy 2020). The failure to shift labour from agriculture towards high value-added sectors not only disadvantages the more impoverished farmers typified by Group 3, as was anticipated by the agrarian transition framework suggested by Byres (1977), but is disadvantaging the country economically and politically. In other words, while capitalist influences over agriculture have been deepening in Egypt, they have taken a form that does not maximise opportunities for real economic development for the society at large and particularly entrenches disadvantage for a large, poor rural sector - and climate change will add substantially to that disadvantage.

The educational attainment of young members of low-income rural households is substantially dependent on parents' backgrounds and community characteristics (Salehi-Isfahani, Hassine & Assaad 2014; Assaad & Krafft 2020). Given the low educational attainment of household heads and lack of other household resources in Group 3, the younger members might not receive the quality of education to meet the labour market's demand for new skills. Additionally, the lack of social connections deprives young members of low-income families to secure jobs, especially highly skilled occupations (World Bank 2014; Sika 2016, 2017, 2020; Bremer 2018). Again, even if agricultural-based households have the education and skills needed for other productive non-agricultural occupations, the failure of national labour markets to create jobs and relocate labour to other productive sectors would lock millions of rural populations in a "low-value trap" (Morsy & Levy 2020), especially with the growing demographic and environmental challenges.

These struggling "trapped" households could be a potential latent group that could continue to drive radical changes in Egypt if agriculture gets worse in the future under climate change conditions. Climate change has already been seen to be destabilising many parts of the MENA region. Prolonged droughts that took place in 2006–2007 in Syria and accelerated water scarcity in Yemen due to climate change have already been identified as significant drivers of conflict in these countries over the last decade (Gleick 2014; Kelley et al. 2015; Suter 2017). In this case, the severe drought caused agricultural failures that affected millions of farmers and herders, and their communities, leading to a massive increase in the rates of migration to urban areas in search of better income provisions (Gleick 2014; Kelley et al. 2015; Suter 2017). The internal mismanaged displacement and the high unemployment rates in the major cities put more pressure on the socio-economic tensions already existing in the area, and helped to trigger the mass protests of 2011 and subsequent conflict (De Châtel 2014; Gleick 2014; Kelley et al. 2015; Suter 2017; Selby et al. 2017). In fact, climate change was an indirect driver of the Egyptian uprisings in 2011 as a result of drought and heatwaves affecting the world’s largest producers of wheat, such as Russia, Ukraine, Australia and China, causing the rapid increases in global food prices (Null & Prebble 2013; Sternberg 2013; Ayeb & Bush 2019). Pressures on natural resources in Egypt are already generating some societal instability. For instance, a number of rural villages in Egypt have already witnessed several protests, both violent and non-violent, driven by frustrated farmers in response to water shortages, pollution and water-intensive land reclamation projects (IRIN 2010; Swain 2011; OOSKNews Correspondent 2012a, 2012b, 2015; Pacific Institute 2020). Consequently, Egypt is not immune from another wave of societal instability driven by environmental change, rising poverty rates, unemployment, growing population and high dependency on food imports.

The urban sector in Egypt has already proven its incapability to absorb and provide livelihoods for farmers who were dispossessed from their lands in the 1990s, leading to successive farmer protests often involving violent uprisings (Bush 2000; El Nour 2015). Future pressures arising from economic, social, and environmental factors could erode millions of rural people's livelihoods. Consequently, a critical question of how the government could manage and support those people throughout this stumbling agrarian transition process is crucial for national societal stability. Governments need to consider the absence of potential pathways or mechanisms to support marginal local communities and households to sustain their livelihoods. Consequently, the state should consider pathways beyond simple rural economic assistance or otherwise, many rural dwellers will become stuck or move in a manner that has the potential to trigger societal instability, similar to what was experienced in Syria. Investing in rural education and reforming the rural micro-economy is crucial to developing marginal communities' living conditions and society at large. Likewise, developing primary manufacturing industries within rural communities could help create jobs and absorb de-skilled farm labour and new entrants (Tregenna 2008; Martins 2019) and reduce poverty (Loayza & Raddatz 2010). This pathway proved successful in some parts of the world, like East Asia and Turkey (Rodrik 2010; Gürbüz 2011; Dabla-Norris et al. 2013; Martins 2019). Improving the rural economy is much needed as climate change impacts would undermine many agrarian societies' living conditions and would act as a multiplier effect to the challenges already evident in every dimension of livelihoods, particularly among poor people in the developing world.

7.4.2 Group Two: Transitioning rural households

Agricultural activities contribute 50 percent to 95 percent of Group 2 household income. Although these households have had the capacity to diversify their income sources, income from agriculture remains significant to their livelihoods. Households in Group 2 have access to relatively large farmlands (Table 5.18). Group 2 has also diversified their farm income through both crop and animal production, with many households possessing relatively large numbers of livestock (Table 5.18). They are also a group of relatively wealthy landowners living in centrally located big houses (Table 5.23). Most seem to manage their agricultural business effectively, and save money to intensify farming or support alterative livelihood activities. This argument seems justified by the relatively low amount of money spent by Group 2 households on the different household expenditure items (Table 5.19). In particular, given their low expenditure on food, their farms appear able to provide them with sufficient food for household consumption (Table 5.19). Their centrally located houses might have also reduced the money spent on commuting to and from schools and reducing their education expenses (Table 5.19).

Households in Group 2 are able to diversify their livelihoods within the rural locales (Kelly 2011; Castella 2012; Barrett et al. 2017a, 2017b) and are forming linkages between farm and non-farm sectors (Johnston & Mullor 1961; Barrett, Reardon & Webb 2001), which are two key components that drive the agrarian transition. An important question is whether the partial transition out of agriculture within the pre-transition society of Egypt is sufficient to reduce poverty, improve their living conditions in the long term, and move them out of agriculture effectively, especially under climate change. The non-agricultural income may be assisting in providing financial capital to manage their agricultural businesses and could be working as a safeguard from any potential losses in agriculture. For those reasons, households in Group 2 have better adaptive capacities to climate change. They have relatively high adaptation levels, despite their lower levels of perception of climate change risks than households in Group 3. Another dimension that contributes to adaptive capacity is the adoption of sustainable and effective adaptation strategies (IPCC 2007). Beside increasing irrigation and chemicals, the adoption of more advanced *in situ* agricultural adaptation strategies was found to be adopted by households in Group 2. More specifically, of those small number of farmers who planted different crop varieties and used some soil conservation and moisture protection strategies, more than half were from households in Group 2 (Section 6.2.1).

Several factors could be seen to boost the adaptive capacities of households in Group 2. Firstly, livelihood diversification through the farm and non-farm incomes (IFAD 2008; Deressa et al. 2009; Thulstrup 2015; Barrett, Reardon & Webb 2001; Barrett, Bezuneh & Aboud 2001; Ekemhonye et al. 2020). Secondly, the household heads' older age could be another factor that influenced their adaptation choices and reinforced their adaptive capacity. Older farmers have considerable experience in farming and are more likely to understand the necessity of adaptation to their livelihoods and know-how to apply appropriate adaptive measures (Nhemachena & Hassan 2007; Hassan & Nhemachena 2008; Deressa et al. 2009; Dang et al. 2019). For example, a higher age in household heads increased the probability of adopting measures such as planting trees and irrigation among Ethiopian farmers (Deressa et al. 2009).

Finally, strong social capital is another factor that can boost household adaptive capacity in Group 2, and households in Group 2 have relatively strong social capital. Households in Group 2 have high levels of social participation and involvement in community events (Table 5.20), and some of the household heads are members of formal bodies and organisations (Tables 5.21 and 5.22). Strong social participation could be directly related to possessing large areas of farmland. Individuals who own large agricultural land areas naturally hold or acquire more power, or vice versa, and become more socially and economically dominant. In other words, possessing large land areas could be why those households actively participate in community events and have strong connections with formal organisations as they may represent a more dynamic elite within the rural area. Consequently, they are likely to have a disproportionate influence on local decision-making, including such decisions that influence their adaptive capacity. In line with earlier findings, social capital and networks are important factors that reduce vulnerability and enhance adaptive capacity (Smit & Wandel 2006; Tinch et al. 2015; Warner, Hoffmaister & Milan 2015). Strong social networks and frequent exposure to government officials and agricultural organisation personnel could also boost chances for marketing of crop produce (Hassan & Nhemachena 2008; Gbetibouo 2009; Fosu-Mensah, Vlek & MacCarthy 2012; Balew, Agwata & Anyango 2014). This argument was further justified with Group 2’s high levels of satisfaction with their produce, rating it to an average of 7 on a 10-point scale (Table 5.23). This result might also imply that households in Group 2 have better accessibility to marketing channels, which has also been proven to improve adaptive capacity (Johnston & Hesseln 2012; Fernández-Giménez et al. 2015; Below, Schmid & Sieber 2015).

