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Making cities work

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Summary

With the rapid development of urbanization globally, climate change has become the undisputed environmental issue and is likely to exaggerate food security, especially in Chongqing, China. Although Chongqing has issued the document to adapt to climate change since 2009, it is difficult to bring satisfactory performance. As the main actors in coping with food security and climate change, it is essential for farmers to take adaptation measures to cope with climate change. Nevertheless, research shows that farmers’ choices for adaptation are related to their perception. Farmers’ participating in adaptation practices will reduce if they are unable to perceive accurate information. Therefore, in order to help the government formulate relevant policies to increase farmers’ enthusiasm for participating in climate change adaptation actions, in-depth study of the variables affecting farmers’ climate change perception and the extent of the influence of each variable is very important. Farmers in Wanzhou are the targeted group in this research. And the survey is the methodology and questionnaire is the key tool to collect data from the 400 farmers in Wanzhou, Chongqing. The main findings and conclusions of this study are as follows:

1. Most farmers in Wanzhou have an accurate perception of the increase of temperature and precipitation. However, they could not remember clearly the extreme weather events happened a long time ago or on a small scale. In addition, Farmers' risk appraisal, perceived adaptation efficacy and adaptation costs on climate change are strong, while the perceived self-efficiency is weak.

2. Objective adaptation and adaptive incentives have a directly positive impact on farmers’ risk appraisal. Each unit increase in the objective adaptation, the farmers’ risk appraisal on climate change increase by 0.15, while the growth of a unit of adaptive incentives will lead to risk appraisal growth of 0.079. Furthermore, trust in social discourse and adaptive incentives can indirectly affect farmers' risk appraisal on climate change by affecting farmers' objective adaptation.

3. Access to climate change information and adaptive incentives are positively related to adaptation appraisal. Each unit increase in the access to climate change information, the farmers’ adaptation appraisal on climate change increase by 0.227, while the growth of a unit of adaptive incentives will lead to adaptation appraisal decrease of 0.184. In addition, trust in social discourse can indirectly affect farmers' adaptation appraisal on climate change by affecting farmers' access to climate change information.

From the findings above, recommendations aiming at improving the farmers’ objective adaptation, access to climate change information, adaptive incentives and trust in social discourse are made in order to further enhance farmers' perception of climate change.

Keywords

Wanzhou District, climate change, food security, perception, adaptation

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Time flies and one year almost ends. Last September, I came to the IHS with knowing nearly nothing about urban and climate change. A year passed, I learned a lot about urban theory and sustainable development and climate change. After completing the dissertation, I also mastered data collection by questionnaire and data process by SPSS. Most importantly, I understood how wonderful it is when you have a dream to create a better living environment for others.

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Abbreviations

IHS	Institute for Housing and Urban Development
OA	Objective adaptability
ACCI	Access to climate change information
TSD	Trust in social discourse
AI	Adaptation incentive
RA	Risk appraisal
AA	Adaptation appraisal
PP	Perceived probability
PS	Perceived severity
PAE	Perceived adaptation efficacy
PSE	Perceived self-efficacy
PAC	Perceived adaptation costs
MPPACC	Model of private proactive adaptation to climate change
EFA	Exploratory factor analysis

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Chapter 1: Introduction

1.1 Background

Climate change has become the undisputed global environmental issue and one of the serious challenges globally (Wheeler and Watts, 2018). According to the IPCC Fourth Assessment Report (2007), the average temperature has increased 0.74 ± 0.18 ℃ for a century, and the growth rate has been particularly significant since 1990 due to human activity factors. Under the condition of a global warming climate, extreme weather events occur more frequently and agricultural production instability will further increase (Gornall, Betts, et al., 2010). According to the data (Dahe, 2015), extreme weather and climate events in China have changed significantly in the past 60 years. From 1960 to 2013, the number of occurrences of mass torrential rains increased from 13.5 to 17.3 times per year. In Addition, the average number of occurrences of heat waves from 1997 to 2008 increased by about 2 times from 1976 to 1994. Since the 21st century, the average number of days of above-average drought in the north, northeast, and southwest of China have increased by 16%, 37%, and 10%, respectively (Dahe, 2015).

Agriculture is considered as one of the industries that are most vulnerable to climate change, especially in developing countries (Pachauri, Allen, et al., 2014). Many kinds of research have shown that climate change is likely to exaggerate Chinese food shortage and security in the future (Xie, Huang, et al., 2018, Wang, Huang, et al., 2014, HUANG, Wei, et al., 2017). Climate change directly or indirectly affects food security through temperature, precipitation, extreme weather (such as floods, hail, drought, etc.) (Wheeler and Von Braun, 2013, Schmidhuber and Tubiello, 2007).

Precipitation affects China's food production (Wang, Huang, et al., 2014). From the research of Wang (2014), increased precipitation will exacerbate the problem of wheat reduction in southern China, while more precipitation will increase wheat production in the water-scarce areas of northern China. Huang (2017) predicts that by 2025, China's food self-reliance rate may fall to around 91% from the rate of 94.5% in 2015.

Temperature changes caused the northward shift of China's cropping system and fluctuations in grain production. In the past 50 years, climate warming has a certain inhibitory effect on the increase of total grain yield in North China, Northwest China, and Southwest China because of the shift to the north (Wang, Huang, et al., 2014). According to statistics, wheat, corn, and barley production worldwide decreased due to rising temperatures between 1981 and 2002 (Lobell and Field, 2007). Moreover, higher temperatures will result in faster loss of soil moisture and provide favourable conditions for pest and disease reproduction.

Extreme weather has caused huge losses to agricultural production globally (Gornall, Betts, et al., 2010). Heavy rainfall and persistent drought will increase soil erosion and plant damage, leading to a serious negative impact on agriculture and sustainable livelihoods. In China, from 1984 to 2013, climate disasters caused an average annual economic loss of 188.8 billion yuan, equivalent to 2.05% of GDP (Dahe, 2015).

In China, the per capita possession of agricultural resources is relatively small with the total population of 1.3 billion, and the continued growth of the population has further led to an increasingly fragile environment for agricultural production. In addition, combined with changes in the topography and production pattern, regional food supply capacity is insufficient, further exacerbating vulnerability in agricultural production. This undoubtedly exerts multiple pressures on food security and people's welfare (Rodima-Taylor, Olwig, et al., 2012).

As climate change may bring irreversible and lasting impact on food security, the scientific communities and governments gradually realized that we need to take actions to address climate change. Since climate change mitigation actions are hard to work in a short time, climate change adaptation has become the choice to address climate change (Mertz, Halsnæs, et al., 2009). World Climate Research Programme (WCRP), International Global Environmental Change Human Factors Program (IHDP), International Geosphere-Biosphere Programme (IGBP) and International Biodiversity Program (DIVERSITAS) all scientifically consider adaptation to climate change as an important criterion for human society to maintain sustainable development (Eriksen, 2009).

Farmers are vulnerable groups but also the main actors in adapting to climate change and food security (Yang, Lin, et al., 2007). The adaptation process is a highly subjective process rather than a purely rational technological process, with a value orientation and embedded in a certain social context. Even after experiencing various external pressures, individuals must perceive the need for action and recognize the ability and motivation of action. Often, the classic pattern of individual response to climate change goes through three interrelated phases, observation, perception, and action, and the previous phase is the basis of the later phase (Bohensky, Smajgl, et al., 2013). Based on the empirical research in some areas of Shandong Province, Xiao (2014) found that there is a strong correlation between perception and adaptation combined with Pearson correlation analysis, and farmers' perception of climate change is the premise and basis for adopting reasonable and effective climate change adaptation behaviours.

Farmers' choices for adaptation to extreme weather such as drought are related to their perceived intensity (Nhemachena and Hassan, 2007). When perceived risks and adaptive capacity of climate change are low, the likelihood of farmers participating in adaptation practices is reduced (Grothmann and Patt, 2005). Burnham considered that it is challenging for farmers with low ability perceiving climate change to adopt effective adaptability to climate change (Burnham and Ma, 2017). In practice, high levels of personal objective adaptability do not automatically promote adaptive behaviour unless the cognitive impairment is eliminated (Kuruppu and Liverman, 2011, Grothmann and Patt, 2005). It provides a new perspective for clarifying farmers' climate change adaptation mechanisms and adaptation processes (Kuruppu and Liverman, 2011). Therefore, a profound insight into farmers' perceptions and awareness of climate change has become an indispensable part for them to adapt to climate change.

As an important micro-subject to cope with climate change, farmers’ perception of climate change is a prerequisite to adopt adaptive actions (Maddison, 2007). Thus, identifying the key factors affecting farmers' climate change perception is critical for the government to develop effective adaptation policies and adopt effective adaptation strategies for farmers. Studies showed that farmers with different backgrounds and characteristics have different perceptions of the environmental changes that occur around them (Mitter, Larcher, et al., 2019, Asrat and Simane, 2018, Luo, Zhao, et al., 2017, Roco, Engler, et al., 2015, Burnham, 2014). Factors such as age, ethnicity, planting experience, education level, income, media information, geographical location, the frequency of extreme climate events are important factors influencing climate change perception (Le Dang, Li, et al., 2014, Ayal and Leal Filho, 2017). Furthermore, studies have shown that farmers' perceptions are the result of internal and external factors, including memory, experience, knowledge, information, institutions, socio-economic, political factors, and social paradox (Gandure, Walker, et al., 2013).

Studies have shown that farmers' perceptions of climate change in Wanzhou, Chongqing are affected by factors such as age, education level, annual household income, cultivated land area, and climatic factors. However, according to personal cognitive climate change-based social cognitive model MPPACC, four factors identified have an impact on the perception of farmers' climate change, namely objective adaptive ability, acquired climate change information, trust in social discourse, acquired climate change information, trust in social discourse, and adaptation incentives (Grothmann and Patt, 2005). This model is widely used in sociology, environmental science, and other research fields. It not only considers the cognitive aspects of the people but also the public's perception of their ability to adapt to the ones that are often overlooked by other models (Grothmann and Patt, 2005).

The previous research in Wanzhou district only determined that the objective adaptability and acquired climate change information have an impact on farmers' perception level, ignoring the influence of other factors (trust in social discourse, and adaptation incentives) on climate change perception and to what extent do they affect farmers' climate change risk appraisal and adaptation appraisal. Therefore, this paper takes Wanzhou, Chongqing as the research area, based on the survey of farmers to understand the situation of farmers' objective adaptive ability, acquired climate change information, trust in social discourse, and adaptation incentives in local area and to estimate that to what extent these factors influence the farmers' perception level of climate change. The purpose is to lay the foundation for exploring the adaptation mechanism of farmers to climate change in the mountain and poor area, which is critical for developing effective adaptation policies.

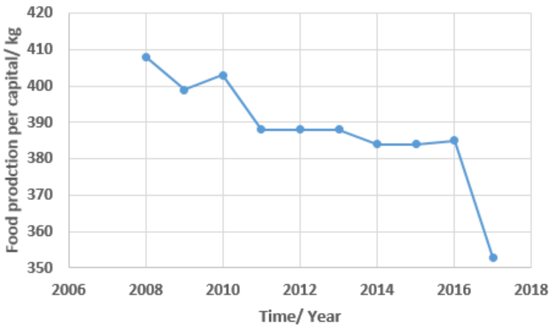
1.2 Problem Statement

Chongqing, known as the "fire stove", is the only municipality directly under the central government in western China. From 1961 to 2013, the average number of droughts in 33 stations in Chongqing in the past 53 years was 42.9. The number of droughts in the north-eastern part of Chongqing is the highest, and the number of droughts in each station is more than 50. In the summer of 2006, 2008 and 2013, most areas of Chongqing caused extreme drought due to high temperature heat waves. The extreme maximum temperature was refreshed many times, which caused a negative influence on food security in Chongqing (Zhou and Han, 2017).

It is generally believed that the government should be mainly responsible for taking measures to improve agricultural production conditions, improve the ability to withstand various meteorological disasters to mitigate the impact of climate change on food security (Hoppe, van den Berg, et al., 2014). However, as the main action agency, farmers' views and actions on climate change are very important (Kibue GW, Liu X, et al., 2016). For example, if farmers' awareness is low, they will not take actions similar to measures such as increasing irrigation to combat climate warming. It is difficult for the government to encourage farmers to take active actions to adapt to climate change. As Grothmann clarified in the MPPACC, climate change perception influences specific adaptation behaviour through adaptation intention. In other words, climate cognition is a prerequisite for action. Therefore, in order to help the government formulate relevant policies and measures to increase farmers' enthusiasm for participating in climate change adaptation actions, in-depth study of the main variables affecting farmers' climate change perception, the extent of the impact, and how these variables affect farmers' climate change levels is very important.

Since Chongqing issued the document "Program to Cope with Climate Change in Chongqing" in 2009, Chongqing has started a new round of strengthening the construction of agricultural disaster adaptation and mitigation system to increase farmers' ability to adapt to climate change and reduce the negative impact of climate change on food security. However, the per capita grain yield distribution of Chongqing from 2008 to 2017 shows that the effect of the plan is not optimistic. It can be seen in graph 1 that the per capita food production in Chongqing experienced a decline to 388kg in 2011, after which it held steady at this level and then declined strikingly to 353kg in 2017.

Figure 1. Total food production and output per capital in Chongqing from 2008 to 2017



Source: (National Bureau of Statistics of China, 2019)

According to the research, 64.2% of farmers can correctly perceive changes in temperature and precipitation in Chongqing, and adopt one or several adaptive behaviours to deal with climate change, such as adjusting crop planting structure, increasing pesticide use intensity, changing crop varieties, straw or film covering and irrigation (Huang, Guan, et al., 2017). However, other investigators have failed to take effective measures to deal with climate change. Based on MPPACC, farmers' behaviour is influenced by behavioural intentions, and adaptation intentions are influenced by climate change perceptions (Grothmann and Patt, 2005). The MPPACC framework uses perception as a key variable affecting adaptive behaviour, and decomposes it into climate change risk appraisal (CCRA) and adaptation appraisal (AA). CCRA assesses the likelihood of damage if its behaviour does not change, and the process generates specific risk perception (severity perception and likelihood perception); AA assesses one's ability to avoid harm and the cost of action, which produces specific adaptive ability perceptions (perceived adaptive performance, perceived self-efficacy, and perceived adaptation costs) (Grothmann and Patt, 2005). If farmers have higher levels of CCRA and AA, they will have higher behavioural intentions and the possibility of adopting climate change adaptation behaviour.

Perception is an important factor mentioned in the MPPACC theory (Grothmann and Patt, 2005). Farmers' perception of climate change is the premise and basis for their adoption of reasonable and effective climate change adaptation behaviour. Studies have shown that there are some variables that have an impact on the level of climate change perception, such as, objective adaptability, acquired climate change information, trust in social discourse and adaptive motivation (Grothmann and Patt, 2005). Objective adaptive ability determines whether individuals can adopt adaptive actions when facing climate change risks. Farmers will have weaker ability to perceive climate risks and take less effective and confident measures in adapting if they have lower socioeconomic status (Nelson, Kokic, et al., 2005), less income and experience (Burnham and Ma, 2017). And farmers' perceptions are also influenced by the time sequence, channels, and scope of information about climate change (Zhao and Xue, 2016). If they have trouble access to comprehensive and correct information, it is hard for them to perceive precise and detailed climate change knowledge and take essential adaptation behaviours to cope with it. And social discourse plays an important role in an individual’s perception (Luo, Zhao, et al., 2017). Farmers’ risk appraisal and adaptation appraisal are always affected by the information from the media, relatives, neighbours and local institutions (Kasperson, Renn, et al., 1988, Choi and Li, 2016). If they do not trust these sources for some reasons, they will refuse to accept the existence of climate change and take actions to adapt. In addition, adaptation incentive is another important factor affecting people's climate change perception (Grothmann and Patt, 2005). They will own higher perception and adaptation to climate change with successful adaptation incentives, including accessible protective infrastructure, social risk management and disaster risk reduction insurance (Mitter, Larcher, et al., 2019, Webber and Donner, 2017, Panda, Sharma, et al., 2013, Hassan and Nhemachena, 2008).

