

RESEARCH ARTICLE

# Study the impact factors of climate change on agricultural land use in Phong Dien district, Thua Thien Hue province

*Nghiên cứu các yếu tố tác động của biến đổi khí hậu đến sử dụng đất nông nghiệp trên địa bàn huyện Phong Điền, tỉnh Thừa Thiên Huế*

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Many factors influence agricultural land use. In particular, the impact of climate change has the most significant and most serious effect on agricultural land use in general and in Phong Dien district in particular. The study used Binary Logistic analysis on SPSS software from the data collected through state agencies, fieldwork, and interviews. Since then, the study has identified the impact of climate change on agricultural land use through the following factors: The most significant influence is temperature and other extreme weather factors. In addition, the elements of rainfall, wind, and cold air also have a substantial impact on agricultural land use. These factors cause serious consequences such as damage, loss of construction quality, and overload of water supply and drainage systems, landslides, damage to infrastructure systems, etc. Some adaptive solutions to climate change to agricultural land use include changing crop structure, upgrading facilities, raising awareness of officials, and people about climate change.

Công tác sử dụng đất nông nghiệp chịu ảnh hưởng từ rất nhiều yếu tố. Trong đó, yếu tố tác động của biến đổi khí hậu gây ảnh hưởng lớn và nghiêm trọng nhất đối với việc sử dụng đất nông nghiệp nói chung và trên địa bàn huyện Phong Điền nói riêng. Nghiên cứu đã sử dụng phân tích Binary Logistic trên phần mềm SPSS từ các số liệu thu thập được qua các cơ quan nhà nước, thực địa, phỏng vấn. Từ đó, nghiên cứu đã xác định được tác động của biến đổi khí hậu đến sử dụng đất nông nghiệp thông qua các yếu tố: Gây ảnh hưởng lớn nhất là yếu tố nhiệt độ và yếu tố cực đoan khác; ngoài ra, các yếu tố lượng mưa, chế độ gió và không khí lạnh cũng tác động không nhỏ vào việc sử dụng đất nông nghiệp. Các yếu tố này gây ra các hậu quả nghiêm trọng như làm hư hại, giảm chất lượng công trình, làm quá tải hệ thống cấp thoát nước, làm sạt lở, hư hại hệ thống cơ sở hạ tầng... Nghiên cứu đã đề xuất được một số giải pháp thích ứng của biến đổi khí hậu đến việc sử dụng đất nông nghiệp như thay đổi cơ cấu cây trồng, nâng cấp cơ sở vật chất, nâng cao nhận thức của cán bộ và người dân về biến đổi khí hậu.

**Keywords:** Climate change, agricultural land use, Phong Dien district

## 1. Introduction

Today environmental hazards and challenges are no longer limited to individual countries or regions but are global. Vietnam is one of the five countries most affected by climate change (Tho Dang, 2013). The manifestation is abnormal changes in climate change (climate change); it is an existing risk for each country's sustainable development. Climate change, first of all, global warming and rising water levels along with extreme weather events such as storms, floods, droughts, etc. have significantly affected people's land use in many fields, especially the agricultural sector.

Over the past 50 years, the average temperature has increased by 0.5°C, and the sea level has risen about 20cm,

the disaster has become more and more fierce. According to climate change scenarios, by the end of the 21st century, the annual average temperature in our country will increase by 2-3°C, the total annual rainfall and the rainy season rainfall will increase, while the dry season rainfall will decrease. The sea level may rise from about 75cm to 1m compared to the average in the period 1980 - 1990. If the action program to reduce emissions and emissions caused by climate change is not implemented belong to the Decree such as Kyoto Protocol in 1997, by 2035, the surface temperature the globe surface will increase to 2°C. It is predicted that in the future there is a 50% chance that the temperature will increase by 5°C. If the sea level rises by 1m, appropriate 40% of the Mekong Delta, 11% of the Red River Delta and 3% of the other coastal provinces will be inundated (Vietnam Financial Review, 2019).