Although they note strong participation, their social relationships with other villagers appear weak (Table 5.20). They might have the knowledge needed to adapt to climate variability and to operate farmlands but are perhaps less inclined to share with other farmers. This finding might have important implications for policymakers if they want to involve farmers of Group 2 who are adapting to climate change, through leadership, to transfer their knowledge and experiences with other smallholder and less wealthy farmers who are at high risk of climate change but less able to adapt.

7.4.3 Group One: Households moving to independence from agriculture

Households' members in Group 1 are more likely to be educated and satisfied with their highly skilled non-agricultural occupations (Tables 5.18 and 5.23). This Group of households typically represents what Springborg (1990) refers to as "agrarian bourgeoise", who have more education qualifications than the traditional capitalist farmers and earn primarily from non-farm activities as a result.

The high educational attainment of respondents within this Group appears to have improved their capabilities to seize other employment alternatives outside the agricultural sector, diversify their income sources, and *vice versa* (Barnett & Adger 2007). Agriculture is a secondary source of income for them, and households seem more reluctant to exert effort or invest money in their agricultural lands. These households have a low level of perceptions of climate change risks (Section 5.5.1). This low level of perception could be a result of their little dependency on agriculture for a living and their high dependence on waged labourers to operate their farms (Table 5.24). Hence, the livelihoods of households in Group 1 are less exposed to the changes in climate patterns and the resulting potential losses (Table 5.14).

This result concurs well with the importance of exposure and socio-economic status as key factors in determining the degree of vulnerability to climate change (IPCC 2014). The results also support previous findings that the higher the household dependency on natural resources for a living, the more exposed they are to climate change risks (Betts 2010; Black, Kniveton & Schmidt 2011). For example, the study of Adoho and Wodon (2014b) in Egypt and other MENA countries found that households whose heads have higher levels of education and better jobs are least likely to suffer from the impacts of climate change in comparison with those household heads who are employed in agriculture. For the households in Group 1, the social and economic risks of climate variability are relatively unimportant. They can voluntarily leave or reduce their investments into the agricultural sector if the agricultural situation in Egypt worsens. Households in Group 1 appear dissatisfied with their product sales and the national agricultural situation (Tables 5.23 and 5.25). That may also be why they are less tied to their agricultural lands and were more willing to migrate whenever they find a better opportunity elsewhere (Table 6.17) or permanently leave the agricultural sector (Tables 6.17 and 6.19).

Even if it seems that households in Group 1 have successfully transitioned out of the agricultural sector, the overall national progression through an agrarian transition appears to be less than effective - or incomplete. During the transition from a low-income agrarian society to a high-income developed society, the agriculture sector should become relatively small, yet remain productive (Barrett, Christian & Shiferaw 2017). However, Egypt has witnessed a real decline in the agricultural share of both GDP and employment over time (World Bank 2020). Additionally, the level of dissatisfaction with the agricultural situation and the willingness of the households in the transition stage to leave the sector might indicate that the sector is perhaps unproductive and doesn't drive real economic growth for those households and society at large.

7.5 Summary

This chapter discussed the key findings presented in Chapters 4, 5 and 6, with respect to the current and future environmental, institutional, socio-economic and political challenges affecting rural communities in Egypt. Results were also explained within the theoretical frameworks of agrarian transition, adaptation and (im)mobility, emphasising differences in rural households' vulnerabilities and adaptive capacities within the same agrarian system. The next chapter will further build upon these discussions and conclude the study findings in relation to the broader structural challenges prevalent in Egypt and the wider MENA region.

Chapter Eight: Conclusion

8.1 Introduction

This thesis examined the degree to which rural households in Egypt perceive and are adapting to climate change risks, and the factors that shape their perceptions of climate change and adaptive responses. The study classified three groups of households, based upon the contribution of agricultural activities to their overall income – guided by the insights of the agrarian transition phases that countries pass through as they develop. This classification reflected some of the differences in the needs and levels of vulnerability of rural households in each group. The analysis applied in the research is based on primary data collected through a questionnaire survey of 350 households at four villages in Damietta governorate in Egypt and eleven in-depth interviews with local farmers. The study also utilised secondary data such as census and government reports to support the analysis and discussion of results. The study covered a special geographical location, Damietta on the Egyptian Mediterranean coast, which is considered to be one of the most vulnerable areas to a potential rise in sea level, while the area already suffers from high levels of water pollution and soil salinity of agricultural lands.

The Middle East and North Africa region (MENA) has distinctive features that are unlike other parts of the world. The region embraces one of the fastest-growing populations in the world. In four decades, population numbers have quadrupled, rising from about 138 million in 1970 to 456 million in 2019 (World Bank 2019b). About 50 percent of the population is younger than 25 years of age, making the region one of the most youthful parts of the globe (Tür 2018; Forouheshfar, El Mekkaoui & d'Albis 2020).

In addition to population growth, multiple environmental challenges face the region. The scarcity of water resources and the projected decline in precipitation due to climate change have significant consequences for water and food security in the region. The damaged environmental systems, the scarcity of natural resources (land and water), and the ongoing degradation of agricultural lands limit the region's capacity for domestic agricultural production. Subsequent changes in agricultural production due to climate change will have huge consequences on rural livelihoods, poverty, national economies and food security (Breisinger et al. 2012; Waha et al. 2017; Sofuoğlu & Ay 2020) and exemplify a significant challenge for sustainable development in the region, which are likely to have ongoing and increasingly global consequences (Sowers, Vengosh & Weinthal 2011).

The Egyptian small-scale agricultural sector is already challenged by demographic, environmental, institutional and regional issues. Small landholders and the landless are among the most vulnerable to climate change (Morton 2007; IFAD 2010; EEAA 2010; Oppenheimer et al. 2014; Warner, Hoffmaister & Milan 2015; Aboulnaga et al. 2017; Abid et al. 2019). Alongside the extensive water pollution and scarcity, population growth, land degradation and fragmentation, the threat of the Grand Renaissance dam on Egypt's share of Nile water, climate change is jeopardising the agricultural sector and the livelihoods of many rural dwellers. Many Egyptian agricultural labourers are predicted to lose their jobs in the near future due to climate change (Gouda 2020; Ahmed et al. 2021). Consequently, Egypt could face rising economic inequalities, food insecurity and unemployment, which, in turn, could spark anti-state protests as previously experienced (Climate Diplomacy n.d-b; Selwaness & Roushdy 2019; Forouheshfar, El Mekkaoui & d'Albis 2020), or even lead to political instability in the Nile basin region (Nunzio 2013; Pemunta et al. 2021), sparked by resource-related conflicts (Selby & Hoffmann 2014; Schleussner et al. 2016; Von Uexkull et al. 2016; Detges 2016; Feitelson & Tubi 2017; Ide et al. 2021). Egypt is a key player in the Middle East, and its political and economic stability is critical for ensuring broader regional stability.

Several climate-modelling studies indicate that the region is experiencing significant climatic change compared to other parts of the world. The changes are in terms of increased summer temperatures and heatwaves (Lange 2019; Varela, Rodríguez-Díaz & deCastro 2020; Ozturk, Saygili-Araci & Kurnaz 2021), as well as decreased precipitation accompanied by long drought periods (Ozturk et al. 2018; Lange 2019). Such changes in climatic patterns have significant effects on agriculture and the livelihood of farmers in the MENA region, as they are also having on many other parts of the developing world. The research here produced important findings in relation to the broader structural and environmental changes in Egypt and the MENA region more broadly.

8.2 Major findings

The key findings of the study are presented here as answers to each of the six key research questions outlined in Chapter 1. Chapter 5, the first results chapter from the work in Damietta, presented data and discussion relating to the first three questions:

- Questions 1: What patterns of climate change have been experienced by rural households?
- Question 2: How do rural households perceive climate change risks and other risks associated with working in the agricultural sector? And,
- Question 3: Do rural households perceive additional future risks associated with climate change?

