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Abstract: The effects of climate change are becoming more and more apparent in Vietnam and are threatening the livelihood of people in both its coastal areas and mountainous regions. However, there is a dearth of knowledge of the adaptive capacity of the minority ethnic groups who depend on forest resources for their livelihood. We interviewed and held group discussions to investigate the climate change adaptability of the local Katu ethnic people in Huong Son commune, Nam Dong District of Thua Thien Hue Province of Vietnam. The data were analysed in descriptive and quantitative manner. Regression analysis was applied to figure out the factors affecting vulnerability of the local people. We found that climate change has negative impacts on the life of the local people and that degradation of natural resources worsens their life conditions and make the poor, low-income and forest-dependent households more vulnerable. We also found that the local people adopt autonomous adaptation, primarily through change in seasonal calendar, cultivation techniques, vaccination, pest and disease prevention, and application of new techniques in daily production activities. We suggest a number of measures for enhancing the adaptive capacity of ethnic groups in mountainous Vietnam.

Key words: Climate change, adaptation, Huong Son, Nam Dong, Thua Thien Hue

INTRODUCTION

Climate change and its impacts are amongst the most prioritised issues in almost every country in the world. Vietnam is one of the countries that have been worst affected by climate change and sea level rise. The World Bank has warned that when the sea level rises by 1 metre, about 5 percent of land in Vietnam will be saturated, 11 percent of the population will be affected and Gross Domestic Product can be reduced by 10 percent. Climate change manifests itself by increase in temperature, rise in sea level and change in rainfall pattern. It can also be seen in the form of increase in density, pattern and fluctuation of extreme weather conditions, such as longer hot and cold periods, drought and salt intrusion, typhoons and flood.

Huong Son is a western mountainous commune in Thua Thien Hue province, with the Katu ethnic group, which has a long tradition of forest dependency and swidden cultivation as the

majority population. They are being resettled in the region since 1968 following the sedentarisation programme of the government. In the past, they lived far inside the forest in upstream areas and their life completely depended on forest resources. They communicated with the outside world only for meeting their need of salt and other important products. Since the sedentarisation programme in 1968 and the ban on swidden cultivation in 1997, they have settled down and lived permanently in the allotted areas. They learnt to cultivate paddy, changing their practices from gathering and hunting to cultivating crops. At present, most of the Katu people live in and around forests and harvest forest products for their daily life. Since 2005, the management of the natural forest is being allocated to local communities. However, most of the allocated forests are poor and degraded (Sunderlin 2006;

Balooni and Inoue 2007; Ngo and Webb 2008). Thus, allocation dramatically reduced forest income; from 18 percent in 2004 to 8 percent in 2009 (Thang *et al.* 2010).

