

MINISTRY OF EDUCATION
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**THE VIETNAM INSTITUTE OF METEOROLOGY,
HYDROLOGY AND CLIMATE CHANGE**



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**STUDYING BEHAVIORAL ADAPTATION TO DRUG TO
PROPOSAL A MODEL FOR HOUSEHOLD ECONOMIC
DEVELOPMENT IN THE CONTEXT OF CLIMATE
CHANGE IN NINH THUAN PROVINCE**

Major: Climate change

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**SUMMARY OF DOCTORAL THESIS IN CLIMATE
CHANGE**

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The thesis is completed at:

**The Vietnam Institute of Meteorology, Hydrology and
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Referee 1:.....

Referee 2:.....

Referee 3:.....

The thesis will be defended before the Institute-level
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.....Date:..... Time:.....

The thesis can be found at the library:

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Hydrology and Climate Change

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INTRODUCTION

1. Urgency of the topic

The impact of unusual climate on food production has become the focus of attention from all walks of life. Global warming and persistent widespread drought have become the most serious threats to agricultural production, especially in recent years, the problem of seasonal drought has become increasingly serious. , threatening harmonious and healthy economic and social development. Therefore, how to adapt to seasonal drought has become a topic of concern to the whole society. How do farmers adapt to seasonal droughts? What are the influencing factors? The solution to this problem is the premise and foundation for scientific disaster mitigation.

For the above reasons, the topic "Research on adaptive behavior to drought to propose a model for household economic development in the context of climate change in Ninh Thuan province" is of scientific urgency. and practice, helping to find practical measures to cope with climate change and sustainable socio-economic development in Ninh Thuan province.

2. Objective of the thesis

- Research on adaptive behavior to seasonal droughts as a basis for identifying adaptation measures and proposing a household economic development model in agricultural production in Ninh Thuan province.

- Identifying a number of household economic development models in agricultural production adapting to drought conditions under the impact of climate change in Ninh Thuan province.

3. Object and scope of the study

a) Research subjects

- Current status, trends and scenarios of drought in the context of climate change;
- Households' behavior to adapt to climate change, including drought;
- Household economic model and measures to adapt to drought conditions due to climate change in Ninh Thuan province.

b) Research scope

- Climate change has a huge impact on many types of natural disasters. Within the framework of the thesis, the research will limit the type of natural disaster to drought.

- Drought in the context of climate change has a strong impact on agricultural production, so the thesis defines the scope of research as household economics in agricultural production..

- The research period is from 2010 - 2020. For drought, the research period is from 2000 - 2020.

- The scope of the study is the entire Ninh Thuan province.

4. Research questions and thesis defense arguments

a) Research question

1) How does climate change affect the level and distribution of drought in Ninh Thuan province? In what direction will drought occur in the coming time? What is the level of impact on the household economy in agricultural production?

2) What factors influence households' behavioral choices to adapt to drought in the context of climate change? What are the specific effects of these behaviors on household economic models?

3) Which household economic models in agricultural production in Ninh Thuan province are adaptive and suitable for drought in the context of climate change.

b) Thesis defense thesis

Thesis 1: Ninh Thuan is greatly affected by climate change, the direct impacts are increasingly severe drought and desertification.

Thesis 2: Groups of factors such as natural and social conditions, drought change trends (frequency of drought occurrence, scale and duration of drought...) have a clear impact on the choice trend and level of pressure. Using household drought adaptation measures.

Thesis 3: Households' adaptive behavior to drought has an impact on household economic development models and adaptation measures appropriate to these behaviors.

Luận điểm 4: The selected family economic models in Ninh Thuan province are those that are able to adapt to behavior and drought conditions in the context of climate change.

5. New contributions of the thesis

- 1) The thesis has determined the frequency and severity distribution of drought at the commune level, and built a drought scenario for the period up to 2050 in Ninh Thuan province..
- 2) The thesis has analyzed and evaluated factors affecting households' choice of drought-adaptive behavior in Ninh Thuan province.
- 3) The thesis has identified a number of household economic development models in agricultural production and proposed measures to adapt to drought in Ninh Thuan province in two directions: population distribution and each commune cluster, commune.