In Chapter 5, a detailed description of rural householders' perceptions of climate change was presented and discussed in relation to the associated current and future risks to the agricultural sector. This study found that 90 percent of rural households have experienced increasing climatic variability and reported various implications of climate change (Section 5.2). Increased frequency of heatwaves, higher temperatures, more cold spells and decreased rainfall are the most important forms of climate change experienced by households (Figure 5.1). Most households perceive of important adverse effects caused by climate change, particularly on crop productivity and quality, livestock productivity, income, health conditions, labourer productivity and time spent on agricultural activities (Figure 5.2).

The findings also indicate that most of the studied households perceive of further risks of climatic variability and extreme weather events, environmental degradation, shortage of resources (mainly land and Nile water), financial and business-related stresses (Table 5.8). The role of the government in supporting local farmers seems to be negligible, and many farmers reveal discontent with government policies and the general situation for agriculture in Egypt (Figure 4.13). They also believe that the future of agriculture in Egypt is uncertain (Table 5.7).

Chapter 6 provided a comprehensive analysis of households *in situ* and *ex situ* adaptation decisions. That work responds directly to the fourth research question posed in the introductory chapter of this thesis:

- Question 4: What kinds of adaptation strategies have been followed by farmers and their households to reduce the risks of impact of climate change?

The results clearly reveal that local farmers and their households are generally not adapting successfully to climate change, although their perception of the adverse impacts of climate change is high. Most of the studied farmers' adaptation strategies were *in situ* incremental adaptations – concurring with the views of Dowd et al. (2014) that the global agricultural sector mostly implements incremental adaptation rather than the necessary transformational adaptation strategies to generate long-term resilience. This study also suggests that most of the *in situ* strategies being applied in rural Damietta are likely to be ineffective for developing a sustainable agricultural sector in the longer term, given the current environmental risks prevailing in Egypt, and could eventually lead to maladaptation (Barnett & O'Neill 2010 Howden, Crimp & Nelson 2010). In fact, most of the *in situ* adaptive methods followed by the households were more related to increasing the use of agricultural inputs such as water and chemicals to deal with immediate short-term emergent problems.

The *ex situ* adaptation methods of occupational and geographical mobility were found to be adopted by few rural households in Damietta (Table 6.2). In fact, and importantly in relation to further discussion below, farmers and their households appear highly reluctant to move (Section 6.4). Their responses suggest that they are strongly tied to the agricultural sector and their local communities, and they are unwilling to move in the future, in spite of their growing discontent with the agricultural situation and their livelihood conditions.

The revelation of the low level of adaptation among local households in Damietta brings me to the last two questions of the research:

- Question 5: What are the socio-economic, demographic and cultural characteristics that influence the capacity of farmers to adapt to the risks associated with climate change?
- Question 6: Does the degree of household dependency on agriculture for their livelihood influence their level of perception of and adaptation to climate change?

These questions were addressed through a synthesis of the three results chapters. Results presented in Chapter 4 suggested that households depend on more than one income source; however, the contribution of agricultural activities to their total income remains high. Therefore, households within this study were assembled into three groups based upon the contribution of agricultural activities to their overall income and reflecting the different stages of agrarian transition. The agricultural sector contributes 95 percent and more to the incomes of households in Group 3, while Group 2 depends on agricultural activities for a living with percentages ranging from 50 to below 95. The final group of households (Group 1) main depend on non-agricultural livelihood activities, with income from agriculture contributing to below 50 percent of their total income.

The findings revealed that demographic, economic, social and physical resources accessed by the households mainly determined their vulnerability and adaptive capacity to the prevailing climate change in the study area. The case study highlights some of the socio-economic inequalities found among small-scale farmers within the local community, and mirrors the views of Clay & King (2019) that within any group of small landholder farmers, vulnerabilities and capacities to adapt to climate change are unevenly distributed.

It is vital to understand the importance of the adaptive capacities of these groups. Some households are fundamentally dependent on agriculture (Group 3) and have few alternatives for income diversification, and are more exposed to environmental losses and less capable of adapting to climate change. Besides these elements of vulnerability, the low educational attainment of the heads of Group 3 households and the lack of social capital of the majority of these agricultural dependent households are also contributing to their low adaptive capacity. Together Group 3 could be considered a particularly vulnerable group of poor rural households with limited access to agricultural land and poor social capital and live in remotely located small houses with inadequate public services. The evidence from this study suggests that the prevalent culture of immobility (both occupationally and spatially) was also remarkably strong among these agriculturally-dependent households, suggesting that they are not looking to use *ex situ* opportunities to adapt either.

On the other hand, there are a group of small-scale transitioning farming households (i.e. Group 2) who are revealing some capacities to adapt to climate change (Section 6.2.1), and are less exposed to income losses due to climate change because they are not solely dependent on agriculture (Table 5.16). This group of households were found to have strong social capital and were diversifying their income sources between farm and non-farm income. Finally, the social and economic impacts of climate change appear largely unimportant for households who depend primarily on non-agricultural activities for a living (Group 1). The heads of these increasingly agriculturally-independent households have high educational attainment and predominantly work in highly skilled and semi-skilled non-agricultural occupations (Table 5.12). They are satisfied with their non-agricultural occupation (Table 5.23) and are more willing to migrate or leave the agricultural sector if they find the opportunity to do so (Table 6.17). Hence, the findings show that agrarian populations in Egypt are not homogenous with respect to vulnerability to climate change or the capacity to adapt to its negative impacts.

8.3 Implications for theory

Much of the focus of migration studies conducted in MENA and Egypt has been about migrants and the role of environmental change in influencing their migration decisions (e.g. Warner et al. 2008; Afifi 2010; Adoho & Wodon 2014a). Perhaps research has not focused sufficiently on the category of non-movers and the causes of their immobility, when in many cases those groups could be seen to be the most vulnerable and are likely to move only when forced and often in a manner that is unplanned and distressed (Lubkemann 2008; Gleick 2014; Kelley et al. 2015; Abel et al. 2019; Nagabhatla et al. 2021). The importance of this research lies in the recognition that some portion of the Egyptian rural populations is largely immobile: a) spatially, either because they are incapable of moving, or simply that they prefer not to move as shown in Chapter 6, and b) economically, because they are not exploiting alternative livelihood opportunities as highlighted in Chapter 5.

This study attempted to explain some of the reasons behind the immobility of people in Damietta communities despite their exposure to climate-related stressors and environmental pressures. Several reasons might explain this issue within the Egyptian context. Firstly, the present stresses from climatic events might have not yet reached the threshold that threatens the basic survival needs of rural people (Bardsley & Hugo 2010). Secondly, Egypt is different from other more mobile poor rural populations from other countries, where migration is an integral part of the culture of many people (Lee 1985; Quisumbing & McNiven 2005; Kelly 2011; Knerr 2017). Migration experiences, history, and continuity generally create a culture of migration of societies (Cohen 2004; Cohen & Sirkici 2011) and over its history, Egypt has revealed comparatively low levels of migration (World Bank 2014; Forouheshfar, El Mekkaoui & d'Albis 2020). Even the rate of internal migration is low, as indicated by the stagnant rate of urbanisation in Egypt since the 1970s associated with limited rural-urban migration flows (World Bank 2014). Thirdly, the limited resources, capital, education and aspirations of poor, small landholders and landless agricultural labourers, restrict their opportunities for mobility even if they were willing to leave the agricultural sector or their local areas (Ramos 2019). The low educational attainment of many small landholder farmers in Egypt could be limiting their current and future adaptive capacities, both in relation to anticipation of *in situ* adaptation responses, and also in relation to developing prospects for occupational or geographical mobility.

Expanding on the views of Black et al. (2011b), the state of limited mobility increases the probability that the Group 3 households would be potentially "trapped" in less-rewarding occupations and fragile local environments as the climate changes, with few options for local transformations of their agricultural systems or options for moving. In Egypt and many countries of the MENA region, the main reason for the potential trapped populations likely goes beyond the lack of households' assets and willingness to move. However, the incapability, and perhaps the unwillingness, of governments to provide competitive employment and educational pathways to those stuck in their agrarian communities also exacerbates this situation.

