THAI NGUYEN UNIVERSITY
UNIVERSITY OF AGRICULTURE AND FORESTRY

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RESEARCH ON PROPOSAL OF AGRICULTURAL LAND USE TO ADAPT TO CLIMATE CHANGE IN DAK LAK PROVINCE

Industry: Land Management

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SUMMARY OF DOCTORAL THESIS ON LAND MANAGEMENT

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Objection 2:

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LIST OF PUBLISHED WORKS

RELATED TO THE THESIS

1. **Pham Thanh Tam,** Le Van Tho, Tran Xuan Bien (2022). Current status of agricultural land degradation under the impact of climate change in Dak Lak province. *Journal of Agriculture & Rural Development* , No. 19/2022, pp. 63-72.

2. **Pham Thanh Tam** , Le Van Tho, Tran Xuan Bien (2022). Forecasting the level of agricultural land erosion according to the climate change scenario RCP4.5 (period 2020 - 2035) in Dak Lak province. *Journal of Agriculture & Rural Development* , No. 22/2022, pp. 18-26.

3. **Pham Thanh Tam** , Le Van Tho, Tran Xuan Bien (2022). Forecasting the level of agricultural land drought according to the climate change scenario RCP4.5 (period 2020 - 2035) in Dak Lak province. *Journal of Natural Resources and Environment Science* , No. 44/2022, pp. 03-11.

4. **Pham Thanh Tam** , Le Van Tho, Tran Xuan Bien (2024). Building a land unit map in Dak Lak province. *Journal of Agriculture & Rural Development,* No. 05/2024, pp. 92-100.

INTRODUCTION

1. Urgency of the topic

Climate change (CC) has a direct impact on agricultural land use, affecting water resources such as drought, floods, groundwater depletion, changing soil physical and chemical properties such as increased salinity, increased acidity due to rising sea levels, loss of organic matter, changes in soil biodiversity, changes in soil moisture and soil temperature. Land use activities always have a strong impact on CC at regional and global scales (Bennett, 2017; Lawrence & cs, 2015). According to research and forecasts by the United Nations Intergovernmental Panel on Climate Change (IPPC) and the World Bank (WB), in Vietnam, if the sea level rises by 1 meter, it will flood about 0.3 to 0.5 million hectares in the Red River Delta, the Mekong Delta will have 1.5-2.0 million hectares and in years of heavy floods, about 90% of the Mekong Delta area will be flooded for 4-5 months. Climate change also increases natural disasters, causing crop yields to decrease. According to ADB's assessment, if the temperature increases by 1 degree Celsius, rice yields will decrease by 10%, this situation will seriously threaten national food security and affect tens of millions of people.

Recognizing the enormous impacts of climate change on socio-economic development and the environment, especially on agricultural land use, in 2008 the Government approved the National Target Program to Respond to Climate Change. To date, many scientists have studied agricultural land use under the impact of climate change in many aspects and at different levels of depth. Some studies focus on the impact of climate change on agriculture (Ha Minh Tuan et al., 2019). Several other studies have evaluated types of agricultural land use that are adaptive to climate change (Nguyen Bich Ngoc et al., 2018; Tran Thi Huong Giang et al., 2015; Pham Thanh Vu et al., 2016; Le Hoang Nam et al., 2021)... However, the theoretical issue of agricultural land use under the impact of climate change has not been clearly synthesized and analyzed and has not been deeply researched to find models of land use that are adaptive to climate change. This is an issue that needs to be focused on and resolved to contribute to perfecting the theoretical and practical basis of this issue in order to improve the efficiency of agricultural land use under the impact of climate change.

Dak Lak province is located in the center of the Central Highlands, the source of the Serepok river system and part of the Ba river, located in the geographical coordinates from 107 ^{0} 28'57" to 108 ^{0} 59'37" East

longitude and from 12 ^{0} 9'45" to 13 ^{0} 25'06" North latitude, with an average altitude of 400 - 800 meters above sea level. In recent years, climate change in Dak Lak province has shown clear signs, especially drought and erosion, which are having a clear impact on agricultural production in general and the cultivation industry in particular. In 2022, the province had 8,949 hectares of crops affected by drought, including 3,761 hectares of rice, 2,011 hectares of cash crops, and 3,176 hectares of perennial crops. However, up to now, there has been no in-depth assessment of agricultural land use in response to climate change in the province to comprehensively assess the current status of agricultural land use and the impacts of climate change on agricultural land use, on that basis, propose solutions to use agricultural land in response to climate change in Dak Lak province more effectively. Therefore, research on the use of agricultural land in response to climate change is one of the effective solutions to achieve the dual goals of ensuring economic efficiency of the agricultural production system while minimizing the impacts of climate change on the production system.

Based on that reality, I chose to carry out the topic ***"Research on proposing agricultural land use adaptation to climate change in Dak Lak province"*** .

2. Topic objectives

- Assess the current status of agricultural land use and some impacts of climate change on agricultural land use in Dak Lak province;

- Assess the potential for agricultural land use, propose orientations and some solutions for agricultural land use to adapt to climate change in Dak Lak province.

3. Scientific and practical significance

3.1. Scientific significance

The study contributes theoretical basis for agricultural land use in the context of climate change , and analyzes and evaluates the impact of climate change factors to orient sustainable agricultural land use, bringing high efficiency to Dak Lak province and provinces with similar ecological conditions.

3.2. Practical significance

- Provide necessary documents in the process of using agricultural land to adapt to climate change in Dak Lak province;

- Contribute to helping agricultural and forestry scientists and farmers use agricultural land use models effectively.

4. New contributions of the Thesis

- The impact of climate change (including 2 factors of erosion and drought) on agricultural land use in Dak Lak province has been assessed. Based on the selection of climate change scenarios for the province, the thesis has forecasted and calculated the level of erosion and drought, combined with the results of research on the current situation and assessment of agricultural land potential, the thesis has oriented agricultural land use to adapt to climate change in Dak Lak province.

- The thesis has proposed 3 land use models and 3 groups of solutions to improve the efficiency of agricultural land use in Dak Lak province to adapt to climate change, including: solutions on land management, solutions to limit the effects of drought and solutions to limit soil erosion.

Chapter 1:
DOCUMENT OVERVIEW

1.1. Theoretical basis of the research problem

The thesis has clarified some concepts of agricultural land use, climate change (CC), collected documents to assess the evolution of CC in 62 years (1958 - 2020), analyzed the causes of CC and methods to respond to CC.

The thesis has analyzed the global and Vietnamese climate change developments, and synthesized climate change scenarios. From there, it clarifies the relationship between climate change and land management and use.

1.2. Practical basis of agricultural land use adaptation to climate change

From previous research works, the thesis has synthesized approaches to agricultural land use adapting to climate change. Management and use of agricultural land adapting to climate change in Vietnam in general and the Central Highlands region in particular.

1.3. Some studies on land use under climate change conditions

1.3.1. In the World

Research and assessment of the impact of climate change on crop and livestock productivity and agricultural business activities account for the majority of research projects on the impact of drought on agricultural production in the world today. The prominent areas in these studies are still arid regions and are strongly affected by drought such as Africa, South America, the United States, Russia, China, India, West Asia, Australia and Southern Europe.