6. Scientific and practical significance of the thesis

1) Scientific significance

- The thesis used the VTCI remote sensing index to determine

the frequency and severity distribution of seasonal droughts for each commune in Ninh Thuan province, thereby serving as a basis for proposing drought adaptation models for family.

- The thesis used logistic analysis models, Poisson and Tobit regression analysis as quantitative research tools and methods to evaluate factors affecting households' choice of seasonal drought adaptation behavior. family in Ninh Thuan province. In particular, it clearly shows the trend of applying drought adaptive behavior and the level of applying drought adaptation measures of each specific farmer in the province.

2) Practical significance

Based on evaluating drought criteria and clarifying factors influencing the choice of drought adaptation behavior, the thesis has identified a number of household economic development models and proposed measures. adapt to drought in two directions: population distribution and each commune and district. These models serve as a basis for households in Ninh Thuan province to develop sustainable agriculture, increase productivity and agricultural output, and eliminate hunger and reduce poverty.

7. Structure of the thesis

In addition to the introduction, conclusions, recommendations, references and appendices, the main content of the thesis is presented in 3 chapters:

Chapter 1: Overview of research on drought adaptation behavior and household economics in the context of climate change.

Chapter 2: Research methods and data used.

Chapter 3: research results on drought, behavior to adapt to drought and propose some models of household economic development to adapt to drought in Ninh Thuan.

CHƯƠNG 1:
OVERVIEW OF RESEARCH ON DROUGHT
ADAPTATION BEHAVIOR AND HOUSEHOLD
ECONOMICS IN THE CONTEXT OF CLIMATE
CHANGE

1.2. Overview of research on drought adaptation behavior and household economics in the context of climate change around the world

Research on behavioral adaptation to climate change and related questions has grown rapidly in recent years. Related contributions explain why it is necessary to focus on adaptive behaviors at the individual level (Clayton et al., 2015), offering specific contributions of adaptive behavior that individuals can participate in (Liu et al., 2013) and research on the psychosocial antecedents of adaptive behavior (Brügger et al., 2016). A recent meta-analysis found that self-efficacy, negative affect, and descriptive norms have the strongest relationships with the behaviors that individuals exhibit. These behaviors can be implemented to respond to climate-related hazards (van Valkengoed and Steg, 2019a).

In the study by (Chen Yang Zhang 2020) investigated farmers' perceptions of climate change, actual adaptation responses at the farm level, and factors influencing farmers' decisions on adaptation with climate change in Wushen Banner, China. A questionnaire survey was conducted among 220 farmers using random sampling technique. The study found that farmers are generally concerned about climate change. Most farmers have adopted adaptation measures to address the adverse impacts of climate change. Adjusting farming behavior and using financial means are the main adaptation measures used by local farmers.

Wong-Parodi, 2022 presented the results of a study on the drivers of individual and family adaptive behavior when facing the threat of climate change, based on a survey of a representative sample of 1846 Residents of Florida and Texas. research focuses on individuals' negative experiences and subjective attributions related to climate changes.

Assessing the factors affecting households adaptive behavior to climate change, studies show that awareness of climate change is the most important factor influencing policy decisions. household climate change adaptation.

Currently, the world is paying more and more attention to the influence and impact of climate change on agricultural production. In their study of households' adaptation to climate change, Bryan, Nhemachena, and Pradeep found that farmers' climate change adaptation behaviors include using new varieties, improving soil, increasing increasing irrigation, changing planting times and changing farming regimes, etc. swearingen found farmers adapted to drought by using machinery, increasing chemical fertilizers and irrigation. Research by Chinese scholar Wang Jinxia suggests that in regions with low temperatures, cold winters and little rain, households apply irrigation measures, while households in warmer regions apply Measures to convert plant varieties. According to research by Chinese scholar Chen Yuping, households have applied more "pre-drought" treatment and response measures to cope with drought in rice growing areas. Scholar Wang Peijuan proposed measures to advance planting time combined with intercropping rice varieties with different harvest times, pointing out that this is the most effective measure to adapt to climate change according to climate change. drought direction. In research on drought and heat adaptation for rice production in Sichuan

province, scholar Chen Chao pointed out the need to strengthen the capture of beneficial climatic resources during the important growing period of rice plants. (branching, tillering) to promote the development of rice production in Sichuan.