The Egyptian labour market has been unable to provide a sufficient number of job opportunities to absorb new entrants and thereby reallocating those leaving the agricultural labour force to other productive sectors (Sika 2016, 2019; Dimova, Elder & Stephan 2016; Morsy & Levy 2020; Dimova & Stephan 2020), which is an essential step for an efficient agrarian transition. Towards the final stages of the agrarian transition, Timmer (1988) argues that the emergent industrial sectors in urban areas across many African countries have not been able to keep pace with the liberation of labour from farming and to sustainably absorb rural migrants, which leads to ongoing rural–urban tensions. The outcome of this societal pressure is a rise in unemployment, forcing agricultural labour to remain in the sector, often in association with rising rural landlessness and poverty (Timmer 1988). The arguments of that seminal work are still playing out across Africa, but are likely to be accentuated by climate change.

With the absence of possible social and economic pathways, rural households will keep suffering from climate change's negative impacts. The current and future threats of climate change are already evident to many farmers in Damietta (Tables 5.5 & 5.8) and some of the quotes are very powerful. One farmer mentioned, "*My losses are severe. I am afraid that we would lose more in the upcoming years*". At the same time, farmers in Damietta are aware of the limited livelihood opportunities they have; as one reported, "*If* *drought or flood happened in the area, where shall I go and what would I work? Even if the agricultural situation gets worse, which is already bad, what shall I do? I have no option other than agriculture … even if I want to migrate, today travelling requires a lot of money".* Another farmer mentioned, "*I have no occupation other than agriculture. I don't know how to work in any other sector,"* and another one added, *"Where would the farmer go? There are no other secondary occupations available today".*

Consequently, rural dwellers might keep holding on for as long as possible even when they fail to sustain sufficient livelihood conditions and become stuck in a deteriorating environment with limited opportunities (Black et al. 2013; Black & Collyer 2014; Adams 2016; Ayeb-Karlsson, Smith & Kniveton 2018; Nawrotzki & DeWaard 2018; Niva, Taka & Varis 2019). The ongoing poverty, the high dependency on small-scale agriculture for many rural dwellers, lack of opportunities for income diversification or remittances from elsewhere will generate problematic situations for Egypt, especially where people move into urban cities only after losing their rural livelihoods. This situation of uncontrolled rural-urban migration is already exacerbating underemployment and unemployment in urban areas such as Cairo (Chaudhuri 2000; Herrmann & Svarin 2009; Zenou 2011; Suter 2017; Selby et al. 2017), and has at times, created groups of angry citizens who are not able to participate fully in societal development, are entrenched in their situations of relative poverty and have the potential to spark political unrest (World Bank 2014; Heyne & Gebel 2016; Al-Shammari & Willoughby 2019; Selwaness & Roushdy 2019; Forouheshfar, El Mekkaoui & d'Albis 2020). Hence, it could be anticipated that unless an effective adaptation policy is implemented, Egypt could reach situations similar to those experienced in Syria, where the escalating impacts of climate change upon agriculture leave no choice for stuck farmers but to migrate to urban areas ineffectively. Already, the uncontrolled movements from rural to urban areas in Syria increased societal pressures - and the implications of the disrupted political security of the country are still playing out (De Châtel 2014; Gleick 2014; Kelley et al. 2015; Suter 2017; Selby et al. 2017).

In fact, social movements in relation to changing environmental conditions have become an increasing characteristic of rural areas across the world. India for example, has lately encountered farmers' movements in response to droughts in semi-arid regions (Chaudhuri 2021). Likewise, drought has sparked violence in Syria (Gleick 2014; Selby et al. 2017), Yemen (Glass 2010; Sowers & Weinthal 2010; Suter 2017), Sudan (Selby & Hoffmann 2014; De Juan 2015) and Kenya (Opiyo et al. 2012; Adano et al. 2012; Scheffran, Ide & Schilling 2014). Riots in Egypt have also been seen to be driven primarily by climate change-induced food crises (Null & Prebble 2013; Sternberg 2013; Maystadt, Trinh Tan & Breisinger 2014; Bush & Martiniello 2017; Ayeb & Bush 2019) and shortages in resources, particularly water (IRIN 2010; Swain 2011; OOSKAnews Corrspeondent 2012a; 2012b; Hamama & Charbel 2015; Local Press Report 2015; Pacific Institute 2020). Those movements are only likely to be empowered by a combination of exposure to climate change and limited adaptation capacities.

Beyond environmental-induced social movements and protests, farmers were at the heart of rural movements that engaged in struggles against liberalisation in Egypt (Bush 2011; El Naggar 2012; Keshk 2012; El Nour 2015; Bush & Martiniello 2017; de Lellis 2019); India (Murari 2015), Burkina Faso (Engles 2021), and Latin America (Vergara-Camus 2014; Tilzey 2020). Over history, small landholder farmers and peasants were often at the centre of political and economic struggles and have already created networks of resistance against the neoliberal processes of "depeasantisation" and "de-agrarianisation" (Bush 2016; Bush & Martiniello 2017). Edelman & Borras (2016, p.3 cited by Engles 2021) believe that the "incompleteness of the transition to capitalism in agriculture" has been driving peasant movements in recent decades. The institutions of neo-liberal governance have failed to represent the needs of an agrarian poor (Engles 2021), and in many cases, added to the economic burdens of small-scale producers who are unable to compete with large scale producers in international markets (Bush & Martiniello 2017). Climate change is also likely to exacerbate these broader political-economic risks.

The message must be heard by decision-makers that unless pathways are developed to provide rural groups with a way forward out of stuck situations, unrest may follow. With the growing water crisis, land depletion and losses in rural livelihoods due to climate change, as well as the ever-increasing unemployment, population growth, rural poverty and marginalisation of rural areas, Egypt could potentially face an agricultural crisis and a growing threat of political instability. Future risk of societal instability should be "anticipated" and incorporated into the present functioning of the current systems as a way of orienting or modulating the influence of the projected future conditions.

8.4 Implications for policy and practice

One of the major contributions of this research is the integration of the agrarian transition framework with climate adaptation theory to present the main findings in a form that acknowledge structural differences in the adaptive capacities of rural households within the single agrarian system. The three groups of households outlined in this study are a good reflection of the range of agrarian transition paths being followed within Egypt, and in fact, in the MENA region or developing countries more broadly. This classification reflects some of the differences in the needs and levels of vulnerabilities within and between groups of rural households, and consequently, could guide further research and also policies that target the situations of rural households, as they experience a particular phase of the transformation in their rural economy. To produce tangible solutions, intervention regarding adaptation should consider the differences found among households in relation to their perceptions of climate change, their intentions to respond to the change; and their capacities to adapt to the change *in situ* or *ex situ*. In fact, this study advocated that the choices of policies must consider the biophysical, cultural, economic and social heterogeneity of the underlying agrarian systems when aiming for sustainable adaptation policy.

Assisting trapped marginal communities with different sustainable pathways for adapting *in situ* should be key priority for policy makers to alleviate the adverse effects of climate change on agrarian households and stimulate the sustainable utilisation of resources in the rural locales. MENA’s growing population, its dependence on food imports, its limited water resources, its deteriorated soil conditions, and its vulnerability to climate change all reinforce the need for integral agricultural policy that are guaranteed to raise farmers’ living conditions and to secure food for its growing population. To achieve sustainable adaptation, a mix of mechanisms that combine policy, technology, education and awareness-raising, and economic or financial pathways is required (Stinger et al. 2020).

As part of any adaptation response, it is vital that the region’s governments identify opportunities to reform the labour market to efficiently allocate its growing labour force and provide opportunities to those agricultural labourers who might potentially lose their jobs due to climate change. Investing in reforming the rural micro-economy is crucial to developing marginal communities' living conditions and society at large. That may involve the development of primary-manufacturing industries and attracting both domestic and foreign investment within and across rural communities to create jobs and absorb new entrants from low-skilled farm labour to reduce poverty (Tregenna 2008; Loayza & Raddatz 2010; Martins 2019). This pathway proved successful in supporting positive agrarian transitions in parts of the world like East Asia and Turkey (Rodrik 2010; Gürbüz 2011; Dabla-Norris et al. 2013; Roncolato & Kucera 2014; Martins 2019). In fact, the study of Ingham, Read and Elkomy (2020) found that the impacts of foreign investments were positive on the manufacturing sector in Egypt over the period from 1990 and 2007, which also have beneficial growth spill-overs in other sectors such as agriculture, finance and retail, tourism and construction. The further development of this approach may be needed to reach the large marginalised populations of rural Egypt.