Chongqing is located in the south-western part of China. The main landform types are mountainous with large terrain differences, complex geological structures, and fragile ecological environment. Chongqing has a total area of 82,400 km^2 and 14 state-level poverty-stricken areas. Due to the large occupation, climate and food types will vary in different regions. Therefore, in order to improve the accuracy of the research result, this study only focuses on Wanzhou District, an environmentally vulnerable area in Chongqing, and study to what extent these factors affect local farmers' perceptions of climate change in Chongqing.

1.3 Research Objectives

Climate change is a major factor affecting agricultural production and directly affects global food production (Wheeler and Watts, 2018). China's food security issues are also directly affected by climate change (Xie, Huang, et al., 2018, Wang, Huang, et al., 2014). Faced with the food security problem brought about by climate change, how to mitigate its impact through adaptation measures has aroused great concern. As the main recipient of climate change, farmers' adaptation behavior is directly related to food security and sustainable development in the local region. The study found that farmers' adaptation to climate change is based on their perception of climate change (Grothmann and Patt, 2005). Therefore, identifying the farmers' climate change perception characteristics, and clarifying the key factors affecting perception and the mechanism of their effects on perception can help the government to screen effective climate change adaptation strategies and formulate practical climate change adaptation policies.

Chongqing is the only municipality directly under the central government in western China. It has typical urban-rural dual economic characteristics, integrating large cities, large rural areas, large mountainous areas, and concentrated poverty areas. Studies on climate change in Chongqing have been carried out since 1997, but studies on how farmers better perceive and adapt to climate change in ecologically fragile areas in Chongqing have not been reported.

Therefore, this paper takes Wanzhou District of Chongqing as the research area, firstly analyzes the climate change perception characteristics of farmers in this region based on the survey data of farmers, and then analyzes the key factors affecting their perception and to what extent these factors influence the climate change of farmers. The aim is to lay the foundation for the identification of climate change adaptation mechanisms for farmers in Chongqing, which is critical for developing effective adaptation policies.

1.4 Provisional Research Question(s)

To what extent do objective adaptive ability, acquired climate change information, trust in social discourse, and adaptation incentives influence the farmers’ perception of climate change? A case study from Wanzhou, Chongqing, China.

Sub-question:

1. What is the current situation of farmers’ perception of climate change in Wanzhou?
2. To what extent does objective adaptive ability affect the farmers’ perception of climate change in Wanzhou, Chongqing.
3. To what extent does the acquired climate change information affect the farmers’ perception of climate change in Wanzhou, Chongqing.
4. To what extent does trust in social discourse affect the farmers’ perception of climate change in Wanzhou, Chongqing.

5. To what extent does adaptation incentives affect the farmers' perception of climate change in Wanzhou, Chongqing.

1.5 Significance of the Study

Theoretical significance: Although Chongqing has carried out research on climate change since 1997, there are few reports on how farmers in Chongqing's ecologically fragile areas can better perceive and address the problem of climate change. On the basis of combining the domestic and international research about farmers' perceptions and adaptations of climate change, this paper explores the factors affecting farmers' perceptions and impacts in Chongqing, China, and provides a case study of climate change cognition in mountainous areas.

Practical implications: This study can provide scientific support and decision-making basis to formulate corresponding climate change adaptation measures for food safety in poverty areas. Farmers' participation in public actions to climate change depends on whether these families are willing to participate. This study selects farmers in Wanzhou, a typical area of Chongqing, as the research object, and deeply explores the influence degree of objective adaptive ability, acquired climate change information, trust in social discourse, and adaptation incentives on farmers' climate change perception, and provides the theoretical basis for relevant policy formulation and implementation.

1.6 Scope and Limitations

The scope of this study is limited to the following:

This paper only uses Wanzhou, Chongqing as a research area, so farmers in this study only refer to people who live in Wanzhou District, Chongqing, China. And the outcomes of the study are limited to the context of a mountain area under climate change.

In the construction of the influencing factor index system, this study has formed a relatively complete index system and model system under the framework of MPPACC and selects indicators as scientifically and reasonably as possible. However, the factors influencing climate change perception are limited to objective adaptability, access to climate change information, the social discourse and adaptation incentives without discussing other factors like social economy.

Due to the limited budget and time, this study randomly selected eight places to do a questionnaire survey. The number of questionnaires issued is limited, and most of the respondents are over 45. Therefore, it is inevitable that the data will be incompletely collected and will result in a certain impact on the analysis results.

The research area of climate change perception and adaptation is single in this study, only focusing on the Wanzhou area. In the future, it is necessary to increase the research scope of Southwest China. At the same time, it is necessary to further analyze the differences and possible causes of climate change perception and adaptation among residents in different regions.

Chapter 2: Theory Review

Chapter 2 introduces the literature about climate change perception and adaptation. In the beginning, it presented the shock of climate change on agriculture and the importance of adaptive behaviours. Then, it introduces the obstacles to adapting to climate change, focusing on understanding the influence of perceived impairment on farmers' response. Perception variables in MPPACC theory will be used in this research to help better explain the adaptability of farmers under climate change from a cognitive perspective. Finally, a theoretical framework is produced based on theory and concepts mentioned.

2.1 State of the Art of the Theories/Concepts of the Study

2.1.1 The effect of climate change to agriculture

The IPCC (2007) showed a comprehensive estimation of worldwide observations on climate change over the last several decades and reported that global temperature will get warmer in all probability. Thus, it becomes increasingly important to recognize the impacts of global warming (LI and Geng, 2013). Climate is the main element of agriculture production, directly affecting global food production (Leal Filho, 2016, Bhattacharya, 2019). Research about the influence of climate change on agricultural production has become an even more major area of scientific concern (Xie, Huang, et al., 2018).

Many types of research have shown that climate change is likely to exaggerate Chinese food shortage and security in the future (Xie, Huang, et al., 2018, Wang, Huang, et al., 2014, HUANG, Wei, et al., 2017). Precipitation has an impact on food production. For wheat, increased precipitation will exacerbate the problem of food reduction in southern China, while more precipitation will increase wheat production in the water-scarce areas of northern China (Wang, Huang, et al., 2014). Huang (2017) predicts that by 2025, China's food self-reliance rate may fall to around 91% from the rate of 94.5% (2015). Xie (2018) predicted that wheat production in China is likely to drop by 9.4% in scenario RCP 8.5 by 2050. And the corn productions are expected to fall by 3–12% by 2100, respectively (Chen, Chen, et al., 2016). Furthermore, temperature changes also have a large impact on food production. An increase in the average seasonal temperature can reduce the growth duration of many crops, thereby reducing the final yield. It was considered that the rice yield would be reduced ranging from 4.2% to 10.8% for GMT changes of 1 ℃ considering CO2-fertilization effects (Xie, Huang, et al., 2018, Tao, Hayashi, et al., 2008). Climate change not only threatens food security and causes food shortage, but also triggers enormous socio-economic losses. It was estimated that global warming in the past decade had led to about $820 million in corn and soybean industries in China (Chen, Chen, et al., 2016).

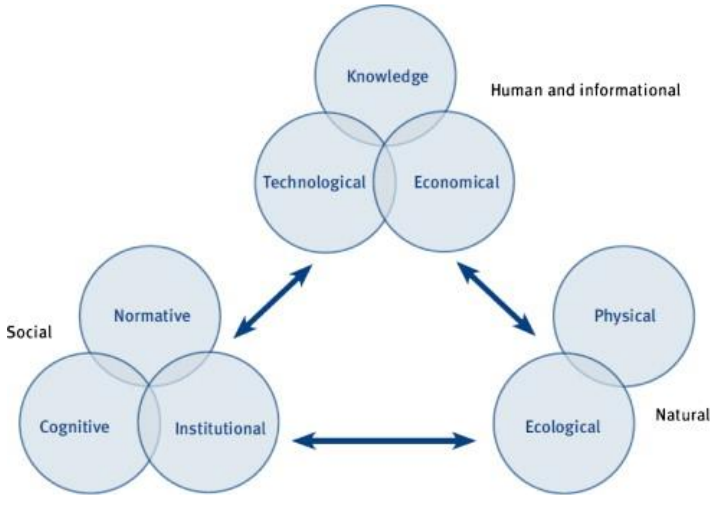
2.1.2 Main barriers to adaptation

In the face of the threat posed by climate change, how to mitigate its impact through adaptation measures has caused great concern. Agricultural production in the future will be contingent on the ability of agriculture-related performers to respond effectively to climate change (Wang, Huang, et al., 2014). Not only does the government need to take action to improve irrigation infrastructure and adopt improved technologies for agriculture (Ye, Xiong, et al., 2013), it is also necessary for farmers to make positive adaptation measures such as changing planting and harvest dates and changing planting varieties and patterns (Wang, Huang, et al., 2014).

However, planned adaptive behaviour may not be realized in practice. People often meet obstacles in seeking sustainable adaptation actions (Wheeler, Zuo, et al., 2013, Moser and Ekstrom, 2010, Jones and Boyd, 2011). Lindsey Jones (2011) classifies adaptation disorders into three categories, namely natural limitations, limitations in knowledge or technical processes, and social limitations. The first category is natural limitations, including ecological and natural constraints. Once climate change exceeds the critical threshold of ecosystems, it is difficult for ecosystems to self-regulate to respond to climate changes to ensure system integrity (Jones and Boyd, 2011). Then, human and informational resource constraints include various temporal and spatial uncertainties associated with predictive models and low-level cognition of decision-makers to carry out adaptive interventions (Jones and Boyd, 2011), which caused by knowledge, technology, and economic constraints. In addition, social barriers are divided into normative, cognitive, and institutional barriers (Jones and Boyd, 2011, Adger, Dessai, et al., 2009, Adger and Vincent, 2005), which not only influence the processes to climate stimuli, but also encourage individuals to take adaptation measures to climate change (Grothmann and Patt, 2005, Jones and Boyd, 2011, Adger, Dessai, et al., 2009).

Normative obstacles are associated with cultural customs that influence human beings' response to climate change, such as the continuation of traditional treatments and long-term adverse adaptations (Jones and Boyd, 2011). Institutional obstacles are related to organizations/institutions that influence individual adaptive behaviour choices, such as institutional inequality and social discrimination, political and social marginalization, which limit individuals' access to crucial resources needed for adaptation (Jones and Boyd, 2011). Cognitive obstacles are thinking processes that affect people's behaviour to current or expected climate stimuli. Individuals' different perceptions of climate change lead to different attitudes toward climate change (Jones and Boyd, 2011, Adger, Dessai, et al., 2009, Adger, 2010). If individuals lack trust for experts and authorities and they are unwilling to accept external assistance bear the risks associated with implementing adaptation actions, they may adapt maladaptation, such as refusing to accept or deny the fact (Grothmann and Patt, 2005).

Figure 2. Limits and barriers to adaptation to climate change



Source: (Jones and Boyd, 2011)

2.1.3 Perception, adaptation and their relationship

Farmers' perceptions to climate change, farmers' choice of adaptive behaviours, and factors affecting farmers' perceptions and adaptive behaviours have become the focus of research work under climate change by domestic and foreign researchers (Burnham and Ma, 2017). Perceived possibility includes not only farmers' perceptions of temperature, precipitation, and extreme weather events (Kibue GW, Liu X, et al., 2016, Lasco, Espaldon, et al., 2016), but also involves farmers' perception of the causes and hazards, and perceptions of government-related regulatory support (Battaglini, Barbeau, et al., 2009). Perceived severity refers to farmers' perception of the impact of climate change on their livelihoods. Studies have shown that different populations have different perceptions. Factors such as age, education level, ethnicity, planting experience, income, media information, geographical location and soil type, extreme climate events, and climate change are important factors influencing climate change perception (Le Dang, Li, et al., 2014, Ayal and Leal Filho, 2017). This perceived difference is closely related to farmers' adoption of corresponding climate change adaptation measures (Grothmann and Patt, 2005). Therefore, a deep study of farmers' perceptions has become an indispensable part of studying their adaptation to climate change.

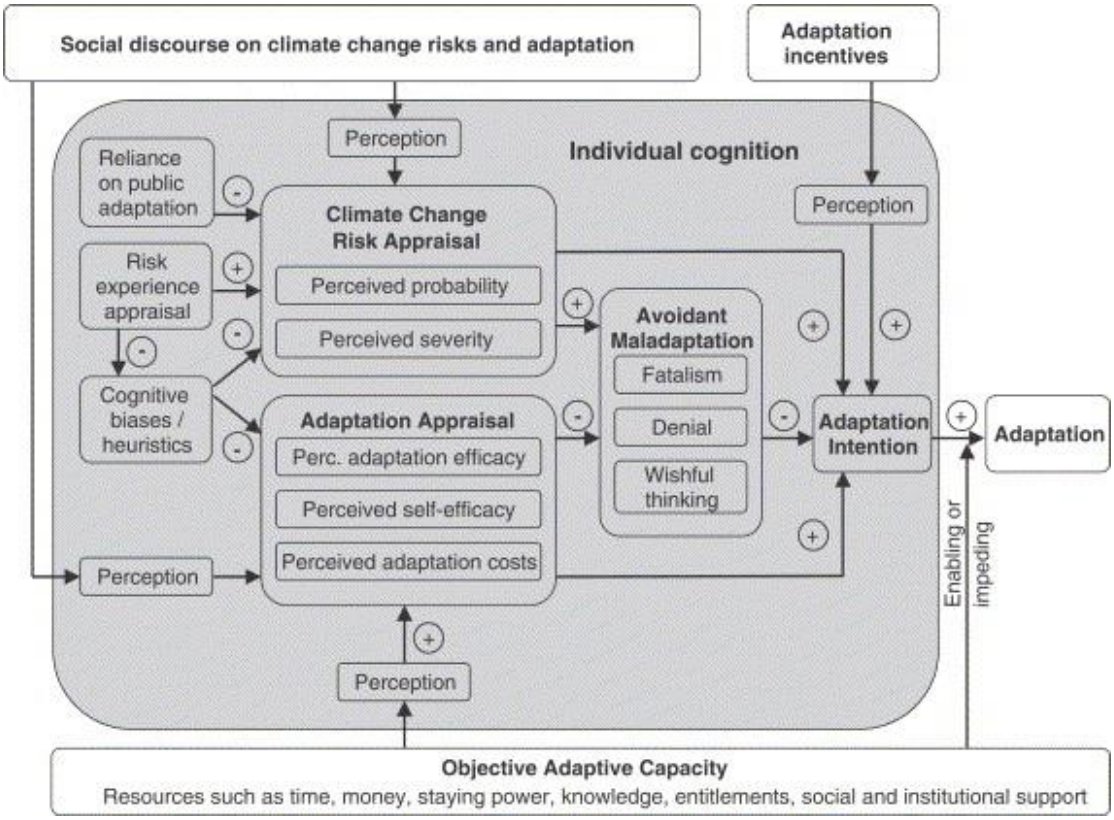
Brondizio (2016) discovered that farmers can gain an understanding of climate change based on observations of changes in production conditions such as precipitation and temperature after a period of time; in addition, farmers' perceptions have local characteristics. They tend to use local methods in the choice of adaptive behaviour. Asrat (2018) considered that changes in rainfall and temperature, the number of past crop failures, and the educational level and the age of farmers have a great impact on farmers' perception according to the data from 734 farmers. Furthermore, Roco (2015) noticed that education level and access to meteorological information are two important factors affecting Chilean farmers' perception of climate change. Policymakers should pay attention to the acquisition of meteorological information by senior farmers and low-income farmers so that farmers can better adapt to extreme weather events and climate change.

Deressa (2009) found that the education level, gender, age, and climate information acquisition will affect the local farmers' adaptation through the survey of farmers in the Nile Basin in Ethiopia. The adaptive behaviour of farmers includes changing crop types, planting trees, and increasing Irrigation, etc. Mertz (2009) discovered that farmers in Senegal have an obvious perception, and local farmers attribute negative phenomena such as reduced crop yields and sick animals to climate change. They change land-use patterns and adjust life strategies to address climate change.

Studies have shown that perception is a key factor affecting farmers' adaptation intentions to climate change (Below, Mutabazi, et al., 2012). Farmers' choices for adaptation to extreme climates (e.g. drought) are related to their perceived intensity (Seres C., 2010). When the perceived appraisal and adaptability associated with climate change are low, the likelihood of farmers participating in adaptation practices is reduced (Grothmann and Patt, 2005). Individual's high objective adaptability will not automatically promote adaptation if cognitive barriers are not addressed (Grothmann and Patt, 2005, Esham and Garforth, 2013).