1.3. Overview of research on drought adaptation behavior and household economics in the context of climate change in Vietnam

In Vietnam, there is not much research on behavioral adaptation to climate change in general and drought adaptation in particular. Some research projects can be summarized as follows:

Regarding household adaptation to climate change: Research by Ngo Trong Thuan and Ngo Sy Giai mentioned the method of calculating the livelihood vulnerability index (LVI) according to 02 approaches: (1) LVI from the perspective of an index composed of 07 main components and (2) LVI determined from 03 impact factors, sensitivity and adaptability determined according to the definition of vulnerability stated in the IPCC documents. This is a highly feasible empirical study. Climate change factors as well as livelihood impact factors are mentioned in scientific algorithms and convenient calculation operations.

Research by Tran Thuc and Tran Hong Thai in 2011 used a comprehensive, multidisciplinary method to research and assess the impact of climate change and adaptation options for socio-economic and ecosystem fields. most vulnerable.

Care International researches community-based climate change adaptation, which addresses the impact of climate change on food security and people's income, water, health and mobility. people.

The 2017 research of Equality Criteria used field survey data and statistical methods to propose solutions to adapt to climate

change for coastal communities in Nam Dien commune, Nghia Hung district, Binh Duong province. Nam was determined and concluded: local capacity to respond to climate change is low, leading to high risk. lack and weakness of infrastructure; People's knowledge and skills are limited and there is a lack of information.

First of all, in research on household economic production, there have been a number of works that comprehensively mention the household economic production model. Mai Thi Thanh Xuan, Dang Thi Thu Hien pointed out that the household economy is an important part of the Vietnamese economy. After nearly 30 years of development, this economic model has achieved important results. In fact, there is currently a gradual change in the direction from fragmented, small, manual production that mainly meets one's own needs to the production of goods according to a modern model, with the appearance of a form of association. among households to form large-scale production (household groups or agricultural production cooperatives), transforming towards a farm economy.

Mai Kim Lien's research in 2020, based on scientific and practical analysis of domestic and foreign publications on sustainable development criteria and response to climate change, the author has proposed a set of Evaluation criteria for integrating climate change into economic restructuring policies in the south central region.

In the study "Cultivation models to respond to climate change for coastal sand dunes in the Mekong Delta", author Le Anh Tuan surveyed farming models to adapt to climate change. through many field surveys in different sand dunes in 4 coastal provinces of the Mekong Delta. The results show that many climate change adaptation models have been implemented in many coastal sand

dune areas in the Mekong Delta.

Nguyen Thi Hao, Nguyen Tai Tue, Tran Dang Quy, Nguyen Duc Hoai, Mai Trong Nhuan have built a set of indicators to assess the ability to adapt to climate change at the household level, accordingly, pointing out 31 related indicators. aspects: people, economy, livelihood, society, access to infrastructure and governance within a certain geographical research area.

In the study "The current household economic picture and some raised issues", author Le Xuan Dinh pointed out that climate change (natural disasters) is a main cause of lack of sustainability. sustainable hunger eradication and poverty reduction in agricultural and rural areas.

In general, recent studies in Vietnam have increasingly focused on the correlation between household economic development and climate change, some studies have mentioned the impact of climate change. to household agricultural production. However, currently in Ninh Thuan province there are not many in-depth studies on behavioral options to adapt to drought and household economic development models that are strongly affected by drought under the impact of climate change.

CHAPTER 2:

RESEARCH METHODS AND DATA USED

2.1. Overall research diagram of the thesis

To achieve the research goals of the thesis and prove the theses, the thesis is implemented according to the research diagram illustrated in Figure 2.1.

Specifically, the research method and data used for each block are presented in the sections below and the connection between the blocks is presented in detail in chapter 3.

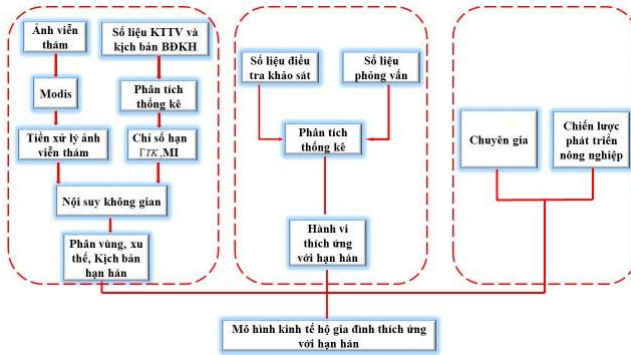


Figure 2.1. Research diagram of the thesis

2.2. Main research methods used in the thesis

- Methods of collecting information, inheriting data, and sociological investigation.