1.3.2. In Vietnam

Research on climate change in Vietnam has been popular since the

1980s, associated with climatologists such as Nguyen Duc Ngu, Nguyen Trong Hieu, Tran Thuc, Nguyen Van Thang and geographers such as Nguyen Van Cu, Nguyen Lap Dan, Nguyen Dinh Ky... Research on the impact of climate change on agricultural production mainly focuses on analyzing the current situation and assessing the damage to productivity, output and changes in crop structure caused by climate change, as shown in the research works of agricultural meteorologists such as Nguyen Van Viet, Duong Van Kham, Nguyen Van Liem, Ngo Si Giai, Doan Van Diem. Research on drought warning forecasts (Nguyen Quang Kim, Nguyen Van Thang) has many achievements in both qualitative and quantitative research, but detailed impact forecasts for agricultural production or forecasts of impacts in the context of climate change are still open. Research proposing solutions to minimize the impact of climate change on agricultural production (Ngo Dinh Tuan, Nguyen Lap Dan, Doan Doan Tuan) has only stopped at general response proposals without specific solutions for small territories (district and commune levels). At the same time, these solutions have not been proposed in the context of climate change to better serve the overall socio-economic planning work in general and the agricultural sector in particular.

1.4. Research orientation of the topic

Domestic research projects on climate change and land use in the context of climate change are an important part of the development and integration process in Vietnam today. Determining the use of agricultural land with an effective growth model is the right choice for restructuring agriculture in some localities and ecological regions.

Studies in the world related to the content of the topic show that most countries are interested in investing and developing agriculture to adapt to climate change. From countries with difficult agricultural production such as Africa, to countries with strong investment in agriculture such as Korea, Japan, Israel, ... that process has a very important contribution of agricultural land use.

Through the published documents presented above, the research works mentioned are quite rich and diverse in terms of climate change and the impact of climate change on agriculture. However, the documents mainly study the impact of climate change on agricultural crops, land use is only of general theoretical nature for large areas and the world. On the other hand, some works only focus on researching one or some specific issues on climate change scenarios for the domestic agricultural sector. On the basis of systematizing the theory of climate change, the impact of climate change

on agricultural land use, the topic has proposed the main research directions including: (1) Assessing the current status of land management, land use and climate change on land use in Dak Lak province . (2) Monitoring and proposing some models of agricultural land use in changing climate conditions in Dak Lak province (3) Proposing solutions to improve the efficiency of agricultural land use to adapt to climate change conditions in Dak Lak province .

Chapter 2
OBJECTS, CONTENT AND METHODS OF RESEARCH

2.1. Research subjects

- Research subjects are agricultural production land (rice land, annual and perennial crops, fruit trees); Climate change scenarios of Dak Lak province;
- The proposed LUT structure for climate change adaptation in Dak Lak province is based on the assessment of the potential suitability of LUTs integrating the analysis of climate change impacts (drought and soil erosion) according to climate change scenarios.

2.2. Scope of research

- Research period: 2017 - 2022;
- About space: In Dak Lak province.

2.3. Research content

- Assessment of natural, socio-economic conditions and State management of land in Dak Lak province;
- Assessment of the current status of agricultural land use in Dak Lak province;
- Assessing the impact of climate change on agricultural land use in Dak Lak province;
- Assessing potential and selecting, monitoring agricultural land use models adapted to climate change in Dak Lak province;
- Orientation and proposal of solutions for agricultural land use to adapt to climate change in Dak Lak province.

2.4. Research methods

2.4.1. Information collection method

- *Secondary data information* : documents on land, economic and social conditions of the research area at departments, branches, and offices: Economics, Natural Resources and Environment, Statistics, Urban

Management, etc. and some other agencies.

- *Primary data information* : Using rapid rural survey (RRA) and participatory rural survey (PRA) methods.

2.4.2. Research zoning method and model monitoring selection

* Select research area: Approach according to 03 ecological sub-regions (central ecological sub-region; northern sub-region; southeastern sub-region).

* Model selection: select households to monitor the pilot model according to the local actual household group classification criteria (Rich, Fair, Average); Models selected for monitoring and evaluation in 2022-2023: Durian growing model; Coffee growing model; Rice growing model;

* Selecting households for investigation: The households for investigation must be representative households producing in models including 3 groups of households : durian production, coffee production and rice production. Within the scope of the topic, the author selected 210 households for investigation (70 households/1 model) according to the questionnaire form in TCVN 8409: 2012 of the Ministry of Agriculture and Rural Development.

2.4.3. System of indicators for evaluating socio-economic and environmental efficiency

According to National Standard TCVN 8409:2012, the process of evaluating agricultural land serves provincial land use planning.

2.4.4. Analysis and forecasting methods

* *Quantitative analysis method using production function* Applied according to the production function research method of Le Tan Luat (2004), Tran Ngoc Minh (2006): Used to quantify the relationships and interactions between input factors (land, labor, capital, farming households) and output results (income). From there, the impact of each input factor and the results obtained can be seen. The Cobb – Douglas production function has the form: $Yi = X_1^{\alpha 1} X_2^{\alpha 2} \ldots . X_n^{\alpha n} e^{(\gamma 1D1 + \gamma 2D2 + Ui)}$

In which: Yi is the endogenous variable to be analyzed such as: income, total income

X1X2…Xn are exogenous variables affecting Y including land, labor…

D: is a qualitative factor: household head's education level, land type, household type (D1= 1, 0; D2= 1, 0)

α 1 α 2… α n are the parameters of the model, which represent the

percentage change of Y when there is a 1% change in certain input factors X.

γ 1 γ 2 are the coefficients of the qualitative variable.

* *Forecasting method:* forecasting the development potential of 03 models in terms of land scale, productivity, output and ability to meet market demand.

Soil sampling and analysis methods

Soil sampling investigation by stratum follows the medium and large scale soil mapping investigation process (TCVN 9487:2012) published by the Ministry of Science and Technology. The analytical indicators include: Analysis of physical and chemical indicators by soil stratum including: OC%, N%, P2O5%, K2O%, CEC (mg/100g soil), Ca2+, Mg2+, K+, Na+, easily available P2O5, easily available K2O (mg/100g soil).

2.4.6. Methods of statistics, comparison, synthesis and processing of data information

Method of using Word and Excel software to compile, compare, synthesize and process primary and secondary documents and data.

2.4.7. Method of using GIS technology to create maps and evaluate land potential

Using overlay technology on ArcGIS, MicroStation to build various types of maps: erosion maps, drought maps, fertility loss maps; Conglomerate maps and land cover maps.

Land potential assessment according to TCVN 8409:2012.

Chapter 3
RESEARCH RESULTS AND DISCUSSION

3.1. Assessment of natural, socio-economic conditions and land management in Dak Lak province

3.1.1. Assessment of natural conditions

Dak Lak province is one of the five provinces in the Central Highlands, located in the central region of the region. Geographic coordinates from 12°9'45" to 13°25'06" North latitude and 107°28'57" to 108°59'37" East longitude; Average altitude 400-800m above sea level, the highest is Chu Yang Sin mountain peak with an altitude of 2442m, which is also the highest mountain peak in Dak Lak. The North borders Gia Lai province, the South borders Lam Dong province, the Southwest borders Dak Nong province, the East borders Phu Yen and Khanh Hoa provinces, the West borders the Kingdom of Cambodia.