2.1.4 Model of perception to climate change

Figure 3. Model of private proactive adaptation to climate change



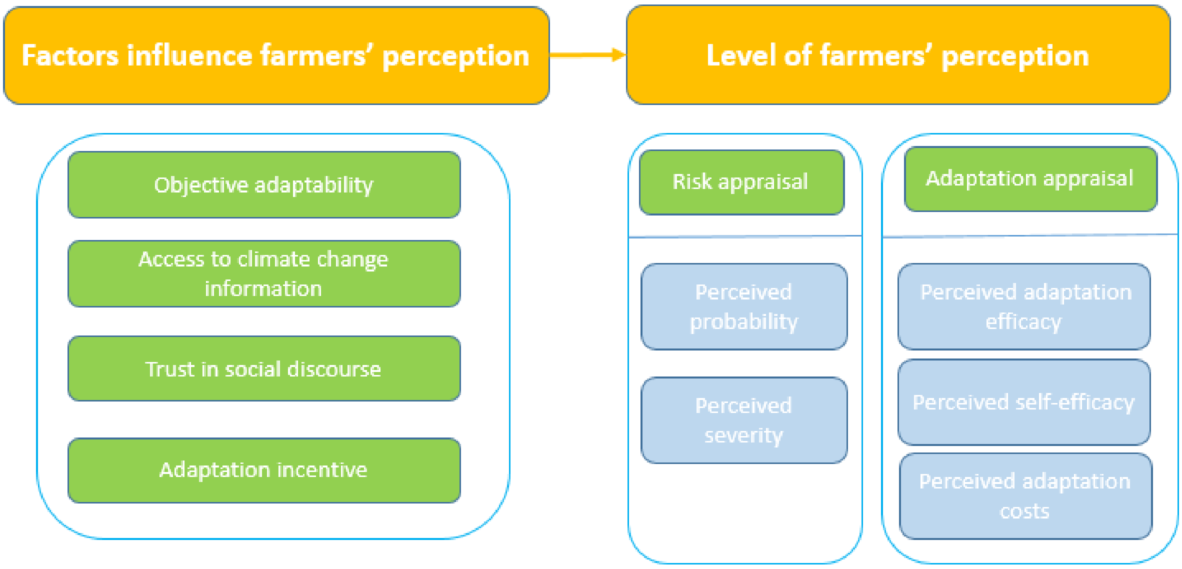
Source: (Grothmann and Patt, 2005)

A socio-cognitive model of Private Proactive Adaptation to Climate Change (MPPACC) proposed by Grothmann and Patt regards perception as a key variable affecting adaptive behaviour, not only examining people's Climate risk appraisal, and the expansion of the analysis of adaptation appraisal, has been widely used in environmental change adaptation research (Grothmann and Patt, 2005, Habiba, Shaw, et al., 2012, Fatorić and Morén-Alegret, 2013). The MPPACC framework decomposes adaptation into two processes: risk appraisal and adaptation appraisal (Grothmann and Patt, 2005). The risk appraisal (RA) process assesses the likelihood of damage if the behaviour does not change. This process produces a specific risk perception. The adaptation appraisal (AA) process refers to the ability to assess oneself from harm and the cost of adaptation behaviours. This process produces a specific adaptation perception. Climate change risk appraisal (RA) includes perceived probability (examining how likely the disaster happens) and perceived severity (examining how serious the situation is). Adaptation appraisal is divided into three sub-components—perceived adaptive efficacy (PAE), perceived self-efficacy (PSE) and perceived adaptation cost (PAC). Perceived adaptation efficacy (PAE) refers to the beliefs in the effectiveness or expected outcome of the adaptation actions taken to protect oneself or others from threats; perceived self-efficacy (PSE) refers to individual's perceived ability to implement or perform adaptive actions; perceived adaptation cost (PAC) refers to the expected cost of performing an adaptation action. The framework points out that perceived self-efficacy (PSE) is highly correlated with perceived adaptation cost (PAC). Low self-efficacy and high adaptation cost often lead to avoidant maladaptation (Grothmann and Patt, 2005).

Many scholars have studied the climate change perception of farmers (Asrat and Simane, 2018, Lasco, Espaldon, et al., 2016, Le Dang, Li, et al., 2014, Roco, Engler, et al., 2015), mainly focusing on the perceptions of farmers in different regions, the perception of the causes and effects, and the characteristics of climate change perception (Habiba, Shaw, et al., 2012, Bryan, Deressa, et al., 2009), among which the factors affecting the perception of climate change have become a key topic of scholars' research. Studies have shown that farmers' perceptions are the result of internal and external factors, including memory, experience, knowledge, information, institutions, socio-economic, political factors, and social paradox (Gandure, Walker, et al., 2013). In addition, Grothman and Patt (2005) attributed the above factors to four factors in the social cognitive model of individual adaptation to climate change, namely objective adaptive ability, acquired climate change information, trust in social discourse, and adaptation incentives, these four factors influences on farmers' risk appraisal and adaptation appraisal to climate change.

2.2 Conceptual Framework

Figure 4. Conceptual framework



Based on the literature reviewed on the adaptation behaviours and models of MPPACC, the conceptual framework of the research is constructed, aiming at displaying the main variables steering the research. The framework focuses on explaining the relationship between different factors and perceived variables to climate change. The independent variables 'objective adaptability' (OA), 'access to climate change information' (ACCI), 'farmers' trust in social discourse' (TSD) and 'adaptation incentives' (AI), as well as the dependent variables 'risk appraisal' (RA) and it sub-variables 'perceived probability' (PP), 'perceived severity' (PS), 'adaptation appraisal' (AA) and its sub-variables 'perceived adaptation efficacy' (PAE), 'perceived self-efficacy' (PSE) and 'perceived adaptation costs' (PAC) are presented in figure 4.

There are many components of objective adaptability. Brooks and Adger (2009) define objective adaptive capacity as the effectiveness of a set of resources (such as natural resource, finance, information access, expertise, and social relations) for adaptation, referring to the capacity of the system to effectively use these assets and resources to adapt. Smit and Pilifosova (2006) also suggested that the key determinants of adaptive capacity are economic resources, the effectiveness of technology choices, climate change information, infrastructure, institutions, and equity.

Objective adaptive ability determines whether individuals can adopt adaptive actions when facing climate change risks (Eakin and Bojórquez-Tapia, 2008). It plays a key role in farmers' perception and adaptation to climate change (Grothmann and Patt, 2005). For example, farmers will have stronger ability to perceive climate risks and take more effective and confident measures in adapting if they have higher socioeconomic status and more resources available (Nelson, Kokic, et al., 2005). And the social network of farmers often encourages farmers to obtain rich knowledge, information and financial assistance (Adger and Vincent, 2005), strengthening their perception and their capability to climate change. However, when individuals lack objective adaptability (such as time, money, information, endurance, knowledge, rights, and social support), they will have lower adaptive performance perception and have difficulty in adopting effective adaptive behaviour (Burnham and Ma, 2017). Nelson et al. (2005)believe that farmers' adaptive ability is the combined expectation effect of their own livelihood capital, including human capital, natural capital, physical capital, financial capital, and social capital. All these capitals affect farmers' perceptions. For example, farmers with more social capital (Adger, 2010), more income and experience (Burnham and Ma, 2017) are more vulnerable to climate change.

Perception is due to the stimulation of information. Farmers' perceptions are often influenced by the time sequence, channels, methods and scope of information dissemination of climate change (Zhao and Xue, 2016). Psychology also defines cognition as the process of message processing, reflecting the decisive role of information in cognition. Powell (Powell, 1996) divides the information that affects risk perception into two parts: risk information and information about the adaptive actions. On the one hand, access to broad and timely information helps to circumvent climate risks and increase the likelihood and effectiveness of adaptation. When information about climate change is not timely and inaccurate, people tend to miscalculate the risk of climate change, resulting in inappropriate risk appraisal and adaptive appraisal (Zhao and Xue, 2016). On the other hand, negative information that reflects the seriousness of the consequences will strengthen the public's risk appraisal of climate change. When risk events seriously threaten their own interests, people will feel panic and fear, thus enhancing their sense of crisis (Grupe and Nitschke, 2013). In conclusion, information acquisition is a key factor affecting objective adaptability. Accurate and timely climate information and effective technical information donate to the improvement of adaptive capacity (Smit and Wandel, 2006).

Social discourse is a decisive factor affecting individual risk perception and adaptive perception (Luo, Zhao, et al., 2017). Farmers often access climate change risk information and adaptation information through social communication. So their risk appraisal and adaptation appraisal are always affected by the information from the media, relatives, neighbours and local institutions (Kasperson, Renn, et al., 1988, Choi and Li, 2016). Social discourse about climate risk has an impact on individual risk perception through a socially enhanced mechanism of risk. When the risk event occurs, the mutual communication between the individual and the group is the initial reason for strengthening the individual's risk appraisal. It is then transmitted and spread through the individual's intuitive feelings (including individual experience, media information, etc.) and informal networks. The process of transmission is further enhanced by social amplification stations (such as government organizations, news media, etc.) and individual amplification stations (including preference filtering, information interpretation, etc.) (Zhao and Xue, 2016).

Adaptation incentive is an important factor affecting people's climate change perception (Grothmann and Patt, 2005). Successful adaptation incentive includes accessible protective infrastructure, social risk management and disaster risk reduction insurance (Mitter, Larcher, et al., 2019, Webber and Donner, 2017, Panda, Sharma, et al., 2013, Hassan and Nhemachena, 2008). For example, climate change information projects, technical services, subsidies, and related legal support can stimulate farmers to take adaptive actions to mitigate the financial and technological barriers to adaptation and effectively mitigate the impact of climate risks (Mitter, Larcher, et al., 2019). In addition, the meteorological information service and climate change warning service provided by the government can ensure the accuracy and timeliness of the information obtained by the public (Webber and Donner, 2017). And the technology promotion provides a platform for farmers to obtain more convenient and effective adaptation technologies, so the farmers can better perceive and adapt to climate change (Hassan and Nhemachena, 2008).

Chapter 3: Research Design and Methods

3.1 Revised Research Question(s)

To what extent do objective adaptive ability, acquired climate change information, trust in social discourse, and adaptation incentives influence the farmers' perception of climate change? A case study from Wanzhou, Chongqing, China.

Sub-question:

1. What is the current situation of farmers' perception of climate change in Wanzhou?
2. To what extent does objective adaptive ability affect the farmers' perception of climate change in Wanzhou, Chongqing.
3. To what extent does the acquired climate change information affect the farmers' perception of climate change in Wanzhou, Chongqing.
4. To what extent does trust in social discourse affect the farmers' perception of climate change in Wanzhou, Chongqing.
5. To what extent does adaptation incentives affect the farmers' perception of climate change in Wanzhou, Chongqing.

3.2 Operationalization: Variables, Indicators

The literature reviewed in Chapter 2 form the basis for the operationalization of variables and indicators. First, this section defines the theory, the elements that influence the adaptive capacity, and the MPPACC perceptual variables adaptively. Table 1 shows the concepts, variables, and indicators used in the study. Questionnaire served as the data collection tool was then prepared based on the results of the operationalization shown in Table 4.

Table 1. Operationalization of independent variables and indicators

Theory	Variables	Definition	Indicators	Question
MPPACC	Objective adaptability	Ability to utilize resources (such as nature, finance, expertise, human assets, and social networks) effectively when adopting adaptive behaviour	**Human capital:** (1) the total number of labour in the family; (2) Average educational level of labour	Q1.1-1.3
			Natural capital: Actual cultivated area per capita (mu)	Q1.4
			Physical capital: Fixed assets in the family	Q1.5
			Financial capital: Annual income per capita	Q1.6
			Social capital: Number of relatives	Q1.7
	Trust in social discourse	Farmers' trust of climate change information from the media, friends and public agencies.	Trust in experts	Q1.8
			Trust in authority	Q1.9
			Trust in the media	Q1.10
	Access to climate change information	The channels and methods of farmers to get information about climate change and whether the information they receive is timely and accurate	Number of information access channel	Q2.2
			Timeliness of information	Q2.1
			Information accuracy and credibility	Q2.3
	Adaptation incentive	Technical support, information services and early warning systems	Technical extension services to climate change provided by local government	Q2.4

		provided by local governments to encourage farmers to adopt climate adaptation behaviours	Weather information service in counties provided by local government	Q2.5
			Climate change warning service provided by local government	Q2.6

Based on the existing research, this paper selects four independent variables: objective adaptability (OA), access to climate change information (ACCI), farmers' trust in social discourse (TSD) and adaptation incentives (AI). According to the literature review of climate change perception and adaptation, the subsistence capital measured by five indicators is selected to represent the objective adaptability of the farmers (Nelson, Kokic, et al., 2005). Human capital is characterized by the overall labour capacity of the family and the average educational level of the labour force. Natural capital is characterized by the per capita arable land area owned by farmers. Physical capital, financial capital and social capital are represented by the number of fixed assets, the income per capita, and the number of relatives of farmers, respectively.

Generally speaking, the more channels farmers use to obtain climate change information, the more timely and accurate the information they receive, the higher perception of climate change they have (Zhao and Xue, 2016, Frank, Eakin, et al., 2011). Therefore, the paper selects a number of information access channel, timeliness and accuracy of information received to characterize climate change information acquired by farmers. This paper also uses the farmers' trust to public climate change information from experts, authorities, and the media to characterize the social discourse (Luo, Zhao, et al., 2017, Kasperson, Renn, et al., 1988, Choi and Li, 2016). Furthermore, Technical extension services, meteorological information services, warning services of climate change are used to characterize adaptation incentives (Mitter, Larcher, et al., 2019, Webber and Donner, 2017, Panda, Sharma, et al., 2013, Hassan and Nhemachena, 2008).

Table 2. Operationalization of dependent variables and indicators

Theory/ concept	**variables**	**Definition**	**Indicators**	**Value**	**Questionnaire**
MPPACC	Risk appraisal	Farmers assesseed the possibility of potential damage happened to their planting without taking adaptive behaviour to climate change	**Perceived probability:** The possibility of further climate change in the future is very high.	Strongly disagree=1; Disagree=2; Neutral=3; Agree=4; Strongly agree=5.	Q2.13
			Perceived severity: Climate change has a serious impact on food production and my life.		Q2.14
	Adaptation appraisal	Farmers evaluate their ability to cope with the harm from climate change with taking relative adaptive measures	**Perceived adaptation efficacy:** Taking relevant measures will definitely reduce the negative impact of climate change.		Q2.15
			Perceived self-efficacy: I have a strong ability to cope with climate change.		Q2.16
			Perceived adaptation costs: The cost of adapting to climate change is extremely high.		Q2.17

3.3 Research strategy

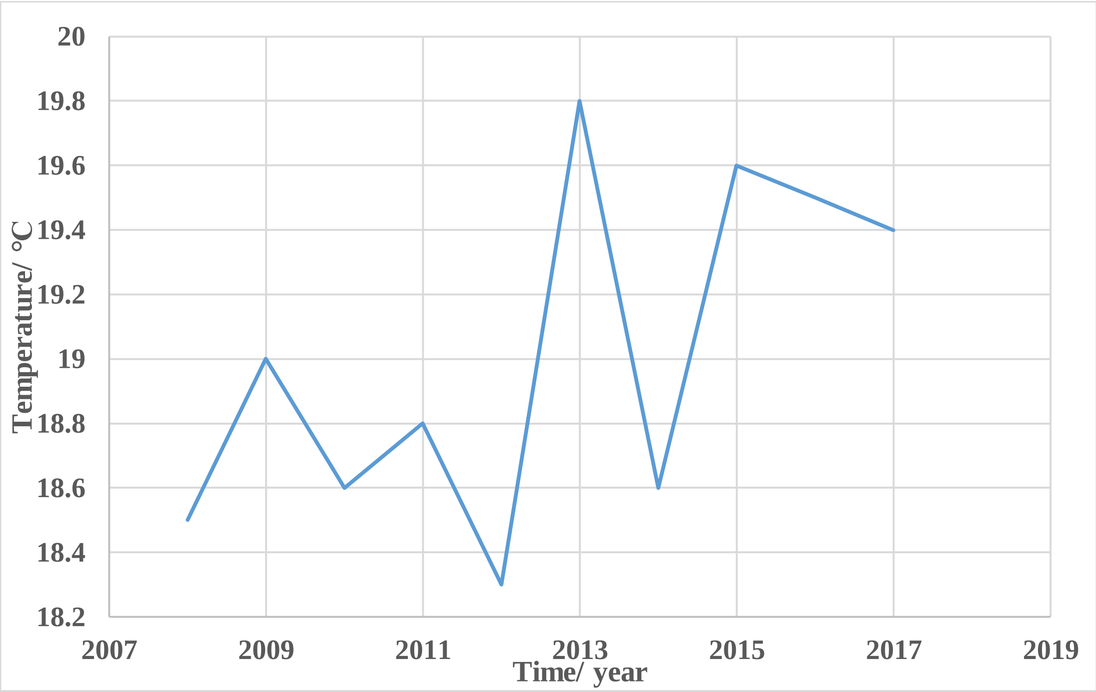
This study wants to know how the factors discovered from the literature review influence the perception of farmers to climate change in Wanhzou, Chongqing". There are much exiting knowledge that can be found in the literature and previous study. Since the number of units involved is large, experiment and case study are not suitable as strategies for this study. Furthermore, the survey becomes the most appropriate research strategy in this study because it involves more research variables. Furthermore, the research is to investigate and collect the perception of the residents to climate change. The survey is regularly utilized by organizations to collect new data, such as investigating residents' opinions (Van Thiel, 2014), making it easier to collect user's cognitive data in this study.