- Statistical method: determine the overall relationship between industries, fields, etc. from which to suggest households' adaptive behaviors to drought and propose economic models.

- The method uses remote sensing index VTCI and GIS to classify drought to the commune level.

- Method of using the Cielianinova Heat Humidity Dryness Index (ΓTK), MI and Cropwat software to calculate meteorological drought to assess drought trends and drought scenarios.

- Method of analyzing the trend of choosing drought adaptation behavior of households: research and application of mathematical models.

- Expert method: combining local reality with the professional knowledge and experience of experts, scientists, and managers from various fields.

2.3. Usage data

1) Hydrometeorological data from 1993 to 2020. 2) 2020 climate change scenario of the Ministry of Natural Resources and Environment. 3) Remote sensing image data: includes 8-day composite MODIS satellite images from 2000 to the end of 2020. 4) Base map and topographic map at scale 1:50,000. 5) Ninh Thuan province statistical yearbook, Ninh Thuan province annual disaster prevention report; Hydrometeorological report of Ninh Thuan province. 6) Investigation and survey data on the agricultural production situation in Ninh Thuan province in the period up to 2020.

CHAPTER 3:

RESEARCH RESULTS ON DRUG, ADAPTATION BEHAVIOR TO DRUG AND PROPOSAL SOME MODELS FOR HOUSEHOLD ECONOMIC DEVELOPMENT ADAPTING TO DRUG IN NINH THUAN

3.1 Proposed basis for a household economic development model to adapt to drought in the context of climate change

(1) Based on Ninh Thuan Provincial Planning for the period 2021-2030, vision to 2050;

(2) Based on the current status of the dam system and existing irrigation works in Ninh Thuan province;

(3) Based on the severity level, trends, and drought scenarios calculated in section 3.2 of the thesis;

(4) Based on households' adaptive behavior to drought in agricultural production development, presented in detail in section 3.3 of the thesis;

(5) Based on the current status of agricultural production development models in general and of households in particular,

they have adapted to climate change and produced effectively according to survey and interview results.

Below, the thesis specifically presents research results of factors serving as a scientific basis to identify adaptation measures and propose household economic development models in agricultural production in Ninh Thuan province.

3.2 Results of drought zoning, assessment of drought trends and development of drought scenarios in Ninh Thuan province

3.2.1 Results of drought zoning using VTCI remote sensing index to commune level

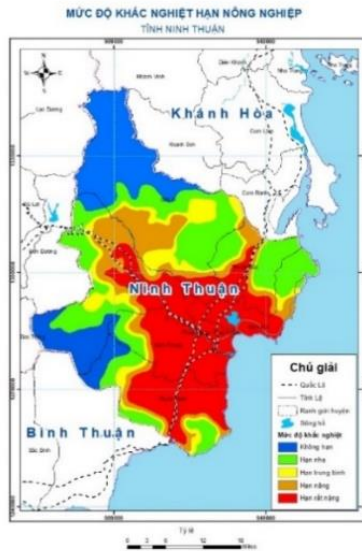


Figure 3.7. Map of agricultural drought severity in Ninh Thuan province according to VTCI index

Drought severity map set according to the VTCI index, showing the distribution of agricultural drought severity for each specific area (Figure 3.7). The area of drought severity in pharmaceutical districts is shown in table 3.3.