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Phong Dien is a Northern gateway district of Thua Thien Hue province. Surrounded by Bo River and O Lau River, a land with a long history and cultural traditions. Phong Dien district has a very diverse topography with 3 main types: mountainous areas, hilly areas; Delta; lagoons and coastal areas with abundant mineral natural resources. With such geographical and natural conditions, Phong Dien has many advantages for agricultural development. However, being contiguous to the sea and big rivers is potentially risky, especially under unpredictable climate change conditions. Specifically, in recent decades, people constantly suffer from extreme weather phenomena such as storms, floods, tropical low pressures, etc. Phong Dien has suffered many storms with vigorous intensity, which has destroyed many coastal ecosystems and strongly affected the local agriculture and seafood industry (Communist party of Vietnam online newspaper, 2018). The prolonged heat due to the effects of climate change in recent years has caused pests to arise on a large scale, outbreaks of epidemics on cattle and poultry in many places. These effects make farmers not feel secure to invest in production. In addition, plant growth and development are slowed down by factors of climate change. Therefore, the research team chooses the topic of the impact factors of climate change on agricultural land use in Phong Dien district.

## 2. Data and methodologies

### 2.1. Data collection

The study collected secondary data from reliable sources such as the Department of Natural Resources and Environment, the People's Committee of Phong Dien district, the People's Committee of the communes in the district.

For primary data, the research was conducted field surveys and consult experts and officials in relevant fields. In addition, after conducting the survey, Through the survey process, the study has identified four typical communes for the study area, where the most heavily affected by climate change, namely Phong My, Phong Thu, Dien Hai and Phong Hai. From there, based on the lectures of Nguyen Minh Hieu, 2009 collect data from the questionnaire with the sample size determined for each commune according to the Slovin formula:

$$n = \frac{N}{1 + N \cdot e^2}$$

Where n is the sample size (number of questionnaires); N is the total number (number of farming households in each commune. It is shown in table 1); e is the standard error. With e = 5%, the sample size of research contents is calculated as in the following table:

**Table 1. Sample size distribution in the study**

| Research area | Total of farming households (N) | Number of questionnaires (n) | The reason for selecting the sample                   |
|---------------|---------------------------------|------------------------------|-------------------------------------------------------|
| Phong My      | 60                              | 52                           | The area is heavily affected by drought               |
| Phong Thu     | 69                              | 59                           | The area is much influenced by inundation and drought |
| Dien Hai      | 104                             | 82                           | The area is much affected by saltwater intrusion      |
| Phong Hai     | 35                              | 32                           | The area is heavily affected by storms, cold air      |
| Total         | 268                             | 225                          |                                                       |

### 2.2. Data analysis method

The study used binary logistic regression model on SPSS to evaluate the impact factors of climate change.

Binary logistic regression model is a regression model used to estimate the probability of an event occurring. This model has a binary variable with 2 values of 0 and 1. In this study, the secondary variable Belonging is agricultural land use with 2 values of 0 meaning no influence and 1 sense having influence. The independent variables are temperature; rainfall; cold wind and air; other extreme weather values are also 0 and 1. In this study, group of authors have thought of extreme weather factors with many manifestations such as drought, storm, cyclone, etc. However, we want to separate the wind and cold air for a more detailed study.

Before including the variables into the regression model, the variables need to be checked for multicollinearity phenomenon. Multicollinearity is a state in which the correlated independent variables exist in the model. Multiple collinearities falsify or sign the regression coefficients in the regression equation, making the model's coefficients less meaningful. At the same time, multicollinearity provides the model with virtual or similar information and it is difficult to separate the influence of each independent variable on the dependent variable.

The easiest way to eliminate multiple collinearity is to remove the variable with the high collinearity sign from the model. To check the multicollinearity phenomenon, it can use VIF - Variance Inflation Factor to determine the sign of multiplicity.