The questionnaire is used as a method of the survey and it has two main advantages in this study. Firstly, this research needs to collect the perception of farmers towards climate change from a large number of units. The questionnaire makes it relatively simple and easy to collect and manage the data required through a list of questions with a set of fixed answer categories (Van Thiel, 2014). What is more, this study will cover the relationship between chosen factors and the perception of farmers. Using a methodology of the questionnaire is quite straightforward to identify the values of the variables and the relationship between variables, so the questionnaire is the appropriate way for this study.

3.4 Introduction to the study area

Chongqing is the only municipality directly under the central government in western China. From 1961 to 2013, the average number of droughts in 33 stations in Chongqing in the past 53 years was 42.9. The number of droughts in the north-eastern part of Chongqing is the highest, and the number of droughts in each station is more than 50. In the summer of 2006, 2008 and 2013, most areas of Chongqing caused extreme drought due to high-temperature heat waves. The extreme maximum temperature was refreshed many times, which caused inconvenience to agriculture, life and work in Chongqing (Zhou and Han, 2017).

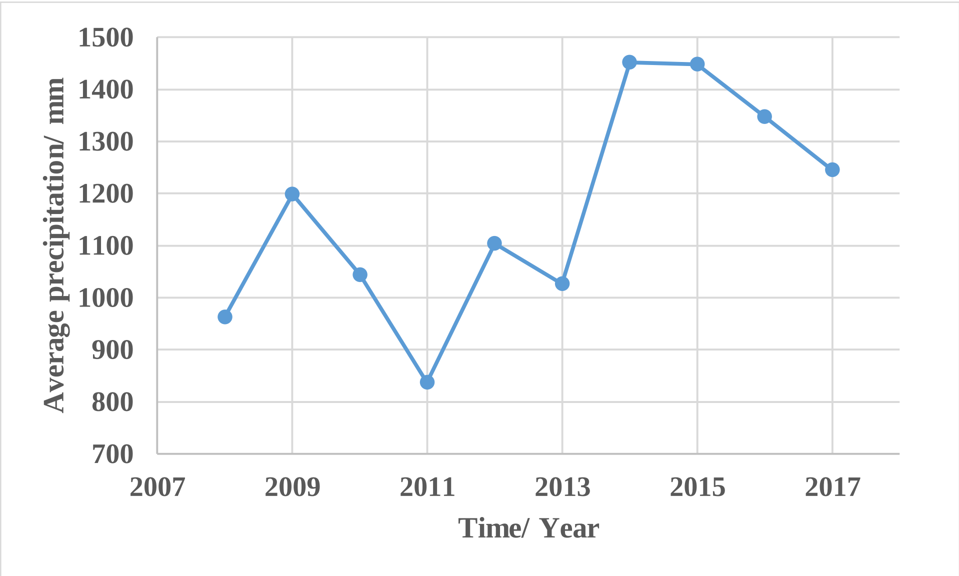
Figure 5. The average temperature in Chongqing from 2008 to 2017 (unit ℃)



Source: (National Bureau of Statistics of China, 2019).

According to the data from National Bureau of Statistic of China, the annual average temperature was on the rise from 2008 to 2017, and the average temperature in 2017 is 0.9 ℃ higher than that in 2008 (Figure 5). Furthermore, it is clear that a ten-year high-temperature appeared in 2013, was 19.8. This is because most of the south of the Yangtze River in China experienced a history of rare high-temperature and low-rain weather in 2013. The extreme hot weather events occurred in most parts of Chongqing with a long duration and wide range. The drought area of crops has reached more than 1 million hectares. The direct economic losses caused by high temperature and drought reached as much as 9.74 billion yuan, of which agricultural economic losses were the largest, reaching 6.21 billion yuan (National Bureau of Statistics of China, 2019).

Figure 6. Total precipitation in Chongqing from 2008 to 2017 (mm)



Source: (National Bureau of Statistics of China, 2019)

Figure 6 provides information about the precipitation of Chongqing from 2008 to 2017. Chongqing has abundant rainfall. The average annual precipitation in Chongqing in the past decade was above 1000mm except for the dry year of 2013. However, the distribution of rainfall time and space is uneven, and the phenomenon of extreme precipitation is serious.

Wanzhou, located in the northeast of Chongqing, covering an area of 3,457 square kilometres. In 2017, the average temperature in Wanzhou was 19.0 ℃, and the annual precipitation was 1717.5 mm. In addition, the meteorological disasters in 2017 were more than that in 2016. There were 4 local rainstorms, 10 regional rainstorms, and 1 drought, and the number of high-temperature days was 9.5 days higher than a normal year (Government of Wanzhou district, 2019).

According to the data of the Wanzhou Government website (Government of Wanzhou district, 2019) shown in Table 1, the resident population of Wanzhou District was 1,647,500 in 2018. And the rural population is 1.0089 million (N) in 2018. There are 10,563 hectares of cultivated land in Wanzhou. It is mainly divided into three types: hilly, mountainous and high mountainous areas. The hills are mainly concentrated in the parallel ridge valley area below 800 meters above sea level, which is the key area of agricultural farming; the low mountainous area is mainly in the mountainous area of 500-1000 meters above sea level, which is the main landform form of Wanzhou, and also the area of grain production and economic crops; In the Qilu Mountain and other places above 1000 meters above sea level, it is mainly suitable for planting forest fruit trees, herbs, and pastures (Government of Wanzhou district, 2019).

In view of the above situation, based on the background of climate change, this paper selects the representative Wanzhou District of the ecologically fragile area as the key research area.

3.5 Data Collection & Sample Size and Selection

The choice of data collection method is driven by the data required (Van Thiel, 2014). Considering the big unit of study (a large number of farmers in Wanzhou, Chongqing: 1 million rural population in 2018) and the variables of this study (farmers' objective adaptability, access to information, trust, incentives and their perception to climate change), primary quantitative data was entailed to meet the goal of the research. Data collection was achieved using face-to-face questionnaires from local farmers. This research wants to know farmers' perception situation and explain the factors influencing their perception and adaptation of climate change. Questionnaire not only simplifies the data collection process but also makes it easy to repeat the research process and compare the difference between farmers' basic situation and perception. Due to the time and budget constraints, this research takes simple random sampling as the sample selection methods. The study area is the Wanzhou District, Chongqing, China and the chosen research places (a questionnaire survey was conducted in 8 places of Wanzheng District, Sanshui, Dioshui, Zhoujiaba, Wuqiao, Longtan, Shidu, Sanmao and Longju.) are shown in Figure 6. The rural population is 1.0089 million (N) in 2018. According to Slovin (1960), the sample size is determined by the following formula:

$$n = \frac{N}{N \times d^2 + 1}$$

d means the tolerance of error, and d=5% here, so the total sample size is 400 respondents.

Figure 7. The map and the sampling selection places in Wanzhou District

The questionnaire is established from an in-depth literature review, consisting of 2 parts with 27 questions. Q1.1-2.6 collect data on factors that influence farmers' perceptions of climate change. Q2.7-2.12 measures whether farmers' perceptions of climate change over the past 10 years are accurate. Q2.13-2.17 collect data about farmers' RA and AA. The specific information is shown in Table 3.4 below. When designing the questionnaire and score the answers, there are some rules to obey.

3.6 Validity and Reliability

3.6.1 Validity

Internal validity: The internal validity is applied to reflect whether the theories and concepts of interest in the research are effectively transformed into measurable indicators (Van Thiel, 2014), thus successfully covering the research objectives involved in the research questions. In order to ensure the internal validity of the questionnaire, a proper design of the items should be comprised in the questionnaire. Based on the existing theoretical framework MPPACC, this study systematically collects the relevant variables (independent variables: OA, ACCI, TSD, and AI; dependent variables: RA and AA) from the literature review, ensuring that the variable selection is derived from the existing literature (e.g.; PP, PS, PAE, PSE and PAC). These variables are recognized as valid variables due to the reason that MPPACC was constructed based on credible theories after a long period of gathering evidence. MPPACC has been successfully used in the case in German cities and rural Zimbabwe to demonstrate the effectiveness of MPPACC in explaining individuals' perception and adaptation to climate change and to test the causal relationship between its variables. In addition, this study tries to guarantee that all measurable indicators (e.g.; five livelihoods capital, timeliness, and accuracy of the information and so on) influencing the perception within the scope of the study are included in this questionnaire when operationalizing the variables. Thus, initial errors in the design of the questionnaire can be avoided. Furthermore, five farmers were selected to conduct a pilot test of the questionnaire before the actual data collection period so that the items of the questionnaire can be adjusted according to the difficulties encountered by the farmers in filling out the questionnaire. Thus, the best clarity and understanding of the items in the questionnaire can be maintained.

External validity: Education level of farmers will affect the perception of farmers towards climate change according to the literature review. So when doing the questionnaire with the lower-educated group, clear explanation about the research goals and significance should be introduced to encourage them to answer the questionnaire, avoiding the non-proportional distribution in the population. Furthermore, non-response can lead to a low response rate from respondents, especially when using an online questionnaire (Van Thiel, 2014). However, this study used a face-to-face questionnaire, which means that researchers can try best to encourage and increase the response from local farmers when communicating, ensuring the sample size to meet the external validity.

3.6.2 Reliability

Reliability refers to the accuracy and consistency of variables that are measured by accurate measurable indicators and items (Van Thiel, 2014). Highly reliable questionnaires mean that the questionnaire can be used to collect data from people at different research times and spaces, but get similar results. Due to time and budget constraints, this research uses internal consistency to test the reliability of the questionnaire, realized on Cronbach's alpha by using SPSS.

3.7 Data Analysis Techniques

3.7.1 Measurement of climate change perception

In order to quantitatively analyze the differences in the perception of climate change among farmers in Wanzhou District, the Climate Change Perception Index is introduced. Based on the MPPACC analysis framework, farmers' risk appraisal and adaptation appraisal are used as variables and operationalized into measurement indicators (Table 2). When calculating the climate change perception index of farmers, various climate change perception options are assigned on a five-point Likert scale. Then the various perceptions of farmers in different regions are summed up. The formula is as follows:

$$F_j = \frac{1}{n}\sum_{i=1}^{n} f_{ij} \qquad \text{Equation (1)}$$

F_j represents the farmer's perception index on the j problem, f_{ij} represents the perception of farmer i on the j problem, and n is the number of farmers.

3.7.2 Multiple linear regression model

Regression analysis tests whether the quantitative relationship between two or more variables is linear. Regression analysis can present which variables have a significant impact on the dependent variables and indicate the intensity of their impact (Van Thiel, 2014). The basic steps include determining variables, establishing predictive models, performing correlation analysis, and calculating prediction errors.

First, the dependent variable of the study was identified as farmers' perception of climate change. The relevant influencing factors of the perception were found and the main influencing factors were identified through a literature review. Second, based on the primary data received from the questionnaire, the regression analysis equation is created.

This paper uses multiple linear regression models to analyze how these aspects affect farmers' perception of climate change. The linear prediction results are closer to reality. Its mathematical model is:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_p x_p + \varepsilon \qquad \text{Equation (2)}$$

There are p explanatory variables in the formula. It shows that the change of the dependent variable y can be explained by two aspects: one is that the change of p independent variables x causes a linear change of y, that is$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_p x_p$; the other is that the remaining random elements cause a change of y, that is ε. β_0 is the regression constant in the model, $\beta_1, \beta_2 \cdots \beta_p$ are the partial regression coefficient in the model, and ε is a random variable called random error. Given the expectation of both sides of equation (2) under the condition of x, then:

$$E(y) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_p x_p \qquad \text{Equation (3)}$$

$$Q(\beta_0, \beta_1, \beta_2, \beta_p) = \sum_{i-1}^{n} (y_i - \beta_0 - \beta_1 x_{i1} - \beta_2 x_{i2} - \cdots - \beta_{ip})^2 \qquad \text{Equation (4)}$$

The estimated values $\widehat{\beta_0}, \widehat{\beta_1}, \widehat{\beta_2}, \cdots, \widehat{\beta_p}$of the parameter $\beta_0, \beta_1, \beta_2, \cdots, \beta_p$ is obtained by applying the least-squares estimation so that the equation (4) can be extremely small. According to the above principle, the extremum and solution equations are obtained, and the estimated value of the equation parameters are obtained. Then the parameters are brought into the corresponding equations to construct a mathematical model of multiple linear regression.

Then, the mathematical analysis is carried out to determine how the four factors and the perception of farmers towards climate change are related, and also the reliability of the relevant degree is determined. The degree of correlation between them is generally determined by the magnitude of the correlation coefficient in the correlation analysis.

Finally, the regression prediction model needs to be tested and the prediction error must be calculated. The regression equation can only be used as a prediction model for actual prediction by passing various tests and with a small prediction error.

Chapter 4: Presentation of data and analysis

4.1 Introduction

This chapter presents the analysis process of data collected through 400 questionnaires. Firstly, the detailed situation of the study area is introduced. Then descriptive analysis and frequencies of each question are conducted. In addition, factor analysis to the data and the reliability and validity of the variables and content are carried out. Finally, multiple linear regression analysis is conducted to analysis the relationship between independent variables and dependent variables.

4.2 Descriptive analysis

From July to August 2015, a questionnaire survey was conducted in 8 places of Wanzheng District, Sanshui, Dioshui, Zhoujiaba, Wuqiao, Longtan, Shidu, Sanmao and Longju. Each place selected 50 farmers, a total of 400 people. A total of 400 questionnaires were distributed in this survey, 400 were recovered, the recovery rate was 100%, and 381 valid questionnaires, the effective rate was 95.25%.

4.2.1 Current perception of farmers to temperature and precipitation

In the survey of each place, it was learned that almost all the respondents perceive climate change. They thought that the temperature rises obviously, and the frequency of climate disasters such as heavy rain and hot wave increases. At the same time, through the analysis of Q2.7-Q2.10, the farmers' perception of temperature and precipitation changes was also initially understood. Over 70 % of the surveyed farmers perceive climate change, of which 60% of the respondents believe that the temperature is increasing year by year (Figure 8), and 58% of the farmers think that precipitation is increasing (Figure 10). This means that farmers' perception of temperature changes is more accurate than precipitation changes, and their perceived ability to temperature is stronger than that of their perceived ability to precipitation. From Figure 9, we can see that most farmers mentioned that they judge whether the temperature rises mainly according to the number of dressing (37.5%), crop planting time (25.5%), grassland return time (15.5%). And the judgment of precipitation is mainly estimated by the precipitation intensity (29.7%), grain growth situation (27.3%) and precipitation frequencies (19.2%) according to Figure 11. Some farmers also mentioned that they heard global warming from mobile phones, TV, and friends, which all aggravated their perception of rising local temperatures.