**Bảng 3.3: Area and rate of agricultural drought in districts
in Ninh Thuan province**

District	Drought level Unit	No drought t	Mild drought t	Moderate Drought	Severe Drought t	Very Severe Drought t
Bac Ai	Area (km ²)	418.0	261.8	139.9	141.9	53.7
	Ratio (%)	41.2	25.8	13.8	14.0	5.3
Thu an Bac	Area (km ²)	0.0	132.2	26.5	62.6	96.1
	Ratio (%)	0.0	41.7	8.4	19.7	30.3
Ninh Thai	Area (km ²)	0.0	84.0	14.1	18.1	129.6
	Ratio (%)	0.0	34.2	5.7	7.3	52.8
Ninh Phuoc	Area (km ²)	0.0	55.3	14.3	21.1	252.9
	Ratio (%)	0.0	16.1	4.2	6.1	73.6
Thu an Nam	Area (km ²)	0.0	172.5	56.1	55.6	271.7
	Ratio (%)	0.0	31.0	10.1	10.0	48.9
Phan Rang	Area (km ²)	0.0	0.0	0.0	0.0	78.5
	Ratio (%)	0.0	0.0	0.0	0.0	100.0
Ninh Son	Area (km ²)	21.5	348.5	75.0	135.5	183.2
	Ratio (%)	2.8	45.6	9.8	17.7	24.0

3.2.2 Drought trends and drought scenarios in Ninh Thuan province

3.2.2.1 Drought trend according to MI drought index in Ninh Thuan

Using the MI index calculation method as presented in Chapter 2, Section 2.3.1, the thesis has calculated the MI term index for each month in Ninh Thuan.

Table 3.5. Calculation results of MI term index by month

Monthly average for the period 1993 - 2020		
Month	MI	Drought level
I	0.15	HNT
II	0.04	HNT
III	0.09	HNT
IV	0.24	HNT
V	0.61	HN
VI	0.56	HN
VII	0.55	HN
VIII	0.37	HNT
IX	1.26	KH
X	1.80	KH
XI	2.31	KH
XII	1.43	KH

*HNT: Very severe drought; HN: hạn nặng, KH: no drought

The months from January to April and August have severe droughts, and months V-VII have mild droughts.

3.2.2.2. Drought scenario in Ninh Thuan

Based on the 2020 climate change scenario for Ninh Thuan province, the thesis has calculated the MI term index for the period up to 2050, corresponding to two scenarios RCP4.5 and RCP8.5 in Ninh Thuan province.

Calculation results and drought classification according to climate change scenarios show that: in the two scenarios RCP 4.5 and RCP 8.5, there are differences in the MI drought index, in the vast majority of months the MI drought index of the scenario is high. RCP8.5 is lower than the RCP4.5 low scenario except for the months of November and December.

Table 3.6. MI term index according to climate change scenarios to 2050 in Ninh Thuan province

Month	RCP 4.5 scenario		RCP 8.5 scenario	
	MI	Level	MI	Level
I	0.02	HNT	0.02	HNT
II	0.02	HNT	0.02	HNT
III	0.06	HNT	0.05	HNT
IV	0.12	HNT	0.11	HNT
V	0.43	HN	0.42	HN
VI	0.52	HN	0.5	HN
VII	0.37	HNT	0.36	HNT
VIII	0.4	HNT	0.39	HNT
IX	1.3	KH	1.29	KH
X	1.43	KH	1.41	KH
XI	1.58	KH	1.71	KH
XII	1.06	KH	1.15	KH

3.3. Results of analyzing households' adaptive behavior to drought in agricultural production

From the perspective of choosing household behavior to adapt to climate change and adapt to drought in agricultural production, it can be seen:

- Regarding quantitative analysis of households' drought adaptation behavior, it can be seen that the top priority measures are (1) changing livestock and crop breeds; (2) supplementing animal and plant varieties; (3) adjust planting and harvesting time; (4) adjust water quantity and irrigation time; (5) participate in irrigation groups and farming groups; (6) participate in agricultural insurance.

- on factors affecting households' choice of drought adaptation behavior: (1) age of the household; (2) educational level; (3) resources obtained from the community; (4) distance between village/commune to national highway; (5) terrain features; (6)

frequency of drought; (7) accessibility of disaster prevention information.

Based on the above results, the thesis proposes recommendations on three aspects: supplementing capital funds for the community, enhancing the ability of households to receive information related to drought, and promoting investment. Investing in the construction of transport infrastructure, irrigation, and small reservoirs in rural areas.

3.5. Proposing a model for household economic development and some measures to adapt to drought

3.5.1 Model of household economic development and some measures to adapt to drought according to population distribution

- Rural populations living along Highway 1 and the coastal corridor: In this area, the level of drought ranges from severe to very severe drought, in terms of behavioral choices and the ability to apply drought adaptive behaviors. very high to high levels.