The formula calculates the VIF coefficient:

$$VIF = \frac{1}{1 - R_k^2}$$

In which  $R_k^2$  is the multiple correlation coefficient of the kth variable in the regression model. The larger the VIF magnification coefficient of the variables, the higher the

collinearity. According to Gujarati (2008), if the VIF of a variable exceeds 10 then the variable is considered highly collinear and excluded from the model.

The Binary Logistic regression has the form:

$$\log_e \left[ \frac{P_i}{1-P_i} \right] = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4$$

In which:

$P_i$  is the probability of land use being affected by the factors of climate change (the value 1 occurs in the binary variable);  $e \sim 2.17$ ;  $B_0, B_1, B_2, B_3, B_4$  are the regression coefficients;  $X_1, X_2, X_3, X_4$  are independent variables.

A very powerful application of Binary Logistic's binary regression is its predictability. From the regression equation, we have the following equation to calculate  $P_i$ :

$$P_i = E(Y = 1/X) = \frac{e^{(B_0+B_1X_1+B_2X_2+B_3X_3+B_4X_4)}}{1+e^{(B_0+B_1X_1+B_2X_2+B_3X_3+B_4X_4)}}$$

The  $P_i$  equation is also the equation that predicts the occurrence of event  $i$  when the independent variables have specific values, through the above regression equation, it is possible to determine which factors of climate change will have the strongest impact, and which factors will have the least impact on agricultural land use through the regression coefficient  $B_i$ . [Where  $P_i = E(Y = 1/X) = P(Y = 1)$  is called the probability that the event will occur ( $Y = 1$ ) when the independent variable  $X$  has a specific value  $X_i$ ].

From the results of the calculation of regression coefficients and based on analyzing the role of the regression coefficient in the relationship between the changes of climatic factors and natural disasters and the change of land use, the number of times of land use change according to changes in grades of climatic factors and natural disasters by the formula (Hair et al, 1998):

$$Y = \frac{e^{B_0} + e^{B_i}}{e^{B_0}}$$

In which:  $B_0$  is a constant = -3,421;  $B_i$ : Regression coefficient of independent variables.

Through the above formula,  $Y$  shows the number of times the impact of agricultural land use depends on the change of climatic factors and natural disasters. With the assumption: one climate / natural disaster factor changes one level while other factors do not change, the land use will change.

### 3. Results and discussion

#### 3.1. Build the Binary Logistic regression

##### 3.1.1. Setup input data

###### Input data

The logistic regression equation shows the regression relationship between the dependent variable and the independent variable. The dependent variable is agricultural land use, and the independent variables selected include: temperature, rainfall; changes in wind and cold air; other extreme weather in study areas. Values of the variables were surveyed in 225 households in 4 communes typical of different study areas in Phong Dien district, specifically:

###### Temperature variable

**Table 2. Effect of temperature on agricultural land use**

| Criteria  |           | Temperature |       |        |
|-----------|-----------|-------------|-------|--------|
|           |           | No          | Yes   | Total  |
| Phong My  | Selection | 7           | 45    | 52     |
|           | Rate (%)  | 3.11        | 20.00 | 23.11  |
| Phong Thu | Selection | 4           | 55    | 59     |
|           | Rate (%)  | 1.78        | 24.44 | 26.22  |
| Phong Hai | Selection | 16          | 16    | 32     |
|           | Rate (%)  | 7.11        | 7.11  | 14.22  |
| Dien Hai  | Selection | 20          | 62    | 82     |
|           | Rate (%)  | 8.89        | 27.56 | 36.44  |
| Total     | Selection | 47          | 178   | 225    |
|           | Rate (%)  | 20.89       | 79.11 | 100.00 |

According to the above data, the temperature affecting agricultural land use accounts for 79.1% in the study area. In recent years, the temperature is getting higher and higher, affecting the local people's land use. Concentrated mainly in coastal communes, lagoons, and areas accounting for a high proportion compared to other regions.