Figure 8. Frequencies of perceived temperature changes in the last 10 years in Wanzhou, Chongqing. (Q2.7)

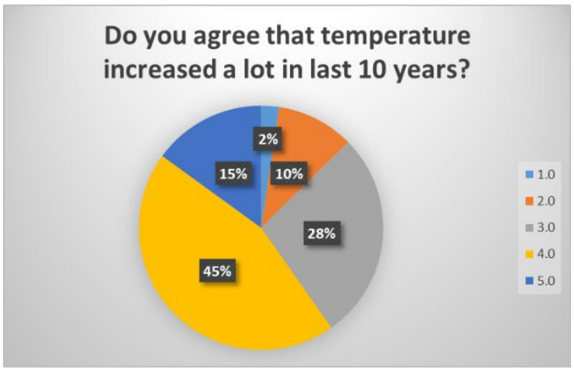


Figure 9. Frequencies of the method to judge temperature changes investigated in Wanzhou, Chongqing. (Q2.8)

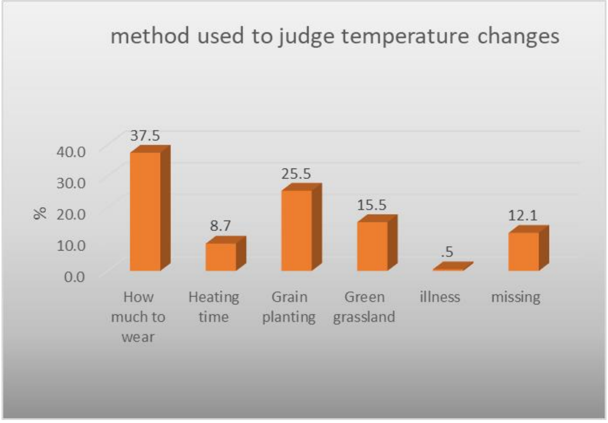


Figure 10. Frequencies of perceived precipitation changes in the last 10 years in Wanzhou, Chongqing. (Q2.9)

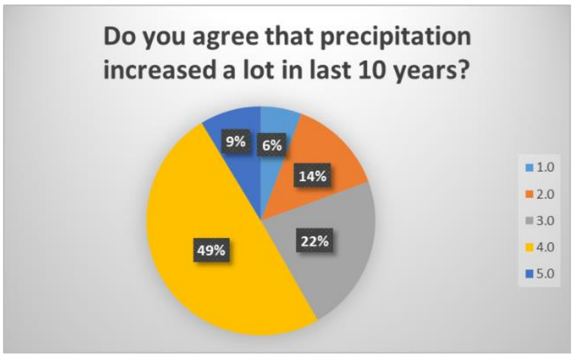
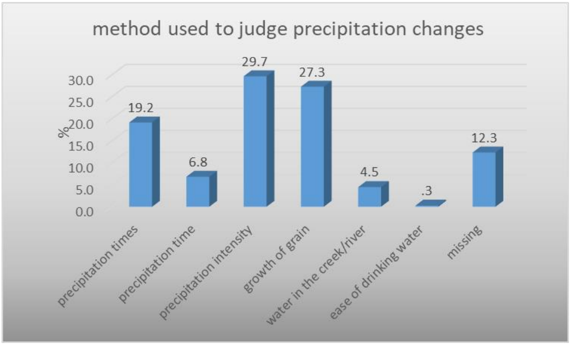


Figure 11. Frequencies of the method to judge temperature changes investigated in Wanzhou, Chongqing. (Q2.10)



4.2.2 Current perception of farmers to extreme weather

Extreme weather has happened frequently in Wanzhou area in recent years. It can be seen from Table 9, the proportion of respondents who believe that heavy rains increased was as high as 74.3%, followed by heat waves, drought, and blizzard. The proportion of respondents with "increased" views was 42%, 18.9%, and 7.9%, respectively.

Heavy rain has become the most extreme weather event perceived by local farmers. It can be seen from Table 10 that the farmers in Wanzhou District have the highest perception index of heavy rain (3.8). In fact, the amount of precipitation and the frequency of occurrence in Wanzhou have increased in recent years. It can be seen that the perception of the increase in heavy rains by farmers is consistent with the actual situation. In the interview about the increase in heavy rain, many farmers pointed out that heavy rain caused damage to crops, farmland, houses, and roads.

Figure 12. Frequencies of the farmers' perception of extreme weather events in Wanzhou, Chongqing. (Q2.11: Do you agree that the extreme weather increased a lot in the past 10 years?)

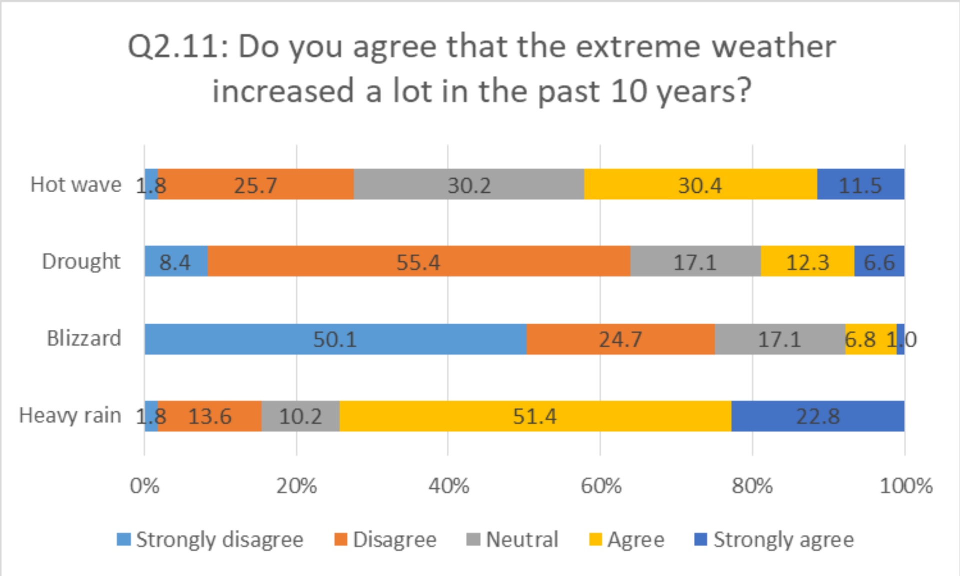


Table 3. Descriptive of the farmers' perception of extreme weather events in Wanzhou, Chongqing. (Q2.11: Do you agree that the extreme weather increased a lot in the past 10 years?)

	N	Mean		Std. Deviation	Variance
	Statistic	Statistic	Std. Error	Statistic	Statistic
Heavy rain	381	3.8	.0513	1.0019	1.004
Blizzard	380	1.8	.0518	1.0090	1.018
Drought	380	2.5	.0529	1.0307	1.062
Hot wave	380	3.2	.0524	1.0218	1.044

The perception of blizzard and drought is also relatively accurate. The index to blizzard is the lowest, at only 1.8. And 82.1% of the farmers believe that the extreme weather in a blizzard has not changed or even decreased, which is consistent with the actual situation.

As for drought, the index is 2.5, which is different from the expected situation. 63.8% of farmers think that drought disasters have a decreasing trend. This is because even if there is a long-term extreme high-temperature situation existing, the drought is not serious due to the increasing extreme rainfall.

It is worth noting that 30% of farmers believe that the degree and frequency of heat waves have not changed in the past decade. This is inconsistent with local meteorological data. Respondents believe that the heat wave situation is very serious every year, so there is no difference. This reminds me of the effect of boiling frogs. Farmers in Wanzhou are in a high-temperature environment for a long time. Under the condition of slow temperature increase, it is difficult for them to notice the threat of rising temperature, let alone respond appropriately.

In addition, farmers have a deeper memory of recent, larger and more severely affected extreme weather, such as the recent heat wave in 2018 and the rainstorm in 2019. During the interview, many people also had a deep memory of the severe drought in August 2013. At that time, there were difficulties in water use for humans and animals in some areas, and crops were also seriously affected, resulting in a direct economic loss of 6.21 billion yuan in Chongqing.

However, when asked about small scale extreme weather or extreme weather happened relatively long ago, farmers often express their inability to remember or even forget.

4.2.3 Farmers' risk appraisal

Perceived severity

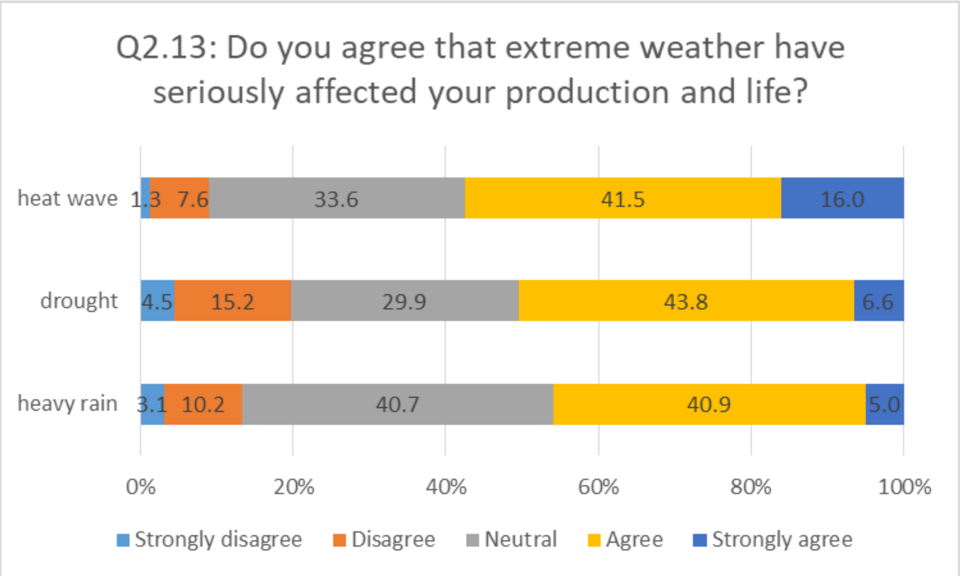
Farmers in Wanzhou District believe that heavy rainfall, drought and heat waves have had a serious negative impact on their production and life. Among them, farmers have the strongest perceived severity of heat waves, followed by heavy rain and drought. Its perceptual index is 3.63, 3.3 and 3.3, respectively.

Table 4. Descriptive of the farmers' perceived severity of climate change in Wanzhou, Chongqing. (Q2.13: Do you agree that climate change and extreme weather have seriously affected your production and life?)

	N	Mean		Std. Deviation	Variance
	Statistic	Statistic	Std. Error	Statistic	Statistic
Heavy rain	381	3.34	.04350	.84908	.721
Drought	381	3.33	.04931	.96244	.926
HW	381	3.63	.04541	.88638	.786

The proportion of respondents who believe that heat waves, droughts and heavy rains affect their production and life are 57.5%, 50.4%, and 45.9%, respectively. During the interview, the farmers mentioned that the perception of the severity of heat wave is the strongest because that the temperature in Wanzhou has increased significantly in recent years, and the heat wave weather happen frequently and also lasts for a long time. The perceived severity of drought and heavy rain is relatively low, which mainly due to the fact that frequent extreme rainfall will alleviate the impact of persistent high temperature in Wanzhou, thus reducing the perceived severity of the drought.

Figure 13. Frequencies of the farmers' perceived severity of climate change in Wanzhou, Chongqing. (Q2.13: Do you agree that climate change and extreme weather have seriously affected your production and life?)



Perceived probability

Farmers in Wanzhou District have a strong perceived possibility of further changes in extreme weather in the future. Among them, the farmers have the strongest perceived possibility of the heat wave, then the rainstorm and drought. The perceptual index is 3.5, 3.2, 3.0, and the proportion of respondents who think that these extreme weather are likely to increase is 53.3%, 36. %, 25.2%, respectively.

However, farmers believe that there is less likelihood that temperatures and precipitation will change further (perceptual index are both 2.7). 79.8% of the respondents believe that the temperature will decrease or remain unchanged in the future, while 86.4% of the farmers believe that future precipitation will decrease or remain unchanged.

It is worth noting that farmers believe that the heat wave will increase further in the future, but they tend to think that the future temperature will decrease. This is a very strange contradiction. In the interview, some people explained that they think the frequency of heat waves will increase, but the temperature will be lower than now; others can't explain it. From my perspective, on the one hand, frequent extreme precipitation phenomena in 2019 have mitigated the impact of high temperatures. Although farmers have perceived the trend of increasing heat waves year by year, this leads them to think that the future temperature will decrease. On the other hand, from a psychological point of view, farmers believe that the temperature rise is not good for themselves, so they refuse to recognize that the future temperature will continue to grow.

Figure 14. Frequencies of the farmers' perceived possibility of climate change in Wanzhou, Chongqing. (Q2.14: Do you agree that climate change and extreme weather are likely to happen further?)

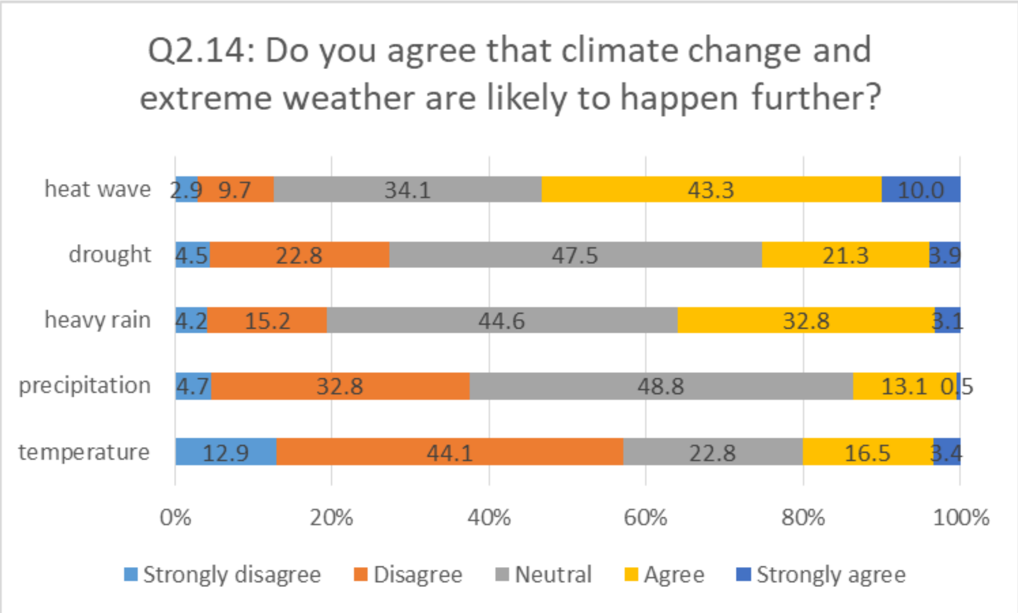


Table 5. Descriptive of the farmers' perceived possibility of climate change in Wanzhou, Chongqing. (Q2.14: Do you agree that climate change and extreme weather are likely to happen further?)