This area can be divided into 2 residential areas:

Delta region: model for developing specialized agricultural areas, high-tech agricultural areas, climate-smart agriculture, high economic value agriculture, combining the development of goods and services travel service...

Coastal areas: coastal ecological model, agricultural development, aquaculture combined with tourism services and experiential tourism. fisheries model, maintaining and developing fishing villages. model of households or cooperatives in aquaculture areas, especially raising black tiger shrimp for export on a large scale.

- Rural mountainous populations: educational level is generally lower than in coastal areas. Characteristics of population

distribution by village, hamlet and village. In this area, the level of drought ranges from moderate to mild drought, in terms of behavioral choices and the ability to apply drought adaptation behaviors at moderate to low levels. The main model is to care for and protect forest ecology. model of growing industrial crops such as rubber, cashew, grass, and corn for livestock production. Traditional craft village development model for tourism.

Drought adaptation measures include:

- Use drought-resistant plant varieties. converting rice cultivation to short-term and long-term crops; growing melons, grapes, and apples in greenhouses combined with economical watering; converting and taking advantage of ineffective crop areas to grow grass for livestock production;
- Actively store fresh water for production.
- Actively participate in purchasing agricultural insurance
- Join groups, link "four houses" to support production, update news and share information to cope with drought
- Encourage ethnic areas to develop community tourism associated with promoting ethnic culture

3.5.2 Some household economic development models and drought adaptation measures for each district, commune cluster and commune

Specifically, household economic development models to adapt to drought for each district, commune cluster and commune are as follows:

Phan Rang Thap Cham City: This area's behavioral choices and ability to apply drought-adaptive behaviors are at a very high level. However, with the very severe level of drought, the economic development model of households is mainly ecological agriculture models combined with tourism, with mainly fruit tree

models such as growing fruit trees, melons, grapes, apples and shrimp seed farming. Two-crop wet rice model with areas that have been provided with sufficient water sources by irrigation systems. Continue to develop sustainable and environmentally friendly agricultural models. Model for producing clean, quality products.

Bac Ai district: This area's behavioral choices are at an average level, but the ability to apply drought-adaptive behaviors is at a high level. Households can develop wet rice growing models with drought-resistant rice varieties, corn, wheat, and bean growing models. Promote the development of economical watering models for fruit trees combined with eco-tourism models, continue to develop models of raising cows, pigs, and goats.

Phuoc Binh commune cluster center is the commune cluster center of communes: Phuoc Binh and Phuoc Hoa to develop the model of growing fruit trees combining eco-tourism, trade and services.

Phuoc Trung, Phuoc Chinh, Phuoc Thanh communes are in the drought center of Ninh Thuan province, the level of drought is very severe, the ability to choose behaviors and the ability to apply behaviors to adapt to drought is at an average level, The irrigation system does not ensure water for this area, so this place can only develop a one-crop rice production model in the rainy season with drought-resistant rice varieties, and the rest can be converted to other models. Economical watering for bean, corn, and fruit trees combined with the eco-tourism model. Develop models of raising cows, goats, and sheep.

Ninh Son district: This area's behavioral choices are at a low to medium level, but the ability to apply drought-adaptive behaviors is at a high level, moreover, the level of drought is low

here, so there is Can develop wet rice production models: 2 rice 1 corn. Develop fruit tree planting models. Model of raising cattle and sheep for fattening and reproduction.

My Son commune cluster center is the commune cluster center of My Son commune. This region's behavioral choices and ability to adopt drought-adaptive behaviors are average. Here, rainfall is low, evaporation is high, and drought is very severe. Therefore, this place can only develop the model of growing fruit trees and medicinal plants in net houses with economical watering models. Develop a model for fattening and breeding cows and goats.

Ma Noi commune cluster center is the commune cluster center of Ma Noi commune. This area's behavioral choices and ability to apply drought-adaptive behaviors are at an average level, this place is only subject to a mild level of drought, so in addition to developing afforestation models, HOUSEHOLDS can It is possible to develop a 3-reduce, 3-increase rice growing model with drought-resistant rice varieties in rice growing areas. Develop water-saving fruit tree planting models. Model of breeding cows, goats, and sheep.