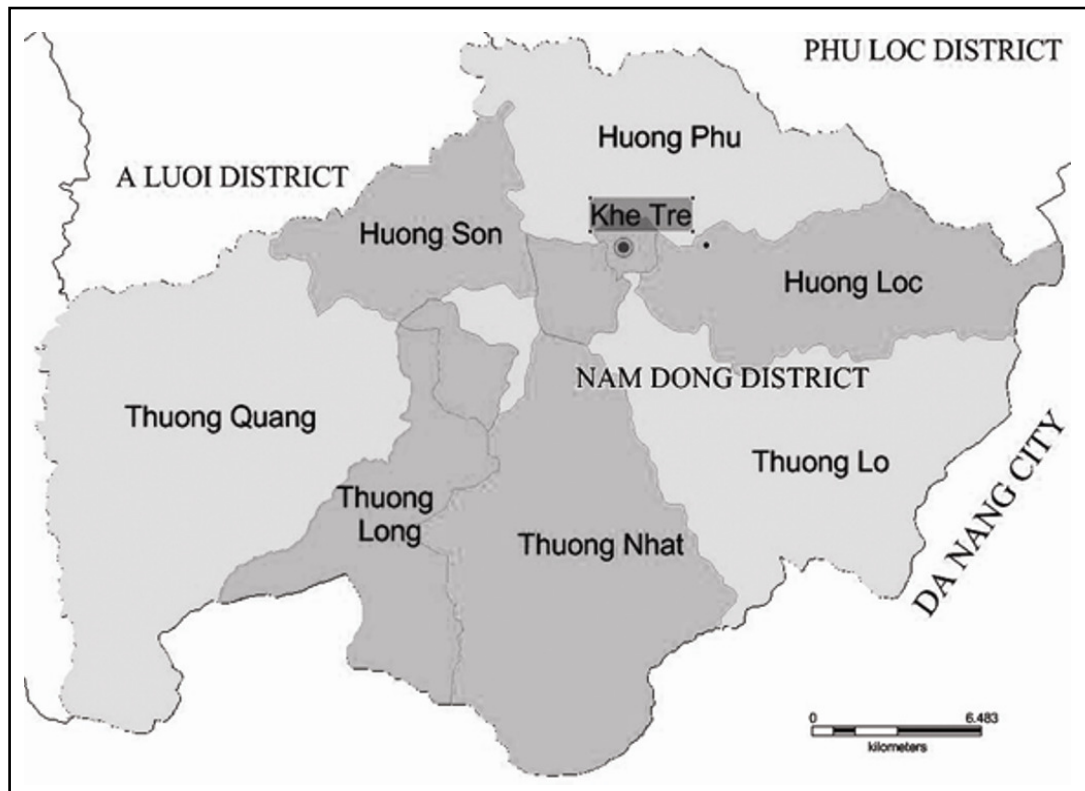


Figure: 1 Study communes in Nam Dong district, Thua Thien Hue province, Vietnam

The report on implementing the national strategies for preventing and reducing impacts of climate change in Thua Thien Hue by the year 2020 (Khoa 2009) suggests that climate change impact would be increased both in number and by degree of typhoons and higher number of sunny days, which will magnify drought in the region. These predictions were proven true by several cases that happened in recent years, such as longer cold period (2006 and 2009 had longest cold periods: 28 days); the highest flood level increase (50–60 cm) compared to the 1977–1986 period; higher number of flood (increase of 0.6 time/year); stronger and abnormal typhoons (Suu *et al.*

2010). The low rainfall season coincides with a period of higher temperatures, leading to high evaporation and causing difficulties in the production and peoples' livelihoods. During the rainy season, floods and typhoons have adverse effects on economic activities and people's lives (Huong Son 2010). Thus, climate change threatens the lives of local people, reducing the cultivation area and quality of soil, creating difficulties for agriculture and forestry production and reducing the yield and quality of those products. Thus, climate change adds to the difficulties of local people such as economic, local politics, natural resources and unemployment (McElwee 2010).

Being a mountainous commune in a remote area, in addition to the existing difficulties of local people, Huong Son suffers from negative effects of climate change. The commune has become highly vulnerable to negative impacts of climate change. Local people observe the changes and use their traditional knowledge to cope with the disasters.

This paper investigates the adaptive capacity of the local people in agriculture and forestry production, local people's perception of preventing natural disasters, their adaptive measures based on available resources, the impacts of income on the adaptability of local people and factors affecting the adaptability of local people in the Huong Son commune of Nam Dong district of Vietnam. It aims to assess the knowledge of climate change adaptation of an ethnic minority in a mountainous area and to help managers know the status, chances and challenges in implementing development projects. Based on that, it offers suggestions to suit policies to the local context, creating incentives for local people to develop agriculture and forestry activities in a sustainable manner.

Before describing the adaptive capacity of one of the ethnic minority community of central Vietnam, the Katu, and how they manage their natural resources, we present below the method used in our study. Then, we present the results of field investigation into the social and economic conditions of households in the study area and the impacts of climate change on agriculture and forestry production, the vulnerability and knowledge of local people. We carried out in-depth analysis of the adaptive capability of the local people in climate change by exploring their perceptions of preventing natural disasters. We looked at the impact of income on the adaptive capacity of the local people. From then, we tried to figure out the factors affecting the adaptability of the local people. Finally, we discuss the implications of

those adaptive measures for the future of community-based forest management in Thua Thien Hue in particular and overall governance of community forestry.