3.1.2. Assessment of socio-economic conditions

In the period 2017 - 2022, Dak Lak's average annual economic growth rate is 6.38% (at 2010 comparative prices). Of which, agriculture, forestry and fishery increased by 4.33%, industry - construction increased by 9.40% and trade - services increased by 6.98%.

3.1.3. Current status of state management of land

According to report No. 1949/BC-TNMT dated November 2, 2021 of the Department of Natural Resources and Environment of Dak Lak in 2021, land management in Dak Lak province is carried out in accordance with 15 contents of State management of land in the direction of specialization: professional contents, with many technical aspects such as granting land use right certificates, land use right registration, land use planning, land allocation, land use right auction, statistics and inventory... are performed by public administrative service agencies such as the Land Use Right Registration Office and the Land Fund Development Center. The Department of Natural Resources and Environment performs the function of appraisal and advising the Provincial People's Committee to make decisions on issues related to land and the environment. The assignment and organization in this direction has contributed to improving the effectiveness of State management of land.

3.2. Assessment of the current status of agricultural land use in Dak Lak province

3.2.1. Current land use status in 2022

Dak Lak is the 4th largest province in the country with a total natural area of 1,307,041 hectares according to land statistics in 2022. Of which, the agricultural land area is 1,189,057 hectares, accounting for 90.97% of the total natural area; the non-agricultural land area of the province is 96,303 hectares, accounting for 7.37% of the total natural area; the unused land area is 21,681 hectares, accounting for 1.66% of the natural area.

3.2.2. Changes in agricultural land use under the impact of climate change in Dak Lak province in the period 2017 - 2022

According to land statistics in 2022, the total natural area of the province is 1,307,041 hectares, a decrease of 5,308 hectares, of which: Ea Sup district has the largest natural area with 176,532 hectares, accounting for 13.54% of the province's natural area. Buon Ho town has the smallest area with 28,261 hectares, accounting for 2.16% of the province's natural area. Of which, the province's agricultural land area is 1,189,057 hectares, accounting for 90.97% of the natural area.

In the period 2017 - 2022, the province's agricultural land area increased by 28,730 hectares. Specifically: Rice land increased by 2,141

hectares (mainly from annual crop land converted); land for other annual crops decreased by 20,736 hectares (partly converted to perennial crops); land for perennial crops increased by 47,309 hectares; protective forest land decreased by 2,437 hectares; special-use forest land increased by 4,987 hectares; production forest land decreased by 2,285 hectares.

3.2.3. Characteristics of agricultural farming systems under the impact of climate change in Dak Lak province

In Dak Lak province, there are currently two main farming systems: rain-fed farming (total area is 708,574 ha, accounting for 59.59%) and irrigated farming (total area is 480,483 ha, accounting for 40.41%).

Table 3.7. Area of main agricultural land use types in Dak Lak province

TT	Land use type	Land use type		Area (ha)	Rate (%)
1	Rice Specialist (LUT 1)	1	Spring rice - Summer rice	50,213	7.7
		2	1 rice crop	21,064	3.2
		Total		**71,277**	**10.9**
2	Annual Plants (LUT 2)	3	Corn	85,650	13.1
		4	Lost	12,835	2.0
		5	Sugarcane	19,585	3.0
		6	Vegetables	30,914	4.7
		7	Other Annual Plants	22,980	3.5
		Total		**148,984**	**22.7**
3	Perennial industrial crops (LUT 3)	8	Cafe	203,063	31.0
		9	Pepper	37,601	5.7
		10	Thing	22,271	3.4
		11	Rubber	37,841	5.8
		Total		**300,776**	**45.9**
4	Fruit Trees (LUT 4)	12	Durian	16,360	2.5
		13	Butter	7,525	1.1
		14	Lychee	2,100	0.3
		15	Rambutan	13,500	2.1
		16	Other fruit trees	16,145	2.5
		Total		**55,630**	8.5
Total area of the evaluation LUTs				**576,667**	**87.9**
Total agricultural land area				**655,818**	**100.0**

Source: Synthesized from data collection results (2022)

3.2.4. Evaluation of the efficiency of agricultural land use under the impact of climate change

3.2.4.1. Economic efficiency

Through the investigation process, the economic efficiency data of agricultural land use types in Dak Lak province are summarized as follows:

- LUT 1 (specialized in rice): with 2 types of land use: spring rice - summer rice, 1 rice crop, average VAT/ha is 42,150,000 VND, VAT/labor is 132,600 VND, capital efficiency is 1.10 times, achieving high economic efficiency (B).

- LUT 2 (annual crops): with some typical farming types such as corn, cassava, sugarcane, and vegetables, the average VAT/ha is 55,421,000 VND, VAT/labor is 134,000 VND, capital efficiency is 1.5 times, achieving high economic efficiency (B).

- LUT 3 (perennial industrial crops): with 4 main cultivation types: coffee, pepper, cashew, rubber, average VAT/ha is 74,750,000 VND/ha/year, VAT/labor is 191,700 VND, capital efficiency is 1.8 times, achieving very high economic efficiency (A).

Table 3.9. Comparison of economic efficiency between LUTs and according to the hierarchy of the Ministry of Science and Technology

LUT	**GTSX** (1000 VND)	**CPTG** (1000 VND)	**VAT** (1000 VND)	**VAT/Labor** (1000 VND)	**Capital efficiency**	**Classification**
LUT 1	79,600	37,450	42,150	132.6	1.1	C
LUT 2	92,963	37,542	55,421	134.0	1.5	B
LUT 3	116,275	41,525	74,750	191.7	1.8	A
LUT 4	515,000	148,250	366,750	608.7	2.5	A

3.2.4.2. Social efficiency

The results of the social performance assessment are as follows:

- Regarding labor settlement: LUTs that attract a lot of labor are LUT 4 (fruit trees) with 603 workers/ha/year, LUT 2 (perennial industrial crops) with 390 workers/ha/year, LUT annual crops with 386 workers/ha/year.

- Regarding VAT/labor: VAT/labor of LUT 4 (fruit trees) has the highest value of 608,700 VND; LUT 3 (perennial industrial crops) reaches 191,700 VND, LUT 2 annual crops gives VAT/labor of 134,000 VND; LUT 1 specializing in rice gives VAT/labor of 132,600 VND;

Table 3.11. Comparison of social efficiency between LUTs according to the criteria of the Ministry of Science and Technology

LUT	**VAT/Labor** (1000 VND)	**Job security** (work/ha/year)	**Product consumption capacity**	**Classification**
LUT 1	132.6	320	Easy	B
LUT 2	134.0	386	Easy	B
LUT 3	191.7	390	Very easy	A

LUT 4	608.7	603	Very easy	A

Source: Survey results, data synthesis (2023)

3.2.4.3. Environmental efficiency

Within the scope of the study, we would like to mention some assessment indicators on the level of land degradation, water resource protection, and crop diversity to assess the suitability of land use types for environmental efficiency issues.