###### Rainfall variable

**Table 3. Effect of rainfall on agricultural land use**

| Criteria  |           | Rainfall |       |        |
|-----------|-----------|----------|-------|--------|
|           |           | No       | Yes   | Total  |
| Phong My  | Selection | 34       | 18    | 52     |
|           | Rate (%)  | 15.11    | 8.00  | 23.11  |
| Phong Thu | Selection | 17       | 42    | 59     |
|           | Rate (%)  | 7.56     | 18.67 | 26.22  |
| Phong Hai | Selection | 9        | 23    | 32     |
|           | Rate (%)  | 4.00     | 10.22 | 14.22  |
| Dien Hai  | Selection | 20       | 62    | 82     |
|           | Rate (%)  | 8.89     | 27.56 | 36.44  |
| Total     | Selection | 80       | 145   | 225    |
|           | Rate (%)  | 35.56    | 64.44 | 100.00 |

As it can be seen, rainfall significantly affects agricultural land use in Phong Dien district (accounting for nearly 64.4%). The effect of rain is concentrated in the coastal and plain areas.

###### Wind, cold air variable

This study has separated wind and cold air factors from extreme weather factors because extreme weather has many phenomena such as floods, storms, droughts, etc. Therefore, to make the research and analysis easier, we consider the wind factor and cold air as a separate factor.

Wind and cold air are a major factor affecting agricultural land use (67.6%). Concentrate mainly in coastal areas, especially Phong Hai commune - where the district is the most abundant in aquaculture and fishing (Table 4).

**Table 4. Effect of wind and cold air on agricultural land use**

| Criteria  |           | Wind, cold air |       |        |
|-----------|-----------|----------------|-------|--------|
|           |           | No             | Yes   | Total  |
| Phong My  | Selection | 15             | 37    | 52     |
|           | Rate (%)  | 6.67           | 16.44 | 23.11  |
| Phong Thu | Selection | 34             | 25    | 59     |
|           | Rate (%)  | 15.11          | 11.11 | 26.22  |
| Phong Hai | Selection | 1              | 31    | 32     |
|           | Rate (%)  | 0.44           | 13.78 | 14.22  |
| Dien Hai  | Selection | 23             | 59    | 82     |
|           | Rate (%)  | 10.22          | 26.22 | 36.44  |
| Total     | Selection | 73             | 152   | 225    |
|           | Rate (%)  | 32.44          | 67.56 | 100.00 |

#### Other extreme weather variables

Other extreme weather affects almost all agricultural land use in all Phong Dien district areas, accounting for a huge proportion (77.8%). Other extreme weather is synthesized from common and frequent phenomena in the district such as droughts, floods, storms, saltwater intrusion, landslides and cyclones, which greatly affect the cultivated area and animal husbandry the whole district (Table 5).

**Table 5. Effect of other extreme weather on agricultural land use**

| Criteria  |           | Other extreme weather |       |        |
|-----------|-----------|-----------------------|-------|--------|
|           |           | No                    | Yes   | Total  |
| Phong My  | Selection | 8                     | 44    | 52     |
|           | Rate (%)  | 3.56                  | 19.56 | 23.11  |
| Phong Thu | Selection | 11                    | 48    | 59     |
|           | Rate (%)  | 4.89                  | 21.33 | 26.22  |
| Phong Hai | Selection | 10                    | 22    | 32     |
|           | Rate (%)  | 4.44                  | 9.78  | 14.22  |
| Dien Hai  | Selection | 21                    | 61    | 82     |
|           | Rate (%)  | 9.33                  | 27.11 | 36.44  |
| Total     | Selection | 50                    | 175   | 225    |
|           | Rate (%)  | 22.22                 | 77.78 | 100.00 |

#### Set up the model's input database

For dependent variables and independent variables are encoded as binary values 0 and 1, where value 1 means influence and value 0 means unaffected. Particularly, the weather independent variable has many small variables (dummy variable), so it is synthesized and encoded into the same variable as other extreme weather variables and encoded into binary values 0 and 1. The value 1 means influence and value 0 is unaffected.

#### 3.1.2. Calculation results

The variables with coded values after sampling are included in the logistic regression model to calculate the relationship between climate change impacts and agricultural land use in the area.