METHODOLOGY

We chose two villages, which have allocated forests to local communities, for our survey. A total of 37 households were randomly chosen for interview. Interviewees were household heads or those who really understood household production. We developed a questionnaire and employed Participatory Rural Appraisal (PRA) tools to collect data with the participation of the local people. After reviewing the data, we organised group discussions for crosschecking and validation of the data. The secondary information included data on social and economic conditions of the commune, district and other functional agencies at the provincial level. We also collected documents on climate change and adaptation activities of the communities.

The data were analysed using Excel and SPSS in a descriptive and quantitative manner. Regression analysis was applied to figure out factors affecting the vulnerability of the local people.

SOCIOECONOMIC CONDITIONS OF HOUSEHOLDS IN THE STUDY AREA

Local people in the study area had little access to education. Table 1 depicts that the largest section of the respondents had a primary schooling (1-5 grade). Similarly, the respondents who attended secondary level education accounted to 27 percent followed by high school (21%). People owned large land areas; more than 55 percent of the households owned more than 1 ha of land, while the landless and marginalized people comprised 3.3 percent and 25 percent of the local population respectively. The average household size was 5 (63%).

Table 1: Socioeconomic and demographic profile of respondents

Characters with unit	Category	Respondents' Opinion	
		Frequency	Percent
Age(Actual year)	Young aged (up to 35)	33	55.0
	Middle aged (35-50)	12	20.0
	Old (> 50)	15	20.0
Education(Year of schooling)	Illiterate (No schooling)	2	3.9
	Primary (1-5)	21	41.2
	Secondary (6-9)	14	27.5
	Cap 3 (10-12)	11	21.6
	Higher (> 12)	3	5.9
Family size (Number)	Small family (< 5)	38	63.3
	Medium family (5-8)	19	31.7
	Large family (> 8)	3	5.0
Farm size(ha)	Landless (< 0.02 ha)	2	3.3
	Marginal (0.02-0.2 ha)	13	21.7
	Small (0.2-1.0 ha)	6	10.0
	Medium (1.0-3.0 ha)	16	26.7
	Large (> 3.0 ha)	23	38.3

The total natural land of the commune was 4,359.44 ha, of which 87.52 percent accounted to agricultural land, 4.49 percent non agricultural land and 7.99 percent unused land (Huong Son 2010). The average land per capita was 24,798.65 m²/person, however, 5.4 percent of the households did not have productive land. The average paddy land accounted to 660 m²/HH, most of which were suitable for cultivating only one crop per year.

Likewise, traditional tools for production—from preparation of the soil to harvesting—were quite simple. Thus, both production and yield were low. This is partly because of the tradition as well as the geographical condition. In addition, the irrigation system does not meet the requirements of production. Currently, 1,500 m of irrigation system meets only 16.2

percent of the requirement. Local people themselves constructed small dams to store water for irrigation, but that has not brought any good results and those dams were usually destroyed in the rainy season.

All houses of local people are built of concrete following the programmes of sedentarisation and Ta Trach dam construction. However, some of the houses already appear degraded. Some houses near the streams have high potential of being washed away by landslides, threatening people's lives and property. In Huong Son, strong winds usually blew away roofs of houses. In 2006, the Sangsane typhoon damaged as many as 161 houses there (Huong Son 2011) and destroyed 50 ha of rubber plantation in Nam Dong district. The typhoon in 2009 alone destroyed 310 ha of rubber plantation in this district.

IMPACTS OF CLIMATE CHANGE ON AGRICULTURE AND FORESTRY PRODUCTION

Thua Thien Hue is located in a monsoon tropical zone with the average annual temperature of 19.25°C; the highest and the lowest being 39°C and 9°C respectively.