Table 3.12. Hierarchy of environmental performance assessment criteria of LUTs

LUT	Diversity plant	Protection ability environment	Classification
LUT 1	Specialization	Environmental impact	C
LUT 2	Crop rotation	Environmental impact	B
LUT 3	Specialization	Environmental impact	B
LUT 4	Specialization	Maintain good environment	B

Source: Survey results, data synthesis (2023)

3.3. Assessment of the impact of climate change on agricultural land use in Dak Lak province

3.3.1. The current status of climate change affecting agricultural land use in Dak Lak province

3.3.1.1. Erosion phenomenon affects agricultural land use

From the results of map data processing, area statistics according to soil erosion level according to Circular No. 14/2012/TT- Ministry of Natural Resources and Environment. The study determined the soil erosion level according to slope level in Dak Lak province as follows:

Table 3.14. Results of determining the area of agricultural land eroded by rain

TT	Leveling	Symbol	Acreage (ha)	Proportion (%)
1	Mild erosion	Xm1	148,240	12.5
2	Average erosion	Xm2	31,375	2.6
3	Strong erosion	Xm3	6,370	0.5
4	Non-erosive	XmN	1,003,072	84.4
Total			**1,189,057**	**100**

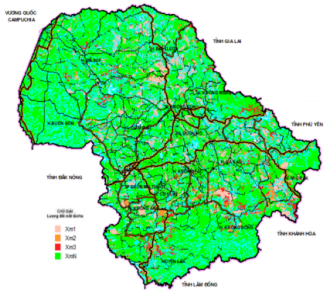

Figure 3.22. Potential erosion diagram

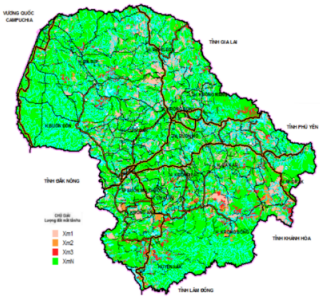

Figure 3.22. Erosion diagram

3.3.1.2. Level of agricultural land drought due to the impact of climate change

Using ArcGIS technology, we overlay the land map, the climate index information layer (information input for land plots taken from meteorological stations), the drought land information layer (interpolation, combined with field surveys) to build a map of agricultural land affected by drought due to the impact of climate change. Statistical results from the map data show that the area of agricultural land currently affected by drought is about 549,594 hectares; the area of forestry land affected by drought is about 512,760 hectares.

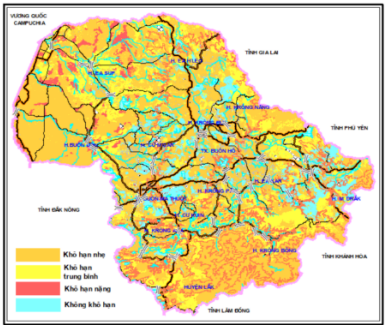

Figure 3.24. Agricultural land drought diagram in Dak Lak province

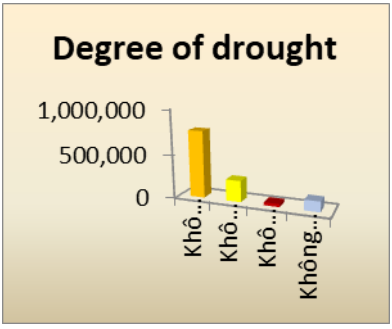

Figure 3.25. Graph of agricultural land drought level in Dak Lak province

3.3.1.3. Climate change reduces soil fertility

The results of the soil fertility survey show that Dak Lak province in particular has clear signs of fertility decline. The area of agricultural land with mild fertility decline is 154,765 ha, the area of agricultural land with moderate fertility decline is 443,233 and the area of land with severe fertility decline is 363,115 ha; a total of 961,113 ha.

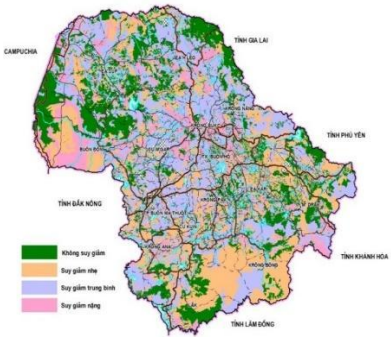

Figure 3.26. Diagram of agricultural soil fertility decline in Dak Lak province

3.3.2.4. Climate change causes laterite concretion phenomenon

Use the classification table to compare the indicators and evaluate the level of concretion and lateritic soil. From the results of constructing the Concretion and Lateritic Soil Map, it is determined that in the whole Dak Lak province, there are all 3 levels of concretion: heavy, light, and medium with an area of 9,960 hectares of concretion land and 1,179,097 hectares of non-concretion land.

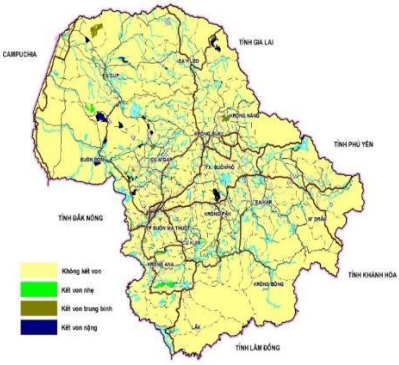

Figure 3.27. Schematic diagram of the degree of coalescence Agricultural land in Dak Lak province

3.3.2. Forecasting the development of some climate change factors affecting agricultural land use in Dak Lak province

According to the Ministry of Natural Resources and Environment (2020), greenhouse gas emission scenarios include: low (B1), medium (B2) and high (A2, A1FI), in which the medium B2 scenario is recommended for ministries, branches and localities to use as initial orientation for short-term planning and plans; to assess the impact of climate change and develop action plans to respond to climate change.

Table 3.21. Average annual temperature change and seasonal (^{0}C) under RCP4.5 and RCP8.5 scenarios

TT	Time	RCP4.5 scenario		RCP8.5 scenario	
		2020 - 2035	2045 - 2065	2020 - 2035	2045 - 2065
1	I - III	0.7 (0.3÷1.2)	1.4 (0.9÷2.0)	0.9 (0.6÷1.2)	1.9 (1.2÷2.7)
2	IV - VI	0.7 (0.4÷1.2)	1.5 (1.0÷2.2)	0.9 (0.6÷1.4)	2.0 (1.3÷3.0)
3	VII - IX	0.6 (0.4÷1.2)	1.3 (0.9÷2.1)	0.8 (0.5÷1.2)	1.8 (1.2÷2.8)
4	X - XII	0.8 (0.4÷1.2)	1.3 (1.0÷1.8)	0.9 (0.6÷1.2)	1.8 (1.3÷2.2)
Average year		**0.7 (0.4÷1.2)**	**1.4 (0.9÷2.0)**	**0.9 (0.6÷1.2)**	**1.9 (1.3÷2.6)**

Source: Ministry of Natural Resources and Environment (2020)

3.3.2.1. Forecasting the level of soil erosion due to the impact of climate change by administrative unit

Using GIS technology to analyze, overlay, synthesize information layers and model in ArcGIS 9.3.