The absence of economic and social opportunities within rural areas raises a critical question of how much the resources of urban centres in Egypt, and many other developing countries, can absorb more migration flows from rural areas in an efficient and sustainable way. For instance, 60 percent of Cairo's urban population are living in informal areas, mostly illegal subdivisions of former agricultural lands (Sims 2012), having poor services and infrastructure (Shehayeb 2009; Abdelhalim & Abou Samra 2010). By understanding the challenges presented to communities such as those in Damietta, policy-makers can anticipate future risks arising from economic, social, and environmental pressures that could potentially erode millions of rural people's livelihoods and lead to unplanned rural-urban migration.

Another important pillar for sustainable inclusive adaptation is that people in rural communities must feel that they are able to voice their concerns and get that represented within a political sphere. It is crucial that farmers work in conjunction with researchers, policy-makers, and government and non-government bodies in order to adapt in a sustainable way and establish resilient agrarian systems (Pretty et al. 2018; Bardsley & Knierim 2020). Policy-makers need to provide economic and social alternatives that can improve the adaptive capacities of agricultural communities against climate change and at the same time suit their socio-economic needs and cultural contexts. Key to that reform would be the evolution of educational systems that run in parallel with the creation of job opportunities that absorb the emerging labour force in Egypt. Investing in education and schools in marginal areas is fundamental so that rural people are provided with the tools and skills that would enable them to diversify their income sources or move away from rural areas in a sustainable manner. Education is also fundamental to improve the adaptive capacities of agrarian communities to climate change (Abid et al. 2019; Ekemhonye et al. 2020) and allow people to effectively seek employment in emerging industries. In other words, rural adaptation extends well beyond the immediate natural resource and chemical inputs at the farm level – it raises important questions about ongoing structural change in the country.

8.5 Future research

The research findings reflect the critical situation of small landholder farmers in Damietta, one of the Northern governorates of the Egyptian Nile Delta. However, it is important to understand whether these findings reflect a societal challenge specific to Damietta or is it something that is going to be affecting other parts or all of rural Egypt, or other parts of the MENA region, in similar ways. Much of the climate change research has focussed on the impacts of sudden climate extremes (Budhathoki et al. 2020), such as cyclones, floods, droughts etc. However, attention should also be given to those people with limited opportunities who are gradually losing their livelihoods over time, through slow-onset long-term climate events. Based upon the findings of this study, some rural farmers are mitigating the risks of climate change but the majority are not. This situation is going to exacerbate inequalities and may drive more complicated challenges across Egyptian society than if people were just needing to respond to a natural disaster. In fact, the size of societal disruption from the gradual changes in resource availability due to climate change that is already witnessed in many developing countries around the world is starting to challenge the way many systems and societies are operating.

This study concluded that there is a large group of small landholder farmers that are not willing to move although their livelihoods are declining due to climate change. They appear to wish to keep holding on to their current agricultural activities until some point until they might not be able to stay immobile. So it is crucial to understand at what stage will people be desperate to move (Bardsley and Hugo 2010)? To where? And what is next? Modelling migration destinations and flows and the combination of factors that could predict migration decisions is crucial to plan for effective future migration patterns and avoid migration crises similar to what happened in Syria. The question of why and when people protest against governmental institutions also requires further consideration (Ide et al. 2021). Aspects like the broader impacts of neoliberal policies, and the pre-existing conditions of unemployment, dispossession of natural resources, poverty and socio-economic marginalization are likely to spark environmental-related conflicts and anti-state opposition (Bush & Martiniello 2017; Ide, Fröhlich & Donges 2020; Ide et al. 2021). Consequently, addressing the links between climate change, environmental degradation, resource constraints, inequality, and liberalisation policies is crucial to understand the depth of vulnerability of rural people in Egypt and many developing countries and find solutions to alleviate potential societal instability.

This study found that younger members of rural households are becoming reluctant to participate in the agricultural sector. There is ample room for further research to determine the particular reasons for the unwillingness of younger members to participate or work in agriculture and how this might interact with capacities to provide other economic alternatives for those members. In fact, it might be effective inter-generational mobility that provides the key mechanism for *ex situ* adaptation. At the same time, however, young people's reluctance to invest in agriculture could affect future adaptation efforts, especially with the growing dependency of agricultural systems around the world on old farmers.

8.6 Summary

It is clear that there are several climate and non-climate concerns that are important for decision-making in the agricultural sector. The growing political insecurity, economic inequalities, poverty, unemployment, and conflicts have historically been key features in many countries of the MENA region. Climate change would serve as a "threat multiplier", exacerbating current environmental, economic, political and social challenges. Small-scale marginalized agricultural-based societies will suffer the most from climate change. Effective and inclusive adaptation is crucial to sustain the livelihoods of agriculturally-dependent groups and at the same time avoid potential food crisis and societal instabilities and conflicts. Agrarian communities need to be supported to build resilient and sustainable systems that consider demographic challenges, resources scarcity and opportunities for mobility in relation to future climate change.

Appendix 1: Survey on climate change perceptions and adaptation in Damietta 2018

			Questionnaire number

Date	
Local Unit	
Village	
Name and code of the interviewer	

Part 1: Household information, Employment situation and perception of working in agriculture

A1 Household members

A1a	Are you the HH head?	1. Yes ☐ 2. No ☐												
A1b	Other members living in the HH *(1 refers to the respondent, from 2 to 13 people are sorted in a descending order from the oldest to the youngest age).*	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
	What is the relationship of the other members to the HH head? 1. Head of the HH 2. Spouse 3. Son/daughter 4. Step son/daughter 5. Parent 6. Parent in Law 7. Son/daughter in law 8. Grandchild 9. Grandparent 10. Brother/Sister 11. Other													
A1c	Gender 1. Male 2. Female													
A1d	Age													
A1e	Marital Status: 1. Married 2. Divorced 3. Widowed 4. Single 5. Separated 6. Contracted													
A1f	Years of schooling/education													
A1g	Number of students pursuing education													

A2 Employment situation

A1b	Other members living in the HH *(Referring to people same as A1b)*	1	2	3	4	5	6	7	8	9	10	11	12	13
A2a	Has any member of the household (aged 16 or older) currently taken up paid work? 1. Yes 2. No													
A2b	In case of No: Why: 1. Unemployed/have no work and looking for work 2. Not wishing to work 3. Housewife 4. Young Child (not yet attending school) 5. Retired person 6. Full time student 7. Have a disability that doesn't allow him/her to work 8. Other (specify)……….													
A2c	Please indicate the primary occupation of your family members (Main occupation that provides the highest wage/income) 1. Farmer 2. Agricultural wage Labourer 3. Craftsman 4. Government employee 5. Technical or Professional Services 6. Non-agricultural Labourer (construction, manufacturing, transportation, and service industries) 7. Small-medium enterprise owner 8. Tradesman 9. Other unskilled work/servant 10. Retired													
A2d	When did you start this job ------ Year													
A2e	Place of main occupation: 1. In Village 2. Other village within the governorate 3. Town 4. Other governorate													

	5. Overseas													
A2f	a. Does this job require the member to travel b. How often? 1. Daily 2. Several days/ weeks per month 2. Once weekly													
A2g	How many times did you change your main occupation since 2012? *(if no change write 0)*													
A2h	For family members who took up paid work over the period from 2012-2017: How satisfied or dissatisfied you are with your job? 0(very dissatisfied) 1 2 3 4 5(neutral) 6 7 8 9 10(very satisfied)													
A2i	Please indicate the secondary occupation of your family members if any? 1. Farmer 2. Agricultural waged Labourer 3. Craftsman 4. Government employee 5. Technical or Professional Services 6. Non-agricultural Labourer (construction, manufacturing, transportation, and service industries) 7. Small-medium enterprise owner 8. Tradesman 9. Other unskilled work/servant 10. None													
A2j	a. Does this job require the member to travel b. How often? 1. Daily 2. Several days/ weeks per month 2. Once weekly													
A2k	Does any member regularly participate in any unpaid agricultural activities? 1. Yes 2. No													
A2l	a. Do any of the children participate in any child labour? 1. Yes 2. No b. What is the nature of work 1. Paid agricultural labour 2. Help in farm without cash returns 3. Paid labour in other sectors													
A2m	In case of working (primary or secondary occupation) as a paid agricultural labourer:													
	a. How many hours per day do you normally work?													