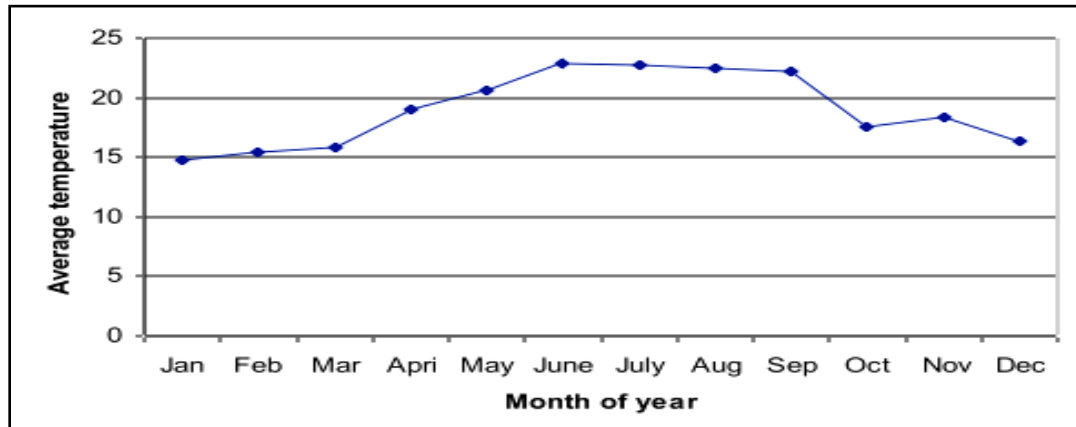


Figure 2: Average temperature in Nam Dong district since 1995 (Nam Dong 2010)

The average annual rainfall in Nam Dong district since 1995 has been 4,677 mm. Heavy precipitation during October–December frequently caused flooding. The average humidity of the region is 86.6 percent. There are two main windy seasons in a year: North-

west (dry and hot) wind from April to September and South-east (wet and cold) wind from October to March. There are great differences of rainfall through out the months in a year; the month with highest rainfall gets 20-30 times more than the lowest one.

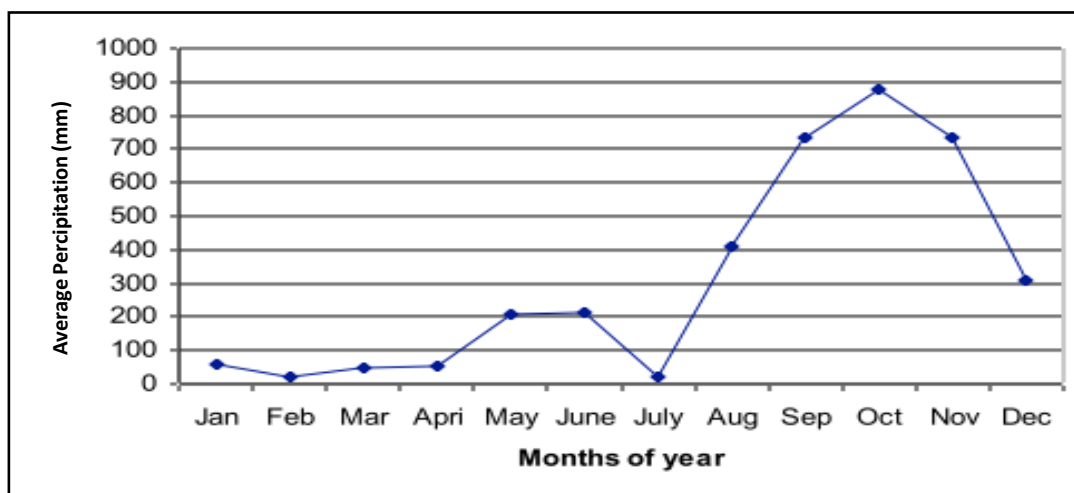


Figure 3: Average precipitation in Nam Dong districts since 1995 (Nam Dong 2010)

Local people confirmed that, in recent years, prolonged dry season caused shortage of water for production in some areas. The shift of rainy and dry seasons has changed the seasonal calendar, in addition to causing stress on production tradition and less understanding of production techniques reduces production and loss of yield. The high rain concentration in October and November caused soil erosion and floods. Likewise, fluctuation in temperature increased pest and disease attacks on plants and animals. Local people have not applied any adaptive measures in fishery aquaculture, resulting in massive losses in production.