According to Circular No. 14/2012/TT-BTNTM dated November 26, 2012 of the Ministry of Natural Resources and Environment promulgating technical regulations on land degradation investigation, the level of erosion is determined according to 3 levels: light erosion, medium erosion and strong erosion. In which, agricultural land erosion due to rain occurs most in the districts of Ea H'leo; M'Drak; Buon Don; Cu M'gar; Krong Buk; Krong Nang..

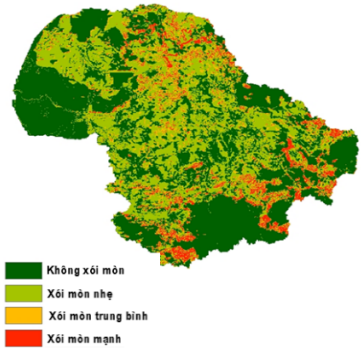

Figure 3.30. Forecast diagram of soil erosion distribution according to RCP4.5 scenario , period 2020-2035

3.3.2.2. Forecasting the level of soil erosion due to the impact of climate change according to the purpose of use

According to the RCP4.5 scenario at the beginning of the century (2020-2035), the area of agricultural land subject to slight erosion is 124,160 ha (of which rice land is 4,630 ha; land for other annual crops is 51,490 ha; land for perennial crops is 68,040 ha); average erosion is 28,280 ha (rice land is 1,190 ha; land for other annual crops is 21,825 ha; land for perennial crops is 5,265 ha); severe erosion is 3,885 ha (rice land is 210 ha; land for other annual crops is 3,225 ha; land for perennial crops is 450 ha).

The area of slightly eroded forest land is 26,275 ha (production forest land is 22,315 ha; protection forest land is 1,844 ha; special-use forest land

is 2,116 ha); moderately eroded is 4,564 ha (production forest land is 4,564 ha); severely eroded is 2,758 ha (production forest land).

3.3.3. Forecast of agricultural land drought level according to RCP4.5 scenario (period 2020 - 2035)

Using ArcGIS technology, we overlay the soil map, the information layer on climate indicators (information input for land plots forecasted according to climate change scenarios), and the drought land information layer (interpolation, combined with field surveys) to build a map of agricultural land affected by drought according to the RCP4.5 scenario at the beginning of the century (2020-2035) due to the impact of climate change.

Table 3.25. Forecast of drought-affected land area by administrative unit

Unit: ha

TT	Administrative unit	Agricultural land affected by drought				Area of land not affected by drought	Agricultural land area
		Mild drought	Average drought	Severe drought	Total		
1	Buon Ma Thuot City	18,950	6,584	0	25,534	3,295	28,829
2	Buon Ho Town	19,880	1,874	0	21,754	3,487	25,241
3	Ea H'leo	78,970	26,413	3.133	108,516	13,841	122,357
4	Ea Soup	93,120	35,350	23,979	152,449	8,029	160,478
5	Buon Don	116,330	9,675	7.154	133,159	810	133,969
6	Cu M'gar	44,688	11,820	600	57,108	17,037	74,145
7	Krong Buk	25,985	5.225	0	31,210	1,489	32,699
8	Krong Nang	34,176	13,576	75	47,827	8,491	56,318
9	Ea Kar	57,775	24,530	0	82,305	12,277	94,582
10	M'Drak	49,632	33,382	2,885	85,899	29,117	115,016
11	Krong Bong	79,985	27,990	2.225	110,200	5,692	115,892
12	Krong Pak	34,775	8,310	55	43,140	10,098	53,238
13	Krong Ana	23,350	7,295	0	30,645	1.105	31,750
14	Lak	80,390	33,553	3.325	117,268	269	117,537
15	Cu Kuin	15,776	7,140	37	22,953	2,052	25,005
Total		**773,782**	**252,717**	**43,468**	**1,069,967**	**117,090**	**1,189,057**

According to the research results, the area of land affected by mild and moderate drought is concentrated in all localities, of which severe drought appears in 4 districts: Ea H'leo; Ea Sup; Buon Don; Cu M'gar. According to the RCP4.5 scenario at the beginning of the century (2016-2035), the area of agricultural land affected by mild drought is 773,782 ha; moderate drought is 252,717 ha; severe drought is 43,468 ha.

3.4. Assessing the potential and selecting options for monitoring agricultural land use models under climate change conditions in Dak Lak province

3.4.1. Land potential assessment

3.4.1.1. Building a land unit map in Dak Lak province

Using ArcGIS software to build 6 single-characteristic maps for 6 hierarchical indicators including: soil type, slope, mechanical composition, soil layer thickness, rainfall and irrigation regime. The land unit map is

built on the basis of overlapping 6 single-characteristic maps.

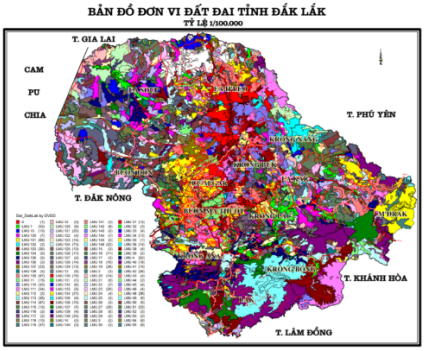

Figure 3.32. Land unit distribution diagram

The results show that the study area has 146 land units with 2,041 plots, of which 1,534 plots have an area of 300 ha or more, and 245 plots have an area of >500 ha. The large area of plots is a favorable condition for selecting and developing specialized crop growing areas.

In the study area of Dak Lak province, there are nearly 800,000 hectares with soil properties favorable for agricultural crop development such as slope <15°, layer thickness >70 cm, medium to heavy mechanical composition, absolute elevation <1,000 m. However, the irrigated area is low, only 296,597 hectares; this is the district's biggest limitation in agricultural development.

3.4.1.2. Land suitability assessment for some major land uses

Based on the growth requirements of land use types and natural conditions of the research area. The results of the appropriate classification are as follows:

Table 3.26. Land suitability classification results of LUTs

Unit: ha

Suitable class	Symbol	LUT1	LUT2	LUT3	LUT4
Very suitable	S1	17,685	30,125	152,046	90.125
Fit	S2	24,120	82,877	215,090	312,254
Poorly suited	S3	38,550	132,829	252,378	357,008
Inappropriate	N	1,108,702	943,226	569,543	429,670
Total area		**1,189,057**	**1,189,057**	**1,189,057**	**1,189,057**

Note: LUT1 (rice); LUT2 (annual crops); LUT3 (fruit trees); LUT 4 (perennial industrial crops)

Through the above table, it can be seen that: With the land conditions of Dak Lak province, LUT3 (fruit trees) has the highest suitable area (S1) (152,046 ha), followed by LUT4 (perennial industrial crops). In addition, LUT1 (specialized in rice) has the largest unsuitable area (1,108,702 ha). Therefore, in the future, there needs to be specific solutions to both develop

commodity products and ensure food security for the entire province.