Ninh Phuoc district: Phuoc Thai commune cluster center is the commune cluster center of Phuoc Vinh and Phuoc Thai communes. This area has a very high level of behavioral choices and the ability to apply drought-adaptive behaviors, this area has levels ranging from severe to moderate drought, with a large area of agricultural land and a large agricultural system. Tan My irrigation system, so the household economic development model here is mainly 2-crop wet rice but must implement 3 reductions 3 increases, develop corn seed production models, and fruit tree planting models. Clean grapes, clean apples save water combined

with the eco-tourism model. Model of raising cows and sheep for meat and reproduction.

Thuan Bac district: Bac Phong commune cluster center is the commune cluster center of Bac Phong and Bac Son communes. This area of behavioral choice and the ability to adopt drought-adaptive behaviors is high. However, this area is located near the epicenter of the drought, so the level of drought here ranges from severe to very severe, so the household agricultural production model here is one crop of wet rice during the rainy season and in places with a wet rice system. The irrigation system runs through but must thoroughly reduce and convert drought-resistant plant varieties. Model of growing garlic, aloe vera, and grass for cattle feed with economical watering methods. Develop a model of raising horned livestock such as cows, goats, and sheep.

Cong Hai commune cluster center is the commune cluster center of Cong Hai, Phuoc Chien, Phuoc Khang communes. Regarding drought, the level of drought ranges from mild to moderate. This area has a high level of behavioral choices and the ability to apply drought-adaptive behaviors, so here, in addition to the area with afforestation models, it is possible to develop rice cultivation models with other areas. Already have irrigation systems, areas without irrigation systems have completely switched to upland crops such as corn, beans, cassava, and garlic. Develop models of growing fruit trees such as cashews, bananas, aloe vera, and models of growing livestock grass with economical watering methods. Promote livestock models such as black pigs, cows, goats, sheep. Building climate-smart agricultural models in high-tech agricultural zones. Combine agriculture with ecotourism.

Thuan Nam district: Center of Phuoc Ha commune cluster is located in the southern development region of Ninh Thuan province, is the center of Phuoc Ha, Nhi Ha, Phuoc Ninh, Phuoc Minh communes. Except for some communes in the Southeast bordering the sea and the Southwest bordering Binh Thuan province, which have mild drought, the vast majority of the district's area has severe and very severe drought. This area has a high level of behavioral choices and the ability to apply drought-adaptive behaviors, so household economic models are mainly drought-adaptive crop models, such as: Economical watering for grapes and grass; Rice production models are similar to areas where irrigation systems pass through. Through crop conversion, effectively exploit ineffective cultivated land to grow some new trees, such as: Soursop, green-skinned grapefruit, dragon fruit. In livestock farming, the model of fattening cows: breeding goats and sheep.

Ninh Hai district: Khanh Hai urban commune cluster is the existing district center of Ninh Hai district including Khanh Hai town, Hoi Hai commune and Xuan Hai commune. In this area, the choice of behavior and the ability to apply behaviors to adapt to drought are at a very high level, plus the level of drought is quite severe. This area needs to change the rice growing model to a fruit tree growing model such as grapes and apples with economical watering models and ecotourism. Develop aquaculture and fishing models, especially tiger shrimp farming.

Thanh Hai urban commune cluster includes the entire administrative boundaries of Thanh Hai commune, Nhon Hai commune, and Tri Hai commune. This area's behavioral choices and ability to apply drought-adaptive behaviors are also at a very

high level, with very severe drought levels and adjacent to the sea, so the agricultural production model here mainly develops. Developing high-tech agriculture, growing onions and garlic indoors with water-saving irrigation. Model of salt industry development. Model of aquaculture and fishing in the northern region of the province.

Vinh Hy urban area includes part of the administrative boundary of Vinh Hai commune. This area, in terms of behavioral choices and the ability to apply adaptive behaviors to very high levels of drought plus moderate to severe drought levels, develops models for growing onions and garlic in greenhouses that save money. save water. Model of growing fruit trees, grapes and apples combined with ecotourism. Model of salt industry development. Model of aquaculture and fishing.

In order for the models to achieve high economic efficiency, some specific measures are required as follows:

- Convert rice cultivation to short-term and long-term crops; Use drought-resistant rice varieties such as new rice varieties; Apply "1 right, 5 down" and "3 down, 3 up; converting and taking advantage of ineffective crop areas to grow grass for livestock farming and investing in building barns,

- Economical watering for crops in general and fruit trees in particular,

- Build more small reservoirs and irrigation canal systems leading to the foot of the fields,

- Actively participate in purchasing agricultural insurance,

- Join groups, link "four houses" to support production, update news and share information to cope with drought.