It was observed that some households cut down natural forest for swidden fields and converted it to plantation (*Acacia* sp. and rubber plantation). These were the major factors resulting in the reduction of natural forest and increase of plantation forest. The district data showed that, in 2003, there were 649.3 ha of plantation forest in Nam Dong. However in 2010, this area expanded to 1,423.24 ha, with an increase of 773.94 ha within seven years (Nam Dong 2010). This means 773.94 ha of natural forest was converted into other land uses. The reduction in area, quality and forest products threatened the livelihoods of households who depended on forest resources.

ADAPTING AGRICULTURE TO CLIMATE CHANGE

Several measures were taken by the local people to adapt to climate change such as integration of different crops on the same field, shifting from swidden cultivation (without soil and water protection measures) to ladder field cultivation and raising fish along the water sources. Among the 77.3 percent of the households who had changed their fertilizer amount for their crops, 81.8 percent of them had reduced it. Local people mentioned that they had to change their cultivation practices due directly to the observed climate change.

Table 2: Adaptive measures in daily production in Huong Son commune

Adaptation strategies of local people	Yes	No
Apply soil conservation measures	10.8	89.2
Change the seasonal calendar	86.5	13.5
Apply pest and disease removal measures	59.5	40.5
Apply pest and disease preventive measures	10.8	89.2

As shown in Table 2, local people mostly apply pest and disease removal measures (59.5%), while the prevention measures seem to be out of their concern. Being a mountainous commune with common swidden cultivation, soil conservation measures are seldom applied (only 10.8%).

Table 3 shows that the local agriculture seasonal calendar can avoid two rainy, typhoon months of October and November. Local people mentioned that agricultural production and swidden cultivation have induced many changes recently and the shift of the seasons in a year. The ‘slash and burn’ method has not been followed anymore. Instead, people tend to change into intensive swidden cultivation.

Table 3: Seasonal calendar in Huong Son

Major Crops	Months											
	1	2	3	4	5	6	7	8	9	10	11	12
Rice	x	x	x	x	x	x	x	x	x			
Cassava	x	x	x	x	x	x	x	x	x	x		
Maize		x	x	x	x	x	x	x				
Ground nuts			x	x	x							

Rubber and *Acacia sp.* are becoming major cash crops in the region. The rubber plantations have long term, higher and more stable income compared to other cash crops and is more resilient to the fluctuations of weather conditions. Currently, 64.9 percent of the households derived income from rubber and 78.4 percent from forest plantation. Intercropping between rubber and *Accacia sp* with short time crops is widely applied when the tree is newly planted. It helps to create a good cover for reducing soil erosion and increase income for local people. Intercropping between maize and ground nut was also applied by the local people. Some crops in the citrus group with low income were not planted anymore because they were susceptible to pest and disease attacks. In general, local people changed from short term crops such as maize, ground nut, cassava and dry rice to long-term crops such as rubber, *Accacia sp.* and bamboo.

The number of livestock in the commune was declining due to the effects of diseases and shortage of fodder.