3.4.2. Selection and monitoring of agricultural land use models under climate change conditions in Dak Lak province

3.4.2.1. Basis for selecting land use models for monitoring and evaluation

- Basis for model selection: selected models are based on research results, assessment of economic, social and environmental efficiency of land use types, land use patterns and based on the Agricultural Development Orientation of Dak Lak Provincial People's Committee (Project on restructuring the agricultural sector of the province) and recommendations of the Department of Agriculture and Rural Development of Dak Lak province on developing and expanding models in the future;

- Criteria for selected model:

+ In terms of economy, the product must be highly economically efficient, suitable for the local consumer market, meet market demand, and contribute to ensuring the lives of workers.

+ Socially, the production model must create many jobs, bring high income, and be accepted by direct producers;

+ In terms of environment, the production model has little negative impact on the environment, air, land and water resources.

- Criteria for selecting households to monitor the model:

Households affected by climate change in the period 2017 - 2022, have existing land use models, family economic conditions at an average level compared to other households in the region, have human resources, investment capital and the ability to apply new science and technology.

Based on the above criteria, we have selected 3 types of agricultural land use in Dak Lak province that bring high economic, social and environmental efficiency and adapt to climate change for monitoring: Durian planting model; Coffee planting model; Rice planting model.

3.4.2.2. Results of model monitoring

a. Results of monitoring the durian growing model

Within the scope of the research, the topic selected 5 households growing durian in 2 different locations with different natural conditions (one location is concentrated, one location is spontaneously grown) in Krong Pak district and monitored in 2022, 2023 to evaluate economic, social and environmental efficiency.

Through the results of monitoring the durian growing model for 2 years (2022; 2023) in Krong Pak district, the average yield/ha reached 22.7 tons/ha; production value added/ha reached 2,130 million VND/ha; and value added/ha reached 1,302 million VND/ha. Specifically, among the 5 households monitored, the household with the lowest production value

added/ha reached 1,910 million VND/ha (Mr. Dinh Van Thu's household), the highest was 2,445 million VND/ha (Mr. Nguyen Huu Nho's household); the lowest value added/ha was 1,055 million VND/ha (Mr. Tran Van Tu's household), the highest was 1,605 million VND/ha (Mr. Nguyen Huu Nho's household).

Table 3.39. Economic efficiency of the Durian growing model

(average value of 2 years 2022-2023)

Follow-up	Yield *(ton/ha)*	Economic efficiency *(million VND/1 ha)*			Labor requirements *(work)*	VAT/Labor *(1000 VND/work)*
		CPSX	GTSX	VAT		
Dinh Van Thu	20.6	755	1,910	1,155	960	1,203.1
Tran Van Tu	20.0	815	1,870	1,055	1,050	1,004.8
Dinh Thi Ngan	22.5	845	2,100	1.255	1,075	1,167.4
Nguyen Huu Nho	25.3	840	2,445	1,605	1,100	1,459.1
Vo Van Hiep	25.2	887.5	2,325	1,438	1,100	1,306.8
Average	**22.7**	**828.5**	**2,130**	**1,302**	**1,057**	**1,228.2**

** Social efficiency*

The results of the study on social efficiency show that the Durian growing model has the ability to attract about 1,057 workers/ha/year. The ability to supply products of the Durian model is from 20.6 - 25.2 tons/ha; the average VAT/1 labor is 1,228.2 thousand VND/labor. The suitability with the capacity of households in terms of land, human resources, capital, and technology is at an average to good level. The ability to consume this product on the market is relatively easy.

** Environmental efficiency*

Indicators of suitability with natural characteristics, ability to apply balanced and reasonable fertilization and create ecological landscape are important indicators to evaluate environmental efficiency.

The research results show that the Durian production model is very suitable for development in Krong Pak district. In addition, this model is also effective in improving the ecological environment, being a perennial fruit tree, a shade tree that regulates the microclimate and air temperature. According to the survey results, 100% of local people highly appreciate this Durian growing model.

Regarding the level of investment in fertilizers and pesticides, the results of the household survey show that:

- 90% of households use manure for durian. Manure is applied after harvest. Fertilizer amount is 12-16 tons/ha (on average, each tree is fertilized with about 40kg).
- Up to 100% of durian growing households follow the correct

intensive farming process , fertilizer dosage, fertilization method and use of plant protection drugs according to the instructions and recommendations of the agricultural extension center.

- Pesticides are used by people in 1 crop from 5-7 sprays, mainly against fruit borers (spraying pesticides to prevent fruit borers at the end of March and April and 10-20 days before harvest with Regent 5SCW), aphids that harm flowers and young fruits (mainly using Trebon 0.2%; Sherpa 0.2%), stink bugs (using Dipterex 0.3%)... the doses of pesticides used by households are all within the allowable limits, so they do not have much impact on the ecological environment.

coffee growing model

Within the scope of the research, 5 coffee-growing households in Cu Kuin district were selected and monitored for 2 years 2022 and 2023 to evaluate economic, social and environmental efficiency.

Table 3.42. Economic efficiency of the Coffee growing model
(average value of 2 years 2022-2023)

Model	Yield *(ton/ha)*	Economic efficiency *(million VND/1 ha)*			Labor requirements *(work)*	VAT/Labor *(1000 VND/work)*
		CPSX	GTSX	VAT		
La Nhu Hoan	3.3	42.8	153.0	110.3	532	207.4
Nguyen Duc Bon	3.6	42.0	157.5	115.5	492	235.0
Hoang Quoc Tien	3.4	43.1	153.0	109.9	574	191.5
Vu Duy Trang	3.6	44.2	166.5	122.3	525	233.0
Nguyen Van Can	3.6	44.0	162.0	118.0	520	226.9
Average	**3.5**	**43.2**	**158.0**	**115.0**	**528**	**218.8**

The results of Table 3.42 show that the average yield/ha is 3.5 tons/ha; the production value/ha is 158 million VND/ha; and the value added/ha is 115.0 million VND/ha. Specifically, among the 5 households monitored, the household with the lowest production value/ha is 153 million VND/ha (Mr. La Nhu Hoan and Hoang Quoc Tien's households), the highest is 166.5 million VND/ha (Mr. Vu Duy Trang's household); the lowest value added/ha is 109.9 million VND/ha (Mr. Hoang Quoc Tien's household), the highest is 122.3 million VND/ha (Mr. Vu Duy Trang's household).

* *Social efficiency*

The Coffee growing model has the ability to attract about 528 workers/ha/year for the model. The ability to supply products of the Coffee model is from 3.3 - 3.6 tons/ha; the average VAT/1 labor is 218.8 thousand VND/labor. The suitability with the capacity of households in terms of land, human resources, capital, and technology is at an average to good level. The ability to consume this product on the market is relatively easy.

* *Environmental efficiency*

The results of the study on environmental efficiency show that Dak Lak province in general and Cu Kuin district in particular have suitable soil

and climate conditions to develop the coffee growing model. Regarding the level of investment in fertilizers and pesticides through the results of the summary of the household survey form, it shows that:

- 100% of surveyed households apply manure (about 18-25 tons/ha) and NPK fertilizer (1.8-2.2 tons/ha) to coffee trees, contributing to improving, protecting and maintaining soil quality in production areas.