#### Analyzing the correlation between the factors of climate change impacts with agricultural land use in the study area

**Table 6. Analysis of the correlation between the factors of climate change impacts with agricultural land use**

|                             |                     | ALU     | Temperature | Rainfall | Wind & cold air | Other extreme weather |
|-----------------------------|---------------------|---------|-------------|----------|-----------------|-----------------------|
| Agricultural land use (ALU) | Pearson Correlation | 1       | 0.429**     | 0.215**  | 0.136*          | 0.469**               |
|                             | Sig. (2-tailed)     |         | 0           | 0.001    | 0.041           | 0                     |
|                             | N                   | 225     | 225         | 225      | 225             | 225                   |
| Temperature                 | Pearson Correlation | 0.429** | 1           | 0.007    | -0.006          | 0.225**               |
|                             | Sig. (2-tailed)     | 0       |             | 0.922    | 0.931           | 0.001                 |
|                             | N                   | 225     | 225         | 225      | 225             | 225                   |
| Rainfall                    | Pearson Correlation | 0.215** | 0.007       | 1        | -0.019          | 0.027                 |
|                             | Sig. (2-tailed)     | 0.001   | 0.922       |          | 0.777           | 0.684                 |
|                             | N                   | 225     | 225         | 225      | 225             | 225                   |
| Wind & cold air             | Pearson Correlation | 0.136*  | -0.006      | -0.019   | 1               | 0.063                 |
|                             | Sig. (2-tailed)     | 0.041   | 0.931       | 0.777    |                 | 0.344                 |
|                             | N                   | 225     | 225         | 225      | 225             | 225                   |
| Other extreme weather       | Pearson Correlation | 0.469** | 0.225**     | 0.027    | 0.063           | 1                     |
|                             | Sig. (2-tailed)     | 0       | 0.001       | 0.684    | 0.344           |                       |
|                             | N                   | 225     | 225         | 225      | 225             | 225                   |

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

From the analysis results in Table 6, it is found that the coefficients (Sig.) <0.05, so accept independent variables and allow to be included in the regression model. On the other hand, the factors that affect climate change are all

correlated with agricultural land use in Phong Dien district, Thua Thien Hue province.

#### Check the multicollinearity phenomenon

**Table 7. Results of multicollinearity test**

| No | Variable                    | VIF   |
|----|-----------------------------|-------|
| 1  | Temperature (T)             | 1.225 |
| 2  | Rainfall (RF)               | 1.048 |
| 3  | Wind and cold air (W&C)     | 1.019 |
| 4  | Other extreme weather (OEW) | 1.282 |

The Variance Inflation Factor of the variables in Table 7 are less than 10, showing that the multicollinearity phenomenon does not affect the model. Therefore, variables are accepted for inclusion in the regression model.

*The results of running the regression model to determine the parameters of the variables*

Regression was performed step by step according to the Enter method. The model run show results show: The value of -2LL (-2 log likelihood) = 93,124 is not enormous, proving that the overall model has a good fit. The values of the variables in the equation are shown in Table 8.

**Table 8. Variables in the Equation**

|         |               | B      | S.E.  | Wald   | df | Sig.  | Exp(B) | 95% C.I. for EXP(B) |        |
|---------|---------------|--------|-------|--------|----|-------|--------|---------------------|--------|
|         |               |        |       |        |    |       |        | Lower               | Upper  |
| Step 1a | T             | 2.964  | 0.610 | 23.572 | 1  | 0     | 19.367 | 5.854               | 64.069 |
|         | RF            | 2.283  | 0.618 | 13.651 | 1  | 0     | 9.802  | 2.92                | 32.898 |
|         | W&C           | 1.591  | 0.587 | 7.359  | 1  | 0.007 | 4.91   | 1.555               | 15.5   |
|         | EW            | 3.139  | 0.616 | 25.953 | 1  | 0     | 23.085 | 6.899               | 77.239 |
|         | Constant (B0) | -3.906 | 0.891 | 19.221 | 1  | 0     | 0.02   |                     |        |