Table 4: Adaptation measures in livestock and animal grazing

		Percentage
Type of grazing	Caged	7.7
	Free ranging	3.8
	Both	88.5
Change in cattle grazing	Increase	92.3
	Reduce	0
	Stop grazing	7.7
Change in small animal grazing	Increase	0
	Reduce	70.6
	Stop grazing	29.4
Change in animal husbandry	Increase	9.1
	Reduce	36.4
	Stop grazing	54.5

In the past, the local people of Huong Son did not build pens for livestock. Only 3.8 percent still follow grazing practice. People are shifting from grazing small animals to cattle grazing, with 92.3 percent of the households participating in this activity. They reduced the number of small animals because of low economic returns and greater difficulty in raising small animals. Of these households, 29.4 percent said that they would stop grazing small animals. In order to reduce loss in grazing (due to high level of diseases), the households chose to reduce the number (36.4%) or stop the activity (54.5%).

According to the local people, the main reasons for the change in grazing activities in the commune were due to increased diseases, lack of fodder and reduced quality of forage area (table 5).

Table 5: Reasons for changes in livestock grazing

Reasons	Percentage		
	Increase	Reduce	Stable
Disease	100.0	0	0
Fodder availability	4.8	90.5	4.8
Quality of foraging area	5.0	95.0	0
Impact of temperature change	20.0	13.3	66.7

People’s perception on preventing natural disasters

All respondents agreed that they got informed by local authorities about typhoons or floods in advance and 97.3 percent of them got information through the local media. Some elderly people responded that they could also have a sense of change in climate. However, very few people could predict natural disasters.

Similarly, local people said that the incidence of natural disasters had increased in recent years. Temperature was higher and rainfall was more frequent and much heavier.

Table 6: Perception of local people on extreme weather conditions

Extreme weather conditions	Percentage		
	Earlier	Later	Stable
Time of appearing cold period	8	92	0
Time of appearing flood period	46	22	32
Time of appearing hot period	95	5	0
Time of appearing droughts	89	8	3
Time of appearing typhoons	46	38	16

The respondents perceived that most of the extreme weather conditions appeared earlier, while only the cold period had occurred later than usual. This shows a clear trend in the shift of extreme weather conditions in the study area

Table 7: Respondents' perception on climate change over time in the study area

Climatic parameters	Respondents' perception (in percentage)					
	Increased	Decreased	No change	Don't know	No idea	Total
Temperature (Summer season)	73.3	16.7	6.7	3.3	0.0	100
Temperature (Winter season)	26.7	38.3	20.0	6.7	8.3	100
Rainfall intensity	60.0	5.0	10.0	23.3	1.7	100
Rainfall frequency	48.3	8.3	6.7	25.0	11.7	100
Landslide length and severity	11.7	15.0	15.0	35.0	23.3	100
Landslide frequency	10.0	6.7	18.3	40.0	25.0	100
Drought length and severity	25.0	10.0	10.0	26.7	28.3	100
Drought frequency	35.0	10.0	18.3	30.0	6.7	100
Typhoon length and severity	21.7	18.3	16.7	0.0	43.3	100
Typhoon frequency	10.0	8.3	43.3	0.0	38.3	100
Hailstorm amount and severity	5.0	20.0	5.0	30.0	36.7	100
Frost/ dew intensity and severity	0.0	6.7	0.0	55.0	38.3	100
Cold spell intensity and severity	8.3	20.0	5.0	30.0	36.7	100



Most houses in Huong Son use tole for roofing, which are easily blown away by strong winds and big typhoons. Majority of the people (67.57%) placed heavy objects on the roof because it was a simple and easy means to prevent the roof from being blown away and was effective as well. Local people only need to put sand bag on the roof to create weight and reduce the threat of the wind blowing away the roof. In addition, they also stored food for the rainy season to avoid shortages as a result of flood. This is actually the direct response of local people to the increasing incidence of strong winds and typhoons.

An interesting thing is that a number of local people did not respond to the questions raised by the researchers. As mentioned earlier, local people had quite low education level where some of them were illiterate and were unable to communicate in the Kinh language (the common language) and could only communicate in their ethnic language. This might explain for this high level of 'no idea' status of local people.