- The disease resistance of coffee trees is relatively good, which has contributed to significantly reducing the amount of pesticides that can be harmful to the environment. Each crop requires an average of 5-7 sprays... the amount of pesticides used by households is within the standards allowed by the agricultural extension center, so it does not have much impact on the general ecological environment.

c. Results of monitoring rice growing model

Within the scope of the research, the topic selected 5 rice-growing households in 2 different locations in Lak district and Ea Sup district, monitored in 2022 and 2023 to evaluate economic, social and environmental efficiency.

** Economic efficiency*

Table 3.45. Economic efficiency of rice cultivation model

(average value of 2 years 2022-2023)

Follow-up	Yield *(tons/ha)*	Economic efficiency *(million VND/1 ha)*			Labor requirements *(work)*	VAT/Labor *(1000 VND/work)*
		CPSX	GTSX	VAT		
Y Phuong Duong Tri	65.0	13.1	63.7	50.6	420	120.5
Medical Design Year	62.3	12.3	61.1	48.8	380	128.3
Y Hem Pang Sur	64.5	13.0	63.2	50.2	410	122.5
H Kim Knul	63.0	13.2	61.7	48.5	395	122.9
H Mit Hmok	66.0	13.6	64.7	51.1	415	123.1
Average	**64.2**	**13.0**	**62.9**	**49.8**	**404**	**123.4**

The results of monitoring the rice growing model for 2 years (2022; 2023) in 02 districts Lak and Ea Sup show that the average yield/ha is 64.2 quintals/ha; production value added/ha is 62.9 million VND/ha; value added/ha is 49.8 million VND/ha. Specifically, among the 5 monitored households, the household with the lowest production value added/ha is 61.1 million VND/ha (Mr. Y Thiet KNam's household), the highest is 64.7 million VND/ha (Mr. H Mit Hmok's household); the lowest value added/ha is 48.5 million VND/ha (Mr. H Kim Knul's household), the highest is 51.1 million VND/ha (Mr. H Mit Hmok's household).

** Social efficiency*

The results of the study on social efficiency show that the rice growing model is capable of attracting about 404 workers/ha/year. The product

supply capacity of the rice model is from 63.0 - 66.0 quintals/ha; the average VAT/1 labor is 123.4 thousand VND/labor. The suitability with the capacity of households in terms of land, human resources, capital, and technology is at an average to good level. The ability to consume this product on the market is relatively easy.

** Environmental efficiency*

The rice growing model brings some environmental benefits as follows: Maintaining good soil cover; Limiting erosion and leaching; Maintaining soil quality, minimizing land degradation.

3.4.3. Analysis of factors affecting the development of typical agricultural production models using the Cobb – Douglas function

To analyze the influence of factors on the efficiency of model production , The study used the Cobb-Douglas function for analysis. The influencing factors include: Investment capital, labor, tree age, professional qualifications, and cultivation techniques.

Table 3.47. Results of Cobb - Douglas function analysis for 03 production models

Factor	Model Durian		Model Coffee		Model rice cultivation	
	Coefficient	Value	Coefficient	Value	Coefficient	Value
Coefficient (A)	1.72	0.90	1.63	0.85	0.82	0.33
Ln. Cost	0.53	14.30	0.19	10.82	0.56	4.11
Ln. Area/(number of trees)	0.05	0.55	0.75	0.78	0.18	1.26
Ln. Labor	0.21	2.16	0.81	3.12	0.15	0.16
Ln. Tree age	1.68	7.21	0.92	5.36		
D1. Professional qualifications	0.25	3.26	0.21	2.68	0.20	1.19
D2. Cultivation techniques	0.18	0.96	1.12	0.76	0.45	1.18
Correlation R^2	0.93		0.83		0.98	
F value	128.3		112.8		75.6	
Observation form	100		100		100	

The analysis results show:

- *For the durian growing model:* the coefficients show the relationship between the mentioned factors and the efficiency obtained on 1 hectare of durian growing land. These coefficients are expressed as the percentage change in production value that 1 hectare of durian growing land brings due to the impact of 1% change of each factor under the condition that other factors remain unchanged.

In general, the factors have a favorable impact on the efficiency of the unit area of land used. Factors such as investment capital, tree age, and cultivation techniques have the strongest impact on the efficiency of land use of the model. If the age of the tree increases by 1%, the efficiency of the unit area is 1.68%. The coefficients of the impact factors are at an average level. Therefore, increasing investment in factors will increase the efficiency of the durian growing model.

- *For the Coffee growing model:* The factors affecting and the significance of the indicators for land use efficiency are the same as for the Durian growing model. In the land use of the Coffee growing model, factors such as tree age, investment capital, level and cultivation techniques directly affect the efficiency per unit area. If input costs increase by 1%, the efficiency is 0.19%, or if tree age increases by 1%, the efficiency per unit area is 0.92%.

- *For the rice growing model:* all factors have a positive impact on increasing the efficiency of the model, labor factors, investment capital... are important factors. That proves that the impact and enhancement of the above factors are fundamental to improving the efficiency of the model.

3.5. Orientation and proposed solutions for agricultural land use to adapt to climate change in Dak Lak province

3.5.1. Orientation of agricultural land use to adapt to climate change in Dak Lak province

3.5.1.1. Land use orientation for annual crop development adapted to climate change

a. Land use orientation for rice cultivation

The result of overlaying the rice land suitability classification map with the drought vulnerability index map gives the product map as a drought-adapted rice cultivation map. The total proposed conversion area is 7,008.7 ha, corresponding to 10.09% of the total rice land area in 2023. Of which, 474.48 ha of rice land belongs to Buon Don district; 487.75 ha of rice land belongs to Ea Hleo district; 6,046.47 ha of rice land belongs to Ea Sup district.

b. Proposed production areas for other annual crops

The total proposed area is 11,303 hectares, accounting for 6.6% of the total annual crop land area of the province. Ea Sup, Buon Don, Ea Kar, and Ea H'leo districts are proposed to have larger areas than the remaining districts and cities. Ea Sup district proposed 5,438.16 hectares, accounting for 23.6% of the total annual crop land area of the district. Buon Don district proposed to convert 2,126 hectares, accounting for 18.5% of the total annual crop land area in the district. Ea Kar district proposed 1,224 hectares, accounting for 5.5% of the total annual crop land area of the district. Ea H'leo district proposed 992 hectares, accounting for 6.1% of the total annual crop land area in the area.

3.5.1.2. Proposed land use for fruit tree cultivation adapted to climate change

By 2030, the whole province is expected to have about 30,000 hectares of fruit trees. Of which, avocado trees are 6,000 hectares (3,000 hectares of CNC production), accounting for 20%; durian trees are 9,000 hectares, accounting for 30%; citrus trees are 24%; longan, lychee, rambutan are 16%; banana, mango, custard apple and other fruit trees are 10%.