CONCLUSIONS AND RECOMMENDATIONS

1. Conclude

The thesis has achieved its set goals. Detail:

The results of building a drought zoning map using remote sensing and GIS technology have objectively and in detail assessed the drought situation at the commune level, without any similar research in Ninh Thuan, and are quite suitable. compatible with reality. In general, throughout the province, over the past 20 years of research, droughts have occurred continuously with high frequency and are quite severe. Drought severity is distributed from the East to the West of the province. Scenarios for droughts up to 2050, the results show that droughts still occur and are very severe.

The study has applied the basis of theoretical analysis related to the decision to choose adaptive behavior of farming households in response to seasonal drought. The results show that: (1) 68.6% of farming households have taken adaptation measures; (2) Replacing crops, switching to growing other crops, adjusting sowing and harvesting dates are the measures most prioritized by farmer households to adapt to seasonal droughts; (3) Along with that, capital and labor are the main limiting factors in the choice and application of adaptation measures of farming households.

The study used Probit, Poisson and Tobit regression models to empirically analyze factors affecting farmers' choice of adaptation measures to seasonal droughts, their scale and intensity. applied measures, the results show: (1) Rich sources of capital in communities use adaptation measures, the scale and intensity of adaptation measures are larger; (2) The farther the village is from the national highway, the less likely farming households are to choose measures to adapt to climate change and drought; (3) Farmers in the delta have less intention to use adaptation measures, and the scale and intensity of using adaptation measures are also

smaller than in mountainous areas; (4) The frequency of drought increases the likelihood, scale and intensity of adaptation measures to adapt to climate change; (5) Available information regarding farmers' adaptation measures has an important influence on the choice, but pre-disaster information will motivate farmers to use effective adaptation measures. better results.

The thesis proposes a number of household economic development models and measures to adapt to drought including: household economic development model according to rural population distribution and by district, commune cluster and commune. Although the models are different, they all have the common features of water-saving irrigation, restructuring of crops, crops, and livestock. Select drought-resistant plant varieties, develop smart agriculture models, climate-smart agriculture, and promote agricultural models combined with ecotourism. Forming specialized farming areas, concentrated commodity production, applying technical advances, high technology and technology to adapt to climate change associated with processing industry and product consumption. In addition, based on each locality's drought adaptation behavior, the thesis has proposed measures to adapt to each behavior and each model to achieve the highest efficiency in agricultural production development. adapt to climate change in general and drought in particular.

2. Recommendations

- The results of analyzing adaptive behavior to seasonal droughts and household economic development models in agricultural production adapting to droughts can be used in similar studies in other regions. together.

- Continue to research other climate change factors affecting household economies and evaluate the costs, benefits, social and environmental impacts of each model when conditions allow.

**LIST OF WORKS RELATED TO THE THESIS HAS
BEEN PUBLISHED**

- 1) **Dang Quoc Khanh**, Duong Van Kham, Duong Hai Yen (2022), "Research and application of remote sensing and GIS technology to build agricultural drought maps in Ninh Thuan province", Vietnam Journal Hydro-meteorological. No. 736, pp. 12 – 24.
- 2) **Dang Quoc Khanh**, Duong Van Kham, Ngo Tien Giang (2022), "Research on a household economic development model to adapt to drought in the context of climate change in Ninh Thuan province", Vietnam Journal Hydro-meteorological. No. 738, pp. 82-96.
- 3) **Dang Quoc Khanh**, Duong Van Kham, Duong Hai Yen, Nguyen Van Son (2022), "Research on assessment of fluctuations and prediction of meteorological drought based on humidity index under the impact of climate change in Ninh Thuan - Binh province Thuan", Journal of Climate Change Science. No. 22, pp. 36-45.
- 4) Duong Van Kham, **Dang Quoc Khanh**, Duong Hai Yen, Nguyen Van Son (2023), "Assessing climate characteristics, agricultural climate conditions, adverse weather and natural disasters in Ninh Thuan and Binh Thuan provinces" Journal of Climate Change Science No. 26, pp. 56 - 67.