Adaptive measures based on available resources

Huong Son has forest allocations to two villages. However, these villages are not properly managed, and the community forest is reducing in both quality and quantity. Some parts of the community forest were already converted into plantation forest, and the quality of both timber and non-timber forest products was poor. In addition, poor households had limited and low benefits from this forest resource. Due to the low quality of allocated forest, local people did not have good incentive for its protection and management. They were allowed to harvest Non-timber Forest Products (NTFPs), and the benefit-sharing mechanism of community forest totally depended on the ability of the household and the available labour force.

We found that income from plantation was really important for wealthy and medium households, while poor and very poor households did not have capability to invest in plantation forest.

With degradation of forest resources, local people used alternative materials such as concrete and plastic for house construction, medicines instead of medicinal plants and gas for fuel. There were very few people who knew how to use medicinal plants for health treatment. Instead, they used health care service and market products.

Local people did not have any soil erosion prevention methods. However, some people practised intercropping in hilly land. This is why soil erosion and soil degradation occurred greatly in the region. It also contributes to water shortage in the dry season.

In Huong Son, the water for daily use mainly came from the running water system that leads water from the mountain to households. However, the degradation of the system had forced many households to use water from wells, stream and the Ta Trach River. The main source of irrigation was stream water, but the water level was reducing, causing shortage of water for irrigation (most of the paddy land can only have one crop/year). Altogether 48.6 percent of the local people thought that water resource was declining and 45.9 percent attributed this problem to overharvesting and forest degradation.

In Huong Son, the geographic condition was unfavourable for aquaculture production. Community people had constructed few ponds or small dams for irrigation. There were no real aquaculture activities in the area. Local people mainly harvested natural fishery resources in the streams and the Ta Trach River.

Table 8: Change of tree and crops composition over time in the study area

Trees and crops	Changes in tree and crops (%)		
	10 years ago	Present	Changes (%)
Food crops	19.2	8.3	-10.9
Fruit trees	10.0	1.7	-8.3
Forest trees	1.7	13.3	11.6
Commercial trees and crops	0.0	13.3	13.3

The increased tree and crops were mainly rubber, *Acacia sp.*, bamboo shoots and cassava, while the decreased trees and crops were *Citrus*, hill rice and groundnut. Significant increase of forestry and rubber plantation could be observed in the area.

Table 9: Change of crop coverage over time in the study area

Crops	Changes in tree and crops (%)		
	10 years ago	Present	Changes (%)
Citrus	11.7	0.0	-11.7
Pineapple	1.7	1.7	0.0
Soil bean	5.0	0.0	-5.0
Groundnut	1.7	0.0	-1.7
Paddy rice	15.0	0.0	-15.0
Maize	15.0	3.3	-11.7
Banana	6.7	3.3	-3.4
Cassava	23.3	25	+1.7

Table 9 shows that the coverage of most of the agricultural crops, including rice, has reduced. There was however a slight increase in cassava production.

Impacts of income on the adaptability of local people

Most of the people in the study area are involved in agriculture and forestry production (Table 10), both of which largely depend on climatic

conditions. The livelihood diversification and taking good advantage of available resources and labour force will slightly reduce the vulnerability to climate change. In Huong Son, the livelihoods are diverse and labour force is available. But, local people have not applied science and right techniques; thus, crop yield and animal production are not high. The main income sources for local people are swidden fields, forest plantation and rubber plantation. Other production activities such as livestock grazing are at small scale. Paddy field cultivation and NTFPs harvesting involves great participation of local people, but economic efficiency is not high. During their free time, people usually work for other households, mostly in planting and harvesting of forest products.

Table 10: Participation of households in different livelihood options

Income source	Percentage	
	Yes	No
Paddy field	73.0	27.0
Plantation forest	78.4	21.6
Livestock grazing	54.1	45.9
Husbandry grazing	43.2	56.8
Fishery and aquaculture	2.7	97.3
Swidden cultivation	83.8	26.2
Rubber plantation	64.9	35.1
NTFP harvesting	32.4	67.6
Small business	2.7	97.3
Wage labour	24.4	74.6

Factors affecting the adaptability of local people

Running the multi-regression analysis, it was observed that the adaptability of local people depended on the economic condition of the household (the better-off household has higher adaptability compared with the poor ones) and

the role of natural forest with household livelihoods (the higher the role, the lower the adaptability of local people). Moreover, poor households suffered the most from the impact of climate change.