	b. Type of employment: 1. Regular/Permanent 2. Seasonal/casual/temporary													
	c. How do you work? 1. Through a contractor 2. Agreement with the landlord 3. Other specify----													

A3 Perception of working in the agricultural sector

A3a	How likely are you exposed to the following as being employed in the agricultural sector?	
	a. Getting poisoned as a result of pesticides application	0(very unlikely) 1 2 3 4 5(neutral) 6 7 8 9 10 (very likely)
	b. Accidents during moving to - from work	0(very unlikely) 1 2 3 4 5(neutral) 6 7 8 9 10 (very likely)
	c. Not getting paid for your work	0(very unlikely) 1 2 3 4 5(neutral) 6 7 8 9 10 (very likely)
	d. Paid less than what was agreed upon	0(very unlikely) 1 2 3 4 5(neutral) 6 7 8 9 10 (very likely)
	e. Not finding work easily	0(very unlikely) 1 2 3 4 5(neutral) 6 7 8 9 10 (very likely)
	f. Income losses as a result of climate variability	0(very unlikely) 1 2 3 4 5(neutral) 6 7 8 9 10 (very likely)
A3b	Do you agree or disagree with the following statements?	
	a. People working in the agriculture sector are well paid in comparison with other sectors	0(strongly disagree) 1 2 3 4 5(neutral) 6 7 8 9 10 (strongly agree)
	b. Working in agriculture is more stable and secured than other sectors	0(strongly disagree) 1 2 3 4 5(neutral) 6 7 8 9 10 (strongly agree)
	c. Current agricultural policies are reinforcing the Egyptian agricultural situation	0(strongly disagree) 1 2 3 4 5(neutral) 6 7 8 9 10 (strongly agree)
	d. The future of agriculture in Egypt is uncertain	0(strongly disagree) 1 2 3 4 5(neutral) 6 7 8 9 10 (strongly agree)

Part 2: Previous movements, migration norms and remittance

B1 Previous movements

A1b	Other members living in the HH (Same order as A1b)	**1**	2	3	**4**	5	6	**7**	8	9	10	11	12	13
B1a	Has this person ever lived outside "this area" for any period of six months or longer within the period from 2012-2017? 1. Yes 2. No													
B1b	Place of destination Within the governorate: 1. Town 2. Rural village Outside the governorate: 3. Town/city 4. Rural village 5 . Abroad/overseas where?.........													
B1c	When did you move? (the latest movement) (mm/yyyy – mm-yyyy) (if not returned yyyy)													
B1d	Nature of migration: 1. New migrant 2. Return migrant 3. Seasonal migrant 4. Temporary migrant 5. Permanent migrant													
B1e	Reason for movement (mention the three main reasons) 1. Work 2. Marriage/joining family 3. Education 4. Patient/Accompanying patient 5. Poor quality of land or depleted soils 6. Accumulate savings 7. Political reasons/ violence 8. Escape flood/drought 9. Better infrastructure 10. Family problems, divorce, separation 11. Other (specify)….													

B1f In case of no migration: What are the reasons of no migration?

……

B2 Family migration culture/norms

<table>
<tr><td rowspan="9">B2a</td><td colspan="5">During the past 5 years, have anyone of your household/ family members and other people who may be important to you ever encouraged you to move away from this area or to stay in this area or exerted no influence?</td></tr>
<tr><td></td><td>No Such Person N/A</td><td>Encouraged you to stay</td><td>No influence</td><td>Encouraged you to move away</td></tr>
<tr><td>a. Spouse</td><td>0</td><td>1</td><td>2</td><td>3</td></tr>
<tr><td>b. Parents</td><td>0</td><td>1</td><td>2</td><td>3</td></tr>
<tr><td>c. Siblings</td><td>0</td><td>1</td><td>2</td><td>3</td></tr>
<tr><td>d. Children</td><td>0</td><td>1</td><td>2</td><td>3</td></tr>
<tr><td>e. Closest friend/neighbour</td><td>0</td><td>1</td><td>2</td><td>3</td></tr>
<tr><td>f. Community leader</td><td>0</td><td>1</td><td>2</td><td>3</td></tr>
<tr><td>g. Other (Specify) -------</td><td></td><td>1</td><td>2</td><td>3</td></tr>
<tr><td>B2b</td><td colspan="2">How likely would your household members encourage you to leave the agricultural sector?</td><td colspan="3">0(very unlikely) 1 2 3 4 5(neutral) 6 7 8 9 10 (very likely)</td></tr>
<tr><td>B2c</td><td colspan="2">How likely would you encourage your HH members and other community members from younger generations to quit working in the agricultural sector?</td><td colspan="3">0(very unlikely) 1 2 3 4 5(neutral) 6 7 8 9 10 (very likely)</td></tr>
<tr><td>B2d</td><td colspan="2">Migration of you or any other family member is the best solution to improve your economic situation</td><td colspan="3">0(strongly disagree) 1 2 3 4 5(neutral) 6 7 8 9 10 (strongly agree)</td></tr>
<tr><td>B2e</td><td colspan="2">If I am financially capable, another family member or I would definitely migrate</td><td colspan="3">0(strongly disagree) 1 2 3 4 5(neutral) 6 7 8 9 10 (strongly agree)</td></tr>
<tr><td>B2f</td><td colspan="2">I would leave this area if I found a guaranteed and good opportunity to move</td><td colspan="3">0(strongly disagree) 1 2 3 4 5(neutral) 6 7 8 9 10 (strongly agree)</td></tr>
<tr><td>B2g</td><td colspan="2">If I found a better work opportunity in other sectors, I would definitely leave the agricultural sector</td><td colspan="3">0(strongly disagree) 1 2 3 4 5(neutral) 6 7 8 9 10 (strongly agree)</td></tr>
</table>

B3 Remittance

B3a	Do the HH receive remittance from the migrant? If no ------- Part 3 If yes: How much per year?........	1. Yes ☐ 2. No ☐					
B3b	How often do you receive it	1. Monthly ☐		2. Bi-monthly ☐	3. Quarterly ☐	4. Half yearly ☐	
B3c	Which purpose(s) does the HH use the remittances?						
	a. Living costs (food)	☐	d. Education/ training	☐	g. Buying land/house	☐	
	b. Savings	☐	e. Health related expenditure	☐	h. Buying assets	☐	
	c. Agricultural intensification/ improvement	☐	f. Business in non-agricultural activity	☐	i. marriage expenditure	☐	

Part 3: Perception and adaptation to climate variability and extremes

C1 Perception of Effects of climate variability and extremes

C1a	Did you or your household experience remarkable climate variability and extreme weather events by 2018?	1. Yes ☐ 2. No ☐		
C1b	How often have you experienced such climate variability and extreme events? (number of times in a year)			
C1c	Which types of climate variability and extremes have you experienced?			
	a. Hotter temperature	☐	e. Changes in duration of rainy season	☐
	b. More erratic rain	☐	f. Decrease in annual rainy days	☐
	c. Changes in timing of rainy season	☐	g. Increase in frequency of sand storms	☐
	d. More heat waves	☐	h. Bouts of snow	☐
C1d	By 2018, did climate variability and extremes adversely impact:			
	a. productivity of crops	0(not at all) 1 2 3 4 5(neutral) 6 7 8 9 10 (most severe impacts)		
	b. quality of crop production	0(not at all) 1 2 3 4 5(neutral) 6 7 8 9 10 (most severe impacts)		
	c. livestock production	0(not at all) 1 2 3 4 5(neutral) 6 7 8 9 10 (most severe impacts)		
	d. water quantity/shortage	0(not at all) 1 2 3 4 5(neutral) 6 7 8 9 10 (most severe impacts)		

	e. quality of irrigation water	0(not at all) 1 2 3 4 5(neutral) 6 7 8 9 10 (most severe impacts)
	f. soil fertility/ land quality	0(not at all) 1 2 3 4 5(neutral) 6 7 8 9 10 (most severe impacts)
	g. income	0(not at all) 1 2 3 4 5(neutral) 6 7 8 9 10 (most severe impacts)
	h. health conditions	0(not at all) 1 2 3 4 5(neutral) 6 7 8 9 10 (most severe impacts)
	i. housing	0(not at all) 1 2 3 4 5(neutral) 6 7 8 9 10 (most severe impacts)
	j. transportation and communication	0(not at all) 1 2 3 4 5(neutral) 6 7 8 9 10 (most severe impacts)
	k. Productivity of individuals/labourers	0(not at all) 1 2 3 4 5(neutral) 6 7 8 9 10 (most severe impacts)
	l. Amount of time spent on agricultural operations	0(not at all) 1 2 3 4 5(neutral) 6 7 8 9 10 (most severe impacts)

C1e Do you have any comments you would like to make about climate variability and extremes?