	N	Mean		Std. Deviation	Variance
	Statistic	Statistic	Std. Error	Statistic	Statistic
temperature	381	2.7	.195	3.801	14.449
precipitation	381	2.7	.039	.769	.592
heavy rain	381	3.2	.04443	.86734	.752
drought	381	3.0	.04520	.88219	.778
heat wave	381	3.5	.04635	.90475	.819

4.2.4 Farmers' adaptation appraisal

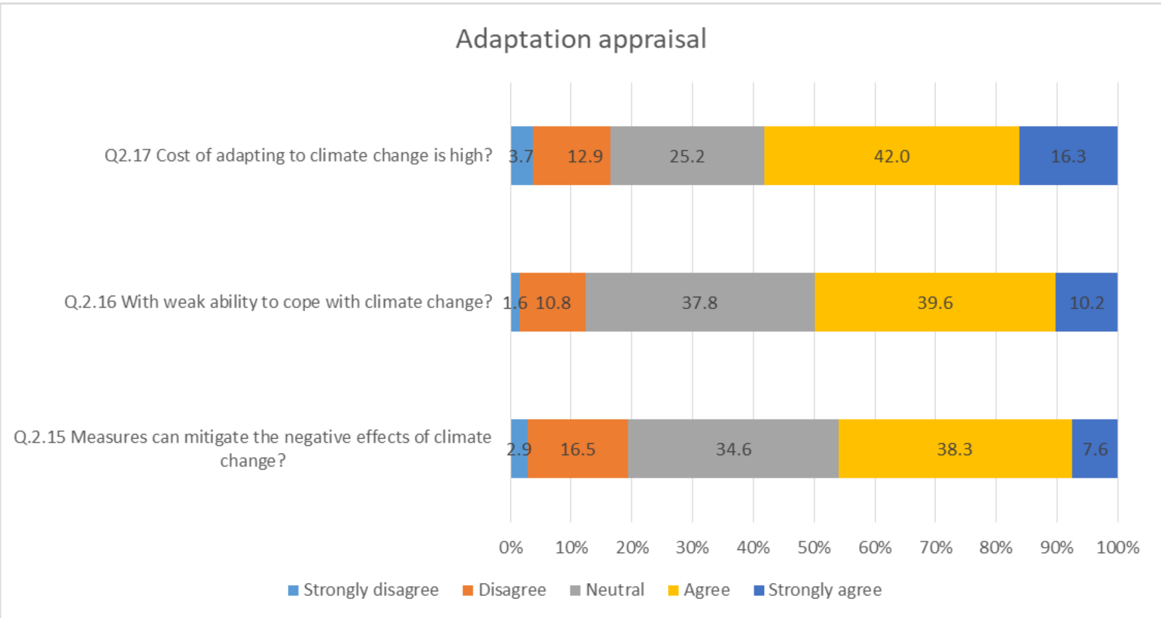
Farmers in Wanzhou District have a strong perceived adaptation efficacy, and the index is 3.3. 58.3% of the respondents believe that appropriate measures can mitigate the negative impacts of climate change. It can be seen that under the severe impact of climate change, farmers always take some effective measures to avoid climate risks, and agree on the implementation of the measures taken. In the interview, most of the farmers engaged in crop farming reflected that adjusting the sowing time and increasing irrigation were the most effective and efficient adaptation measures.

Table 6. Descriptive of responses on adaptation appraisal in Wanzhou, Chongqing.

	N	Minimum	Maximum	Mean	Std. Deviation
Q2.15	381	1.00	5.00	3.3123	.93447
Q2.16	381	1.00	5.00	3.4619	.87464
Q2.17	381	1.00	5.00	3.5433	1.02666

For processing data conveniently, question Q.2.16 about whether farmers with strong ability to cope with climate change is reverse coded in the database for 'Strongly agree' with the lowest value 1 up to 'Strongly disagree' with the highest value 5. From Figure 15, perceived self-efficacy of climate change perceived by farmers in Wanzhou District is relatively weak. Only 12.4% of respondents believe that they have strong adaptability capacity. Overall, farmers in Wanzhou District lack sufficient confidence in their ability to adapt and believe that they do not have enough capacity to cope with the risks brought about by climate change.

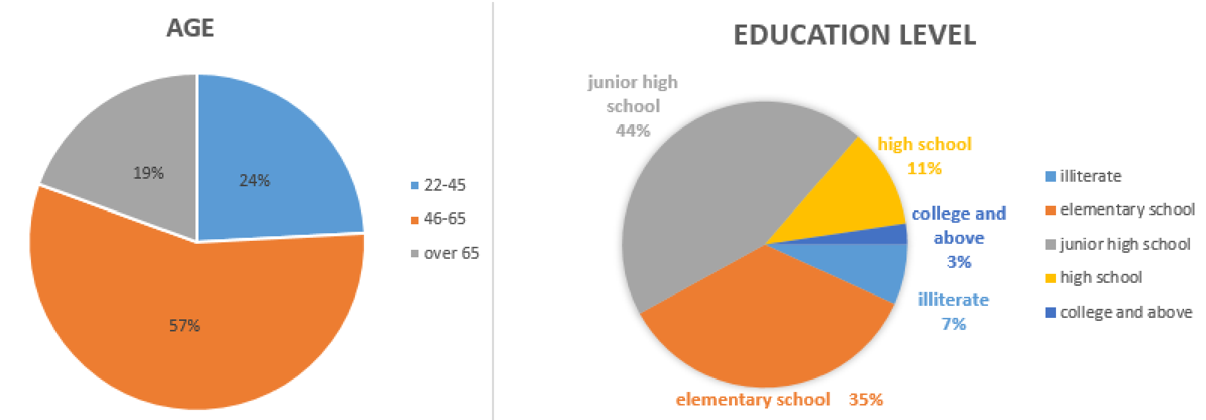
Figure 15. Summary of responses on adaptation appraisal in Wanzhou, Chongqing.



Perceived adaptation costs index (3.54) is the highest in Wanzhou District. Over half the respondents believe that adapting to climate change requires high costs. In the interview, most farmers reflected that the cost of adapting to climate change was relatively high. Adaptation measures like the purchase of pesticides and fertilizers, the introduction of new varieties and new technologies, and the improvement of agricultural facilities, all increased the cost of their agricultural production.

4.2.5 Objective adaptability

Figure 16. Frequencies of age and education level of farmers investigated in Wanzhou, Chongqing.



According to the survey data (Figure 16), the majority of the respondents were between the ages of 46 and 66, accounting for 57% of the total. Farmers' education level is generally low. 88% of the farmers (average family education level) had only the junior high school or lower education level. And only 3% of the farmers have college or higher education level. From table 15, the average labour number is around 3 or 4 people and their average land area is 3.7 mu.

Table 7. Descriptive of the farmers' objective adaptability of climate change in Wanzhou, Chongqing.

	N	Minimum	Maximum	Mean	Std. Deviation
Edu. Level	381	1.0	5.0	2.672	.8522
labour num.	381	1.0	5.0	3.724	1.1517
land area	381	.2	10.0	3.651	1.8942
belongings	381	1.0	13.0	5.373	1.9968
annual income	381	0.00	25.00	4.6227	3.18948
relatives	381	1.0	5.0	3.428	.9587

And the average annual income of the family is 46 thousand. From the graph we can know that 30% of the respondents have an annual income of 10~30 thousand and 12% of the farmers has the lowest income, less than 10 thousand. At the same time, according to field surveys and visits, it is learned that most of the farmers are mostly elderly and children and most young people choose other occupations to make a living.

4.2.6 Access to climate change information

Table 8. Descriptive of the farmers' objective adaptability of climate change in Wanzhou, Chongqing.

	N	Minimum	Maximum	Mean	Std. Deviation
Q2.1 acceptance	381	.00	1.00	.5643	.49650
Q2.2 channels	381	1.00	5.00	3.2415	1.04603
Q2.3 accuracy	381	1.00	5.00	3.3045	.73392

From the Mean of the data above, over 56% of the respondents believe they can get timely information about climate change, and most of the respondents have 3 and more channels to learn the knowledge of climate change, the top three methods chosen are by television, mobile phone, friends and family. And people tend to agree that the climate change information they have obtained is accurate and reliable and only 9.7% of the farmers think that the information obtained is not accurate. In conclusion, all those results indicate that most people tend to have good access to the broad and timely information about climate change, thereby reinforcing their perception of risk events.

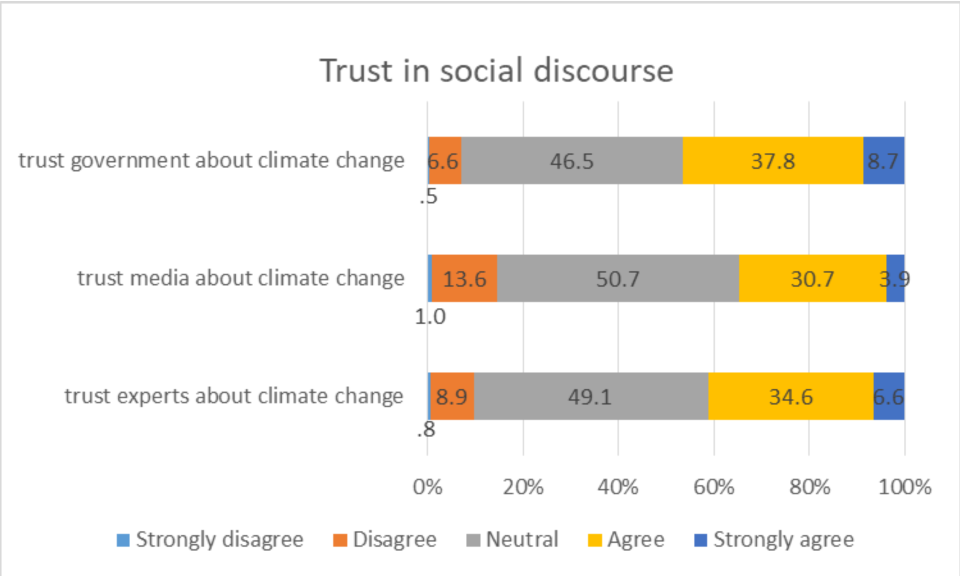
4.2.7 Trust in social discourse

Trust in social discourse in this study was defined as farmers' (in Wanzhou district) degree of trust in the media, government, and experts and scholars by obtaining climate change risk information and adaptation information accurately to improve their perception about climate change. Farmers were required to indicate on a five-point Likert scale the extent of their agreement to Q1.8-Q1.10. Table 15 shows that all the 3 questions' mean values are over 3.2, which indicates that most farmers' perception and adaptability are influenced by the information provided by the media, scholars and public institutions.

Table 9. Descriptive of the farmers' trust in social discourse in Wanzhou, Chongqing.

	N	Minimum	Maximum	Mean	Std. Deviation
Trust in experts	381	1.00	5.00	3.3727	.76961
Trust in media	381	1.00	5.00	3.2283	.76971
Trust in government	381	1.00	5.00	3.4751	.76608

Figure 17. Summary of responses on the trust in social discourse



However, it is obvious from the values to experts (value as 3.37), media (value as 3.23) and the government (value as 3.48) that farmers have different levels of trust in the three sources of information. Farmers have the highest trust and confidence in the government, followed by the experts, and finally the media's remarks about climate change. In addition, from the summary of response on the trust in social discourse, the media is the most untrusted climate change information channel. 14.6% of the respondents do not trust the climate warning information issued by the media channel, followed by the experts, about 9.7%, and then by the government, 7.1% of the farmers chose "disagree" and "strongly disagree". In the interview, some farmers explained that they don't trust the government's remarks about climate change for two reasons. One is that they obtained too little relevant warning information from the government. Furthermore, they don't believe the government's explanation of some incidents in other areas, causing them to hold an attitude of disbelief about the remarks on climate change. The reason why farmers do not trust experts and the media is that there are too many different media reports on climate change with different opinions. And experts also hold opposing views on climate change. These lead farmers to not know who to trust.

4.2.8 Adaptation incentive

Table 10. Descriptive of the farmers' adaptation incentive of climate change in Wanzhou, Chongqing.

Questions	Number of No	Number of Yes	Percentage of No	Percentage of Yes
Q2.4 Providing weather information service?	193	188	50.7	49.3
Q2.5 Providing warning information on climate change?	238	143	62.5	37.5
Q2.6 Providing technical promotion services?	273	108	71.7	28.3

Adaptation incentives here refers to whether the government provides effective climate change information acquisition, protective infrastructure, and technical services to enhance their climate change perception level. Farmers were required to indicate on a two-point Likert scale the extent of their agreement to Q2.4-Q2.6. The answer they can choose is Yes or No. We can see from Table 15 that half of the respondents think local government failed to provide relevant weather information services, or the government provided but farmers failed to receive the relevant information. 62.5% of farmers believe that the government did not provide climate warning information, and Wanzhou District lacked a complete early warning system designed to improve extreme weather warning and support climate change adaptation. In addition, more than 70% of the respondents believe that the government had no corresponding research and extension services officials to exchange information with local farmers, so farmers did not know what behaviors are helping agriculture adapt to climate change and reduce pollution.

4.3 Validity and reliability analysis

4.3.1 Validity test

Validity analysis is to test whether the questionnaire topic is in harmony with the study object. It is normally divided into content validity and structural validity. The former refers to the fitness and logical consistency of the questions and the variables. In this paper, the questionnaire was designed in reference to the questionnaires used by other scholars, so there is no problem for the content validity. The latter refers to the capability of the question to evaluate the variables. The EFA test can be used to verify the structural validity of the scale.

EFA is a statistical approach that explores the common characteristics of analytical indicators and extracts indicators with common characteristics as new indicators, thereby reducing the number of variables. Based on Kaiser (1974), the outcomes of the validity analysis refers to the Kaiser-Meyer-Olkin (KMO) value and significance (sig.). KMO>0.7 indicates that there is a certain relationship between the variables, so the questionnaire is acceptablely designed. And sig. < 0.001 means that the questionnaire is in harmony with factor analysis.

Validity test of dependent variables

Table 11. KMO and Bartlett's Test for dependent variables

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.707
Bartlett's Test of Sphericity	Approx. Chi-Square	519.455
	df	21
	Sig.	.000

Through the EFA of the initial variables, the KMO data is 0.707, showing that the set of data appropriate for the EFA method. From the rotated component matrix, two new factors can be obtained as the main factors. Detailed information is as followed:

Table 12. EFA results for dependent variables

Rotated Component Matrix[a]

	Component	
	1	2
Possibility of drought	.653	
Possibility of heat wave	.696	
Severity of drought	.749	
Severity of heat wave	.706	
measures		.795
ability		.735
cost		.871

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

Based on the results of EFA, the two principal components can be redefined as two factors. Factor 1 is the Risk Appraisal (RA), which means that the farmers evaluate the possibility of potential damage happened to their planting without taking adaptive behavior to climate change. Factor 2 is the Adaptation appraisal (AA), which means that farmers evaluate their ability to cope with the harm from climate change with taking relative adaptive measures

Validity test of influencing variables

Table 13. KMO and Bartlett's Test for influencing variables

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.709
Bartlett's Test of Sphericity	Approx. Chi-Square	1722.959
	df	105
	Sig.	.000

Through the EFA of the independent variables, the KMO data is 0.709, indicating that the set of data is suitable for the EFA method. Based on the rotated component matrix, four new factors can be extracted as the main factors. The specific information is shown in the table below.

Table 14. EFA results for influencing variables

	Component			
	1	2	3	4
Education level	0.746			
Labour number	0.792			
Land area	0.781			
Annual income	0.708			
Relatives	0.51			
Believe in the experts		0.834		
Believe in the government		0.818		
Believe in the .media		0.743		
Acceptance			0.928	
Channels			0.813	
Accuracy			0.74	
Weather information service				0.843
Warning information service				0.837
Technical service				0.642

Based on the results of EFA, the two principal components can be redefined as two factors. Factor 1 is the Risk Appraisal (RA), which means that farmers assessed the possibility of potential damage happened to their planting without taking adaptive behavior to climate change. Factor 2 is the Adaptation appraisal (AA), which means that t Farmers evaluate their ability to cope with the harm from climate change with taking relative adaptive measures

The above figure shows a total of 4 component factors in independent variables, factor 1 is defined as Objective Adaptability (OA), which means farmers' ability to utilize resources (such as nature, finance, expertise, human assets, and social networks) when adopting adaptive behavior. Factor 2 is defined as Trust in Social Discourse (TSD), which means farmers' trust of climate change information from the media, friends and public agencies. Factor 3 is defined as Access to Climate Change Information (ACCI), which evaluate that how many the channels and methods of farmers to get information about climate change and whether the information they receive is timely and accurate. Factor 4 is defined as the Adaptation Incentive (AI), which means technical support, information services and early warning systems provided by local governments to encourage farmers to adopt climate adaptation behaviours.

4.3.2 Reliability test

Internal consistency reliability (ICR) is utilized to check the reliability of the questionnaire. The ICR verifies whether the designed questionnaire has internal consistency through SPSS analysis, mainly reflecting the connection between the test objects, and checking whether each subject evaluates the same subject or quality. For example, whether there is a good correlation between the questionnaire questions, and whether the respondents' answers are contradictory. ICR analysis is done by computing Cronbach's alpha through SPSS. The meaning of Cronbach's alpha value is shown as followed.