Table 11: Coefficients^{a,b} of the multi-regression models

Model	U. C.		S. C.	t	Sig.
	B	Std. Error	Beta		
Household income	4.391	.331	.943	13.262	.000
Household income	6.698	.779	1.438	8.600	.000
Dependency on natural forest	-1.396	.440	-.530	-3.172	.005

U.C. = Unstandardized Coefficients

S.C. = Standardized Coefficients

a. Dependent Variable: Adaptive capability

b. Linear Regression through the Origin

In comparison with other regions within the Tam Giang Lagoon in Thua Thien Hue province (Suu *et al.* 2010), we found that the traditional knowledge of local people in Huong Son commune regarding agricultural production, climate change adaptation and coping with natural disasters was poor.

CONCLUSION

We found that the fluctuations in climate conditions have a clear impact on the life of the Katu ethnic people in Huong Son commune, Nam Dong District of Thua Thien Hue Province of Vietnam. The local people are trying their best to adapt to and cope with those changes through their daily livelihood activities and cultivation practices. They have been changing their agricultural production activities: seasonal calendar, cultivation techniques, vaccination, pest and disease prevention measures and new farming

techniques. The higher the local people's awareness on climate change, the higher is the effectiveness and efficiency of prevention and control measures against climate change impacts and natural disasters. However, it is really difficult to establish a clear link of environmental changes with climate change. Some changes are indirect effects of climate change; for example, with greater prevalence of diseases and pests, local people changed their livestock grazing pattern. The changes in indirect responses to climate change are number of livestock and husbandry, crop composition as well as other daily production activities.

Most of the adaptation activities of local people are autonomous adaptation. They draw on the lessons from their own experiences or learn from each other. No programmes were being implemented by the government or local authorities in the study area to help local people adapt to climate change. The biggest concern of the government is about the coastal area, where the impacts of the climate change are much more serious. There are a number of climate change adaptation programmes and projects as well as support along the coastal area of Thua Thien Hue province.

Local people are getting keener to learn about measures to reduce risks and impact of climate change to apply them in their daily activities and production. That would help them step by step to safeguard their lives and their production.

Natural resources play important roles in providing materials for production, improving household income and reducing the risk of natural disasters. However, these resources are gradually degraded and difficult to restore due to ineffective management of forest and soil resources.

There are several factors affecting climate change vulnerability of household and community: wealth conditions, forest dependency. We found that households

dependant on forest resources are more vulnerable to climate change. In addition, the poor and degraded conditions of the allocated community forest make people ignore their forest resource. Community forests were put at the lowest priority in climate change adaptation strategies. Local people are mostly concerned about agricultural production and livestock grazing because they are much more vulnerable compared to the resilience of the natural forest. In addition, assets and infrastructure development, health and nutrition of the local people, diversity in their livelihood options and education, as well as access of local people to the mass media or educational programmes, also contribute to their vulnerability.

In order to increase the adaptability of the local people in the Huong Son commune, it is necessary to better manage natural forest, conserve water resources and implement flood control measures. Second, poverty reduction and diversification of livelihoods will help them to become more climate-resilient. Third, there should be in-depth research to measure and monitor climate variables and see how it actually affects livelihoods and how negative impacts could be mitigated over the long term. Fourth, there is a need for training and awareness raising on climate change in the vulnerable areas, such as through regular discussions between local people, local authorities and experts on climate change, in order to work out on the most suitable adaptation measures for the region. Finally, it is also necessary to document and communicate applicable traditional knowledge of predicting climatic events, natural disasters and adaptive measures.

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