……

……

C2 Adaptation to climate variability and extremes

<table>
<tr><td rowspan="13">C2a</td><td colspan="4">Which of the following strategies have you/your HH adopted the following means to reduce loses or adapt to climate variability and extremes within the past 5 years?</td></tr>
<tr><td colspan="2">Strategies adopted for continuation of Agro-based livelihood strategies (for those HHs owning/renting farmlands)</td><td colspan="2">Other strategies involved change in livelihood options</td></tr>
<tr><td>a. Increasing irrigation</td><td>☐</td><td>k. Shifted from agriculture to non-agriculture occupation</td><td>☐</td></tr>
<tr><td>b. Improving irrigation systems</td><td>☐</td><td>l. Migration of family members to nearby town/market centre for different occupation</td><td>☐</td></tr>
<tr><td>c. Increased water sources for irrigation</td><td>☐</td><td>m. Migration of family members to city for different occupation</td><td>☐</td></tr>
<tr><td>d. Planting different crop varieties (more resistant to drought, heat/varieties with shorter growing seasons)</td><td>☐</td><td>n. Migration of family members to other rural area for agro-based occupation</td><td>☐</td></tr>
<tr><td>e. Stop planting certain crops</td><td>☐</td><td>o. Migration of family member to other country</td><td>☐</td></tr>
<tr><td>f. Increase use of chemicals fertilizers/ insecticides, pesticides or fungicides</td><td>☐</td><td>p. improving accessibility to weather information</td><td>☐</td></tr>
<tr><td>g. Changing planting dates</td><td>☐</td><td></td><td></td></tr>
<tr><td>h. Formally educated family member joined agriculture</td><td>☐</td><td></td><td></td></tr>
<tr><td>i. Change livestock types/ sizes</td><td>☐</td><td></td><td></td></tr>
<tr><td>j. Mulching/ soil conservation/ moisture protection</td><td>☐</td><td></td><td></td></tr>
</table>

C2d Do you wish to comment on the previously mentioned adaptation strategies?

………

………

Part 4: Livelihood and economic conditions

D1 Social capital

D1a1	Did anyone other than your family members provide you any kind of help in times of difficulties?	1. Yes ☐ 2. No ☐
D1a2	How many times did you ask for help in the past year?	
D1a3	Kind of help offered 1. Financial help (borrowing money or products/ finding job/ helping in agricultural land) 2. Psychological help(emotional support/ giving advice) 3. Help in daily activities (taking care of children or patient)	
D1b	How do you rate your relationship with 0(very poor) 1 2 3 4 5(neutral) 6 7 8 9 10(very good)	
	a. Family members	
	b. Relatives and friends	
	c. Neighbours and village fellows	
	d. Colleagues	
	e. Government cadres	
D1c	How often do your family participate in the following affairs 0(never) 1 2 3 4 5(neutral) 7 8 9 10(always)	
	a. Discussion of public affairs in your village	
	b. Organizing public activities in your village	
	c. Giving advice to other villagers	
	d. Solving conflicts between other	
	e. Attendance of local community events	
D1d	Are you a member in any of the following:	
	a. Syndicate	☐
	b. Farmers or labour organizations/unions	☐
	c. Non-governmental organization	☐
	d. Governmental agencies	☐
	e. Political party	☐
D1e1	What information sources are accessible to you and your family members?	
	a. Internet	☐
	b. TV	☐
	c. Mobile phones	☐

	d. Radio broadcast	☐
	e. Newspapers	☐
	f. Land-line phone	☐
D1e2	What is the main source of information for your HH?	

2 Economic conditions

D2a1	HH expenditure (per month in Egyptian Pounds)	a. Food	
		b. Clothes	
		c. Health	
		d. Education	
		e. House maintenance	
		f. Cigarettes/ mobile recharge	
		g. Electricity	
		h. Gas	
		i. Transportation	
		j. House rent	
		k. Gifts/Donations	
		l. water	
		m. Entertaining activities	
		n. non-food groceries	
		o. other	
D2a2		Total monthly income	
D2a3		Total annual income	

D2b	In percentage, how does each income source contribute to the total annual income of your family?	Total 100%				
			1. Animal Production	2.Plant production	3. Paid seasonal work	4. Regular day to day labouring
	a. Agricultural production and related activities					
	b. Non-agricultural production and businesses (manufacturing, construction, tourism and services..etc)					
	c. Social security, subsidy and compensation from government					
	d. Remittances					

D2c Do you or your family members own any of the following? Please indicate the quantity

	a. Business Shop	☐		d. motorcycle	☐		g. Chicken/ducks	☐	
	b. Land	☐		e. Car	☐		h. Goats/sheep	☐	
	c. apartment	☐		f. bicycle	☐		i. Cows/bulls/buffalo	☐	

D3 Health conditions

	Members living in the HH (1 refers to the respondent)	**1**	2	3	**4**	5	6	**7**	8	9	10	11	12	13
D3a	In general, how would you rate the health condition of the family members? 0(very poor) 1 2 3 4 5(neutral) 6 7 8 9 10(very good)													
D3b	Does any member in the household have a chronic disease? 1. Yes 2. No													
D3c	Do you have any health insurance?	1. Yes ☐ 2. No ☐												
D3d	How satisfied or dissatisfied are you with the health services provided in your village?	0(very dissatisfied) 1 2 3 4 5(neutral) 6 7 8 9 10 (totally satisfied)												

D4 Housing and transportation

D4a	Property type: 1. Renting house 2. Owned		
D4b	Number of rooms in the house / How large is the house (m^2)		
D4c	Please tick if the property has the following facilities:	a. tap water	☐
		b. electricity	☐
		c. toilet	☐
		d. separated room for livestock and poultry	☐
		e. Sanitation	☐
D4d	Please indicate the average distance in kilometers between your home and the following destinations	a. primary school	
		b. nearest public transportation	
		c. medical unit	
		d. market	
		e. Main road	
		f. Town	
D4e	How satisfied or dissatisfied are you with your house?	0(very dissatisfied) 1 2 3 4 5(neutral) 6 7 8 9 10 (totally satisfied)	
D4f	In your opinion, what is the quality of the following services in the area you live in?		
	a. Water	0(very poor quality) 1 2 3 4 5(neutral) 6 7 8 9 10 (very good quality)	
	b. Electricity	0(very poor quality) 1 2 3 4 5(neutral) 6 7 8 9 10 (very good quality)	
	c. Sewerage system	0(very poor quality) 1 2 3 4 5(neutral) 6 7 8 9 10 (very good quality)	
	d. Refuse removal	0(very poor quality) 1 2 3 4 5(neutral) 6 7 8 9 10 (very good quality)	

Part 5: Land use and agricultural situation

E1 Land Use and patterns of production

E1a1	Do you or any member of your HH own or rent any agricultural farmland? If yes: write down the area (in feddans) of the farmland If No: Skip to E1h1	Own ----- Rent ----- Shared -----		
E1a2	How far is the farmland? 1. Near 2. Not very far 3. Faraway			
E1a3	The current use of this agricultural land 1. crops 2. Livestock 3. Fruits 4. Vegetables 5. Medicinal Plants 6. Fallow			
E1b	Which main marketing channel does your family adopt to sell your products? 1. Self-selling 2. Tradesman 3. Collective marketing 4. Government-arranged purchase			
E1c	What kind of training on agriculture have you or your household receive in the past 2 years?			
E1d	What kind of training on off-farm skills have you or your household receive in the past 2 years?			
E1e	Who was responsible for the following agricultural operations in past 2 years? 1. HH head 2. Spouse 3. Sons/daughters 4. Relatives			
	a. Land Preparation			
	b. Planting			
	c. Irrigation			
	d. Crop operations (pesticides application, fertilization etc.)			
	e. Harvesting			
E1f	In percentage how much do you use/depend on paid agricultural labour in such operations?	1. Family members	2. Paid Labour	3. Unpaid labour/relatives/ friends
	a. Land preparation			
	b. Planting			
	c. Irrigation			
	d. Crop operations (pesticides application, fertilization etc.)			