$\alpha = 0.05$ ;  $-2LL = 93.124a$

Sig value of all variables are  $<0.05$ , all independent variables influence agricultural land use in the period 2015-2019 and have a regression relationship. With the coefficient B determined, the regression equation takes the form:

$$\text{Loge}\left(\frac{P_i}{1-P_i}\right) = -3,906 + 2,964 \times T + 2,283 \times RF + 1,591 \times W\&C + 3,139 \times OEW$$

The equation can interpret the meaning of the independent variables as follows: when the temperature variable increases, rainfall increases, wind and cold air increase more, other extreme weather occurs more the impacts on agricultural land use potentially increased. Specifically:

- Wind, cold air is the factor that has the least impact on agricultural land use; When the quantity is increased by one level, the probability of a land use effect increases only 4,910 times.
- The precipitation factor has an average impact on agricultural land; When the wind, the air is cold more

than one level, the probability of land use right increases only 9,802 times.

- The temperature factor has a great influence on agricultural land use. When the temperature increases by one level, the probability of land use effect increases by 19,367 times.
- Other extreme weather affects agricultural land use the most; When other extreme weather increases one level, land use effects increase by 23,085 times.

### 3.1.3. Verify calculation results

To assess the appropriateness of the results of the regression model calculation on the impact of selected climate change impact factors on the use of agricultural land in the area, the study conducted Verify these results with reality on the effects of climate change on agricultural land use that took place in Phong Dien district in the period 2015-2019. The verification results are as follows:

*Based on the questionnaire*

**Table 9. Classification of factors of climate change that affect and do not affect agricultural land use according to questionnaires and regression calculations**

| Criteria                                                        |     | Impacts on agricultural land use according to the calculation |     | Correct prediction rate % |
|-----------------------------------------------------------------|-----|---------------------------------------------------------------|-----|---------------------------|
|                                                                 |     | Yes                                                           | No  |                           |
| Impacts on agricultural land use according to the questionnaire | Yes | 19                                                            | 12  | 61.3                      |
|                                                                 | No  | 8                                                             | 186 | 95.9                      |
| Overall percentage                                              |     |                                                               |     | 91.1                      |

By row is the actual number of observations and by column is the predicted number, specifically:

- Out of 31 households that are not affected, 19 are correctly predicted, the correct rate is 61.3%.
- Of 194 affected households, 186 households are correctly predicted, the correct rate is 95.9%.

Thus, the average rate of correct prediction of the model is 91.1%.

*According to analysis from calculation results*

The impact of temperature and rainfall on agricultural land use:

For many years, the planning of agricultural land use in Phong Dien district has been concerned with climatic conditions (mainly by heat). local average annual rainfall and degrees). But the research results show that the changes of temperature and precipitation factors in the period 2010-2019 affecting the use of agricultural land are relatively large, especially on the arrangement of different types of land use. agricultural land use of the province.

On the other hand, the variation of temperature and rainfall significantly impacted crop structure and production season. The results of analyzing Phong Dien climate data show that: In the period 2010–2019, the average temperature in Phong Dien was only increasing about 0.8-2°C, affecting the use of agricultural land about six times. Thus, the effect of temperature on agricultural land use is relatively large.

Rainfall in Phong Dien over the past time tended to decrease, in some years with unusually heavy rainfall due to the occurrence of extremely heavy rains in a short time. Therefore, in general, rainfall has little effect on agricultural land use, but only on the planting and harvesting seasons.

The effects of wind, cold air on agricultural land use:

Phong Dien in the period had been controlled by two main monsoons, winter monsoon and summer monsoon. About the winter monsoon (from last September to April next year). The coming northeast monsoon often brings cold climate, bad weather, causing rain.