3.5.1.3. Proposal for land use to develop perennial crops adapted to

climate change

The coffee growing area has been reduced to 180,000 hectares. Building an organic coffee production area, intercropping fruit trees to increase revenue and create sustainable development based on the principle that fruit trees provide shade for coffee trees.

Cashew trees will stabilize the cashew growing area at about 22,500 hectares in 2023, with productivity increasing to 15.0 quintals/ha to reach an output of nearly 30.8 thousand tons. By 2030, the cashew growing area will be reduced to 21,500 hectares, with a yield of 17.0 quintals/ha and an output of 35.6 thousand tons.

Regarding rubber tree development, by 2023, the rubber area will be 40 thousand hectares in districts and towns, with a yield of 16.8 quintals/ha and an output of 47.04 thousand tons. The orientation to 2030 is to maintain a stable 40 thousand hectares, a yield of 20.2 quintals/ha and an output of 64.51 thousand tons.

3.5.2 . Proposing solutions to improve the efficiency of agricultural land use in climate change conditions in Dak Lak province.

3.5.2.1. Land management solutions

- Strengthen basic investigation work, build initial database, improve the quality of forecasting work, and participate in scientific debate on land use issues in the context of climate change;
- Innovate and improve the content, methods and procedures for land use planning to integrate climate change factors;

3.5.2.2. Solutions to prevent and limit the effects of drought

- Investing in building new reservoirs

The province has the most reservoirs in the Central Highlands with more than 600 reservoirs of different sizes with a total capacity of about 650 million m3. However, only the upper Ea Sup and lower Krong Buk reservoirs have large capacities, while most of the reservoirs have small and medium capacities, so there is often a shortage of water in the dry season. With the characteristic of very large rainfall from May to October, but very little rain in the dry season from November to April of the following year. Therefore, investing in the construction of new reservoirs of different sizes for the province to store water must be considered in the strategy of proactively adapting to climate change.

- Improve the capacity of reservoirs

Currently, many medium and small reservoirs in the province are seriously degraded. The reservoirs were built a long time ago, and after a long period of exploitation, the reservoir bed has silted up, reducing the effective capacity, the dam body has cracked and sunk, increasing the possibility of water loss. Therefore, it is necessary to renovate and upgrade the existing reservoir system to increase capacity and prevent water loss.

- Construction of water irrigation system

This is a very important measure in restoring soil productivity and

increasing the fertility of degraded soil.

- Use biological products that can keep the soil moist and provide enough water for crop needs during long droughts such as special humectants like AMS - 1.

3.5.2.3. Solutions to prevent and limit soil erosion

a. Construction solution group

b. Group of farming solutions

CONCLUSION - RECOMMENDATION

1. Conclusion

1) Dak Lak is located in the center of the Central Highlands with a natural area of 13,034.95 km2 , a population of more than 1.83 million people including 47 ethnic groups. Buon Ma Thuot City is the political, economic, cultural and social center of the province and the Central Highlands region. Dak Lak has advantages in agricultural development, especially perennial industrial crops with high economic value such as coffee, rubber, cashew, pepper and fruit trees. However, in recent years, climate change has increased the frequency, intensity, volatility and extremity of negative weather phenomena, increasing risks to agricultural production. Temperatures tend to increase, droughts occur more frequently and last longer, interspersed with flash floods, landslides... causing great damage to people's lives, challenging the socio-economic development goals of the locality.

2) Dak Lak has an agricultural land area of 1,189,057 ha (accounting for 90.97% of the total natural area). Of which, the main area is agricultural land with an area of 655,818 ha (accounting for 50.18% of the total natural area) and forestry land of 528,306 ha (accounting for 40.42% of the total natural area). In the period of 2017 - 2022, the area of agricultural land increased by 28,730 ha. Agricultural land use is most affected by climate change in Dak Lak province as well as the Central Highlands region in general. Currently, there are 2 main farming systems in the province: rain-fed farming and irrigated farming.

The study conducted a re-examination of 1,189,057 ha (accounting for 90.97% of the total natural area), and built 6 single-characteristic maps (soil type, slope, soil thickness, mechanical composition, average annual rainfall, irrigation regime). The evaluation index maps were overlaid using ArcGIS software to identify 146 land units and on that basis, assess the suitability for some main types of use in Dak Lak province.

3) Greenhouse gas emission scenarios, including: low (B1), medium (B2) and high (A2, A1FI), in which the medium B2 scenario is recommended for ministries, sectors and localities to use as initial orientation for short-term planning and plans; to assess the impact of climate change and develop action plans to respond to climate change. According to the RCP4.5 scenario, at the beginning of the century, the

average annual temperature of Dak Lak province will increase from 0.4÷1.2 ^{0} C. In the middle of the century, the increase will be from 0.9÷2.0 ^{0} C. According to the RCP8.5 scenario, at the beginning of the century, the average annual temperature of Dak Lak province will increase from 0.6÷1.2 ^{0} C. In the middle of the century, the increase will be from 1.3÷2.6 ^{0} C.

The results of the survey and statistical analysis of the impacts of climate change on land use in Dak Lak province show that the level of severe erosion is 6,370 ha (accounting for 0.5%) concentrated in some districts with high terrain such as: Ea Sup, M'Drak, Krong Bong, Lak; the average level of erosion is 31,375 ha (accounting for 2.6%) concentrated in some districts such as M'Drak, Krong Bong, Ea H'leo, Ea Sup; the level of mild erosion is 148,240 ha (accounting for 12.5%) concentrated in some districts such as Ea H'leo, Ea Sup, M'Drak, Krong Bong, Krong Buk, Krong Nang. The area of agricultural land currently suffering from drought is about 549,594 ha; the area of forestry land suffering from drought is about 512,760 ha. The area of agricultural land with mild fertility loss is 154,765 ha, the area of agricultural land with moderate fertility loss is 443,233 and the area of land with severe fertility loss is 363,115 ha; a total of 961,113 ha. From the results of constructing the Map of concretion and lateritic soil, it is determined that all three levels of concretion: severe, mild and moderate, appear in the whole Dak Lak province with an area of 9,960 ha of concretion land and 1,179,097 ha of non-concretion land.

4) The study monitored 3 agricultural production models in Dak Lak province. These models are: Durian growing model; Coffee growing model; Rice growing model. The monitoring results were evaluated based on 3 criteria: Economic efficiency, social efficiency and environmental efficiency.

5) Based on the research on agricultural development orientation according to the Dak Lak province's agricultural restructuring project to 2020 and vision to 2030 announced by the Dak Lak Provincial People's Committee; analysis of current land use structure; results of assessment of soil potential, climate, terrain and analysis of economic efficiency of main land use types of Dak Lak province, the study selected the main crop structure for agricultural development as rice, vegetables, perennial plants and fruit trees .

Based on the limitations and shortcomings in the process of using agricultural land, the study has proposed a number of solutions to improve the efficiency of converting the structure of agricultural land use in the context of climate change, such as solutions on drought, erosion, etc.

2. Recommendations

- Focus resources on research and application of science and technology in production to improve land use efficiency to adapt to climate change.

- It is necessary to continue to have in-depth research programs on the impact of climate change on agricultural land use in terms of: floods, inundation, landslides...