	e. Harvesting			
E1g	How satisfied or dissatisfies are you with the following			
	a. Availability of agricultural inputs	0(very dissatisfied) 1 2 3 4 5(neutral) 6 7 8 9 10 (totally satisfied)		
	b. Prices of the different agricultural inputs	0(very dissatisfied) 1 2 3 4 5(neutral) 6 7 8 9 10 (totally satisfied)		
	c. Quality of the inputs	0(very dissatisfied) 1 2 3 4 5(neutral) 6 7 8 9 10 (totally satisfied)		
	d. Irrigation water flow and availability	0(very dissatisfied) 1 2 3 4 5(neutral) 6 7 8 9 10 (totally satisfied)		
	e. Irrigation water quality	0(very dissatisfied) 1 2 3 4 5(neutral) 6 7 8 9 10 (totally satisfied)		
	f. Soil quality	0(very dissatisfied) 1 2 3 4 5(neutral) 6 7 8 9 10 (totally satisfied)		
	g. Quality of the agricultural drainage system	0(very dissatisfied) 1 2 3 4 5(neutral) 6 7 8 9 10 (totally satisfied)		
	h. Agricultural policies imposed by the government	0(very dissatisfied) 1 2 3 4 5(neutral) 6 7 8 9 10 (totally satisfied)		
	i. The agricultural situation in general	0(very dissatisfied) 1 2 3 4 5(neutral) 6 7 8 9 10 (totally satisfied)		

E1h1 In the previous two years 2016-2017, have you and your family members been exposed to the following shocks/problems and if yes what did you do to solve such problems?

			E1 h2 Adaptation action *(please use "," to separate different choices)*	
			1. Lending money from relatives/friends 2. Taking a loan 3. Donation from a religious institution/people 4. Advance payment from a tradesman 5. Decreasing number of meals 6. Changing types of food consumed 7. A family member had to migrate	8. Selling livestock 9. Selling assets from your house 10. Agricultural production intensification 11. Changed occupation 12. Worked in a secondary occupation 13. Withdrawing Children from school 14. Child/women started working 15. No action 16. Other (specify) -----
	a. Poor crop returns due to water shortage	☐		
	b. Crop/income losses due to extreme weather events	☐		
	c. Reduction in yields as a result of pests and diseases	☐		
	d. Reductions in crop yields due to irregularities in agricultural operations (irrigation, fertilization, pesticide application, etc.,)	☐		
	e. Crop prices dropped upon selling your production	☐		
	f. Food shortage in the HH	☐		
	g. Labour shortage	☐		
	h. Increase in the land rent prices	☐		
	i. Any increase in the prices of the agricultural inputs	☐		
	j. Lack of cash liquidity when purchasing production inputs	☐		

E2 Perception of future risks and related governmental actions

E2a	What do you perceive to be the greatest risk to your farm/business/agricultural job in the next five years? Please give a value for each risk		
			Unsure
	a. Reduction in demand for your produce	0(no risk) 1 2 3 4 5(neutral) 6 7 8 9 10(high risk)	
	b. Impacts of large agricultural businesses/corporations	0(no risk) 1 2 3 4 5(neutral) 6 7 8 9 10(high risk)	
	c. Environmental degradation/soil erosion/desertification/salinization	0(no risk) 1 2 3 4 5(neutral) 6 7 8 9 10(high risk)	
	d. Wage reduction/ lower purchasing power	0(no risk) 1 2 3 4 5(neutral) 6 7 8 9 10(high risk)	
	e. Climate variability and extremes	0(no risk) 1 2 3 4 5(neutral) 6 7 8 9 10(high risk)	
	f. Urban development pressure	0(no risk) 1 2 3 4 5(neutral) 6 7 8 9 10(high risk)	
	g. Lack of government support	0(no risk) 1 2 3 4 5(neutral) 6 7 8 9 10(high risk)	
	h. Nile river water shortage	0(no risk) 1 2 3 4 5(neutral) 6 7 8 9 10(high risk)	
	i. Decrease of resources (electricity, fuel, land)	0(no risk) 1 2 3 4 5(neutral) 6 7 8 9 10(high risk)	
	j. Financial stress and related impacts	0(no risk) 1 2 3 4 5(neutral) 6 7 8 9 10(high risk)	
	k. Loss of agricultural land	0(no risk) 1 2 3 4 5(neutral) 6 7 8 9 10(high risk)	
	l. Unemployment	0(no risk) 1 2 3 4 5(neutral) 6 7 8 9 10(high risk)	

E2b Do you have any comments you would like to make about future risks to agriculture?

E2c Are there any government policies you would like to see implemented to address these risks, for example water shortage, climate variability and extremes?

E2d	What kind of government support have you received in the last 5 years? If received please rate its impact on your business/returns		
	a. Marketing assistance	☐	0(negative effect) 1 2 3 4 5(neutral) 6 7 8 9 10(positive effect)
	b. Research and development assistance	☐	0(negative effect) 1 2 3 4 5(neutral) 6 7 8 9 10(positive effect)
	c. Subsidized input prices	☐	0(negative effect) 1 2 3 4 5(neutral) 6 7 8 9 10(positive effect)
	d. Exceptional circumstances payment	☐	0(negative effect) 1 2 3 4 5(neutral) 6 7 8 9 10(positive effect)

E2e	What further action would you like the government to be taking to support you as a farmer or hired agricultural labourer? Please rate how important each item is.	
	a. More financial investment in farming cooperative	0(not important) 1 2 3 4 5(neutral) 6 7 8 9 10(very important)
	b. Reduce costs of inputs	0(not important) 1 2 3 4 5(neutral) 6 7 8 9 10(very important)
	c. Marketing support	0(not important) 1 2 3 4 5(neutral) 6 7 8 9 10(very important)
	d. Apply a minimum hourly rate/ increase wages	0(not important) 1 2 3 4 5(neutral) 6 7 8 9 10(very important)
	e. Provide exceptional circumstances payment in times of crisis	0(not important) 1 2 3 4 5(neutral) 6 7 8 9 10(very important)
	f. Ensure supply of agricultural inputs	0(not important) 1 2 3 4 5(neutral) 6 7 8 9 10(very important)
	g. More financial investment in agricultural research and training	0(not important) 1 2 3 4 5(neutral) 6 7 8 9 10(very important)
	h. Financial investment in climate variability and extremes adaptation programs	0(not important) 1 2 3 4 5(neutral) 6 7 8 9 10(very important)
	i. Integrating farmers and labourers in DMP and in setting policy	0(not important) 1 2 3 4 5(neutral) 6 7 8 9 10(very important)
	j. Providing loans with less restrictions (lower interest rate- accepting tenants)	0(not important) 1 2 3 4 5(neutral) 6 7 8 9 10(very important)
	k. Improving climate information and early warning systems	0(not important) 1 2 3 4 5(neutral) 6 7 8 9 10(very important)

Part 6 F Movement intentions and plans

f1	How likely are you to leave the agricultural sector permanently and join another sector/occupation in the next 2 years?	0(very unlikely) 1 2 3 4 5(neutral) 6 7 8 9 10 (very likely)
f2	Are you and family members willing to move in the future?	0(very reluctant to) 1 2 3 4 5(neutral) 6 7 8 9 10(very willing to)
f3	How likely are you or some of your family members to leave this area permanently in the next 2 years?	0(very unlikely) 1 2 3 4 5(neutral) 6 7 8 9 10 (very likely)
f4	How likely are you or some of your family members to leave this area temporarily in the next 2 years?	0(very unlikely) 1 2 3 4 5(neutral) 6 7 8 9 10 (very likely)
f5	Do your family or some family members plan to move away from "this area" in the next 12 months?	1.Yes ☐ 2. No ☐
f6	If yes: to where: Within the governorate: 1. Town 2. Rural village Outside the governorate: 3. Town/city 4. Rural village 5 . Abroad/overseas	

………………………………..THE END……………..………………

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