During this time, there are often coordinated effects here, especially at the beginning of the season in September, October and November. There may be a Northeast monsoon and tropical low pressure or storms in many cases. Other factors cause heavy rains and severe floods. However, up to February of March for many years, there are still strong northeast monsoons, very low temperatures, and a lack of sunlight, causing great harm to crops. The early transplanted rice tea, flowering sometimes lost white.

Summer monsoons usually start from March, April to September. The wind is southwestern, bringing in hot and humid air from the sea. The air becomes dry and hot on the Eastside, making the summer here, which is already hotter, hotter, usually at 36 - 37°C, sometimes up to 39 – 40°C. Phong Dien is close to Quang Tri, where the “Laos wind” has a very strong impact, the influence of the “Laos wind” or the southwest monsoon may be stronger than the southern districts and Hue city, especially in the prevailing time. At this point, the southwest winds are also thicker and last throughout the day, sometimes into the night.

The above shows that the wind and rainfall affecting agricultural land use in the district is moderate. The drought in Thua Thien Hue province has taken place quite strongly. Drought makes the land arid, the water shortage of crops is serious, leading to many cultivated areas' death or loss. This fact has been encountered in some places in Phong My, Phong Xuan, Phong Hoa, and Phong Thu.

Otherwise, climate change causes prolonged hot weather and drought, low water levels in rivers have created conditions for saltwater intrusion to penetrate inland, directly affecting agricultural production areas, especially in wet rice cultivation areas. Inundation causes many cultivated lands to be lost, leading to significant agricultural land fluctuations in recent years. In addition, storms, landslides, and tornadoes occur with relatively high intensity and frequency, affecting the people's agricultural land.

From the practice as mentioned earlier, it can be observed that other extreme weather is the most influencing factor in agricultural land use in the district. Referring to the logistic calculation results, when other severe weather changes one level, the probability of affecting agricultural land use will increase by 23,085 times.

Facing the above situation, the tasks set out for the Phong Dien district government and people must prepare to respond and adapt to climate change and sea-level rise, ensuring sustainable development. Therefore, making "Adjustment of land use planning to 2030 and first-year land use plan of Phong Dien district" is part of the action plan to respond to climate change and sea-level rise of the district to equip management levels, local authorities as well as land users with a scientific basis for the effective management and use of land resources. They are building-specific solutions to limit the damage caused by climate change to ensure the goal of sustainable development.

#### **3.1.4. Impact factors of climate change on local people's lives in Phong Dien district**

Over the past years, climate change has affected all aspects of local people's lives in the study area; especially agricultural production activities; change the crop structure; adversely affecting cultivation and husbandry; fishing, aquaculture and the risk of new diseases appearing on plants, animals, etc. These are also the impacts of climate change on specific socio-economic locality activities in the past and the years to come (Vietnam Hydrometeorology Data Center, 2020). In particular, the biggest influence is agricultural production activities. Therefore, the organization of agricultural production should be oriented with a scientific basis to arrange the types of use to adapt to climate change according to the goal of sustainable development is an urgent issue. However, this activity still has many problems in dealing with climate change; There are no solutions and adaptive models to help people effectively respond to climate change, and people's lives still face many difficulties. That requires the form of territorial

organization of agricultural production and solutions to mitigate climate change impacts to promote socio-economic development, improving the life quality. Through the

results of household survey in 3 regions in the district, then analyzing and statistics on SPSS software got the following results:

**Table 10. Impacts of climate change on the local people's lives in Phong Dien district**

| Criteria                                         | Affect | Area        |          |           |          |           |          |           |          |
|--------------------------------------------------|--------|-------------|----------|-----------|----------|-----------|----------|-----------|----------|
|                                                  |        | Mountainous |          | Delta     |          | Coastal   |          | Sum       |          |
|                                                  |        | Selection   | Rate (%) | Selection | Rate (%) | Selection | Rate (%) | Selection | Rate (%) |
| Damaging, reducing construction quality          | Yes    | 3           | 1.3      | 8         | 3.6      | 34        | 15.1     | 45        | 20.0     |
|                                                  | No     | 49          | 21.8     | 51        | 22.7     | 80        | 35.6     | 180       | 80.0     |
| Overloading the water supply and drainage system | Yes    | 40          | 17.8     | 30        | 13.3     | 83        | 36.9     | 153       | 68.0     |
|                                                  | No     | 12          | 5.3      | 29        | 12.9     | 31        | 13.8     | 72        | 32.0     |
| Eroding, damaging roads, canals, dikes, dams...  | Yes    | 22          | 9.8      | 5         | 2.2      | 28        | 12.4     | 55        | 24.4     |
|                                                  | No     | 30          | 13.3     | 54        | 24.0     | 86        | 38.2     | 170       | 75.6     |
| Other effects                                    | Yes    | 25          | 11.1     | 17        | 7.6      | 36        | 16.0     | 78        | 34.7     |
|                                                  | No     | 27          | 12.0     | 42        | 18.7     | 78        | 34.7     | 147       | 65.3     |

The survey results shown in table 10 illustrates that the impact factors of climate change on life are relatively large. Specifically, climate change damages and reduces the quality of works with 80% of the votes being affected, this is a warning number of infrastructure and infrastructure concentrated in mountainous and delta areas. That sees the dangers of climate change. Climate change also overloads the water supply and drainage system, with 32% of the votes being affected, this number is small because the majority of the district already has a dyke system, the drainage regime is newly invested and built. People's life has been somewhat improved in the period of climate change adaptation.

On the other hand, climate change causes landslides, damages roads, canals, dikes, and embankments, etc. the survey results show that 75.6% of interviewed people agree that climate change affects people's production. Factors such as weather fluctuations, storms and floods with increasing density and frequency have caused these phenomena. Furthermore, the lack of responsibility in the construction process and the subjectivity of the people in the face of the factors of climate change also affect people's lives and production. Besides, 65.3% of people choose other effects of climate change on their lives including epidemics, environmental pollution, human health, etc.

### 3.2. Proposed solutions

- Irrigation systems are most affected by climate change. Therefore, it is necessary to continue to complete and build a system of in-field canals, improve pumping stations to ensure irrigation water for crops, especially in the dry season.
- Do better research and research of new varieties of plants and animals with good adaptability to weather conditions, short production time, high productivity and quality, and hand them over to farmers. people.

- To build a ring dikes and embankments system to fight floods, combat waterlogging and combat landslides along two sides of O Lau and Bo rivers. Handling riverbank erosion, especially riverside and coastal communes, creates a comfortable psychology for people to live and develop socio-economic.
- Information on natural disasters, storms, floods, droughts, etc. should be communicated to the people as soon as possible through the radio and television system. This is an important measure to help farmers live with the impact factors of climate change, especially storms and floods.
- Policies for lending, capital support, concessional loans, financing, re-lending, and mortgage assets need to be supported and more widely disseminated to households.
- Develop and promulgate mechanisms and policies to encourage the development of clean production models and environmentally friendly technologies from agricultural production to daily life to reduce emissions that cause environmental pollution.
- Raising awareness about climate change and natural disaster prevention methods for households by participating in training courses and disseminating knowledge about climate change.
- Professional training to popularize knowledge on cultivation, farming as well as offshore fishing for people.
- There is a high degree of flexibility in changing the planting season schedule to limit the losses brought by natural disasters. Actively irrigate properly to ensure water for production and living in high and prolonged temperature conditions, leading to drought and waterlogging at the time of flood.

- Raising awareness of people in preventing and coping with unusual weather conditions, actively responding in all circumstances.

## 4. Conclusions

The study results have been established regression equation of climate change factors that affect agricultural land use. The factors that affect the most are other extreme weather and temperature. Besides, factors of rainfall, wind, and cold air also affect agricultural land use in the study area. Combined with the general practice results, the accuracy of this model is up to 91.1%. Moreover, the above factors affect people's lives, especially overloading the water supply and drainage system. Since then, the topic has proposed solutions to improve capacity to adapt to climate change impacts on agricultural land use for both infrastructure and policies.

## 5. References

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