Figure 18. Meaning of the Cronbach's alpha value

Cronbach's alpha	Internal consistency
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

Source: (Tavakol, 2011)

Through the analysis, the study of independent variables extracts 6 factors, including objective adaptability, trust in social discourse, access to climate change information, adaptation incentive, risk appraisal, and adaptation appraisal. Cronbach's alpha coefficients of these 6 factors are 0.723, 0.743, 0.707, 0.716, 0.660 and 0.733, respectively. The values are greater than 0.70 except for the value of risk appraisal, thus guaranteeing the consistency of factor structure of the partial questionnaire.

Table 15. Descriptive of the farmers' adaptation incentive of climate change in Wanzhou, Chongqing.

Variables	Questions	Number	Cronbach's alpha
Objective adaptability	Q1.2-Q1.7	5	0.723
Trust in social discourse	Q1.8-Q1.10	3	0.743
Access to climate change information	Q2.1-Q2.3	3	0.707
Adaptation incentive	Q2.4-Q2.6	3	0.716
Risk appraisal	Q2.11-2.14	4	0.660
Adaptation appraisal	Q2.15-Q2.17	3	0.733

4.4 Correlation and regression analysis

In order to investigate the correlation structure of influencing variables and farmers' perception, it is necessary to analyze the correlation between the above four impact factors and two consciousness factors. Before performing the correlation analysis, the average of each factor should be taken first (for example, the three questions of adaptation appraisal are taken as factor 1, and the average of factor 1 is the average of the dimensions of the three questions). Correlation analysis was performed after the average of the dimensions of the six factors was obtained.

4.4.1 Correlation analysis

For clarifying the relationship between the influencing factors and the farmers' consciousness, Pearson correlation and multiple regression analysis were first conducted between the influencing variables. Correlation analysis explains whether related variable items measure the same quality and content. Multiple regression determines the impact of influencing factors (TSD, OA, and AI) on farmers' perceptions of climate change. According to the literature, there is a relationship between TSD, OA, and AI, which is also can be seen from the results of Pearson correlation and regression analysis. Detailed consequences of the correlation analysis of the four influencing factors and the two factors of perception can be found in Annex 2 and an excerpt of the test results for TSD, OA, and AI is shown in Table 20.

Table 16. Pearson correlation and linear regression test results for OA, ACCI, and TSD

	R value	sig.	coefficient B
TSD & OA	0.260	0.000	0.203
AI & TSD	0.137	0.007	0.077
AI & OA	0.300	0.000	0.414

We can see that there is a significant relationship between TSD and OA, AI and TSD, and AI and OA. The coefficient value B shows a relatively significant linear correlation between them and the significance of all are below 0.01 level. The results show that each unit increase of AI will cause an increase of TSD and OA by 0.137 and 0.203, respectively. When farmers receive more adaptation support, they will become more confident in social communication like media and experts, so they can receive knowledge and measures about climate changes more widely and accurately to avoid climate risks. Also, stronger adaptation incentives will strengthen farmers' objective adaptability to climate change.

Furthermore, for every unit increase in TSD, the OA increases by 0.414. This means that the more the farmers are influenced by the remarks of the media and the government on climate change, the richer social networks and more knowledge about climate change they will get, thus enhancing their objective adaptability.

Influence of OA on farmers' RA and AA in Wanzhou

Pearson correlation test results showed that objective adaptability (OA) is positively correlated with risk appraisal (RA) and the significance is at the 0.01 level. This means that the stronger the farmers' objective adaptability is. For example, the more cultivated land the farmer owns, the more the annual income and the higher the level of education they get, and the more the relatives they have, the stronger their risk appraisal of climate change is. Thus, we can enhance farmers' perception of climate change by improving their objective adaptability.

Furthermore, the correlation test consequences shown in Table 17 further present that there is no significant relationship between farmers' objective adaptation and adaptation appraisal because of the significant values over 0.05, indicating that OA has no expected effect on AA. This result means that farmers with strong objective climate change adaptability will not have higher AA.

Table 17. Pearson correlation results for influencing factors on RA and AA in Wanzhou

		RA	AA
OA	Pearson Correlation	.174**	.086
	Sig. (2-tailed)	.001	.092
	N	381	381
ACCI	Pearson Correlation	.054	-.176**
	Sig. (2-tailed)	.297	.001
	N	381	381
TSD	Pearson Correlation	.085	-.006
	Sig. (2-tailed)	.099	.913
	N	381	381
AI	Pearson Correlation	.124*	.221**
	Sig. (2-tailed)	.015	.000
	N	381	381

Influence of TSD on farmers' RA and AA in Wanzhou

It can be seen from Table 17 that TSD is not directly related to the results of the two perception measurements in this study. The significant values between the AC and two classifications of farmers' climate change perception are both over 0.05. This shows the results of the regression analysis to some extent. Therefore, TSD does not establish a significant relationship with the dependent variable so that regression analysis is not required. The relevance of the results means that farmers' trust in outside media, experts, and government does not directly affect their perception of climate change. However, from the above analysis, TSD will indirectly affect farmers' awareness through the influence of OA and ACCI.

Influence of ACCI on farmers' RA and AA in Wanzhou

The table 17 shows that ACCI is negatively correlated with adaptation appraisal (AA) ($P < 0.01$). The result indicates that farmers' adaptation appraisal will be reduced if they receive more information about climate change and extreme weather events. They will think that the cost of adapting to climate change is too high and that even if they take relevant measures, they cannot eliminate the negative impact of climate change on their production and life.

However, there is no significant correlation between ACCI and RA because its significance is higher than 0.05. Due to the reason that the outcome of regression analysis will show no significant influence without significant correlation relationship between ACCI and RA, the regression is not required at this point. The correlation outcome implies that even with ACCI successfully and accurately, farmers may not be able to have a higher risk appraisal.

Influence of AI on farmers' RA and AA in Wanzhou

As shown in table 17, farmers' AI is positively correlated with risk appraisal (RA) for its significant level lower than 0.05. The result indicates that if farmers receive more adaptation incentives (like technical support) provided by government and authorities, they will have a higher risk appraisal towards climate change. Furthermore, AI is also positively correlated with adaptation appraisal (AA) ($P < 0.01$). The correlation result implies that farmers with strong adaptation incentives provided by local government or institutions may have a higher risk appraisal on climate change.

In summary, among the four components of influencing factors, only OA and AI these two factors have a statistically significant relationship to farmers' climate change perception in Wanzhou, Chongqing. Furthermore, AI has a significantly positive impact on RA while ACCI has a negative influence on RA.

4.4.2 Regression analysis

After explaining the relationship between the four influencing variables (OA, AI, TSD and ACCI) and the two measured perception of climate change, it is necessary to establish the separate relationship and impact of variables (OA, AI, TSD and ACCI) on farmers' perception on climate change because the factors affecting the RA and AA are different. Multiple regression analyses were conducted to help explain the extent and contribution of the influencing variables to climate change awareness. The detailed statistical results can be found in Annex 2.

The influence of OA and ACCI on farmers' RA in Wanzhou

Table 18. Summary of regression results for OA and AI on RA in Wanzhou

dependent variable	independent variable	Unstandardized Coefficients		Standardized Coefficients				
		B	Std. Error	Beta	t	Sig.	R Square	Durbin-Watson
RA	(Constant)	2.823	.145		19.499	.000	.036	1.670
	OA	.120	.042	.150	2.834	.005		
	AI	.046	.031	.079	1.502	.134		

Table 18 shows the results of multiple regression, where OA and AI are combined in one model as a predictor of farmers' perception as dependent variable on climate change. However, it can be inferred from Table 22 that OA is the only variable that has a statistically significant impact on farmers' perception towards climate change, with a significant value of 0.005 (<0.01). The R2 is 0.036 indicates that these 2 influencing factors (OA and AI) accounts for 3.6% of the variance in farmers' risk appraisal on climate change. In other words, the higher the level of farmers' objective adaptability and adaptation incentives is, and the more farmers are conscious of climate change risk appraisal.

In addition, OA has the greatest impact on farmers' perception of climate change. This is followed by AI, with the least impact on farmers' risk appraisal. It implies that the farmers' objective adaptability significantly explains the change in their perception of climate change.

According to the results of the regression model, the equation between the independent variables OA, AI, and dependent variable RA is as followed:

$$\mathrm{RA} = 0.15\ \mathrm{OA} + 0.079\ \mathrm{AI}$$

It can be implied that for each unit increase in the OA, the farmers' risk appraisal on climate change increase by 0.15, while the growth of a unit of AI will lead to RA growth of 0.079.

The influence of AI and ACCI on farmers' AA in Wanzhou

Table 19. Summary of regression results for AI and ACCI on AA in Wanzhou

dependent variable	independent variable	Unstandardized Coefficients		Standardized Coefficients				
		B	Std. Error	Beta	t	Sig.	R Square	Durbin-Watson
AA	(Constant)	3.093	.124		24.882	.000	.083	1.948
	AI	.157	.034	.227	4.608	.000		
	ACCI	-.078	.021	-.184	-3.729	.000		

Table 19 shows the results of multiple regression, where ACCI and AI are combined in one model as a predictor of farmers' perception as dependent variable on climate change. As shown in the table, both ACCI and AI have statistically significant relationships with farmers' adaptation appraisal on climate change, with a significant value lower than 0.01. The R2 is 0.083, indicating that these 2 influencing factors (ACCI and AI) accounts for 8.3% of the variance in farmers' adaptation appraisal on climate change.

In addition, the results of multiple regression analysis show that the AI has the greatest impact on farmers' adaptation appraisal on climate change, followed by ACCI. This means that the farmers' outside adaptation incentives (like technical support) have a greater impact than successful ACCI on the increase in their adaptation appraisal. According to the results of the regression model, the equation between independent variables AI, ACCI, and dependent variable AA could be expressed as follows:

$$\mathrm{AA} = 0.227\ \mathrm{AI} - 0.184\ \mathrm{ACCI}$$

It can be implied that for each unit increase in the ACCI, the farmers' adaptation appraisal on climate change increase by 0.227, while the growth of a unit of AI will lead to AA decrease of 0.184.

Chapter 5: Conclusions

The main purpose of the study is to find out the current situation of farmers' perception on climate change and to explain that to what extent objective adaptation, access to climate change information, trust in social discourse and adaptation incentives affect farmer's climate change perception in Wanzhou, Chongqing by empirical research methods. Based on the literature review about perception and adaptation of climate change, this study developed several important questions in the first part. After data collection and analysis in the previous chapters, chapter 5 is to answer the questions raised and link them with relevant literature, as well as present some policy recommendations and further study.

5.1 answering the questions and linking to literature

5.1.1 Answering the sub-research question 1

What is the current situation of farmers' perception of climate change in Wanzhou?
Perception of climate change and extreme weather events:

Research showed that most farmers have an accurate perception of the increase of temperature and precipitation. This is consistent with the conclusion discovered by Brondizio (2016) that farmers can gain an understanding of climate change based on observations of changes in production conditions such as precipitation and temperature after a period of time. However, farmers' perceptions of temperature changes are more accurate than precipitation perceptions. There may be two reasons. One is that most farmers judge the precipitation in Wanzhou according to the intensity of precipitation and the growth of crops. However, the crops in Wanzhou District has a negative growth trend in recent years, so farmers think precipitation is also in a decreasing trend. What is more, the precipitation in the Wanzhou, Chongqing has uneven spatial and temporal distribution (Zhou and Han, 2017). The disturbances with large fluctuations affect the farmers' perception of precipitation.

Farmers have a deeper memory of extreme weather events with characteristics like larger scales, recently happened, or having serious impacts on their life and production. However, they have a vague memory of the extreme weather events, which happened a long time ago or have a small scale of influence. This is consistent with the research results that farmers' perceptions are affected by internal and external factors, including memory and experience (Gandure, Walker, et al., 2013). The main reason is that people's perceptions are affected by both memory and emotions. People have a bad memory and will generate strong anxiety and crisis under the impact of extremely serious climate risk. The interview showed that farmers in Wanzhou District had the strongest perception of heavy rain. Many farmers said that heavy rains in recent years caused serious losses in farmland, livestock, and roads.

Risk appraisal and adaptation appraisal

As for the perceived severity of extreme events, farmers are deeply impressed by the negative impacts of climate change and extreme events (3.48). However, their perceived severity of the drought is relatively low, which mainly due to the fact that frequent extreme rainfall will alleviate the impact of persistent high temperature in Wanzhou, thus reducing the perceived severity of the drought. For the perceived possibility, farmers tend to believe that future heat wave is more likely to increase further (3.5), but the future temperature will decrease (2.7). There are two reasons. One is that frequent extreme precipitation phenomena in 2019 have cool the temperature, so farmers tend to think that the future temperature is likely to decrease. On the other hand, from a psychological point of view, farmers believe that the temperature rise is not good for themselves, so they refuse to recognize that the future temperature will continue to grow.

Farmers in Wanzhou has a strong perceived adaptation efficacy (3.31), and they positively think that they can adapt to the bad impact of climate change with appropriate measures taken. Mertz (2009) also discovered that farmers in Senegal have a strong perception of adaptation efficacy, local farmers attribute negative phenomena such as reduced crop yields to climate change and they are confident that they can adapt to climate change risks by adjusting agricultural strategies.

However, farmers think taking successful adaptation measures costs a lot (perceived adaptation costs index is 3.54), such as purchasing pesticides and fertilizers, introducing new technologies, and improving agricultural facilities. Furthermore, farmers' perceived self-efficacy of climate change in Wanzhou District is relatively weak, only 12.4% of respondents believe that they have strong perceived self-efficacy. This is mainly because the education level of farmers in Wanzhou District is generally low (86% of the farmer with the education level of junior high school and below). Farmers are greatly influenced by traditional concepts and have poor ability to accept new things and new technologies. This was also confirmed in studies by Asrat (2018), Roco (2015) and Deressa (2009) et al. For example, Asrat (2018) found that the educational level of farmers have a great impact on farmers' objective adaptability and their perception on climate change according to the data from 734 farmers.

5.1.2 Answering the sub-research question 2

To what extent does objective adaptive ability affect the farmers' perception of climate change in Wanzhou, Chongqing.

The objective adaptability has a significant impact on farmers' perceptions of climate change. Form the analysis, the objective adaptability has a significant positive impact on farmers' risk appraisal on climate change. This can be explained by that farmers' with stronger objective adaptability, can find more resources (such as human capital, natural capital, physical capital, financial capital and social capital) to receive information about climate change and more sensitive to the extreme weather events, thus strengthening their risk appraisal on climate change. Grothmann and Patt (2005), Nelson and Kokic (2005), Nelson et al. (2005), Adger (2010) and Burnham and Ma (2017) all believed that objective adaptability plays a key role in farmers' perception and adaptation to climate change. For example, farmers will have a stronger objective adaptability to perceive climate risks and possibilities if they have higher socioeconomic status and more resources available (Nelson, Kokic, et al., 2005).

5.1.3 Answering the sub-research question 3

To what extent does the acquired climate change information affect the farmers' perception of climate change in Wanzhou, Chongqing.

Information acquisition has an impact on farmers' perceptions of climate change. For farmers' adaptation appraisal, information acquisition has a significant negative impact on it. This is different from some findings observed by Powell (1996), Smit and Wandel (2006), Deressa (2009), Grupe and Nitschke (2013), Roco (2015), and Zhao and Xue (2016). For example, Roco (2015) noticed that access to meteorological information has a positive impact on Chilean farmers' perception of climate change and policymakers should pay attention to the acquisition of meteorological information by farmers so that farmers can better perceive and adapt to extreme weather events and climate change. However, the result of this study shows that information acquisition has a negative impact on perception, which can be explained by the result of Grupe (2013). He believed that negative information on climate change that reflects the seriousness of the consequences will strengthen the scared emotion within farmers. When farmers feel their interests are to be seriously threatened, they will think the cost to cope with climate change is too high and it is unrealistic to take relevant measures to successfully adapt to climate change.

5.1.4 Answering the sub-research question 4

To what extent does trust in social discourse affect the farmers' perception of climate change in Wanzhou, Chongqing.

Social discourse trust does not have a direct relationship with both farmers' risk appraisal and adaption appraisal. Although this result is contrary to the explanation of Grothmann and Patt (2005), Luo (2017) and Choi (2016), who all think risk appraisal is always affected by the information from the media, relatives, neighbours and local institutions. The possible cause is the questionable internal inconsistency in the combination of the RA, whose Cronbach's $\alpha < 0.7$). However, it can indirectly affect farmers' risk appraisal on climate change by affecting farmers' objective adaptability. In addition, social discourse trust can indirectly affect farmers' climate change risk perception by affecting farmers' ACCI. This is because that if farmers are more confident in the opinions of experts and the government on climate change, they can grasp more accurate and timely information about climate change and extreme weather events, which will stimulate the multiple risk information to the current situation so to affect their climate change risk appraisal.

5.1.5 Answering the sub-research question 5

To what extent does adaptation incentives affect the farmers' perception of climate change in Wanzhou, Chongqing.

Adaptation incentives have a significant positive impact on farmers' risk perception on climate change. At the same time, it indirectly affects farmers' risk perception by affecting farmers' objective adaptation to climate change. The reason is that when the government provides farmers with better warning systems for climate change and extreme weather changes, farmers can find more resources to perceive climate change situations. This helps reduce the knowledge barriers they encounter and improves farmers' objective adaptability, leading to a higher level of risk appraisal. In addition, adaptation incentives also have a significant positive impact on farmers' climate change adaptation appraisal. It can be explained by the fact that the more measures and technologies provided by the government to encourage farmers to adapt to climate change, the richer resources farmers can use to cope with climate change negative impact. So there is a smaller knowledge and technical barriers when farmers facing climate change risks and farmers become more confident that they are able to deal with climate change challenge. Many scholars agreed that adaptation incentive is positively related to farmers' perception on climate change (Mitter, Larcher, et al., 2019, Webber and Donner, 2017, Panda, Sharma, et al., 2013, Hassan and Nhemachena, 2008, Grothmann and Patt, 2005). For example, Mitter (2019) suggested that climate change information projects, technical services, subsidies, and related legal support can help farmers have a more comprehensive and clear understanding of climate change conditions, as well as receive more information on adaptation methods and technology. This reduces the financial and technological barriers for farmers to effectively adapt to the impact of climate risks so that they have more confidence to adapt to the bad impact taken by climate change risks.

5.2 Policy recommendation

Climate change and extreme weather conditions have seriously affected the food security of cities. In order to alleviate the threat of food production in Wanzhou District, farmers should take relevant measures to adapt to the negative impact of climate change spontaneously under the help of the agencies and government. The study found that farmers' premise of adopting climate change adaptation measures is that they have a good perception of climate change (Grothmann and Patt, 2005, Jones and Boyd, 2011, Adger, Dessai, et al., 2009). Therefore, how farmers accurately perceive climate change and enhance their ability to adapt to climate change is not only a concern of farmers themselves but also a priority for the government to make decisions on climate change adaptation. This study shows that it is currently possible to develop practical and adaptable policies from farmers' objective adaptability, information acquisition, and social discourse trust and government adaptation incentive to improve their perception of climate change, thus enhancing the effectiveness of adaptive behaviour. According to all the analysis, this paper puts forward the following suggestions:

1. Suggestions to improve objective adaptability: According to the survey, most farmers have only 3 to 4 relatives, so their network of information exchange is weak. And most farmers have relatively low cultural level so that their information acquisition ability is weak. Therefore, the government can establish food cooperative organizations between farmers or between regions to increase mutual cooperation and resource exchanges, and also help realize the sharing of resources such as information, technology and capital between them. Furthermore, the survey found that the average annual income of farmers is low, so the government can give appropriate subsidies to farmers or guide farmers to actively participate in agricultural insurance, medical insurance, and pension insurance, thereby improving the objective adaptability of farmers to climate change.

2. Suggestions to strengthen information services: Research showed that nearly half of the respondents said that the climate change information they received was not accurate. Therefore, the governments at all levels in Wanzhou District should first of all strengthen the construction of meteorological basic services, and then improve the specialized agricultural meteorological monitoring and forecasting technology system, so to provide timely and accurate climate change information for farmers. In addition, most farmers mentioned they use television and mobile phones to receive information about climate change. Thus, on the basis of traditional media, the government can provide climate change information and knowledge through the diversity of information service provision by means of modern media forms such as WeChat (Chinese WhatsApp with more features) and Weibo (Chinese Facebook), so to help farmers better understand the information and impact of climate change.

3. Suggestions to increase the trust of farmers in social discourse: More than half of the people have no enough trust in experts, governments, and media, which is not conducive to their perception of climate change. Therefore, the government should firstly call on farmers to actively pay attention to climate change information and adaptation technology information issued by the government, media and other institutions. Secondly, education activities or presentations on knowledge such as "climate change perception and adaptation, and climate change risks and impact" should be appropriately carried out to cultivate farmers' trust in government, experts and the media, which can enrich farmers' knowledge of climate change and broaden the sources of information for adaptation technologies.

4. Suggestions to adaptation incentives: 62.5% of the respondents believe that the government failed to provide climate warning services, and 71.7% believe that there was no extension services and technologies for climate change adaptation. Therefore, first of all, the government

should improve the basic weather service facilities in villages and towns, and establish corresponding climate change warning information services to provide meteorological disaster prevention and adaptation services. Secondly, the government should carry out more extension services for climate change adaptation technologies and introduce these new technologies to farmers through knowledge publicity and education. In addition, the government needs to provide skills training activities for farmers by group training or one-on-one targeted training. For example, an “agricultural seminar” can be conducted in the town to provide specific advice to farmers, including the knowledge about choice of crops, the best time to plant, and the technologies like how to optimize agricultural inputs and harvest management.

5.3 Limitations of the methods

It is worth noticing that this research has some limitations based on data collection methods and analytical methods:

1. Through the analysis, the study of independent variables extracts 2 factors, risk appraisal, and adaptation appraisal. However, the Cronbach’s alpha coefficient of risk appraisal is 0.660, a low point for the internal consistency reliability. This means that the suggested indicators of risk appraisal in the questionnaires need to be reconsidered to make sure each item of this part evaluates the same subject and quality in future research.
2. Due to the limited budget and time, this study only chooses eight places in Wanzhou to do the questionnaire. The number of questionnaires issued is limited, thus weakening the external validity of this research.
3. The average age of the respondents is too old. In the study, most of the respondents are over 45. This is one of the characteristics of the farming situation in Wanzhou District. However, it is inevitable that the data will be incompletely collected and will result in a certain impact on the external validity of this study.

5.4 Future research recommendation

1. This paper only uses Wanzhou District of Chongqing as a research area to analyze farmers' risk appraisal and adaptive appraisal characteristics of climate change, Research area of climate change perception and adaptation is single in this study. In the future, it is necessary to increase the research scope of Southwest China. At the same time, it is necessary to further analyze the differences and possible causes of climate change perception and adaptation among residents in different regions.
2. In the construction of the influencing factor index system, this study has formed a conceptual framework under MPPACC and selects four influencing aspects on perception (climate change information, objective adaptability, trust in social discourse and adaptation incentives) without discussing other factors. However, the influence factors of personal climate change perception are complex in reality, involving various fields such as psychology, sociology, and disaster science and so on. In future research, we should broaden the research perspective and further explore the factors affecting the perception of farmers' climate change based on the relevant theories of more disciplines. Also, the interaction mechanism of various factors in the process of farmers' climate change perception formation and its influence on farmers’ decision-making should be paid more attention.

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Annex 1: Farmers' Climate Change Perception Questionnaire

Dear friends:

I am a graduate student at Erasmus University in the Netherlands. I am here to understand your perception of climate change, the impact of climate change on your home and whether you can cope with climate change. These information can go to the relevant government departments to reflect the main difficulties and problems in your life and production, providing better suggestions for government to solve these problems. I hope to get your support and cooperation. Our survey is anonymous and guarantees that it will not affect your life. Thank you for your support and assistance!

Survey location: _____town _____village； Investigation time: _____/_____/_____

1. Basic information

1.1 Respondents' situation

(1) Gender: A. male B. female; (2) age____; (3) Education level: A. illiterate B. elementary school C. junior high school D. high school E. college and above

1.2 At present, the total population participating in agriculture in your family is:
A. 1people B. 2 people C. 3 people D.4 people E. > = 5 people

1.3 Among them, Male____ and female____; Age under 10 years old____, 11-17____; 18-60____, over 60____; disabled ______, long-term sick person ______; Educational level: illiterate ____ (people), elementary school ____, junior high school ____, high school ____, college and above ____.

1.4 Cultivated land area (mu/household)
A. < = 1 mu B. 1~3 mu C.3~5 mu D. 5~7 mu E. over 7

1.5 Does your family have the following items? If so, please tick the option.
(1) Bioenergy (biogas) stove, (2) Solar cooker, (3) Gas/liquefied stove, (4) Computer, (5) TV, (6) Telephone/cell phone, (7) Camera, (8) Water heater, (9) Refrigerator, (10) Washing machine, (11) Car, (12) Truck/agricultural vehicle/production machinery, (12) Motorcycle, (13) Greenhouse, (14) Water pump, (15) other ______. (A. 0-3, B. 4-6, C. 7-9, D. 10-12; E. 12-15)

1.6 Annual household income from agriculture? _______ (10 thousands).
A. < 10 B.10~30 C.30-50 D. 50~70 E. over 70 thousands

1.7 How many relatives does your family have in the same village or neighbouring townships?
A. rarely B. less C. general D. more E. a lot

1.8 Do you trust experts about climate change?
A. no trust at all B. not trust C. neutral D. trust E. trust strongly

1.9 Do you trust authorities about climate change?
A. no trust at all B. not trust C. neutral D. trust E. trust strongly

1.10 Do you trust the media about climate change?
A. no trust at all B. not trust C. neutral D. trust E. trust strongly

2. Perception towards climate change
2.1 Can you get timely information about climate change? (1) Yes (2) No
2.2 From which channels did you learn about climate change? (Multiple choice)
(1) TV (2) Mobile (3) Broadcast (4) Network (5) Newspaper (6) Friends and family (7) Feeling by yourself (8) Others (A. 0-2, B. 3-4, C. 4-5, D. 5-6; E. > = 7)
2.3 Do you agree that the climate change information you have obtained is accurate and reliable?
A. strongly disagree B. disagree C. neutral D. agree E. strongly agree

2.4 Does your village or town provide any weather information service? (1) Yes (2) No (3) don't know
2.5 Does the government in your area provide early warning information on climate change or meteorological disasters? (1) Yes (2) No (3) don't know
2.6 Can you get technical promotion services toward climate change? (1) Yes (2) No (3) don't know

2.7 What do you think about the temperature trend in the past 10 years?
A. dropped a lot B. dropped some C. don't change D. increased some E. increased a lot

2.8 What methods do you use to judge changes in temperature?
(1) How much to wear (2) Heating time (6) Grain planting/harvest time (7) Disease incidence rate (8) Others.
Mainly judged by ________

2.9 What do you think about the precipitation trend in the past 10 years?
A. dropped a lot B. dropped some C. don't change D. increased some E. increased a lot

2.10 What methods do you use to judge the changes in precipitation?
(1) The number of precipitation times (2) The length of precipitation time (3) The precipitation intensity (4) The growth of grassland Grain yield (5) The amount of water in the creek (6) The ease of drinking water for humans and animals
Mainly judged by ________

2.11 Do you agree that the extreme weather increased a lot in the past 10 years?

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Heavy rain					
Blizzard					
Drought					
Heat wave					

2.12 What do you think is the most important meteorological disaster affecting your production and life?
(1) Heavy rain (2) Blizzard (3) Drought (4) Heat wave (5) Strong wind (6) Dust storm (7) Others _____; When was it happen? ______
2.13 Do you agree that climate change and extreme weather have seriously affected

your production and life?

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Temperature					
Precipitation					
Torrential rain					
Drought					
Heat wave					

2.14 Do you agree that future climate change is likely to happen?

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Temperature					
Precipitation					
Torrential rain					
Drought					
Heat wave					

2.15 Do you agree that measures can mitigate the negative effects of climate change and extreme weather?

A. Strongly disagree B. Disagree C. Neutral D. Agree E. Strongly agree

2.16 Do you think you have a strong ability to cope with climate change and extreme weather?

A. Strongly disagree B. Disagree C. Neutral D. Agree E. Strongly agree

2.17 Do you agree think the cost of improving climate change and extreme weather is high?

A. very low B. relatively low C. general D. relatively high E. very high

Annex 2: Results of Statistical Tests

Pearson Correlations between OA, ACCI, TSD, AI and RA, AA

Correlations

		RA	AA	OA	AI	TSD	ACCI
RA	Pearson Correlation	1	.126*	.174**	.124*	.085	.054
	Sig. (2-tailed)		.014	.001	.015	.099	.297
	N	381	381	381	381	381	381
AA	Pearson Correlation	.126*	1	.086	.221**	-.006	-.176**
	Sig. (2-tailed)	.014		.092	.000	.913	.001
	N	381	381	381	381	381	381
OA	Pearson Correlation	.174**	.086	1	.300**	.260**	.121*
	Sig. (2-tailed)	.001	.092		.000	.000	.018
	N	381	381	381	381	381	381
AI	Pearson Correlation	.124*	.221**	.300**	1	.137**	.034
	Sig. (2-tailed)	.015	.000	.000		.007	.511
	N	381	381	381	381	381	381
TSD	Pearson Correlation	.085	-.006	.260**	.137**	1	.114*
	Sig. (2-tailed)	.099	.913	.000	.007		.026
	N	381	381	381	381	381	381
ACCI	Pearson Correlation	.054	-.176**	.121*	.034	.114*	1
	Sig. (2-tailed)	.297	.001	.018	.511	.026	
	N	381	381	381	381	381	381

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

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

Regression analysis for TSD & ACCI

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.137[a]	.019	.016	.61963

a. Predictors: (Constant), TSD

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.794	1	2.794	7.278	.007[b]
	Residual	145.516	379	.384		
	Total	148.310	380			

a. Dependent Variable: ACCI

b. Predictors: (Constant), TSD

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.106	.099		31.357	.000
	access.info	.077	.029	.137	2.698	.007

a. Dependent Variable: ACCI

Regression analysis for TSD & OA

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.260[a]	.068	.065	.60400

a. Predictors: (Constant), TSD

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	10.046	1	10.046	27.538	.000[b]
	Residual	138.264	379	.365		
	Total	148.310	380			

a. Dependent Variable: OA

b. Predictors: (Constant), TSD

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.715	.126		21.470	.000
	objective	.203	.039	.260	5.248	.000

a. Dependent Variable: OA

Multiple regression analysis for ACCI & OA

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.300[a]	.090	.087	1.05769

a. Predictors: (Constant), ACCI

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	41.813	1	41.813	37.376	.000[b]
	Residual	423.991	379	1.119		
	Total	465.804	380			

a. Dependent Variable: OA

b. Predictors: (Constant), ACCI

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.955	.221		8.828	.000
	objective	.414	.068	.300	6.114	.000

a. Dependent Variable: OA

Detailed result of multiple regression of RA

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.190[a]	.036	.031	.62978	.036	7.052	2	378	.001	1.670

a. Predictors: (Constant), AI, OA

b. Dependent Variable: RA

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5.594	2	2.797	7.052	.001[b]
	Residual	149.925	378	.397		
	Total	155.519	380			

a. Dependent Variable: RA

b. Predictors: (Constant), AI, OA

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	2.823	.145		19.499	.000		
	OA	.120	.042	.150	2.834	.005	.910	1.099
	AI	.046	.031	.079	1.502	.134	.910	1.099

a. Dependent Variable: RA

Detailed result of multiple regression of AA

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.287[a]	.083	.078	.73451	.083	17.007	2	378	.000	1.948

a. Predictors: (Constant), ACCI, AI

b. Dependent Variable: AA

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	18.351	2	9.176	17.007	.000[b]
	Residual	203.935	378	.540		
	Total	222.286	380			

a. Dependent Variable: AA

b. Predictors: (Constant), ACCI, AI

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	3.093	.124		24.882	.000		
	access.info	.157	.034	.227	4.608	.000	.999	1.001
	tech.likert5	-.078	.021	-.184	-3.729	.000	.999	1.001

a. Dependent Variable: adaptationappraisal

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